NISAR L&S Band Level-1 & Level -2

Data Product Format Document

Version 1.2.1

By

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Document Change History

A: Addition**; M:** Modification**; D:** Deletion

Version Number	Date	Section Number	A/M/D	Description
Ver 1.0	27/06/2024	All	-	First Version
Ver 1.1	14/08/2024	All	A	Attributes of few datasets were modified
Ver 1.1.1	31/01/2025	All	M	Attributes of few datasets modified
Ver 1.2.1	21/04/2025	All	A+M	Please Refer Table Version 1.2.1

Product Name	Changes / Modifications/ Deletions Details
RSLC	In calibration group changed the elevationAntennaPattern from dataset to group. Changed the dataset nesz to noiseEquivalentBackscatter. Added dataset rfiLikelihood in calibration group.
GSLC	Added longitude_of_central_meridian and scale_factor_at_central_meridial in projection dataset. Updated scription of mask. In calibration group changed the elevationAntennaPattern from dataset to group. Changed the dataset nesz to noiseEquivalentBackscatter. Added dataset rfiLikelihood in calibration group. Added the group geocoding in group parameters of processingInformation. Added group timingCorrections in processingInformation. Added dataset tecFiels in group inputs. Added group ceosAnalysisReadyData in group metadata.
GCOV	Added longitude_of_central_meridian and scale_factor_at_central_meridial in projection dataset. Updated description of mask. In calibration group changed the elevationAntennaPattern from dataset to group. Added dataset rfiLikelihood in calibration group. Added datasets productDoi and productGemotery in sourceData group. Added few datasets in sourceData/swaths/ group. Added groups preProcessing, geocoding and rtc in processingInformation. Added dataset tecFiels in group inputs. Added group ceosAnalysisReadyData in group metadata. Changed the dataset rfiCorrection to rfiMitigation.
RIFG	Added the layer dem, mask for the interferogram, and offset group. Added orbit and attitude of the secondary RSLC. Added information corresponding to the the no of range and scan lines of primary and secondary RLSC's. Modified the location of sceneCentreAlongTrackSpacing and sceneCentreGroundRangeSpacing. Added the dataset temporalBaseline in orbit group.
RUNW	Added the layer dem, mask for the interferogram, and offset group. Added orbit and attitude of the secondary RSLC. Added information corresponding to the the no of range and scan lines of primary and secondary RLSC's. Modified the location of sceneCentreAlongTrackSpacing and sceneCentreGroundRangeSpacing. Added the dataset temporalBaseline in orbit group. Added the dataset losDeformation in the interferogram group.
GUNW	Added the layer mask for the interferogram (wrapped and unwrapped), and offset group. Added orbit and attitude of the secondary RSLC. Added information corresponding to the the no of range and scan lines of primary and secondary RLSC's. Modified the location of sceneCentreAlongTrackSpacing and sceneCentreGroundRangeSpacing. Added the dataset temporalBaseline in orbit group. Added the dataset losDeformation in the interferogram group.

ROFF	Added the layer dem, mask for the offset group. Added orbit and attitude of the secondary RSLC. Added information corresponding to the the no of range and scan lines of primary and secondary RLSC's. Modified the location of sceneCentreAlongTrackSpacing and sceneCentreGroundRangeSpacing. Added the dataset temporalBaseline in orbit group.
GOFF	Added the layer mask for the offset group. Added orbit and attitude of the secondary RSLC. Added information corresponding to the the no of range and scan lines of primary and secondary RLSC's. Modified the location of sceneCentreAlongTrackSpacing and sceneCentreGroundRangeSpacing. Added the dataset temporalBaseline in orbit group.
COMMON	In Identification group added datasets productDoi, platformName, isFullFrame, compositeReleaseId, isJointObservation. Updated the description of the dataset boundingPolygon. Added interpMethod in Orbit group. Updated the description of attitudeType and orbitType

Dcoument Change Details for Version 1.2.1

Contents

ACRONYMS AND ABBREVIATIONS

NISAR - NASA ISRO SYNTHETIC APERTURE RADAR

IMGEOS - INTEGARTED MULTI-MISSION GROUND SEGMENT FOR EARTH OBSERVATION SATELLITE

DPGS - DATA PRODUCTS GENERATION SYSTEM

NSRC - NATIONAL REMOTE SENSING CENTRE

SAR - SYNTHETIC APERTURE RADAR

PRI - PULSE REPETITION INTERVAL

PRF - PULSE REPETITION FREQUENCY

TRIM - TRANS RECEIVE INTEGRATED MODULE

PSLR - PEAK TO SIDELOBE RATIO

ISLR - INTEGRATED SIDELOBE RATIO

RCM - RANGE CELL MIGRATION

RCMC - RANGE CELL MIGRATION CORRECTION

RDA - RANGE DOPPLER ALGORITHM

RRST - RADAR RAW SCIENCE TELEMETRY

CRSD - CALIBRATED RAW SIGNAL DATA

RRSD - RADAR RAW SIGNAL DATA

RSLC - RANGE DOPPLER SINGLE LOOK COMPLEX

RUNW - RANGE DOPPLER UNWRAPPED INTERFEROGRAM

ROFF - RANGE DOPPLER PIXEL OFFSET

GSLC - GEOCODED SINGLE LOOK COMPLEX

GUNW - GEOCODED UNWRAPPED INTERFEROGRAM

GCOV - GEOCODED POLARIMETRIC COVARIENCE

GOFF - GEOCODED DOPPLER PIXEL OFFSET

BAQ	- BLOCK ADAPTIVE QUANTIZATION
BFPQ	- BLOCK ADAPTIVE FLOATING POINT QUANTIZATION
SWST	- SAMPLING WINDOW START TIME
MOE	- MEDIUM FIDELITY ORBIT EPHEMERIS
NOE	- NEAR TIME FIDELITY ORBIT EPHEMERIS
POE	- PRECISE FIDELITY ORBIT EPHEMERIS
NRT	- NEAR REAL TIME TARGETS
DEM	- DIGITAL ELEVATION MODEL
ECMWF	- EUROPEAN CENTRE FOR MEDIUM RANGE WEATHER FORECAST
UTM	- UNIVERSAL TRASNVERSE MERCATOR
HDF5	- HIERARCHIAL DATA FORMAT 5
ECEF	- EARTH CENTRED EARTH FIXED
PLC	- PAYLOAD CONTROLLER
DACS	- DATA ACQUISITION SYSTEM
SDP	-SCIENCE DATA PRODUCT

CHAPTER-1
Introduction

1 Introduction

1.1 Purpose of the Document

This document provides the data format details of all Level-1 and Level-2, L & S Band HDF-5 NISAR products generated by ISRO. For the purpose of harmonization, ISRO and JPL generated Level-1 and Level-2 data products formats are hormonzied with similar product structure and format (HDF5).To meet requirements of ISRO Science team, few additions has been done in the format. This document specifies those additions along with the common data product format.

The JPL product format and naming convention documents referred are listed here:

1) ***NISAR Science Data Systems (SDS) L-SAR Product File Naming Conventions Rev A Working Version 3.2 JPL D-102255 03/02/20223.***
2) ***NASA SDS Product Specification Level-1 Range Doppler Single Look Complex L1 RSLC Rev C JPL D-102268 Feburary 7, 2024, Version 1.1.0***
3) ***NASA SDS Product Specification Level-2 Geocoded Single Look Complex L2_GSLC Rev C JPL D-102269 Feburary 7, 2024, Version 1.1.0***
4) ***NASA SDS Product Specification Level-2 Geocoded Polarimetric Covariance L2_GCOV Rev C JPL D-102274 Feburary 7, 2024, Version 1.1.0***
5) ***NASA SDS Product Specification Level-1 Range Doppler Wrapped Interferogram L1_RIFG Rev C JPL D-102270 Feburary 7, 2024, Version 1.1.0***
6) ***NASA SDS Product Specification Level-1 Range Doppler UnWrapped Interferogram L1_RUNW Rev C JPL D-102271 Feburary 7, 2024, Version 1.1.0***
7) ***NASA SDS Product Specification Level-2 Geocoded Unwrapped Interferogram L2_GUNW Rev C JPL D-102272 Feburary 7, 2024, Version 1.1.0***
8) ***NASA SDS Product Specification Level-1 Range Doppler Pixel Offsets L1_ROFF Rev A JPL D-105009 Feburary 7, 2024, Version 1.1.0***
9) ***NASA SDS Product Specification Level-2 Geocoded Pixel Offsets L2_GOFF Rev A JPL D-105010 Feburary 7, 2024, Version 1.1.0***

1.2 NISAR Introduction

NASA-ISRO SAR (NISAR) is a joint L & S Band SAR mission in which S-Band SAR instrument is developed by ISRO while NASA has developed L-Band SAR instrument. It is the first earth bound Dual frequency SAR mission with parabolic reflector-based antenna. It is capable of acquiring wide swath high-resolution SAR images in Stripmap mode with the help of a novel concept called as SweepSAR imaging. Conflicting requirements of high resolution and wide swath imaging results in blind range gaps in receive data window. Blind Range Gaps are distributed in the image with the help of PRI staggering. NISAR is capable of acquiring datasets in L-only, S-only and in Joint Mode (L+S) with various bandwidth and polarization combinations. Major mission and instrument characteristics of NISAR are given in Table 1-1.

Parameters	S-band	L-band
Orbit	747 km with 98° inclination	
Repeat Cycle	12 days	
Time of Nodal Crossing & Look Direction	6 AM / 6 PM & Left Look	
Frequency	3.2 GHz ± 37.5 MHz	1.2575 GHz ± 40 MHz
Available Polarimetric Modes	Single Pol (SP): HH or VV Dual Pol (DP): HH/HV or VV/VH Compact Pol (CP): RH/RV Quasi-Quad Pol (QQP): HH/HV and VH/VV	SP: HH or VV DP: HH/HV or VV/VH CP: RH/RV Quad Pol (QP): HH/HV/VH/VV Quasi Dual: HH/VV Quasi Quad Pol (QQP): HH/HV and VH/VV
Available Range Bandwidths	10 MHz, 25 MHz, 37.5 MHz, 75 MHz	5 MHz, 20 MHz, 40 MHz, 80 MHz (Additional 5 MHz Auxiliary Band for 20 & 40 MHz modes at other end of pass-band)
Swath Width	> 240 Km	> 240 Km (except for 80MHz BW-Half swath)
Spatial Resolution	7m (Az.); 3m-24m (Slant-Ra)	7m (Az.); 3m-48m (Slant-Ra)
Incidence Angle Range	33° – 47°	33° – 47°
Noise Equivalent Sigma Zero	-25 dB (except 75MHz Mode)	-25 dB (for required full-swath modes)
Ambiguities	< -20dB for all modes except QQP	< -23dB swath average in SP or DP modes < - 17dB swath average in QP mode

Pointing control	< 273 arc seconds
Orbit control	< 350 meters
Data and Product Access	Free & Open *https://bhoonidhi.nrsc.gov.in*

Table 1-1 Major Mission and Instrument Characteristics of NISAR

1.3 NISAR Data Products

NISAR will operate in L and S band with Single, Dual, Circular, QQP and Quad Polarization(LSAR only) combinations. NISAR Data Products Generation System (DPGS) will have following three main levels of processing and corresponding product types from Level-0 to Level2. However, higher level of science/information products (Level-3/4) are also planned to be generated operationally. Details regarding Level-0B product and higher level of products is out of scope of this document.

I. Level-0: Raw signal product
II. Level-1: Geo-Tagged product
III. Level-2: Terrain Geo-Referenced product
IV. Level-3/4: Higher Level Science/Information Products

Level-0 to Level-2 products are further categorized as per the Table 1-2 and

Figure 1-1.

Product	Level	Scope	Description
Radar Raw Science Telemetry (L0A) (RRST)	L0A	Global	L0A product is the raw downlinked data. It is not a user product and hence unavailable for dissemination.
Radar Raw Signal Data (L0B) (RRSD)	L0B	Global	L0B product is corrected, aligned radar pulse data derived from the RRST products and used for further processing.
Radar Single Look Complex (RSLC)	L1	Global	The L1 RSLC product contains focused SAR images in range-Doppler coordinates. The RSLC is input to other L1 or L2 products
Range Doppler Wrapped Interferogram (RIFG)	L1	Antarctica, Greenland, and selected mountain glaciers. Nearest pair in time and co- pol channels only.	Multi-looked interferogram in range-Doppler coordinates, ellipsoid and topographic phase flattened and formed with precise coregistration using geometrical offsets and high-resolution pixel offsets obtained from incoherent

			cross-correlation
Range Doppler UnWrapped Interferogram (RUNW)	L1	Antarctica, Greenland, and selected mountain glacers. Nearest pair in time and co-pol channels	Multi-looked, ellipsoid and topography flattened unwrapped interferogram in Range Doppler coordinates.
Range Doppler Pixel Offsets (ROFF)	L1	Antarctica, Greenland, and selected mountain glaciers. Nearest pair in time and co- pol channels only.	Unfiltered and unculled layers of pixel offsets in Range Doppler coordinates with different resolutions obtained from incoherent cross correlation.
Geocoded Single Look Complex (GSLC)	L2	Global and all channels.	Single Look Complex SAR image on geocoded map coordinate system.
Geocoded Unwrapped Interferogram Product (GUNW)	L2	Global. Nearest pair in time and co-pol channels only.	Geocoded, Multi-looked, ellipsoid and topography flattened unwrapped interferogram.
Geocoded Polarimetric Covariance (GCOV)	L2	Global and all channels. Single/Dual/Quad pol.	Geocoded, multi-looked polarimetric covariance matrix.
Geocoded Pixel Offset Product (GOFF)	L2	Antarctica, Greenland, and selected mountain glaciers. Nearest pair in time co-pol channels only	Unfiltered and unculled layers of pixel offsets with different resolutions obtained from incoherent cross correlation and geocoded on map coordinate system.

Table 1-2 NISAR L0-L2 Data Products

Note: Nearest Pair are those scenes (Track-Frame) which has compatible mode acquired 12 days (1 cycles) apart. In the case of unavailability of compatible mode in previous cycle, earlier cycle is used.

NISAR data products generation workflow given in Figure 1-1. L0B products and are used to generate RSLC products, which in-turn used to generate GSLC and GCOV products. Current and nearest time RSLC is used to generate InSAR products (RIFG/RUNW/GUNW). In Antarctica, green land and selected mountain glaciers, Level-1 InSAR and offset products will be generated (RIFG/RUNW/ROFF/GOFF). GUNW prodcuts will be generated globally except oceans.

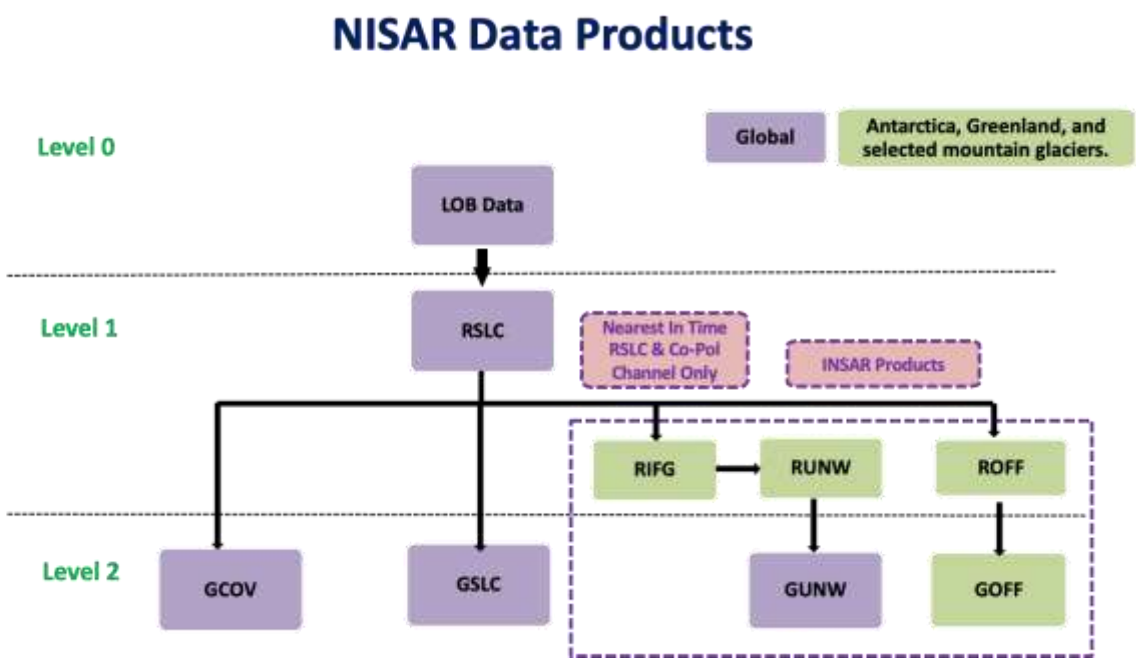


Figure 1-1: NISAR Data Products Generation workflow

To maintain harmonization, ISRO is having the same nomenclature and product definitions as described by NASA for L-Band products. Except RRST (Level-0A) product, all products will be available to the users. RRSD (L0B) product is used to generate Level-1 products, which are further used to generate Level-2 products. The Chapter 5 to Chapter 12 describe in detail the data product format and content of all Level-1 and Level-2 products. The Data Products specifications are given in Table 1-3.

SN	Specifications	L-Band	S-Band	Remarks
1	Geometric accuracy	~20m	~10m	Ionosphere Effect
2	Radiometric Accuracy	±1.5dB	±1.5 dB	
3	PSLR	<-13dB	<-13dB	
4	ISLR	<-7dB	<-7dB	

5	Slant Resolution (pixels)	1.2P	1.2P	P Changes with chirp Bandwidth
6	Phase accuracy	±15 degree	±15 degree	
7	Polarisation / L+S Registration	Sub Pixel	Sub Pixel	

Table 1-3 Data Product Specifications

In NISAR Geocoded SLC (GSLC) products are being provided instead of Geocoded detected products, enabling users to perform amplitude as well as phase analysis directly on a geocoded grid. In addition to this, interferometric (GUNW) and polarimetric (GCOV) products are also provided in geocoded domain. Offset products for pre-defined geographical areas are also planned in radar and map coordinates.

The data products are generated scenewise (Track-Frame) with scene size of ~ 240 X 240 km (refer section 2.2.7). The volume of each product for S-Band and L-Band is given in Table 1-4 and Table 1-5 respectively.

Product Short Name	Product Long Name	Product Type	Scene Spacing (m*m)	Estimated Avg. Daily Volume (TB/day)	Estimated Volume In an Year (PB)	Estimated Volume In 5 Year (PB)
L1_S_RSLC	Level 1 S-SAR background single look complex data product	SDP	Native	3.57	1.26	6.28
L1_S_RIFG	Level 1 S-SAR interferogram data product	SDP	30*30	0.34	0.12	0.6
L1_S_RUNW	Level 1 S-SAR unwrapped	SDP	80*80	0.04	0.02	0.07

	interferogram product					
L1_S_ROFF	Level 1 S-SAR range doppler offset product	SDP	37.5 MHZ :: (12 sample* 15 sample) 25 MHZ :: (8 sample* 15 sample)	0.178 5	0.063	0.314
L2_S_GSLC	Level 2 S-SAR geocoded single look complex data product	SDP	10MHZ: 20*5 25 MHZ: 10*5 37.5 MHz: 5*5 75 MHz: 2.5*5	4.56	1.61	8.01
L2_S_GCOV	Level 2 S-SAR geocoded polarimetric covariance product	SDP	20*20	1.03	0.36	1.8
L2_S_GUNW	Level 2 S-SAR geocoded unwrapped Interferogram	SDP	80*80	0.08	0.03	0.14
L2_S_GOFF	Level 2 S-SAR geocoded offset product	SDP	37.5 MHZ :: (12 sample* 15 sample) 25 MHZ :: (8 sample* 15 sample)	0.178 5	0.063	0.314
TOTAL				11.8	4.186	20.828

Table 1-4 Product Volume for S-Band Products

Product Short Name	Product Long Name	Product Type	Scene Spacing (m*m)	Estimated Avg. Daily Volume (TB/day)	Estimated Volume In an Year (PB)	Estimated Volume In 5 Year (PB)
L1_L_RSLC	Level 1 L-SAR background single look complex data product	SDP	Native	4.26	1.5	7.49
L1_L_RIFG	Level 1 L-SAR interferogram data product	SDP	30*30	0.4	0.14	0.7
L1_L_RUNW	Level 1 L-SAR unwrapped interferogram product	SDP	80*80	0.05	0.02	0.08
L1_L_ROFF	Level 1 L-SAR range doppler offset product	SDP	80 MHZ :: (30 sample* 15 sample) 40 MHZ :: (15 sample* 15 sample)	0.21	0.075	0.37
L2_L_GSLC	Level 2 L-SAR geocoded single look complex data product	SDP	5MHZ: 25*5 20+5 MHZ: 10*5 40+5: 5*5 80MHz: 2.5*5	5.76	2.03	10.12

L2_L_GCOV	Level 2 L-SAR geocoded polarimetric covariance product	SDP	20*20	1.36	0.48	2.39
L2_L_GUNW	Level 2 L-SAR geocoded unwrapped Interferogram	SDP	80*80	0.07	0.03	0.12
L2_L_GOFF	Level 2 L-SAR geocoded offset product	SDP	80 MHZ :: (30 sample* 15 sample) 40 MHZ :: (15 sample* 15 sample)	0.21	0.075	0.37
TOTAL				17.1	6	30.04

Table 1-5 Product Volume for L-Band Products

1.4 Differences between ISRO generated and JPL generated products.

For harmonization, ISRO is aiming to generate L&S Band products as per the product format provided by JPL for L-Band products. However, to cater to the science community requirements few additions have been done in certain products. These additions with description and scope of products has been detailed in Table 1-6.

Parameter Description	JPL Product Format	Products in which modification is done	Remarks
Extra layer of metadata cube is provided in the product, which is generated at true height.	Metadata Cube is provided at specific fixed heights.	All Products	This is done to provide user ease of doing geolocation analysis, without the necessity of having a DEM.

Addition of rtcGammaToSigmaFactor Per pixel layer.	Provided in GCOV product only.	GSLC	ISRO generated GSLC product is RTC corrected. Hence, the DN is in Gamma0 plane. This layer is provided to generate Sigma0 from Gamma0.
Addition of attributes to provide pixel & azimuth spacing & sampling for all 2D LUT's.		All Products	For datasets that are at coarser spacing than that of image, this information is provided in the attributes of dataset.
Perpendicular and Parallel Baseline for all heights of metadata cube.	Parallel and Perpendicular baselines are provided at only two heights of the metadata cube.	RIFG, RUNW,GUNW, ROFF and GOFF	To maintain consistency of all datasets in metadata cube, Parallel and Perpendicular are provided for all heights.

Table 1-6 Additions in ISRO L&S Band Product format wrt to JPL Product format.

CHAPTER-2

Product Contents

2 Product Contents

This chapter describes briefly about the product contents of all Level-1 and Level-2 Products, the directory structure in which products will be available along with the description about the naming convention of product. It also gives a brief introduction about the HDF-5 product format.

2.1 Product Directory Structure

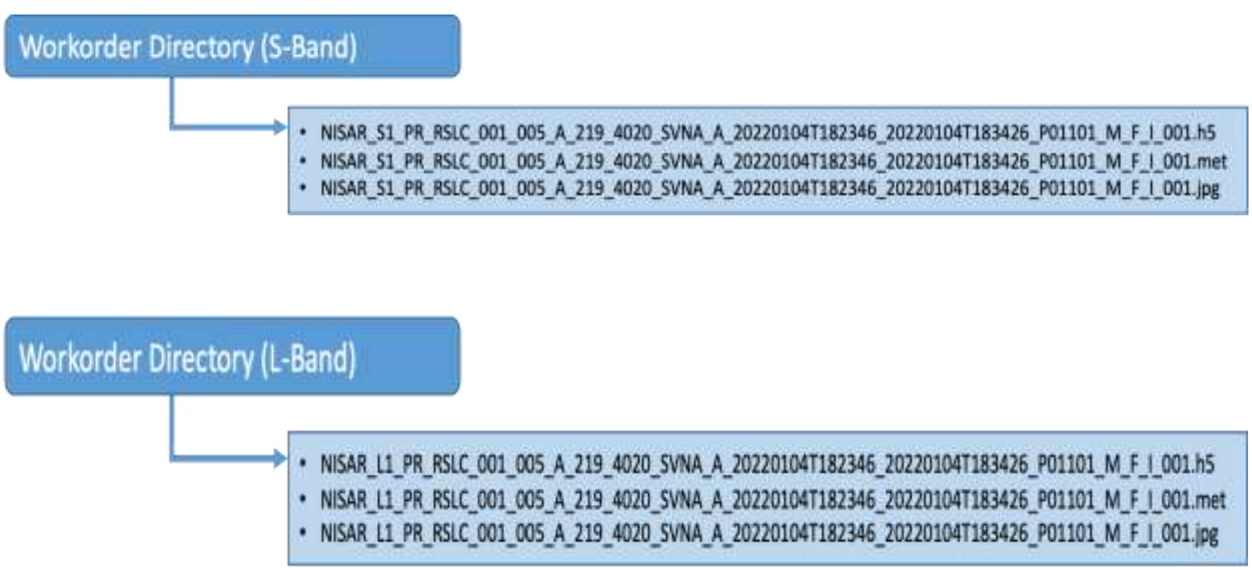
The ISRO L & S Band products (e.g. for Joint mode L+S acquisition) will be generated in different .h5 files corresponding to the respective Band for a given scene covering the same geographical area. For a given area, frequency band (L or S) and type of products (among all eight Level-1 and Level-2 products) will be based on the track frame database. A unique "Filename" which is described in section 2.2 will identify each product. All the files in the product- "Filename" directory will be having the same name, but the extension will change as per the type of file (.h5, .met, .jpg).

The following are the files that will be available inside the "Filename" directory.

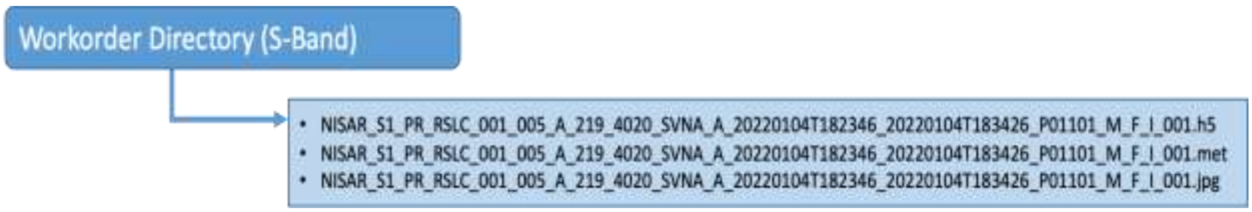
1. Filename.h5 – It is the HDF-5 file containing all the information of the product, video data, orbit, attitude and other Meta information.
2. Filename.met – It is a JSON file, containing the auxiliary information of the product, like date of generation, frame number, track number, etc. for the identification of product.
3. Filename.jpg – It is a JPEG file, for the browse image of the product video data.

An example directory structure along with the file contents are shown in Figure 2-1. The example taken here is for RSLC product, the same holds true for all product types. Here, the workorder represents the trigger given by the data product generation center. The workorder directory is generated corresponding to that trigger.

For Joint Mode



For S Only Mode



For L Only Mode

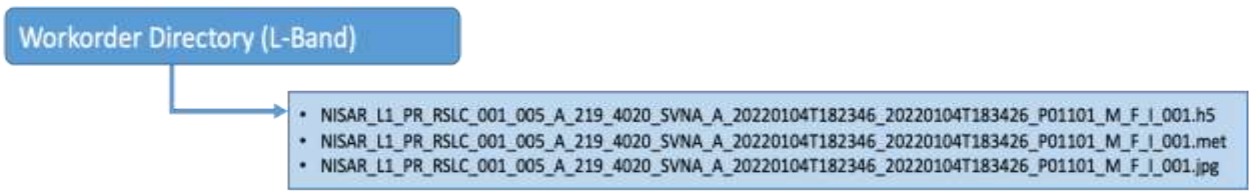


Figure 2-1 Directory Structure of NISAR products.

In case of Joint mode, where all eight products per frequency band are to be generated, 16 product directories will be formed. The sample filenames for a joint mode case are listed here:

- NISAR_S1_PR_RSLC_022_022_D_023_2800_SHNA_A_20081127T060959_20081127T061015_T00000_M_F_I_000.h5
- NISAR_S2_PR_GSLC_022_022_D_023_2800_SHNA_A_20081127T060959_20081127T061015_T00000_M_F_I_000.h5
- NISAR_S2_PR_GCOV_022_022_D_023_2800_SHNA_A_20081127T060959_20081127T061015_T00000_M_F_I_000.h5
- NISAR_S1_PR_RIFG_013_011_A_015_013_2800_SH_20081012T060910_20081012T060926_20081127T060959_20081127T061015_T00000_M_F_I_001.h5
- NISAR_S1_PR_RUNW_013_011_A_015_013_2800_SH_20081012T060910_20081012T060926_20081127T060959_20081127T061015_T00000_M_F_I_001.h5
- NISAR_S2_PR_GUNW_013_011_A_015_013_2800_SH_20081012T060910_20081012T060926_20081127T060959_20081127T061015_T00000_M_F_I_001.h5
- NISAR_S1_PR_ROFF_123_000_D_000_123_4000_SH_20081012T060910_20081012T060926_20081127T060959_20081127T061015_T00000_M_F_I_001.h5
- NISAR_S2_PR_GOFF_123_000_D_000_123_4000_SH_20081012T060910_20081012T060926_20081127T060959_20081127T061015_T00000_M_F_I_001.h5
- NISAR_L1_PR_RSLC_022_022_D_023_2800_SHNA_A_20081127T060959_20081127T061015_T00000_M_F_I_000.h5
- NISAR_L2_PR_GSLC_022_022_D_023_2800_SHNA_A_20081127T060959_20081127T061015_T00000_M_F_I_000.h5
- NISAR_L2_PR_GCOV_022_022_D_023_2800_SHNA_A_20081127T060959_20081127T061015_T00000_M_F_I_000.h5
- NISAR_L1_PR_RIFG_013_011_A_015_013_2800_SH_20081012T060910_20081012T060926_20081127T060959_20081127T061015_T00000_M_F_I_001.h5
- NISAR_L1_PR_RUNW_013_011_A_015_013_2800_SH_20081012T060910_20081012T060926_20081127T060959_20081127T061015_T00000_M_F_I_001.h5
- NISAR_L2_PR_GUNW_013_011_A_015_013_2800_SH_20081012T060910_20081012T060926_20081127T060959_20081127T061015_T00000_M_F_I_001.h5

- NISAR_L1_PR_ROFF_123_000_D_000_123_4000_SH_20081012T060910_20081012T060926_20081127T060959_20081127T061015_T00000_M_F_I_001.h5
- NISAR_L2_PR_GOFF_123_000_D_000_123_4000_SH_20081012T060910_20081012T060926_20081127T060959_20081127T061015_T00000_M_F_I_001.h5

2.2 File Naming Convention

This section describes the file naming convention for all Level-1 and Level-2 Products. The Interferometric products contain information corresponding to the two RSLC's pair and hence have a file naming convention different from basic RSLC, GSLC and GCOV data products .The following sections describes the file naming format for both basic products and interferometric products. [1]

2.2.1 File Naming format for RSLC, GSLC and GCOV

Syntax:

NISAR_*IL_PT_PROD_CYL_REL_P_FRM_MODE_POLE_S_StartDateTime_EndDateTime_CRID_A_C_LOC_CTR*.EXT

Where:

NISAR – 5 char for mission: **NISAR**

I – 1 char for Instrument: **L** for L-SAR, **S** for S-SAR

L – 1 char for Level: **1** or **2** or **3**

PT – 2 char for Processing Type:

PR – Production or Nominal

UR – Urgent Response

PROD – 4 chars for Product Identifier: **RSLC, GSLC, GCOV,**

CYL – 3 chars for CYcLe number in the mission, each cycle represents 12 days, zero padded, starting at 001. Refer Section 2.2.7

REL – 3 chars for RELative orbit track number within a cycle, resets to 1 with a cycle number increment, zero padded. Valid values: 001-173. Refer Section 2.2.7

P – 1 char for direction of movement of the satellite at the time of imaging

A for Ascending

D for Descending

FRM – 3 chars for track frame number, a segment of an orbital track corresponding to the product, zero padded Valid Values: 001-176 on each track. Refer Section 2.2.7

MODE – 4 chars for Bandwidth Mode Code of Primary and Secondary Frequency Bands:

For L-Band the Bandwidth combinations for frequency A or frequency B, are 80,40,20, 05, 00 and for S-Band the Bandwidth combinations for Frequency A are 75,37,25,10, for Frequnecy B "00" will be used for secondary frequency bands characters as frequency B is not present in S-Band.

POLE – 4 chars for Polarization of the data for the Primary and Secondary frequency bands. Each band uses a two-character code among the following:

SH = HH – Single Polarity (H transmit and receive)

SV = VV – Single Polarity (V transmit and receive)

DH = HH/HV – Dual Polarity (H transmit)

DV = VV/VH – Dual Polarity (V transmit)

CL= LH/LV – Compact Polarity (Left transmit)

CR = RH/RV – Compact Polarity (Right transmit)

QP = HH/HV/VV/VH – Quad Polarity

NA if band does not exist

For example, a "quasi-quad" polarization mode would be noted DHDV while a "quasi-dual" polarization mode would be noted SHSV.

In S-Band, since only Primary band is present, the last two characters of polarization mode will always be NA. For example for HH polarization the polarization mode will be SHNA.

S – 1 char for source of data for the product

A = Acquired source of the observation, single mode

M = Mixed source of observations, mixed mode

StartDateTime – 15 chars for Radar Start Time of the data processed as zero Doppler contained in the file as YYYYMMDDTHHMMSS, UTC

EndDateTime – 15 chars for Radar End Time of the data processed as zero Doppler contained in the file as YYYYMMDDTHHMMSS, UTC

CRID – 6 chars for Composite Release Identifier Format of EPMMmm. Refer Section 0.

A – 1 char for Product Accuracy or Fidelity of the Orbit Ephermis and Radar Pointing

P - POE, **M- MOE**, **N - NOE**, or **F- FOE**. Refer Section 2.2.4

C – 1 char as Coverage Indicator: **F** for Full or **P** for Partial. Refer Section 2.2.5

LOC – 1 char to represent the location of the Product generation. I for ISRO, J for JPL

CTR – 3 chars for Product Version. Refer Section 2.2.6

EXT – 1 to n chars for Extension: **h5, met, jpg**

NOTES:

17 spacing characters: 16 for underscores plus one period

Total number of characters: **91** excluding extension

2.2.2 File Naming Format for Interferometry Products (RIFG, RUNW, GUNW, ROFF and GOFF)

Syntax:

NISAR_*IL_PT_PROD_CYL_REL_P_FRM_SCY_MODE_PO_RefStartDateTime_RefEndDateTime_SecStartDateTime_SecEndDateTime_CRID_A_C_LOC_CTR.EXT*

Where:

NISAR – 5 char for mission: **NISAR**

I – 1 char for Instrument: **L** for L-SAR, **S** for S-SAR

L – 1 char for Processing Level: **1** or **2**

T – 2 char for Processing Type:

PR – Production

UR – Urgent Response

PROD – 4 chars for Product ID: RIFG, RUNW, GUNW, ROFF, GOFF

CYL – 3 chars for CYcLe number in the mission, each cycle represents 12 days, zero padded, starting at 001. Refer Section 2.2.7

REL – 3 chars for RELative orbit track number within a cycle, resets to 1 with a cycle number increment, zero padded.Valid values: 001-173. Refer Section 2.2.7

P – 1 char for direction of movement of the satellite at the time of imaging.

A for Ascending

D for Descending

FRM – 3 chars for track frame number, a segment of an orbital track corresponding to the product, zero padded. Valid Values: 001-176 on each track. Refer Section 2.2.7

MODE – 4 chars for Bandwidth Mode Code of Primary and Secondary frequency Bands:

For L-Band the Bandwidth combinations for frequency A or frequency B, are 40,22,77,05, 00 and for S-Band the Bandwidth combinations for Frequency A are 10, 25, 37, 75, for Frequncey B "00" will be used for secondary frequency bands characters as frequency B is not present in S-Band

SCY – 3 char for the second CYcLe number

PO – 2 chars for Polarization (corresponding to primary Frequency A band):

where the polarization pair notation refers to the transmit and receive polarizations, respectively of the main band and the side band of the reference (e.g., HH refers to H transmit and H receive)

SV = VV - Single Polarity

SH = HH - Single Polarity

DH =HH/HV – Dual Polarity

DV =VV/VH – Dual Polarity

CL **=** LH/LV – Compact Polarity

CR =RH/RV – Compact Polarity

QP =HH/HV/VV/VH – Quad Polarity

QH =HH/HV + VV/VH – Quasi Quad Polarity

QV =VV/VH + HH/HV – Quasi Quad Polarity

QD =HH/VV Quasi Dual Pole

RefStartDateTime – 15 chars for the data from the reference listed cycle contained in the file as YYYYMMDDTHHMMSS, UTC

RefEndDateTime – 15 chars for the data from the reference listed cycle contained in the file as YYYYMMDDTHHMMSS, UTC

SecStartDateTime – 15 chars for the data from the secondary listed cycle contained in the file as YYYYMMDDTHHMMSS, UTC

SecEndDateTime – 15 chars for the data from the secondary listed cycle contained in the file as YYYYMMDDTHHMMSS, UTC

CRID – 6 chars for Composite Release Identifier. For Format of EPMMmm Refer Section 0.

A – 1 char for Product Accuracy or Fidelity of the Orbit Ephermis and Radar Pointing:

P - POE, **M- MOE**, **N - NOE**, or **F- FOE**. Refer Section 2.2.4

C – 1 char as Coverage Indicator: **F** for Full or **P** for Partial. Refer Section 2.2.5

LOC – 1 char to represent the location of the Product Generation. I for ISRO, J for JPL

CTR – 3-digit number for Product Version, zero padded. Refer Section 2.2.6

EXT – 1 to n chars for Extension: **h5, met, jpg.**

NOTES:

19 spacing characters: 18 for underscores plus one period

Total number of chars: **122** excluding extension

2.2.3 CRID (Composite Release Identifier)

- Definition: A version identifier to identify the version of the software and the environment of the software development. It is maintained by ISRO-NISAR Data Product Generation Software, and is part of the filename and part of product for all Level-1 and Level-2 products.

  Format: **EPMMmp**

  E: Environment

  Definition: The environment or venue the product was produced on.

  Format: Single character

  A – ADT

  D – Development

  P – Production

  T – Integration and Test (I&T)

  P: Phase – 1 digit

  First character for mission phase:

  0 for pre-launch (Phase D)

  1 for Primary Science Phase operations, (Phase E)

  2 extended Mission (Phase E)

  3 for post-operations (Phase F), decommissioning, EOM reprocessing

MM: Major Release

Definition: Indicates a major change in a product.

Format: Two numeric digits

- Monotonically increases
- Valid Values: [0…99]
- Reset to zero when there is a change in mission phase

m: Minor Release

Definition: Indicates a *minor* change in a product or any change in the data system.

− Format: One numeric digit

- Monotonically increases
- Valid values: [0-9]
- Reset to zero when Major Release is updated

p: Patch Release

− Definition: Indicates a patch update to a release.

− Format: One numeric digits

- Monotonically increases
- Valid Values: [0…9]
- Reset to zero when Major Release or Minor Release is updated

After the commissioning phase and during the mission duration time of NISAR the Environment will be P and the Phase will be 1.

2.2.4 Product Accuracy

Definition: The *accuracy* or fidelity of the Orbit Ephemeris and Radar Pointing Attitude data used to produce the product indicated by "*A*" in the filename syntax.

Format: Single character

− **P**: Precise accuracy based

Precise Orbit Ephemeris (POE) and Precise Radar Pointing (PRP) used in processing

− **M**: Medium accuracy based,

Medium Orbit Ephemeris (MOE) and Precise Radar Pointing (PRP) used in processing

− **N**: Near Real-Time accuracy based,

Near real-time Orbit Ephemeris (NOE) and Near real-time Radar Pointing (NRP) used in processing

− **F**: Forecast accuracy based,

Forecast Orbit Ephemeris (FOE) and Forecast Radar Pointing (FRP) used in processing

− **T**: Telemetry accuracy based,

Values are from the Science Telemetry HST/DRT fields; used for L0B product processing

2.2.5 Product Coverage

Product Coverage indicates the coverage of a granule, where a granule represents an orbital track-frame. The values are "F" for full coverage and "P" for partial coverage. If 75% of the granule is contained in the product, the coverage is considered to be a full product otherwise it will be marked as partial.

2.2.6 Product Counter

Product Counter is used to version data products that are generated multiple times. The counter starts with 001 and increments for subsequent generation of the same granule of any particular product type. It is reset to 001 upon deployment of a new CRID, or change in product accuracy, or product coverage. Product Counter is referred to as CTR in the file naming conventions. The CTR will be incremented based on full file naming convention which includes the CRID.

Format: three-digit number, leading zero padded.

2.2.7 Cycle, Track, & Frame

The science data collected can be uniquely identified by cycle, track and frame for level 1 and level 2 products.

Repeat Cycle - SAR data collected covering the globe with identical timings and geometry over a 12-day period, and repeated every 12 days. (CYL token).

Orbital Track – A ground track pattern, which lays down swaths on the globe in a non- contiguous order within the 12-day repeat cycle, called an orbital track. There are 173 orbital tracks in 12 days for NISAR. Orbital tracks are referred as relative orbits in the file naming conventions (REL token).

Orbital Track Frame – A 240 x240 km consistent and unique segment of a NISAR orbital track. There are 176 frames within a single NISAR orbital track. (FRM token).

2.3 HDF-5 Product Content Overview

All Level-1 and Level-2 Products will comprise of the product video data, along with other auxiliary information like orbit, attitude, processing information. Figure 2-2 represents the overview of the information available in the HDF-5 product.

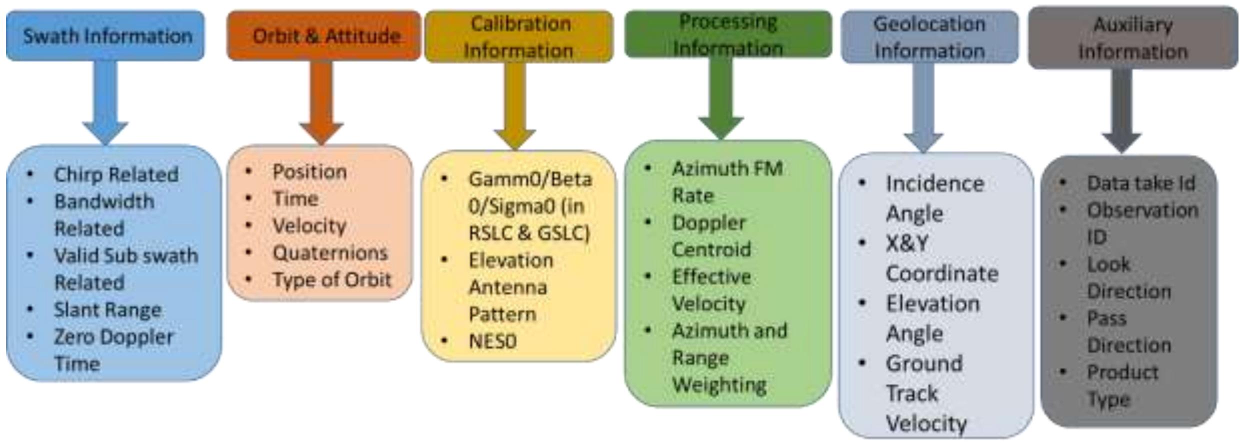


Figure 2-2: Overview of Product Contents of Level-1 & 2 Products

2.4 HDF-5 File Format

All NISAR standard products are in the Hierarchical Data Format version 5 (HDF5).

HDF5 is a general-purpose file format and programming library for storing scientific data. The National Centre for Supercomputing Applications (NCSA) at the University of Illinois developed HDF to help scientists share data more easily. Use of the HDF library enables users to read HDF files regardless of the underlying computing environments. HDF files are equally accessible in Fortran, C/C++, and other high-level computation packages such as IDL, Python or MATLAB.

The HDF Group, a spin-off organization of the NCSA, is responsible for development and maintenance of HDF. Users should refer the HDF Group website at https://portal.hdfgroup.org/display/HDF5/HDF5 to download HDF software and documentation.

HDF5 represents a significant departure from the conventions of previous versions of HDF. The changes that appear in HDF5 provide flexibility to overcome many of the limitations of previous releases. The basic building blocks have been largely redefined, and are more powerful but less numerous. The key concepts of the HDF5 Abstract Data Model are Files, Groups, Datasets, Datatypes, Attributes and Property Lists. The following sections provide a brief description of each of these key HDF5 concepts.

2.4.1 HDF5 File

A File is the abstract representation of a physical data file. Files are containers for HDF5 Objects. These Objects include Groups, Datasets, and Datatypes.

2.4.2 HDF5 Group

Groups provide a means to organize the HDF5 Objects in HDF5 Files. Groups are containers for other Objects, including Datasets, named Datatypes and other Groups. In that sense, groups are analogous to directories that are used to categorize and classify files in standard operating systems.

The notation for files is identical to the notation used for UNIX directories. The root Group is "/".

A Group contained in root might be called "/myGroup." Like UNIX directories, Objects appear in Groups through "links". Thus, the same Object can simultaneously be in multiple Groups.

2.4.3 HDF5 Dataset

The Dataset is the HDF5 component that stores user data. Each Dataset associates with a Dataspace that describes the data dimensions, as well as a Datatype that describes the basic unit of storage element. A Dataset can also have Attributes.

2.4.4 HDF5 Datatype

A Datatype describes a unit of data storage for Datasets and Attributes. Datatypes are subdivided into Atomic and Composite Types.

Atomic Datatypes are analogous to simple basic types in most programming languages. HDF5 Atomic Datatypes include Time, Bitfield, String, Reference, Opaque, Integer, and Float. Each atomic type has a specific set of properties. Examples of the properties associated with Atomic Datatypes are:

- Integers are assigned size, precision, offset, pad byte order, and are designated as signed or unsigned.
- Strings can be fixed or variable length, and may or may not be null-terminated.
- References are constructs within HDF5 Files that point to other HDF5 Objects in the same file.

HDF5 provides a large set of predefined Atomic Datatypes. Table 2-1 lists the Atomic Datatypes that are used in NISAR data products.

HDF5 Atomic Datatypes	Description
H5T_STD_U8LE	unsigned, 8-bit, little-endian integer
H5T_STD_U16LE	unsigned, 16-bit, little-endian integer
H5T_STD_U32LE	unsigned, 32-bit, little-endian integer
H5T_STD_U64LE	unsigned, 64-bit, little-endian integer

H5T_STD_I8LE	signed, 8-bit, little-endian integer
H5T_STD_I16LE	signed, 16-bit, little-endian integer
H5T_STD_I32LE	signed, 32-bit, little-endian integer
H5T_STD_I64LE	signed, 64-bit, little-endian integer
H5T_IEEE_F32LE	32-bit, little-endian, IEEE floating point
H5T_IEEE_F64LE	64-bit, little-endian, IEEE floating point
H5T_C_S1	character string made up of one or more bytes

Table 2-1 Atomic Datatypes

Derived Datatypes are user-defined variants of predefined Atomic Datatypes where the data organization has been modified at the bit-level. Derived data types are particularly useful for representing custom n-bit integers and floating point numbers.

Composite Datatypes incorporate sets of Atomic datatypes. Composite Datatypes include Array, Enumeration, Variable Length and Compound.

The Array Datatype defines a multi-dimensional array that can be accessed atomically.

Variable Length presents a 1-D array element of variable length. Variable Length Datatypes are useful as building blocks of ragged arrays.

Compound Datatypes are composed of named fields, each of which may be dissimilar Datatypes. Compound Datatypes are conceptually equivalent to structures in the C programming language.

Named Datatypes are explicitly stored as Objects within an HDF5 File. Named Datatypes provide a means to share Datatypes among Objects. Datatypes that are not explicitly stored as Named Datatypes are stored implicitly. They are stored separately for each Dataset or Attribute they describe.

NISAR products employ the Derived and Compound Datatypes as mentioned in Table 2-2.

Description	**Comments**
16-bit little-endian floating point	“binary16” half precision type in IEEE 754-2008 standard. Matches numpy. float16 type in Python. We will refer to this type as H5T_IEEE_F16LE or Float16 in our documents.

H5T_COMPOUND { 16-bit little-endian floating-point "r"; 16-bit little-endian floating-point "i"; }	Complex numbers made up of two half precision floating point numbers. We will refer to this type as H5T_CPX_F16LE or CFloat16 in our documents.
H5T_COMPOUND { 32-bit little-endian floating-point "r"; 32-bit little-endian floating-point "i"; }	Complex numbers made of two single precision floating point numbers. We will refer to this type as H5T_CPX_F32LE or CFloat32 in our documents.
H5T_COMPOUND { 64-bit little-endian floating-point "r"; 64-bit little-endian floating-point "i"; }	Complex numbers made of two double precision floating point numbers. We will refer to this type as H5T_CPX_F64LE or CFloat64 in our documents.

Table 2-2 Derived and Compound Datatypes

2.4.5 HDF5 Attribute

An Attribute is a small aggregate of data that describes Groups or Datasets. Like Datasets, Attributes are also associated with a particular Dataspace and Datatype. Attributes cannot be subsetted or extended. Attributes themselves cannot have Attributes.

2.5 NISAR File Organization

2.5.1 Groups

All NISAR HDF5 files are organized as groups with no actual data at the root ("/") level. Table 2-3 Shows the general layout of the HDF5 files that are generated by the ISRO-NISAR Data Product Generation Software. All data are organized under "/science" with data from the L-SAR and S-SAR instruments separated into their own groups.

Group Name	Description
/science/LSAR	All science data from the L-SAR instrument is organized under this group
/science/SSAR	All science data from the S-SAR instrument is organized under this group
/science/[L|S]SAR/identification	File level metadata for cataloging, archiving the particular granule

Table 2-3 Group organization at the top level of a NISAR HDF5 File

In the nominal baseline, L-SAR and S-SAR data will not appear in the same granule, even if they cover the same geographic area. Data structure described below the primary groups

("/science/LSAR" for L-SAR and "/science/SSAR" for S-SAR) will be the same for L-SAR and S-SAR products. ***ISRO will be generating both L& S Band products, but here for the rest of the document from this point on describes the layout of the product containing S-SAR data. The***

same paths will be applicable to L-SAR data as well; only with the change that S-SAR would be replaced by L-SAR.

2.5.2 File Level Metadata

Global metadata at the file level are currently given as Global Attributes shown in Table 2-4.

Metadata regarding the data in the particular granule are given in

"/science/ [L|S] SAR/identification" for L- or S-SAR. These data are described further in following sections.

Attribute	Format	Description
Conventions	string	NetCDF-4 conventions adopted in this product. This attribute should be set to CF-1.8 to indicate that the group is compliant with the Climate and Forecast NetCDF conventions.
title	string	NISAR Level_ProductType Product
institution	string	Name of producing agency.
mission_name	string	"NISAR"
reference_document	string	Name and version of Product Description Document to use as reference for product.
contact	string	Contact information for producer of product. (e.g., "bhoonidhi@nrsc.gov.in").

Table 2-4 Global attributes of all products

2.5.3 Variable Metadata (HDF5 Attributes)

NISAR standards incorporate additional metadata that describe each HDF5 Dataset within the HDF5 file. Each of these metadata elements appear in an HDF5 Attribute that is directly associated with the HDF5 Dataset. Wherever possible, these HDF5 Attributes employ names that conform to the Climate and Forecast (CF) conventions.

Table 2-5 lists the CF names for the HDF5 Attributes that NISAR products typically employ.

Attribute	Description
_FillValue	The value used to represent missing or undefined data. (Before applying add_offset and scale_factor).
add_offset	If present, this value should be added to each data element after it is read. If both scale_factor and add_offset attributes are present, the data are first scaled before the offset is added.
scale_factor	If present, the data are to be multiplied by the value after they are read. If both scale_factor and add_offset attributes are present, the data are first scaled before the offset is added.
comment	Miscellaneous information about the data or the methods to generate it.

coordinates	Coordinate variables associated with the variable. The basename of the coordinate variable is used in this representation and group scoping rules for CF conventions apply.
long_name	A descriptive variable name that indicates its content.
quality_flag	Names of variable quality flag(s) that are associated with this variable to indicate its quality.
units	Unit of data after applying offset (add_offset) and scale_factor.
valid_max	Maximum theoretical value of variable before applying scale_factor and add_offset (not necessarily the same as maximum value of actual data)
valid_min	Minimum theoretical value of variable before applying scale_factor and add_offset (not necessarily the same as minimum value of actual data)

Table 2-5 Common variable attributes in HDF5 file.

Some HDF5 datasets are populated with statistical attributes.Table 2-6 and Table 2-7 describe statistical attributes added to real- and complex-valued HDF5 datasets, respectively.

Attribute	Description
min_value	Minimum value of a real-valued HDF5 dataset
mean_value	Mean value of a real-valued HDF5 dataset
max_value	Maximum value of a real-valued HDF5 dataset
sample_stddev	Sample standard deviation of a real-valued HDF5 dataset

Table 2-6 Statistical attributes for real-valued HDF5 datasets.

Attribute	Description
min_value_real	Minimum value of the real part of a complex-valued HDF5 dataset
mean_value_real	Mean value of the real part of a complex-valued HDF5 dataset
max_value_real	Maximum value of the real part of a complex-valued HDF5 dataset
sample_stddev_real	Sample standard deviation of the real part of a complex-valued HDF5 dataset
min_value_imag	Minimum value of the imaginary part of a complexvalued HDF5 dataset
mean_value_imag	Mean value of the imaginary part of a complex-valued HDF5 dataset
max_value_imag	Maximum value of the imaginary part of a complexvalued HDF5 dataset
sample_stddev_imag	Sample standard deviation of the imaginary part of a complex-valued HDF5 dataset

Table 2-7 : Statistical attributes for complex-valued HDF5 datasets.

2.5.4 Georeferenced HDF-5 Datasets

NISAR L2 products contain georeferenced Datasets where the georeferencing information is provided in accordance with Climate and Forecast 1.7 (CF 1.7) conventions.

CF conventions require a "grid mapping" dataset, which describes the coordinate system associated with the georeferenced Dataset. For NISAR L2 products, this grid mapping is represented by the Dataset "projection", which is included under the same Group as each georeferenced Dataset. Accordingly, each georeferenced Dataset contains an Attribute "grid_mapping", whose value is always hard-coded to the string "projection" as mentioned in Table 2-8.

The value of the "projection" Dataset is set to the European Petroleum Survey Group (EPSG) code of the associated georeferenced Dataset. The "projection" Dataset has Attributes with additional grid mapping information as described in Table 2-9. More information about the projections used to represent NISAR L2 products is provided in Annexure-4: Geocoded Product Grids

In addition to a grid mapping dataset, CF conventions use HDF5 Dimension Scales to associate coordinates to each georeferenced Dataset. The Dimension Scales employed in NISAR L2 products are the "xCoordinates", "yCoordinates", and "heightAboveEllipsoid" Datasets, which represent the horizontal X- and Y-coordinates, and elevation Z-coordinates, respectively, and are located within the same Group as the associated georeferenced Dataset. These are one dimensional (1-D) vectors with lengths matching the associated Dataset's dimensions; each vector element corresponds to the grid-mapping location at the center of the georeferenced array pixels. "heightAboveEllipsoid" is only included for three-dimensional (3-D) georeferenced Datasets.

Attribute	Description	Value
grid_mapping	Grid mapping Dataset name	projection

Table 2-8 Geolcoation attributes for georeferenced HDF-5 Datasets

Attribute	Description
ellipsoid	Projection ellipsoid
epsg_code	Projection EPSG code
false_easting	The value added to all abscissa values in the rectangular coordinates for a map projection
false_northing	The value added to all ordinate values in the rectangular coordinates for a map projection
grid_mapping_name	Grid mapping variable name
inverse_flattening	Inverse flattening of the ellipsoidal figure
latitude_of_projection_origin	The latitude chosen as the origin of rectangular coordinates for a map projection
longitude_of_projection_origin	The longitude, with respect to Greenwich, of the prime meridian associated with the geodetic datum
semi_major_axis	Semi-major axis
spatial_ref	Spatial reference
utm_zone_number	UTM zone number
longitude_of_central_meridian	The line of longitude at the center of a map projection generally used as the basis for constructing the projection

scale_factor_at_central_meridian	A multiplier for reducing a distance obtained from a map by computation or scaling to the actual distance along the central meridian.

Table 2-9 Attributes of the HDF-5 Datasets "Projection" containing the grid mapping

CHAPTER-3

Radiometric Calibration of RSLC, GSLC and GCOV Data Products

3 Radiometric Calibration of RSLC, GSLC and GCOV Data Products

This chapter describes the calibration of basic i.e. RSLC, GSLC and GCOV data products.

3.1 Calibration for RSLC products

Radiometric calibration of the SAR data is required to transform processed SAR data or images into measurements of radar backscatter of targets. Depending upon the plane of measurement, radar backscatter coefficients can be classified as Sigma0 (σ_0), Gamma0 (γ_0) and Beta0 (β_0). In NISAR RSLC products, images for different polarizations are available as Beta-Naught (Beta0) images.

Following are the calibration equations for generating Sigma-Naught (σ_0), Gamma-Naught (γ_0) and Beta-Naught (β_0) for RSLC.

$$Beta0_p = \frac{DN_p^2}{KBeta_p} \quad (1)$$

$$Gamma0_p = \frac{DN_p^2}{KGamma_p} \quad (2)$$

$$Sigma0_p = \frac{DN_p^2}{KSigma_p} \quad (3)$$

Here

$Beta0_p$ is the radar backscatter coefficient Beta0 for pixel p in eqn. (1)
$Gamma0_p$ is the radar backscatter coefficient Gamma0 for pixel p in eqn. (2)
$Sigma0_p$ is the radar backscatter coefficient Sigma0 for pixel p in eqn. (3)

Here DN_p is the digital number or the image pixel gray-level count for the pixel p.

It can be estimated as

$$DN_p = \sqrt{{DNI_p}^2 + {DNQ_p}^2}$$

DNI_p : DN Value of I (Real) component

DNQ_p : DN Value of Q (Imaginary) component

There are separate datasets in .h5 files for each polarization in RSLC (*/science/SSAR/RSLC/swaths/frequencyA/TxRx)* which represents the DN in Beta plane.

The LUT for each $KBeta_p$,$KSigma_p$, $KGamma_p$ and NES0 is available in the product in the form of a 2D grid . The paths are as follows:

/science/SSAR/RSLC/metadata/calibrationInformation/geometry/beta0

/science/SSAR/RSLC/metadata/calibrationInformation/geometry/gamma0

/science/SSAR/RSLC/metadata/calibrationInformation/geometry/sigma0

In addition, the NES0 layer is provided for each polarization combination as

/science/SSAR/RSLC/metadata/calibrationInformation/frequency/TxRx[A/B]/nes0

The grid sampling for LUT's and NES0 is coarser than that of the image. To estimate $Beta0_p$ per pixel, the noise and calibration constant has to be calculated per pixel. For per pixel estimation interpolation has to be done. In RSLC product, the image data contains absolute Beta0, hence the LUT for beta0 in the product, will be having all values as 1 (one).

3.2 Calibration for GSLC and GCOV

NISAR GSLC product is a radiometric terrain corrected (RTC) Level 2 product derived from the Level-1 RSLC product by geocoding the input RSLC into a geocoded map coordinate system such as UTM/ Polar stereographic projection system. GCOV is also a geocoded product providing radiometric terrain-corrected polarimetric covariance matrix layers projected onto a predefined UTM or Polar stereographic system map grid. Unlike RSLC products, GSLC and GCOV product layers for different polarizations are available as Gamma-Naught (Gamma0) images.

3.2.1 For GSLC

Following are the Calibration Equation for generating Gamma-Naught (γ_0) and Sigma-Naught (σ_0) for GSLC.

$$Gamma0_p = \frac{DN_p^2}{KGamma_p} \qquad (4)$$

$$Sigma0_p = \eta * Gamma0_p \qquad (5)$$

In GSLC product, the image data contains absolute Gamma0, hence per pixel Gamm0 is estimated using the mentioned equation:

$$DN_p = \sqrt{DNI_p{}^2 + DNQ_p{}^2}$$

Here DN_p is the digital number or the image pixel gray-level count for the pixel p and

DNI_p : DN Value of I component

DNQ_p : DN Value of Q component

$KGamma_p$ is having value as one (1).

To estimate the Sigma0 there is a dataset, which is added in the GSLC product that is:

/science/SSAR/GSLC/grids/rtcGammaToSigmaFactor (represented as η in equation 5) that contains the factor to generate Sigma0 from Gamma0 using equation (5). This layer will be provided for per pixel in the product.

To maintain the harmonization between JPL and ISRO formats, the GSLC products also contains datasets corresponding to LUT's for each $KBeta_p$, $KSigma_p$, $KGamma_p$. In GSLC product, the image data contains absolute Gamma0, hence the LUT for gamma0 in the product, will be having all values as 1 (one).

3.2.2 For GCOV

Following are the Calibration Equation for generating Gamma-Naught (γ_0) and Sigma-Naught (σ_0) for GCOV.

$$Gamma0_p = S_p \tag{6}$$

$$Sigma0_p = \eta * Gamma0_p \tag{7}$$

In GCOV product, the image data contains covariance layers (real layers and complex layers). The calibration defined here is for real covariance layers. The real layers contain the power for each polarization and hence they are representing the absolute Gamma0 for each pixel, as shown in equation (6). Here S_p is the per pixel scattering power in real layers of covariance matrix e.g. HHHH*, HVHV*, VVVV*, VHVH*, RHRH*, RVRV* etc.

To estimate the Sigma0 in GCOV, there is a dataset available in the product

/science/SSAR/GCOV/grids/rtcGammaToSigmaFactor (represented as η in equation 7) that contains the 2D look up table,to generate Sigma0 from Gamma0 using equation (7). This layer will be provided per pixel in the product.

3.3 Noise Usage

Calibrated thermal noise is given as 2D LUT as a part of HDF5 in the following group

"/science/SSAR/RSLC/metadata/frequency[A/B]/TxRx/nes0". The dataset provided is at a coarser spacing than the image layer.

CHAPTER-4
Meta File Format

4 Meta File Format

In all Level-1 and Level-2 products, a .met file is provided as part of product in JSON format for archival. This .met comprises of all the necessary auxillary information corresponding to the product

This chapter describes the met file format for Level-1 and Level-2 Products. The basic products (RSLC, GSLC and GCOV) have a common format. An example GCOV .met format is shown in Section 4.1. All InSAR products have a common format and it contains some extra parameters, apart from all the parameters present in basic products .met. The extra parameters are added to accommodate the information corresponding to baselines, the atmospheric corrections and the input RSLC's used for generating InSAR products. An example GUNW .met format is given in Section 4.2. The description and datatype information of each parameter of .met file is given in Annexure-1: Meta File Format Parameter Description.

4.1 Met format for GCOV


```
{
"AcquistionMode:  "S",
"Coverage": "F",
  "CycleNumber": 13,
  "DEMCorrection" : "True",
  "DEMSource" : "Copernicus GLO-30,
  "DateOfDump" : "27-NOV-2008",
  "DateOfPass" : "27-NOV-2008",
  "Datum" : "WGS_84",
  "DumpingOrbitNumber": 1,
  "EPSG" : 32611,
  "Ellipsoid": "WGS_84",
  "Ephemeris": "MOE",
  "FalseEasting" : 0.0,
  "FalseNorthing" : 500000.0,
  "FrameNumber" : 10,
  "GeneratingAgency" : "ISRO",
  "GenerationDateTime" : "2024-04-19T11:52:18,
  "GroundTrackVelocity" : 7057.080078,
  "ImageFormat" : "HDF-5",
  "ImageHeadingAngle" : 0.0,
  "ImageLLLat" : 34.2432424,
  "ImageLLLon" : -118.2259292,
  "ImageLLMapX" : 387108.6218,
  "ImageLLMapY" : 3789806.332,
  "ImageLRLat" : 35.2325223,
  "ImageLRLon" : -118.4620579,
  "ImageLRMapX" : 366958.4371,
  "ImageLRMapY" : 3899808.621,
  "ImageTraceHeadingAngle" : 30.45,
  "ImageULLat" : 35.35744928,
  "ImageULLon" : -117.7085747,
```

"ImageULMapX" : 435623.2772,
"ImageULMapY" : 3912914.354,
"ImageURLat" : 34.37167557,
"ImageURLon" : -117.459475,
"ImageURMapX" : 457754.0087,
"ImageURMapY" : 3803463.509,
"ImagingMode" : "W"
"ImagingOrbitNumber" : 1,
"IncidenceAngle" : 24.16205876,
"InputResolutionAcross" : 13.27255185,
"InputResolutionAlong" : 5.54574929,
"LookAngle" : 16.0,
"MapOriginLat" : 0.0,
"MapOriginLon" : -117.0,
"MapProjection" : "UTM",
"MissingFramesFlag" : 0,
"NoOfAzimuthLooks" : 1,
"NoOfPolarizations" : 1,
"NoOfRangeLooks" : 1,
"NoPixels" : 4680,
"NoScans" : 6210,
"Node" : "Descending",
"OTSProductID":
"NISAR_L2_PR_GCOV_013_011_D_010_2800_SHNA_A_20081127T060959_20081127T061015_T00000_P_P_I_999",
"ObservationID" : 2007122175218,
"OutputLineSpacing" : 20.0,
"OutputPixelSpacing" : 20.0,
"PRF" : 1862.197,
"ProcessingLevel" : "NOMINAL",
"ProcessingNode" : "nisar4",
"ProdCode" : "STUCGCPED",
"ProdLLLat" : 34.24129096,
"ProdLLLon" : -117.4452368,
"ProdLLMapX" : 459000.0,
"ProdLLMapY" : 3789000.0,
"ProdLRLat" : 34.23339013,
"ProdLRLon" : -118.4614829,
"ProdLRMapX" : 365400.0,
"ProdLRMapY" : 3789000.0,
"ProdULLat" : 35.35302347,
"ProdULLon" : -118.4813773,
"ProdULMapX" : 365400.0,
"ProdULMapY" : 3913200.0,
"ProdURLat" : 35.36125881,
"ProdURLon" : -117.4512983,
"ProdURMapX" : 459000.0,
"ProdURMapY" : 3913200.0,

"ProductID" : "99101",
"ProductType" : "GCOV",
"RTCApplyFlag" : "True",
"SatID" : "NIS",
"SatelliteAltitude" : 727000.0,
"SatelliteHeadingAngle" : 10,
"SceneCenterLat" : 34.79836436,
"SceneCenterLon" : -117.9598646,
"SceneCenterPitch" : 0.001,
"SceneCenterRoll" : 0.002,
"SceneCenterTime" : "2008-11-27T06:10:7.63413450",
"SceneCenterYaw" : -3.153,
"SceneEndTime" : "2008-11-27T06:10:15.61030340",
"SceneNumber" : 1,
"SceneStartTime" : "2008-11-27T06:09:59.21031999",
"Sensor" : "SSAR",
"SensorOrientation" : "Right",
"SessionNumber" : 5,
"SoftwareVersion" : "T00000",
"SourceOfAttitude" : "Custom",
"SourceOfOrbit" : "Custom",
"StationID" : "SAN",
"StripNumber" : 4,
"TerrainHeightApplied" : "True_Height",
"TrackNumber" : 11,
"TxRxPol1" : "HH",
"ZoneNo" : 11
}

4.2 Met format for GUNW

{
"AcquistionMode: "S",
"Coverage" : "F",
"CycleNumber" : 14,
"DEMCorrection" : "True",
"DEMSource" : "Copernicus GLO-30",
"DateOfDump" : "21-JAN-2024",
"DateOfPass" : "21-JAN-2024",
"Datum" : "WGS_84",
"DumpingOrbitNumber" : 5252,
"EPSG" : 32642,
"Ellipsoid" : "WGS-84",
"EllipsoidalFlatteningApplied" : "True",
"Ephemeris": "MOE",
"FalseEasting" : 0.0,

"FalseNorthing" : 500000.0,
"FrameNumber" : 12,
"GeneratingAgency" : "ISRO",
"GenerationDateTime" : "2024-04-19T12:12:16 ",
"GroundTrackVelocity" : 6732.428809,
"HydrostaticTroposphericCorrectionApplied" : "False",
"ImageFormat" : "HDF-5",
"ImageHeadingAngle" : 0.0,
"ImageLLLat" : 20.84680217,
"ImageLLLon" : 71.11359384,
"ImageLLMapX" : 719924.1585,
"ImageLLMapY" : 2306636.277,
"ImageLRLat" : 20.7274966,
"ImageLRLon" : 70.44369351,
"ImageLRMapX" : 650323.9935,
"ImageLRMapY" : 2292659.654,
"ImageTraceHeadingAngle" : 123.0,
"ImageULLat" : 21.66967665,
"ImageULLon" : 70.25126364,
"ImageULMapX" : 629460.9958,
"ImageULMapY" : 2396787.485,
"ImageURLat" : 21.7885273,
"ImageURLon" : 70.92614867,
"ImageURMapX" : 699139.4775,
"ImageURMapY" : 2410662.481,
"ImagingMode" : "W"
"ImagingOrbitNumber" : 5251,
"IncidenceAngle" : 38.71273804,
"InputResolutionAcross" : 8.518439319,
"InputResolutionAlong" : 5.519863269,
"IonospherePhaseCorrectionApplied" : "False",
"IonosphericPhaseScreenAvailable" : "True",
"IsOffsetBendingApplied" : "False",
"L1RSLCReferenceName" :
"NISAR_S1_PR_RSLC_014_013_D_012_2800_SHNA_A_20070203T175309_20070203T175325_T00000_P_P_I_999.h5",
"L1RSLCSecondaryName" :
"NISAR_S1_PR_RSLC_014_013_D_012_2800_SHNA_A_20071222T175218_20071222T175234_T00000_P_P_I_999.h5",
"LookAngle" : 16.0,
"MapOriginLat" : 0.0,
"MapOriginLon" : 69.0,
"MapProjection" : "UTM",
"MissingFramesFlag" : 0,
"NoOfAzimuthLooks" : 10,
"NoOfPolarizations" : 1,
"NoOfRangeLooks" : 5,
"NoPixels" : 1148,

"NoScans" : 1508,
"Node" : "Descending",
"OTSProductID" : "NISAR_S2_PR_GUNW_014_013_D_012_014_2800_SH_20070203T175309_20070203T175325_20071222T175218_20071222T175234_T00000_P_P_I_999",
"ObservationID" :   2007122175218,
"OutputLineSpacing" : 80.0,
"OutputPixelSpacing" : 80.0,
"PRF" : 2159.827,
"ParallelBaseline" : 558.4121525,
"PerpendicularBaseline" : -593.9110455,
"ProcessingLevel" : "NOMINAL",
"ProcessingNode" : "nisar3",
"ProdCode" : "STUCUWFED",
"ProdLLLat" : 20.7092141,
"ProdLLLon" : 71.11240558,
"ProdLLMapX" : 720000.0,
"ProdLLMapY" : 2291400.0,
"ProdLRLat" : 20.717768,
"ProdLRLon" : 70.23116606,
"ProdLRMapX" : 628200.0,
"ProdLRMapY" : 2291400.0,
"ProdULLat" : 21.80717802,
"ProdULLon" : 70.24025695,
"ProdULMapX" : 628200.0,
"ProdULMapY" : 2412000.0,
"ProdURLat" : 21.79813051,
"ProdURLon" : 71.1279962,
"ProdURMapX" : 720000.0,
"ProdURMapY" : 2412000.0,
"ProductID" : "991011",
"ProductType" : "GUNW",
"RTCApplyFlag" : "False",
"SatID" : "NIS",
"SatelliteAltitude" : 720000.0,
"SatelliteHeadingAngle" : 134.0,
"SceneCenterLat" : 21.2586711,
"SceneCenterLon" : 70.67791531,
"SceneCenterPitch" : -0.001,
"SceneCenterRoll" : 0.009,
"SceneCenterTime" : "2007-02-03T17:53:16.232342",
"SceneCenterYaw" : -3.591,
"SceneEndTime" : "2007-02-03T17:53:25.00600123",
"SceneNumber" : 1,
"SceneStartTime" : "2007-02-03T17:53:09.39363980",
"Sensor" : "SSAR",
"SensorOrientation" : "Right",
"SessionNumber" : 6,

"SoftwareVersion" : "T00000",
"SourceOfAttitude" : "Custom",
"SourceOfOrbit" : "Custom",
"StationID" : "SAN",
"StripNumber" : 1,
"TemporalBaseline" : 12,
"TerrainHeightApplied" : "True_Height",
"TopographicFlatteningApplied" : "True",
"TrackNumber" : 13,
"TxRxPol1" : "HH",
"UnwrappingAlgorithm" : "SNAPHU",
"WetTroposphericCorrectionApplied" : "False",
"ZoneNo" : 42
}

CHAPTER-5

Range Doppler Single Look Complex (RSLC) Data Product

5 Range Doppler Single Look Complex (RSLC)

RSLC product contains the focused SAR images in range-doppler coordinates. RSLC is an input to all other Level-1 and Level-2 products. It is global in nature and is generated for pre-defined track frame.

The following Table 5-1 represents the posting for RSLC products for L-Band and S-Band products for different bandwidth configurations *(Fs is sampling frequency; BW is chirp bandwidth).*

L-Band (Mode Specs)		**L-Band Product Spacing & Resolution (Rng*Azm)**				**S-Band (Mode Specs)**		**S-Band Product Spacing & Resolution (Rng*Azm)**	
Fs (MHz)	BW (MHz)	Main Band/Freq A		Aux Band/Freq B		Fs (MHz)	BW (MHz)	Spacing (m)	Resolution (m)
		Spacing (m)	Resolution (m)	Spacing (m)	Resolution (m)				
6+6	5+5	25*5	~30*6	25*5	~30*6	13.89	10	10.8*5	~15*6
24+6	20+5	6.25*5	~7.5*6	25*5	~30*6	27.78	25	5.4*5	~6*6
48+6	40+5	3.12*5	~3.75*6	25*5	~30*6	41.67	37.5	3.6*5	~4*6
96	77	1.56*5	~1.95*6	-	-	83.33	75	1.8*5	~2*6

Table 5-1 Posting for RSLC product for L and S Band

5.1 RSLC Product Overview

The RSLC product is in the zero-Doppler radar geometry convention. The output image is on a grid characterized by constant azimuth time interval and one-way slant range spacing. The output grid is also characterized by a fixed set of starting slant range, azimuth time interval, and slant range spacing values to allow for easy interpolation. All the primary image layers for a multi-polarization or multi-frequency product are generated on a common azimuth time-slant range grid.

The RSLC product, which is used to derive other L1/L2 products, contains individual binary raster layers representing complex signal return for each polarization layer. The RSLC data corresponding to the auxiliary sub-band (available in only L-Band) is stored in a similar format but in a separate data group within the HDF5 product granule. The RSLC product is also packed with input, instrument and processing facility information, processing, calibration and noise parameters and geolocation grid.

The RSLC product complex backscatter is provided in Digital Numbers (DNs) in Beta0 domain, with secondary layer look up tables (LUTs) provided to convert to beta-naught, sigma-naught, and gamma-naught. Details of this calibration is provided in section 3.1. These radiometric correction LUTs are defined with respect to the ellipsoid (e.g., not with respect to the local terrain). Additional secondary layers of slowly varying quantities are compactly stored in metadata cubes. In ISRO generated products, an additional metadata cube layer is provided which is generated at true height.

All standard (i.e., non-urgent response) products are processed using the Medium-fidelity Orbit Ephemeris (MOE) product for nominal processing and the Precise Orbit Ephemeris (POE) product for reprocessing campaigns.

5.2 RSLC Product Organization

5.2.1 Granule Definition

NISAR RSLC granules will conform to the Tiling Scheme being developed for the mission and are expected to have a ground footprint of 240 km x 240 km (except in L-Band for 77 MHz data, which cover half of the swath in range direction).

5.2.2 File Naming Convention

NISAR RSLC Granule names will conform to the Standard Product File Naming as discussed in section 2.2.1

5.2.3 Temporal Organization

The RSLC data are arranged on a uniformly spaced, increasing zero-Doppler azimuth time grid. Using row-major order convention of representing 2D raster arrays, zero-Doppler azimuth time is represented by the row direction or the slowest changing dimension.

5.2.4 Spatial Organization

The RSLC data are arranged on a uniformly spaced, increasing zero-Doppler azimuth time in the row direction and increasing slant range grid in the column direction following the row-major order convention of representing 2D raster arrays.

5.2.5 Spatial Sampling and Resolution

The NISAR L/S-SAR uses a non-uniformly spaced sequence of pulses in SweepSAR mode to collect radar data, to overcome the limitations imposed by transmit gaps affecting the wide imaging swath. Processing software accounts for the non-uniform sampling to generate the final RSLC product on a uniform grid. Some salient features of the output grid for the RSLC product are:

- The center of the top-left pixel will correspond to the same zero-Doppler azimuth time and slant range for all imagery layers in an L-SAR RSLC product – frequency A and frequency B.
- All imagery layers in an L-SAR/S-SAR RSLC product – frequency A and frequency B(L-SAR Only), are generated on the same zero-Doppler azimuth time grid corresponding to a 1520 Hz PRF, which is approximately 1.2 times the processed azimuth bandwidth and results in roughly 5 m ground postings.

- For L-SAR, the slant range sampling is generally 1.2 times the range bandwidth. For example, 20 MHz data are sampled at 24 MHz. The only exceptions are 77 MHz data, which are sampled at 96 MHz.
- For S-SAR, the slant range sampling is generally 1.1 times the range bandwidth. For example, 25 MHz data are sampled at 27.78 MHz. The only exceptions are 10 MHz data, which are sampled at 13.89 MHz.
- The main (frequency A) and auxiliary (frequency B) bands of L-SAR data have an exact integer scaling relationship. All bands are sampled at an integer multiple of 6 MHz.

The RSLC products are all processed to 6 m azimuth resolution. No windowing or whitening is applied in azimuth, so the antenna pattern determines the shape of the azimuth spectrum. A Kaiser window with shape parameter 1.6 is applied in range.

5.2.6 Along Track Mosaicking

The spatial sampling of the output grid has also been designed to facilitate along-track mosaicking of contiguous RSLC product granules if the user desires. The following features simplify the implementation of along-track mosaicking

- The slow time sampling frequency (inverse of the zero Doppler time spacing between consecutive lines) will be chosen to be an integer, to allow synchronization between adjacent granules at integer second boundaries without the need for resampling in the azimuth time direction.

- For L-SAR, the slant range to the first pixel will be a multiple of the lowest sampling frequency (corresponding to 5MHz) to enable concatenation of adjacent granules with simple integer shifts of imagery in the slant range direction.

5.2.7 Partially Compressed RSLC Data

Some applications can benefit from using partially compressed data in near and far ranges, as well as in transmit gaps during operation in constant Pulse Repetition Frequency (PRF) mode. The number of contiguous image swaths is given by a variable named “numberOfSubSwaths”. The slant range extent for each of these contiguous, fully focused regions is captured in an array named “validSamplesSubSwathN” where “N” is the index of the contiguous regions in data. Each of these extent arrays are as long as the raster imagery themselves and each line contains two numbers indicating the starting index and last index in pixels. In ISRO generated products, both the start index and last index are inclusive.

Partially compressed (processed) data should be explicitly discarded for radiometric studies and for generation of polarimetric products.

5.3 RSLC Product Description

In this section, we briefly describe the layout of RSLC data and associated metadata in the NISAR HDF5 file. Detailed description of Group and Dataset names can be found in section 5.4. In this section, we focus on the organization of S-SAR instrument data under the Group name “/science/SSAR”. The same holds true for L-Band products too.

5.3.1 Shapes and Dimensions of Data

Information on the shapes and dimensions of the data items in various data tables are described as part of the metadata in section 5.4. This information is useful both as part of the product identification and for setting up further processing, i.e., dimensioning arrays.

5.3.2 Product Identification

Information needed to identify this particular product is given under the Group "/science/SSAR/identification". This includes information such as orbit number, track-frame number, acquisition times, a polygon representing the bounding box of the included imagery in geographic coordinates, and product version.

5.3.3 Radar Imagery

All the imagery layers corresponding to the RSLC product are organized by center frequency under the Group "/science/SSAR/RSLC/swaths". For L-SAR imaging modes with split imaging bands, the data is further organized into individual groups labeled "frequencyA" and "frequencyB". Imagery layers are further organized as individual 2D datasets by polarization (TxRx) within the frequency sub-groups, i.e., dataset "/science/SSAR/RSLC/swaths/frequencyA/HH" corresponds to the SLC imagery layer for polarization combination HH processed with center frequency corresponding to frequencyA. In S-SAR, only "frequencyA" group will be present.

5.3.4 Radar Metadata

Radar metadata needed to interpret the amplitude and phase information, as well as the geolocation of the imagery are organized under the Group "/science/SSAR/RSLC/metadata".

5.3.4.1 Calibration Information

The subgroup "calibrationInformation" contains two major types of information: radiometric calibration and radar information. The complete list of calibration information fields is given in section 5.4. Details of the usage of these datasets are discussed in section 3.1.

5.3.4.1.1 Radiometric Calibration

Secondary lookup tables (LUT), common to all frequencies and polarizations as these are purely a function of imaging geometry, are organized under the subgroup

"calibrationInformation/geometry". The radar imagery themselves are provided as Digital Numbers (DNs), and LUTs are provided to transform the DNs to beta0, sigma0, and gamma0.

5.3.4.1.2 Radar Information

Complex two-way antenna patterns and noise-equivalent sigma0 (nes0) are provided organized by frequency and polarization. Noise-equivalent-sigma0 could be used to apply noise correction during radiometric calibration. These datasets are provided on a sparse grid in map coordinates and values of interest at any geographical location can be estimated using simple 2D interpolation (bilinear or higher order).

5.3.5 Processing Information

Metadata giving processing parameters, algorithms, and inputs used are given in section 5.4.

5.3.5.1 Parameters

Common parameters such as reference terrain height and chirp weighting parameters are included in the group “processingInformation/parameters”. All processing parameters that vary spatially are organized on low resolution grids, to allow for easy lookup based on radar coordinates.

5.3.5.2 Algorithm Information

The processing algorithm information is provided in the subgroup “processingInformation/algorithms/”. It includes the software version (“softwareVersion”), which is the version of the ISRO NISAR DPGS software that is used to generate the product, and the list of algorithms employed in the product processing.

5.3.5.3 Inputs

The key input files – L0B granules, orbit, attitude, calibration, DEM source description, and configuration files are tracked and listed under the subgroup “processingInformation/inputs”.

5.3.6 Other Radar Metadata

Section 5.4 includes the orbit ephemeris used for generating the RSLC under a subgroup named “metadata/orbit” and the attitude under a subgroup named “metadata/attitude”.

5.3.6.1 Orbit

The orbit ephemeris used for generating the RSLC product can be found under a subgroup named “orbit”. This group includes time-tagged antenna phase center position and velocity vectors in Earth Centered Earth Fixed (ECEF) cartesian coordinates. In nominal operations, this would be the Medium Orbit Ephemeris (MOE) state vectors that were used by the L1 processor.

5.3.6.2 Attitude

The attitude state vectors used for generating the RSLC product can be found under a subgroup named “attitude”. This group includes time-tagged quaternions and Euler Angles representing the orientation of the radar antenna in the Earth Centered Earth Fixed (ECEF) cartesian system. In nominal operations, this would be the Precise Radar Pointing (PRP) state vectors that were used by the L1 processor.

5.3.7 Geolocation Grid

Section 5.4.7 and section 5.4.8 contains information describing the radar geometry of the sensor during data acquisition in the group "/science/SSAR/RSLC/metadata/geolocationGrid”. The geolocationGrid cubes are referenced over the radar-grid which is defined by the coordinate vectors slantRange, zeroDopplerTime, and heightAboveEllipsoid. Normals are with respect to the WGS84 ellipsoid.

Geolocation grid cubes also provide the following list of radar geometry information in the associated HDF5 datasets:

1. The mapping of the zero-Doppler grid to the geographic grid is described by the cubes datasets “coordinateX” and “coordinateY”, expressed in units defined by the EPSG code in “geolocationGrid/epsg”.

2. The line-of-sight (LOS) unit vector, i.e., the vector from the target to the sensor, is defined by the datasets “losUnitVectorX” and “losUnitVectorY” which contain respectively the east and north components of the LOS unit vector in the east-north-up (ENU) coordinate system. The third component of the LOS unit vector is not provided in the product as it can be simply derived from the other two components as

$$losUnitVectorZ = \sqrt{1 - losUnitVectorX^2 - losUnitVectorY^2}$$

3. The along-track unit vector represents the projection of the along-track vector at the ground height. It is defined by the datasets “alongTrackUnitVectorX” and

   “alongTrackUnitVectorY” containing respectively the east and north components of the along-track unit vector in ENU coordinates.

4. The incidence angle *(ellipsoid)*, i.e., the angle between the LOS vector and the normal to the ellipsoid at the target height, is given by the dataset “incidenceAngle”.

5. The elevation angle, defined as the angle between the LOS vector and the normal to the ellipsoid at the sensor, is provided as “elevationAngle”.

6. The ground track velocity which contains the absolute value of the platform velocity scaled at the target height is given as “groundTrackVelocity”.

The details of the usage of metadata cube are given in

Annexure-2: Metadata Cube.

In ISRO generated L and S Band products, a separate layer is defined in a separate sub-group for all these parameters at true height:

"/science/SSAR/RSLC/metadata/geolocationGridTrueHeight/”.

In this group, all the parameters of metadata will be generated at true height (meaning they will be generated at actual height of terrain) and will be a part of the product. This layer will be at a finer sampling than the actual Meta data cube layers. The number of dimensions, description and datatype will be same as that of actual metadata cube layer.

The details of this are present in Annexure-3: Metadata Cube at True Height.

5.4 RSLC Product Specification

In this section, actual datasets are defined in tabular form. They contain the dataset information available in RSLC product, which comprises of name, datatype, shape, and information corresponding to attributes. In product, there are few datasets or few sub-groups that are per polarization. For representation, here only one polarization is used; in product, the layers/datasets/groups will be present as per the number of polarizations available in the product. The same holds true for frequency A/B for L-Band products. For representation, frequencyA is used; the same information will be present for frequencyB, if it is available in product.

5.4.1 Dimensions and Shapes

To simplify the description of the layout of data within the HDF5 file, we will use a table of dimensions and shapes to represent the relationship between similarly sized datasets. The entries in this table do not present actual datasets in the HDF5. This table is meant to be a guide to interpreting the shapes of the datasets in subsequent subsections.

Name	Shape	Description
scalar	scalar	None
numberOfDatatakes	scalar	number of datatakes in product
numberOfObservations	scalar	number of observations in product
numberOfFrequencies	scalar	Number of S/L-SAR frequencies in product
zeroDopplerTimeLength	scalar	Number of lines in all S/L-SAR imagery datasets
numberOfFrequencyAPolarizations	scalar	Number of polarization layers associated with S/L-SAR frequency A
frequencyASlantRangeWidth	scalar	Number of pixels in all S/L-SAR frequency A imagery datasets
complexDataFrequencyAShape	(zeroDopplerTimeLength, frequencyASlantRangeWidth)	Shape associated with S/L-SAR frequency A imagery datasets
numberOfFrequencyBPolarizations	scalar	Number of polarization layers associated with L-SAR frequency B
frequencyBSlantRangeWidth	scalar	Number of pixels in all L-SAR

		frequency B imagery datasets
complexDataFrequencyBShape	(zeroDopplerTimeLength, frequencyBSlantRangeWidth)	Shape associated with L-SAR frequency B imagery datasets
validSamplesShape	(zeroDopplerTimeLength, 2)	Shape associated with S/L-SAR valid samples dataset
geolocationCubeShape	(geolocationCubeHeight, geolocationCubeLength, geolocationCubeWidth)	Shape associated with metadata cubes
geolocationCubeHeight	scalar	Height dimension of the metadata cube
geolocationCubeLength	scalar	Length dimension of the metadata cube
geolocationCubeWidth	scalar	Width dimension of the metadata cube
geolocationCubeShapeTrueHeight	(1, geolocationCubeLengthTrueHeight, geolocationCubeWidthTrueHeight)	Shape associated with metadata cube at true height
geolocationCubeHeightTrueHeight	scalar	Height dimension of the metadata cube at true height, this will be one.
geolocationCubeLengthTrueHeight	scalar	Length dimension of the metadata cube at true height
geolocationCubeWidthTrueHeight	scalar	Width dimension of the metadata cube at true height
dopplerCentroidTimeLength	scalar	Length dimension of Doppler centroid grid
dopplerCentroidSlantRangeWidth	scalar	Length dimension of

		Doppler centroid grid
dopplerCentroidShape	(dopplerCentroidTimeLength, dopplerCentroidSlantRangeWidth)	Shape of the Doppler centroid grid
calibrationTimeLength	scalar	Length of calibration LUTs
calibrationSlantRangeWidth	scalar	Width of calibration LUTs
calibrationScaleShape	(calibrationTimeLength, calibrationSlantRangeWidth)	Shape of calibration LUTs
antennaPatternComplexShape	(calibrationTimeLength, calibrationSlantRangeWidth)	Shape of antenna pattern datasets
crosstalkComplexShape	scalar	Shape of crosstalk datasets
orbitListLength	scalar	Number of orbit state vectors
orbitShape	(orbitListLength, 3)	Shape of orbit state vector triplets dataset
attitudeListLength	scalar	Number of attitude state vectors
attitudeQuaternionShape	(attitudeListLength, 4)	Shape of attitude quaternion dataset
attitudeShape	(attitudeListLength, 3)	Shape of attitude Euler angle triplets dataset
chirpWeightingFrequencyLength	scalar	Shape associated with 1D filter representations in frequency domain
numberOfInputL0BFiles	scalar	Number of input L0B granules
numberOfInputOrbitFiles	scalar	Number of input orbit files
numberOfInputAttitudeFiles	scalar	Number of input attitude files
numberOfInputAuxcalFiles	scalar	Number of input calibration files

numberOfInputConfigFiles	scalar	Number of input configuration files
numberOfInputDemFiles	scalar	Number of input dem files

5.4.2 Product Identification

Product Identification Variables	
/science/SSAR/identification/absoluteOrbitNumber	
Type: UInt32	**Shape: scalar**
Description: Absolute orbit number	
/science/SSAR/identification/trackNumber	
Type: UByte	**Shape: scalar**
Description: Track number	
/science/SSAR/identification/frameNumber	
Type: UInt16	**Shape: scalar**
Description: Frame number	
/science/SSAR/identification/missionId	
Type: string	**Shape: scalar**
Description: Mission identifier	
/science/SSAR/identification/processingCenter	
Type: string	**Shape: scalar**
Description: Data processing center	
/science/SSAR/identification/productType	
Type: string	**Shape: scalar**
Description: Product type	
/science/SSAR/identification/granuleId	
Type: string	**Shape: scalar**
Description: Unique granule identification name	
/science/SSAR/identification/productDoi	
Type: string	**Shape: scalar**
Description: Digital Object Identifier (DOI) for the product	
/science/SSAR/identification/productVersion	
Type: string	**Shape: scalar**
Description: Product version which represents the structure of the product and the science content governed by the algorithm, input data, and processing parameters	
/science/SSAR/identification/productSpecificationVersion	
Type: string	**Shape: scalar**
Description: Product specification version which represents the schema of this product	
/science/SSAR/identification/lookDirection	
Type: string	**Shape: scalar**
Description: Look direction, either "Left" or "Right"	
/science/SSAR/identification/orbitPassDirection	
Type: string	**Shape: scalar**
Description: Orbit direction, either "Ascending" or "Descending"	
/science/SSAR/identification/zeroDopplerStartTime	
Type: string	**Shape: scalar**

Description: Azimuth start time (in UTC) of the product in the format YYYY-mm-ddTHH:MM:SS.sssssss	
/science/SSAR/identification/zeroDopplerEndTime	
Type: string	**Shape: scalar**
Description: Azimuth stop time (in UTC) of the product in the format YYYY-mm-ddTHH:MM:SS.sssssss	
/science/SSAR/identification/plannedDatatakeId	
Type: string	**Shape: (numberOfDatatakes)**
Description: List of planned datatakes included in the product	
/science/SSAR/identification/plannedObservationId	
Type: string	**Shape: (numberOfObservations)**
Description: List of planned observations included in the product	
/science/SSAR/identification/isUrgentObservation	
Type: string	**Shape: scalar**
Description: Flag indicating if observation is nominal ("False") or urgent ("True")	
/science/SSAR/identification/listOfFrequencies	
Type: string	**Shape: (numberOfFrequencies)**
Description: List of frequency layers available in the product	
/science/SSAR/identification/diagnosticModeFlag	
Type: UByte	**Shape: scalar**
Description: Indicates if the radar operation mode is a diagnostic mode (1-2) or DBFed science (0): 0, 1, or 2	
/science/SSAR/identification/productLevel	
Type: string	**Shape: scalar**
Description: Product level. L0A: Unprocessed instrument data; L0B: Reformatted, unprocessed instrument data; L1: Processed instrument data in radar coordinates system; and L2: Processed instrument data in geocoded coordinates system	
/science/SSAR/identification/isGeocoded	
Type: string	**Shape: scalar**
Description: Flag to indicate if the product data is in the radar geometry ("False") or in the map geometry ("True")	
/science/SSAR/identification/boundingPolygon	
Type: string	**Shape: scalar**
Description: OGR compatible WKT representation of bounding polygon of the image. Horizontal coordinates are WGS84 longitude followed by latitude (both in degrees), and the vertical coordinate is the height above the WGS84 ellipsoid in meters. The first point corresponds to the start-time, near-range radar coordinate, and the perimeter is traversed in counterclockwise order on the map. This means the traversal order in radar coordinates differs for left-looking and right-looking sensors. The polygon includes the four corners of the radar grid, with equal numbers of points distributed evenly in radar coordinates along each edge	
ogr_geometry	polygon
Epsg	4326
/science/SSAR/identification/processingDateTime	
Type: string	**Shape: scalar**
Description: Processing date and time (in UTC) in the format YYYY-mm-ddTHH:MM:SS	
/science/SSAR/identification/radarBand	
Type: string	**Shape: scalar**
Description: Acquired radar frequency band, either "L" or "S"	
/science/SSAR/identification/platformName	
Type: string	**Shape: scalar**
Description: Name of the platform used to collect the remote sensing data provided in this product	
/science/SSAR/identification/instrumentName	
Type: string	**Shape: scalar**
Description: Name of the instrument used to collect the remote sensing data provided in this product	
/science/SSAR/identification/processingType	
Type: string	**Shape: scalar**
Description: Nominal (or) Urgent (or) Custom (or) Undefined	
/science/SSAR/identification/isDithered	

Type: string	**Shape: scalar**	
Description: "True" if the pulse timing was varied (dithered) during acquisition, "False" otherwise.		
/science/SSAR/identification/isMixedMode		
Type: string	**Shape: scalar**	
Description: "True" if this product is a composite of data collected in multiple radar modes, "False" otherwise.		
/science/SSAR/identification/isFullFrame		
Type: string	**Shape: scalar**	
Description: "True" if this product fully covers a NISAR frame**,** "False" if partial coverage.		
	frameCoveragePercentage	Percentage of NISAR frame containing processed data
	thresholdPercentage	Threshold percentage used to determine if the product is full frame or partial frame
/science/SSAR/identification/compositeReleaseId		
Type: string	**Shape: scalar**	
Description: Unique version identifier of the science data production system		
/science/SSAR/identification/isJointObservation		
Type: string	**Shape: scalar**	
Description: "True" if any portion of this product was acquired in a joint observation mode (e.g., L-band and S-band simultaneously), "False" otherwise		

5.4.3 Radar Imagery

Product Imagery Variables		
/science/SSAR/RSLC/swaths/zeroDopplerTime		
Type: Float64	**Shape: (zeroDopplerTimeLength)**	
Description: Zero Doppler time since UTC epoch dimension		
	units	seconds since YYYY-MM-DDTHH:MM:SS
/science/SSAR/RSLC/swaths/zeroDopplerTimeSpacing		
Type: Float64	**Shape: scalar**	
Description: Time interval in the along track direction for raster layers. This is same as the spacing between consecutive entries in the zeroDopplerTime array		
	units	second
/science/SSAR/RSLC/swaths/frequencyA/listOfPolarizations		
Type: string	**Shape: (numberOfFrequencyAPolarizations)**	
Description: List of processed polarization layers with frequencyA		
/science/SSAR/RSLC/swaths/frequencyA/sceneCenterAlongTrackSpacing		
Type: Float64	**Shape: scalar**	
Description: Nominal along-track spacing in meters between consecutive lines near mid swath of the RSLC image		
	units	meters
/science/SSAR/RSLC/swaths/frequencyA/sceneCenterGroundRangeSpacing		
Type: Float64	**Shape: scalar**	
Description: Nominal ground range spacing in meters between consecutive pixels near mid swath of the RSLC image		
	units	meters
/science/SSAR/RSLC/swaths/frequencyA/processedRangeBandwidth		
Type: Float64	**Shape: scalar**	
Description: Processed range bandwidth in hertz		
	units	hertz
/science/SSAR/RSLC/swaths/frequencyA/acquiredRangeBandwidth		
Type: Float64	**Shape: scalar**	
Description: Acquisition range bandwidth in hertz. In case of mode combination, this corresponds to mode with largest bandwidth.		
	units	hertz

/science/SSAR/RSLC/swaths/frequencyA/processedAzimuthBandwidth		
Type: Float64		**Shape: scalar**
Description: Processed azimuth bandwidth in hertz		
	units	hertz
/science/SSAR/RSLC/swaths/frequencyA/nominalAcquisitionPRF		
Type: Float64		**Shape: scalar**
Description: Nominal PRF of acquisition. In case of mode combination, this corresponds to mode with least nominal PRF.		
	units	hertz
/science/SSAR/RSLC/swaths/frequencyA/processedCenterFrequency		
Type: Float64		**Shape: scalar**
Description: Center frequency of the processed image in hertz		
	units	hertz
/science/SSAR/RSLC/swaths/frequencyA/acquiredCenterFrequency		
Type: Float64		**Shape: scalar**
Description: Center frequency of the acquisition in hertz. In case of mode combination, this corresponds to the mode with highest center Frequency.		
	units	hertz
/science/SSAR/RSLC/swaths/frequencyA/slantRangeSpacing		
Type: Float64		**Shape: scalar**
Description: Slant range spacing of grid. Same as difference between consecutive samples in slantRange array		
	units	meters
/science/SSAR/RSLC/swaths/frequencyA/slantRange		
Type: Float64		**Shape: (frequencyASlantRangeWidth)**
Description: Slant range dimension		
	units	meters
/science/SSAR/RSLC/swaths/frequencyA/HH		
Type: CFloat32		**Shape:(zeroDopplerTimeLength,frequencyASlantRangeWidth)**
Description: Focused RSLC Beta0 image (HH)		
	units	DN
	min_value_real	Minimum value of the real part
	mean_value_real	Mean value of the real part
	max_value_real	Maximum value of the real part
	sample_stddev_real	Sample standard deviation of the real part
	min_value_imag	Minimum value of the imaginary part
	mean_value_imag	Mean value of the imaginary part
	max_value_imag	Maximum value of the imaginary part
	sample_stddev_imag	Sample standard deviation of the imaginary part
	_FillValue	nan
/science/SSAR/RSLC/swaths/frequencyA/numberOfSubSwaths		
Type: UByte		**Shape: scalar**
Description: Number of swaths of continuous imagery, due to transmit gaps		
	units	1
/science/SSAR/RSLC/swaths/frequencyA/validSamplesSubSwath1		
Type: UInt32		**Shape: (zeroDopplerTimeLength, firstLastPair)**
Description: First and last valid sample in each line of 1st subswath		
	units	1
/science/SSAR/RSLC/swaths/frequencyA/validSamplesSubSwath2		
Type: UInt32		**Shape: (zeroDopplerTimeLength, firstLastPair)**
Description: First and last valid sample in each line of 2nd subswath		

	units	1
/science/SSAR/RSLC/swaths/frequencyA/validSamplesSubSwath3		
Type: UInt32	**Shape: (zeroDopplerTimeLength, firstLastPair)**	
Description: First and last valid sample in each line of 3rd subswath		
	units	1
/science/SSAR/RSLC/swaths/frequencyA/validSamplesSubSwath4		
Type: UInt32	**Shape: (zeroDopplerTimeLength, firstLastPair)**	
Description: First and last valid sample in each line of 4th subswath		
	units	1

5.4.4 Calibration Information

Calibration-related variables		
/science/SSAR/RSLC/metadata/calibrationInformation/geometry/zeroDopplerTime		
Type: Float64	**Shape: (calibrationTimeLength)**	
Description: Zero doppler time since UTC epoch dimension corresponding to calibration records		
	units	seconds since YYYY-mm-ddTHH:MM:SS
/science/SSAR/RSLC/metadata/calibrationInformation/geometry/slantRange		
Type: Float64	**Shape: (calibrationSlantRangeWidth)**	
Description: Slant range dimension corresponding to calibration records		
	units	meters
/science/SSAR/RSLC/metadata/calibrationInformation/geometry/beta0		
Type: Float32	**Shape: (calibrationTimeLength, calibrationSlantRangeWidth)**	
Description: 2D LUT to convert DN to beta 0 assuming as a function of zero doppler time and slant range**.**		
	units	1
	_FillValue	nan
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (second)
/science/SSAR/RSLC/metadata/calibrationInformation/geometry/sigma0		
Type: Float32	**Shape: (calibrationTimeLength, calibrationSlantRangeWidth)**	
Description: 2D LUT to convert DN to sigma 0 assuming as a function of zero doppler time and slant range		
	units	1
	_FillValue	nan
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (second)
/science/SSAR/RSLC/metadata/calibrationInformation/geometry/gamma0		
Type: Float32	**Shape: (calibrationTimeLength, calibrationSlantRangeWidth)**	
Description: 2D LUT to convert DN to gamma 0 as a function of zero doppler time and slant range		
	units	1
	_FillValue	nan
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (second)
/science/SSAR/RSLC/metadata/calibrationInformation/frequencyA/elevationAntennaPattern/HH		

Type: CFloat32	**Shape: (calibrationTimeLength, calibrationSlantRangeWidth)**	
Description: Complex two-way elevation antenna pattern		
	units	1
	_FillValue	nan
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (second)
/science/SSAR/RSLC/metadata/calibrationInformation/frequencyA/elevationAntennaPattern/zeroDopplerTime		
Type: Float64	**Shape: (calibrationTimeLength)**	
Description: Zero doppler time since UTC epoch dimension corresponding to calibration elevationAntennaPattern records		
	units	seconds since YYYY-mm-ddTHH:MM:SS
/science/SSAR/RSLC/metadata/calibrationInformation/frequencyA/elevationAntennaPattern/slantRange		
Type: Float64	**Shape: (calibrationSlantRangeWidth)**	
Description: Slant range dimension corresponding to calibration elevationAntennaPattern records		
	units	meters
/science/SSAR/RSLC/metadata/calibrationInformation/frequencyA/noiseEquivalentBackscatter/zeroDopplerTime		
Type: Float64	**Shape: (calibrationTimeLength)**	
Description: Zero doppler time since UTC epoch dimension corresponding to calibration noiseEquivalentBackscatter records		
	units	seconds since YYYY-mm-ddTHH:MM:SS
/science/SSAR/RSLC/metadata/calibrationInformation/frequencyA/noiseEquivalentBackscatter/slantRange		
Type: Float64	**Shape: (calibrationSlantRangeWidth)**	
Description: Slant range dimension corresponding to calibration noiseEquivalentBackscatter records		
	units	Meters
/science/SSAR/RSLC/metadata/calibrationInformation/frequencyA/ noiseEquivalentBackscatter /HH		
Type: Float32	**Shape: (calibrationTimeLength, calibrationSlantRangeWidth)**	
Description: Noise equivalent backscatter in linear scale (units of DN^2)		
	units	1
	_FillValue	nan
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (second)
/science/SSAR/RSLC/metadata/calibrationInformation/crosstalk /slantRange		
Type: Float64	**Shape: (calibrationSlantRangeWidth)**	
Description: Slant range dimension corresponding to crosstalk records		
	units	meters
/science/SSAR/RSLC/metadata/calibrationInformation/crosstalk/txHorizontalCrosspol		
Type: CFloat32	**Shape: (calibrationSlantRangeWidth)**	
Description: Crosstalk in H-transmit channel expressed as ratio txV / txH		
	units	1
	pixel_interval	The interval in Pixel direction
	pixel_spacing	The spacing in Pixel direction (meters)
/science/SSAR/RSLC/metadata/calibrationInformation/crosstalk/txVerticalCrosspol		
Type: CFloat32	**Shape: (calibrationSlantRangeWidth)**	
Description: Crosstalk in V-transmit channel expressed as ratio txH / txV		

	units	1
	pixel_interval	The interval in Pixel direction
	pixel_spacing	The spacing in Pixel direction (meters)
/science/SSAR/RSLC/metadata/calibrationInformation/crosstalk/rxHorizontalCrosspol		
Type: CFloat32		**Shape: (calibrationSlantRangeWidth)**
Description: Crosstalk in H-receive channel expressed as ratio rxV / rxH		
	units	1
	pixel_interval	The interval in Pixel direction
	pixel_spacing	The spacing in Pixel direction (meters)
/science/SSAR/RSLC/metadata/calibrationInformation/crosstalk/rxVerticalCrosspol		
Type: CFloat32		**Shape: (calibrationSlantRangeWidth)**
Description: Crosstalk in V-recieve channel expressed as ratio rxH / rxV		
	units	1
	pixel_interval	The interval in Pixel direction
	pixel_spacing	The spacing in Pixel direction (meters)
/science/SSAR/RSLC/metadata/calibrationInformation/frequencyA/commonDelay		
Type: Float64		**Shape: scalar**
Description: Range delay correction applied to all polarimetric channels		
	units	meters
/science/SSAR/RSLC/metadata/calibrationInformation/frequencyA/faradayRotation		
Type: Float64		**Shape: scalar**
Description: Faraday rotation correction applied in processing		
	units	radian
/science/SSAR/RSLC/metadata/calibrationInformation/frequencyA/HH/differentialDelay		
Type: Float64		**Shape: scalar**
Description: Range delay correction applied to HH channel		
	units	meters
/science/SSAR/RSLC/metadata/calibrationInformation/frequencyA/HH/differentialPhase		
Type: Float64		**Shape: scalar**
Description: Phase correction applied to HH channel		
	units	radian
/science/SSAR/RSLC/metadata/calibrationInformation/frequencyA/HH/scaleFactor		
Type: Float64		**Shape: scalar**
Description: Scale factor applied to HH channel complex amplitude (at antenna boresite)		
	units	1
/science/SSAR/RSLC/metadata/calibrationInformation/frequencyA/HH/scaleFactorSlope		
Type: Float64		**Shape: scalar**
Description: Slope of scale factor applied to HH channel complex amplitude with respect to elevation angle		
	units	radians^-1
/science/SSAR/RSLC/metadata/calibrationInformation/frequencyA/HH/rfiLikelihood		
Type: Float64		**Shape: scalar**
Description: Severity of radio frequency interference (RFI) contamination in the data. Value is in the interval [0,1], where 0: lowest severity, and 1: highest severity (or NaN if RFI detection was skipped)		
	units	1

5.4.5 Processing Information

Processing-related variables		
/science/SSAR/RSLC/metadata/processingInformation/parameters/azimuthChirpWeighting		
Type: Float32		**Shape: (chirpFFTFrequency)**
Description: 1-D array in frequency domain for azimuth processing. This is used for processing L0b to L1. FFT length=256 (assumed)		
	units	1

/science/SSAR/RSLC/metadata/processingInformation/parameters/rangeChirpWeighting		
Type: Float32	**Shape: (chirpFFTFrequency)**	
Description: 1-D array in frequency domain for range processing. This is used for processing L0b to L1. FFT length=256 (assumed)		
	units	1
	window_shape	Parameter that controls the shape of the apodization window
	window_name	Name of the apodization window, e.g., "Kaiser"
/science/SSAR/RSLC/metadata/processingInformation/parameters/referenceTerrainHeight		
Type: Float32	**Shape:(dopplerCentroidTimeLength, dopplerCentroidSlantRangeWidth)**	
Description: Reference Terrain Height as a function of time		
	units	meters
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (second)
/science/SSAR/RSLC/metadata/processingInformation/parameters/zeroDopplerTime		
Type: Float64	**Shape: (dopplerCentroidTimeLength)**	
Description: Zero doppler time dimension corresponding to processing information records		
	units	seconds since YYYY-mm-ddTHH:MM:SS
/science/SSAR/RSLC/metadata/processingInformation/parameters/slantRange		
Type: Float64	**Shape: (dopplerCentroidSlantRangeWidth)**	
Description: Slant range dimension corresponding to processing information records		
	units	meters
/science/SSAR/RSLC/metadata/processingInformation/parameters/frequencyA/dopplerCentroid		
Type: Float64	**Shape: (dopplerCentroidTimeLength, dopplerCentroidSlantRangeWidth)**	
Description: 2D LUT of Doppler Centroid for Frequency A		
	units	hertz
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (second)
/science/SSAR/RSLC/metadata/processingInformation/parameters/frequencyA/zeroDopplerTime		
Type: Float64	**Shape: (dopplerCentroidTimeLength)**	
Description: Zero doppler time dimension corresponding to processing information records		
	units	seconds since YYYY-mm-ddTHH:MM:SS
/science/SSAR/RSLC/metadata/processingInformation/parameters/frequencyA/slantRange		
Type: Float64	**Shape: (dopplerCentroidSlantRangeWidth)**	
Description: Slant range dimension corresponding to processing information records		
	units	meters

/science/SSAR/RSLC/metadata/processingInformation/parameters/runConfigurationContents	
Type: string	**Shape: scalar**
Description: Contents of the run configuration file with parameters used for processing	
/science/SSAR/RSLC/metadata/processingInformation/algorithms/demInterpolation	
Type: string	**Shape: scalar**
Description: DEM interpolation method	
/science/SSAR/RSLC/metadata/processingInformation/algorithms/rfiDetection	
Type: string	**Shape: scalar**

Description: Algorithm used for radio frequency interference (RFI) detection	
/science/SSAR/RSLC/metadata/processingInformation/algorithms/rfiMitigation	
Type: string	**Shape: scalar**
Description: Algorithm used for radio frequency interference (RFI) mitigation, either "ST-EVD" or "FDNF" (or "disabled" if no RFI mitigation was applied)	
/science/SSAR/RSLC/metadata/processingInformation/algorithms/rangeCompression	
Type: string	**Shape: scalar**
Description: Algorithm for focusing the data in the range direction	
/science/SSAR/RSLC/metadata/processingInformation/algorithms/elevationAntennaPatternCorrection	
Type: string	**Shape: scalar**
Description: Algorithm for calibrating the antenna pattern	
/science/SSAR/RSLC/metadata/processingInformation/algorithms/rangeSpreadingLossCorrection	
Type: string	**Shape: scalar**
Description: Algorithm for calibrating range fading	
/science/SSAR/RSLC/metadata/processingInformation/algorithms/dopplerCentroidEstimation	
Type: string	**Shape: scalar**
Description: Algorithm for calculating Doppler centroid	
/science/SSAR/RSLC/metadata/processingInformation/algorithms/azimuthPresumming	
Type: string	**Shape: scalar**
Description: Algorithm for regridding and filling gaps in the raw data in azimuth	
/science/SSAR/RSLC/metadata/processingInformation/algorithms/azimuthCompression	
Type: string	**Shape: scalar**
Description: Algorithm for focusing the data in the azimuth direction	
/science/SSAR/RSLC/metadata/processingInformation/algorithms/softwareVersion	
Type: string	**Shape: scalar**
Description: Software version used for processing	
/science/SSAR/RSLC/metadata/processingInformation/inputs/l0bGranules	
Type: string	**Shape: (numberOfInputL0BFiles)**
Description: List of input L0B products used	
/science/SSAR/RSLC/metadata/processingInformation/inputs/orbitFiles	
Type: string	**Shape: (numberOfInputOrbitFiles)**
Description: List of input orbit files used	
/science/SSAR/RSLC/metadata/processingInformation/inputs/attitudeFiles	
Type: string	**Shape: (numberOfInputAttitudeFiles)**
Description: List of input attitude files used	
/science/SSAR/RSLC/metadata/processingInformation/inputs/auxcalFiles	
Type: string	**Shape: (numberOfInputAuxcalFiles)**
Description: List of input calibration files used	
/science/SSAR/RSLC/metadata/processingInformation/inputs/configFiles	
Type: string	**Shape: (numberOfInputConfigFiles)**
Description: List of input config files used	
/science/SSAR/RSLC/metadata/processingInformation/inputs/demFiles	
Type: string	**Shape: (numberOfInputDemFiles)**
Description: List of input dem files used	
/science/SSAR/RSLC/metadata/processingInformation/inputs/demSource	
Type: string	**Shape: scalar**
Description: Description of the input digital elevation model (DEM)	

5.4.6 Other Radar Metadata

Calibration-related variables	
/science/SSAR/RSLC/metadata/orbit/interpMethod	
Type: string	**Shape: scalar**
Description: Orbit Interpolation method, either "Hermite" or "Legendre"	

/science/SSAR/RSLC/metadata/orbit/time		
Type: Float64	**Shape: (orbitListLength)**	
Description: Time vector record. This record contains the time corresponding to position and velocity records		
	units	seconds since YYYY-mm-ddTHH:MM:SS
/science/SSAR/RSLC/metadata/orbit/position		
Type: Float64	**Shape: (orbitListLength, tripletxyz)**	
Description: Position vector record. This record contains the platform position data with respect to WGS84 G1762 reference frame		
	units	meters
/science/SSAR/RSLC/metadata/orbit/velocity		
Type: Float64	**Shape: (orbitListLength, tripletxyz)**	
Description: Velocity vector record. This record contains the platform velocity data with respect to WGS84 G1762 reference frame		
	units	meters / second
/science/SSAR/RSLC/metadata/orbit/orbitType		
Type: string	**Shape: scalar**	
Description: Orbit product type, either "FOE", "NOE", "MOE", "POE", or "Custom", where "FOE" stands for Forecast Orbit Ephemeris, "NOE" is Near real-time Orbit Ephemeris, "MOE" is Medium precision Orbit Ephemeris, and "POE" is Precise Orbit Ephemeris		
/science/SSAR/RSLC/metadata/attitude/time		
Type: Float64	**Shape: (attitudeListLength)**	
Description: Time vector record. This record contains the time corresponding to attitude and quaternion records		
	units	seconds since YYYY-mm-ddTHH:MM:SS
/science/SSAR/RSLC/metadata/attitude/quaternions		
Type: Float64	**Shape: (attitudeListLength, quaternions)**	
Description: Attitude quaternions (q0, q1, q2, q3)		
	units	1
/science/SSAR/RSLC/metadata/attitude/eulerAngles		
Type: Float64	**Shape: (attitudeListLength, tripletxyz)**	
Description: Attitude Euler angles (roll, pitch, yaw)		
	units	degree
/science/SSAR/RSLC/metadata/attitude/attitudeType		
Type: string	**Shape: scalar**	
Description: Attitude type, either "FRP", "NRP", "PRP, or "Custom", where "FRP" stands for Forecast Radar Pointing, "NRP" is Near Real-time Pointing, and "PRP" is Precise Radar Pointing		

5.4.7 Geolocation Grid

Metadata cube-related variables		
/science/SSAR/RSLC/metadata/geolocationGrid/epsg		
Type: Int32	**Shape: scalar**	
Description: EPSG code corresponding to coordinate system used for representing geolocation grid		
/science/SSAR/RSLC/metadata/geolocationGrid/coordinateY		
Type: Float64	**Shape: (geolocationCubeHeight, geolocationCubeLength, geolocationCubeWidth)**	
Description: Y coordinate in specified EPSG code		
	units	degree
	_FillValue	nan
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)

	azimuth_spacing	The spacing in Azimuth direction (second)
/science/SSAR/RSLC/metadata/geolocationGrid/coordinateX		
Type: Float64	**Shape: (geolocationCubeHeight, geolocationCubeLength, geolocationCubeWidth)**	
Description: X coordinate in specified EPSG code		
	units	degree
	_FillValue	nan
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (second)
/science/SSAR/RSLC/metadata/geolocationGrid/incidenceAngle		
Type: Float32	**Shape: (geolocationCubeHeight, geolocationCubeLength, geolocationCubeWidth)**	
Description: Incidence angle is defined as the angle between the LOS vector and the normal to the ellipsoid at the target height		
	valid_max	90.0
	valid_min	0.0
	units	degree
	_FillValue	nan
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (second)
/science/SSAR/RSLC/metadata/geolocationGrid/losUnitVectorX		
Type: Float32	**Shape: (geolocationCubeHeight, geolocationCubeLength, geolocationCubeWidth)**	
Description: East component of unit vector of LOS from target to sensor		
	valid_max	1.0
	valid_min	-1.0
	units	1
	_FillValue	nan
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (second)
/science/SSAR/RSLC/metadata/geolocationGrid/losUnitVectorY		
Type: Float32	**Shape: (geolocationCubeHeight, geolocationCubeLength, geolocationCubeWidth)**	
Description: North component of unit vector of LOS from target to sensor		
	valid_max	1.0
	valid_min	-1.0
	units	1
	_FillValue	nan
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (second)

/science/SSAR/RSLC/metadata/geolocationGrid/alongTrackUnitVectorX		
Type: Float32	**Shape: (geolocationCubeHeight, geolocationCubeLength, geolocationCubeWidth)**	
Description: East component of unit vector along ground track		
	valid_max	1.0
	valid_min	-1.0
	units	1
	_FillValue	nan
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (second)
/science/SSAR/RSLC/metadata/geolocationGrid/alongTrackUnitVectorY		
Type: Float32	**Shape: (geolocationCubeHeight, geolocationCubeLength, geolocationCubeWidth)**	
Description: North component of unit vector along ground track		
	valid_max	1.0
	valid_min	-1.0
	units	1
	_FillValue	nan
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (second)
/science/SSAR/RSLC/metadata/geolocationGrid/elevationAngle		
Type: Float32	**Shape: (geolocationCubeHeight, geolocationCubeLength, geolocationCubeWidth)**	
Description: Elevation angle is defined as the angle between the LOS vector and the normal to the ellipsoid at the sensor		
	valid_max	90.0
	valid_min	0.0
	units	degree
	_FillValue	nan
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (second)
/science/SSAR/RSLC/metadata/geolocationGrid/groundTrackVelocity		
Type: Float64	**Shape: (geolocationCubeHeight, geolocationCubeLength, geolocationCubeWidth)**	
Description: Absolute value of the platform velocity scaled at the target height		
	units	meters / second
	_FillValue	nan
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (second)
/science/SSAR/RSLC/metadata/geolocationGrid/slantRange		

Type: Float64	**Shape: (geolocationCubeWidth)**	
Description: Slant range values corresponding to the geolocation grid		
	units	meters
/science/SSAR/RSLC/metadata/geolocationGrid/zeroDopplerTime		
Type: Float64	**Shape: (geolocationCubeLength)**	
Description: Zero Doppler time values corresponding to the geolocation grid		
	units	seconds since YYYY-mm-ddTHH:MM:SS
/science/SSAR/RSLC/metadata/geolocationGrid/heightAboveEllipsoid		
Type: Float64	**Shape: (geolocationCubeHeight)**	
Description: Height values above WGS84 Ellipsoid corresponding to the location grid		
	units	meters
	standard_name	height_above_reference_ellipsoid

5.4.8 Geolocation Grid True Height (Available Only in ISRO Generated Products)

Geolocation grid at true height is at a finer spacing as compared to the geolocation grid documented in section 5.4.7.

Metadata cube-related variables		
/science/SSAR/RSLC/metadata/geolocationGridTrueHeight/epsg		
Type: Int32	**Shape: scalar**	
Description: EPSG code corresponding to coordinate system used for representing geolocation grid		
/science/SSAR/RSLC/metadata/geolocationGridTrueHeight/coordinateY		
Type: Float64	**Shape:(geolocationCubeHeightTrueHeight, geolocationCubeLengthTrueHeight, geolocationCubeWidthTrueHeight)**	
Description: Y coordinate in specified EPSG code		
	units	degree
	_FillValue	nan
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (second)
/science/SSAR/RSLC/metadata/geolocationGridTrueHeight/coordinateX		
Type: Float64	**Shape: (geolocationCubeHeightTrueHeight, geolocationCubeLengthTrueHeight, geolocationCubeWidthTrueHeight)**	
Description: X coordinate in specified EPSG code		
	units	Degree
	_FillValue	nan
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (second)
/science/SSAR/RSLC/metadata/geolocationGridTrueHeight/incidenceAngle		
Type: Float32	**Shape: (geolocationCubeHeightTrueHeight, geolocationCubeLengthTrueHeight, geolocationCubeWidthTrueHeight)**	
Description: Incidence angle is defined as the angle between the LOS vector and the normal to the ellipsoid at the target height		

	valid_max	90.0
	valid_min	0.0
	units	degree
	_FillValue	nan
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (second)
/science/SSAR/RSLC/metadata/geolocationGridTrueHeight/losUnitVectorX		
Type: Float32	**Shape: (geolocationCubeHeightTrueHeight, geolocationCubeLengthTrueHeight, geolocationCubeWidthTrueHeight)**	
Description: East component of unit vector of LOS from target to sensor		
	valid_max	1.0
	valid_min	-1.0
	units	1
	_FillValue	nan
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (second)
/science/SSAR/RSLC/metadata/geolocationGridTrueHeight/losUnitVectorY		
Type: Float32	**Shape: (geolocationCubeHeightTrueHeight, geolocationCubeLengthTrueHeight, geolocationCubeWidthTrueHeight)**	
Description: North component of unit vector of LOS from target to sensor		
	valid_max	1.0
	valid_min	-1.0
	units	1
	_FillValue	nan
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (second)
/science/SSAR/RSLC/metadata/geolocationGridTrueHeight/alongTrackUnitVectorX		
Type: Float32	**Shape: (geolocationCubeHeightTrueHeight, geolocationCubeLengthTrueHeight, geolocationCubeWidthTrueHeight)**	
Description: East component of unit vector along ground track		
	valid_max	1.0
	valid_min	-1.0
	units	1
	_FillValue	nan
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (second)
/science/SSAR/RSLC/metadata/geolocationGridTrueHeight/alongTrackUnitVectorY		

Type: Float32		**Shape: (geolocationCubeHeightTrueHeight, geolocationCubeLengthTrueHeight, geolocationCubeWidthTrueHeight)**
Description: North component of unit vector along ground track		
	valid_max	1.0
	valid_min	-1.0
	units	1
	_FillValue	nan
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (second)
/science/SSAR/RSLC/metadata/geolocationGridTrueHeight/elevationAngle		
Type: Float32		**Shape: (geolocationCubeHeightTrueHeight, geolocationCubeLengthTrueHeight, geolocationCubeWidthTrueHeight)**
Description: Elevation angle is defined as the angle between the LOS vector and the normal to the ellipsoid at the sensor		
	valid_max	90.0
	valid_min	0.0
	units	degree
	_FillValue	nan
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (second)
/science/SSAR/RSLC/metadata/geolocationGridTrueHeight/groundTrackVelocity		
Type: Float64		**Shape: (geolocationCubeHeightTrueHeight, geolocationCubeLengthTrueHeight, geolocationCubeWidthTrueHeight)**
Description: Absolute value of the platform velocity scaled at the target height		
	units	meters / second
	_FillValue	nan
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (second)
/science/SSAR/RSLC/metadata/geolocationGridTrueHeight/slantRange		
Type: Float64		**Shape: (geolocationCubeWidthTrueHeight)**
Description: Slant range values corresponding to the geolocation grid		
	units	meters
/science/SSAR/RSLC/metadata/geolocationGridTrueHeight/zeroDopplerTime		
Type: Float64		**Shape: (geolocationCubeLengthTrueHeight)**
Description: Zero Doppler time values corresponding to the geolocation grid		
	units	seconds since YYYY-mm-ddTHH:MM:SS

CHAPTER-6

Geocoded Single Look Complex (GSLC) Data Product

6 Geocoded Single Look Complex (GSLC) Data Product

GSLC product is described as Single Look Complex SAR image on geocoded map coordinate system. It is a global product and will be generated for all channels, on a pre-defined track frame.

Table 6-1 represents the posting for L and S band GSLC products for differenct bandwidth configuration; The spacing of the GSLC product in East and North directions is comparable to the full resolution original RSLC product. The ground range spacing in Table 6-1 is derived assuming mid-range incidence angle.

L-Band (Mode Specs)		L-Band Product Ground Range Spacing & Ground Range Resolution (Rng*Azm)				S-Band (Mode Specs)		S-Band Product Ground Range Spacing & Ground Range Resolution (Rng*Azm)	
Fs (MHz)	BW (MHz)	Main Band/Freq A		Aux Band/Freq B		Fs (MHz)	BW (MHz)	GR Spacing (m)	GR Resolution (m)
		GR Spacing (m)	GR Resolution (m)	GR Spacing (m)	GR Resolution (m)				
6+6	5+5	40*5	~38.5*6	40*5	~38.5*6	13.89	10	20*5	~19.2*6
24+6	20+5	10*5	~9.6 *6	40*5	~38.5*6	27.78	25	10*5	~7.68*6
48+6	40+5	5*5	~4.8*6	40*5	~38.5*6	41.67	37.5	5*5	~5.12*6
96	77	2.5*5	~2.4 *6	-	-	83.33	75	2.5*5	~2.56*6

Table 6-1 Posting for GSLC product for L and S Band

6.1 GSLC Product Overview

The GSLC product is a Level-2 product derived from the Level-1 RSLC product by geocoding the input RSLC into a geocoded map coordinate system such as UTM/ Polar stereographic projection system Annexure-4: Geocoded Product Grids. The geocoding is performed by inverse mapping of the map coordinates with their topographic heights into the radar coordinate system and interpolating the radar signal at the radar location corresponding to the map coordinate.

For ISRO generated L&S Band products the GSLC products are RTC corrected products and are provided in the Gamma0 plane.

Phase preserving complex interpolation is used to project the data onto a uniformly spaced, north-south/east-west aligned geographic grid. The phase of the GSLC product is flattened with respect to the orbit used in the RSLC processing**.** The phase flattening removes the topographic phase contribution in the GSLC. Consequently, cross multiplying two GSLC products will result in an interferometric phase flattened interferogram. For more details about the geocoding algorithm please see the NISAR Data Products Algorithms [RD1]. The GSLC product contains individual binary raster layers representing complex signal return for each polarization layer.

The GSLC product contains lookup tables referenced to geographic coordinates instead of image coordinates.

6.2 GSLC Product Organization

6.2.1 Granule Definition

NISAR GSLC Granules will conform to the Tiling Scheme being developed for the mission and are expected to have a ground footprint of 240 km x 240 km. The exact size may differ depending on the frame location. Each GSLC product is provided on a predefined fixed geocoded output grid.

6.2.2 File Naming Convention

NISAR GSLC Granule names will conform to the S/L-SAR Product File Naming Conventions as discussed in section 2.2.1.

6.2.3 Temporal Organization

Temporal organization is not specifically applicable to the GSLC product, although it is generally arranged in order of increasing azimuth time.

6.2.4 Spatial Organization

The L2 data are arranged on a uniformly spaced, North-up and West-left grid – i.e., decreasing North or Y coordinate in the row direction and increasing East or X coordinate in the column direction following the row-major order convention of representing 2D raster arrays. Pixel-is-area convention Annexure-4: Geocoded Product Grids) is used to tag the raster layers with coordinate information.

6.2.5 Spatial Sampling and Resolution

Some salient features of the output grid for the GSLC product are:

- The top-left corner of the top-left pixel will correspond to the same geographic coordinate for all imagery layers in an L/S-SAR GSLC product – frequency A and frequency B (L-SAR).
- The main (frequency A) and auxiliary (frequency B) bands of L-SAR data will share an exact integer scaling relationship to allow for easy inter-comparison (Table 6-1).
- The posting of L-SAR and S-SAR products are an integral multiple so that there is no need for resampling during usage of joint mode data.

6.2.6 Mosaicking

The spatial sampling of the output grid has been designed to facilitate along-track mosaicking of contiguous GSLC product granules. See Appendix 4: Geocoded Product Grids for details on common output grid used for all L2 products.

Note that GSLC products generated from L1 RSLC products with different central frequencies cannot be mosaicked for applications that expect phase continuity.

6.2.7 Partially Compressed Data

Partially compressed (processed) data in RSLC products will be also provided in the GSLC products. In case of constant PRF acquisitions, the RSLC products will contain multiple sub-swaths (4 or 5 sub-swaths) with fully focused SAR data within each sub-swath and with partially focused SAR data between the different sub-swaths. The SAR complex imagery in the GSLC product will contain fully and partially focused data. However, a mask of the sub-swaths geocoded to the same grid of the geocoded SAR data is provided to the users so that they can distinguish between the fully focused data from the partially focused data. See section 6.4 for more information about the subswath mask.

6.3 GSLC Product Description

In this section, we briefly describe the layout of GSLC data and associated metadata in the NISAR HDF5 file. Detailed description of Group and Dataset names can be found in section 6.4. In this section, we focus on the organization of S-SAR instrument data under the Group name “/science/SSAR”. The same holds true for L-Band products too.

6.3.1 Dimensions and Shapes of Data

Information on the dimensions and shapes of the data items in various data tables is described as part of the metadata in section 6.4. This information is useful both as part of the product identification and for setting up further processing, i.e., dimensioning arrays.

6.3.2 Product Identification

Information needed to identify this particular product is given under the Group “/science/SSAR/identification”. This includes information such as orbit number, track-frame number, acquisition times, a polygon representing the bounding box of the included imagery in geographic coordinates, and product version.

6.3.3 Radar Imagery

The primary data elements for the granule are in the group “/science/SSAR/GSLC/grids” with subgroups for frequencyA and frequencyB (if present, in case of L-Band). Imagery layers are further organized as individual 2D datasets by polarization (TxRx) under/frequency [A|B]. The details of the data elements are given in section 6.4.

6.3.4 Radar Metadata

Radar metadata needed to interpret the amplitude and phase information, as well as the geolocation of the imagery are organized under the folder “/science/SSAR/GSLC/metadata”.

6.3.4.1 Calibration Information

The subgroup “calibrationInformation” contains two major types of information: radiometric calibration and radar information. The complete list of calibration information fields is given in section 6.4. Details of the usage of these datasets are discussed in section 3.2

6.3.4.1.1 Radiometric Calibration

In GSLC product, the images are radiometric terrain corrected, hence DN is available in Gamma0 domain. To convert to Sigma0, a layer rtcGammaToSigmaFactor is provided in the data product. To maintain consistency between ISRO and JPL generated GSLC products; LUT’s for beta0, sigma0 and gamma0 are retained in the product.

6.3.4.1.2 Radar Information

Complex two-way antenna patterns and noise-equivalent sigma0 (nes0) are organized by frequency and polarization. These datasets are provided on a sparse grid in map coordinates and values of interest at any geographical location can be estimated using simple 2D interpolation (bilinear or higher order).

6.3.5 Processing Information

The metadata related to processing parameters, algorithms, and inputs used to produce the product are given in section 6.4.

6.3.5.1 Parameters

Processing parameters such as Doppler centroid are organized by frequency under the subgroup “processingInformation/parameters”. Common parameters such as reference terrain height and chirp weighting parameters are also included in this subgroup. All processing parameters that vary spatially are organized on low resolution geocoded grids to allow for easy lookup based on map coordinates. This subgroup also includes flags identifying different possible corrections applied to improve the geolocation accuracy of the product. In the current version of the product, the geolocation is corrected for ionospheric range delay and dry tropospheric range delay. The ionospheric delay is estimated using GNSS-based TEC data and corrected during the geocoding process. The dry tropospheric delay is computed using a static model [RD1] and corrected during focusing the RSLC product. The subgroup also includes a flag for possible radio frequency interference (RFI) correction (“rfiCorrectionApplied”) applied to the input RSLC product.

6.3.5.2 Algorithm Information

The processing algorithm information is provided in the subgroup “processingInformation/algorithms/”. It includes the software version (“softwareVersion”), which is the version of the ISRO NISAR DPGS software that was used to generate the product, and the list of the algorithms employed in the product processing.

6.3.5.3 Inputs

The key input file – L1 RSLC granule, orbit, DEM source description, and configuration files are tracked and listed under the subgroup “processingInformation/inputs”.

6.3.6 Other Radar Metadata

Section 6.4 includes the orbit ephemeris used for generating the GSLC under a subgroup named “metadata/orbit” and the attitude under a subgroup named “metadata/attitude”.

6.3.6.1 Orbit

The orbit ephemeris used for generating the GSLC product can be found under a subgroup named “orbit”. This group includes time-tagged antenna phase center position and velocity vectors in Earth Centered Earth Fixed (ECEF) Cartesian coordinates. In nominal operations, this would be the MOE state vectors that were used by the L2 processor.

6.3.6.2 Attitude

The attitude state vectors used for generating the GSLC product can be found under a subgroup named “attitude”. This group includes time-tagged quaternions and euler angles representing the slant range plane from the antenna phase center in Earth Centered Earth Fixed (ECEF) cartesian system. In nominal operations, this would be the restituted attitude state vectors that were used by the L2 processor.

6.3.7 Radar Grid

Section 5.4.7 contains information describing the radar geometry of the sensor during data taking in the group "/science/SSAR/GSLC/metadata/radarGrid/”. This information is given in the form of data cubes, referred to as *radar grid cubes* that are organized over a three-dimensional geographic grid. The representation as data cubes, rather than two-dimensional rasters, is used to reduce the amount of space required to store radar geometry values within NISAR Level-2 products. This is possible because each radar grid cube contains slowly-varying values in space that can be described by a low-resolution three-dimensional grid with sufficient accuracy.

These values, however, are usually required at the terrain height, often characterized by a fast-varying surface representing the local topography. A higher-resolution DEM can then be used to interpolate radar grid cubes and generate high-resolution maps of the corresponding radar geometry variable; this is explained in

Annexure-2: Metadata Cube.

Radar grid cubes (for geocoded products) is provided in the same coordinate system as the product imagery with similar extents (bounding box) but coarser pixel spacing. The three-dimensional geographic grid is defined by the HDF5 datasets “xCoordinates” (defining the east component), “yCoordinates” (north component), and “heightAboveEllipsoid” (height above the WGS84 ellipsoid), common to all radar grid cubes, and following CF conventions 1.7.

Radar grid cubes provide the following list of radar geometry information in the associated HDF5 datasets:

1. The zero-Doppler radar grid is defined through the datasets “slantRange” and “zeroDopplerAzimuthTime”, which contain respectively the range position in meters and the zero-Dopper azimuth time in seconds for each point of the geographic grid.

2. The line-of-sight (LOS) unit vector, i.e., the vector from the target to the sensor, is defined by the datasets “losUnitVectorX” and “losUnitVectorY” which contain respectively the east and north components of the LOS unit vector in the east-north-up (ENU) coordinate system for each point of the geographic grid. Note that the third (“up”) component of the LOS unit vector eZ is not provided in the product as it can be simply derived from the other two components as

$$eZ = \sqrt{1 - eX^2 - eY^2}$$

3. The along-track unit vector represents the projection of the along-track vector at the ground height. It is defined by the datasets “alongTrackUnitVectorX” and “alongTrackUnitVectorY” containing respectively the east and north components of the along-track unit vector in ENU coordinates.

4. The incidence angle, i.e., the angle between the LOS vector and the normal to the ellipsoid at the target height, is given by the dataset “incidenceAngle.

5. The elevation angle, defined as the angle between the LOS vector and the normal to the ellipsoid at the sensor, is provided as “elevationAngle”.

6. The ground track velocity which contains the absolute value of the platform velocity scaled at the target height is given as “groundTrackVelocity”.

The details of the usage of metadata cube are given in

Annexure-2: Metadata Cube.

In ISRO generated L and S Band products, a separate layer is defined in a separate sub-group for all these parameters at true height:

"/science/SSAR/GSLC/metadata/radarGridTrueHeight/”.

In this group all the parameters of metadata will be generated at true height (meaning they will be generated at actual height of terrain) and will be a part of the product. This layer will be at a finer sampling than the actual Meta data cube layers. The number of dimensions, description and datatype will be same as that of actual metadata cube layer.

The details of this are present in Annexure-3: Metadata Cube at True Height.

6.4 GSLC Product Specifications

In this section, actual datasets are defined in tabular form. They contain the dataset information available in GSLC product, which comprises of name, datatype, shape, and information corresponding to attributes. In product there are few datasets or few sub-groups that are per polarization. For representation, here only one polarization is used; in product, the layers/datasets/groups will be present as per the number of polarizations available in the product. The same holds true for frequency A/B for L-Band products. For representation, frequencyA is used; the same information will be present for frequencyB, if it is available in product.

6.4.1 Dimensions and Shapes

To simplify the description of the layout of data within the HDF5 file, we will use a table of dimensions and shapes to represent the relationship between similarly sized datasets. The entries in this table do not present actual datasets in the HDF5. This table is meant to be a guide for interpreting the shapes of the datasets in subsequent subsections.

Name	Shape	Description
scalar	scalar	None
numberOfDatatakes	scalar	number of datatakes in product
numberOfObservations	scalar	number of observations in product
numberOfFrequencies	scalar	Number of S/L-SAR frequencies in product
yCoordinateLength	Scalar	Number of lines in all S/L-SAR imagery datasets
numberOfFrequencyAPolarizations	scalar	Number of polarization layers associated with S/L-SAR frequency A
frequencyAWidth	scalar	Number of pixels in all S/L-SAR frequency A imagery datasets
frequencyALength	scalar	Number of lines in all S/L-SAR frequency A imagery datasets
complexDataFrequencyAShape	(yCoordianteLength, frequencyAWidth)	Shape associated with S/L-SAR frequency A imagery datasets
numberOfFrequencyBPolarizations	scalar	Number of polarization layers associated with L-SAR frequency B
frequencyBWidth	scalar	Number of pixels in all L-SAR frequency B imagery datasets
frequencyBLength	scalar	Number of lines in all L-SAR

		frequency B imagery datasets
complexDataFrequencyBShape	(frequencyBLength, frequencyBWidth)	Shape associated with L-SAR frequency B imagery datasets
radarGridShape	(radarCubeLength, radarCubeWidth)	Shape associated with metadata 2D layers.
radarCubeShape	(radarCubeHeight, radarCubeLength, radarCubeWidth)	Shape associated with metadata cubes
radarCubeHeight	scalar	Height dimension of the metadata cube
radarCubeLength	scalar	Length dimension of the metadata cube
radarCubeWidth	scalar	Width dimension of the metadata cube
radarGridShapeTrueHeight	(radarCubeLengthTrueHeight, radarCubeWidthTrueHeight)	Shape associated with metadata 2D layers at true height
radarCubeShapeTrueHeight	(1, radarCubeLengthTrueHeight, radarCubeWidthTrueHeight)	Shape associated with metadata cubes at true height
radarCubeHeightTrueHeight	scalar	Height dimension of the metadata cube at true height. The value will be one.
radarCubeLengthTrueHeight	scalar	Length dimension of the metadata cube at true height
radarCubeWidthTrueHeight	scalar	Width dimension of the metadata cube at true height
dopplerCentroidLength	scalar	Length dimension of Doppler centroid grid
dopplerCentroidWidth	scalar	Length dimension of Doppler centroid grid
dopplerCentroidShape	(dopplerCentroidLength, dopplerCentroidWidth)	Shape of the Doppler centroid grid

calibrationLength	scalar	Length of calibration LUTs
calibrationWidth	scalar	Width of calibration LUTs
calibrationScaleShape	(calibrationLength, calibrationWidth)	Shape of calibration LUTs
antennaPatternComplexShape	(calibrationLength, calibrationWidth)	Shape of antenna pattern datasets
crosstalkComplexShape	(calibrationLength, calibrationWidth)	Shape of crosstalk datasets
orbitListLength	scalar	Number of orbit state vectors
orbitShape	(orbitListLength, 3)	Shape of orbit state vector triplets dataset
attitudeListLength	scalar	Number of attitude state vectors
attitudeQuaternionShape	(attitudeListLength, 4)	Shape of attitude quaternion dataset
attitudeShape	(attitudeListLength, 3)	Shape of attitude Euler angle triplets dataset
numberOfInputL1Files	scalar	Number of input L1 granules
numberOfInputOrbitFiles	scalar	Number of input orbit files
numberOfInputConfigFiles	scalar	Number of input configuration files
numberOfInputDemFiles	scalar	Number of input dem files
timingCorrectionLength	scalar	Length of timing correction LUTs
timingCorrectionWidth	scalar	Width of timing correction LUTs
timingCorrectionShape	(timingCorrectionLength, timingCorrectionWidth)	Shape of timing correction LUTs

6.4.2 Product Identification

Product Identification Variables	
/science/SSAR/identification/absoluteOrbitNumber	
Type: UInt32	**Shape: scalar**
Description: Absolute orbit number	
/science/SSAR/identification/trackNumber	
Type: UByte	**Shape: scalar**
Description: Track number	
/science/SSAR/identification/frameNumber	
Type: UInt16	**Shape: scalar**
Description: Frame number	

/science/SSAR/identification/missionId	
Type: string	**Shape: scalar**
Description: Mission identifier	
/science/SSAR/identification/processingCenter	
Type: string	**Shape: scalar**
Description: Data processing center	
/science/SSAR/identification/productType	
Type: string	**Shape: scalar**
Description: Product type	
/science/SSAR/identification/granuleId	
Type: string	**Shape: scalar**
Description: Unique granule identification name	
/science/SSAR/identification/productVersion	
Type: string	**Shape: scalar**
Description: Product version which represents the structure of the product and the science content governed by the algorithm, input data, and processing parameters	
/science/SSAR/identification/productDoi	
Type: string	**Shape: scalar**
Description: Digital Object Identifier (DOI) for the product	
/science/SSAR/identification/productSpecificationVersion	
Type: string	**Shape: scalar**
Description: Product specification version which represents the schema of this product	
/science/SSAR/identification/lookDirection	
Type: string	**Shape: scalar**
Description: Look direction, either “Left” or “Right”	
/science/SSAR/identification/orbitPassDirection	
Type: string	**Shape: scalar**
Description: Orbit direction, either “Ascending” or “Descending”	
/science/SSAR/identification/zeroDopplerStartTime	
Type: string	**Shape: scalar**
Description: Azimuth start time (in UTC) of the product in the format YYYY-mm-ddTHH:MM:SS.sssssss	
/science/SSAR/identification/zeroDopplerEndTime	
Type: string	**Shape: scalar**
Description: Azimuth stop time (in UTC) of the product product in the format YYYY-mm-ddTHH:MM:SS.sssssss	
/science/SSAR/identification/plannedDatatakeId	
Type: string	**Shape: (numberOfDatatakes)**
Description: List of planned datatakes included in the product	
/science/SSAR/identification/plannedObservationId	
Type: string	**Shape: (numberOfObservations)**
Description: List of planned observations included in the product	
/science/SSAR/identification/isUrgentObservation	
Type: string	**Shape: scalar**
Description: Flag indicating if observation is nominal ("False") or urgent ("True")	
/science/SSAR/identification/listOfFrequencies	
Type: string	**Shape: (numberOfFrequencies)**
Description: List of frequency layers available in the product	
/science/SSAR/identification/diagnosticModeFlag	
Type: UByte	**Shape: scalar**
Description: Indicates if the radar operation mode is a diagnostic mode (1-2) or DBFed science (0): 0, 1, or 2	
/science/SSAR/identification/productLevel	
Type: string	**Shape: scalar**
Description: Product level. L0A: Unprocessed instrument data; L0B: Reformatted, unprocessed instrument data; L1: Processed instrument data in radar coordinates system; and L2: Processed instrument data in geocoded coordinates system	

/science/SSAR/identification/isGeocoded		
Type: string	**Shape: scalar**	
Description: Flag to indicate if the product data is in the radar geometry ("False") or in the map geometry ("True")		
/science/SSAR/identification/boundingPolygon		
Type: string	**Shape: scalar**	
Description: OGR compatible WKT representation of bounding polygon of the image. Horizontal coordinates are WGS84 longitude followed by latitude (both in degrees), and the vertical coordinate is the height above the WGS84 ellipsoid in meters. The first point corresponds to the start-time, near-range radar coordinate, and the perimeter is traversed in counterclockwise order on the map. This means the traversal order in radar coordinates differs for left-looking and right-looking sensors. The polygon includes the four corners of the radar grid, with equal numbers of points distributed evenly in radar coordinates along each edge.		
	ogr_geometry	polygon
	Epsg	4326
/science/SSAR/identification/processingDateTime		
Type: string	**Shape: scalar**	
Description: Processing date and time (in UTC) in the format YYYY-mm-ddTHH:MM:SS		
/science/SSAR/identification/radarBand		
Type: string	**Shape: scalar**	
Description: Acquired frequency band , either "L" or "S"		
/science/SSAR/identification/platformName		
Type: string	**Shape: scalar**	
Description: Name of the platform used to collect the remote sensing data provided in this product		
/science/SSAR/identification/instrumentName		
Type: string	**Shape: scalar**	
Description: Name of the instrument used to collect the remote sensing data provided in this product		
/science/SSAR/identification/processingType		
Type: string	**Shape: scalar**	
Description: Nominal (or) Urgent (or) Custom (or) Undefined		
/science/SSAR/identification/isDithered		
Type: string	**Shape: scalar**	
Description: "True" if the pulse timing was varied (dithered) during acquisition, "False" otherwise.		
/science/SSAR/identification/isMixedMode		
Type: string	**Shape: scalar**	
Description: "True" if this product is a composite of data collected in multiple radar modes, "False" otherwise.		
/science/SSAR/identification/isFullFrame		
Type: string	**Shape: scalar**	
Description: "True" if this product fully covers a NISAR frame**,** "False" if partial coverage.		
	frameCoveragePercentage	Percentage of NISAR frame containing processed data
	thresholdPercentage	Threshold percentage used to determine if the product is full frame or partial frame
/science/SSAR/identification/compositeReleaseId		
Type: string	**Shape: scalar**	
Description: Unique version identifier of the science data production system		
/science/SSAR/identification/isJointObservation		
Type: string	**Shape: scalar**	
Description: "True" if any portion of this product was acquired in a joint observation mode (e.g., L-band and S-band simultaneously), "False" otherwise		

6.4.3 Radar Imagery

Product Imagery Variables	
/science/SSAR/GSLC/grids/frequencyA/listOfPolarizations	
Type: string	**Shape: (numberOfFrequencyAPolarizations)**
Description: List of processed polarization layers with frequencyA	

/science/SSAR/GSLC/grids/frequencyA/yCoordinateSpacing		
Type: Float64		**Shape: scalar**
Description: Nominal spacing in meters between consecutive lines		
	units	meters
	long_name	Y coordinates spacing
/science/SSAR/GSLC/grids/frequencyA/xCoordinateSpacing		
Type: Float64		**Shape: scalar**
Description: Nominal spacing in meters between consecutive pixels		
	units	meters
	long_name	X coordinates spacing
/science/SSAR/GSLC/grids/frequencyA/rangeBandwidth		
Type: Float64		**Shape: scalar**
Description: Processed range bandwidth in hertz		
	units	hertz
/science/SSAR/GSLC/grids/frequencyA/azimuthBandwidth		
Type: Float64		**Shape: scalar**
Description: Processed azimuth bandwidth in hertz		
	units	hertz
/science/SSAR/GSLC/grids/frequencyA/centerFrequency		
Type: Float64		**Shape: scalar**
Description: Center frequency of the processed image in hertz		
	units	hertz
/science/SSAR/GSLC/grids/frequencyA/slantRangeSpacing		
Type: Float64		**Shape: scalar**
Description: Slant range spacing of grid. Same as difference between consecutive samples in slantRange array		
	units	meters
/science/SSAR/GSLC/grids/frequencyA/zeroDopplerTimeSpacing		
Type: Float64		**Shape: scalar**
Description: Time interval in the along track direction for raster layers. This is same as the spacing between consecutive entries in the zeroDopplerTime array		
	units	second
/science/SSAR/GSLC/grids/frequencyA/projection		
Type: UInt32		**Shape: scalar**
Description: Product map grid projection: EPSG code, with additional projection information as HDF5 Attributes		
	ellipsoid	Projection ellipsoid
	epsg_code	Projection EPSG code
	false_easting	The value added to all abscissa values in the rectangular coordinates for a map projection.
	false_northing	The value added to all ordinate values in the rectangular coordinates for a map projection.
	grid_mapping_name	Grid mapping variable name
	inverse_flattening	Inverse flattening of the ellipsoidal figure
	latitude_of_projection_origin	The latitude chosen as the origin of rectangular coordinates for a map projection.
	longitude_of_projection_origin	The longitude, with respect to Greenwich, of the prime meridian associated with the geodetic datum.
	semi_major_axis	Semi-major axis
	spatial_ref	Spatial reference
	utm_zone_number	UTM zone number
	longitude_of_central_meridian	The line of longitude at the center of a map projection generally used as the basis for constructing the projection.

	scale_factor_at_central_meridian	A multiplier for reducing a distance obtained from a map by computation or scaling to the actual distance along the central meridian.
/science/SSAR/GSLC/grids/frequencyA/rtcGammaToSigmaFactor		
Type: Float32		**Shape: (frequencyALength, frequencyAWidth)**
Description: Radiometric terrain correction factor to normalize GSLC terms from gamma0 to sigma0		
	units	1
	valid_min	0
	_FillValue	nan
	grid_mapping	projection
	min_value	Minimum value of the real valued dataset
	mean_value	Mean value of the real valued dataset
	max_value	Maximum value of the real valued dataset
	sample_stddev	Sample standard deviation of the real valued dataset
	long_name	Radiometric terrain correction area normalization factor gamma0 to sigma0

/science/SSAR/GSLC/grids/frequencyA/xCoordinates		
Type: Float64		**Shape: (frequencyAWidth)**
Description: X coordinates in specified projection		
	units	meters
	standard_name	projection_x_coordinate
	long_name	X coordinates of projection
/science/SSAR/GSLC/grids/frequencyA/yCoordinates		
Type: Float64		**Shape: (frequencyALength)**
Description: Y coordinates in specified projection		
	units	meters
	standard_name	projection_y_coordinate
	long_name	Y coordinates of projection
/science/SSAR/GSLC/grids/frequencyA/mask		
Type: UByte		**Shape: (frequencyALength, frequencyAWidth)**
Description: Mask indicating the subswath number representing valid GSLC samples. Each GSLC pixel is assumed valid if all the pixels in the interpolation window are fully focused in the input RSLC. A value of `0` indicates that at least one RSLC pixel in the interpolation window is partially focused or invalid. Pixels outside of the radar acquisition extent are filled with the value `255`.		
	units	1
	valid_min	0
	grid_mapping	projection
	_FillValue	255
	long_name	Valid samples subswath mask
/science/SSAR/GSLC/grids/frequencyA/HH		
Type: CFloat32		**Shape: (freqeuncyALength, frequencyAWidth)**
Description: Focused GSLC Gamma0 image (HH)		
	units	DN
	_FillValue	(nan+nan*j)
	min_value_real	Minimum value of the real part
	mean_value_real	Mean value of the real part
	max_ value_real	Maximum value of the real part
	sample_stddev_real	Sample standard deviation of the real part
	min_value_imag	Minimum value of the imaginary part
	mean_value_imag	Mean value of the imaginary part

	max_value_imag	Maximum value of the imaginary part
	sample_stddev_imag	Sample standard deviation of the imaginary part
	long_name	Geocoded single-look complex image HH
	grid_mapping	projection
/science/SSAR/GSLC/grids/frequencyA/numberOfSubSwaths		
Type: UByte		**Shape: scalar**
Description: Number of swaths of continuous imagery, due to transmit gaps		
	units	1

6.4.4 Calibration Information

Calibration-related variables		
/science/SSAR/GSLC/metadata/calibrationInformation/geometry/projection		
Type: UInt32		**Shape: scalar**
Description: Product map grid projection: EPSG code, with additional projection information as HDF5 Attributes		
	ellipsoid	Projection ellipsoid
	epsg_code	Projection EPSG code
	false_easting	The value added to all abscissa values in the rectangular coordinates for a map projection.
	false_northing	The value added to all ordinate values in the rectangular coordinates for a map projection.
	grid_mapping_name	Grid mapping variable name
	inverse_flattening	Inverse flattening of the ellipsoidal figure
	latitude_of_projection_origin	The latitude chosen as the origin of rectangular coordinates for a map projection.
	longitude_of_projection_origin	The longitude, with respect to Greenwich, of the prime meridian associated with the geodetic datum.
	semi_major_axis	Semi-major axis
	spatial_ref	Spatial reference
	utm_zone_number	UTM zone number
	longitude_of_central_meridian	The line of longitude at the center of a map projection generally used as the basis for constructing the projection.
	scale_factor_at_central_meridian	A multiplier for reducing a distance obtained from a map by computation or scaling to the actual distance along the central meridian.
/science/SSAR/GSLC/metadata/calibrationInformation/geometry/yCoordinates		
Type: Float64		**Shape: (calibrationLength)**
Description: Y coordinates in specified projection		
	units	meters
	standard_name	projection_y_coordinate
	long_name	Y coordinates of projection
/science/SSAR/GSLC/metadata/calibrationInformation/geometry/xCoordinates		
Type: Float64		**Shape: (calibrationWidth)**
Description: X coordinate in specified projection		
	units	meters
	standard_name	projection_x_coordinate
	long_name	X coordinates of projection
/science/SSAR/GSLC/metadata/calibrationInformation/geometry/beta0		
Type: Float32		**Shape: (calibrationLength, calibrationWidth)**
Description: 2D LUT to convert DN to beta 0 assuming as a function of geographical location		
	units	1

	grid_mapping	projection
	_FillValue	nan
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GSLC/metadata/calibrationInformation/geometry/sigma0		
Type: Float32		**Shape: (calibrationLength, calibrationWidth)**
Description: 2D LUT to convert DN to sigma 0 assuming as a function of geographical location		
	units	1
	grid_mapping	projection
	_FillValue	nan
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GSLC/metadata/calibrationInformation/geometry/gamma0		
Type: Float32		**Shape: (calibrationLength, calibrationWidth)**
Description: 2D LUT to convert DN to gamma 0 assuming as a function of geographical location.		
	units	1
	grid_mapping	projection
	_FillValue	nan
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GSLC/metadata/calibrationInformation/frequencyA/elevationAntennaPattern/projection		
Type: UInt32		**Shape: scalar**
Description: Product map grid projection: EPSG code, with additional projection information as HDF5 Attributes		
	ellipsoid	Projection ellipsoid
	epsg_code	Projection EPSG code
	false_easting	The value added to all abscissa values in the rectangular coordinates for a map projection.
	false_northing	The value added to all ordinate values in the rectangular coordinates for a map projection.
	grid_mapping_name	Grid mapping variable name
	inverse_flattening	Inverse flattening of the ellipsoidal figure
	latitude_of_projection_origin	The latitude chosen as the origin of rectangular coordinates for a map projection.
	longitude_of_projection_origin	The longitude, with respect to Greenwich, of the prime meridian associated with the geodetic datum.
	semi_major_axis	Semi-major axis
	spatial_ref	Spatial reference
	utm_zone_number	UTM zone number
	longitude_of_central_meridian	The line of longitude at the center of a map projection generally used as the basis for constructing the projection.
	scale_factor_at_central_meridian	A multiplier for reducing a distance obtained from a map by computation or scaling to the actual distance along the central meridian.

/science/SSAR/GSLC/metadata/calibrationInformation/frequencyA/elevationAntennaPattern/yCoordinates		
Type: Float64		**Shape: (calibrationLength)**
Description: Y coordinates in specified projection		
	units	meters
	standard_name	projection_y_coordinate
	long_name	Y coordinates of projection
/science/SSAR/GSLC/metadata/calibrationInformation/frequencyA/elevationAntennaPattern/xCoordinates		
Type: Float64		**Shape: (calibrationWidth)**
Description: X coordinate in specified projection		
	units	meters
	standard_name	projection_x_coordinate
	long_name	X coordinates of projection
/science/SSAR/GSLC/metadata/calibrationInformation/frequencyA/elevationAntennaPattern/HH		
Type: CFloat32		**Shape: (calibrationLength, calibrationWidth)**
Description: Complex two-way elevation antenna pattern		
	units	1
	grid_mapping	projection
	_FillValue	nan + nan*j
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GSLC/metadata/calibrationInformation/frequencyA/noiseEquivalentBacksatter/HH		
Type: Float32		**Shape: (calibrationLength, calibrationWidth)**
Description: Noise equivalent backscatter in linear scale (units of DN^2)		
	units	1
	grid_mapping	projection
	_FillValue	nan
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
	min_value	Minimum value of the numeric data points
	mean_value	Mean value of the numeric data points
	max_ value	Maximum value of the numeric data points
	sample_stddev	Sample standard deviation of the numeric data points
/science/SSAR/GSLC/metadata/calibrationInformation/frequencyA/noiseEquivalentBackscatter/projection		
Type: UInt32		**Shape: scalar**
Description: Product map grid projection: EPSG code, with additional projection information as HDF5 Attributes		
	ellipsoid	Projection ellipsoid
	epsg_code	Projection EPSG code
	false_easting	The value added to all abscissa values in the rectangular coordinates for a map projection.
	false_northing	The value added to all ordinate values in the rectangular coordinates for a map projection.
	grid_mapping_name	Grid mapping variable name
	inverse_flattening	Inverse flattening of the ellipsoidal figure

	latitude_of_projection_origin	The latitude chosen as the origin of rectangular coordinates for a map projection.
	longitude_of_projection_origin	The longitude, with respect to Greenwich, of the prime meridian associated with the geodetic datum.
	semi_major_axis	Semi-major axis
	spatial_ref	Spatial reference
	utm_zone_number	UTM zone number
	longitude_of_central_meridian	The line of longitude at the center of a map projection generally used as the basis for constructing the projection.
	scale_factor_at_central_meridian	A multiplier for reducing a distance obtained from a map by computation or scaling to the actual distance along the central meridian.
/science/SSAR/GSLC/metadata/calibrationInformation/frequencyA/noiseEquivalentBackscatter/yCoordinates		
Type: Float64		**Shape: (calibrationLength)**
Description: Y coordinates in specified projection		
	units	meters
	standard_name	projection_y_coordinate
	long_name	Y coordinates of projection
/science/SSAR/GSLC/metadata/calibrationInformation/frequencyA/noiseEquivalentBackscatter/xCoordinates		
Type: Float64		**Shape: (calibrationWidth)**
Description: X coordinate in specified projection		
	units	meters
	standard_name	projection_x_coordinate
	long_name	X coordinates of projection

/science/SSAR/GSLC/metadata/calibrationInformation/crosstalk/txHorizontalCrosspol		
Type: CFloat32		**Shape: (calibrationLength, calibrationWidth)**
Description: Crosstalk in H-transmit channel expressed as ratio txV / txH		
	units	1
	grid_mapping	projection
	_FillValue	nan
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GSLC/metadata/calibrationInformation/crosstalk/txVerticalCrosspol		
Type: CFloat32		**Shape: (calibrationLength, calibrationWidth)**
Description: Crosstalk in V-transmit channel expressed as ratio txH / txV		
	units	1
	grid_mapping	projection
	_FillValue	nan
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GSLC/metadata/calibrationInformation/crosstalk/rxHorizontalCrosspol		
Type: CFloat32		**Shape: (calibrationLength, calibrationWidth)**
Description: Crosstalk in H-receive channel expressed as ratio rxV / rxH		
	units	1

	grid_mapping	projection
	_FillValue	nan
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GSLC/metadata/calibrationInformation/crosstalk/rxVerticalCrosspol		
Type: CFloat32	**Shape: (calibrationLength, calibrationWidth)**	
Description: Crosstalk in V-recieve channel expressed as ratio rxH / rxV		
	units	1
	grid_mapping	projection
	_FillValue	nan
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GSLC/metadata/calibrationInformation/frequencyA/commonDelay		
Type: Float64	**Shape: scalar**	
Description: Range delay correction applied to all polarimetric channels		
	units	meters
/science/SSAR/GSLC/metadata/calibrationInformation/frequencyA/faradayRotation		
Type: Float64	**Shape: scalar**	
Description: Faraday rotation correction applied in processing		
	units	radian
/science/SSAR/GSLC/metadata/calibrationInformation/frequencyA/HH/differentialDelay		
Type: Float64	**Shape: scalar**	
Description: Range delay correction applied to HH channel		
	units	meters
/science/SSAR/GSLC/metadata/calibrationInformation/frequencyA/HH/differentialPhase		
Type: Float64	**Shape: scalar**	
Description: Phase correction applied to HH channel		
	units	radian
/science/SSAR/GSLC/metadata/calibrationInformation/frequencyA/HH/scaleFactor		
Type: Float64	**Shape: scalar**	
Description: Scale factor applied to HH channel complex amplitude (at antenna boresite)		
	units	1
/science/SSAR/GSLC/metadata/calibrationInformation/frequencyA/HH/scaleFactorSlope		
Type: Float64	**Shape: scalar**	
Description: Slope of scale factor applied to HH channel complex amplitude with respect to elevation angle		
	units	radians^-1
/science/SSAR/GSLC/metadata/calibrationInformation/frequencyA/HH/rfiLikelihood		
Type: Float64	**Shape: scalar**	
Description: Severity of radio frequency interference (RFI) contamination in the data. Value is in the interval [0,1], where 0: lowest severity, and 1: highest severity (or NaN if RFI detection was skipped)		
	units	1

6.4.5 Processing Information

Processing-related variables	
/science/SSAR/GSLC/metadata/processingInformation/parameters/azimuthChirpWeighting	
Type: Float32	**Shape: (chirpFFTFrequency)**

Description: 1-D array in frequency domain for azimuth processing. This is used for processing L0b to L1. FFT length=256(assumed)		
	units	1
/science/SSAR/GSLC/metadata/processingInformation/parameters/rangeChirpWeighting		
Type: Float32		**Shape: (chirpFFTFrequency)**
Description: 1-D array in frequency domain for range processing. This is used for processing L0b to L1. FFT length=256 (assumed)		
	window_shape	Parameter that controls the shape of the apodization window
	window_name	Name of the apodization window, e.g., "Kaiser"
	units	1
/science/SSAR/GSLC/metadata/processingInformation/parameters/dryTroposphericGeolocationCorrectionApplied		
Type: string		**Shape: scalar**
Description: Flag to indicate if the dry tropospheric correction has been applied to improve geolocation		
/science/SSAR/GSLC/metadata/processingInformation/parameters/wetTroposphericGeolocationCorrectionApplied		
Type: string		**Shape: scalar**
Description: Flag to indicate if the wet tropospheric correction has been applied to improve geolocation		
/science/SSAR/GSLC/metadata/processingInformation/parameters/rangeIonosphericGeolocationCorrectionApplied		
Type: string		**Shape: scalar**
Description: Flag to indicate if the range ionospheric correction has been applied to improve geolocation		
/science/SSAR/GSLC/metadata/processingInformation/parameters/azimuthIonosphericGeolocationCorrectionApplied		
Type: string		**Shape: scalar**
Description: Flag to indicate if the azimuth ionospheric correction has been applied to improve geolocation		
/science/SSAR/GSLC/metadata/processingInformation/parameters/rfiMitigationpplied		
Type: string		**Shape: scalar**
Description: Flag to indicate if an RFI mitigation has been applied		
/science/SSAR/GSLC/metadata/processingInformation/parameters/ellipsoidalFlatteningApplied		
Type: string		**Shape: scalar**
Description: Flag to indicate if the GSLC phase has been flattened with respect to a zero height ellipsoid		
/science/SSAR/GSLC/metadata/processingInformation/parameters/topographicFlatteningApplied		
Type: string		**Shape: scalar**
Description: Flag to indicate if the GSLC phase has been flattened with respect to topographic height using a DEM		
/science/SSAR/GSLC/metadata/processingInformation/parameters/radiometricTerrainCorrectionApplied		
Type: string		**Shape: scalar**
Description: Flag to indicate if radiometric terrain correction has been applied		
/science/SSAR/GSLC/metadata/processingInformation/parameters/referenceTerrainHeight		
Type: Float32		**Shape: (dopplerCentroidLength, dopplerCentroidWidth)**
Description: Reference Terrain Height as a function of geographical location		
	units	meters
	grid_mapping	projection
	_FillValue	nan
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GSLC/metadata/processingInformation/parameters/projection		
Type: UInt32		**Shape: scalar**
Description: Product map grid projection: EPSG code, with additional projection information as HDF5 Attributes		

	ellipsoid	Projection ellipsoid
	epsg_code	Projection EPSG code
	false_easting	The value added to all abscissa values in the rectangular coordinates for a map projection.
	false_northing	The value added to all ordinate values in the rectangular coordinates for a map projection.
	grid_mapping_name	Grid mapping variable name
	inverse_flattening	Inverse flattening of the ellipsoidal figure
	latitude_of_projection_origin	The latitude chosen as the origin of rectangular coordinates for a map projection.
	longitude_of_projection_origin	The longitude, with respect to Greenwich, of the prime meridian associated with the geodetic datum.
	semi_major_axis	Semi-major axis
	spatial_ref	Spatial reference
	utm_zone_number	UTM zone number
	longitude_of_central_meridian	The line of longitude at the center of a map projection generally used as the basis for constructing the projection.
	scale_factor_at_central_meridian	A multiplier for reducing a distance obtained from a map by computation or scaling to the actual distance along the central meridian.
/science/SSAR/GSLC/metadata/processingInformation/parameters/yCoordinates		
Type: Float64		**Shape: (dopplerCentroidLength)**
Description: Y coordinates in specified projection		
	units	meters
	long_name	Y coordinates of projection
	standard_name	projection_y_coordinate
/science/SSAR/GSLC/metadata/processingInformation/parameters/xCoordinates		
Type: Float64		**Shape: (dopplerCentroidWidth)**
Description: X coordinates in specified projection		
	units	meters
	long_name	X coordinates of projection
	standard_name	projection_x_coordinate
/science/SSAR/GSLC/metadata/processingInformation/parameters/geocoding/snapToGridX		
Type: Float64		**Shape: scalar**
Description: Snap to the grid along the X direction with the origin set at 0. The X-coordinate of the scene's upper-left corner is a multiple of this value		
	units	meters
/science/SSAR/GSLC/metadata/processingInformation/parameters/geocoding/snaptToGridY		
Type: Float64		**Shape: scalar**
Description: Snap to the grid along the Y direction with the origin set at 0. The Y-coordinate of the scene's upper-left corner is a multiple of this value		
	units	meters
/science/SSAR/GSLC/metadata/processingInformation/parameters/frequencyA/projection		
Type: UInt32		**Shape: scalar**
Description: Product map grid projection: EPSG code, with additional projection information as HDF5 Attributes		
	ellipsoid	Projection ellipsoid
	epsg_code	Projection EPSG code
	false_easting	The value added to all abscissa values in the rectangular coordinates for a map projection.
	false_northing	The value added to all ordinate values in the rectangular coordinates for a map projection.
	grid_mapping_name	Grid mapping variable name

	inverse_flattening	Inverse flattening of the ellipsoidal figure
	latitude_of_projection_origin	The latitude chosen as the origin of rectangular coordinates for a map projection.
	longitude_of_projection_origin	The longitude, with respect to Greenwich, of the prime meridian associated with the geodetic datum.
	semi_major_axis	Semi-major axis
	spatial_ref	Spatial reference
	utm_zone_number	UTM zone number
	longitude_of_central_meridian	The line of longitude at the center of a map projection generally used as the basis for constructing the projection.
	scale_factor_at_central_meridian	A multiplier for reducing a distance obtained from a map by computation or scaling to the actual distance along the central meridian.
/science/SSAR/GSLC/metadata/processingInformation/parameters/frequencyA/yCoordinates		
Type: Float64		**Shape: (dopplerCentroidLength)**
Description: Y coordinates in specified projection		
	units	meters
	long_name	Y coordinates of projection
	standard_name	projection_y_coordinate
/science/SSAR/GSLC/metadata/processingInformation/parameters/frequencyA/xCoordinates		
Type: Float64		**Shape: (dopplerCentroidWidth)**
Description: X coordinates in specified projection		
	units	meters
	long_name	X coordinates of projection
	standard_name	projection_x_coordinate
/science/SSAR/GSLC/metadata/processingInformation/parameters/frequencyA/dopplerCentroid		
Type: Float64		**Shape: (dopplerCentroidLength, dopplerCentroidWidth)**
Description: 2D LUT of Doppler Centroid for Frequency A		
	units	hertz
	_FillValue	nan
	grid_mapping	projection
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)

/science/SSAR/GSLC/metadata/processingInformation/timingCorrections/frequencyA/azimuthIonosphere		
Type: Float64		**Shape: (timingCorrectionLength, timingCorrectionWidth)**
Description: 2D lookup table of azimuth ionosphere timing correction derived from Total Electron Content data		
	_FillValue	nan
	units	seconds
/science/SSAR/GSLC/metadata/processingInformation/timingCorrections/frequencyA/slantRangeIonosphere		
Type: Float64		**Shape: (timingCorrectionLength, timingCorrectionWidth)**
Description: 2D lookup table of line-of-sight ionosphere timing correction derived from Total Electron Content data		
	_FillValue	nan
	units	meters
/science/SSAR/GSLC/metadata/processingInformation/timingCorrections/frequencyA/slantRangeSolidEarthTides		

Type: Float64	**Shape: (timingCorrectionLength, timingCorrectionWidth)**	
Description: 2D lookup table of line-of-sight solid Earth tides timing correction		
	_FillValue	nan
	units	meters
/science/SSAR/GSLC/metadata/processingInformation/timingCorrections/frequencyA/slantRange		
Type: Float64	**Shape: (timingCorrectionWidth)**	
Description: Slant range dimension corresponding to the timing correction lookup tables		
	units	meters
/science/SSAR/GSLC/metadata/processingInformation/timingCorrections/frequencyA/slantRangeSpacing		
Type: Float64	**Shape: scalar**	
Description: Slant range spacing of the timing correction lookup tables		
	units	meters
/science/SSAR/GSLC/metadata/processingInformation/timingCorrections/frequencyA/zeroDopplerTime		
Type: Float64	**Shape: (timingCorrectionLength)**	
Description: Zero Doppler time dimension since UTC epoch corresponding to the timing correction lookup tables		
	units	seconds since YYYY-mm-ddTHH:MM:SS
/science/SSAR/GSLC/metadata/processingInformation/timingCorrections/frequencyA/zeroDopplerTimeSpacing		
Type: Float64	**Shape: scalar**	
Description: Time interval in the along-track direction of the timing correction lookup tables		
	units	second
/science/SSAR/GSLC/metadata/processingInformation/parameters/runConfigurationContents		
Type: string	**Shape: scalar**	
Description: Contents of the run configuration file with parameters used for processing		
/science/SSAR/GSLC/metadata/processingInformation/algorithms/softwareVersion		
Type: string	**Shape: scalar**	
Description: Software version used for processing		
/science/SSAR/GSLC/metadata/processingInformation/algorithms/demInterpolation		
Type: string	**Shape: scalar**	
Description: DEM interpolation method		
/science/SSAR/GSLC/metadata/processingInformation/algorithms/geocoding		
Type: string	**Shape: scalar**	
Description: Geocoding algorithm		
/science/SSAR/GSLC/metadata/processingInformation/inputs/l1SlcGranules		
Type: string	**Shape: (numberOfInputL1Files)**	
Description: List of input L1 products used		
/science/SSAR/GSLC/metadata/processingInformation/inputs/orbitFiles		
Type: string	**Shape: (numberOfInputOrbitFiles)**	
Description: List of input orbit files used		
/science/SSAR/GSLC/metadata/processingInformation/inputs/configFiles		
Type: string	**Shape: (numberOfInputConfigFiles)**	
Description: List of input config files used		
/science/SSAR/GSLC/metadata/processingInformation/inputs/demFiles		
Type: string	**Shape: (numberOfInputDemFiles)**	
Description: List of input dem files used		
/science/SSAR/GSLC/metadata/processingInformation/inputs/tecFiles		
Type: string	**Shape: (numberOfInputDemFiles)**	
Description: List of input total electron content (TEC) files used		
/science/SSAR/GSLC/metadata/processingInformation/inputs/demSource		
Type: string	**Shape: scalar**	
Description: Description of the input digital elevation model (DEM)		

6.4.6 Other Radar Metadata

Radar metadata-related variables		
/science/SSAR/GSLC/metadata/ceosAnalysisReadyData/boundingBox		
Type: string		**Shape: scalar**
Description: OGR compatible WKT representing the bounding box of the product (the union of the geocoded grid for available frequency A and frequency B image datasets). Horizontal coordinates are X and Y directions of the geocoded grid coordinate system, and the vertical coordinate is the height above the WGS84 ellipsoid in meters. The first point corresponds to the top left edge of the bounding box. The remaining points are traversed in counterclockwise order on the map. The fifth point closes the bounding box by repeating the first point		
	epsg	EPSG code
/science/SSAR/GSLC/metadata/ceosAnalysisReadyData/staticLayersDataAccess		
Type: string		**Shape: scalar**
Description: Location of the static layers product associated with this product (URL or DOI)		
/science/SSAR/GSLC/metadata/ceosAnalysisReadyData/ceosAnalysisReadyDataProductType		
Type: string		**Shape: scalar**
Description: CEOS Analysis Ready Data (CARD) product type		
/science/SSAR/GSLC/metadata/ceosAnalysisReadyData/ceosAnalysisReadyDataDocumentIdentifier		
Type: string		**Shape: scalar**
Description: CEOS Analysis Ready Data (CARD) document identifier		
/science/SSAR/GSLC/metadata/ceosAnalysisReadyData/geometricAccuracy/bias/y		
Type: Float32		**Shape: scalar**
Description: An estimate of the localization error bias in the Y/northing direction		
	epsg	EPSG code
	units	meters
/science/SSAR/GSLC/metadata/ceosAnalysisReadyData/geometricAccuracy/bias/x		
Type: Float32		**Shape: scalar**
Description: An estimate of the localization error bias in the X/easting direction		
	epsg	EPSG code
	units	meters
/science/SSAR/GSLC/metadata/ceosAnalysisReadyData/geometricAccuracy/standardDeviation/y		
Type: Float32		**Shape: scalar**
Description: An estimate of the localization error standard deviation in the Y/northing direction		
	epsg	EPSG code
	units	meters
/science/SSAR/GSLC/metadata/ceosAnalysisReadyData/geometricAccuracy/standardDeviation/x		
Type: Float32		**Shape: scalar**
Description: An estimate of the localization error standard deviation in the X/easting direction		
	epsg	EPSG code
	units	meters
/science/SSAR/GSLC/metadata/orbit/time		
Type: Float64		**Shape: (orbitListLength)**
Description: Time vector record. This record contains the time corresponding to position and velocity records		
	units	seconds since YYYY-mm-ddTHH:MM:SS
/science/SSAR/GSLC/metadata/orbit/position		
Type: Float64		**Shape: (orbitListLength, tripletxyz)**
Description: Position vector record. This record contains the platform position data with respect to WGS84 G1762 reference frame		
	units	meters
/science/SSAR/GSLC/metadata/orbit/velocity		
Type: Float64		**Shape: (orbitListLength, tripletxyz)**

Description: Velocity vector record. This record contains the platform velocity data with respect to WGS84 G1762 reference frame		
	units	meters / second
/science/SSAR/GSLC/metadata/orbit/orbitType		
Type: string	**Shape: scalar**	
Description: Orbit product type, either "FOE", "NOE", "MOE", "POE", or "Custom", where "FOE" stands for Forecast Orbit Ephemeris, "NOE" is Near real-time Orbit Ephemeris, "MOE" is Medium precision Orbit Ephemeris, and "POE" is Precise Orbit Ephemeris		
/science/SSAR/GSLC/metadata/orbit/interpMethod		
Type: string	**Shape: scalar**	
Description: Orbit interpolation method, either "Hermite" or "Legendre"		
	units	seconds since YYYY-MM-DD HH:MM:SS
/science/SSAR/GSLC/metadata/attitude/quaternions		
Type: Float64	**Shape: (attitudeListLength, quaternions)**	
Description: Attitude quaternions (q0, q1, q2, q3)		
	units	1
/science/SSAR/GSLC/metadata/attitude/eulerAngles		
Type: Float64	**Shape: (attitudeListLength, tripletxyz)**	
Description: Attitude Euler angles (roll, pitch, yaw)		
	units	degree
/science/SSAR/GSLC/metadata/attitude/attitudeType		
Type: string	**Shape: scalar**	
Description: Attitude type, either "FRP", "NRP", "PRP, or "Custom", where "FRP" stands for Forecast Radar Pointing, "NRP" is Near Real-time Pointing, and "PRP" is Precise Radar Pointing		

6.4.7 Radar Grid

Metadata cube-related variables		
/science/SSAR/GSLC/metadata/radarGrid/zeroDopplerAzimuthTime		
Type: Float64	**Shape: (radarCubeHeight, radarCubeLength, radarCubeWidth)**	
Description: Zero doppler aximuth time in seconds since UTC epoch		
	long_name	Zero Doppler Azimuth Time
	grid_mappping	projection
	_FillValue	nan
	units	seconds since YYYY-mm-ddTHH:MM:SS
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GSLC/metadata/radarGrid/slantRange		
Type: Float64	**Shape: (radarCubeHeight, radarCubeLength, radarCubeWidth)**	
Description: Slant Range in meters		
	units	meters
	long_name	Slant range
	grid_mappping	projection
	_FillValue	nan
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GSLC/metadata/radarGrid/incidenceAngle		
Type: Float32	**Shape: (radarCubeHeight, radarCubeLength, radarCubeWidth)**	

Description: Incidence angle is defined as the angle between the LOS vector and the normal to the ellipsoid at the target height		
	valid_max	90.0
	valid_min	0.0
	units	degree
	_FillValue	nan
	grid_mapping	projection
	long_name	Incidence Angle
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GSLC/metadata/radarGrid/losUnitVectorX		
Type: Float32	**Shape: (radarCubeHeight, radarCubeLength, radarCubeWidth)**	
Description: East component of unit vector of LOS from target to sensor		
	valid_max	1.0
	valid_min	-1.0
	units	1
	_FillValue	nan
	grid_mapping	projection
	long_name	LOS unit vector X
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GSLC/metadata/radarGrid/losUnitVectorY		
Type: Float32	**Shape: (radarCubeHeight, radarCubeLength, radarCubeWidth)**	
Description: North component of unit vector of LOS from target to sensor		
	valid_max	1.0
	valid_min	-1.0
	units	1
	_FillValue	nan
	grid_mapping	projection
	long_name	LOS unit vector Y
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GSLC/metadata/radarGrid/alongTrackUnitVectorX		
Type: Float32	**Shape: (radarCubeHeight, radarCubeLength, radarCubeWidth)**	
Description: East component of unit vector along ground track		
	valid_max	1.0
	valid_min	-1.0
	units	1
	_FillValue	nan
	grid_mapping	projection
	long_name	Along-track unit vector X
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction

	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GSLC/metadata/radarGrid/alongTrackUnitVectorY		
Type: Float32	**Shape: (radarCubeHeight, radarCubeLength, radarCubeWidth)**	
Description: North component of unit vector along ground track		
	valid_max	1.0
	valid_min	-1.0
	units	1
	_FillValue	nan
	grid_mapping	projection
	long_name	Along-track unit vector Y
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GSLC/metadata/radarGrid/elevationAngle		
Type: Float32	**Shape: (radarCubeHeight, radarCubeLength, radarCubeWidth)**	
Description: Elevation angle is defined as the angle between the LOS vector and the normal to the ellipsoid at the sensor		
	valid_max	90.0
	valid_min	0.0
	units	degree
	_FillValue	nan
	grid_mapping	projection
	long_name	Elevation Angle
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GSLC/metadata/radarGrid/projection		
Type: UInt32	**Shape: scalar**	
Description: Product map grid projection: EPSG code, with additional projection information as HDF5 Attributes		
	ellipsoid	Projection ellipsoid
	epsg_code	Projection EPSG code
	false_easting	The value added to all abscissa values in the rectangular coordinates for a map projection.
	false_northing	The value added to all ordinate values in the rectangular coordinates for a map projection.
	grid_mapping_name	Grid mapping variable name
	inverse_flattening	Inverse flattening of the ellipsoidal figure
	latitude_of_projection_origin	The latitude chosen as the origin of rectangular coordinates for a map projection.
	longitude_of_projection_origin	The longitude, with respect to Greenwich, of the prime meridian associated with the geodetic datum.
	semi_major_axis	Semi-major axis
	spatial_ref	Spatial reference
	utm_zone_number	UTM zone number
	longitude_of_central_meridian	The line of longitude at the center of a map projection generally used as the basis for constructing the projection.

	scale_factor_at_central_meridian	A multiplier for reducing a distance obtained from a map by computation or scaling to the actual distance along the central meridian.
/science/SSAR/GSLC/metadata/radarGrid/groundTrackVelocity		
Type: Float64	**Shape: (radarCubeHeight, radarCubeLength, radarCubeWidth)**	
Description: Absolute value of the platform velocity scaled at the target height		
	units	meters / second
	_FillValue	nan
	grid_mapping	projection
	long_name	Ground-track velocity
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GSLC/metadata/radarGrid/xCoordinates		
Type: Float64	**Shape: (radarCubeWidth)**	
Description: X Coordinates corresponding to the radar grid		
	units	meters
	long_name	Y coordinates of projection
	standard_name	projection_y_coordinate
/science/SSAR/GSLC/metadata/radarGrid/yCoordinates		
Type: Float64	**Shape: (radarCubeLength)**	
Description: Y Coordinaes corresponding to the radar grid		
	units	meters
	long_name	X coordinates of projection
	standard_name	projection_x_coordinate
/science/SSAR/GSLC/metadata/radarGrid/heightAboveEllipsoid		
Type: Float64	**Shape: (radarCubeHeight)**	
Description: Height values above WGS84 Ellipsoid corresponding to the location grid		
	units	meters
	standard_name	height_above_reference_ellipsoid

6.4.8 Radar Grid True Height (Available Only in ISRO Generated Products)

Radar grid at true height is at a finer spacing as compared to the radar grid documented in section 6.4.7.

Metadata cube-related variables		
/science/SSAR/GSLC/metadata/radarGridTrueHeight/zeroDopplerAzimuthTime		
Type: Float64	**Shape: (radarCubeHeightTrueHeight, radarCubeLengthTrueHeight, radarCubeWidthTrueHeight)**	
Description: Zero doppler azimuth time in seconds since UTC epoch		
	units	seconds since YYYY-mm-ddTHH:MM:SS
	long_name	Zero Doppler Azimuth Time
	grid_mappping	projection
	_FillValue	nan
	units	seconds since YYYY-mm-ddTHH:MM:SS
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GSLC/metadata/radarGridTrueHeight/slantRange		

Type: Float64	**Shape: (radarCubeHeightTrueHeight, radarCubeLengthTrueHeight, radarCubeWidthTrueHeight)**	
Description: Slant Range in meters		
	units	meters
	long_name	Slant range
	grid_mappping	projection
	_FillValue	nan
	units	seconds since YYYY-mm-ddTHH:MM:SS
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GSLC/metadata/radarGridTrueHeight/incidenceAngle		
Type: Float32	**Shape: (radarCubeHeightTrueHeight, radarCubeLengthTrueHeight, radarCubeWidthTrueHeight)**	
Description: Incidence angle is defined as the angle between the LOS vector and the normal to the ellipsoid at the target height		
	valid_max	90.0
	valid_min	0.0
	units	degree
	_FillValue	nan
	grid_mapping	projection
	long_name	Incidence Angle
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GSLC/metadata/radarGridTrueHeight/losUnitVectorX		
Type: Float32	**Shape: (radarCubeHeightTrueHeight, radarCubeLengthTrueHeight, radarCubeWidthTrueHeight)**	
Description: East component of unit vector of LOS from target to sensor		
	valid_max	1.0
	valid_min	-1.0
	units	1
	_FillValue	nan
	grid_mapping	projection
	long_name	LOS unit vector X
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GSLC/metadata/radarGridTrueHeight/losUnitVectorY		
Type: Float32	**Shape: (radarCubeHeightTrueHeight, radarCubeLengthTrueHeight, radarCubeWidthTrueHeight)**	
Description: North component of unit vector of LOS from target to sensor		
	valid_max	1.0
	valid_min	-1.0
	units	1
	_FillValue	nan
	grid_mapping	projection
	long_name	LOS unit vector Y

	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GSLC/metadata/radarGridTrueHeight/alongTrackUnitVectorX		
Type: Float32	**Shape: (radarCubeHeightTrueHeight, radarCubeLengthrueHeight, radarCubeWidthTrueHeight)**	
Description: East component of unit vector along ground track		
	valid_max	1.0
	valid_min	-1.0
	units	1
	_FillValue	nan
	grid_mapping	projection
	long_name	Along-track unit vector X
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GSLC/metadata/radarGridTrueHeight/alongTrackUnitVectorY		
Type: Float32	**Shape: (radarCubeHeightTrueHeight, radarCubeLengthTrueHeight, radarCubeWidthTrueHeight)**	
Description: North component of unit vector along ground track		
	valid_max	1.0
	valid_min	-1.0
	units	1
	_FillValue	nan
	grid_mapping	projection
	long_name	Along-track unit vector Y
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GSLC/metadata/radarGridTrueHeight/elevationAngle		
Type: Float32	**Shape: (radarCubeHeightTrueHeight, radarCubeLengthTrueHeight, radarCubeWidthTrueHeight)**	
Description: Elevation angle is defined as the angle between the LOS vector and the normal to the ellipsoid at the sensor		
	valid_max	90.0
	valid_min	0.0
	units	degree
	_FillValue	nan
	grid_mapping	projection
	long_name	Elevation Angle
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GSLC/metadata/radarGridTrueHeight/groundTrackVelocity		
Type: Float64	**Shape: (radarCubeHeightTrueHeight, radarCubeLengthTrueHeight, radarCubeWidthTrueHeight)**	

Description: Absolute value of the platform velocity scaled at the target height		
	units	meters / second
	_FillValue	nan
	grid_mapping	projection
	long_name	Ground-track velocity
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GSLC/metadata/radarGridTrueHeight/projection		
Type: UInt32	**Shape: scalar**	
Description: Product map grid projection: EPSG code, with additional projection information as HDF5 Attributes		
	ellipsoid	Projection ellipsoid
	epsg_code	Projection EPSG code
	false_easting	The value added to all abscissa values in the rectangular coordinates for a map projection.
	false_northing	The value added to all ordinate values in the rectangular coordinates for a map projection.
	grid_mapping_name	Grid mapping variable name
	inverse_flattening	Inverse flattening of the ellipsoidal figure
	latitude_of_projection_origin	The latitude chosen as the origin of rectangular coordinates for a map projection.
	longitude_of_projection_origin	The longitude, with respect to Greenwich, of the prime meridian associated with the geodetic datum.
	semi_major_axis	Semi-major axis
	spatial_ref	Spatial reference
	utm_zone_number	UTM zone number
	longitude_of_central_meridian	The line of longitude at the center of a map projection generally used as the basis for constructing the projection.
	scale_factor_at_central_meridian	A multiplier for reducing a distance obtained from a map by computation or scaling to the actual distance along the central meridian.
/science/SSAR/GSLC/metadata/radarGridTrueHeight/xCoordinates		
Type: Float64	**Shape: (radarCubeWidthTrueHeight)**	
Description: X Coordinates corresponding to the radar grid		
	units	meters
	long_name	X coordinates of projection
	standard_name	projection_x_coordinate
/science/SSAR/GSLC/metadata/radarGridTrueHeight/yCoordinates		
Type: Float64	**Shape: (radarCubeLengthTrueHeight)**	
Description: Y Coordinaes corresponding to the radar grid		
	units	meters
	long_name	Y coordinates of projection
	standard_name	projection_y_coordinate

CHAPTER -7

Geocoded Polarimetric Covariance (GCOV) Data Product

7 Geocoded Polarimetric Covariance (GCOV) Data Product

GCOV product contains geocoded, multi-looked polarimetric covariance matrix for all polarization channels (Single/Dual/Circular/Quad). It is a global product and is defined for pre-defined track-frame. The posting of GCOV for different bandwidth configurations is shown in Table 7-1.

L-Band (Mode Specs)		L-Band Product Spacing (Rng*Azm)		S-Band (Mode Specs)		S-Band Product Spacing (Rng*Azm)
Fs (MHz)	BW (MHz)	Main Band/Freq A Spacing (m)	Aux Band/Freq B Spacing (m)	Fs (MHz)	BW (MHz)	Spacing (m)
6+6	5+5	80*80	80*80	13.89	10	40*40
24+6	20+5	20*20	80*80	27.78	25	20*20
48+6	40+5	10*10	80*80	41.67	37.5	10*10
96	77	20*20	-	83.33	75	10*10

Table 7-1 Posting for GCOV product for L and S Band

7.1 GCOV Product Overview

The GCOV product is a Level-2 product derived from the Level-1 Range Doppler Single Look Complex (RSLC) product providing terrain-corrected polarimetric covariance projected onto a predefined UTM or Polar stereographic system map grid Annexure-4: Geocoded Product Grids.

RSLC radar samples, organized as a polarimetric scattering vector, are cross-correlated with the scattering vector's conjugate transpose, originating the polarimetric covariance matrix expressed in the same grid as the RSLC product grid (range-Doppler grid). The magnitude of the resulting polarimetric covariance terms is strongly affected by the topography, with areas facing the sensor becoming brighter and areas away from the sensor turning darker in the images, biasing covariance measurements. To reduce the effect of the topography, an area-based radiometric terrain correction (RTC) is applied over the covariance terms, normalizing the backscatter coefficient beta0 to gamma0. The normalized covariance terms are then geocoded (map projected) onto an output grid.

Since the polarimetric covariance matrix is Hermitian, only the upper triangular covariance terms are provided. The diagonal terms of the polarimetric covariance matrix are real-valued, representing the radar backscatter associated with each polarimetric channel. The off-diagonal terms of the polarimetric covariance matrix are complex-valued.

For Single Pol a single layer of intensity, of the available polarization channel will be provided.

For Dual Pol or Circular pol three layers (two intensities and one complex) will be provided in the product as highlighted in this matrix.

$$\begin{pmatrix} C_{11} & C_{12} \\ C_{12}^{*} & C_{22} \end{pmatrix}$$

For quad pol, six layers will be provided (three intensities and three complex) will be provided in the product as highlighted in the matrix.

$$\begin{pmatrix} C_{11} & C_{12} & C_{13} \\ C_{12}^{*} & C_{22} & C_{23} \\ C_{13}^{*} & C_{23}^{*} & C_{33} \end{pmatrix}$$

7.2 GCOV Product Organization

7.2.1 Granule Definition

NISAR GCOV granules will conform to the Tiling Scheme being developed for the mission and are expected to have a ground footprint of 240 km x 240 km (except in L-Band for 77 MHz data, which cover half of the swath in range direction).

7.2.2 File Naming Convention

NISAR GCOV Granule names will conform to the S/L-SAR Product File Naming Conventions as discussed in section 2.2.1

7.2.3 Temporal Organziation

Temporal organization is not specifically applicable to the GCOV product, although it is generally arranged in order of increasing azimuth time.

7.2.4 Spatial Organization

The L2 data are arranged on a uniformly spaced, North-up and West-left grid – i.e., decreasing North or Y coordinate in the row direction and increasing East or X coordinate in the column direction following the row-major order convention of representing 2D raster arrays. Pixel-isarea convention Annexure-4: Geocoded Product Grids is used to tag the raster layers with coordinate information.

7.2.5 Spatial Sampling and Resolution

Some salient features of the output grid for the Level-2 GCOV product are:

1. The top-left corner of the top-left pixel will correspond to the same geographic coordinate for all imagery layers in an L-SAR Level-2 GCOV product – frequency A and frequency B.

2. The main imaging band (frequencyA) is spatially averaged to the same posting, irrespective of the imaging mode. This allows for spatial mosaicking operations across instrument mode changes.

3. The main (frequency A) and auxiliary (frequency B) bands of L-SAR data will have an exact integer scaling relationship to allow for easy inter-comparison (Table 7.1).

4. The posting of L-SAR and S-SAR products are an integral multiple so that there is no need for resampling during usage of joint mode data

7.2.6 Mosaicking

The spatial sampling of the output grid has been designed to facilitate along-track mosaicking of contiguous GCOV product granules if the user desires. See Annexure-4: Geocoded Product Grids Geocoded Product Grids for details on the common output grid used for all L2 products.

7.2.7 Partially compressed RSLC data

Partially compressed (processed) data in RSLC products will be provided in the GCOV products. In case of constant PRF acquisitions, the RSLC products will contain multiple sub-swaths (4 or 5 sub-swaths) with fully focused SAR data within each sub-swath and with partially focused SAR data between the different sub-swaths. A mask layer geocoded to the same grid of the GCOV imagery is provided to the users so that they can distinguish between the fully focused data from the partially focused data. See Section 7.3.7 for more information about the mask layer.

7.3 GCOV Product Description

In this section, we briefly describe the layout of GCOV data and associated metadata in the NISAR HDF5 file. Detailed description of Group and Dataset names can be found in section 7.4. In this section, we focus on the organization of S-SAR instrument data under the Group name “/science/SSAR”. The same holds true for L-Band products too.

The GCOV product is organized by the available frequency bands, i.e., frequency A or B (For L-band), or both. For each frequency band, the GCOV product contains multiple images representing the real or complex covariance terms. These images are normalized to gamma0 in a process called radiometric terrain correction, to reduce the dependence of the covariance terms with respect to the terrain. Conversion to the backscatter coefficient sigma0 can be accomplished by using the area normalization factor provided at the same posting as the imagery layers.

7.3.1 Dimensions and Shapes of Data

Information on the dimensions and shapes of the data items in various data tables is described as part of the metadata (Section 7.4.1). This information is useful both as part of the product identification and for setting up further processing, i.e., dimensioning arrays.

7.3.2 Product Identification

Information needed to identify the product is given under the Group

7.3.3 "/science/SSAR/identification" (Section 7.4.2). This includes information such as orbit number, track-frame number, acquisition times, a polygon representing the bounding box of the included imagery in geographic coordinates, and product version. Radar Imagery

The primary data elements of the GCOV product, referred to as the GCOV imagery, are the covariance terms of the geocoded polarimetric covariance matrix that are stored within the Group "/science/SSAR/GCOV/grids/frequencyA". (frequencyA/B in case of L-Band).

GCOV terms are derived from the RSLC product single-look complex (SLC) data. For each

Polarimetric channel $P_1 \ldots\ldots P_n$, the SLCs can be arranged in the form of scattering vector k_n

$$k_n = \left[s_{p1}, s_{p2}, s_{p3} \ldots\ldots s_{pn}\right]^T$$

Where n is the number of polarimetric channels.

The polarimetric covariance matrix in the range-Doppler domain is then obtained by cross multiplying the scattering vector k_n with its conjugate transpose (Hermitian transpose) k_n^{*T}according to:

$$[C_n] = k_n k_n^{*T}$$

The diagonal terms of the covariance matrix $[C_n]$ are real-valued and represent the radar backscatter of polarimetric channels of the scattering vector k. The off-diagonal terms are complex-valued and are only computed if the GCOV is product is full-covariance, which can be verified by the flag "science/SAR/GCOV/metadata/processingInformation/parameters/isFullCovariance".

Quad-polarimetric data are represented by the scattering vector:

$$k_4 = [s_{HH}, s_{HV}, s_{VH}, s_{VV}]^T$$

Due to reciprocity between HV and VH channels, symmetrization can be done. This leads to reduction of k_4 to k_3 matrix.

$$k_3 = \left[s_{HH,} \overline{s_{HV}}, s_{vv}\right]^T$$

Where $\overline{s_{HV}}$ is the average of s_{HV} and s_{VH} channels.

From k_3, C_3 covariance matrix is generated using:

$$[C_3] = k_3 k_3^{*T}$$

A flag in the GCOV product metadata indicates if the polarimetric symmetrization has been applied:
"/science/SSAR/GCOV/metadata/processingInformation/parameters/polarimetricSymmetrizatio nApplied".

The polarimetric covariance matrix $[C_n]$ is generated using radiometrically terrain corrected input, which is then geocoded and then multilooked to generate GCOV matrix, which is populated in the product. The datasets containing the GCOV matrix terms are provided under the HDF5 Group

"/science/SSAR/GCOV/grids /frequencyA". For L-SAR it is frequencyA/B or both frequency and frequncyB (depending on availability of the band).

7.3.4 Radiometric Terrain Correction Gamma-to-Sigma Factor

The map projected RTC Gamma-To-Sigma factor η is provided as georeferenced HDF5 Dataset

under the Group "/science/SSAR/GCOV/grids/frequencyA/rtcGammaToSigmaFactor and for L-SAR ,"/science/LSAR/GCOV/grids/frequency[A|B]/rtcGammaToSigmaFactor.

Usage of this dataset is discussed in 3.2.2.

7.3.5 Number of Looks

The GCOV is generated after multilooking the geocoded covariance matrix. The multilooking for ISRO generated L and S Band products, is a single value for all pixels of the image, but for harmonization of product structure, with JPL generated products, it is provided in 2D grid and has the same grid as that of imagery layers. It is available in the dataset

/science/SSAR/GCOV/grids/frequencyA/numberOfLooks.

7.3.6 Radar Metadata

Radar metadata needed to interpret the amplitude and phase information, as well as the geolocation of the imagery are organized under the folder "/science/SSAR/GCOV/metadata".

7.3.6.1 Calibration Information

Complex two-way antenna patterns and noise-equivalent sigma0 (nes0) are organized by frequency and polarization in the subgroup "/calibrationInformation". These datasets are provided on a sparse grid in map coordinates and values of interest at any geographical location can be estimated using simple 2D interpolation (bilinear or higher order).

7.3.6.2 Source Data

The subgroup "/sourceData" includes relevant information about the input RSLC product that was used to generate the GCOV product. It includes the RSLC identification parameters provided at the subgroup "/sourceData" level, the RSLC processing information parameters provided under the subgroup "/sourceData/processingInformation", and swath (radar grid) parameters provided under the subgroup "/sourceData/swaths".

7.3.7 Processing Information

The metadata related to processing parameters, algorithms, and inputs used to produce the product are given in Section 7.4.6.

7.3.7.1 Parameters

The subgroup "/metadata/processingInformation/parameters" describes product processing parameters such as flags identifying corrections applied to the product, e.g., radiometric terrain correction (RTC) ("radiometricTerrainCorrectionApplied"), radio frequency interference (RFI) correction ("rfiCorrectionApplied"), and corrections applied to improve the geolocation accuracy of the product, such as geolocation correction to compensate for ionospheric range delay

("rangeIonosphericGeolocationCorrectionApplied" and

"azimuthIonosphericGeolocationCorrectionApplied") and tropospheric range delay

("dryTroposphericGeolocationCorrectionApplied" and

"wetTroposphericGeolocationCorrectionApplied"). The ionospheric delay is estimated using GNSS-based TEC data and corrected during the geocoding process. The dry tropospheric delay is computed using a static model and corrected during focusing the RSLC product. This subgroup also includes processing parameters that vary spatially, such as the Doppler centroid ("dopplerCentroid") and reference terrain height ("referenceTerrainHeight"), organized on a geographic grid with the same coordinate system as the product imagery, but with coarser pixel spacing.

7.3.7.2 Algorithm Information

The processing algorithm information is provided in the subgroup "processingInformation/algorithms/". It includes the software version ("softwareVersion"), which is the version of the ISRO NISAR DPGS software that was used to generate the product, and the list of the algorithms employed in the product processing

7.3.7.3 Inputs

The key input file – L1 RSLC granule, orbit, DEM source description, and configuration files are tracked and listed under the subgroup "processingInformation/inputs".

7.3.8 Other Radar Metadata

Section 7.4 includes the orbit ephemeris used for generating the GCOV under a subgroup named “metadata/orbit” and the attitude under a subgroup named “metadata/attitude”.

7.3.8.1 Orbit

The orbit ephemeris used for generating the GCOV product can be found under a subgroup named “orbit”. This group includes time-tagged antenna phase center position and velocity vectors in Earth Centered Earth Fixed (ECEF) Cartesian coordinates. In nominal operations, this would be the MOE state vectors that were used by the L2 processor.

7.3.8.2 Attitude

The attitude state vectors used for generating the GCOV product can be found under a subgroup named “attitude”. This group includes time-tagged quaternions and Euler Angles representing the slant range plane from the antenna phase center in Earth Centered Earth Fixed (ECEF) Cartesian system. In nominal operations, this would be the restituted attitude state vectors that were used by the L2 processor.

7.3.9 Radar Grid

Section 4.7 contains information describing the radar geometry of the sensor during data taking in the group "/science/SSAR/GCOV/metadata/radarGrid/”. This information is given in the form of data cubes, referred to as *radar grid cubes*, which are organized over a three-dimensional geographic grid. The representation as data cubes, rather than two-dimensional rasters, is used to reduce the amount of space required to store radar geometry values within NISAR Level-2 products. This is possible because each radar grid cube contains slowly-varying values in space that can be described by a low-resolution three-dimensional grid with sufficient accuracy.

These values, however, are usually required at the terrain height, often characterized by a fast-varying surface representing the local topography. A higher-resolution DEM can then be used to interpolate radar grid cubes and generate high-resolution maps of the corresponding radar geometry variable.

Radar grid cubes (for geocoded products) are provided in the same coordinate system as the product imagery with similar extents (bounding box) but coarser pixel spacing. The three-dimensional geographic grid is defined by the HDF5 datasets “xCoordinates” (defining the east component), “yCoordinates” (north component), and “heightAboveEllipsoid” (height above the WGS84 ellipsoid), common to all radar grid cubes, and following CF conventions 1.7.

Radar grid cubes provide the following list of radar geometry information in the associated HDF5 datasets:

1. The zero-Doppler radar grid is defined through the datasets “slantRange” and “zeroDopplerAzimuthTime”, which contain respectively the range position in meters and the zero-Dopper azimuth time in seconds for each point of the geographic grid.

2. The line-of-sight (LOS) unit vector, i.e., the vector from the target to the sensor, is defined by the datasets “losUnitVectorX” and “losUnitVectorY” which contain respectively the east and north components of the LOS unit vector in the east-north-up (ENU) coordinate system for each point of the geographic grid. Note that the third (“up”) component of the LOS unit vector

eZ is not provided in the product as it can be simply derived from the other two components as

$$eZ = \sqrt{1 - eX^2 - eY^2}$$

3. The along-track unit vector represents the projection of the along-track vector at the ground height. It is defined by the datasets “alongTrackUnitVectorX” and “alongTrackUnitVectorY” containing respectively the east and north components of the along-track unit vector in ENU coordinates.

4. The incidence angle, i.e., the angle between the LOS vector and the normal to the ellipsoid at the target height, is given by the dataset “incidenceAngle.

5. The elevation angle, defined as the angle between the LOS vector and the normal to the ellipsoid at the sensor, is provided as “elevationAngle”.

6. The ground track velocity which contains the absolute value of the platform velocity scaled at the target height is given as “groundTrackVelocity”.

The details of the usage of metadata cube are given in

Annexure-2: Metadata Cube.

In ISRO generated L and S Band products, a separate layer is defined in a separate sub-group for all these parameters at true height: "/science/SSAR/GCOV/metadata/radarGridTrueHeight/”.

In this group all the parameters of metadata will be generated at true height (meaning they will be generated at actual height of terrain) and will be a part of the product. This layer will be at a finer sampling than the actual Meta data cube layers. The number of dimensions, description and datatype will be same as that of actual metadata cube layer.

The details of this are present in Annexure-3: Metadata Cube at True Height.

7.4 GCOV Product Specification

In this section, actual datasets are defined in tabular form. They contain the dataset information available in GCOV product, which comprises of name, datatype, shape, and information corresponding to attributes. In product there are few datasets or few sub-groups that are per polarization. For representation, here only one polarization is used; in product, the layers/datasets/groups will be present as per the number of polarizations available in the product. Being a GCOV product the layers will be as described in Section 7.3.3. For repesnetation only HHHH for real layer and HHHV for complex layer, is present here, the same information will be present for other layers too, if available in the product. For representation, frequencyA is used; the same information will be present for frequencyB, if it is available in product.

7.4.1 Dimensions and Shapes

To simplify the description of the layout of data within the HDF5 file, we will use a table of dimensions and shapes to represent the relationship between similarly sized datasets. The entries in this table do not present actual datasets in the HDF5. This table is meant to be a guide to interpreting the shapes of the datasets in subsequent subsections.

Name	Shape	Description
scalar	scalar	None
numberOfDatatakes	scalar	Number of datatakes in product
numberOfObservations	scalar	Number of observations in product
numberOfFrequencies	scalar	Number of S/L-SAR frequencies in product
numberOfFrequencyAPolarizations	scalar	Number of polarization layers associated with S/L-SAR frequency A
numberOfFrequencyA CovarianceTerms	scalar	Number of covariance terms associated with S/L-SAR frequency A
frequencyAWidth	scalar	Number of pixels in all S/L-SAR frequency A imagery datasets
frequencyALength	scalar	Number of lines in all S/L-SAR frequency A imagery datasets
complexDataFrequencyAShape	(frequencyALength, frequencyAWidth)	Shape associated with S/L-SAR frequency A imagery datasets
numberOfFrequencyBPolarizations	scalar	Number of polarization layers associated with L-SAR frequency B
numberOfFrequencyB CovarianceTerms	scalar	Number of covariance terms associated with L-SAR frequency B
frequencyBWidth	scalar	Number of pixels in all L-SAR frequency B imagery datasets
frequencyBLength	scalar	Number of lines in all L-SAR frequency B imagery datasets
complexDataFrequencyBShape	(frequencyBLength, frequencyBWidth)	Shape associated with L-SAR frequency B imagery datasets
radarGridShape	(radarCubeLength, radarCubeWidth)	Shape associated with 2D rasters on same grid as metadata cubes
radarCubeShape	(radarCubeHeight, radarCubeLength, radarCubeWidth)	Shape associated with metadata cubes

radarCubeHeight	scalar	Height dimension of the metadata cube
radarCubeLength	scalar	Length dimension of the metadata cube
radarCubeWidth	scalar	Width dimension of the metadata cube
radarGridShapeTrueHeight	(radarCubeLengthTrueHeight, radarCubeWidthTrueHeight)	Shape associated with metadata 2D layers at true height
radarCubeShapeTrueHeight	(1, radarCubeLengthTrueHeight, radarCubeWidthTrueHeight)	Shape associated with metadata cubes at true height
radarCubeHeightTrueHeight	scalar	Height dimension of the metadata cube at true height. The value will be one.
radarCubeLengthTrueHeight	scalar	Length dimension of the metadata cube at true height
radarCubeWidthTrueHeight	scalar	Width dimension of the metadata cube at true height
dopplerCentroidLength	scalar	Length dimension of Doppler centroid grid
dopplerCentroidWidth	scalar	Length dimension of Doppler centroid grid
dopplerCentroidShape	(dopplerCentroidLength, dopplerCentroidWidth)	Shape of the Doppler centroid grid
calibrationLength	scalar	Length of calibration LUTs
calibrationWidth	scalar	Width of calibration LUTs
calibrationScaleShape	(calibrationLength, calibrationWidth)	Shape of calibration LUTs
antennaPatternComplexShape	(calibrationLength, calibrationWidth)	Shape of antenna pattern datasets
crosstalkComplexShape	(calibrationLength, calibrationWidth)	Shape of crosstalk datasets
orbitListLength	scalar	Number of orbit state vectors
orbitShape	(orbitListLength, 3)	Shape of orbit state vector triplets dataset
attitudeListLength	scalar	Number of attitude state vectors
attitudeQuaternionShape	(attitudeListLength, 4)	Shape of attitude quaternion dataset
attitudeShape	(attitudeListLength, 3)	Shape of attitude Euler angle triplets dataset
numberOfInputL1Files	scalar	Number of input L1 granules

numberOfInputOrbitFiles	scalar	Number of input orbit files
numberOfInputConfigFiles	scalar	Number of input configuration files
numberOfInputDemFiles	scalar	Number of input Dem files
sourceDataDoppler CentroidTimeLength	scalar	Length dimension of Doppler centroid grid corresponding to the source data
sourceDataDoppler CentroidSlantRangeWidth	scalar	Length dimension of Doppler centroid grid corresponding to the source data
sourceDataDoppler CentroidShape	(sourceDataDoppler CentroidTimeLength, sourceDataDoppler CentroidSlantRangeWidth)	Shape of the Doppler centroid grid corresponding to the source data

7.4.2 Product Identification

Product Identification Variables	
/science/SSAR/identification/absoluteOrbitNumber	
Type: UInt32	**Shape: scalar**
Description: Absolute orbit number	
/science/SSAR/identification/trackNumber	
Type: UByte	**Shape: scalar**
Description: Track number	
/science/SSAR/identification/frameNumber	
Type: UInt16	**Shape: scalar**
Description: Frame number	
/science/SSAR/identification/missionId	
Type: string	**Shape: scalar**
Description: Mission identifier	
/science/SSAR/identification/processingCenter	
Type: string	**Shape: scalar**
Description: Data processing center	
/science/SSAR/identification/productType	
Type: string	**Shape: scalar**
Description: Product type	
/science/SSAR/identification/granuleId	
Type: string	**Shape: scalar**
Description: Unique granule identification name	
/science/SSAR/identification/productDoi	
Type: string	**Shape: scalar**
Description: Digital Object Identifier (DOI) for the product	
/science/SSAR/identification/productVersion	
Type: string	**Shape: scalar**
Description: Product version which represents the structure of the product and the science content governed by the algorithm, input data, and processing parameters	
/science/SSAR/identification/productSpecificationVersion	
Type: string	**Shape: scalar**
Description: Product specification version which represents the schema of this product	
/science/SSAR/identification/lookDirection	

Type: string	**Shape: scalar**	
Description: : Look direction, either “Left” or “Right”		
/science/SSAR/identification/orbitPassDirection		
Type: string	**Shape: scalar**	
Description: Orbit direction, either “Ascending” or “Descending”		
/science/SSAR/identification/zeroDopplerStartTime		
Type: string	**Shape: scalar**	
Description: Azimuth start time (in UTC) of the product in the format YYYY-mm-ddTHH:MM:SS.sssssssss		
/science/SSAR/identification/zeroDopplerEndTime		
Type: string	**Shape: scalar**	
Description: Azimuth stop time (in UTC) of the product in the format YYYY-mm-ddTHH:MM:SS.sssssssss		
/science/SSAR/identification/plannedDatatakeId		
Type: string	**Shape: (numberOfDatatakes)**	
Description: List of planned datatakes included in the product		
/science/SSAR/identification/plannedObservationId		
Type: string	**Shape: (numberOfObservations)**	
Description: List of planned observations included in the product		
/science/SSAR/identification/isUrgentObservation		
Type: string	**Shape: scalar**	
Description: Flag indicating if observation is nominal ("False") or urgent ("True")		
/science/SSAR/identification/listOfFrequencies		
Type: string	**Shape: (numberOfFrequencies)**	
Description: List of frequency layers available in the product		
/science/SSAR/identification/diagnosticModeFlag		
Type: UByte	**Shape: scalar**	
Description: Indicates if the radar operation mode is a diagnostic mode (1-2) or DBFed science (0): 0, 1, or 2		
/science/SSAR/identification/productLevel		
Type: string	**Shape: scalar**	
Description: Product level. L0A: Unprocessed instrument data; L0B: Reformatted, unprocessed instrument data; L1: Processed instrument data in radar coordinates system; and L2: Processed instrument data in geocoded coordinates system		
/science/SSAR/identification/isGeocoded		
Type: string	**Shape: scalar**	
Description: Flag to indicate if the product data is in the radar geometry ("False") or in the map geometry ("True")		
/science/SSAR/identification/boundingPolygon		
Type: string	**Shape: scalar**	
Description: OGR compatible WKT representation of bounding polygon of the image. Horizontal coordinates are WGS84 longitude followed by latitude (both in degrees), and the vertical coordinate is the height above the WGS84 ellipsoid in meters. The first point corresponds to the start-time, near-range radar coordinate, and the perimeter is traversed in counterclockwise order on the map. This means the traversal order in radar coordinates differs for left-looking and right-looking sensors. The polygon includes the four corners of the radar grid, with equal numbers of points distributed evenly in radar coordinates along each edge.		
	ogr_geometry	polygon
	epsg	4326
/science/SSAR/identification/processingDateTime		
Type: string	**Shape: scalar**	
Description: Processing UTC date and time in the format YYYY-mm-ddTHH:MM:SS		
/science/SSAR/identification/radarBand		
Type: string	**Shape: scalar**	
Description: Acquired frequency band, either “L” or “S”		
/science/SSAR/identification/platformName		
Type: string	**Shape: scalar**	
Description: Name of the platform used to collect the remote sensing data provided in this product		
/science/SSAR/identification/instrumentName		

Type: string		**Shape: scalar**
Description: Name of the instrument used to collect the remote sensing data provided in this product		
/science/SSAR/identification/processingType		
Type: string		**Shape: scalar**
Description: Nominal (or) Urgent (or) Custom (or) Undefined		
/science/SSAR/identification/isDithered		
Type: string		**Shape: scalar**
Description: "True" if the pulse timing was varied (dithered) during acquisition, "False" otherwise.		
/science/SSAR/identification/isMixedMode		
Type: string		**Shape: scalar**
Description: "True" if this product is a composite of data collected in multiple radar modes, "False" otherwise.		
/science/SSAR/identification/isFullFrame		
Type: string		**Shape: scalar**
Description: "True" if this product fully covers a NISAR frame**,** "False" if partial coverage.		
	frameCoveragePercentage	Percentage of NISAR frame containing processed data
	thresholdPercentage	Threshold percentage used to determine if the product is full frame or partial frame
/science/SSAR/identification/compositeReleaseId		
Type: string		**Shape: scalar**
Description: Unique version identifier of the science data production system		
/science/SSAR/identification/isJointObservation		
Type: string		**Shape: scalar**
Description: "True" if any portion of this product was acquired in a joint observation mode (e.g., L-band and S-band simultaneously), "False" otherwise		

7.4.3 Radar Imagery

Product Imagery Variables		
/science/SSAR/GCOV/grids/frequencyA/listOfPolarizations		
Type: string		**Shape: (numberOfFrequencyAPolarizations)**
Description: List of processed polarization layers with frequencyA		
/science/SSAR/GCOV/grids/frequencyA/listOfCovarianceTerms		
Type: string		**Shape: (numberOfFrequencyACovarianceTerms)**
Description: List of processed covariance terms		
/science/SSAR/GCOV/grids/frequencyA/yCoordinateSpacing		
Type: Float64		**Shape: scalar**
Description: Nominal spacing in meters between consecutive lines		
	units	meters
	long_name	Y coordinates spacing
/science/SSAR/GCOV/grids/frequencyA/xCoordinateSpacing		
Type: Float64		**Shape: scalar**
Description: Nominal spacing in meters between consecutive pixels		
	units	meters
	long_name	X coordinates spacing
/science/SSAR/GCOV/grids/frequencyA/numberOfLooks		
Type: Float32		**Shape: (frequencyALength, frequencyAWidth)**
Description: Number of averaged radar-grid pixels for covariance estimation		
	units	1
	valid_min	0
	_FillValue	nan
	grid_mapping	projection
	min_value	Minimum value of the real valued dataset

	mean_value	Mean value of the real valued dataset
	max_value	Maximum value of the real valued dataset
	sample_stddev	Sample standard deviation of the real valued dataset
	long_name	Number of range looks
/science/SSAR/GCOV/grids/frequencyA/projection		
Type: UInt32		**Shape: scalar**
Description: Product map grid projection: EPSG code, with additional projection information as HDF5 Attributes		
	ellipsoid	Projection ellipsoid
	epsg_code	Projection EPSG code
	false_easting	The value added to all abscissa values in the rectangular coordinates for a map projection.
	false_northing	The value added to all ordinate values in the rectangular coordinates for a map projection.
	grid_mapping_name	Grid mapping variable name
	inverse_flattening	Inverse flattening of the ellipsoidal figure
	latitude_of_projection_origin	The latitude chosen as the origin of rectangular coordinates for a map projection.
	longitude_of_projection_origin	The longitude, with respect to Greenwich, of the prime meridian associated with the geodetic datum.
	semi_major_axis	Semi-major axis
	spatial_ref	Spatial reference
	utm_zone_number	UTM zone number
	longitude_of_central_meridian	The line of longitude at the center of a map projection generally used as the basis for constructing the projection.
	scale_factor_at_central_meridian	A multiplier for reducing a distance obtained from a map by computation or scaling to the actual distance along the central meridian.
/science/SSAR/GCOV/grids/frequencyA/xCoordinates		
Type: Float64		**Shape: (frequencyAWidth)**
Description: X coordinates in specified projection		
	units	meters
	long_name	X coordinate of projection
	standard_name	projection_x_coordinate
/science/SSAR/GCOV/grids/frequencyA/yCoordinates		
Type: Float64		**Shape: (frequencyALength)**
Description: Y coordinates in specified projection		
	units	meters
	long_name	Y coordinate of projection
	standard_name	projection_y_coordinate
/science/SSAR/GCOV/grids/frequencyA/rtcGammaToSigmaFactor		
Type: Float32		**Shape: (frequencyALength, frequencyAWidth)**
Description: Radiometric terrain correction factor to normalize GCOV terms from gamma0 to sigma0		
	units	1
	valid_min	0.0
	_FillValue	nan
	grid_mapping	projection
	min_value	Minimum value of the real valued dataset
	mean_value	Mean value of the real valued dataset
	max_value	Maximum value of the real valued dataset

	sample_stddev	Sample standard deviation of the real valued dataset
	long_name	Radiometric terrain correction area normalization factor gamma0 to sigma0
/science/SSAR/GCOV/grids/frequencyA/mask		
Type: UByte		**Shape: (frequencyALength, frequencyAWidth)**
Description: Mask indicating the subswath number associated with valid GCOV samples. A GCOV sample is only considered valid if it is generated from fully-focused radar samples. If at least one radar sample in the averaging set is partially focused or invalid, the corresponding mask pixel will contain the value \`0\`. GCOV pixels outside of the radar acquisition extent are filled with the value \`255\`		
	units	1
	long_name	Valid samples subswath mask
	valid_min	0
	_FillValue	255
	grid_mapping	projection
/science/SSAR/GCOV/grids/frequencyA/HHHH		
Type: Float32		**Shape: (frequencyALength, frequencyAWidth)**
Description: Covariance between HH and HH in Gamma0		
	units	DN
	_FillValue	nan
	grid_mapping	projection
	min_value	Minimum value of the real valued dataset
	mean_value	Mean value of the real valued dataset
	max_value	Maximum value of the real valued dataset
	sample_stddev	Sample standard deviation of the real valued dataset
	long_name	Geocoded polarimetric covariance term HHHH
	valid_min	0
/science/SSAR/GCOV/grids/frequencyA/HHHV		
Type: CFloat32		**Shape: (frequencyALength, frequencyAWidth)**
Description: Covariance between HH and HV in Gamma0		
	units	DN
	_FillValue	nan+nan*j
	grid_mapping	projection
	min_value_real	Minimum value of the real part
	mean_value_real	Mean value of the real part
	max_value_real	Maximum value of the real part
	sample_stddev_real	Sample standard deviation of the real part
	min_value_imag	Minimum value of the imaginary part
	mean_value_imag	Mean value of the imaginary part
	max_value_imag	Maximum value of the imaginary part
	sample_stddev_imag	Sample standard deviation of the imaginary part
	long_name	Geocoded polarimetric covariance term HHHV
/science/SSAR/GCOV/grids/frequencyA/numberOfSubSwaths		
Type: UByte		**Shape: scalar**
Description: Number of swaths of continuous imagery, due to transmit gaps		
	units	1

7.4.4 Calibration Information

Calibration-related variables

/science/SSAR/GCOV/metadata/calibrationInformation/frequencyA/elevationAntennaPattern/projection		
Type: UInt32		**Shape: scalar**
Description: Product map grid projection: EPSG code, with additional projection information as HDF5 Attributes		
	ellipsoid	Projection ellipsoid
	epsg_code	Projection EPSG code
	false_easting	The value added to all abscissa values in the rectangular coordinates for a map projection.
	false_northing	The value added to all ordinate values in the rectangular coordinates for a map projection.
	grid_mapping_name	Grid mapping variable name
	inverse_flattening	Inverse flattening of the ellipsoidal figure
	latitude_of_projection_origin	The latitude chosen as the origin of rectangular coordinates for a map projection.
	longitude_of_projection_origin	The longitude, with respect to Greenwich, of the prime meridian associated with the geodetic datum.
	semi_major_axis	Semi-major axis
	spatial_ref	Spatial reference
	longitude_of_central_meridian	The line of longitude at the center of a map projection generally used as the basis for constructing the projection.
	scale_factor_at_central_meridian	A multiplier for reducing a distance obtained from a map by computation or scaling to the actual distance along the central meridian.
	utm_zone_number	UTM zone number
/science/SSAR/GCOV/metadata/calibrationInformation/frequencyA/elevationAntennaPattern/yCoordinates		
Type: Float64		**Shape: (calibrationLength)**
Description: Y coordinates in specified projection		
	units	meters
	long_name	Y coordinates of projection
	standard_name	projection_y_coordinate
/science/SSAR/GCOV/metadata/calibrationInformation/frequencyA/elevationAntennaPattern/xCoordinates		
Type: Float64		**Shape: (calibrationWidth)**
Description: X coordinates in specified projection		
	units	meters
	long_name	X coordinates of projection
	standard_name	projection_x_coordinate
/science/SSAR/GCOV/metadata/calibrationInformation/frequencyA/elevationAntennaPattern/HH		
Type: CFloat32		**Shape: (calibrationLength, calibrationWidth)**
Description: Complex two-way elevation antenna pattern		
	units	1
	grid_mapping	projection
	_FillValue	(nan+nan*j)
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)

	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GCOV/metadata/calibrationInformation/frequency/noiseEquivalentBackscatter/HH		
Type: Float32		**Shape: (calibrationLength, calibrationWidth)**
Description: Noise equivalent sigma zero		
	units	1
	grid_mapping	projection
	_FillValue	nan
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
	min_value	Minimum value of the real valued dataset
	mean_value	Mean value of the real valued dataset
	max_value	Maximum value of the real valued dataset
	sample_stddev	Sample standard deviation of the real valued dataset
/science/SSAR/GCOV/metadata/calibrationInformation/frequencyA/noiseEquivalentBackscatter/projection		
Type: UInt32		**Shape: scalar**
Description: Product map grid projection: EPSG code, with additional projection information as HDF5 Attributes		
	ellipsoid	Projection ellipsoid
	epsg_code	Projection EPSG code
	false_easting	The value added to all abscissa values in the rectangular coordinates for a map projection.
	false_northing	The value added to all ordinate values in the rectangular coordinates for a map projection.
	grid_mapping_name	Grid mapping variable name
	inverse_flattening	Inverse flattening of the ellipsoidal figure
	latitude_of_projection_origin	The latitude chosen as the origin of rectangular coordinates for a map projection.
	longitude_of_projection_origin	The longitude, with respect to Greenwich, of the prime meridian associated with the geodetic datum.
	semi_major_axis	Semi-major axis
	spatial_ref	Spatial reference
	longitude_of_central_meridian	The line of longitude at the center of a map projection generally used as the basis for constructing the projection.
	scale_factor_at_central_meridian	A multiplier for reducing a distance obtained from a map by computation or scaling to the actual distance along the central meridian.
	utm_zone_number	UTM zone number
/science/SSAR/GCOV/metadata/calibrationInformation/frequencyA/noiseEquivalentBackscatter/yCoordinates		
Type: Float64		**Shape: (calibrationLength)**
Description: Y coordinates in specified projection		
	units	meters
	long_name	Y coordinates of projection

	standard_name	projection_y_coordinate
/science/SSAR/GCOV/metadata/calibrationInformation/frequencyA/noiseEquivalentBackscatter/xCoordinates		
Type: Float64	**Shape: (calibrationWidth)**	
Description: X coordinates in specified projection		
	units	meters
	long_name	X coordinates of projection
	standard_name	projection_x_coordinate

/science/SSAR/GCOV/metadata/calibrationInformation/crosstalk/txHorizontalCrosspol		
Type: CFloat32	**Shape: (calibrationLength, calibrationWidth)**	
Description: Crosstalk in H-transmit channel expressed as ratio txV / txH		
	units	1
	grid_mapping	projection
	_FillValue	nan+nan*j
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GCOV/metadata/calibrationInformation/crosstalk/txVerticalCrosspol		
Type: CFloat32	**Shape: (calibrationLength, calibrationWidth)**	
Description: Crosstalk in V-transmit channel expressed as ratio txH / txV		
	units	1
	grid_mapping	projection
	_FillValue	nan+nan*j
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GCOV/metadata/calibrationInformation/crosstalk/rxHorizontalCrosspol		
Type: CFloat32	**Shape: (calibrationLength, calibrationWidth)**	
Description: Crosstalk in H-receive channel expressed as ratio rxV / rxH		
	units	1
	grid_mapping	projection
	_FillValue	nan+nan*j
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GCOV/metadata/calibrationInformation/crosstalk/rxVerticalCrosspol		
Type: CFloat32	**Shape: (calibrationLength, calibrationWidth)**	
Description: Crosstalk in V-recieve channel expressed as ratio rxH / rxV		
	units	1
	grid_mapping	Projection
	_FillValue	nan+nan*j
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GCOV/metadata/calibrationInformation/frequencyA/commonDelay		

Type: Float64	**Shape: scalar**	
Description: Range delay correction applied to all polarimetric channels		
	units	meters
/science/SSAR/GCOV/metadata/calibrationInformation/frequencyA/faradayRotation		
Type: Float64	**Shape: scalar**	
Description: Faraday rotation correction applied in processing		
	units	radian
/science/SSAR/GCOV/metadata/calibrationInformation/frequencyA/HH/differentialDelay		
Type: Float64	**Shape: scalar**	
Description: Range delay correction applied to HH channel		
	units	meters
/science/SSAR/GCOV/metadata/calibrationInformation/frequencyA/HH/differentialPhase		
Type: Float64	**Shape: scalar**	
Description: Phase correction applied to HH channel		
	units	radian
/science/SSAR/GCOV/metadata/calibrationInformation/frequencyA/HH/scaleFactor		
Type: Float64	**Shape: scalar**	
Description: Scale factor applied to HH channel complex amplitude (at antenna boresite)		
	units	1
/science/SSAR/GCOV/metadata/calibrationInformation/frequencyA/HH/scaleFactorSlope		
Type: Float64	**Shape: scalar**	
Description: Slope of scale factor applied to HH channel complex amplitude with respect to elevation angle		
	units	radian^-1
/science/SSAR/GCOV/metadata/calibrationInformation/frequencyA/HH/rfiLikelihood		
Type: Float64	**Shape: scalar**	
Description: Severity of radio frequency interference (RFI) contamination in the data. Value is in the interval [0,1], where 0: lowest severity, and 1: highest severity (or NaN if RFI detection was skipped)		
	units	1

7.4.5 Source Data Metadata

Source data variables	
/science/SSAR/GCOV/metadata/sourceData/productVersion	
Type: string	**Shape: scalar**
Description: Product version of the source data	
/science/SSAR/GCOV/metadata/sourceData/productDoi	
Type: string	**Shape: scalar**
Description: Digital Object Identifier (DOI) of the source product	
/science/SSAR/GCOV/metadata/sourceData/lookDirection	
Type: string	**Shape: scalar**
Description: Look direction, either “Left” or “Right”	
/science/SSAR/GCOV/metadata/sourceData/productLevel	
Type: string	**Shape: scalar**
Description: Source data product level. Product level. L0A: Unprocessed instrument data; L0B: Reformatted, unprocessed instrument data; L1: Processed instrument data in radar coordinates system; and L2: Processed instrument data in geocoded coordinates system	
/science/SSAR/GCOV/metadata/sourceData/productGeometry	
Type: string	**Shape: scalar**
Description: Source data product geometry, either "Slant range" or "Ground range"	
/science/SSAR/GCOV/metadata/sourceData/processingDateTime	
Type: string	**Shape: scalar**
Description: Source data processing date and time (in UTC) in the format YYYY-mm-ddTHH:MM:SS	
/science/SSAR/GCOV/metadata/sourceData/processingCenter	

Type: string	**Shape: scalar**	
Description: Source data processing center		
/science/SSAR/GCOV/metadata/sourceData/processingInformation/parameters/runConfigurationContents		
Type: string	**Shape: scalar**	
Description: Contents of the run configuration file with parameters used for processing of the source data product		
/science/SSAR/GCOV/metadata/sourceData/processingInformation/parameters/referenceTerrainHeight		
Type: Float32	**Shape: (sourceDataDopplerCentroidTimeLength, sourceDataDopplerCentroidSlantRangeWidth)**	
Description: Reference terrain height corresponding to the source data processing information records		
	units	meters
/science/SSAR/GCOV/metadata/sourceData/processingInformation/parameters/zeroDopplerTime		
Type: Float64	**Shape: (sourceDataDopplerCentroidTimeLength)**	
Description: Zero Doppler time since UTC epoch dimension corresponding to source data processing information records		
	units	seconds since YYYY-mm-ddTHH:MM:SS
/science/SSAR/GCOV/metadata/sourceData/processingInformation/parameters/slantRange		
Type: Float64	**Shape: (sourceDataDopplerCentroidSlantRangeWidth)**	
Description: Slant range dimension corresponding to source data processing information records		
	units	meters
/science/SSAR/GCOV/metadata/sourceData/processingInformation/parameters/frequencyA/zeroDopplerTime		
Type: Float64	**Shape: (sourceDataDopplerCentroidTimeLength)**	
Description: Zero Doppler time since UTC epoch dimension corresponding to source data processing information records		
	units	seconds since YYYY-mm-ddTHH:MM:SS
/science/SSAR/GCOV/metadata/sourceData/processingInformation/parameters/frequencyA/slantRange		
Type: Float64	**Shape: (sourceDataDopplerCentroidSlantRangeWidth)**	
Description: Slant range dimension corresponding to source data processing information records		
	units	meters
/science/SSAR/GCOV/metadata/sourceData/processingInformation/parameters/frequencyA/dopplerCentroid		
Type: Float64	**Shape: (sourceDataDopplerCentroidTimeLength, sourceDataDopplerCentroidSlantRangeWidth)**	
Description: 2D LUT of Doppler centroid for frequency A corresponding to the source data processing information records		
	units	hertz
/science/SSAR/GCOV/metadata/sourceData/processingInformation/algorithms/rfiDetection		
Type: string	**Shape: scalar**	
Description: Algorithm used for radio frequency interference (RFI) detection corresponding to the source data processing information records.		
/science/SSAR/GCOV/metadata/sourceData/processingInformation/algorithms/rfiMitigation		
Type: string	**Shape: scalar**	
Description: Algorithm used for radio frequency interference (RFI) mitigation corresponding to the source data processing information records, either "ST-EVD" or "FDNF" (or "disabled" if no RFI mitigation was applied)		
/science/SSAR/GCOV/metadata/sourceData/processingInformation/algorithms/rangeCompression		
Type: string	**Shape: scalar**	
Description: Algorithm for focusing the data in the range direction corresponding to the source data processing information records		
/science/SSAR/GCOV/metadata/sourceData/processingInformation/algorithms/elevationAntennaPatternCorrection		
Type: string	**Shape: scalar**	

Description: Algorithm for calibrating the antenna pattern corresponding to the source data processing information records		
/science/SSAR/GCOV/metadata/sourceData/processingInformation/algorithms/rangeSpreadingLossCorrection		
Type: string	**Shape: scalar**	
Description: Algorithm for calibrating range fading corresponding to the source data processing information records		
/science/SSAR/GCOV/metadata/sourceData/processingInformation/algorithms/dopplerCentroidEstimation		
Type: string	**Shape: scalar**	
Description: Algorithm for calculating Doppler centroid corresponding to the source data processing information records		
/science/SSAR/GCOV/metadata/sourceData/processingInformation/algorithms/azimuthPresumming		
Type: string	**Shape: scalar**	
Description: Algorithm for regridding and filling gaps in the raw data in azimuth corresponding to the source data processing information records		
/science/SSAR/GCOV/metadata/sourceData/processingInformation/algorithms/azimuthCompression		
Type: string	**Shape: scalar**	
Description: Algorithm for focusing the data in the azimuth direction		
/science/SSAR/GCOV/metadata/sourceData/processingInformation/algorithms/softwareVersion		
Type: string	**Shape: scalar**	
Description: Software version used for processing the source data		
/science/SSAR/GCOV/metadata/sourceData/swaths/zeroDopplerStartTime		
Type: string	**Shape: scalar**	
Description: Azimuth start time (in UTC) of the source data product in the format YYYY-mm-ddTHH:MM:SS.sssssssss		
/science/SSAR/GCOV/metadata/sourceData/swaths/zeroDopplerEndTime		
Type: string	**Shape: scalar**	
Description: Azimuth stop time (in UTC) of the source data product in the format YYYY-mm-ddTHH:MM:SS.sssssssss		
/science/SSAR/GCOV/metadata/sourceData/swaths/zeroDopplerTimeSpacing		
Type: Float64	**Shape: scalar**	
Description: Time interval in the along-track direction of the source data in seconds		
	units	second
/science/SSAR/GCOV/metadata/sourceData/swaths/numberOfAzimuthLines		
Type: UInt64	**Shape: scalar**	
Description: Number of azimuth lines within the source data product		
/science/SSAR/GCOV/metadata/sourceData/swaths/frequencyA/listOfPolarizations		
Type: string	**Shape: (numberOfSourceDataFrequencyAPolarizations)**	
Description: List of polarization layers with frequency A within the source data product		
/science/SSAR/GCOV/metadata/sourceData/swaths/frequencyA/sceneCenterAlongTrackResolution		
Type: Float64	**Shape: scalar**	
Description: Nominal along-track resolution in meters of the source data at scene center		
	units	meters
/science/SSAR/GCOV/metadata/sourceData/swaths/frequencyA/rangeResolution		
Type: Float64	**Shape: scalar**	
Description: Nominal range resolution in meters of the source data		
	units	meters
/science/SSAR/GCOV/metadata/sourceData/swaths/frequencyA/sceneCenterAlongTrackSpacing		
Type: Float64	**Shape: scalar**	
Description: Nominal along-track spacing in meters between consecutive lines near mid swath of the source data		
	units	meters
/science/SSAR/GCOV/metadata/sourceData/swaths/frequencyA/sceneCenterGroundRangeSpacing		
Type: Float64	**Shape: scalar**	

Description: Nominal ground range spacing in meters between consecutive pixels near mid swath of the source data		
	units	meters
/science/SSAR/GCOV/metadata/sourceData/swaths/frequencyA/acquiredRangeBandwidth		
Type: Float64	**Shape: scalar**	
Description: Source data acquisition range bandwidth in hertz. In case of mode combination, this corresponds to mode with largest bandwidth		
	units	hertz
/science/SSAR/GCOV/metadata/sourceData/swaths/frequencyA/processedRangeBandwidth		
Type: Float64	**Shape: scalar**	
Description: Source data processed range bandwidth in hertz		
	units	hertz
/science/SSAR/GCOV/metadata/sourceData/swaths/frequencyA/processedAzimuthBandwidth		
Type: Float64	**Shape: scalar**	
Description: Source data processed azimuth bandwidth in hertz		
	units	hertz
/science/SSAR/GCOV/metadata/sourceData/swaths/frequencyA/centerFrequency		
Type: Float64	**Shape: scalar**	
Description: Center frequency of the processed source data image in hertz		
	units	hertz
/science/SSAR/GCOV/metadata/sourceData/swaths/frequencyA/slantRangeStart		
Type: Float64	**Shape: scalar**	
Description: Source data slant range start distance		
	units	meters
/science/SSAR/GCOV/metadata/sourceData/swaths/frequencyA/slantRangeSpacing		
Type: Float64	**Shape: scalar**	
Description: Slant range spacing of the source data in meters		
	units	meters
/science/SSAR/GCOV/metadata/sourceData/swaths/frequencyA/numberOfRangeSamples		
Type: UInt64	**Shape: scalar**	
Description: Number of slant range samples for each azimuth line within the source data		
	units	1
/science/SSAR/GCOV/metadata/sourceData/swaths/frequencyA/nearRangeIncidenceAngle		
Type: Float64	**Shape: scalar**	
Description: Near-range incidence angle in degrees at the central azimuth line. The incidence angle is defined as the angle between the LOS vector and the normal to the ellipsoid at the target height		
	units	degrees
/science/SSAR/GCOV/metadata/sourceData/swaths/frequencyA/farRangeIncidenceAngle		
Type: Float64	**Shape: scalar**	
Description: Far-range incidence angle in degrees at the central azimuth line. The incidence angle is defined as the angle between the LOS vector and the normal to the ellipsoid at the target height		
	units	degrees

7.4.6 Processing Information

Processing information variables	
/science/SSAR/GCOV/metadata/processingInformation/parameters/noiseCorrectionApplied	
Type: string	**Shape: scalar**
Description: Flag to indicate if noise correction has been applied	
/science/SSAR/GCOV/metadata/processingInformation/parameters/preprocessingMultilookingApplied	
Type: string	**Shape: scalar**
Description: Flag to indicate if a preprocessing multilooking has been applied	
/science/SSAR/GCOV/metadata/processingInformation/parameters/polarizationOrientationCorrectionApplied	

Type: string	**Shape: scalar**	
Description: Flag to indicate if the polarization orientation correction has been applied		
/science/SSAR/GCOV/metadata/processingInformation/parameters/faradayRotationApplied		
Type: string	**Shape: scalar**	
Description: Flag to indicate if the Faraday rotation correction has been applied		
/science/SSAR/GCOV/metadata/processingInformation/parameters/radiometricTerrainCorrectionApplied		
Type: string	**Shape: scalar**	
Description: Flag to indicate if the radiometric terrain correction has been applied		
/science/SSAR/GCOV/metadata/processingInformation/parameters/dryTroposphericGeolocationCorrectionApplied		
Type: string	**Shape: scalar**	
Description: Flag to indicate if the dry tropospheric correction has been applied		
/science/SSAR/GCOV/metadata/processingInformation/parameters/wetTroposphericGeolocationCorrectionApplied		
Type: string	**Shape: scalar**	
Description: Flag to indicate if the wet tropospheric correction has been applied		
/science/SSAR/GCOV/metadata/processingInformation/parameters/rangeIonosphericGeolocationCorrectionApplied		
Type: string	**Shape: scalar**	
Description: Flag to indicate if the range ionospheric correction has been applied		
/science/SSAR/GCOV/metadata/processingInformation/parameters/azimuthIonosphericGeolocationCorrectionApplie d		
Type: string	**Shape: scalar**	
Description: Flag to indicate if the azimuth ionospheric correction has been applied		
/science/SSAR/GCOV/metadata/processingInformation/parameters/rfiMitigationApplied		
Type: string	**Shape: scalar**	
Description: Flag to indicate if an RFI mitigation has been applied		
/science/SSAR/GCOV/metadata/processingInformation/parameters/postProcessingFilteringApplied		
Type: string	**Shape: scalar**	
Description: Flag to indicate if the post-processing filtering has been applied		
/science/SSAR/GCOV/metadata/processingInformation/parameters/isFullCovariance		
Type: string	**Shape: scalar**	
Description: Flag to indicate if the product is full-covariance		
/science/SSAR/GCOV/metadata/processingInformation/parameters/validSamplesSubSwathMaskingApplied		
Type: string	**Shape: scalar**	
Description: Flag to indicate if the valid samples subswath masking has been applied		
/science/SSAR/GCOV/metadata/processingInformation/parameters/shadowMaskingApplied		
Type: string	**Shape: scalar**	
Description: Flag to indicate if the shadow masking has been applied		
/science/SSAR/GCOV/metadata/processingInformation/parameters/polarimetricSymmetrizationApplied		
Type: string	**Shape: scalar**	
Description: Flag to indicate if the polarimetric symmetrization has been applied		
/science/SSAR/GCOV/metadata/processingInformation/parameters/preprocessing/frequencyA/numberOfRangeLooks		
Type: UInt64	**Shape: scalar**	
Description: Number of range looks applied to the RSLC before geocoding		
	units	1
/science/SSAR/GCOV/metadata/processingInformation/parameters/preprocessing/frequencyA/numberOfAzimuthLoo ks		
Type: UInt64	**Shape: scalar**	
Description: Number of azimuth looks applied to the RSLC before geocoding		
	units	1

/science/SSAR/GCOV/metadata/processingInformation/parameters/rtc/inputBackscatterNormalizationConvention		
Type: string	**Shape: scalar**	
Description: Backscatter normalization convention of the source data		
/science/SSAR/GCOV/metadata/processingInformation/parameters/rtc/outputBackscatterNormalizationConvention		
Type: string	**Shape: scalar**	
Description: Backscatter normalization convention of the primary data associated with this product		
/science/SSAR/GCOV/metadata/processingInformation/parameters/rtc/outputBackscatterExpressionConvention		
Type: string	**Shape: scalar**	
Description: Backscatter expression convention		
/science/SSAR/GCOV/metadata/processingInformation/parameters/rtc/memoryMode		
Type: string	**Shape: scalar**	
Description: Radiometric terrain correction (RTC) memory mode		
/science/SSAR/GCOV/metadata/processingInformation/parameters/rtc/minRtcAreaNormalizationFactorInDB		
Type: Float64	**Shape: scalar**	
Description: Radiometric terrain correction (RTC) minimum area normalization factor value in dB computed as `10 * log10(area_out / area_in)` where `area_in` and `area_out` are the reference surfaces associated with the source data (input) and GCOV terms (output) backscatter conventions, respectively		
	units	1
/science/SSAR/GCOV/metadata/processingInformation/parameters/rtc/geogridUpsampling		
Type: Float64	**Shape: scalar**	
Description: Radiometric terrain correction (RTC) geogrid upsampling		
	units	1
/science/SSAR/GCOV/metadata/processingInformation/parameters/geocoding/memoryMode		
Type: string	**Shape: scalar**	
Description: Geocoding memory mode		
/science/SSAR/GCOV/metadata/processingInformation/parameters/geocoding/geogridUpsampling		
Type: Float64	**Shape: scalar**	
Description: Geocoding geogrid upsampling		
	units	1
/science/SSAR/GCOV/metadata/processingInformation/parameters/geocoding/minBlockSize		
Type: UInt64	**Shape: scalar**	
Description: Minimum block size in megabytes (MB) per thread		
	units	1
/science/SSAR/GCOV/metadata/processingInformation/parameters/geocoding/maxBlockSize		
Type: UInt64	**Shape: scalar**	
Description: Maximum block size in megabytes (MB) per thread		
	units	1
/science/SSAR/GCOV/metadata/processingInformation/parameters/geocoding/isSourceDataUpsampled		
Type: string	**Shape: scalar**	
Description: Flag to indicate if the source data is upsampled for geocoding		
/science/SSAR/GCOV/metadata/processingInformation/parameters/geocoding/snapToGridX		
Type: Float64	**Shape: scalar**	
Description: Snap to the grid along the X direction with the origin set at 0. The X-coordinate of the scene's upper-left corner is a multiple of this value		
	units	meters
/science/SSAR/GCOV/metadata/processingInformation/parameters/geocoding/snapToGridY		
Type: Float64	**Shape: scalar**	
Description: Snap to the grid along the Y direction with the origin set at 0. The Y-coordinate of the scene's upper-left corner is a multiple of this value		
	units	meters

/science/SSAR/GCOV/metadata/processingInformation/parameters/geo2rdr/convergenceThreshold		
Type: Float64	**Shape: scalar**	
Description: Slant range convergence threshold for geo2rdr transformation		
	units	1
/science/SSAR/GCOV/metadata/processingInformation/parameters/geo2rdr/maxNumberOfIterations		
Type: UInt64	**Shape: scalar**	
Description: Maximum number of iterations for geo2rdr transformation		
	units	1
/science/SSAR/GCOV/metadata/processingInformation/parameters/geo2rdr/deltaRange		
Type: Float64	**Shape: scalar**	
Description: Step size for computing numerical gradient of Doppler in meters for geo2rdr transformation		
	units	1
/science/SSAR/GCOV/metadata/processingInformation/parameters/projection		
Type: UInt32	**Shape: scalar**	
Description: Product map grid projection: EPSG code, with additional projection information as HDF5 Attributes		
	ellipsoid	Projection ellipsoid
	epsg_code	Projection EPSG code
	false_easting	The value added to all abscissa values in the rectangular coordinates for a map projection.
	false_northing	The value added to all ordinate values in the rectangular coordinates for a map projection.
	grid_mapping_name	Grid mapping variable name
	inverse_flattening	Inverse flattening of the ellipsoidal figure
	latitude_of_projection_origin	The latitude chosen as the origin of rectangular coordinates for a map projection.
	longitude_of_projection_origin	The longitude, with respect to Greenwich, of the prime meridian associated with the geodetic datum.
	semi_major_axis	Semi-major axis
	spatial_ref	Spatial reference
	utm_zone_number	UTM zone number
	longitude_of_central_meridian	The line of longitude at the center of a map projection generally used as the basis for constructing the projection.
	scale_factor_at_central_meridian	A multiplier for reducing a distance obtained from a map by computation or scaling to the actual distance along the central meridian.
/science/SSAR/GCOV/metadata/processingInformation/parameters/yCoordinates		
Type: Float64	**Shape: (dopplerCentroidLength)**	
Description: Y coordinate dimension corresponding to processing information records		
	units	meters
	long_name	Y coordinates of projection
	standard_name	projection_y_coordinate
/science/SSAR/GCOV/metadata/processingInformation/parameters/xCoordinates		
Type: Float64	**Shape: (dopplerCentroidWidth)**	
Description: X coordinate dimension corresponding to processing information records"		
	units	meters
	long_name	X coordinates of projection
	standard_name	projection_x_coordinate
/science/SSAR/GCOV/metadata/processingInformation/parameters/referenceTerrainHeight		
Type: Float32	**Shape: (dopplerCentroidLength, dopplerCentroidWidth)**	
Description: Reference Terrain Height as a function of map coordinates		
	units	meters
	_FillValue	nan

	grid_mapping	projection
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth directionsourceData
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GCOV/metadata/processingInformation/parameters/rangeIonosphericGeolocationCorrectionApplied		
Type: string	**Shape: scalar**	
Description: Flag to indicate if the range ionospheric correction has been applied to improve geolocation		
/science/SSAR/GCOV/metadata/processingInformation/parameters/azimuthIonosphericGeolocationCorrectionApplied		
Type: string	**Shape: scalar**	
Description: Flag to indicate if the azimuth ionospheric correction has been applied to improve geolocation		
/science/SSAR/GCOV/metadata/processingInformation/parameters/frequencyA/projection		
Type: UInt32	**Shape: scalar**	
Description: Product map grid projection: EPSG code, with additional projection information as HDF5 Attributes		
	ellipsoid	Projection ellipsoid
	epsg_code	Projection EPSG code
	false_easting	The value added to all abscissa values in the rectangular coordinates for a map projection.
	false_northing	The value added to all ordinate values in the rectangular coordinates for a map projection.
	grid_mapping_name	Grid mapping variable name
	inverse_flattening	Inverse flattening of the ellipsoidal figure
	latitude_of_projection_origin	The latitude chosen as the origin of rectangular coordinates for a map projection.
	longitude_of_projection_origin	The longitude, with respect to Greenwich, of the prime meridian associated with the geodetic datum.
	semi_major_axis	Semi-major axis
	spatial_ref	Spatial reference
	utm_zone_number	UTM zone number
	longitude_of_central_meridian	The line of longitude at the center of a map projection generally used as the basis for constructing the projection.
	scale_factor_at_central_meridian	A multiplier for reducing a distance obtained from a map by computation or scaling to the actual distance along the central meridian.
/science/SSAR/GCOV/metadata/processingInformation/parameters/frequencyA/yCoordinates		
Type: Float64	**Shape: (dopplerCentroidLength)**	
Description: Y coordinate dimension corresponding to processing information records		
	units	meters
	long_name	Y coordinates of projection
	standard_name	projection_y_coordinate
/science/SSAR/GCOV/metadata/processingInformation/parameters/frequencyA/xCoordinates		
Type: Float64	**Shape: (dopplerCentroidWidth)**	
Description: X coordinate dimension corresponding to processing information records"		
	units	meters
	long_name	X coordinates of projection
	standard_name	projection_x_coordinate
/science/SSAR/GCOV/metadata/processingInformation/parameters/frequencyA/dopplerCentroid		
Type: Float64	**Shape: (dopplerCentroidLength, dopplerCentroidWidth)**	
Description: 2D LUT of Doppler Centroid for Frequency A		
	_FillValue	nan

	grid_mapping	projection
	units	hertz
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)

/science/SSAR/GCOV/metadata/processingInformation/parameters/runConfigurationContents	
Type: string	**Shape: scalar**
Description: Contents of the run configuration file with parameters used for processing	
/science/SSAR/GCOV/metadata/processingInformation/algorithms/demInterpolation	
Type: string	**Shape: scalar**
Description: DEM interpolation method	
/science/SSAR/GCOV/metadata/processingInformation/algorithms/geocoding	
Type: string	**Shape: scalar**
Description: Geocoding algorithm	
/science/SSAR/GCOV/metadata/processingInformation/algorithms/radiometricTerrainCorrection	
Type: string	**Shape: scalar**
Description: Radiometric terrain correction (RTC) algorithm	
/science/SSAR/GCOV/metadata/processingInformation/algorithms/rfiCorrection	
Type: string	**Shape: scalar**
Description: RFI correction algorithm	
/science/SSAR/GCOV/metadata/processingInformation/algorithms/polarimetricSymmetrization	
Type: string	**Shape: scalar**
Description: Polarimetric symmetrization algorithm	
/science/SSAR/GCOV/metadata/processingInformation/algorithms/radiometricTerrainCorrectionAlgorithmReference	
Type: string	**Shape: scalar**
Description: Reference to the radiometric terrain correction (RTC) algorithm applied (if applicable)	
/science/SSAR/GCOV/metadata/processingInformation/algorithms/geocodingAlgorithmReference	
Type: string	**Shape: scalar**
Description: Reference to the geocoding algorithm applied (if applicable)	
/science/SSAR/GCOV/metadata/processingInformation/algorithms/softwareVersion	
Type: string	**Shape: scalar**
Description: Software version used for processing	
/science/SSAR/GCOV/metadata/processingInformation/inputs/l1SlcGranules	
Type: string	**Shape: (numberOfInputL1Files)**
Description: List of input L1 RSLC products used	
/science/SSAR/GCOV/metadata/processingInformation/inputs/orbitFiles	
Type: string	**Shape: (numberOfInputOrbitFiles)**
Description: List of input orbit files used	
/science/SSAR/GCOV/metadata/processingInformation/inputs/configFiles	
Type: string	**Shape: (numberOfInputConfigFiles)**
Description: List of input config files used	
/science/SSAR/GCOV/metadata/processingInformation/inputs/tecFiles	
Type: string	**Shape: (numberOfInputTecFiles)**
Description: List of input total electron content (TEC) files used	
/science/SSAR/GCOV/metadata/processingInformation/inputs/demFiles	
Type: string	**Shape: (numberOfInputDemFiles)**
Description: List of input files used	
/science/SSAR/GCOV/metadata/processingInformation/inputs/demSource	
Type: string	**Shape: scalar**
Description: Description of the input digital elevation model (DEM)	

7.4.7 Other Radar Metadata

Radar metadata-related variables		
/science/SSAR/GCOV/metadata/orbit/time		
Type: Float64	**Shape: (orbitListLength)**	
Description: Time vector record. This record contains the time corresponding to position, velocity, acceleration records		
	units	seconds since YYYY-MM-DDTHH:MM:SS
/science/SSAR/GCOV/metadata/orbit/position		
Type: Float64	**Shape: (orbitListLength, tripletxyz)**	
Description: Position vector record. This record contains the platform position data with respect to WGS84 G1762 reference frame		
	units	meters
/science/SSAR/GCOV/metadata/orbit/velocity		
Type: Float64	**Shape: (orbitListLength, tripletxyz)**	
Description: Velocity vector record. This record contains the platform velocity data with respect to WGS84 G1762 reference frame		
	units	meters / second
/science/SSAR/GCOV/metadata/orbit/orbitType		
Type: string	**Shape: scalar**	
Description: Orbit product type, either "FOE", "NOE", "MOE", "POE", or "Custom", where "FOE" stands for Forecast Orbit Ephemeris, "NOE" is Near real-time Orbit Ephemeris, "MOE" is Medium precision Orbit Ephemeris, and "POE" is Precise Orbit Ephemeris		
/science/SSAR/GCOV/metadata/orbit/interpMethod		
Type: string	**Shape: scalar**	
Description: Orbit interpolation method, either "Hermite" or "Legendre"		
	units	seconds since YYYY-MM-DDTHH:MM:SS
/science/SSAR/GCOV/metadata/ceosAnalysisReadyData/boundingBox		
Type: string	**Shape: scalar**	
Description: OGR compatible WKT representing the bounding box of the product (the union of the geocoded grid for available frequency A and frequency B image datasets). Horizontal coordinates are X and Y directions of the geocoded grid coordinate system, and the vertical coordinate is the height above the WGS84 ellipsoid in meters. The first point corresponds to the top left edge of the bounding box. The remaining points are traversed in counterclockwise order on the map. The fifth point closes the bounding box by repeating the first point		
	epsg	EPSG code
/science/SSAR/GCOV/metadata/ceosAnalysisReadyData/staticLayersDataAccess		
Type: string	**Shape: scalar**	
Description: Location of the static layers product associated with this product (URL or DOI)		
/science/SSAR/GCOV/metadata/ceosAnalysisReadyData/outputBackscatterDecibelConversionFormula		
Type: string	**Shape: scalar**	
Description: Formula to convert provided backscatter to decibel (dB)		
/science/SSAR/GCOV/metadata/ceosAnalysisReadyData/ceosAnalysisReadyDataProductType		
Type: string	**Shape: scalar**	
Description: CEOS Analysis Ready Data (CARD) product type		
/science/SSAR/GCOV/metadata/ceosAnalysisReadyData/ceosAnalysisReadyDataDocumentIdentifier		
Type: string	**Shape: scalar**	
Description: CEOS Analysis Ready Data (CARD) document identifier		
/science/SSAR/GCOV/metadata/ceosAnalysisReadyData/geometricAccuracy/bias/y		
Type: Float32	**Shape: scalar**	
Description: An estimate of the localization error bias in the Y/northing direction		
	epsg	EPSG code
	units	meters
/science/SSAR/GCOV/metadata/ceosAnalysisReadyData/geometricAccuracy/bias/x		
Type: Float32	**Shape: scalar**	
Description: An estimate of the localization error bias in the X/easting direction		

	epsg	EPSG code
	units	meters
/science/SSAR/GCOV/metadata/ceosAnalysisReadyData/geometricAccuracy/standardDeviation/y		
Type: Float32	**Shape: scalar**	
Description: An estimate of the localization error standard deviation in the Y/northing direction		
	epsg	EPSG code
	units	meters
/science/SSAR/GCOV/metadata/ceosAnalysisReadyData/geometricAccuracy/standardDeviation/x		
Type: Float32	**Shape: scalar**	
Description: An estimate of the localization error standard deviation in the X/easting direction		
	epsg	EPSG code
	units	meters
/science/SSAR/GCOV/metadata/attitude/time		
Type: Float64	**Shape: (attitudeListLength)**	
Description: Time vector record. This record contains the time since UTC epoch corresponding to attitude and quaternion records		
	units	seconds since YYYY-mm-ddTHH:MM:SS
/science/SSAR/GCOV/metadata/attitude/quaternions		
Type: Float64	**Shape: (attitudeListLength, quaternions)**	
Description: Attitude quaternions (q0, q1, q2, q3)		
	units	1
/science/SSAR/GCOV/metadata/attitude/eulerAngles		
Type: Float64	**Shape: (attitudeListLength, tripletxyz)**	
Description: Attitude Euler angles (roll, pitch, yaw)		
	units	degree
/science/SSAR/GCOV/metadata/attitude/attitudeType		
Type: string	**Shape: scalar**	
Description: Attitude type, either "FRP", "NRP", "PRP, or "Custom", where "FRP" stands for Forecast Radar Pointing, "NRP" is Near Real-time Pointing, and "PRP" is Precise Radar Pointing		

7.4.8 Radar Grid

Metadata cube-related variables		
/science/SSAR/GCOV/metadata/radarGrid/slantRange		
Type: Float64	**Shape: (radarCubeHeight, radarCubeLength, radarCubeWidth)**	
Description: Slant range in meters		
	units	meters
	long_name	Slant range
	grid_mapping	projection
	_FillValue	nan
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GCOV/metadata/radarGrid/zeroDopplerAzimuthTime		
Type: Float64	**Shape: (radarCubeHeight, radarCubeLength, radarCubeWidth)**	
Description: Zero doppler azimuth time in seconds since UTC epoch		
	units	seconds since YYYY-mm-ddTHH:MM:SS
	long_name	Zero Doppler azimuth time
	grid_mapping	projection
	_FillValue	nan
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction

	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GCOV/metadata/radarGrid/incidenceAngle		
Type: Float32	**Shape: (radarCubeHeight, radarCubeLength, radarCubeWidth)**	
Description: Incidence angle is defined as the angle between the LOS vector and the normal to the ellipsoid at the target height		
	valid_max	90.0
	valid_min	0.0
	units	degree
	_FillValue	nan
	grid_mapping	projection
	long_name	Incidence Angle
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GCOV/metadata/radarGrid/losUnitVectorX		
Type: Float32	**Shape: (radarCubeHeight, radarCubeLength, radarCubeWidth)**	
Description: East component of unit vector of LOS from target to sensor		
	valid_max	1.0
	valid_min	-1.0
	units	1
	_FillValue	nan
	grid_mapping	projection
	long_name	LOS unit vector X
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GCOV/metadata/radarGrid/losUnitVectorY		
Type: Float32	**Shape: (radarCubeHeight, radarCubeLength, radarCubeWidth)**	
Description: North component of unit vector of LOS from target to sensor		
	valid_max	1.0
	valid_min	-1.0
	units	1
	_FillValue	nan
	grid_mapping	projection
	long_name	LOS unit vector Y
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GCOV/metadata/radarGrid/alongTrackUnitVectorX		
Type: Float32	**Shape: (radarCubeHeight, radarCubeLength, radarCubeWidth)**	
Description: East component of unit vector along ground track		
	valid_max	1.0
	valid_min	-1.0
	units	1
	_FillValue	nan
	grid_mapping	projection

	long_name	Along-track unit vector X
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GCOV/metadata/radarGrid/alongTrackUnitVectorY		
Type: Float32	**Shape: (radarCubeHeight, radarCubeLength, radarCubeWidth)**	
Description: North component of unit vector along ground track		
	valid_max	1.0
	valid_min	-1.0
	units	1
	_FillValue	nan
	grid_mapping	projection
	long_name	Along-track unit vector Y
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GCOV/metadata/radarGrid/elevationAngle		
Type: Float32	**Shape: (radarCubeHeight, radarCubeLength, radarCubeWidth)**	
Description: Elevation angle is defined as the angle between the LOS vector and the normal to the ellipsoid at the sensor		
	valid_max	90.0
	valid_min	0.0
	units	degree
	_FillValue	nan
	grid_mapping	projection
	long_name	Elevation Angle
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GCOV/metadata/radarGrid/groundTrackVelocity		
Type: Float64	**Shape: ((radarCubeHeight ,radarCubeLength, radarCubeWidth)**	
Description: Absolute value of the platform velocity scaled at the target height		
	units	meters / second
	_FillValue	nan
	grid_mapping	projection
	long_name	Ground-track velocity
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GCOV/metadata/radarGrid/projection		
Type: UInt32	**Shape: scalar**	
Description: Product map grid projection: EPSG code, with additional projection information as HDF5 Attributes		
	ellipsoid	Projection ellipsoid
	epsg_code	Projection EPSG code

	false_easting	The value added to all abscissa values in the rectangular coordinates for a map projection.
	false_northing	The value added to all ordinate values in the rectangular coordinates for a map projection.
	grid_mapping_name	Grid mapping variable name
	inverse_flattening	Inverse flattening of the ellipsoidal figure
	latitude_of_projection_origin	The latitude chosen as the origin of rectangular coordinates for a map projection.
	longitude_of_projection_origin	The longitude, with respect to Greenwich, of the prime meridian associated with the geodetic datum.
	semi_major_axis	Semi-major axis
	spatial_ref	Spatial reference
	utm_zone_number	UTM zone number
	longitude_of_central_meridian	The line of longitude at the center of a map projection generally used as the basis for constructing the projection.
	scale_factor_at_central_meridian	A multiplier for reducing a distance obtained from a map by computation or scaling to the actual distance along the central meridian.
/science/SSAR/GCOV/metadata/radarGrid/xCoordinates		
Type: Float64	**Shape: (radarCubeWidth)**	
Description: X coordinate values corresponding to the radar grid		
	units	meters
	standard_name	projection_x_coordinate
	long_name	X coordinates of projection
/science/SSAR/GCOV/metadata/radarGrid/yCoordinates		
Type: Float64	**Shape: (radarCubeLength)**	
Description: Y coordinate values corresponding to the radar grid		
	units	meters
	standard_name	projection_y_coordinate
	long_name	Y coordinates of projection
/science/SSAR/GCOV/metadata/radarGrid/heightAboveEllipsoid		
Type: Float64	**Shape: (radarCubeHeight)**	
Description: Height values above WGS84 Ellipsoid corresponding to the radar grid		
	units	meters
	standard_name	height_above_reference_ellipsoid

7.4.9 Radar Grid True Height (Available Only in ISRO Generated Products)

Radar grid at true height is at a finer spacing as compared to the radar grid documented in section 7.4.8.

Metadata cube-related variables		
/science/SSAR/GCOV/metadata/radarGridTrueHeight/slantRange		
Type: Float64	**Shape: (radarCubeHeightTrueHeight, radarCubeLengthTrueHeight, radarCubeWidthTrueHeight)**	
Description: Slant range in meters		
	units	meters
	long_name	Slant range
	grid_mapping	projection
	_FillValue	nan
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)

	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GCOV/metadata/radarGridTrueHeight/zeroDopplerAzimuthTime		
Type: Float64	**Shape: (radarCubeHeightTrueHeight, radarCubeLengthTrueHeight, radarCubeWidthTrueHeight)**	
Description: Zero doppler azimuth time in seconds since UTC epoch		
	units	seconds since YYYY-mm-ddTHH:MM:SS
	long_name	Zero Doppler azimuth time
	grid_mapping	projection
	_FillValue	nan
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GCOV/metadata/radarGridTrueHeight/incidenceAngle		
Type: Float32	**Shape: (radarCubeHeightTrueHeight, radarCubeLengthTrueHeight, radarCubeWidthTrueHeight)**	
Description: Incidence angle is defined as the angle between the LOS vector and the normal to the ellipsoid at the target height		
	valid_max	90.0
	valid_min	0.0
	units	degrees
	_FillValue	nan
	grid_mapping	projection
	long_name	Incidence Angle
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GCOV/metadata/radarGridTrueHeight/losUnitVectorX		
Type: Float32	**Shape: (radarCubeHeightTrueHeight, radarCubeLengthTrueHeight, radarCubeWidthTrueHeight)**	
Description: East component of unit vector of LOS from target to sensor		
	valid_max	1.0
	valid_min	-1.0
	units	1
	_FillValue	nan
	grid_mapping	projection
	long_name	LOS unit vector X
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GCOV/metadata/radarGridTrueHeight/losUnitVectorY		
Type: Float32	**Shape: (radarCubeHeightTrueHeight, radarCubeLengthTrueHeight, radarCubeWidthTrueHeight)**	
Description: North component of unit vector of LOS from target to sensor		
	valid_max	1.0
	valid_min	-1.0
	units	1
	_FillValue	nan
	grid_mapping	projection

	long_name	LOS unit vector Y
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GCOV/metadata/radarGridTrueHeight/alongTrackUnitVectorX		
Type: Float32	**Shape: (radarCubeHeightTrueHeight, radarCubeLengthTrueHeight, radarCubeWidthTrueHeight)**	
Description: East component of unit vector along ground track		
	valid_max	1.0
	valid_min	-1.0
	units	1
	_FillValue	nan
	grid_mapping	projection
	long_name	Along-track unit vector X
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GCOV/metadata/radarGridTrueHeight/alongTrackUnitVectorY		
Type: Float32	**Shape: (radarCubeHeightTrueHeight, radarCubeLengthTrueHeight, radarCubeWidthTrueHeight)**	
Description: North component of unit vector along ground track		
	valid_max	1.0
	valid_min	-1.0
	units	1
	_FillValue	nan
	grid_mapping	projection
	long_name	Along-track unit vector Y
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GCOV/metadata/radarGridTrueHeight/elevationAngle		
Type: Float32	**Shape: (radarCubeHeightTrueHeight, radarCubeLengthTrueHeight, radarCubeWidthTrueHeight)**	
Description: Elevation angle is defined as the angle between the LOS vector and the normal to the ellipsoid at the sensor		
	valid_max	90.0
	valid_min	0.0
	units	degree
	_FillValue	nan
	grid_mapping	projection
	long_name	Elevation Angle
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GCOV/metadata/radarGridTrueHeight/groundTrackVelocity		

Type: Float64	**Shape: (radarCubeHeightTrueHeight ,radarCubeLengthTrueHeight, radarCubeWidthTrueHeight)**	
Description: Absolute value of the platform velocity scaled at the target height		
	units	meters / second
	_FillValue	nan
	grid_mapping	projection
	long_name	Ground-track velocity
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GCOV/metadata/radarGridTrueHeight/projection		
Type: UInt32	**Shape: scalar**	
Description: Product map grid projection: EPSG code, with additional projection information as HDF5 Attributes		
	ellipsoid	Projection ellipsoid
	epsg_code	Projection EPSG code
	false_easting	The value added to all abscissa values in the rectangular coordinates for a map projection.
	false_northing	The value added to all ordinate values in the rectangular coordinates for a map projection.
	grid_mapping_name	Grid mapping variable name
	inverse_flattening	Inverse flattening of the ellipsoidal figure
	latitude_of_projection_origin	The latitude chosen as the origin of rectangular coordinates for a map projection.
	longitude_of_projection_origin	The longitude, with respect to Greenwich, of the prime meridian associated with the geodetic datum.
	semi_major_axis	Semi-major axis
	spatial_ref	Spatial reference
	utm_zone_number	UTM zone number
	longitude_of_central_meridian	The line of longitude at the center of a map projection generally used as the basis for constructing the projection.
	scale_factor_at_central_meridian	A multiplier for reducing a distance obtained from a map by computation or scaling to the actual distance along the central meridian.
/science/SSAR/GCOV/metadata/radarGridTrueHeight/xCoordinates		
Type: Float64	**Shape: (radarCubeWidthTrueHeight)**	
Description: X coordinate values corresponding to the radar grid		
	units	meters
	long_name	X coordinates of projection
	standard_name	projection_x_coordinate
/science/SSAR/GCOV/metadata/radarGridTrueHeight/yCoordinates		
Type: Float64	**Shape: (radarCubeLengthTrueHeight)**	
Description: Y coordinate values corresponding to the radar grid		
	units	meters
	long_name	Y coordinates of projection
	standard_name	projection_y_coordinate

CHAPTER-8

Range Doppler Wrapped Interferogram (RIFG) Data Product

8 Range Doppler Wrapped Interferogram (RIFG) Data Product

Range Doppler Wrapped Interferogram (RIFG) is defined as Multi-looked interferogram in Range Doppler coordinates with geometrical phase removed and formed using high-resolution dense pixel offsets. It is generated with nearest pair in time and for co-pol (HH, VV) and circular pol (RH, RV) channels only. In case of L-Band, RIFG is generated for Main Frequency band (frequencyA) only. The averaging window size for RIFG for different bandwidth combinations and for L&S Band is shown in Table 8-1. The mid swath incidence angle used for ground range spacing is 42 degrees. The posting for RIFG product is approximatly 30 m on ground in range and azimuth direction

Band	Fs (MHz)	BW (MHz)	SLC Slant Range Spacing (m)	SLC Azimuth spacing (m)	Ground Range Spacing (at mid swath) (m)	Range Looks	Azimuth Looks
S	13.89	10	10.80	5	16.14	2	6
	27.78	25	5.40	5	8.07	4	6
	41.67	37.5	3.60	5	5.38	6	6
	83.33	75	1.80	5	2.69	11	6
L	6	5	25.00	5	37.36	1	6
	24	20	6.25	5	9.34	3	6
	48	40	3.13	5	4.67	6	6
	96	77	1.56	5	2.33	13	6

Table 8-1 Averaging window size for L&S Band RIFG products

8.1 RIFG Product Overview

The RIFG product represents the topographic and ellipsoid flattened wrapped interferogram generated from two L1 range-Doppler Single Look Complex (RSLC) products in the rangeDoppler geometry of the earlier ("reference") acquisition. The RIFG product is primarily meant for detecting grounding lines and is only generated for NISAR frames covering

Antarctica, Greenland, and pre-selected mountain glaciers. The DEM height is used as the reference surface for flat earth correction.

The RIFG product contains a binary raster layer of complex numbers i.e., the wrapped interferogram; its phase represents the wrapped interferometric phase in radians. The product also contains a binary raster layer of floating-point numbers representing the normalized (in [0, 1]) interferometric correlation i.e., the interferometric coherence magnitude. Both the wrapped interferogram and the interferometric coherence magnitude are multi-looked to a nominal posting of 30 m on the ground. No ionospheric phase screen correction layers are available with this product.

The interferometric workflow producing RIFG products coregisters a pair of RSLC products using a Digital Elevation Model and the best available orbit ephemeris. This coregistration is further refined by using incoherent cross-correlation on the pair of coarsely coregistered RSLCs. The RIFG product includes the slant range and along-track sub-pixel offsets obtained from incoherent cross-correlation and used to generate the complex wrapped interferogram. If an offset pmroduct in range-Doppler coordinates (e.g., ROFF) is available for the processed frame, the sub-pixel offset layers included in RIFG are obtained by optimally blending the multiresolution offset layers included in ROFF. The application of the offset layers blending algorithm is indicated by setting the flag in

"/science/SSAR/RIFG/metadata/processingInformation/parameters/pixelOffsets/frequencyA/isOffsetsBlendingApplied" to "True".

Conversely, if this flag is set to "False", the offset blending algorithm is not applied, and the sub-pixel offset layers included in RIFG are obtained by simply running incoherent cross-correlation on a coarser radar grid. The pixel-offset layers in RIFG may be subject to several post-processing operations (e.g., outlier removal, no-data filling, and noise reduction).

8.2 RIFG Product Organization

8.2.1 Granule Definition

NISAR RIFG granules will conform to the Tiling Scheme being developed for the mission and are expected to have a ground footprint of 240 km x 240 km. (except in L-Band for 77 MHz data, which cover half of the swath in range direction).

8.2.2 File Naming Convention

NISAR RIFG Granule names will conform to the S/L-SAR Product File Naming Conventions as discussed in section 2.2.2.

8.2.3 Temporal Organization

The RIFG data are arranged on a uniformly spaced, increasing Zero-Doppler azimuth time grid. Using row-major order convention of representing 2D raster arrays, Zero-Doppler azimuth time is represented by the row direction or the slowest changing dimension.

8.2.4 Spatial Organization

The RIFG data are arranged on a uniformly spaced, increasing Zero-Doppler azimuth time in the row direction and increasing slant range grid in the column direction following the row-major order convention of representing 2D raster arrays.

8.2.5 Spatial Sampling and Resolution

NISAR mission uses a non-uniformly spaced sequence of pulses in SweepSAR mode to collect radar data, to overcome the limitations imposed by transmit gaps affecting the wide imaging swath. Processing software accounts for the nonuniform sampling to generate the final RIFG product on a uniform grid. Some salient features of the output grid for the RIFG product are:

1) The center of the top-left pixel of all the data layers within the "/science/SSAR/RIFG/swaths/frequencyA/interferogram/" group will correspond to the same Zero-Doppler azimuth time and slant range.
2) The center of the top-left pixel of all the data layers within the "/science/SSAR/RIFG/swaths/frequencyA/pixelOffsets/" group will correspond to the same Zero-Doppler azimuth time and slant range.
3) The main imaging band ("frequencyA") is spatially averaged to the same posting, irrespective of the imaging mode. This allows for spatial mosaicking operations across instrument mode changes.

8.2.6 Along Track Mosaicking

The spatial sampling of the output grid has also been designed to facilitate along-track mosaicking of contiguous RIFG product granules if the user desires. The following features simplify the implementation of along-track mosaicking

1) The slow time sampling frequency (inverse of the zero Doppler time spacing between consecutive lines) will be chosen to be an integer, to allow synchronization between adjacent granules at integer second boundaries without the need for resampling in the azimuth time direction.

2) The slant range to the first pixel will be a multiple of the lowest sampling frequency (corresponding to 5 MHz) to enable concatenation of adjacent granules with simple integer shifts of imagery in the slant range direction.

Since the RIFG product represents the wrapped interferometric phase, it is currently not possible to mosaic products generated using data acquired with different bandwidths (different wavelengths) in the along-track direction.

8.2.7 Partially compressed SLC data

Partially compressed data in RSLC files will not be used to produce RIFG products. Spatially averaged pixels with any partially compressed or missing data in RSLCs will be set to the fill value (specified by _FillValue attribute).

8.3 RIFG Product Description

In this section, we briefly describe the layout of RIFG data and associated metadata within the NISAR HDF5 file. Detailed description of Group and Dataset names can be found in section 8.4. In this section, we focus on the organization of S-SAR instrument data within the file under the Group name "/science/SSAR/". The same holds true for L-SAR data products too.

8.3.1 Shapes and Dimensions of Data

Information on the shapes and dimensions of the data items in various data tables are described as part of the metadata as described in section 8.4.1. This information is useful both as part of the product identification and for setting up further processing, i.e. dimensioning arrays

8.3.2 Product Identification

Information needed to identify this product is given under the Group "/science/SSAR/identification. This includes information such as orbit, cycle, track, and frame numbers, acquisition times, a polygon representing the bounding box of the included imagery in geographic coordinates, product version, and product specification version (i.e., the version number of this document).

8.3.3 Radar Imagery

The RIFG product's imagery layers and associated datasets are initially organized based on the center frequency within the Group "/science/SSAR/RIFG/swaths/frequencyA/". For L-Band, only the main NISAR imaging band ("frequencyA") will be processed for RIFG products.

Imagery data is further categorized by their type. The Wrapped Interferogram layer and associated Datasets are located under the Group

"/science/SSAR/RIFG/swaths/frequencyA/interferogram/". The crosscorrelation sub-pixel offsets are located under the Group "/science/SSAR/RIFG/swaths/frequencyA/pixelOffsets/". Each of these Groups is further organized by polarization (TxRx), and by a final grouping. For example, the Interferogram Group could contain the Group "/science/SSAR/RIFG/swaths/frequencyA/interferogram/HH/".
The imagery Datasets reside within these polarization Groups. As an example, the Dataset "/science/LSAR/RIFG/swaths/frequencyA/interferogram/HH/wrappedInterferogram" corresponds to the complex interferogram derived from the "frequencyA" and "HH" polarization imagery layers within the reference and secondary input RSLCs. The same description holds true for all polarization channels present in the product. The same convention holds true for L-Band products.

8.3.4 Radar Metadata

The Group "/science/SSAR/RIFG/metadata/" includes a list of miscellaneous metadata needed to interpret the geolocation and the imagery (e.g., complex wrapped interferogram, normalized interferometric coherence magnitude, slant range and along-track pixel offsets) included in the RIFG product.

8.3.4.1 Processing Information

The Group "/science/SSAR/RIFG/metadata/processingInformation/" includes the processing parameters used to generate the RIFG product. This group also includes a list of the algorithms and the input granules used to produce RIFG. For a complete description of this group, refer to section 8.4.5.

8.3.4.2 Parameters

The Group "/science/SSAR/RIFG/metadata/processingInformation/parameters/" is further organized in five Groups:

1. common: organized by frequency, and including the parameters derived by combining the information from the reference and secondary RSLC such as common Doppler Centroid and the common Doppler bandwidth.

2. reference: including the effective velocity and the reference terrain height of the reference RSLC. This Group is further organized by frequency and includes some relevant parameters of the reference RSLC such as the slant range and zero Doppler time spacing's, the slant range and the azimuth bandwidth, and the Doppler centroid.

3. secondary: this Group follows the same organization of reference but includes the corresponding metadata for the secondary RSLC.

4. interferogram: including the parameters used to generate the complex wrapped interferogram and the normalized interferometric correlation e.g., the common slant range and azimuth bandwidth and the number of looks in slant range and azimuth directions.

5. pixelOffsets: including the parameters used to generate the layers of pixel offsets e.g., spacing.

The Group parameters also contains the Dataset runConfigurationContents which includes a copy of the run configuration file used for processing populated with all the processing options, parameter values, and input files.

8.3.4.3 Algorithms

The Group "/science/SSAR/RIFG/metadata/processingInformation/algorithms/" includes the name and the version of the software used to generate the product. The Group is further organized in distinct Groups identifying the processing steps used to generate the RIFG product:

1. coregistration: including the algorithms used to perform the coarse and fine coregistration of the reference and secondary RSLCs (e.g., geometry coregistration, cross-correlation algorithm).

2. interferogramFormation: including the algorithms used to form the complex wrapped interferogram and the normalized interferometric correlation (e.g., flattening method).

8.3.4.4 Input Files

The Group "/science/SSAR/RIFG/metadata/processingInformation/inputs/" includes the filenames of the input RSLC granules, configuration files, orbit files, and a description of the DEM used for processing.

8.3.5 Other Radar Metadata

8.3.5.1 Orbit

The reference RSLC orbit ephemeris used for generating the RIFG product is provided under the Group "/science/SSAR/RIFG/metadata/orbit/" and further detailed in section 8.4.5. This Group includes time-tagged antenna phase center position and velocity vectors in Earth Centered Earth Fixed (ECEF) Cartesian coordinates and information on the used orbit fidelity (e.g., Medium Orbit Ephemeris).

8.3.5.2 Attitude

The attitude state vectors of the reference RSLC used for generating the RIFG product can be found under the Group "/science/SSAR/RIFG/metadata/attitude/". This Group includes timetagged quaternions and Euler angles representing the slant range plane from the antenna phase center in an ECEF Cartesian system.

8.3.6 Geolocation Grid

The Group "/science/SSAR/RIFG/metadata/geolocationGrid/" contains information on the radar geometry of the reference RSLC. The Datasets within this Group (i.e., the geolocation grid cubes) are referenced over the radar-grid which is defined by the coordinate vectors "slantRange", "zeroDopplerTime", and "heightAboveEllipsoid". Normals are with respect to the WGS84 ellipsoid.

The "geolocationGrid" Group also include the Datasets:

1. "coordinateX" and "coordinateY" containing the mapping of the zero-Doppler grid to the geographic grid in the units defined by the Dataset "epsg" within the same Group

2. "losUnitVectorX" and "losUnitVectorY" identifying the East and North components of the Line-Of-Sight (LOS) unit vector (i.e., the vector from the target to the sensor) in the East-North-Up (ENU) coordinate system for each point of the geographic grid. The Up component of the LOS unit vector can be simply derived from the East and North components as:

$$losUnitVectorZ = \sqrt{1 - losUnitVectorX^2 - losUnitVectorY^2}$$

3. "alongTrackUnitVectorX" and "alongTrackUnitVectorY" containing the East and North components of the along-track unit vector (i.e., the projection of the along-track vector at the ground height) in ENU coordinates.

4. "incidenceAngle containing the incidence angle, i.e., the angle between the LOS vector and the normal to the ellipsoid at the target height.

5. "elevationAngle" containing the elevation angle i.e., the angle between the LOS vector and the normal to the ellipsoid at the sensor

6. "groundTrackVelocity" containing the ground track velocity i.e., the absolute value of the platform velocity scaled at the target height

7. "perpendicularBaseline" and "parallelBaseline" containing the perpendicular and parallel component of the baseline between the reference and secondary RSLCs. The baseline components are computed on same heights as other datasets of metadata cube.

The details of the usage of metadata cube are given in

Annexure-2: Metadata Cube

In ISRO generated L and S Band products, a separate layer is defined in a separate sub-group for all these parameters at true height:

"/science/SSAR/RSLC/metadata/geolocationGridTrueHeight/".

In this group all the parameters of metadata will be generated at true height (meaning they will be generated at actual height of terrain) and will be a part of the product. This layer will be at a finer sampling than the actual meta data cube layers. The number of dimensions, description and datatype will be same as that of actual metadata cube layer.

The details of this are present in Annexure-3: Metadata Cube at True Height.

8.4 RIFG Product Specification

In this section, actual datasets are defined in tabular form. They contain the dataset information available in RIFG product, which comprises of name, datatype, shape, and information corresponding to attributes. In product, there are few datasets or few sub-groups that are per polarization. For representation, here only one polarization is used; in product, the layers/datasets/groups will be present as per the number of polarizations available in the product. The same holds true for frequency A for L-Band products.

8.4.1 Dimensions and Shapes

To simplify the description of the layout of data within the HDF5 file, we will use a table of dimensions and shapes to represent the relationship between similarly sized datasets. The entries in this table do not present actual datasets in the HDF5. This table is meant to be a guide to interpreting the shapes of the datasets in subsequent subsections.

Name	Shape	Description
scalar	scalar	None
numberOfDatatakes	scalar	Number of datatakes in product
numberOfObservations	scalar	Number of observations in product
numberOfFrequencies	scalar	Number of S/L-SAR frequencies in product
numberOfFrequencyAPolarizations	scalar	Number of polarization layers associated with S/L-SAR frequency A
interferogramSlantRangeWidth	scalar	Number of pixels in all S/L-SAR datasets within the interferogram group
interferogramZeroDopplerTimeLength	scalar	Number of lines in all S/L-SAR datasets within the interferogram group.

complexInterferogramShape	(interferogramZeroDopplerTimeLength, interferogramSlantRangeWidth)	Shape associated with S/L-SAR complex datasets in the interferogram group.
interferogramShape	(interferogramZeroDopplerTimeLength, interferogramSlantRangeWidth)	Shape associated with S/L-SAR real or integer datasets in th intergferogram group.
offsetShape	(offsetZeroDopplerTimeLength, offsetSlantRangeWidth)	Shape associated with S/L-SAR datasets in the pixelOffsets group.
offsetSlantRangeWidth	scalar	Number of pixels in all S/L-SAR datasets in the pixelOffsets group.
offsetZeroDopplerTimeLength	scalar	Number of lines in all S/L-SAR datasets within the pixelOffsets group.
validSamplesShapeFrequencyA	(frequencyAZeroDopplerTimeLength, 2)	Shape associated with S/L-SAR frequency A valid samples dataset
geolocationCubeShape	(geolocationCubeHeight, geolocationCubeLength, geolocationCubeWidth)	Shape associated with metadata cubes
geolocationCubeHeight	scalar	Height dimension of the metadata cube
geolocationCubeLength	scalar	Length dimension of the metadata cube
geolocationCubeWidth	scalar	Width dimension of the metadata cube
geolocationCubeShapeTrueHeight	(1, geolocationCubeLengthTrueHeight, geolocationCubeWidthTrueHeight)	Shape associated with metadata cubes at True Height
geolocationCubeHeightTrueHeight	scalar	Height dimension of the metadata cube at True Height. The value will be one.
geolocationCubeLengthTrueHeight	scalar	Length dimension of the metadata cube at TrueHeight
geolocationCubeWidthTrueHeight	scalar	Width dimension of the metadata cube at TrueHeight
dopplerCentroidTimeLength	scalar	Length dimension of Doppler centroid grid
dopplerCentroidSlantRangeWidth	scalar	Length dimension of Doppler centroid grid
dopplerCentroidShape	(dopplerCentroidTimeLength, dopplerCentroidSlantRangeWidth)	Shape of the Doppler centroid grid

calibrationTimeLength	scalar	Length of calibration LUTs
calibrationSlantRangeWidth	scalar	Width of calibration LUTs
calibrationScaleShape	(calibrationTimeLength, calibrationSlantRangeWidth)	Shape of calibration LUTs
antennaPatternComplexShape	(calibrationTimeLength, calibrationSlantRangeWidth)	Shape of antenna pattern datasets
orbitListLength	scalar	Number of orbit state vectors
orbitShape	(orbitListLength, 3)	Shape of orbit state vector triplets dataset
attitudeListLength	scalar	Number of attitude state vectors
attitudeQuaternionShape	(attitudeListLength, 4)	Shape of attitude quaternion dataset
attitudeShape	(attitudeListLength, 3)	Shape of attitude Euler angle triplets dataset
chirpWeightingFrequencyLength	scalar	Shape associated with 1D filter representations in frequency domain
numberOfInputL1Files	scalar	Number of input L1 granules
numberOfInputConfigFiles	scalar	Number of input configuration files
numberOfInputOrbitFiles	scalar	Number of input orbit files

8.4.2 Product Identification

Product Identification Variables	
/science/SSAR/identification/referenceAbsoluteOrbitNumber	
Type: UInt32	**Shape: scalar**
Description: Absolute orbit number for the reference SLC	
/science/SSAR/identification/secondaryAbsoluteOrbitNumber	
Type: UInt32	**Shape: scalar**
Description: Absolute orbit number for the secondary SLC	
/science/SSAR/identification/referenceIsJointObservation	
Type: string	**Shape: scalar**
Description: "True" if any portion of the reference RSLC was acquired in a joint observation mode (e.g., L-band and S-band simultaneously), "False" otherwise	
/science/SSAR/identification/secondaryIsJointObservation	
Type: string	**Shape: scalar**
Description: "True" if any portion of the reference RSLC was acquired in a joint observation mode (e.g., L-band and S-band simultaneously), "False" otherwise	
/science/SSAR/identification/trackNumber	
Type: UByte	**Shape: scalar**
Description: Track number	
/science/SSAR/identification/frameNumber	
Type: UInt16	**Shape: scalar**
Description: Frame number	
/science/SSAR/identification/missionId	

Type: string	**Shape: scalar**
Description: Mission identifier	
/science/SSAR/identification/processingCenter	
Type: string	**Shape: scalar**
Description: Data processing center	
/science/SSAR/identification/productType	
Type: string	**Shape: scalar**
Description: Product type	
/science/SSAR/identification/granuleId	
Type: string	**Shape: scalar**
Description: Unique granule identification name	
/science/SSAR/identification/productDoi	
Type: string	**Shape: scalar**
Description: Digital Object Identifier (DOI) for the product	
/science/SSAR/identification/productVersion	
Type: string	**Shape: scalar**
Description: Product version which represents the structure of the product and the science content governed by the algorithm, input data, and processing parameters	
/science/SSAR/identification/productSpecificationVersion	
Type: string	**Shape: scalar**
Description: Product specification version which represents the schema of this product	
/science/SSAR/identification/lookDirection	
Type: string	**Shape: scalar**
Description: Look Direction, either “Left” or “Right”	
/science/SSAR/identification/orbitPassDirection	
Type: string	**Shape: scalar**
Description: Orbit direction, either “Ascending” or “Descending”	
/science/SSAR/identification/referenceZeroDopplerStartTime	
Type: string	**Shape: scalar**
Description: Azimuth start time (in UTC) of reference RSLC product in the format YYYY-mm-ddTHH:MM:SS.sssssssss	
/science/SSAR/identification/secondaryZeroDopplerStartTime	
Type: string	**Shape: scalar**
Description: Azimuth start time (in UTC) of secondary RSLC product in the format YYYY-mm-ddTHH:MM:SS.sssssssss	
/science/SSAR/identification/referenceZeroDopplerEndTime	
Type: string	**Shape: scalar**
Description: Azimuth stop time (in UTC) of reference RSLC product in the format YYYY-mm-ddTHH:MM:SS.sssssssss	
/science/SSAR/identification/secondaryZeroDopplerEndTime	
Type: string	**Shape: scalar**
Description: Azimuth stop time (in UTC) of secondary RSLC product in the format YYYY-mm-ddTHH:MM:SS.sssssssss	
/science/SSAR/identification/plannedDatatakeId	
Type: string	**Shape: (numberOfDatatakes)**
Description: List of planned datatakes included in the product	
/science/SSAR/identification/plannedObservationId	
Type: string	**Shape: (numberOfObservations)**
Description: List of planned observations included in the product	
/science/SSAR/identification/isUrgentObservation	
Type: string	**Shape: scalar**
Description: Flag indicating if observation is nominal ("False") or urgent ("True")	

/science/SSAR/identification/listOfFrequencies	
Type: string	**Shape: (numberOfFrequencies)**
Description: List of frequency layers available in the product	
/science/SSAR/identification/diagnosticModeFlag	
Type: UByte	**Shape: scalar**
Description: Indicates if the radar operation mode is a diagnostic mode (1-2) or DBFed science (0): 0, 1, or 2	
/science/SSAR/identification/productLevel	
Type: string	**Shape: scalar**
Description: Product level. L0A: Unprocessed instrument data; L0B: Reformatted, unprocessed instrument data; L1: Processed instrument data in radar coordinates system; and L2: Processed instrument data in geocoded coordinates system	
/science/SSAR/identification/isGeocoded	
Type: string	**Shape: scalar**
Description: Flag to indicate if the product data is in the radar geometry ("False") or in the map geometry ("True")	
/science/SSAR/identification/boundingPolygon	
Type: string	**Shape: scalar**
Description: OGR compatible WKT representing the bounding polygon of the image. Horizontal coordinates are WGS84 longitude followed by latitude (both in degrees), and the vertical coordinate is the height above the WGS84 ellipsoid in meters. The first point corresponds to the start-time, near-range radar coordinate, and the perimeter is traversed in counterclockwise order on the map. This means the traversal order in radar coordinates differs for left-looking and right-looking sensors. The polygon includes the four corners of the radar grid, with equal numbers of points distributed evenly in radar coordinates along each edge	
ogr_geometry	polygon
epsg	4326
/science/SSAR/identification/processingDateTime	
Type: string	**Shape: scalar**
Description: Processing date and time (in UTC) in the format YYYY-mm-ddTHH:MM:SS	
/science/SSAR/identification/radarBand	
Type: string	**Shape: scalar**
Description: Acquired frequency band, either "L" or "S"	
/science/SSAR/identification/platformName	
Type: string	**Shape: scalar**
Description: Name of the platform used to collect the remote sensing data provided in this product	
/science/SSAR/identification/instrumentName	
Type: string	**Shape: scalar**
Description: Name of the instrument used to collect the remote sensing data provided in this product	
/science/SSAR/identification/processingType	
Type: string	**Shape: scalar**
Description: Nominal (or) Urgent (or) Custom (or) Undefined	
/science/SSAR/identification/isDithered	
Type: string	**Shape: scalar**
Description: "True" if the pulse timing was varied (dithered) during acquisition, "False" otherwise.	
/science/SSAR/identification/isMixedMode	
Type: string	**Shape: scalar**
Description: "True" if this product is generated from reference and secondary RSLCs with different range bandwidths, "False" otherwise.	

/science/SSAR/identification/isFullFrame		
Type: string		**Shape: scalar**
Description: "True" if this product fully covers a NISAR frame**,** "False" if partial coverage.		
	frameCoveragePercentage	Percentage of NISAR frame containing processed data
	thresholdPercentage	Threshold percentage used to determine if the product is full frame or partial frame
/science/SSAR/identification/compositeReleaseId		

Type: string	**Shape: scalar**
Description: Unique version identifier of the science data production system	

8.4.3 Radar Imagery

Product imagery variables		
/science/SSAR/RIFG/swaths/frequencyA/listOfPolarizations		
Type: string		**Shape: (numberOfFrequencyAPolarizations)**
Description: List of processed polarization layers with frequencyA		
/science/SSAR/RIFG/swaths/frequencyA/interferogram/sceneCenterAlongTrackSpacing		
Type: Float64		**Shape: scalar**
Description: Nominal along-track spacing in meters between consecutive lines near mid-swath of the product images		
	units	meters
/science/SSAR/RIFG/swaths/frequencyA/interferogram/sceneCenterGroundRangeSpacing		
Type: Float64		**Shape: scalar**
Description: Nominal ground range spacing in meters between consecutive pixels near mid-swath of the product images		
	units	meters
/science/SSAR/RIFG/swaths/frequencyA/centerFrequency		
Type: Float64		**Shape: scalar**
Description: Center frequency of the processed image in hertz		
	units	hertz
/science/SSAR/RIFG/swaths/frequencyA/interferogram/slantRangeSpacing		
Type: Float64		**Shape: scalar**
Description: Slant range spacing of grid. Same as difference between consecutive samples in slantRange array		
	units	meters
/science/SSAR/RIFG/swaths/frequencyA/interferogram/zeroDopplerTimeSpacing		
Type: Float64		**Shape: scalar**
Description: Time interval in the along-track direction for raster layers. This is same as the spacing between consecutive entries in the zeroDopplerTime array		
	units	seconds
/science/SSAR/RIFG/swaths/frequencyA/interferogram/slantRange		
Type: Float64		**Shape: (interferogramSlantRangeWidth)**
Description: Slant range vector		
	units	meters
/science/SSAR/RIFG/swaths/frequencyA/interferogram/zeroDopplerTime		
Type: Float64		**Shape: (interferogramZeroDopplerTimeLength)**
Description: Zero Doppler azimuth time since UTC epoch vector		
	units	seconds since YYYY-mm-ddTHH:MM:SS
/science/SSAR/RIFG/swaths/frequencyA/interferogram/digitalElevationModel		
Type: Float32		**Shape: (interferogramZeroDopplerTimeLength, interferogramSlantRangeWidth)**
Description: Digital Elevation Model (DEM) in radar coordinates. This dataset is produced using Copernicus WorldDEM-30. Copyright DLR e.V. 2010-2014 and Copyright Airbus Defence and Space GmbH 2014-2018 provided under COPERNICUS by the European Union and ESA; all rights reserved. This dataset is generated by referencing the Copernicus DEM elevations to the WGS84 ellipsoid and projecting them onto a range/Doppler grid		
	_FillValue	nan
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points

	units	meters
/science/SSAR/RIFG/swaths/frequencyA/interferogram/mask		
Type: UByte		**Shape: (interferogramZeroDopplerTimeLength, interferogramSlantRangeWidth)**
Description: Mask indicating the subswaths of valid samples in the reference RSLC and geometrically-coregistered secondary RSLC. Each pixel value is a two-digit number: the least significant digit represents the subswath number of that pixel in the secondary RSLC, and the most significant digit represents the subswath number of that pixel in the reference RSLC. A value of '0' in either digit indicates an invalid sample in the corresponding RSLC		
	_FillValue	255
	valid_min	0
	long_name	Valid samples subswath mask
/science/SSAR/RIFG/swaths/frequencyA/interferogram/HH/wrappedInterferogram		
Type: CFloat32		**Shape: (interferogramZeroDopplerTimeLength, interferogramSlantRangeWidth)**
Description: Interferogram between HH layers		
	_FillValue	(nan+nan*j)
	units	1
/science/SSAR/RIFG/swaths/frequencyA/interferogram/HH/coherenceMagnitude		
Type: Float32		**Shape: (interferogramZeroDopplerTimeLength, interferogramSlantRangeWidth)**
Description: Coherence magnitude between HH layers		
	_FillValue	nan
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points
	units	1
/science/SSAR/RIFG/swaths/frequencyA/pixelOffsets/sceneCenterAlongTrackSpacing		
Type: Float64		**Shape: scalar**
Description: Nominal along-track spacing in meters between consecutive lines near mid-swath of the product images		
	units	meters
/science/SSAR/RIFG/swaths/frequencyA/pixelOffsets/sceneCenterGroundRangeSpacing		
Type: Float64		**Shape: scalar**
Description: Nominal ground range spacing in meters between consecutive pixels near mid-swath of the product images		
	units	meters
/science/SSAR/RIFG/swaths/frequencyA/pixelOffsets/slantRangeSpacing		
Type: Float64		**Shape: scalar**
Description: Slant range spacing of the offset grid		
	units	meters
/science/SSAR/RIFG/swaths/frequencyA/pixelOffsets/zeroDopplerTimeSpacing		
Type: Float64		**Shape: scalar**
Description: Along-track spacing of the offset grid		
	units	seconds
/science/SSAR/RIFG/swaths/frequencyA/pixelOffsets/HH/slantRangeOffset		
Type: Float32		**Shape: (offsetZeroDopplerTimeLength, offsetSlantRangeWidth)**
Description: Slant range offset		
	_FillValue	nan
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points

	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points
	units	meters
/science/SSAR/RIFG/swaths/frequencyA/pixelOffsets/HH/alongTrackOffset		
Type: Float32		**Shape: (offsetZeroDopplerTimeLength, offsetSlantRangeWidth)**
Description: Along-track offset		
	_FillValue	nan
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points
	units	meters
/science/SSAR/RIFG/swaths/frequencyA/pixelOffsets/digitalElevationModel		
Type: Float32		**Shape: (offsetZeroDopplerTimeLength, offsetSlantRangeWidth)**
Description: Digital Elevation Model (DEM) in radar coordinates. This dataset is produced using Copernicus WorldDEM-30 Copyright DLR e.V. 2010-2014 and Copyright Airbus Defence and Space GmbH 2014-2018 provided under COPERNICUS by the European Union and ESA; all rights reserved. This dataset is generated by referencing the Copernicus DEM elevations to the WGS84 ellipsoid and projecting them onto a range/Doppler grid		
	_FillValue	nan
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points
	units	meters
/science/SSAR/RIFG/swaths/frequencyA/pixelOffsets/mask		
Type: UByte		**Shape: (offsetZeroDopplerTimeLength, offsetSlantRangeWidth)**
Description: Mask indicating the subswaths of valid samples in the reference RSLC and geometrically-coregistered secondary RSLC. Each pixel value is a two-digit number: the least significant digit represents the subswath number of that pixel in the secondary RSLC, and the most significant digit represents the subswath number of that pixel in the reference RSLC. A value of '0' in either digit indicates an invalid sample in the corresponding RSLC		
	_FillValue	255
	valid_min	0
	long_name	Valid samples subswath mask
/science/SSAR/RIFG/swaths/frequencyA/pixelOffsets/HH/correlationSurfacePeak		
Type: Float32		**Shape: (offsetZeroDopplerTimeLength, offsetSlantRangeWidth)**
Description: Normalized correlation surface peak		
	_FillValue	nan
	units	1
/science/SSAR/RIFG/swaths/frequencyA/pixelOffsets/slantRange		
Type: Float64		**Shape: (offsetSlantRangeWidth)**
Description: Slant range vector		
	units	meters
/science/SSAR/RIFG/swaths/frequencyA/pixelOffsets/zeroDopplerTime		
Type: Float64		**Shape: (offsetZeroDopplerTimeLength)**
Description: Zero Doppler azimuth time since UTC epoch vector		
	units	seconds since YYYY-mm-ddTHH:MM:SS

8.4.4 Processing Information

Processing-related variables		
/science/SSAR/RIFG/metadata/processingInformation/parameters/runConfigurationContents		
Type: string		**Shape: scalar**
Description: Contents of the run configuration file with parameters used for processing		
/science/SSAR/RIFG/metadata/processingInformation/parameters/reference/isMixedMode		
Type: string		**Shape: scalar**
Description: "True" if reference RSLC is a composite of data collected in multiple radar modes, "False" otherwise		
/science/SSAR/RIFG/metadata/processingInformation/parameters/reference/rfiMitigationApplied		
Type: string		**Shape: scalar**
Description: Flag to indicate if RFI mitigation has been applied to reference RSLC		
/science/SSAR/RIFG/metadata/processingInformation/parameters/reference/referenceTerrainHeight		
Type: Float32		**Shape: (dopplerCentroidTimeLength, dopplerCentroidSlantRangeWidth)**
Description: Reference Terrain Height as a function of time for reference RSLC		
	units	meters
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (seconds)
/science/SSAR/RIFG/metadata/processingInformation/parameters/reference/frequencyA/slantRangStart		
Type: Float64		**Shape: scalar**
Description: Slant range start distance for the reference RSLC		
	units	meters
/science/SSAR/RIFG/metadata/processingInformation/parameters/reference/frequencyA/numberOfRangeSamples		
Type: UInt64		**Shape: scalar**
Description: Number of slant range samples for each azimuth line within the reference RSLC		
	units	1
/science/SSAR/RIFG/metadata/processingInformation/parameters/reference/frequencyA/numberOfAzimuthLines		
Type: UInt64		**Shape: scalar**
Description: Number of azimuth lines within the reference RSLC		
	units	1
/science/SSAR/RIFG/metadata/processingInformation/parameters/reference/frequencyA/slantRangeSpacing		
Type: Float64		**Shape: scalar**
Description: Slant range spacing of reference RSLC		
	units	meters
/science/SSAR/RIFG/metadata/processingInformation/parameters/reference/frequencyA/zeroDopplerTimeSpacing		
Type: Float64		**Shape: scalar**
Description: Time interval in the along-track direction for reference RSLC raster layers		
	units	seconds
/science/SSAR/RIFG/metadata/processingInformation/parameters/reference/frequencyA/zeroDopplerStartTime		
Type: String		**Shape: scalar**
Description: Azimuth start time (in UTC) of the reference RSLC product in the format YYYY-mm-ddTHH:MM:SS.sssssssss		
/science/SSAR/RIFG/metadata/processingInformation/parameters/reference/frequencyA/zeroDopplerEndTime		
Type: String		**Shape: scalar**

Description: Azimuth stop time (in UTC) of the reference RSLC product in the format YYYY-mm-ddTHH:MM:SS.sssssssss		
/science/SSAR/RIFG/metadata/processingInformation/parameters/reference/frequencyA/rangeBandwidth		
Type: Float64		**Shape: scalar**
Description: Processed slant range bandwidth for reference RSLC		
	units	hertz
/science/SSAR/RIFG/metadata/processingInformation/parameters/reference/frequencyA/azimuthBandwidth		
Type: Float64		**Shape: scalar**
Description: Processed azimuth bandwidth for reference RSLC		
	units	hertz
/science/SSAR/RIFG/metadata/processingInformation/parameters/reference/frequencyA/dopplerCentroid		
Type: Float64		**Shape: (dopplerCentroidTimeLength, dopplerCentroidSlantRangeWidth)**
Description: 2D LUT of Doppler centroid for frequency A		
	units	hertz
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (seconds)
/science/SSAR/RIFG/metadata/processingInformation/parameters/secondary/isMixedMode		
Type: string		**Shape: scalar**
Description: "True" if secondary RSLC is a composite of data collected in multiple radar modes, "False" otherwise		
/science/SSAR/RIFG/metadata/processingInformation/parameters/secondary/rfiMitigationApplied		
Type: string		**Shape: scalar**
Description: Flag to indicate if RFI mitigation has been applied to secondary RSLC		
/science/SSAR/RIFG/metadata/processingInformation/parameters/secondary/referenceTerrainHeight		
Type: Float32		**Shape: (dopplerCentroidTimeLength, dopplerCentroidSlantRangeWidth)**
Description: Reference Terrain Height as a function of time for secondary RSLC		
	units	meters
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (seconds)
/science/SSAR/RIFG/metadata/processingInformation/parameters/secondary/frequencyA/slantRangStart		
Type: Float64		**Shape: scalar**
Description: Slant range start distance for the secondary RSLC		
	units	meters
/science/SSAR/RIFG/metadata/processingInformation/parameters/secondary/frequencyA/numberOfRangeSamples		
Type: UInt64		**Shape: scalar**
Description: Number of slant range samples for each azimuth line within the secondary RSLC		
	units	1
/science/SSAR/RIFG/metadata/processingInformation/parameters/secondary/frequencyA/numberOfAzimuthLines		
Type: UInt64		**Shape: scalar**
Description: Number of azimuth lines within the secondary RSLC		
	units	1
/science/SSAR/RIFG/metadata/processingInformation/parameters/secondary/frequencyA/slantRangeSpacing		

Type: Float64		**Shape: scalar**
Description: Slant range spacing of secondary RSLC		
	units	meters
/science/SSAR/RIFG/metadata/processingInformation/parameters/secondary/frequencyA/zeroDopplerTimeSpacing		
Type: Float64		**Shape: scalar**
Description: Time interval in the along-track direction for secondary RSLC raster layers		
	units	seconds
/science/SSAR/RIFG/metadata/processingInformation/parameters/secondary/frequencyA/zeroDopplerStartTime		
Type: String		**Shape: scalar**
Description: Azimuth start time (in UTC) of the secondary RSLC product in the format YYYY-mm-ddTHH:MM:SS.sssssssss		
/science/SSAR/RIFG/metadata/processingInformation/parameters/secondary/frequencyA/zeroDopplerEndTime		
Type: String		**Shape: scalar**
Description: Azimuth stop time (in UTC) of the secondary RSLC product in the format YYYY-mm-ddTHH:MM:SS.sssssssss		
/science/SSAR/RIFG/metadata/processingInformation/parameters/secondary/frequencyA/rangeBandwidth		
Type: Float64		**Shape: scalar**
Description: Processed slant range bandwidth for secondary RSLC		
	units	hertz
/science/SSAR/RIFG/metadata/processingInformation/parameters/secondary/frequencyA/azimuthBandwidth		
Type: Float64		**Shape: scalar**
Description: Processed azimuth bandwidth for secondary RSLC		
	units	hertz
/science/SSAR/RIFG/metadata/processingInformation/parameters/secondary/frequencyA/dopplerCentroid		
Type: Float64		**Shape: (dopplerCentroidTimeLength, dopplerCentroidSlantRangeWidth)**
Description: 2D LUT of Doppler centroid for frequency A		
	units	hertz
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (seconds)
/science/SSAR/RIFG/metadata/processingInformation/parameters/common/frequencyA/dopplerCentroid		
Type: Float64		**Shape: (dopplerCentroidTimeLength, dopplerCentroidSlantRangeWidth)**
Description: 2D LUT of common Doppler centroid between reference and secondary RSLCs		
	units	hertz
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (seconds)
/science/SSAR/RIFG/metadata/processingInformation/parameters/common/frequencyA/dopplerBandwidth		
Type: Float64		**Shape: scalar**
Description: Common Doppler bandwidth between reference and secondary RSLCs		
	units	hertz
/science/SSAR/RIFG/metadata/processingInformation/parameters/interferogram/frequencyA/rangeBandwidth		

Type: Float64	**Shape: scalar**	
Description: Processed slant range bandwidth for frequency A interferometric layers		
	units	hertz
/science/SSAR/RIFG/metadata/processingInformation/parameters/interferogram/frequencyA/azimuthBandwidth		
Type: Float64	**Shape: scalar**	
Description: Processed azimuth bandwidth for frequency A interferometric layers		
	units	hertz
/science/SSAR/RIFG/metadata/processingInformation/parameters/interferogram/frequencyA/numberOfRangeLooks		
Type: UInt32	**Shape: scalar**	
Description: Number of looks applied in the slant range direction to form the wrapped interferogram		
	units	1
/science/SSAR/RIFG/metadata/processingInformation/parameters/interferogram/frequencyA/numberOfAzimuthLooks		
Type: UInt32	**Shape: scalar**	
Description: Number of looks applied in the along-track direction to form the wrapped interferogram		
	units	1
/science/SSAR/RIFG/metadata/processingInformation/parameters/interferogram/frequencyA/commonBandRangeFilterApplied		
Type: string	**Shape: scalar**	
Description: Flag to indicate if common band range filter has been applied		
/science/SSAR/RIFG/metadata/processingInformation/parameters/interferogram/frequencyA/commonBandAzimuthFilterApplied		
Type: string	**Shape: scalar**	
Description: Flag to indicate if common band azimuth filter has been applied		
/science/SSAR/RIFG/metadata/processingInformation/parameters/interferogram/frequencyA/ellipsoidalFlatteningApplied		
Type: string	**Shape: scalar**	
Description: Flag to indicate if the interferometric phase has been flattened with respect to a zero height ellipsoid		
/science/SSAR/RIFG/metadata/processingInformation/parameters/interferogram/frequencyA/topographicFlatteningApplied		
Type: string	**Shape: scalar**	
Description: Flag to indicate if the interferometric phase has been flattened with respect to topographic height using a DEM		
/science/SSAR/RIFG/metadata/processingInformation/parameters/pixelOffsets/frequencyA/isOffsetsBlendingApplied		
Type: string	**Shape: scalar**	
Description: Flag to indicate if pixel offsets are the results of blending multi-resolution layers of pixel offsets		
/science/SSAR/RIFG/metadata/processingInformation/parameters/pixelOffsets/frequencyA/alongTrackWindowSize		
Type: UInt32	**Shape: scalar**	
Description: Along-track cross-correlation window size in pixels		
	units	1
/science/SSAR/RIFG/metadata/processingInformation/parameters/pixelOffsets/frequencyA/slantRangeWindowSize		
Type: UInt32	**Shape: scalar**	
Description: Slant range cross-correlation window size in pixels		
	units	1
/science/SSAR/RIFG/metadata/processingInformation/parameters/pixelOffsets/frequencyA/alongTrackSearchWindowSize		
Type: UInt32	**Shape: scalar**	
Description: Along-track cross-correlation search window size in pixels		

	units	1
/science/SSAR/RIFG/metadata/processingInformation/parameters/pixelOffsets/frequencyA/slantRangeSearchWindowSize		
Type: UInt32	**Shape: scalar**	
Description: Slant range cross-correlation search window size in pixels		
	units	1
/science/SSAR/RIFG/metadata/processingInformation/parameters/pixelOffsets/frequencyA/alongTrackSkipWindowSize		
Type: UInt32	**Shape: scalar**	
Description: Along-track cross-correlation skip window size in pixels		
	units	1
/science/SSAR/RIFG/metadata/processingInformation/parameters/pixelOffsets/frequencyA/slantRangeSkipWindowSize		
Type: UInt32	**Shape: scalar**	
Description: Slant range cross-correlation skip window size in pixels		
	units	1
/science/SSAR/RIFG/metadata/processingInformation/parameters/pixelOffsets/frequencyA/correlationSurfaceOversampling		
Type: UInt32	**Shape: scalar**	
Description: Oversampling factor of the cross-correlation surface		
	units	1
/science/SSAR/RIFG/metadata/processingInformation/algorithms/softwareVersion		
Type: string	**Shape: scalar**	
Description: Software version used for processing		
/science/SSAR/RIFG/metadata/processingInformation/algorithms/coregistration/coregistrationMethod		
Type: string	**Shape: scalar**	
Description: RSLC coregistration method		
/science/SSAR/RIFG/metadata/processingInformation/algorithms/coregistration/geometryCoregistration		
Type: string	**Shape: scalar**	
Description: Geometry coregistration algorithm		
/science/SSAR/RIFG/metadata/processingInformation/algorithms/coregistration/crossCorrelation		
Type: string	**Shape: scalar**	
Description: Cross-correlation algorithm for sub-pixel offsets computation		
/science/SSAR/RIFG/metadata/processingInformation/algorithms/coregistration/resampling		
Type: string	**Shape: scalar**	
Description: Secondary RSLC resampling algorithm		
/science/SSAR/RIFG/metadata/processingInformation/algorithms/coregistration/crossCorrelationOutliers		
Type: string	**Shape: scalar**	
Description: Outliers identification algorithm		
/science/SSAR/RIFG/metadata/processingInformation/algorithms/coregistration/crossCorrelationFilling		
Type: string	**Shape: scalar**	
Description: Outliers data filling algorithm for cross-correlation offsets		
/science/SSAR/RIFG/metadata/processingInformation/algorithms/coregistration/crossCorrelationFilterKernel		
Type: string	**Shape: scalar**	
Description: Filtering algorithm for cross-correlation offsets		
/science/SSAR/RIFG/metadata/processingInformation/algorithms/interferogramFormation/multilooking		
Type: string	**Shape: scalar**	

Description: Multilooking algorithm	
/science/SSAR/RIFG/metadata/processingInformation/algorithms/interferogramFormation/wrappedInterferogramFiltering	
Type: string	**Shape: scalar**
Description: Algorithm used to filter the wrapped interferogram prior to phase unwrapping	
/science/SSAR/RIFG/metadata/processingInformation/algorithms/interferogramFormation/flatteningMethod	
Type: string	**Shape: scalar**
Description: Algorithm used to flatten the wrapped interferogram	
/science/SSAR/RIFG/metadata/processingInformation/inputs/l1ReferenceSlcGranules	
Type: string	**Shape: (numberOfInputL1Files)**
Description: List of input reference L1 RSLC products used	
/science/SSAR/RIFG/metadata/processingInformation/inputs/l1SecondarySlcGranules	
Type: string	**Shape: (numberOfInputL1Files)**
Description: List of input secondary L1 RSLC products used	
/science/SSAR/RIFG/metadata/processingInformation/inputs/configFiles	
Type: string	**Shape: (numberOfInputConfigFiles)**
Description: List of input config files used	
/science/SSAR/RIFG/metadata/processingInformation/inputs/demSource	
Type: string	**Shape: scalar**
Description: Description of the input digital elevation model (DEM)	
/science/SSAR/RIFG/metadata/processingInformation/inputs/orbitFiles	
Type: string	**Shape: (numberOfInputOrbitFiles)**
Description: List of input orbit files used	

8.4.5 Other Radar Metadata

Calibration-related variables		
/science/SSAR/RIFG/metadata/orbit/temporalBaseline		
Type: UInt16	**Shape: scalar**	
Description: Time interval between reference and secondary RSLCs		
	units	days
/science/SSAR/RIFG/metadata/orbit/reference/interpMethod		
Type: string	**Shape: scalar**	
Description: Orbit interpolation method, either "Hermite" or "Legendre"		
/science/SSAR/RIFG/metadata/orbit/reference/time		
Type: Float64	**Shape: (orbitListLength)**	
Description: Time vector record. This record contains the time corresponding to position and velocity records		
	units	seconds since YYYY-mm-ddTHH:MM:SS
/science/SSAR/RIFG/metadata/orbit/reference/position		
Type: Float64	**Shape: (orbitListLength, tripletxyz)**	
Description: Position vector record. This record contains the platform position data with respect to WGS84 G1762 reference frame		
	units	meters
/science/SSAR/RIFG/metadata/orbit/reference/velocity		
Type: Float64	**Shape: (orbitListLength, tripletxyz)**	
Description: Velocity vector record. This record contains the platform velocity data with respect to WGS84 G1762 reference frame		
	units	meters / second
/science/SSAR/RIFG/metadata/orbit/reference/orbitType		
Type: string	**Shape: scalar**	

Description: Orbit product type, either "FOE", "NOE", "MOE", "POE", or "Custom", where "FOE" stands for Forecast Orbit Ephemeris, "NOE" is Near real-time Orbit Ephemeris, "MOE" is Medium precision Orbit Ephemeris, and "POE" is Precise Orbit Ephemeris		
/science/SSAR/RIFG/metadata/orbit/secondary/interpMethod		
Type: string	**Shape: scalar**	
Description: Orbit interpolation method, either "Hermite" or "Legendre"		
/science/SSAR/RIFG/metadata/orbit/secondary/time		
Type: Float64	**Shape: (orbitListLength)**	
Description: Time vector record. This record contains the time corresponding to position and velocity records		
	units	seconds since YYYY-mm-ddTHH:MM:SS
/science/SSAR/RIFG/metadata/orbit/secondary/position		
Type: Float64	**Shape: (orbitListLength, tripletxyz)**	
Description: Position vector record. This record contains the platform position data with respect to WGS84 G1762 reference frame		
	units	meters
/science/SSAR/RIFG/metadata/orbit/secondary/velocity		
Type: Float64	**Shape: (orbitListLength, tripletxyz)**	
Description: Velocity vector record. This record contains the platform velocity data with respect to WGS84 G1762 reference frame		
	units	meters / second
/science/SSAR/RIFG/metadata/orbit/secondary/orbitType		
Type: string	**Shape: scalar**	
Description: Orbit product type, either "FOE", "NOE", "MOE", "POE", or "Custom", where "FOE" stands for Forecast Orbit Ephemeris, "NOE" is Near real-time Orbit Ephemeris, "MOE" is Medium precision Orbit Ephemeris, and "POE" is Precise Orbit Ephemeris		
/science/SSAR/RIFG/metadata/attitude/reference/time		
Type: Float64	**Shape: (attitudeListLength)**	
Description: Time vector record. This record contains the time corresponding to attitude and quaternion records		
	units	seconds since YYYY-mm-ddTHH:MM:SS
/science/SSAR/RIFG/metadata/attitude/reference/quaternions		
Type: Float64	**Shape: (attitudeListLength, quaternions)**	
Description: Attitude quaternions (q0, q1, q2, q3)		
	units	1
/science/SSAR/RIFG/metadata/attitude/reference/eulerAngles		
Type: Float64	**Shape: (attitudeListLength, tripletxyz)**	
Description: Attitude Euler angles (roll, pitch, yaw)		
	units	degrees
/science/SSAR/RIFG/metadata/attitude/reference/attitudeType		
Type: string	**Shape: scalar**	
Description: Attitude type, either "FRP", "NRP", "PRP, or "Custom", where "FRP" stands for Forecast Radar Pointing, "NRP" is Near Real-time Pointing, and "PRP" is Precise Radar Pointing		
/science/SSAR/RIFG/metadata/attitude/secondary/time		
Type: Float64	**Shape: (attitudeListLength)**	
Description: Time vector record. This record contains the time corresponding to attitude and quaternion records		
	units	seconds since YYYY-mm-ddTHH:MM:SS
/science/SSAR/RIFG/metadata/attitude/secondary/quaternions		
Type: Float64	**Shape: (attitudeListLength, quaternions)**	
Description: Attitude quaternions (q0, q1, q2, q3)		
	units	1
/science/SSAR/RIFG/metadata/attitude/secondary/eulerAngles		
Type: Float64	**Shape: (attitudeListLength, tripletxyz)**	
Description: Attitude Euler angles (roll, pitch, yaw)		
	units	degrees
/science/SSAR/RIFG/metadata/attitude/secondary/attitudeType		

Type: string	**Shape: scalar**
Description: Attitude type, either "FRP", "NRP", "PRP, or "Custom", where "FRP" stands for Forecast Radar Pointing, "NRP" is Near Real-time Pointing, and "PRP" is Precise Radar Pointing	

8.4.6 Geolocation Grid

Metadata cube-related variables		
/science/SSAR/RIFG/metadata/geolocationGrid/epsg		
Type: Int32	**Shape: scalar**	
Description: EPSG code corresponding to the coordinate system used for representing the geolocation grid		
	long_name	EPSG code
/science/SSAR/RIFG/metadata/geolocationGrid/coordinateY		
Type: Float64	**Shape: (geolocationCubeHeight, geolocationCubeLength, geolocationCubeWidth)**	
Description: Y coordinates in specified EPSG code		
	_FillValue	nan
	grid_mapping	projection
	long_name	Coordinate Y
	units	degrees
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (seconds)
/science/SSAR/RIFG/metadata/geolocationGrid/coordinateX		
Type: Float64	**Shape: (geolocationCubeHeight, geolocationCubeLength, geolocationCubeWidth)**	
Description: X coordinates in specified EPSG code		
	_FillValue	nan
	grid_mapping	projection
	long_name	Coordinate X
	units	degrees
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (seconds)
/science/SSAR/RIFG/metadata/geolocationGrid/incidenceAngle		
Type: Float32	**Shape: (geolocationCubeHeight, geolocationCubeLength, geolocationCubeWidth)**	
Description: Incidence angle is defined as the angle between the LOS vector and the normal to the ellipsoid at the target height		
	valid_max	90.0
	valid_min	0.0
	_FillValue	nan
	grid_mapping	projection
	long_name	Incidence angle
	units	degrees
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)

	azimuth_spacing	The spacing in Azimuth direction (seconds)
/science/SSAR/RIFG/metadata/geolocationGrid/losUnitVectorX		
Type: Float32	**Shape: (geolocationCubeHeight, geolocationCubeLength, geolocationCubeWidth)**	
Description: East component of unit vector of LOS from target to sensor		
	valid_max	1.0
	valid_min	-1.0
	_FillValue	nan
	grid_mapping	projection
	long_name	LOS unit vector X
	units	1
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (seconds)
/science/SSAR/RIFG/metadata/geolocationGrid/losUnitVectorY		
Type: Float32	**Shape: (geolocationCubeHeight, geolocationCubeLength, geolocationCubeWidth)**	
Description: North component of unit vector of LOS from target to sensor		
	valid_max	1.0
	valid_min	-1.0
	_FillValue	nan
	grid_mapping	projection
	long_name	LOS unit vector Y
	units	1
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (seconds)
/science/SSAR/RIFG/metadata/geolocationGrid/alongTrackUnitVectorX		
Type: Float32	**Shape: (geolocationCubeHeight, geolocationCubeLength, geolocationCubeWidth)**	
Description: East component of unit vector along ground track		
	_FillValue	nan
	grid_mapping	projection
	valid_max	1.0
	valid_min	-1.0
	units	1
	long_name	Along-track unit vector X
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (seconds)
/science/SSAR/RIFG/metadata/geolocationGrid/alongTrackUnitVectorY		
Type: Float32	**Shape: (geolocationCubeHeight, geolocationCubeLength, geolocationCubeWidth)**	
Description: North component of unit vector along ground track		
	_FillValue	nan
	grid_mapping	projection
	valid_max	1.0
	valid_min	-1.0

	units	1
	long_name	Along-track unit vector Y
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (seconds)
/science/SSAR/RIFG/metadata/geolocationGrid/elevationAngle		
Type: Float32	**Shape: (geolocationCubeHeight, geolocationCubeLength, geolocationCubeWidth)**	
Description: Elevation angle is defined as the angle between the LOS vector and the normal to the ellipsoid at the sensor		
	_FillValue	nan
	grid_mapping	projection
	long_name	Elevation angle
	valid_max	90.0
	valid_min	0.0
	units	degrees
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (seconds)
/science/SSAR/RIFG/metadata/geolocationGrid/parallelBaseline		
Type: Float32	**Shape: (geolocationCubeHeight, geolocationCubeLength, geolocationCubeWidth)**	
Description: Parallel component of the InSAR baseline		
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points
	units	meters
	long_name	Parallel baseline
	_FillValue	nan
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (seconds)
/science/SSAR/RIFG/metadata/geolocationGrid/perpendicularBaseline		
Type: Float32	**Shape: (geolocationCubeHeight, geolocationCubeLength, geolocationCubeWidth)**	
Description: Perpendicular component of the InSAR baseline		
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points
	units	meters
	long_name	Perpendicular baseline
	_FillValue	nan
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)

	azimuth_spacing	The spacing in Azimuth direction (seconds)
/science/SSAR/RIFG/metadata/geolocationGrid/groundTrackVelocity		
Type: Float64	**Shape: (geolocationCubeHeight, geolocationCubeLength, geolocationCubeWidth)**	
Description: Absolute value of the platform velocity scaled at the target height		
	_FillValue	nan
	grid_mapping	projection
	long_name	Ground track velocity
	units	meters / second
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (seconds)
/science/SSAR/RIFG/metadata/geolocationGrid/slantRange		
Type: Float64	**Shape: (geolocationCubeWidth)**	
Description: Slant range values corresponding to the geolocation grid		
	long_name	Slant range
	units	meters
/science/SSAR/RIFG/metadata/geolocationGrid/zeroDopplerTime		
Type: Float64	**Shape: (geolocationCubeLength)**	
Description: Zero Doppler time values corresponding to the geolocation grid		
	long_name	Zero-Doppler time
	units	seconds since YYYY-mm-ddTHH:MM:SS
/science/SSAR/RIFG/metadata/geolocationGrid/heightAboveEllipsoid		
Type: Float64	**Shape: (geolocationCubeHeight)**	
Description: Height values above WGS84 Ellipsoid corresponding to the location grid		
	standard_name	height_above_reference_ellipsoid
	units	meters

8.4.7 Geolocation Grid True Height (Available Only in ISRO Generated Products)

Geolocation grid at true height is at a finer spacing as compared to the radar grid documented in section 8.4.6.

Metadata cube-related variables		
/science/SSAR/RIFG/metadata/geolocationGridTrueHeight/epsg		
Type: Int32	**Shape: scalar**	
Description: EPSG code corresponding to the coordinate system used for representing the geolocation grid		
	long_name	EPSG code
/science/SSAR/RIFG/metadata/geolocationGridTrueHeight/coordinateY		
Type: Float64	**Shape: (geolocationCubeHeightTrueHeight, geolocationCubeLengthTrueHeight, geolocationCubeWidthTrueHeight)**	
Description: Y coordinates in specified EPSG code		
	_FillValue	nan
	grid_mapping	projection
	long_name	Coordinate Y
	units	degrees
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (seconds)

/science/SSAR/RIFG/metadata/geolocationGridTrueHeight/coordinateX		
Type: Float64	**Shape: (geolocationCubeHeightTrueHeight, geolocationCubeLengthTrueHeight, geolocationCubeWidthTrueHeight)**	
Description: X coordinates in specified EPSG code		
	_FillValue	nan
	grid_mapping	projection
	long_name	Coordinate X
	units	degrees
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (seconds)
/science/SSAR/RIFG/metadata/geolocationGridTrueHeight/incidenceAngle		
Type: Float32	**Shape: (geolocationCubeHeightTrueHeight, geolocationCubeLengthTrueHeight, geolocationCubeWidthTrueHeight)**	
Description: Incidence angle is defined as the angle between the LOS vector and the normal to the ellipsoid at the target height		
	valid_max	90.0
	valid_min	0.0
	_FillValue	nan
	grid_mapping	projection
	long_name	Incidence angle
	units	degrees
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (seconds)
/science/SSAR/RIFG/metadata/geolocationGridTrueHeight/losUnitVectorX		
Type: Float32	**Shape: (geolocationCubeHeightTrueHeight, geolocationCubeLengthTrueHeight, geolocationCubeWidthTrueHeight)**	
Description: East component of unit vector of LOS from target to sensor		
	valid_max	1.0
	valid_min	-1.0
	_FillValue	nan
	grid_mapping	projection
	long_name	LOS unit vector X
	units	1
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (seconds)
/science/SSAR/RIFG/metadata/geolocationGridTrueHeight/losUnitVectorY		
Type: Float32	**Shape: (geolocationCubeHeightTrueHeight, geolocationCubeLengthTrueHeight, geolocationCubeWidthTrueHeight)**	
Description: North component of unit vector of LOS from target to sensor		
	valid_max	1.0
	valid_min	-1.0
	_FillValue	nan
	grid_mapping	projection
	long_name	LOS unit vector Y

	units	1
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (seconds)
/science/SSAR/RIFG/metadata/geolocationGridTrueHeight/alongTrackUnitVectorX		
Type: Float32	**Shape: (geolocationCubeHeightTrueHeight, geolocationCubeLengthTrueHeight, geolocationCubeWidthTrueHeight)**	
Description: East component of unit vector along ground track		
	_FillValue	nan
	grid_mapping	projection
	valid_max	1.0
	valid_min	-1.0
	units	1
	long_name	Along-track unit vector X
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (seconds)
/science/SSAR/RIFG/metadata/geolocationGridTrueHeight/alongTrackUnitVectorY		
Type: Float32	**Shape: (geolocationCubeHeightTrueHeight, geolocationCubeLengthTrueHeight, geolocationCubeWidthTrueHeight)**	
Description: North component of unit vector along ground track		
	_FillValue	nan
	grid_mapping	projection
	valid_max	1.0
	valid_min	-1.0
	units	1
	long_name	Along-track unit vector Y
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (seconds)
/science/SSAR/RIFG/metadata/geolocationGridTrueHeight/elevationAngle		
Type: Float32	**Shape: (geolocationCubeHeightTrueHeight, geolocationCubeLengthTrueHeight, geolocationCubeWidthTrueHeight)**	
Description: Elevation angle is defined as the angle between the LOS vector and the normal to the ellipsoid at the sensor		
	_FillValue	nan
	grid_mapping	projection
	long_name	Elevation angle
	valid_max	90.0
	valid_min	0.0
	units	degrees
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (seconds)

/science/SSAR/RIFG/metadata/geolocationGridTrueHeight/parallelBaseline		
Type: Float32	**Shape: (geolocationCubeHeightTrueHeight, geolocationCubeLengthTrueHeight, geolocationCubeWidthTrueHeight)**	
Description: Parallel component of the InSAR baseline		
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points
	long_name	Parallel baseline
	units	meters
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (seconds)
/science/SSAR/RIFG/metadata/geolocationGridTrueHeight/perpendicularBaseline		
Type: Float32	**Shape: (geolocationCubeHeightTrueHeight, geolocationCubeLengthTrueHeight, geolocationCubeWidthTrueHeight)**	
Description: Perpendicular component of the InSAR baseline		
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points
	long_name	Perpendicular baseline
	units	meters
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (seconds)
/science/SSAR/RIFG/metadata/geolocationGridTrueHeight/groundTrackVelocity		
Type: Float64	**Shape: (geolocationCubeHeightTrueHeight, geolocationCubeLengthTrueHeight, geolocationCubeWidthTrueHeight)**	
Description: Absolute value of the platform velocity scaled at the target height		
	_FillValue	nan
	grid_mapping	projection
	long_name	Ground track velocity
	units	meters / second
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (seconds)
/science/SSAR/RIFG/metadata/geolocationGridTrueHeight/slantRange		
Type: Float64	**Shape: (geolocationCubeWidthTrueHeight)**	
Description: Slant range values corresponding to the geolocation grid		
	long_name	Slant range
	units	meters
/science/SSAR/RIFG/metadata/geolocationGridTrueHeight/zeroDopplerTime		
Type: Float64	**Shape: (geolocationCubeLengthTrueHeight)**	
Description: Zero Doppler time values corresponding to the geolocation grid		

	long_name	Zero-Doppler time
	units	seconds since YYYY-mm-ddTHH:MM:SS

CHAPTER – 9

Range Doppler Unwrapped Interferogram (RUNW) Data Product

9 Range Doppler UnWrapped Interferogram (RUNW) Data Product

Range Doppler UnWrapped Interferogram (RUNW) is defined as Multi-looked unwrapped interferogram in Range Doppler coordinates with ellipsoid and topography flattened. It is generated with nearest pair in time and for copol (HH, VV) and circular pol (RH, RV) channels only. In case of L-Band, RUNW is generated for Main Frequency band (FrequencyA) only. The averaging window size for RUNW for different bandwidth combinations and for L&S Band is shown in Table 9-1. The mid swath incidence angle used for computing ground range spacing is 42 degrees. The posting for RUNW product is 80m on ground in range and azimuth direction.

Band	Fs (MHz)	BW (MHz)	SLC Slant Range Spacing (m)	SLC Azimuth spacing (m)	Ground Range Spacing (at mid swath) (m)	Range Looks	Azimuth Looks
S	13.89	10	10.80	5	16.14	5	16
	27.78	25	5.40	5	8.07	10	16
	41.67	37.5	3.60	5	5.38	15	16
	83.33	75	1.80	5	2.69	30	16
L	6	5	25.00	5	37.36	2	16
	24	20	6.25	5	9.34	9	16
	48	40	3.13	5	4.67	17	16
	96	77	1.56	5	2.33	34	16

Table 9-1 Averaging window size for L&S Band RUNW products

9.1 RUNW Product Overview

The RUNW product represents the unwrapped, ellipsoid- and topography-flattened, multi-looked interferogram generated from two L1 Range Doppler Single Look Complex (RSLC) products in the range-Doppler geometry of the earlier ("reference") acquisition. The RUNW product is with a nominal posting of 80 meters on the ground irrespective of the slant range bandwidth (see Table 9-1). The RUNW is generated for copol and circular pol channels only and for main imaging bands only (frequencyA in case of L-Band).

The product contains raster layers representing single precision floating point unwrapped phase and normalized interferometric coherence magnitude. The product includes the connected component mask, a mask layer identifying invalid pixels (i.e., pixels affected by geometric distortions), and the slant range and along track offsets obtained from incoherent cross-correlation. Lookup tables for parallel and perpendicular baseline components are also included. The RUNW product also includes an ionospheric phase screen layer and a layer quantifying its uncertainty.

For S-Band, split spectrum technique will be used to generate the ionospheric phase screen layer.

For L-Band, the ionospheric phase screen is estimated from the two spectral bands "frequencyA" and "frequencyB" wherever possible. In the case of mode transitions where continuity of spectral bands is impacted, a split spectrum ionospheric phase estimate and an estimate of its standard deviation is derived from the main imaging band (“frequencyA”). The estimated ionospheric phase screen is included as a layer in the product but not applied to the data layers within RUNW by default.

The RUNW product includes the slant range and along-track sub-pixel offsets obtained from incoherent cross-correlation and used to generate the complex wrapped interferogram. If an offset product in Range-Doppler coordinates (e.g., ROFF) is available for the processed frame, the sub-pixel offset layers included in RUNW are obtained by optimally blending the multiresolution offset layers included in ROFF. The application of the offset layers blending algorithm is indicated by setting the flag

“/science/SSAR/RUNW/metadata/processingInformation/parameters/pixelOffsets/frequencyA/is OffsetsBlendingApplied” to “True”. Conversely, if this flag is set to “False”, the offset blending algorithm is not applied, and the sub-pixel offset layers included in RUNW are obtained by simply running incoherent cross-correlation on a coarser radar grid. The pixel offset layers in RUNW may be subject to several post-processing operations (e.g., outlier removal, no-data filling, and noise reduction).

9.2 RUNW Product Organization

9.2.1 Granule Definition

NISAR RUNW granules will conform to the Tiling Scheme being developed for the mission and are expected to have a ground footprint of 240 km x 240 km. (except in L-Band for 77 MHz data, which cover half of the swath in range direction).

9.2.2 File Naming Convention

NISAR RUNW Granule names will conform to the S/L-SAR Product File Naming Conventions as discussed in section 2.2.2.

9.2.3 Temporal Organization

The RUNW data are arranged on a uniformly spaced, increasing Zero-Doppler azimuth time grid.
Using row-major order convention of representing 2D raster arrays, Zero-Doppler azimuth time is represented by the row direction or the slowest changing dimension.

9.2.4 Spatial Organization

The RUNW data are arranged on a uniformly spaced, increasing Zero-Doppler azimuth time in the row direction and increasing slant range grid in the column direction following the row-major order convention of representing 2D raster arrays.

9.2.5 Spatial Sampling and Resolution

NISAR mission uses a non-uniformly spaced sequence of pulses in SweepSAR mode to collect radar data, to overcome the limitations imposed by transmit gaps affecting the wide imaging swath. Processing software accounts for the non-uniform sampling to generate the final RUNW product on a uniform grid. Some salient features of the output grid for the RUNW product are:

1. The center of the top-left pixel of all the data layers within the

"/science/SSAR/RUNW/swaths/frequencyA/interferogram/" Group correspond to the same Zero-Doppler azimuth time and slant range for all imagery layers in an S-SAR RUNW product.

2. The center of the top-left pixel of all the data layers within the

"/science/SSAR/RUNW/swaths/frequencyA/pixelOffsets/" group correspond to the same Zero-Doppler azimuth time and slant range for all imagery layers in an S-SAR RUNW product.

3. The main imaging band (frequencyA) is spatially averaged to the same posting, irrespective of the imaging mode (Table 9-1). This allows for spatial mosaicking operations across instrument mode changes.

9.2.6 Along Track Mosaicking

The spatial sampling of the output grid has also been designed to facilitate along-track mosaicking of contiguous RUNW product granules if the user desires. The following features simplify the implementation of along-track mosaicking

1. The slow time sampling frequency (inverse of the zero Doppler time spacing between consecutive lines) will be chosen to be an integer, to allow synchronization between adjacent granules at integer second boundaries without the need for resampling in the azimuth time direction.

2. The slant range to the first pixel will be a multiple of the lowest sampling frequency (corresponding to 5 MHz) to enable concatenation of adjacent granules with simple integer shifts of imagery in the slant range direction.

Since the RUNW product represents unwrapped phase in radians, these quantities need to be transformed to two-way displacement using the wavelength information to mosaic products in the along-track direction.

9.2.7 Partially compressed SLC data

Partially compressed data in RSLC files will not be used to produce RUNW products. Spatially averaged pixels with any partially compressed or missing data in RSLCs will be set to the fill value specified by _FillValue attribute.

9.3 RUNW Product Description

In this section, we will describe the layout of RUNW data and associated metadata within the NISAR HDF5 file. Detailed description of Group and Dataset names can be found in section 9.4. In this section, we focus on the organization of S-SAR instrument data within the file under the Group name "/science/SSAR/". The same holds true for L-SAR products too.

9.3.1 Shapes and Dimensions of Data

Information on the shapes and dimensions of the data items in various data tables are described as part of the metadata section 9.4.1. This information is useful both as part of the product identification and for setting up further processing, i.e., dimensioning arrays.

9.3.2 Product Identification

Information required to identify this product is given under the Group:

"/science/SSAR/identification/". This includes information such as orbit, cycle, track, and frame numbers, acquisition times, a polygon representing the bounding box of the included imagery in geographic coordinates, product version, and product specification version (i.e., the version number of this document).

9.3.3 Radar Imagery

The RUNW product's imagery layers and associated datasets are initially organized based on the center frequency within the Group "/science/SSAR/RUNW/swaths/frequencyA/". Only the main NISAR imaging band ("frequencyA") will be processed for RUNW products. Imagery data is further categorized by their type. The Wrapped Interferogram layer and associated Datasets are located under the Group "/science/SSAR/RUNW/swaths/frequencyA/interferogram/". The crosscorrelation sub-pixel offsets are located under the Group "/science/SSAR/RUNW/swaths/frequencyA/pixelOffsets/". Each of these Groups is further organized by polarization (TxRx), and by a final grouping. For example, the Interferogram group could contain the Group "/science/SSAR/RUNW/swaths/frequencyA/interferogram/HH/". The imagery Datasets reside within these polarization Groups. As an example, the Dataset "/science/SSAR/RUNW/swaths/frequencyA/interferogram/HH/unwrappedPhase" corresponds to the unwrapped phase derived from the "frequencyA" and "HH" polarization imagery layers within the reference and secondary input RSLCs. The same description holds true for all polarization channels present in the product. The same convention holds true for L-Band products. The details of the data elements are given in section 9.4.2

9.3.4 Radar Metadata

The Group "/science/SSAR/RUNW/metadata/" includes a list of miscellaneous metadata needed to interpret the geolocation and the imagery (e.g., unwrapped interferometric phase, normalized interferometric coherence magnitude, slant range and along-track pixel offsets) included in the RUNW product.

9.3.4.1 Processing Information

The Group "/science/SSAR/RUNW/metadata/processingInformation/" includes the processing parameters used to generate the RUNW product. This group also include a list of the used algorithms and the input granules used to produce RUNW. For a complete description of this group, refer to Section 9.4.4.

9.3.4.2 Parameters

The Group "/science/SSAR/RUNW/metadata/processingInformation/parameters/" is further organized in six Groups:

1. *common*: organized by frequency, and including the parameters derived by combining the information from the reference and secondary RSLC e.g., Doppler centroid and the Doppler bandwidth

2. *reference*: including the reference terrain height of the reference RSLC and flags to indicate if the reference RSLC is the result of mixed mode processing or if it has been corrected for RFI. This Group is further organized by frequency and includes some relevant parameters of the reference RSLC such as the slant range and zero Doppler time spacing's, the slant range and the azimuth bandwidth, and the Doppler centroid

3. *secondary*: this Group follows the same organization of *reference* but includes the corresponding metadata for the secondary RSLC.

4. *interferogram*: including the parameters used to generate the complex wrapped interferogram and the normalized interferometric correlation e.g., the common slant range and azimuth bandwidth and the slant range and azimuth number of looks

5. *pixelOffsets*: including the parameters (e.g., window size, search windows) used to generate the along-track and slant range dense pixel offsets layers used during the fine coregistration of the reference and secondary RSLCs

6. *ionosphere*: including the parameters used to generate the ionosphere phase screen e.g., the bandwidth of the low and high sub-images used in the ionosphere phase estimation with the range split spectrum technique.

The Group *parameters* also contains the Dataset *runConfigurationContents* which includes a copy of the run configuration used for processing populated with all the processing options, parameters values, and input files.

9.3.4.3 Algorithms

The Group "/science/SSAR/RUNW/metadata/processingInformation/algorithms/" includes the name and the version of the software used to generate the product. The Group is further organized by distinct Groups identifying the processing steps used to generate the RUNW product:

1. *coregistration*: including the algorithms used to perform the coarse and fine coregistration of the reference and secondary RSLCs (e.g., geometry coregistration, cross-correlation algorithm).

2. *interferogramFormation*: including the algorithms used to form the complex wrapped interferogram and the normalized interferometric correlation (e.g., flattening method)

3. *unwrapping*: including the algorithms used to perform phase unwrapping (e.g., unwrapping algorithm, unwrapping initializer, type of performed preprocessing of the wrapped interferometric phase).

4. *ionosphereEstimation*: including the algorithm used to perform the estimation of the ionosphere phase screen (e.g., outlier estimation and filling, unwrapping error correction).

9.3.4.4 Input Files

The Group "/science/SSAR/RUNW/metadata/processingInformation/inputs/" includes the filenames of the input RSLC granules, configuration files, orbit files, and a description of the DEM used for processing.

9.3.5 Other Radar Metadata

9.3.5.1 Orbit

The reference RSLC orbit ephemeris used for generating the RUNW product is provided under the Group "/science/SSAR/RUNW/metadata metadata/orbit/" and further detailed in section 9.4. This group includes time-tagged antenna phase center position and velocity vectors in Earth Centered Earth Fixed (ECEF) Cartesian coordinates and information on the used orbit fidelity (e.g., Medium Orbit Ephemeris).

9.3.5.2 Attitude

The attitude state vectors of the reference RSLC used for generating the RUNW product can be found under the Group "/science/SSAR/RUNW/metadata/attitude/". This group includes timetagged quaternions and Euler angles representing the slant range plane from the antenna phase center in an ECEF Cartesian system.

9.3.6 Geolocation Grid

The Group "/science/SSAR/RUNW/metadata/geolocationGrid/" contains information on the radar geometry of the reference RSLC. The Datasets within this Group (i.e., the geolocation grid cubes) are referenced over the radar-grid which is defined by the coordinate vectors "slantRange", "zeroDopplerTime", and "heightAboveEllipsoid". Normals are with respect to the WGS84 ellipsoid.

The "geolocationGrid" Group also include the Datasets:

1. "coordinateX" and "coordinateY" containing the mapping of the zero-Doppler grid to the geographic grid in the units defined by the Dataset "epsg" within the same Group

2. "losUnitVectorX" and "losUnitVectorY" identifying the East and North components of the Line-Of-Sight (LOS) unit vector (i.e., the vector from the target to the sensor) in the East-North-Up (ENU) coordinate system for each point of the geographic grid. The Up component LOS unit vector can be simply derived from the East and North components as:

$$losUnitVectorZ = \sqrt{1 - losUnitVectorX^2 - losUnitVectorY^2}$$

3. "alongTrackUnitVectorX" and "alongTrackUnitVectorY" containing the East and North components of the along-track unit vector (i.e., the projection of the along-track vector at the ground height) in ENU coordinates.

4. "incidenceAngle containing the incidence angle, i.e., the angle between the LOS vector and the normal to the ellipsoid at the target height

5. "elevationAngle" containing the elevation angle i.e., the angle between the LOS vector and the normal to the ellipsoid at the sensor

6. "groundTrackVelocity" containing the ground track velocity i.e., the absolute value of the platform velocity scaled at the target height

7. "perpendicularBaseline" and "parallelBaseline" containing the perpendicular and parallel component of the baseline between the reference and secondary RSLCs. The baseline components are computed on same heights as other datasets of metadata cube.

The details of the usage of metadata cube are given in

Annexure-2: Metadata Cube

In ISRO generated L and S Band products, a separate layer is defined in a separate sub-group for all these parameters at true height:

"/science/SSAR/RSLC/metadata/geolocationGridTrueHeight/".

In this group all the parameters of metadata will be generated at true height (meaning they will be generated at actual height of terrain) and will be a part of the product. This layer will be at a finer sampling than the actual Meta data cube layers. The number of dimensions, description and datatype will be same as that of actual metadata cube layer.

The details of this are present in Annexure-3: Metadata Cube at True Height.

9.4 RUNW Product Specification

In this section, actual datasets are defined in tabular form. They contain the dataset information available in RUNW product, which comprises of name, datatype, shape, and information corresponding to attributes. In product there are few datasets or few sub-groups that are per polarization. For representation, here only one polarization is used; in product, the layers/datasets/groups will be present as per the number of polarizations available in the product. The same holds true for frequency A for L-Band products.

9.4.1 Dimensions and Shapes

To simplify the description of the layout of data within the HDF5 file, we will use a table of dimensions and shapes to represent the relationship between similarly sized datasets. The entries in this table do not present actual datasets in the HDF5. This table is meant to be a guide to interpreting the shapes of the datasets in subsequent subsections.

Name	Shape	Description
scalar	scalar	None
numberOfDatatakes	scalar	Number of datatakes in product
numberOfObservations	scalar	Number of

		observations in product
numberOfFrequencies	scalar	Number of S/L-SAR frequencies in product
numberOfFrequencyAPolarizations	scalar	Number of polarization layers associated with S/L-SAR frequency A
interferogramSlantRangeWidth	scalar	Number of pixels in all S/L-SAR frequency A imagery datasets
interferogramZeroDopplerTimeLength	scalar	Number of lines in all S/L-SAR frequency A imagery datasets
interferogramShape	(interferogramSlantRangeWidth, interferogramZeroDopplerTimeLength)	Shape associated with real or integer datasets in the interferogram group
offsetShape	(offsetZeroDopplerTimeLength, offsetSlantRangeWidth)	Shape associated with S/L-SAR datasets in the pixelOffsets group.
offsetSlantRangeWidth	scalar	Number of pixels in all S/L-SAR datasets within the pixelOffsets group
offsetZeroDopplerTimeLength	scalar	Number of lines in all S/L-SAR datasets within the pixelOffsets group
geolocationCubeShape	(geolocationCubeHeight, geolocationCubeLength, geolocationCubeWidth)	Shape associated with metadata cubes
geolocationCubeHeight	scalar	Height dimension of the metadata cube
geolocationCubeLength	scalar	Length dimension of the metadata cube

geolocationCubeWidth	scalar	Width dimension of the metadata cube
geolocationCubeShapeTrueHeight	(1, geolocationCubeLengthTrueHeight, geolocationCubeWidthTrueHeight)	Shape associated with metadata cubes at True Height
geolocationCubeHeightTrueHeight	scalar	Height dimension of the metadata cube at True Height. The value will be one.
geolocationCubeLengthTrueHeight	scalar	Length dimension of the metadata cube at True Height
geolocationCubeWidthTrueHeight	scalar	Width dimension of the metadata cube at True Height
dopplerCentroidTimeLength	scalar	Length dimension of Doppler centroid grid
dopplerCentroidSlantRangeWidth	scalar	Length dimension of Doppler centroid grid
dopplerCentroidShape	(dopplerCentroidTimeLength, dopplerCentroidSlantRangeWidth)	Shape of the Doppler centroid grid
orbitListLength	scalar	Number of orbit state vectors
orbitShape	(orbitListLength, 3)	Shape of orbit state vector triplets dataset
attitudeListLength	scalar	Number of attitude state vectors
attitudeQuaternionShape	(attitudeListLength, 4)	Shape of attitude quaternion dataset
attitudeShape	(attitudeListLength, 3)	Shape of attitude Euler angle triplets dataset

numberOfInputL1Files	scalar	Number of input L1 granules
numberOfInputConfigFiles	scalar	Number of input configuration files
numberOfInputOrbitFiles	scalar	Number of input orbit files

9.4.2 Product Identification

Product identification variables	
/science/SSAR/identification/referenceAbsoluteOrbitNumber	
Type: UInt32	**Shape: scalar**
Description: Absolute orbit number for the reference SLC	
/science/SSAR/identification/secondaryAbsoluteOrbitNumber	
Type: UInt32	**Shape: scalar**
Description: Absolute orbit number for the secondary SLC	
/science/SSAR/identification/referenceIsJointObservation	
Type: string	**Shape: scalar**
Description: "True" if any portion of the reference RSLC was acquired in a joint observation mode (e.g., L-band and S-band simultaneously), "False" otherwise	
/science/SSAR/identification/secondaryIsJointObservation	
Type: string	**Shape: scalar**
Description: "True" if any portion of the reference RSLC was acquired in a joint observation mode (e.g., L-band and S-band simultaneously), "False" otherwise	
/science/SSAR/identification/trackNumber	
Type: UByte	**Shape: scalar**
Description: Track number	
/science/SSAR/identification/frameNumber	
Type: UInt16	**Shape: scalar**
Description: Frame number	
/science/SSAR/identification/missionId	
Type: string	**Shape: scalar**
Description: Mission identifier	
/science/SSAR/identification/processingCenter	
Type: string	**Shape: scalar**
Description: Data processing center	
/science/SSAR/identification/productType	
Type: string	**Shape: scalar**
Description: Product type	
/science/SSAR/identification/granuleId	
Type: string	**Shape: scalar**
Description: Unique granule identification name	
/science/SSAR/identification/productDoi	
Type: string	**Shape: scalar**
Description: Digital Object Identifier (DOI) for the product	
/science/SSAR/identification/productVersion	
Type: string	**Shape: scalar**
Description: Product version which represents the structure of the product and the science content governed by the algorithm, input data, and processing parameters	
/science/SSAR/identification/productSpecificationVersion	
Type: string	**Shape: scalar**
Description: Product specification version which represents the schema of this product	
/science/SSAR/identification/lookDirection	

Type: string	**Shape: scalar**	
Description: Look direction, either "Left" or "Right"		
/science/SSAR/identification/orbitPassDirection		
Type: string	**Shape: scalar**	
Description: Orbit direction, either "Ascending" or "Descending"		
/science/SSAR/identification/referenceZeroDopplerStartTime		
Type: string	**Shape: scalar**	
Description: Azimuth start time (in UTC) of reference RSLC product in the format YYYY-mm-ddTHH:MM:SS.sssssssss		
/science/SSAR/identification/secondaryZeroDopplerStartTime		
Type: string	**Shape: scalar**	
Description: Azimuth start time (in UTC) of secondary RSLC product in the format YYYY-mm-ddTHH:MM:SS.sssssssss		
/science/SSAR/identification/referenceZeroDopplerEndTime		
Type: string	**Shape: scalar**	
Description: Azimuth stop time (in UTC) of reference RSLC product in the format YYYY-mm-ddTHH:MM:SS.sssssssss		
/science/SSAR/identification/secondaryZeroDopplerEndTime		
Type: string	**Shape: scalar**	
Description: Azimuth stop time (in UTC) of secondary RSLC product in the format YYYY-mm-ddTHH:MM:SS.sssssssss		
/science/SSAR/identification/plannedDatatakeId		
Type: string	**Shape: (numberOfDatatakes)**	
Description: List of planned datatakes included in the product		
/science/SSAR/identification/plannedObservationId		
Type: string	**Shape: (numberOfObservations)**	
Description: List of planned observations included in the product		
/science/SSAR/identification/isUrgentObservation		
Type: string	**Shape: scalar**	
Description: Flag indicating if observation is nominal ("False") or urgent ("True")		
/science/SSAR/identification/listOfFrequencies		
Type: string	**Shape: (numberOfFrequencies)**	
Description: List of frequency layers available in the product		
/science/SSAR/identification/diagnosticModeFlag		
Type: UByte	**Shape: scalar**	
Description: Indicates if the radar operation mode is a diagnostic mode (1-2) or DBFed science (0): 0, 1, or 2		
/science/SSAR/identification/productLevel		
Type: string	**Shape: scalar**	
Description: Product level. L0A: Unprocessed instrument data; L0B: Reformatted, unprocessed instrument data; L1: Processed instrument data in radar coordinates system; and L2: Processed instrument data in geocoded coordinates system		
/science/SSAR/identification/isGeocoded		
Type: string	**Shape: scalar**	
Description: Flag to indicate if the product data is in the radar geometry ("False") or in the map geometry ("True")		
/science/SSAR/identification/boundingPolygon		
Type: string	**Shape: scalar**	
Description: OGR compatible WKT representation of bounding polygon of the image. Horizontal coordinates are WGS84 longitude followed by latitude (both in degrees), and the vertical coordinate is the height above the WGS84 ellipsoid in meters. The first point corresponds to the start-time, near-range radar coordinate, and the perimeter is traversed in counterclockwise order on the map. This means the traversal order in radar coordinates differs for left-looking and right-looking sensors. The polygon includes the four corners of the radar grid, with equal numbers of points distributed evenly in radar coordinates along each edge		
	ogr_geometry	polygon
	epsg	4326

/science/SSAR/identification/processingDateTime		
Type: string		**Shape: scalar**
Description: Processing date and time (in UTC) in the format YYYY-mm-ddTHH:MM:SS		
/science/SSAR/identification/radarBand		
Type: string		**Shape: scalar**
Description: Acquired frequency band, either "L" or "S"		
/science/SSAR/identification/platformName		
Type: string		**Shape: scalar**
Description: Name of the platform used to collect the remote sensing data provided in this product		
/science/SSAR/identification/instrumentName		
Type: string		**Shape: scalar**
Description: Name of the instrument used to collect the remote sensing data provided in this product		
/science/SSAR/identification/processingType		
Type: string		**Shape: scalar**
Description: Nominal (or) Urgent (or) Custom (or) Undefined		
/science/SSAR/identification/isDithered		
Type: string		**Shape: scalar**
Description: "True" if the pulse timing was varied (dithered) during acquisition, "False" otherwise		
/science/SSAR/identification/isMixedMode		
Type: string		**Shape: scalar**
Description: "True" if this product is generated from reference and secondary RSLCs with different range bandwidths, "False" otherwise.		
/science/SSAR/identification/isFullFrame		
Type: string		**Shape: scalar**
Description: "True" if this product fully covers a NISAR frame**,** "False" if partial coverage.		
	frameCoveragePercentage	Percentage of NISAR frame containing processed data
	thresholdPercentage	Threshold percentage used to determine if the product is full frame or partial frame
/science/SSAR/identification/compositeReleaseId		
Type: string		**Shape: scalar**
Description: Unique version identifier of the science data production system		

9.4.3 Radar Imagery

Product imagery variables		
/science/SSAR/RUNW/swaths/frequencyA/listOfPolarizations		
Type: string		**Shape: (numberOfFrequencyAPolarizations)**
Description: List of processed polarization layers with frequency A		
/science/SSAR/RUNW/swaths/frequencyA/centerFrequency		
Type: Float64		**Shape: scalar**
Description: Center frequency of the processed image in hertz		
	units	hertz
/science/SSAR/RUNW/swaths/frequencyA/interferogram/sceneCenterAlongTrackSpacing		
Type: Float64		**Shape: scalar**
Description: Nominal along-track spacing in meters between consecutive lines near mid-swath of the product images		
	units	meters
/science/SSAR/RUNW/swaths/frequencyA/interferogram/sceneCenterGroundRangeSpacing		
Type: Float64		**Shape: scalar**
Description: Nominal ground range spacing in meters between consecutive pixels near mid-swath of the product images		
	units	meters
/science/SSAR/RUNW/swaths/frequencyA/interferogram/slantRangeSpacing		
Type: Float64		**Shape: scalar**

Description: Slant range spacing of grid. Same as difference between consecutive samples in slantRange array		
	units	meters
/science/SSAR/RUNW/swaths/frequencyA/interferogram/zeroDopplerTimeSpacing		
Type: Float64		**Shape: scalar**
Description: Time interval in the along-track direction for raster layers. This is same as the spacing between consecutive entries in the zeroDopplerTime array		
	units	seconds
/science/SSAR/RUNW/swaths/frequencyA/interferogram/slantRange		
Type: Float64		**Shape: (interferogramSlantRangeWidth)**
Description: Slant range vector		
	units	meters
/science/SSAR/RUNW/swaths/frequencyA/interferogram/zeroDopplerTime		
Type: Float64		**Shape: (interferogramZeroDopplerTimeLength)**
Description: Zero Doppler azimuth time since UTC epoch vector		
	units	seconds since YYYY-mm-ddTHH:MM:SS
/science/SSAR/RUNW/swaths/frequencyA/interferogram/digitalElevationModel		
Type: Float32		**Shape: (interferogramZeroDopplerTimeLength, interferogramSlantRangeWidth)**
Description: Digital Elevation Model (DEM) in radar coordinates. This dataset is produced using Copernicus WorldDEM-30 Copyright DLR e.V. 2010-2014 and Copyright Airbus Defence and Space GmbH 2014-2018 provided under COPERNICUS by the European Union and ESA; all rights reserved. This dataset is generated by referencing the Copernicus DEM elevations to the WGS84 ellipsoid and projecting them onto a range/Doppler grid		
	_FillValue	nan
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points
	units	meters
/science/SSAR/RUNW/swaths/frequencyA/interferogram/mask		
Type: UByte		**Shape: (interferogramZeroDopplerTimeLength, interferogramSlantRangeWidth)**
Description: Mask indicating the subswaths of valid samples in the reference RSLC and geometrically-coregistered secondary RSLC. Each pixel value is a two-digit number: the least significant digit represents the subswath number of that pixel in the secondary RSLC, and the most significant digit represents the subswath number of that pixel in the reference RSLC. A value of '0' in either digit indicates an invalid sample in the corresponding RSLC		
	_FillValue	255
	valid_min	0
	long_name	Valid samples subswath mask
/science/SSAR/RUNW/swaths/frequencyA/interferogram/HH/unwrappedPhase		
Type: Float32		**Shape: (interferogramZeroDopplerTimeLength, interferogramSlantRangeWidth)**
Description: Unwrapped interferogram between HH layers		
	_FillValue	nan
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points
	units	radians
/science/SSAR/RUNW/swaths/frequencyA/interferogram/HH/coherenceMagnitude		
Type: Float32		**Shape: (interferogramZeroDopplerTimeLength, interferogramSlantRangeWidth)**

Description: Coherence magnitude between HH layers		
	_FillValue	nan
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points
	units	1
/science/SSAR/RUNW/swaths/frequencyA/interferogram/HH/losDeformation		
Type: Float32		**Shape: (interferogramZeroDopplerTimeLength, interferogramSlantRangeWidth)**
Description: Line Of Sight (LOS) between HH layers		
	_FillValue	nan
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points
	units	1
/science/SSAR/RUNW/swaths/frequencyA/interferogram/HH/connectedComponents		
Type: Int16		**Shape: (interferogramZeroDopplerTimeLength, interferogramSlantRangeWidth)**
Description: Connected components for HH layer		
	_FillValue	255
	units	1
/science/SSAR/RUNW/swaths/frequencyA/interferogram/HH/ionospherePhaseScreen		
Type: Float32		**Shape: (interferogramZeroDopplerTimeLength, interferogramSlantRangeWidth)**
Description: Ionosphere phase screen		
	_FillValue	nan
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points
	units	radians
/science/SSAR/RUNW/swaths/frequencyA/interferogram/HH/ionospherePhaseScreenUncertainty		
Type: Float32		**Shape: (interferogramZeroDopplerTimeLength, interferogramSlantRangeWidth)**
Description: Uncertainty of the ionosphere phase screen		
	_FillValue	nan
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points
	units	radians
/science/SSAR/RUNW/swaths/frequencyA/pixelOffsets/sceneCenterAlongTrackSpacing		
Type: Float64		**Shape: scalar**
Description: Nominal along-track spacing in meters between consecutive lines near mid-swath of the product images		
	units	meters
/science/SSAR/RUNW/swaths/frequencyA/pixelOffsets/sceneCenterGroundRangeSpacing		
Type: Float64		**Shape: scalar**
Description: Nominal ground range spacing in meters between consecutive pixels near mid-swath of the product images		

	units	meters
/science/SSAR/RUNW/swaths/frequencyA/pixelOffsets/slantRangeSpacing		
Type: Float64		**Shape: scalar**
Description: Slant range spacing of the offset grid		
	units	meters
/science/SSAR/RUNW/swaths/frequencyA/pixelOffsets/zeroDopplerTimeSpacing		
Type: Float64		**Shape: scalar**
Description: Along-track spacing of the offset grid		
	units	seconds
/science/SSAR/RUNW/swaths/frequencyA/pixelOffsets/mask		
Type: UByte		**Shape: (interferogramZeroDopplerTimeLength, interferogramSlantRangeWidth)**
Description: Mask indicating the subswaths of valid samples in the reference RSLC and geometrically-coregistered secondary RSLC. Each pixel value is a two-digit number: the least significant digit represents the subswath number of that pixel in the secondary RSLC, and the most significant digit represents the subswath number of that pixel in the reference RSLC. A value of '0' in either digit indicates an invalid sample in the corresponding RSLC		
	_FillValue	255
	valid_min	0
	long_name	Valid samples subswath mask
/science/SSAR/RUNW/swaths/frequencyA/pixelOffsets/digitalElevationModel		
Type: Float32		**Shape: (interferogramZeroDopplerTimeLength, interferogramSlantRangeWidth)**
Description: Digital Elevation Model (DEM) in radar coordinates. This dataset is produced using Copernicus WorldDEM-30 Copyright DLR e.V. 2010-2014 and Copyright Airbus Defence and Space GmbH 2014-2018 provided under COPERNICUS by the European Union and ESA; all rights reserved. This dataset is generated by referencing the Copernicus DEM elevations to the WGS84 ellipsoid and projecting them onto a range/Doppler grid		
	_FillValue	nan
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points
	units	meters
/science/SSAR/RUNW/swaths/frequencyA/pixelOffsets/HH/slantRangeOffset		
Type: Float32		**Shape: (offsetZeroDopplerTimeLength, offsetSlantRangeWidth)**
Description: Slant range offset		
	_FillValue	nan
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points
	units	meters
/science/SSAR/RUNW/swaths/frequencyA/pixelOffsets/HH/alongTrackOffset		
Type: Float32		**Shape: (offsetZeroDopplerTimeLength, offsetSlantRangeWidth)**
Description: Along-track offset		
	_FillValue	nan
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points

	units	meters
/science/SSAR/RUNW/swaths/frequencyA/pixelOffsets/HH/correlationSurfacePeak		
Type: Float32		**Shape: (offsetZeroDopplerTimeLength, offsetSlantRangeWidth)**
Description: Normalized correlation surface peak		
	_FillValue	nan
	units	1
/science/SSAR/RUNW/swaths/frequencyA/pixelOffsets/slantRange		
Type: Float64		**Shape: (offsetSlantRangeWidth)**
Description: Slant range vector		
	units	meters
/science/SSAR/RUNW/swaths/frequencyA/pixelOffsets/zeroDopplerTime		
Type: Float64		**Shape: (offsetZeroDopplerTimeLength)**
Description: Zero Doppler azimuth time vector since UTC epoch vector		
	units	seconds since YYYY-mm-ddTHH:MM:SS

9.4.4 Processing Information

Processing-related variables		
/science/SSAR/RUNW/metadata/processingInformation/parameters/runConfigurationContents		
Type: string		**Shape: scalar**
Description: Contents of the run configuration file with parameters used for processing		
/science/SSAR/RUNW/metadata/processingInformation/parameters/reference/rfiMitigationApplied		
Type: string		**Shape: scalar**
Description: Flag to indicate if RFI mitigation has been applied to reference RSLC		
/science/SSAR/RUNW/metadata/processingInformation/parameters/reference/isMixedMode		
Type: string		**Shape: scalar**
Description: "True" if reference RSLC is a composite of data collected in multiple radar modes, "False" otherwise		
/science/SSAR/RUNW/metadata/processingInformation/parameters/reference/referenceTerrainHeight		
Type: Float32		**Shape: (dopplerCentroidTimeLength, dopplerCentroidSlantRangeWidth)**
Description: Reference Terrain Height as a function of time for reference RSLC		
	units	meters
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (seconds)
/science/SSAR/RUNW/metadata/processingInformation/parameters/reference/frequencyA/slantRangStart		
Type: Float64		**Shape: scalar**
Description: Slant range start distance for the reference RSLC		
	units	meters
/science/SSAR/RUNW/metadata/processingInformation/parameters/reference/frequencyA/numberOfRangeSamples		
Type: UInt64		**Shape: scalar**
Description: Number of slant range samples for each azimuth line within the reference RSLC		
	units	1
/science/SSAR/RUNW/metadata/processingInformation/parameters/reference/frequencyA/numberOfAzimuthLines		
Type: UInt64		**Shape: scalar**
Description: Number of azimuth lines within the reference RSLC		
	units	1

/science/SSAR/RUNW/metadata/processingInformation/parameters/reference/frequencyA/slantRangeSpacing		
Type: Float64		**Shape: scalar**
Description: Slant range spacing of reference RSLC		
	units	meters
/science/SSAR/RUNW/metadata/processingInformation/parameters/reference/frequencyA/zeroDopplerTimeSpacing		
Type: Float64		**Shape: scalar**
Description: Time interval in the along-track direction for reference RSLC raster layers		
	units	seconds
/science/SSAR/RUNW/metadata/processingInformation/parameters/reference/frequencyA/zeroDopplerStartTime		
Type: String		**Shape: scalar**
Description: Azimuth start time (in UTC) of the reference RSLC product in the format YYYY-mm-ddTHH:MM:SS.sssssssss		
/science/SSAR/RUNW/metadata/processingInformation/parameters/reference/frequencyA/zeroDopplerEndTime		
Type: String		**Shape: scalar**
Description: Azimuth stop time (in UTC) of the reference RSLC product in the format YYYY-mm-ddTHH:MM:SS.sssssssss		
/science/SSAR/RUNW/metadata/processingInformation/parameters/reference/frequencyA/rangeBandwidth		
Type: Float64		**Shape: scalar**
Description: Processed slant range bandwidth for reference RSLC		
	units	hertz
/science/SSAR/RUNW/metadata/processingInformation/parameters/reference/frequencyA/azimuthBandwidth		
Type: Float64		**Shape: scalar**
Description: Processed azimuth bandwidth for reference RSLC		
	units	hertz
/science/SSAR/RUNW/metadata/processingInformation/parameters/reference/frequencyA/dopplerCentroid		
Type: Float64		**Shape: (dopplerCentroidTimeLength, dopplerCentroidSlantRangeWidth)**
Description: 2D LUT of Doppler centroid for frequency A		
	units	hertz
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (seconds)
/science/SSAR/RUNW/metadata/processingInformation/parameters/secondary/referenceTerrainHeight		
Type: Float32		**Shape: (dopplerCentroidTimeLength, dopplerCentroidSlantRangeWidth)**
Description: Reference Terrain Height as a function of time for secondary RSLC		
	units	meters
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (seconds)
/science/SSAR/RUNW/metadata/processingInformation/parameters/secondary/rfiMitigationApplied		
Type: string		**Shape: scalar**
Description: Flag to indicate if RFI mitigation has been applied to secondary RSLC		
/science/SSAR/RUNW/metadata/processingInformation/parameters/secondary/isMixedMode		

Type: string		**Shape: scalar**
Description: "True" if secondary RSLC is a composite of data collected in multiple radar modes, "False" otherwise		
/science/SSAR/RUNW/metadata/processingInformation/parameters/secondary/frequencyA/slantRangStart		
Type: Float64		**Shape: scalar**
Description: Slant range start distance for the secondary RSLC		
	units	meters
/science/SSAR/RUNW/metadata/processingInformation/parameters/secondary/frequencyA/numberOfRangeSamples		
Type: UInt64		**Shape: scalar**
Description: Number of slant range samples for each azimuth line within the secondary RSLC		
	units	1
/science/SSAR/RUNW/metadata/processingInformation/parameters/secondary/frequencyA/numberOfAzimuthLines		
Type: UInt64		**Shape: scalar**
Description: Number of azimuth lines within the secondary RSLC		
	units	1
/science/SSAR/RUNW/metadata/processingInformation/parameters/secondary/frequencyA/zeroDopplerTimeSpacing		
Type: Float64		**Shape: scalar**
Description: Time interval in the along-track direction for secondary RSLC raster layers		
	units	seconds
/science/SSAR/RUNW/metadata/processingInformation/parameters/secondary/frequencyA/zeroDopplerStartTime		
Type: String		**Shape: scalar**
Description: Azimuth start time (in UTC) of the secondary RSLC product in the format YYYY-mm-ddTHH:MM:SS.sssssssss		
/science/SSAR/RUNW/metadata/processingInformation/parameters/secondary/frequencyA/zeroDopplerEndTime		
Type: String		**Shape: scalar**
Description: Azimuth stop time (in UTC) of the secondary RSLC product in the format YYYY-mm-ddTHH:MM:SS.sssssssss		
/science/SSAR/RUNW/metadata/processingInformation/parameters/secondary/frequencyA/slantRangeSpacing		
Type: Float64		**Shape: scalar**
Description: Slant range spacing of secondary RSLC		
	units	meters
/science/SSAR/RUNW/metadata/processingInformation/parameters/secondary/frequencyA/rangeBandwidth		
Type: Float64		**Shape: scalar**
Description: Processed slant range bandwidth for secondary RSLC		
	units	hertz
/science/SSAR/RUNW/metadata/processingInformation/parameters/secondary/frequencyA/azimuthBandwidth		
Type: Float64		**Shape: scalar**
Description: Processed azimuth bandwidth for secondary RSLC		
	units	hertz
/science/SSAR/RUNW/metadata/processingInformation/parameters/secondary/frequencyA/dopplerCentroid		
Type: Float64		**Shape: (dopplerCentroidTimeLength, dopplerCentroidSlantRangeWidth)**
Description: 2D LUT of Doppler centroid for frequency A		
	units	hertz
	pixel_interval	The interval in Pixel direction

	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (seconds)

/science/SSAR/RUNW/metadata/processingInformation/parameters/common/frequencyA/dopplerCentroid	
Type: Float64	**Shape: (dopplerCentroidTimeLength, dopplerCentroidSlantRangeWidth)**
Description: 2D LUT of common Doppler centroid between reference and secondary RSLCs	

	units	hertz
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (seconds)

/science/SSAR/RUNW/metadata/processingInformation/parameters/common/frequencyA/dopplerBandwidth	
Type: Float64	**Shape: scalar**
Description: Common Doppler Bandwidth between reference and secondary RSLCs	

	units	hertz

/science/SSAR/RUNW/metadata/processingInformation/parameters/interferogram/frequencyA/rangeBandwidth	
Type: Float64	**Shape: scalar**
Description: Processed slant range bandwidth for frequency A interferometric layers	

	units	hertz

/science/SSAR/RUNW/metadata/processingInformation/parameters/interferogram/frequencyA/azimuthBandwidth	
Type: Float64	**Shape: scalar**
Description: Processed azimuth bandwidth for frequency A interferometric layers	

	units	hertz

/science/SSAR/RUNW/metadata/processingInformation/parameters/interferogram/frequencyA/numberOfRangeLooks	
Type: UInt32	**Shape: scalar**
Description: Number of looks applied in the slant range direction to form the wrapped interferogram	

	units	1

/science/SSAR/RUNW/metadata/processingInformation/parameters/interferogram/frequencyA/numberOfAzimuthLooks	
Type: UInt32	**Shape: scalar**
Description: Number of looks applied in the along-track direction to form the wrapped interferogram	

	units	1

/science/SSAR/RUNW/metadata/processingInformation/parameters/interferogram/frequencyA/commonBandRangeFilterApplied	
Type: string	**Shape: scalar**
Description: Flag to indicate if common band range filter has been applied	
/science/SSAR/RUNW/metadata/processingInformation/parameters/interferogram/frequencyA/commonBandAzimuthFilterApplied	
Type: string	**Shape: scalar**
Description: Flag to indicate if common band azimuth filter has been applied	
/science/SSAR/RUNW/metadata/processingInformation/parameters/interferogram/frequencyA/ellipsoidalFlatteningApplied	
Type: string	**Shape: scalar**
Description: Flag to indicate if the interferometric phase has been flattened with respect to a zero height ellipsoid	
/science/SSAR/RUNW/metadata/processingInformation/parameters/interferogram/frequencyA/topographicFlatteningApplied	
Type: string	**Shape: scalar**

Description: Flag to indicate if the interferometric phase has been flattened with respect to topographic height using a DEM		
/science/SSAR/RUNW/metadata/processingInformation/parameters/ionosphere/lowBandBandwidth		
Type: Float64	**Shape: scalar**	
Description: Slant range bandwidth of the low sub-band image		
	units	hertz
/science/SSAR/RUNW/metadata/processingInformation/parameters/ionosphere/highBandBandwidth		
Type: Float64	**Shape: scalar**	
Description: Slant range bandwidth of the high sub-band image		
	units	hertz
/science/SSAR/RUNW/metadata/processingInformation/parameters/pixelOffsets/frequencyA/alongTrackWindowSize		
Type: UInt32	**Shape: scalar**	
Description: Along-track cross-correlation window size in pixels		
	units	1
/science/SSAR/RUNW/metadata/processingInformation/parameters/pixelOffsets/frequencyA/slantRangeWindowSize		
Type: UInt32	**Shape: scalar**	
Description: Slant range cross-correlation window size in pixels		
	units	1
/science/SSAR/RUNW/metadata/processingInformation/parameters/pixelOffsets/frequencyA/alongTrackSearchWindowSize		
Type: UInt32	**Shape: scalar**	
Description: Along-track cross-correlation search window size in pixels		
	units	1
/science/SSAR/RUNW/metadata/processingInformation/parameters/pixelOffsets/frequencyA/slantRangeSearchWindowSize		
Type: UInt32	**Shape: scalar**	
Description: Slant range cross-correlation search window size in pixels		
	units	1
/science/SSAR/RUNW/metadata/processingInformation/parameters/pixelOffsets/frequencyA/alongTrackSkipWindowSize		
Type: UInt32	**Shape: scalar**	
Description: Along-track cross-correlation skip window size in pixels		
	units	1
/science/SSAR/RUNW/metadata/processingInformation/parameters/pixelOffsets/frequencyA/slantRangeSkipWindowSize		
Type: UInt32	**Shape: scalar**	
Description: Slant range cross-correlation skip window size in pixels		
	units	1
/science/SSAR/RUNW/metadata/processingInformation/parameters/pixelOffsets/frequencyA/correlationSurfaceOversampling		
Type: UInt32	**Shape: scalar**	
Description: Oversampling factor of the cross-correlation surface		
	units	1
/science/SSAR/RUNW/metadata/processingInformation/parameters/pixelOffsets/frequencyA/isOffsetsBlendingApplied		
Type: string	**Shape: scalar**	
Description: Flag to indicate if pixel offsets are the results of blending multi-resolution layers of pixel offsets		
/science/SSAR/RUNW/metadata/processingInformation/algorithms/softwareVersion		
Type: string	**Shape: scalar**	
Description: Software version used for processing		
/science/SSAR/RUNW/metadata/processingInformation/algorithms/coregistration/coregistrationMethod		
Type: string	**Shape: scalar**	

Description: RSLC coregistration method		
/science/SSAR/RUNW/metadata/processingInformation/algorithms/coregistration/geometryCoregistration		
Type: string	**Shape: scalar**	
Description: Geometry coregistration algorithm		
/science/SSAR/RUNW/metadata/processingInformation/algorithms/coregistration/crossCorrelation		
Type: string	**Shape: scalar**	
Description: Cross-correlation algorithm for sub-pixel offsets computation		
	algorithm_type	RSLC coregistration
/science/SSAR/RUNW/metadata/processingInformation/algorithms/coregistration/resampling		
Type: string	**Shape: scalar**	
Description: Secondary RSLC resampling algorithm		
/science/SSAR/RUNW/metadata/processingInformation/algorithms/coregistration/crossCorrelationOutliers		
Type: string	**Shape: scalar**	
Description: Outliers identification algorithm		
/science/SSAR/RUNW/metadata/processingInformation/algorithms/coregistration/crossCorrelationFilling		
Type: string	**Shape: scalar**	
Description: Outliers data filling algorithm for cross-correlation offsets		
/science/SSAR/RUNW/metadata/processingInformation/algorithms/coregistration/crossCorrelationFilterKernel		
Type: string	**Shape: scalar**	
Description: Filtering algorithm for cross-correlation offsets		
/science/SSAR/RUNW/metadata/processingInformation/algorithms/interferogramFormation/multilooking		
Type: string	**Shape: scalar**	
Description: Multilooking algorithm		
/science/SSAR/RUNW/metadata/processingInformation/algorithms/interferogramFormation/wrappedInterferogramFiltering		
Type: string	**Shape: scalar**	
Description: Algorithm used to filter the wrapped interferogram prior to phase unwrapping		
/science/SSAR/RUNW/metadata/processingInformation/algorithms/interferogramFormation/flatteningMethod		
Type: string	**Shape: scalar**	
Description: Algorithm used to flatten the wrapped interferogram		
/science/SSAR/RUNW/metadata/processingInformation/algorithms/unwrapping/unwrappingAlgorithm		
Type: string	**Shape: scalar**	
Description: Algorithm used for phase unwrapping		
/science/SSAR/RUNW/metadata/processingInformation/algorithms/unwrapping/unwrappingInitializer		
Type: string	**Shape: scalar**	
Description: Algorithm used to initialize phase unwrapping		
/science/SSAR/RUNW/metadata/processingInformation/algorithms/unwrapping/costMode		
Type: string	**Shape: scalar**	
Description: Cost mode algorithm for phase unwrapping		
/science/SSAR/RUNW/metadata/processingInformation/algorithms/unwrapping/preprocessing/wrappedPhaseOutliers		
Type: string	**Shape: scalar**	
Description: Algorithm identifying outliers in the wrapped interferogram		
/science/SSAR/RUNW/metadata/processingInformation/algorithms/unwrapping/preprocessing/wrappedPhaseFilling		
Type: string	**Shape: scalar**	
Description: Outliers data filling algorithm for phase unwrapping preprocessing		

/science/SSAR/RUNW/metadata/processingInformation/algorithms/ionosphereEstimation/ionosphereAlgorithm	
Type: string	**Shape: scalar**
Description: Algorithm used to estimate ionosphere phase screen	
/science/SSAR/RUNW/metadata/processingInformation/algorithms/ionosphereEstimation/ionosphereOutliers	
Type: string	**Shape: scalar**
Description: Algorithm identifying outliers in unfiltered ionosphere phase screen	
/science/SSAR/RUNW/metadata/processingInformation/algorithms/ionosphereEstimation/ionosphereFilling	
Type: string	**Shape: scalar**
Description: Outliers data filling algorithm for ionosphere phase estimation	
/science/SSAR/RUNW/metadata/processingInformation/algorithms/ionosphereEstimation/ionosphereFiltering	
Type: string	**Shape: scalar**
Description: Filtering algorithm for ionosphere phase screen computation	
/science/SSAR/RUNW/metadata/processingInformation/algorithms/ionosphereEstimation/unwrappingErrorCorrection	
Type: string	**Shape: scalar**
Description: Algorithm correcting unwrapping errors in sub-band unwrapped interferograms	
/science/SSAR/RUNW/metadata/processingInformation/inputs/l1ReferenceSlcGranules	
Type: string	**Shape: (numberOfInputL1Files)**
Description: List of input reference L1 RSLC products used	
/science/SSAR/RUNW/metadata/processingInformation/inputs/l1SecondarySlcGranules	
Type: string	**Shape: (numberOfInputL1Files)**
Description: List of input secondary L1 RSLC products used	
/science/SSAR/RUNW/metadata/processingInformation/inputs/configFiles	
Type: string	**Shape: (numberOfInputConfigFiles)**
Description: List of input config files used	
/science/SSAR/RUNW/metadata/processingInformation/inputs/demSource	
Type: string	**Shape: scalar**
Description: Description of the input digital elevation model (DEM)	
/science/SSAR/RUNW/metadata/processingInformation/inputs/orbitFiles	
Type: string	**Shape: (numberOfInputOrbitFiles)**
Description: List of input orbit files used	

9.4.5 Other Radar Metadata

Calibration-related variables		
/science/SSAR/RUNW/metadata/orbit/temporalBaseline		
Type: UInt16	**Shape: scalar**	
Description: Time interval between reference and secondary RSLCs		
	units	days
/science/SSAR/RUNW/metadata/orbit/reference/interpMethod		
Type: string	**Shape: scalar**	
Description: Orbit interpolation method, either "Hermite" or "Legendre"		
/science/SSAR/RUNW/metadata/orbit/reference/time		
Type: Float64	**Shape: (orbitListLength)**	
Description: Time vector record. This record contains the time corresponding to position and velocity records		
	units	seconds since YYYY-mm-ddTHH:MM:SS
/science/SSAR/RUNW/metadata/orbit/reference/position		

Type: Float64	**Shape: (orbitListLength, tripletxyz)**	
Description: Position vector record. This record contains the platform position data with respect to WGS84 G1762 reference frame		
	units	meters
/science/SSAR/RUNW/metadata/orbit/reference/velocity		
Type: Float64	**Shape: (orbitListLength, tripletxyz)**	
Description: Velocity vector record. This record contains the platform velocity data with respect to WGS84 G1762 reference frame		
	units	meters / second
/science/SSAR/RUNW/metadata/orbit/reference/orbitType		
Type: string	**Shape: scalar**	
Description: Orbit product type, either "FOE", "NOE", "MOE", "POE", or "Custom", where "FOE" stands for Forecast Orbit Ephemeris, "NOE" is Near real-time Orbit Ephemeris, "MOE" is Medium precision Orbit Ephemeris, and "POE" is Precise Orbit Ephemeris		
/science/SSAR/RUNW/metadata/orbit/secondary/interpMethod		
Type: string	**Shape: scalar**	
Description: Orbit interpolation method, either "Hermite" or "Legendre"		
/science/SSAR/RUNW/metadata/orbit/secondary/time		
Type: Float64	**Shape: (orbitListLength)**	
Description: Time vector record. This record contains the time corresponding to position and velocity records		
	units	seconds since YYYY-mm-ddTHH:MM:SS
/science/SSAR/RUNW/metadata/orbit/secondary/position		
Type: Float64	**Shape: (orbitListLength, tripletxyz)**	
Description: Position vector record. This record contains the platform position data with respect to WGS84 G1762 reference frame		
	units	meters
/science/SSAR/RUNW/metadata/orbit/secondary/velocity		
Type: Float64	**Shape: (orbitListLength, tripletxyz)**	
Description: Velocity vector record. This record contains the platform velocity data with respect to WGS84 G1762 reference frame		
	units	meters / second
/science/SSAR/RUNW/metadata/orbit/secondary/orbitType		
Type: string	**Shape: scalar**	
Description: Orbit product type, either "FOE", "NOE", "MOE", "POE", or "Custom", where "FOE" stands for Forecast Orbit Ephemeris, "NOE" is Near real-time Orbit Ephemeris, "MOE" is Medium precision Orbit Ephemeris, and "POE" is Precise Orbit Ephemeris		
/science/SSAR/RUNW/metadata/attitude/reference/time		
Type: Float64	**Shape: (attitudeListLength)**	
Description: Time vector record. This record contains the time corresponding to attitude and quaternion records		
	units	seconds since YYYY-mm-ddTHH:MM:SS
/science/SSAR/RUNW/metadata/attitude/reference/quaternions		
Type: Float64	**Shape: (attitudeListLength, quaternions)**	
Description: Attitude quaternions (q0, q1, q2, q3)		
	units	1
/science/SSAR/RUNW/metadata/attitude/reference/eulerAngles		
Type: Float64	**Shape: (attitudeListLength, tripletxyz)**	
Description: Attitude Euler angles (roll, pitch, yaw)		
	units	degrees
/science/SSAR/RUNW/metadata/attitude/reference/attitudeType		
Type: string	**Shape: scalar**	
Description: Attitude type, either "FRP", "NRP", "PRP, or "Custom", where "FRP" stands for Forecast Radar Pointing, "NRP" is Near Real-time Pointing, and "PRP" is Precise Radar Pointing		
/science/SSAR/RUNW/metadata/attitude/secondary/time		
Type: Float64	**Shape: (attitudeListLength)**	

Description: Time vector record. This record contains the time corresponding to attitude and quaternion records		
	units	seconds since YYYY-mm-ddTHH:MM:SS
/science/SSAR/RUNW/metadata/attitude/secondary/quaternions		
Type: Float64	**Shape: (attitudeListLength, quaternions)**	
Description: Attitude quaternions (q0, q1, q2, q3)		
	units	1
/science/SSAR/RUNW/metadata/attitude/secondary/eulerAngles		
Type: Float64	**Shape: (attitudeListLength, tripletxyz)**	
Description: Attitude Euler angles (roll, pitch, yaw)		
	units	degrees
/science/SSAR/RUNW/metadata/attitude/secondary/attitudeType		
Type: string	**Shape: scalar**	
Description: Attitude type, either "FRP", "NRP", "PRP, or "Custom", where "FRP" stands for Forecast Radar Pointing, "NRP" is Near Real-time Pointing, and "PRP" is Precise Radar Pointing		

9.4.6 Geolocation Grid

Metadata cube-related variables		
/science/SSAR/RUNW/metadata/geolocationGrid/epsg		
Type: Int32	**Shape: scalar**	
Description: EPSG code corresponding to the coordinate system used for representing the geolocation grid		
	long_name	EPSG code
/science/SSAR/RUNW/metadata/geolocationGrid/coordinateY		
Type: Float64	**Shape: (geolocationCubeHeight, geolocationCubeLength, geolocationCubeWidth)**	
Description: Y coordinates in specified EPSG code		
	_FillValue	nan
	grid_mapping	projection
	long_name	Coordinate Y
	units	degrees
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (seconds)
/science/SSAR/RUNW/metadata/geolocationGrid/coordinateX		
Type: Float64	**Shape: (geolocationCubeHeight, geolocationCubeLength, geolocationCubeWidth)**	
Description: X coordinates in specified EPSG code		
	_FillValue	nan
	grid_mapping	projection
	long_name	Coordinate X
	units	degrees
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (seconds)
/science/SSAR/RUNW/metadata/geolocationGrid/incidenceAngle		
Type: Float32	**Shape: (geolocationCubeHeight, geolocationCubeLength, geolocationCubeWidth)**	
Description: Incidence angle is defined as the angle between the LOS vector and the normal to the ellipsoid at the target height		
	valid_max	90.0

	valid_min	0.0
	_FillValue	nan
	grid_mapping	projection
	long_name	Incidence angle
	units	degrees
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (seconds)
/science/SSAR/RUNW/metadata/geolocationGrid/losUnitVectorX		
Type: Float32	**Shape: (geolocationCubeHeight, geolocationCubeLength, geolocationCubeWidth)**	
Description: East component of unit vector of LOS from target to sensor		
	valid_max	1.0
	valid_min	-1.0
	_FillValue	nan
	grid_mapping	projection
	long_name	LOS unit vector X
	units	1
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (seconds)
/science/SSAR/RUNW/metadata/geolocationGrid/losUnitVectorY		
Type: Float32	**Shape: (geolocationCubeHeight, geolocationCubeLength, geolocationCubeWidth)**	
Description: North component of unit vector of LOS from target to sensor		
	valid_max	1.0
	valid_min	-1.0
	_FillValue	nan
	grid_mapping	projection
	long_name	LOS unit vector X
	units	1
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (seconds)
/science/SSAR/RUNW/metadata/geolocationGrid/alongTrackUnitVectorX		
Type: Float32	**Shape: (geolocationCubeHeight, geolocationCubeLength, geolocationCubeWidth)**	
Description: East component of unit vector along ground track		
	valid_max	1.0
	valid_min	-1.0
	_FillValue	nan
	grid_mapping	projection
	long_name	Along-track unit vector X
	units	1
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)

	azimuth_spacing	The spacing in Azimuth direction (seconds)
/science/SSAR/RUNW/metadata/geolocationGrid/alongTrackUnitVectorY		
Type: Float32	**Shape: (geolocationCubeHeight, geolocationCubeLength, geolocationCubeWidth)**	
Description: North component of unit vector along ground track		
	valid_max	1.0
	valid_min	-1.0
	_FillValue	nan
	grid_mapping	projection
	long_name	Along-track unit vector Y
	units	1
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (seconds)
/science/SSAR/RUNW/metadata/geolocationGrid/elevationAngle		
Type: Float32	**Shape: (geolocationCubeHeight, geolocationCubeLength, geolocationCubeWidth)**	
Description: Elevation angle is defined as the angle between the LOS vector and the normal to the ellipsoid at the sensor		
	valid_max	90.0
	valid_min	0.0
	_FillValue	nan
	grid_mapping	projection
	long_name	Elevation angle
	units	degree
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (seconds)
/science/SSAR/RUNW/metadata/geolocationGrid/parallelBaseline		
Type: Float32	**Shape: (geolocationCubeHeight, geolocationCubeLength, geolocationCubeWidth)**	
Description: Parallel component of the InSAR baseline		
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points
	units	meters
	_FillValue	nan
	long_name	Parallel baseline
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (seconds)
/science/SSAR/RUNW/metadata/geolocationGrid/perpendicularBaseline		
Type: Float32	**Shape: (geolocationCubeHeight, geolocationCubeLength, geolocationCubeWidth)**	
Description: Perpendicular component of the InSAR baseline		
	mean_value	Arithmetic average of the numeric data points

	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points
	units	meters
	_FillValue	nan
	long_name	Perpendicular baseline
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (seconds)
/science/SSAR/RUNW/metadata/geolocationGrid/groundTrackVelocity		
Type: Float64	**Shape: (geolocationCubeHeight, geolocationCubeLength, geolocationCubeWidth)**	
Description: Absolute value of the platform velocity scaled at the target height		
	_FillValue	nan
	grid_mapping	projection
	long_name	Ground track velocity
	units	meters / second
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (seconds)
/science/SSAR/RUNW/metadata/geolocationGrid/slantRange		
Type: Float64	**Shape: (geolocationCubeWidth)**	
Description: Slant range values corresponding to the geolocation grid		
	long_name	Slant range
	units	meters
/science/SSAR/RUNW/metadata/geolocationGrid/zeroDopplerTime		
Type: Float64	**Shape: (geolocationCubeLength)**	
Description: Zero Doppler time since UTC epoch values corresponding to the geolocation grid		
	long_name	Zero-Doppler time
	units	seconds since YYYY-mm-ddTHH:MM:SS
/science/SSAR/RUNW/metadata/geolocationGrid/heightAboveEllipsoid		
Type: Float64	**Shape: (geolocationCubeHeight)**	
Description: Height values above WGS84 Ellipsoid corresponding to the location grid		
	standard_name	height_above_reference_ellipsoid
	units	meters

9.4.7 Geolocation Grid True Height (Available Only in ISRO Generated Products)

Geolocation grid at true height is at a finer spacing as compared to the radar grid documented in section 9.4.6.

Metadata cube-related variables		
/science/SSAR/RUNW/metadata/geolocationGridTrueHeight/epsg		
Type: Int32	**Shape: scalar**	
Description: EPSG code corresponding to the coordinate system used for representing the geolocation grid		
	long_name	EPSG code
/science/SSAR/RUNW/metadata/geolocationGridTrueHeight/coordinateY		

Type: Float64	**Shape: (geolocationCubeHeightTrueHeight, geolocationCubeLengthTrueHeight, geolocationCubeWidthTrueHeight)**	
Description: Y coordinates in specified EPSG code		
	_FillValue	nan
	grid_mapping	projection
	long_name	Coordinate Y
	units	degrees
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (seconds)
/science/SSAR/RUNW/metadata/geolocationGridTrueHeight/coordinateX		
Type: Float64	**Shape: (geolocationCubeHeightTrueHeight, geolocationCubeLengthTrueHeight, geolocationCubeWidthTrueHeight)**	
Description: X coordinates in specified EPSG code		
	_FillValue	nan
	grid_mapping	projection
	long_name	Coordinate X
	units	degrees
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (seconds)
/science/SSAR/RUNW/metadata/geolocationGridTrueHeight/incidenceAngle		
Type: Float32	**Shape: (geolocationCubeHeightTrueHeight, geolocationCubeLengthTrueHeight, geolocationCubeWidthTrueHeight)**	
Description: Incidence angle is defined as the angle between the LOS vector and the normal to the ellipsoid at the target height		
	valid_max	90.0
	valid_min	0.0
	_FillValue	nan
	grid_mapping	projection
	long_name	Incidence angle
	units	degrees
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (seconds)
/science/SSAR/RUNW/metadata/geolocationGridTrueHeight/losUnitVectorX		
Type: Float32	**Shape: (geolocationCubeHeightTrueHeight, geolocationCubeLengthTrueHeight, geolocationCubeWidthTrueHeight)**	
Description: East component of unit vector of LOS from target to sensor		
	valid_max	1.0
	valid_min	-1.0
	_FillValue	nan
	grid_mapping	projection
	long_name	LOS unit vector X

	units	1
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (seconds)
/science/SSAR/RUNW/metadata/geolocationGridTrueHeight/losUnitVectorY		
Type: Float32	**Shape: (geolocationCubeHeightTrueHeight, geolocationCubeLengthTrueHeight, geolocationCubeWidthTrueHeight)**	
Description: North component of unit vector of LOS from target to sensor		
	valid_max	1.0
	valid_min	-1.0
	_FillValue	nan
	grid_mapping	projection
	long_name	LOS unit vector Y
	units	1
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (seconds)
/science/SSAR/RUNW/metadata/geolocationGridTrueHeight/alongTrackUnitVectorX		
Type: Float32	**Shape: (geolocationCubeHeightTrueHeight, geolocationCubeLengthTrueHeight, geolocationCubeWidthTrueHeight)**	
Description: East component of unit vector along ground track		
	valid_max	1.0
	valid_min	-1.0
	_FillValue	nan
	grid_mapping	projection
	long_name	Along-track unit vector X
	units	1
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (seconds)
/science/SSAR/RUNW/metadata/geolocationGridTrueHeight/alongTrackUnitVectorY		
Type: Float32	**Shape: (geolocationCubeHeightTrueHeight, geolocationCubeLengthTrueHeight, geolocationCubeWidthTrueHeight)**	
Description: North component of unit vector along ground track		
	valid_max	1.0
	valid_min	-1.0
	_FillValue	nan
	grid_mapping	projection
	long_name	Along-track unit vector Y
	units	1
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (seconds)

/science/SSAR/RUNW/metadata/geolocationGridTrueHeight/elevationAngle		
Type: Float32	**Shape: (geolocationCubeHeightTrueHeight, geolocationCubeLengthTrueHeight, geolocationCubeWidthTrueHeight)**	
Description: Elevation angle is defined as the angle between the LOS vector and the normal to the ellipsoid at the sensor		
	valid_max	90.0
	valid_min	0.0
	_FillValue	nan
	grid_mapping	projection
	long_name	Elevation angle
	units	degrees
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (seconds)
/science/SSAR/RUNW/metadata/geolocationGridTrueHeight/parallelBaseline		
Type: Float32	**Shape:(geolocationCubeHeightTrueHeight, geolocationCubeLengthTrueHeight, geolocationCubeWidthTrueHeight)**	
Description: Parallel component of the InSAR baseline		
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points
	units	meters
	long_name	Parallel baseline
	_FillValue	nan
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (seconds)
/science/SSAR/RUNW/metadata/geolocationGridTrueHeight/perpendicularBaseline		
Type: Float32	**Shape:(geolocationCubeHeightTrueHeight, geolocationCubeLengthTrueHeight, geolocationCubeWidthTrueHeight)**	
Description: Perpendicular component of the InSAR baseline		
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points
	units	meters
	_FillValue	nan
	long_name	Perpendicular baseline
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (seconds)
/science/SSAR/RUNW/metadata/geolocationGridTrueHeight/groundTrackVelocity		
Type: Float64	**Shape: (geolocationCubeHeight, geolocationCubeLength, twoLayersCubeWidth)**	

Description: Absolute value of the platform velocity scaled at the target height		
	_FillValue	nan
	grid_mapping	projection
	long_name	Ground track velocity
	units	meters / second
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (seconds)

/science/SSAR/RUNW/metadata/geolocationGridTrueHeight/slantRange	
Type: Float64	**Shape: (geolocationCubeWidth)**
Description: Slant range values corresponding to the geolocation grid	

	long_name	Slant range
	units	meters

/science/SSAR/RUNW/metadata/geolocationGridTrueHeight/zeroDopplerTime	
Type: Float64	**Shape: (geolocationCubeLength)**
Description: Zero Doppler time since UTC epoch values corresponding to the geolocation grid	

	long_name	Zero-Doppler time
	units	seconds since YYYY-mm-ddTHH:MM:SS

CHAPTER-10

Geocoded Unwrapped Interferogram (GUNW) Data Product

10 Geocoded Unwrapped Interferogram Product (GUNW) Data Product

The GUNW product is a global product which comprises of the geocoded, multi-looked, ellipsoid and topography flattened unwrapped interferogram. This product is generated with nearest pair in time for co-pol and circular pol channels only. The averaging window size for GUNW for different bandwidth combinations and for L&S Band is shown in Table 10-1 .The mid swath incidence angle is used for computation of ground range spacing.

Band	Fs (MHz)	BW (MHz)	SLC Slant Range Spacing (m)	SLC Azimuth spacing (m)	Ground Range Spacing (at mid swath) (m)	Range Looks	Azimuth Looks
S	13.89	10	10.80	5	16.14	5	16
	27.78	25	5.40	5	8.07	10	16
	41.67	37.5	3.60	5	5.38	15	16
	83.33	75	1.80	5	2.69	30	16
L	6	5	25.00	5	37.36	2	16
	24	20	6.25	5	9.34	9	16
	48	40	3.13	5	4.67	17	16
	96	77	1.56	5	2.33	34	16

Table 10-1 Averaging window size for L&S Band GUNW products

10.1 GUNW Product Overview

The GUNW product is a L2 product derived from the RIFG and RUNW products by geocoding the unwrapped phase and its associated data layers (i.e., coherence magnitude, ionospheric phase screen) on a geographical grid at 80 m posting. Geocoding is performed by using the orbit of the reference RSLC product and a Digital Elevation Model (DEM) to project the data onto a predefined Universal Transverse Mercator (UTM) or Polar stereographic projection system map grid Annexure-4: Geocoded Product Grids. The geocoding algorithm uses a bilinear interpolation for interpolating data layers with floating-point data types, Sinc for the complex wrapped interferogram, and nearest-neighbor interpolation for unsigned integer datasets (e.g., connected components mask).

The GUNW products also includes the wrapped complex interferogram (multilooked at 30 m in range-Doppler coordinates and geocoded at 20 m posting), the unwrapped interferometric phase in radians (80 m posting), the normalized interferometric coherence magnitude (20 m and 80 m posting), connected components mask, and sub-pixel offset layers obtained from incoherent cross-correlation. If an offset product in Range-Doppler coordinates (e.g., ROFF) is available for the processed frame, the sub-pixel offset layers included in GUNW are obtained by optimally blending the multiresolution offset layers included in ROFF. The application of the offset layers blending is indicated by setting the flag

"/science/SSAR/GUNW/metadata/processingInformation/parameters/pixelOffsets/frequency A/is OffsetsBlendingApplied" to "True". Conversely, if this flag is set to "False", the offset blending algorithm is not applied, and the sub-pixel offset layers included in GUNW are obtained by running incoherent cross-correlation on a coarse radar grid. Regardless of the use of the offset blending algorithm, the pixel offsets layers are consistently geocoded at 80 m posting on the same geographical grid of the other data layers included in the GUNW product.

The GUNW product also includes an ionospheric phase screen layer and a layer quantifying its uncertainty. The ionospheric phase screen comes from the RUNW product. In S-Band, it is estimated using the Split Spectrum Method, and in L-Band it is estimated from the two spectral bands “frequencyA” and “frequencyB" whenever possible. In the case of mode transitions where continuity of spectral bands is impacted, a split spectrum ionospheric phase estimate is derived from the main imaging band (“frequencyA”). The estimated ionospheric phase screen is included as a layer in the product but not applied to the data layers within GUNW by default. The GUNW product also includes geocoded lookup tables for external phase corrections (e.g., solid Earth tides, hydrostatic and wet tropospheric phases). These phase corrections, when available, are not removed from the interferometric data.

10.2 GUNW Product Organization

10.2.1 Granule Definition

NISAR GUNW granules will conform to the Tiling Scheme being developed for the mission and are expected to have a ground footprint of 240 km x 240 km. (except in L-Band for 77 MHz data, which cover half of the swath in range direction).

10.2.2 File Naming Convention

NISAR GUNW Granule names will conform to the S/L-SAR Product File Naming Conventions as discussed in section 2.2.2.

10.2.3 Temporal Organization

Temporal organization is not specifically applicable to the GUNW product.

10.2.4 Spatial Organization

The L2 data are arranged on a uniformly spaced, North-up and East-right grid, i.e., decreasing North or Y coordinate in the row direction and increasing East or X coordinate in the column direction following the row-major order convention of representing 2D raster arrays. Pixel-isarea convention is used to tag the raster layers with coordinate information.

10.2.5 Spatial Sampling and Resolution

Some salient features of the output grid for the GUNW product are:

1. The top-left corner of the top-left pixel will correspond to the same geographic coordinate for all imagery layers in a GUNW product.

2. The main imaging band (“frequencyA”) is spatially averaged to the same posting, irrespective of the imaging. This allows for spatial mosaicking operations across instrument mode changes.

10.2.5.1 Mosaicking

The spatial sampling of the output grid has also been designed to facilitate along-track mosaicking of contiguous GUNW product granules if the user desires.

10.2.6 Partially compressed SLC data

Partially compressed data in RSLC files will not be used to produce GUNW products.

10.3 GUNW Product Description

In this section, we briefly describe the layout of GUNW data and associated metadata within the NISAR HDF5 file. Detailed description of Group and Dataset names can be found in section 10.4. In this section, we focus on the organization of S-SAR instrument data within the file under the Group name "/science/SSAR/". The same holds true for L-SAR data products too.

10.3.1 Dimensions and Shapes of Data

Information on the dimensions and shapes of the data items in various data tables is described as part of the metadata, section 10.4.1. This information is useful both as part of the product identification and for setting up further processing, i.e., dimensioning arrays.

10.3.2 Product Identification

Information needed to identify this product is given under the Group

"/science/SSAR/identification/" (section 10.4.2). This includes information such as orbit, cycle, track, and frame numbers, acquisition times, a polygon representing the bounding box of the included imagery in geographic coordinates, product version, and product specification version (i.e., the version number of this document).

10.3.3 Radar Imagery

The GUNW product's imagery layers and associated datasets are initially organized based on the center frequency within the Group "/science/SSAR/GUNW/grids/frequencyA/".

In case of L-Band, only the main NISAR imaging band ("frequencyA") will be processed for GUNW products. Imagery data is further categorized by their type. The Unwrapped Interferogram layer and associated Datasets are located under the Group "/science/SSAR/GUNW/grids/frequencyA/unwrappedInterferogram/".

The Wrapped Interferogram and its associated datasets are situated under the Group "/science/SSAR/GUNW/grids/frequencyA/wrappedInterferogram/".

Subsequently, the crosscorrelation sub-pixel offsets are located under the Group "/science/SSAR/GUNW/grids/frequencyA/pixelOffsets/".

Each of these Groups is further organized by polarization (TxRx), and by a final grouping. For example, the Unwrapped Phase Group could contain the Group "/science/SSAR/GUNW/grids/frequencyA/unwrappedInterferogram/HH/".

The imagery datasets reside within these polarization Groups. As an example, the Dataset "/science/SSAR/GUNW/grids/frequencyA/unwrappedInterferogram/HH/unwrappedPhase" corresponds to the unwrapped phase Dataset derived from the "frequencyA" and "HH" polarization imagery layers within the reference and secondary input RSLCs.

The same description holds true for all polarization channels present in the product. The same convention holds true for L-Band products. Details of the data elements for the granule are given in section 10.4.3.

10.3.4 Radar Metadata

The Group "/science/SSAR/GUNW/metadata/" includes a list of miscellaneous metadata needed to interpret the imagery (e.g., wrapped complex interferogram, unwrapped interferometric phase) included in the GUNW product.

10.3.4.1 Processing Information

The Group "/science/SSAR/GUNW/metadata/processingInformation/" includes the processing parameters used to generate the GUNW product. This group also include a list of the algorithms, and the inputs granules and files used to produce GUNW. For a complete description of this group, refer to section 10.4.4.

10.3.4.2 Parameters

The Group "/science/SSAR/GUNW/metadata/processingInformation/parameters/" is further organized in seven Groups:

1. *common*: organized by frequency, and including the parameters derived by combining the information from the reference and secondary RSLC e.g., Doppler centroid and the Doppler bandwidth.

2. *reference*: including the reference terrain height of the reference RSLC and flags to indicate if the RSLC is the results of mixed mode processing and if RFI correction has been applied. This Group is further organized by frequency and includes some relevant parameters of the reference RSLC such as the slant range and zero Doppler time spacing's, the slant range and the azimuth bandwidths, and the Doppler centroid.

3. *secondary*: this Group follows the same organization of *reference* but includes the corresponding metadata for the secondary RSLC.

4. *interferogram*: including the parameters used to generate the complex wrapped interferogram and the normalized interferometric correlation e.g., the common slant range and azimuth bandwidths and the number of looks in along-track and slant range directions used to generate the complex wrapped interferogram in radar coordinates.

5. *ionosphere*: including the parameters used to generate the ionosphere phase screen e.g., the bandwidth of the low and high sub-images used in the ionosphere phase estimation with the range split spectrum technique.

6. *pixelOffsets*: including the parameters (e.g., window size, search window, offset spacings) to generate the along-track and slant range layers of pixelOffsets in radar coordinates. This Group is further organized by frequency.

7. *geocoding*: including a set of Boolean flags indicating the corrections that have been applied while geocoding the pixel offsets layers from radar to geographical coordinates i.e., wet and dry troposphere correction, slant range and azimuth ionosphere corrections.

The Group *parameters* also contains the Dataset *runConfigurationContents* which includes a copy of the run configuration used for processing populated with all the processing options, parameter values, and input files.

10.3.4.3 Algorithms

The Group "/science/SSAR/GUNW/metadata/processingInformation/algorithms/" includes the name and the version of the software used to generate the product. The Group is further organized in distinct Groups identifying the processing steps used to generate the GUNW product:

1. *coregistration*: including the algorithms used to perform the coarse and fine coregistration of the reference and secondary RSLCs (e.g., geometry coregistration, cross-correlation algorithm).

2. *interferogramFormation*: including the algorithms used to form the complex wrapped interferogram and the normalized interferometric correlation (e.g., flattening method)

3. *unwrapping*: including the algorithms used to perform phase unwrapping (e.g., unwrapping algorithm, unwrapping initializer, type of performed preprocessing of the wrapped interferometric phase).

4. *ionosphereEstimation*: including the algorithm used to perform the estimation of the ionosphere phase screen (e.g., outlier estimation and filling, unwrapping error correction).

5. *geocoding*: including the algorithms to geocode the different data layers contained in the GUNW product e.g., floating, integer, and complex geocoding interpolation and flags to identify which correction (i.e., slant range ionospheric delay) has been used during geocoding.

10.3.4.4 Input Files

The Group "/science/SSAR/GUNW/metadata/processingInformation/inputs/" includes the filenames of the input RSLC granules, configuration files, orbit files, and a description of the DEM used for processing used to generate the product.

10.3.5 Other Radar Metadata

10.3.5.1 Orbit

The reference RSLC orbit ephemeris used for generating the GUNW product is provided under "/science/SSAR/GUNW/metadata/orbit/" and further detailed in section 10.4.5. This Group includes time-tagged antenna phase center position and velocity vectors in Earth Centered Earth Fixed (ECEF) Cartesian coordinates and information on the used orbit fidelity (e.g., Medium Orbit Ephemeris).

10.3.5.2 Attitude

The attitude state vectors of the reference RSLC used for generating the GUNW product can be found under the Group “/science/SSAR/GUNW/metadata/attitude/”. This Group includes timetagged quaternions and Euler angles representing the slant range plane from the antenna phase center in an ECEF Cartesian system.

10.3.6 Radar Grid

The group "/science/SSAR/GUNW/metadata/radarGrid/” contains information on the radar geometry of the reference RSLCs. The Datasets within this Group are given in the form of metadata cubes, referred to as *radar grid cubes*, that are organized over a three-dimensional geographic grid. The representation as data cubes, rather than two-dimensional rasters, is used to reduce the amount of space required to store radar geometry values within NISAR L2 products. This is possible because each radar grid cube contains slowly varying values in space that can be described by a low-resolution three-dimensional grid with sufficient accuracy.

These values, however, are usually required at the terrain height, often characterized by a fast varying surface representing the local topography. A higher-resolution DEM can then be used to interpolate radar grid cubes and generate high-resolution maps of the corresponding radar geometry variable. Further information on metadata cubes along with examples on how to interpolate them using a reference DEM is provided in

Annexure-2: Metadata Cube.

Radar grid cubes (for geocoded products) are provided in the same coordinate system as the product imagery with similar extents (bounding box) but coarser pixel spacing. The threedimensional geographic grid is defined by the HDF5 Datasets “xCoordinates” (defining the east component), “yCoordinates” (north component), and “heightAboveEllipsoid” (height above the WGS84 ellipsoid), common to all radar grid cubes, and following the CF-1.7 convention.

The “radarGrid” Group also included the Datasets:

1. “referenceSlantRange” (“secondarySlantRange”) and “referenceZeroDopplerAzimuthTime” (“secondaryZeroDopplerAzimuthTime”) defining the zero-Doppler radar grid of the reference (secondary) RSLC. These Datasets contain respectively the range position in meters and the zero-Doppler azimuth time in seconds for each point of the geographical grid

2. “losUnitVectorX” and “losUnitVectorY” identifying the East and North components of the Line-Of-Sight (LOS) unit vector (i.e., the vector from the target to the sensor) in the East-North-Up (ENU) coordinate system for each point of the geographic grid. The Up component of the LOS unit vector can be simply derived from the East and North components as:

$$losUnitVectorZ = \sqrt{1 - losUnitVectorX^2 - losUnitVectorY^2}$$

3. “alongTrackUnitVectorX” and “alongTrackUnitVectorY” containing the East and North components of the along-track unit vector (i.e., the projection of the along-track vector at the ground height) in ENU coordinates.

4. “incidenceAngle” containing the incidence angle, i.e., the angle between the LOS vector and the normal to the ellipsoid at the target height

5. “elevationAngle” containing the elevation angle i.e., the angle between the LOS vector and the normal to the ellipsoid at the sensor

6. “groundTrackVelocity” containing the ground track velocity i.e., the absolute value of the platform velocity scaled at the target height

7. “slantRangeSolidEarthTidesPhase” and “alongTrackSolidEarthTidesPhase” representing the slant range and along-track phase components due to Solid Earth tides

8. “wetTroposphericPhaseScreen”, “hydrostaticTroposphericPhaseScreen” representing the interferometric phase due to the wet and hydrostatic components of the tropospheric delay

9. “perpendicularBaseline” and “parallelBaseline” containing the perpendicular and parallel component of the baseline between the reference and secondary RSLCs. The baseline components are computed on same heights as other datasets of metadata cube.

The details of the usage of metadata cube are given in

Annexure-2: Metadata Cube.

In ISRO generated L and S Band products, *a separate layer is defined in a separate sub-group for all these parameters at true height:*

"/science/SSAR/RSLC/metadata/geolocationGridTrueHeight/”.

In this group all the parameters of metadata will be generated at true height (meaning they will be generated at actual height of terrain) and will be a part of the product. This layer will be at a finer sampling than the actual meta data cube layers. The number of dimensions, description and datatype will be same as that of actual metadata cube layer.

The details of this are present in Annexure-3: Metadata Cube at True Height.

10.4 GUNW Product Specification

In this section, actual datasets are defined in tabular form. They contain the dataset information available in GUNW product, which comprises of name, datatype, shape, and information corresponding to attributes. In product there are few datasets or few sub-groups that are per polarization. For representation, here only one polarization is used; in product, the layers/datasets/groups will be present as per the number of polarizations available in the product. The same holds true for frequency A for L-Band products.

10.4.1 Dimensions and Shapes

To simplify the description of the layout of data within the HDF5 file, we will use a table of dimensions and shapes to represent the relationship between similarly sized datasets. The entries in this table do not present actual datasets in the HDF5. This table is meant to be a guide to interpret the shapes of the datasets in subsequent subsections.

Name	Shape	Description
scalar	scalar	Scalar values
numberOfDatatakes	scalar	Number of datatakes in product
numberOfObservations	scalar	Number of observations in product
numberOfFrequencies	scalar	Number of S/L-SAR frequencies in product
numberOfFrequencyAPolarizations	scalar	Number of polarization layers associated with S/L-SAR frequencyA
wrappedInterferogramWidth	scalar	Number of pixels in all S/L-SAR datasets within the wrappedInterferogram group
wrappedInterferogramLength	scalar	Number of lines in all S/L-SAR datasets within the wrapped Interferogram group
complexWrappedInterferogramShape	(wrappedInterferogramWidth, wrappedInterferogramLength)	Shape associated with complex datasets in the wrappedInterferogram group
wrappedInterferogramShape	(wrappedInterferogramWidth, wrappedInterferogramLength)	Shape associated with real or integer datasets in the wrappedInterferogram group
unwrappedInterferogramWidth	scalar	Number of pixels in all S/L-SAR datasets within the unwrappedInterferogram group
unwrappedInterferogramLength	scalar	Number of lines in all S/L-SAR datasets within the unwrapped Interferogram group
unwrappedInterferogramShape	(unwrappedInterferogramWidth, unwrappedInterferogramLength)	Shape associated with real or integer datasets in the unwrappedInterferogram group
offsetShape	(offsetLength, offsetWidth)	Shape associated with Pixel Offset layers
offsetWidth	scalar	Number of pixels in Pixel Offset layers
offsetLength	scalar	Number of lines in all S/L-SAR pixel offset layers

radarGridShape	(radarCubeLength, radarCubeWidth)	Shape associated with 2D rasters on same grid as metadata cubes
radarCubeShape	(radarCubeHeight, radarCubeLength, radarCubeWidth)	Shape associated with metadata cubes
radarCubeHeight	scalar	Height dimension of the metadata cube
radarCubeLength	scalar	Length dimension of the metadata cube
radarCubeWidth	scalar	Width dimension of the metadata cube
radarCubeShapeTrueHeight	(1, radarCubeLength TrueHeight, radarCubeWidth TrueHeight)	Shape associated with metadata cubes at True Height
radarCubeHeightTrueHeight	scalar	Height dimension of the metadata cube at True Height. The value will be one.
radarCubeLengthTrueHeight	scalar	Length dimension of the metadata cube at True Height
radarCubeWidthTrueHeight	scalar	Width dimension of the metadata cube at True Height
dopplerCentroidLength	scalar	Length dimension of Doppler centroid grid
dopplerCentroidWidth	scalar	Width dimension of Doppler centroid grid
dopplerCentroidShape	(dopplerCentroidLength, dopplerCentroidWidth)	Shape of the Doppler centroid grid
orbitListLength	scalar	Number of orbit state vectors
orbitShape	(orbitListLength, 3)	Shape of orbit state vector triplets dataset
attitudeListLength	scalar	Number of attitude state vectors
attitudeQuaternionShape	(attitudeListLength, 4)	Shape of attitude quaternion dataset
attitudeShape	(attitudeListLength, 3)	Shape of attitude Euler angle triplets dataset
numberOfInputL1Files	scalar	Number of input L1 granules
numberOfInputOrbitFiles	scalar	Number of input orbit files
numberOfInputConfigFiles	scalar	Number of input configuration files

10.4.2 Product Identification

Product identification variables	
/science/SSAR/identification/referenceAbsoluteOrbitNumber	
Type: UInt32	**Shape: scalar**
Description: Absolute orbit number for the reference SLC	
/science/SSAR/identification/secondaryAbsoluteOrbitNumber	

Type: UInt32	**Shape: scalar**
Description: Absolute orbit number for the secondary SLC	
/science/SSAR/identification/referenceIsJointObservation	
Type: string	**Shape: scalar**
Description: "True" if any portion of the reference RSLC was acquired in a joint observation mode (e.g., L-band and S-band simultaneously), "False" otherwise	
/science/SSAR/identification/secondaryIsJointObservation	
Type: string	**Shape: scalar**
Description: "True" if any portion of the reference RSLC was acquired in a joint observation mode (e.g., L-band and S-band simultaneously), "False" otherwise	
/science/SSAR/identification/trackNumber	
Type: UByte	**Shape: scalar**
Description: Track number	
/science/SSAR/identification/frameNumber	
Type: UInt16	**Shape: scalar**
Description: Frame number	
/science/SSAR/identification/missionId	
Type: string	**Shape: scalar**
Description: Mission identifier	
/science/SSAR/identification/processingCenter	
Type: string	**Shape: scalar**
Description: Data processing center	
/science/SSAR/identification/productType	
Type: string	**Shape: scalar**
Description: Product type	
/science/SSAR/identification/granuleId	
Type: string	**Shape: scalar**
Description: Unique granule identification name	
/science/SSAR/identification/productDoi	
Type: string	**Shape: scalar**
Description: Digital Object Identifier (DOI) for the product	
/science/SSAR/identification/productVersion	
Type: string	**Shape: scalar**
Description: Product version which represents the structure of the product and the science content governed by the algorithm, input data, and processing parameters	
/science/SSAR/identification/productSpecificationVersion	
Type: string	**Shape: scalar**
Description: Product specification version which represents the schema of this product	
/science/SSAR/identification/lookDirection	
Type: string	**Shape: scalar**
Description: Look direction, either "Left" or "Right"	
/science/SSAR/identification/orbitPassDirection	
Type: string	**Shape: scalar**
Description: Orbit direction, either "Ascending" or "Descending"	
/science/SSAR/identification/referenceZeroDopplerStartTime	
Type: string	**Shape: scalar**
Description: Azimuth start time (in UTC) of reference RSLC product in the format YYYY-mm-ddTHH:MM:SS.sssssssss	
/science/SSAR/identification/secondaryZeroDopplerStartTime	
Type: string	**Shape: scalar**
Description: Azimuth start time (in UTC) of secondary RSLC product in the format YYYY-mm-ddTHH:MM:SS.sssssssss	
/science/SSAR/identification/referenceZeroDopplerEndTime	
Type: string	**Shape: scalar**

Description: Azimuth stop time (in UTC) of reference RSLC product in the format YYYY-mm-ddTHH:MM:SS.sssssssss		
/science/SSAR/identification/secondaryZeroDopplerEndTime		
Type: string	**Shape: scalar**	
Description: Azimuth stop time (in UTC) of secondary RSLC product in the format YYYY-mm-ddTHH:MM:SS.sssssssss		
/science/SSAR/identification/plannedDatatakeId		
Type: string	**Shape: (numberOfDatatakes)**	
Description: List of planned datatakes included in the product		
/science/SSAR/identification/plannedObservationId		
Type: string	**Shape: (numberOfObservations)**	
Description: List of planned observations included in the product		
/science/SSAR/identification/isUrgentObservation		
Type: string	**Shape: scalar**	
Description: Flag indicating if observation is nominal ("False") or urgent ("True")		
/science/SSAR/identification/listOfFrequencies		
Type: string	**Shape: (numberOfFrequencies)**	
Description: List of frequency layers available in the product		
/science/SSAR/identification/diagnosticModeFlag		
Type: UByte	**Shape: scalar**	
Description: Indicates if the radar operation mode is a diagnostic mode (1-2) or DBFed science (0): 0, 1, or 2		
/science/SSAR/identification/productLevel		
Type: string	**Shape: scalar**	
Description: Product level. L0A: Unprocessed instrument data; L0B: Reformatted, unprocessed instrument data;L1: Processed instrument data in radar coordinates system; and L2: Processed instrument data in geocoded coordinates system		
/science/SSAR/identification/isGeocoded		
Type: string	**Shape: scalar**	
Description: Flag to indicate if the product data is in the radar geometry ("False") or in the map geometry ("True")		
/science/SSAR/identification/boundingPolygon		
Type: string	**Shape: scalar**	
Description: OGR compatible WKT representation of bounding polygon of the image**.** Horizontal coordinates are WGS84 longitude followed by latitude (both in degrees), and the vertical coordinate is the height above the WGS84 ellipsoid in meters. The first point corresponds to the start-time, near-range radar coordinate, and the perimeter is traversed in counterclockwise order on the map. This means the traversal order in radar coordinates differs for left-looking and right-looking sensors. The polygon includes the four corners of the radar grid, with equal numbers of points distributed evenly in radar coordinates along each edge		
	ogr_geometry	polygon
	epsg	4326
/science/SSAR/identification/processingDateTime		
Type: string	**Shape: scalar**	
Description: Processing date and time (in UTC) in the format YYYY-mm-ddTHH:MM:SS		
/science/SSAR/identification/radarBand		
Type: string	**Shape: scalar**	
Description: Acquired frequency band, either "L" or "S"		
/science/SSAR/identification/platformName		
Type: string	**Shape: scalar**	
Description: Name of the platform used to collect the remote sensing data provided in this product		
/science/SSAR/identification/instrumentName		
Type: string	**Shape: scalar**	
Description: Name of the instrument used to collect the remote sensing data provided in this product		
/science/SSAR/identification/processingType		
Type: string	**Shape: scalar**	
Description: Nominal (or) Urgent (or) Custom (or) Undefined		

/science/SSAR/identification/isDithered		
Type: string		**Shape: scalar**
Description: "True" if the pulse timing was varied (dithered) during acquisition, "False" otherwise		
/science/SSAR/identification/isMixedMode		
Type: string		**Shape: scalar**
Description: "True" if this product is generated from reference and secondary RSLCs with different range bandwidths, "False" otherwise.		
/science/SSAR/identification/isFullFrame		
Type: string		**Shape: scalar**
Description: "True" if this product fully covers a NISAR frame**,** "False" if partial coverage.		
	frameCoveragePercentage	Percentage of NISAR frame containing processed data
	thresholdPercentage	Threshold percentage used to determine if the product is full frame or partial frame
/science/SSAR/identification/compositeReleaseId		
Type: string		**Shape: scalar**
Description: Unique version identifier of the science data production system		

10.4.3 Radar Imagery

Product imagery variables		
/science/SSAR/GUNW/grids/frequencyA/listOfPolarizations		
Type: string		**Shape: (numberOfFrequencyAPolarizations)**
Description: List of processed polarization layers with frequency A		
/science/SSAR/GUNW/grids/frequencyA/centerFrequency		
Type: Float64		**Shape: scalar**
Description: Center frequency of the processed image in hertz		
	units	hertz
/science/SSAR/GUNW/grids/frequencyA/pixelOffsets/projection		
Type: UInt32		**Shape: scalar**
Description: Product map grid projection: EPSG code, with additional projection information as HDF5 Attributes		
	ellipsoid	Projection ellipsoid
	epsg_code	Projection EPSG code
	false_easting	The value added to all abscissa values in the rectangular coordinates for a map projection.
	false_northing	The value added to all ordinate values in the rectangular coordinates for a map projection.
	grid_mapping_name	Grid mapping variable name
	inverse_flattening	Inverse flattening of the ellipsoidal figure
	latitude_of_projection_origin	The latitude chosen as the origin of rectangular coordinates for a map projection.
	longitude_of_projection_origin	The longitude, with respect to Greenwich, of the prime meridian associated with the geodetic datum.
	semi_major_axis	Semi-major axis
	spatial_ref	Spatial reference
	utm_zone_number	UTM zone number
	longitude_of_central_meridian	The line of longitude at the center of a map projection generally used as the basis for constructing the projection.
	scale_factor_at_central_meridian	A multiplier for reducing a distance obtained from a map by computation or scaling to the actual distance along the central meridian.
/science/SSAR/GUNW/grids/frequencyA/pixelOffsets/xCoordinateSpacing		
Type: Float64		**Shape: scalar**
Description: Nominal spacing in meters between consecutive pixels		

	long_name	X coordinates spacing
	units	meters
/science/SSAR/GUNW/grids/frequencyA/pixelOffsets/yCoordinateSpacing		
Type: Float64		**Shape: scalar**
Description: Nominal spacing in meters between consecutive lines		
	long_name	Y coordinates spacing
	units	meters
/science/SSAR/GUNW/grids/frequencyA/wrappedInterferogram/projection		
Type: UInt32		**Shape: scalar**
Description: Product map grid projection: EPSG code, with additional projection information as HDF5 Attributes		
	ellipsoid	Projection ellipsoid
	epsg_code	Projection EPSG code
	false_easting	The value added to all abscissa values in the rectangular coordinates for a map projection.
	false_northing	The value added to all ordinate values in the rectangular coordinates for a map projection.
	grid_mapping_name	Grid mapping variable name
	inverse_flattening	Inverse flattening of the ellipsoidal figure
	latitude_of_projection_origin	The latitude chosen as the origin of rectangular coordinates for a map projection.
	longitude_of_projection_origin	The longitude, with respect to Greenwich, of the prime meridian associated with the geodetic datum.
	semi_major_axis	Semi-major axis
	spatial_ref	Spatial reference
	utm_zone_number	UTM zone number
	longitude_of_central_meridian	The line of longitude at the center of a map projection generally used as the basis for constructing the projection.
	scale_factor_at_central_meridian	A multiplier for reducing a distance obtained from a map by computation or scaling to the actual distance along the central meridian.
/science/SSAR/GUNW/grids/frequencyA/wrappedInterferogram/yCoordinateSpacing		
Type: Float64		**Shape: scalar**
Description: Nominal spacing in meters between consecutive lines		
	long_name	Y coordinates spacing
	units	meters
/science/SSAR/GUNW/grids/frequencyA/wrappedInterferogram/xCoordinateSpacing		
Type: Float64		**Shape: scalar**
Description: Nominal spacing in meters between consecutive pixels		
	long_name	X coordinates spacing
	units	meters
/science/SSAR/GUNW/grids/frequencyA/unwrappedInterferogram/projection		
Type: UInt32		**Shape: scalar**
Description: Product map grid projection: EPSG code, with additional projection information as HDF5 Attributes		
	ellipsoid	Projection ellipsoid
	epsg_code	Projection EPSG code
	false_easting	The value added to all abscissa values in the rectangular coordinates for a map projection.
	false_northing	The value added to all ordinate values in the rectangular coordinates for a map projection.
	grid_mapping_name	Grid mapping variable name
	inverse_flattening	Inverse flattening of the ellipsoidal figure

	latitude_of_projection_origin	The latitude chosen as the origin of rectangular coordinates for a map projection.
	longitude_of_projection_origin	The longitude, with respect to Greenwich, of the prime meridian associated with the geodetic datum.
	semi_major_axis	Semi-major axis
	spatial_ref	Spatial reference
	utm_zone_number	UTM zone number
	longitude_of_central_meridian	The line of longitude at the center of a map projection generally used as the basis for constructing the projection.
	scale_factor_at_central_meridian	A multiplier for reducing a distance obtained from a map by computation or scaling to the actual distance along the central meridian.
/science/SSAR/GUNW/grids/frequencyA/unwrappedInterferogram/yCoordinateSpacing		
Type: Float64		**Shape: scalar**
Description: Nominal spacing in meters between consecutive lines		
	long_name	Y coordinates spacing
	units	meters
/science/SSAR/GUNW/grids/frequencyA/unwrappedInterferogram/xCoordinateSpacing		
Type: Float64		**Shape: scalar**
Description: Nominal spacing in meters between consecutive pixels		
	long_name	X coordinates spacing
	units	meters
/science/SSAR/GUNW/grids/frequencyA/pixelOffsets/xCoordinates		
Type: Float64		**Shape: (offsetWidth)**
Description: X coordinates in specified projection		
	long_name	X coordinates of projection
	standard_name	projection_x_coordinate
	units	meters
/science/SSAR/GUNW/grids/frequencyA/pixelOffsets/yCoordinates		
Type: Float64		**Shape: (offsetLength)**
Description: Y coordinates in specified projection		
	long_name	Y coordinates of projection
	standard_name	projection_y_coordinate
	units	meters
/science/SSAR/GUNW/grids/frequencyA/unwrappedInterferogram/xCoordinates		
Type: Float64		**Shape: (unwrappedInterferogramWidth)**
Description: X coordinates in specified projection		
	long_name	X coordinates of projection
	standard_name	projection_x_coordinate
	units	meters
/science/SSAR/GUNW/grids/frequencyA/unwrappedInterferogram/yCoordinates		
Type: Float64		**Shape: (unwrappedInterferogramLength)**
Description: Y coordinates in specified projection		
	long_name	Y coordinates of projection
	standard_name	projection_y_coordinate
	units	meters
/science/SSAR/GUNW/grids/frequencyA/wrappedInterferogram/xCoordinates		
Type: Float64		**Shape: (wrappedInterferogramWidth)**
Description: X coordinates in specified projection		
	long_name	X coordinates of projection
	standard_name	projection_x_coordinate
	units	meters

/science/SSAR/GUNW/grids/frequencyA/wrappedInterferogram/yCoordinates		
Type: Float64		**Shape: (wrappedInterferogram Length)**
Description: Y coordinates in specified projection		
	long_name	Y coordinates of projection
	standard_name	projection_y_coordinate
	units	meters
/science/SSAR/GUNW/grids/frequencyA/unwrappedInterferogram/mask		
Type: UByte		**Shape: (unwrappedInterferogramLength, unwrappedInterferogramWidth)**
Description: Combination of water mask and a mask of subswaths of valid samples in the reference RSLC and geometrically coregistered secondary RSLC. Each pixel value is a three-digit number: the most significant digit represents the water flag of that pixel the reference RSLC, where 1 is water and 0 is non-water; the second digit represents the subswath number of that pixel in the reference RSLC; the least significant digit represents the subswath number of that pixel in the secondary RSLC. A value of '0' in either subswath digit indicates an invalid sample in the corresponding RSLC		
	_FillValue	255
	grid_mapping	projection
	valid_min	0
	percentage_water	Percentage of pixels over water bodies and ocean
/science/SSAR/GUNW/grids/frequencyA/unwrappedInterferogram/HH/projection		
Type: UInt32		**Shape: scalar**
Description: Product map grid projection: EPSG code, with additional projection information as HDF5 Attributes		
	ellipsoid	Projection ellipsoid
	epsg_code	Projection EPSG code
	false_easting	The value added to all abscissa values in the rectangular coordinates for a map projection.
	false_northing	The value added to all ordinate values in the rectangular coordinates for a map projection.
	grid_mapping_name	Grid mapping variable name
	inverse_flattening	Inverse flattening of the ellipsoidal figure
	latitude_of_projection_origin	The latitude chosen as the origin of rectangular coordinates for a map projection.
	longitude_of_projection_origin	The longitude, with respect to Greenwich, of the prime meridian associated with the geodetic datum.
	semi_major_axis	Semi-major axis
	spatial_ref	Spatial reference
	utm_zone_number	UTM zone number
	longitude_of_central_meridian	The line of longitude at the center of a map projection generally used as the basis for constructing the projection.
	scale_factor_at_central_meridian	A multiplier for reducing a distance obtained from a map by computation or scaling to the actual distance along the central meridian.
/science/SSAR/GUNW/grids/frequencyA/unwrappedInterferogram/HH/yCoordinateSpacing		
Type: Float64		**Shape: scalar**
Description: Nominal spacing in meters between consecutive lines		
	long_name	Y coordinates spacing
	units	meters
/science/SSAR/GUNW/grids/frequencyA/unwrappedInterferogram/HH/xCoordinateSpacing		
Type: Float64		**Shape: scalar**
Description: Nominal spacing in meters between consecutive pixels		
	long_name	X coordinates spacing
	units	meters
/science/SSAR/GUNW/grids/frequencyA/wrappedInterferogram/HH/projection		

Type: UInt32		**Shape: scalar**
Description: Product map grid projection: EPSG code, with additional projection information as HDF5 Attributes		
	ellipsoid	Projection ellipsoid
	epsg_code	Projection EPSG code
	false_easting	The value added to all abscissa values in the rectangular coordinates for a map projection.
	false_northing	The value added to all ordinate values in the rectangular coordinates for a map projection.
	grid_mapping_name	Grid mapping variable name
	inverse_flattening	Inverse flattening of the ellipsoidal figure
	latitude_of_projection_origin	The latitude chosen as the origin of rectangular coordinates for a map projection.
	longitude_of_projection_origin	The longitude, with respect to Greenwich, of the prime meridian associated with the geodetic datum.
	semi_major_axis	Semi-major axis
	spatial_ref	Spatial reference
	utm_zone_number	UTM zone number
	longitude_of_central_meridian	The line of longitude at the center of a map projection generally used as the basis for constructing the projection.
	scale_factor_at_central_meridian	A multiplier for reducing a distance obtained from a map by computation or scaling to the actual distance along the central meridian.
/science/SSAR/GUNW/grids/frequencyA/wrappedInterferogram/HH/yCoordinateSpacing		
Type: Float64		**Shape: scalar**
Description: Nominal spacing in meters between consecutive lines		
	long_name	Y coordinates spacing
	units	meters
/science/SSAR/GUNW/grids/frequencyA/wrappedInterferogram/HH/xCoordinateSpacing		
Type: Float64		**Shape: scalar**
Description: Nominal spacing in meters between consecutive pixels		
	long_name	X coordinates spacing
	units	meters
/science/SSAR/GUNW/grids/frequencyA/unwrappedInterferogram/HH/xCoordinates		
Type: Float64		**Shape: (unwrappedInterferogramWidth)**
Description: X coordinates in specified projection		
	long_name	X coordinates of projection
	standard_name	projection_x_coordinate
	units	meters
/science/SSAR/GUNW/grids/frequencyA/unwrappedInterferogram/HH/yCoordinates		
Type: Float64		**Shape: (unwrappedInterferogramLength)**
Description: Y coordinates in specified projection		
	long_name	Y coordinates of projection
	standard_name	projection_y_coordinate
	units	meters
/science/SSAR/GUNW/grids/frequencyA/wrappedInterferogram/HH/xCoordinates		
Type: Float64		**Shape: (wrappedInterferogramWidth)**
Description: X coordinates in specified projection		
	long_name	X coordinates of projection
	standard_name	projection_x_coordinate
	units	meters
/science/SSAR/GUNW/grids/frequencyA/wrappedInterferogram/HH/yCoordinates		
Type: Float64		**Shape: (wrappedInterferogram Length)**

Description: Y coordinates in specified projection		
	long_name	Y coordinates of projection
	standard_name	projection_y_coordinate
	units	meters
/science/SSAR/GUNW/grids/frequencyA/unwrappedInterferogram/HH/unwrappedPhase		
Type: Float32		**Shape: (unwrappedInterferogramLength, unwrappedInterferogramWidth)**
Description: Unwrapped interferogram between HH layers		
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points
	units	radians
	_FillValue	nan
	gris_mapping	projection
/science/SSAR/GUNW/grids/frequencyA/unwrappedInterferogram/HH/connectedComponents		
Type: UInt16		**Shape: (unwrappedInterferogramLength, unwrappedInterferogramWidth)**
Description: Connected components for HH layer		
	_FillValue	65535
	grid_mapping	projection
	units	1
/science/SSAR/GUNW/grids/frequencyA/unwrappedInterferogram/HH/coherenceMagnitude		
Type: Float32		**Shape: (unwrappedInterferogramLength, unwrappedInterferogramWidth)**
Description: Coherence magnitude between HH layers		
	_FillValue	nan
	grid_mapping	projection
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points
	units	1
/science/SSAR/GUNW/grids/frequencyA/unwrappedInterferogram/HH/ionospherePhaseScreen		
Type: Float32		**Shape: (unwrappedInterferogramLength, unwrappedInterferogramWidth)**
Description: Ionosphere phase screen		
	_FillValue	nan
	grid_mapping	projection
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points
	units	radians
/science/SSAR/GUNW/grids/frequencyA/unwrappedInterferogram/HH/ionospherePhaseScreenUncertainty		
Type: Float32		**Shape: (unwrappedInterferogramLength, unwrappedInterferogramWidth)**
Description: Uncertainty of the ionosphere phase screen		
	_FillValue	nan
	grid_mapping	projection

	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points
	units	radians
/science/SSAR/GUNW/grids/frequencyA/unwrappedInterferogram/HH/losDeformation		
Type: Float32		**Shape: (unwrappedInterferogramLength, unwrappedInterferogramWidth)**
Description: Line Of Sight (LOS) Deformation between HH layers		
	_FillValue	nan
	grid_mapping	projection
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points
	units	meters
/science/SSAR/GUNW/grids/frequencyA/wrappedInterferogram/mask		
Type: UByte		**Shape: (wrappedInterferogramLength, wrappedInterferogramWidth)**
Description: Combination of water mask and a mask of subswaths of valid samples in the reference RSLC and geometrically coregistered secondary RSLC. Each pixel value is a three-digit number: the most significant digit represents the water flag of that pixel the reference RSLC, where 1 is water and 0 is non-water; the second digit represents the subswath number of that pixel in the reference RSLC; the least significant digit represents the subswath number of that pixel in the secondary RSLC. A value of '0' in either subswath digit indicates an invalid sample in the corresponding RSLC		
	_FillValue	255
	grid_mapping	projection
	valid_min	0
	valid_max	155
	percentage_water	Percentage of pixels over water bodies and ocean
/science/SSAR/GUNW/grids/frequencyA/wrappedInterferogram/HH/wrappedInterferogram		
Type: CFloat32		**Shape: (wrappedInterferogramLength, wrappedInterferogramWidth)**
Description: Complex wrapped interferogram between HH layers		
	_FillValue	nan
	grid_mapping	projection
	units	uniltess
/science/SSAR/GUNW/grids/frequencyA/wrappedInterferogram/HH/coherenceMagnitude		
Type: Float32		**Shape: (wrappedInterferogramLength, wrappedInterferogramWidth)**
Description: Coherence magnitude between HH layers		
	_FillValue	nan
	grid_mapping	projection
	units	1
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points
/science/SSAR/GUNW/grids/frequencyA/pixelOffsets/HH/projection		
Type: UInt32		**Shape: scalar**
Description: Product map grid projection: EPSG code, with additional projection information as HDF5 Attributes		

	ellipsoid	Projection ellipsoid
	epsg_code	Projection EPSG code
	false_easting	The value added to all abscissa values in the rectangular coordinates for a map projection.
	false_northing	The value added to all ordinate values in the rectangular coordinates for a map projection.
	grid_mapping_name	Grid mapping variable name
	inverse_flattening	Inverse flattening of the ellipsoidal figure
	latitude_of_projection_origin	The latitude chosen as the origin of rectangular coordinates for a map projection.
	longitude_of_projection_origin	The longitude, with respect to Greenwich, of the prime meridian associated with the geodetic datum.
	semi_major_axis	Semi-major axis
	spatial_ref	Spatial reference
	utm_zone_number	UTM zone number
	longitude_of_central_meridian	The line of longitude at the center of a map projection generally used as the basis for constructing the projection.
	scale_factor_at_central_meridian	A multiplier for reducing a distance obtained from a map by computation or scaling to the actual distance along the central meridian.
/science/SSAR/GUNW/grids/frequencyA/pixelOffset/mask		
Type: UByte		**Shape: (offsetLength, offsetWidth)**
Description: Combination of water mask and a mask of subswaths of valid samples in the reference RSLC and geometrically coregistered secondary RSLC. Each pixel value is a three-digit number: the most significant digit represents the water flag of that pixel the reference RSLC, where 1 is water and 0 is non-water; the second digit represents the subswath number of that pixel in the reference RSLC; the least significant digit represents the subswath number of that pixel in the secondary RSLC. A value of '0' in either subswath digit indicates an invalid sample in the corresponding RSLC		
	_FillValue	255
	grid_mapping	projection
	valid_min	0
	valid_max	155
	percentage_water	Percentage of pixels over water bodies and ocean
/science/SSAR/GUNW/grids/frequencyA/pixelOffsets/HH/slantRangeOffset		
Type: Float32		**Shape: (offsetLength, offsetWidth)**
Description: Slant range offset		
	_FillValue	nan
	grid_mapping	projection
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points
	units	meters
/science/SSAR/GUNW/grids/frequencyA/pixelOffsets/HH/alongTrackOffset		
Type: Float32		**Shape: (offsetLength, offsetWidth)**
Description: Along-track offset		
	_FillValue	nan
	grid_mapping	projection
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points

	units	meters
/science/SSAR/GUNW/grids/frequencyA/pixelOffsets/HH/correlationSurfacePeak		
Type: Float32		**Shape: (offsetLength, offsetWidth)**
Description: Normalized cross-correlation surface peak		
	_FillValue	nan
	grid_mapping	projection
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points
	units	1
/science/SSAR/GUNW/grids/frequencyA/pixelOffsets/HH/xCoordinates		
Type: Float64		**Shape: (offsetWidth)**
Description: X coordinates in specified projection		
	long_name	X coordinates of projection
	standard_name	projection_x_coordinate
	units	meters
/science/SSAR/GUNW/grids/frequencyA/pixelOffsets/HH/yCoordinates		
Type: Float64		**Shape: (offsetLength)**
Description: Y coordinates in specified projection		
	long_name	Y coordinates of projection
	standard_name	projection_y_coordinate
	units	meters
/science/SSAR/GUNW/grids/frequencyA/pixelOffsets/HH/xCoordinateSpacing		
Type: Float64		**Shape: scalar**
Description: Nominal spacing in meters between consecutive pixels		
	long_name	X coordinates spacing
	units	meters
/science/SSAR/GUNW/grids/frequencyA/pixelOffsets/HH/yCoordinateSpacing		
Type: Float64		**Shape: scalar**
Description: Nominal spacing in meters between consecutive lines		
	long_name	Y coordinates spacing
	units	meters

10.4.4 Processing Informations

Processing-related variables		
/science/SSAR/GUNW/metadata/processingInformation/parameters/runConfigurationContents		
Type: string	**Shape: scalar**	
Description: Contents of the run configuration file with parameters used for processing		
/science/SSAR/GUNW/metadata/processingInformation/parameters/reference/rfiMitigationApplied		
Type: string	**Shape: scalar**	
Description: Flag to indicate if RFI correction has been applied to reference RSLC		
/science/SSAR/GUNW/metadata/processingInformation/parameters/reference/isMixedMode		
Type: string	**Shape: scalar**	
Description: "True" if reference RSLC is a composite of data collected in multiple radar modes, "False" otherwise		
/science/SSAR/GUNW/metadata/processingInformation/parameters/reference/referenceTerrainHeight		
Type: Float32	**Shape: (dopplerCentroidLength, dopplerCentroidWidth)**	
Description: Reference Terrain Height as a function of map coordinates for reference RSLC		
	units	meters

	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (seconds)
/science/SSAR/GUNW/metadata/processingInformation/parameters/reference/frequencyA/slantRangeStart		
Type: Float64	**Shape: scalar**	
Description: Slant range start distance for the reference RSLC		
	units	meters
/science/SSAR/GUNW/metadata/processingInformation/parameters/reference/frequencyA/numberOfRangeSamples		
Type: UInt64	**Shape: scalar**	
Description: Number of slant range samples for each azimuth line within the reference RSLC		
	units	1
/science/SSAR/GUNW/metadata/processingInformation/parameters/reference/frequencyA/numberOfAzimuthLines		
Type: UInt64	**Shape: scalar**	
Description: Number of azimuth lines within the reference RSLC		
	units	1
/science/SSAR/GUNW/metadata/processingInformation/parameters/reference/frequencyA/slantRangeSpacing		
Type: Float64	**Shape: scalar**	
Description: Slant range spacing of reference RSLC		
	units	meters
/science/SSAR/GUNW/metadata/processingInformation/parameters/reference/frequencyA/zeroDopplerTimeSpacing		
Type: Float64	**Shape: scalar**	
Description: Time interval in the along-track direction for reference RSLC raster layers		
	units	seconds
/science/SSAR/GUNW/metadata/processingInformation/parameters/reference/frequencyA/zeroDopplerStartTime		
Type: String	**Shape: scalar**	
Description: Azimuth start time (in UTC) of the reference RSLC product in the format YYYY-mm-ddTHH:MM:SS.sssssssss		
/science/SSAR/GUNW/metadata/processingInformation/parameters/reference/frequencyA/zeroDopplerEndTime		
Type: string	**Shape: scalar**	
Description: Azimuth stop time (in UTC) of the reference RSLC product in the format YYYY-mm-ddTHH:MM:SS.sssssssss		
/science/SSAR/GUNW/metadata/processingInformation/parameters/reference/frequencyA/rangeBandwidth		
Type: Float64	**Shape: scalar**	
Description: Processed slant range bandwidth for reference RSLC		
	units	hertz
/science/SSAR/GUNW/metadata/processingInformation/parameters/reference/frequencyA/azimuthBandwidth		
Type: Float64	**Shape: scalar**	
Description: Processed azimuth bandwidth for reference RSLC		
	units	hertz
/science/SSAR/GUNW/metadata/processingInformation/parameters/reference/frequencyA/dopplerCentroid		
Type: Float64	**Shape: (dopplerCentroidLength, dopplerCentroidWidth)**	
Description: 2D LUT of Doppler centroid for frequency A		
	units	hertz

	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (seconds)
/science/SSAR/GUNW/metadata/processingInformation/parameters/secondary/referenceTerrainHeight		
Type: Float32	**Shape: (dopplerCentroidLength, dopplerCentroidWidth)**	
Description: Reference Terrain Height as a function of map coordinates for secondary RSLC		
	units	meters
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (seconds)
/science/SSAR/GUNW/metadata/processingInformation/parameters/secondary/rfiMitigationApplied		
Type: string	**Shape: scalar**	
Description: Flag to indicate if RFI correction has been applied to secondary RSLC		
/science/SSAR/GUNW/metadata/processingInformation/parameters/secondary/isMixedMode		
Type: string	**Shape: scalar**	
Description: "True" if secondary RSLC is a composite of data collected in multiple radar modes, "False" otherwise		
/science/SSAR/GUNW/metadata/processingInformation/parameters/secondary/frequencyA/slantRangeStart		
Type: Float64	**Shape: scalar**	
Description: Slant range start distance for the secondary RSLC		
	units	meters
/science/SSAR/GUNW/metadata/processingInformation/parameters/secondary/frequencyA/numberOfRangeSamples		
Type: UInt64	**Shape: scalar**	
Description: Number of slant range samples for each azimuth line within the secondary RSLC		
	units	1
/science/SSAR/GUNW/metadata/processingInformation/parameters/secondary/frequencyA/numberOfAzimuthLines		
Type: UInt64	**Shape: scalar**	
Description: Number of azimuth lines within the secondary RSLC		
	units	1
/science/SSAR/GUNW/metadata/processingInformation/parameters/secondary/frequencyA/slantRangeSpacing		
Type: Float64	**Shape: scalar**	
Description: Slant range spacing of secondary RSLC		
	units	meters
/science/SSAR/GUNW/metadata/processingInformation/parameters/secondary/frequencyA/zeroDopplerTimeSpacing		
Type: Float64	**Shape: scalar**	
Description: Time interval in the along-track direction for secondary RSLC raster layers		
	units	seconds
/science/SSAR/GUNW/metadata/processingInformation/parameters/secondary/frequencyA/zeroDopplerStartTime		
Type: String	**Shape: scalar**	
Description: Azimuth start time (in UTC) of the reference RSLC product in the format YYYY-mm-ddTHH:MM:SS.sssssssss		
/science/SSAR/GUNW/metadata/processingInformation/parameters/secondary/frequencyA/zeroDopplerEndTime		
Type: string	**Shape: scalar**	

Description: Azimuth stop time (in UTC) of the reference RSLC product in the format YYYY-mm-ddTHH:MM:SS.sssssssss		
/science/SSAR/GUNW/metadata/processingInformation/parameters/secondary/frequencyA/rangeBandwidth		
Type: Float64	**Shape: scalar**	
Description: Processed slant range bandwidth for secondary RSLC		
	units	hertz
/science/SSAR/GUNW/metadata/processingInformation/parameters/secondary/frequencyA/azimuthBandwidth		
Type: Float64	**Shape: scalar**	
Description: Processed azimuth bandwidth for secondary RSLC		
	units	hertz
/science/SSAR/GUNW/metadata/processingInformation/parameters/secondary/frequencyA/dopplerCentroid		
Type: Float64	**Shape: (dopplerCentroidLength, dopplerCentroidWidth)**	
Description: 2D LUT of Doppler centroid for frequency A		
	units	hertz
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (second)
/science/SSAR/GUNW/metadata/processingInformation/parameters/common/frequencyA/dopplerCentroid		
Type: Float64	**Shape: (dopplerCentroidLength, dopplerCentroidWidth)**	
Description: 2D LUT of common Doppler centroid between reference and secondary RSLCs		
	units	hertz
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (second)
/science/SSAR/GUNW/metadata/processingInformation/parameters/common/frequencyA/dopplerBandwidth		
Type: Float64	**Shape: scalar**	
Description: Common Doppler bandwidth between reference and secondary RSLCs		
	units	hertz
/science/SSAR/GUNW/metadata/processingInformation/parameters/wrappedInterferogram/frequencyA/rangeBandwidth		
Type: Float64	**Shape: scalar**	
Description: Processed slant range bandwidth for frequency A interferometric layers		
	units	hertz
/science/SSAR/GUNW/metadata/processingInformation/parameters/wrappedInterferogram/frequencyA/azimuthBandwidth		
Type: Float64	**Shape: scalar**	
Description: Processed azimuth bandwidth for frequency A interferometric layers		
	units	hertz
/science/SSAR/GUNW/metadata/processingInformation/parameters/wrappedInterferogram/frequencyA/commonBandRangeFilterApplied		
Type: string	**Shape: scalar**	
Description: Flag to indicate if common band range filter has been applied		
/science/SSAR/GUNW/metadata/processingInformation/parameters/wrappedInterferogram/frequencyA/commonBandAzimuthFilterApplied		
Type: string	**Shape: scalar**	
Description: Flag to indicate if common band azimuth filter has been applied		

/science/SSAR/GUNW/metadata/processingInformation/parameters/wrappedInterferogram/frequencyA/numberOfRangeLooks		
Type: UInt32	**Shape: scalar**	
Description: Number of looks applied in the slant range direction to form the wrapped interferogram		
	units	1
/science/SSAR/GUNW/metadata/processingInformation/parameters/wrappedInterferogram/frequencyA/numberOfAzimuthLooks		
Type: UInt32	**Shape: scalar**	
Description: Number of looks applied in the along-track direction to form the wrapped interferogram		
	units	1
/science/SSAR/GUNW/metadata/processingInformation/parameters/wrappedInterferogram/frequencyA/ellipsoidalFlatteningApplied		
Type: string	**Shape: scalar**	
Description: Flag to indicate if the interferometric phase has been flattened with respect to a zero height ellipsoid		
/science/SSAR/GUNW/metadata/processingInformation/parameters/wrappedInterferogram/frequencyA/topographicFlatteningApplied		
Type: string	**Shape: scalar**	
Description: Flag to indicate if the interferometric phase has been flattened with respect to topographic height using a DEM		
/science/SSAR/GUNW/metadata/processingInformation/parameters/unwrappedInterferogram/frequencyA/rangeBandwidth		
Type: Float64	**Shape: scalar**	
Description: Processed slant range bandwidth for frequency A interferometric layers		
	units	hertz
/science/SSAR/GUNW/metadata/processingInformation/parameters/unwrappedInterferogram/frequencyA/azimuthBandwidth		
Type: Float64	**Shape: scalar**	
Description: Processed azimuth bandwidth for frequency A interferometric layers		
	units	hertz
/science/SSAR/GUNW/metadata/processingInformation/parameters/unwrappedInterferogram/frequencyA/commonBandRangeFilterApplied		
Type: string	**Shape: scalar**	
Description: Flag to indicate if common band range filter has been applied		
/science/SSAR/GUNW/metadata/processingInformation/parameters/unwrappedInterferogram/frequencyA/commonBandAzimuthFilterApplied		
Type: string	**Shape: scalar**	
Description: Flag to indicate if common band azimuth filter has been applied		
/science/SSAR/GUNW/metadata/processingInformation/parameters/unwrappedInterferogram/frequencyA/numberOfRangeLooks		
Type: UInt32	**Shape: scalar**	
Description: Number of looks applied in the slant range direction to form the unwrapped interferogram		
	units	1
/science/SSAR/GUNW/metadata/processingInformation/parameters/unwrappedInterferogram/frequencyA/numberOfAzimuthLooks		
Type: UInt32	**Shape: scalar**	
Description: Number of looks applied in the along-track direction to form the unwrapped interferogram		
	units	1
/science/SSAR/GUNW/metadata/processingInformation/parameters/unwrappedInterferogram/frequencyA/ellipsoidalFlatteningApplied		
Type: string	**Shape: scalar**	
Description: Flag to indicate if the interferometric phase has been flattened with respect to a zero height ellipsoid		
/science/SSAR/GUNW/metadata/processingInformation/parameters/unwrappedInterferogram/frequencyA/topographicFlatteningApplied		

Type: string	**Shape: scalar**	
Description: Flag to indicate if the interferometric phase has been flattened with respect to topographic height using a DEM		
/science/SSAR/GUNW/metadata/processingInformation/parameters/ionosphere/lowBandBandwidth		
Type: Float32	**Shape: scalar**	
Description: Slant range bandwidth of the low sub-band image		
	units	hertz
/science/SSAR/GUNW/metadata/processingInformation/parameters/ionosphere/highBandBandwidth		
Type: Float32	**Shape: scalar**	
Description: Slant range bandwidth of the high sub-band image		
	units	hertz
/science/SSAR/GUNW/metadata/processingInformation/parameters/geocoding/rangeIonosphericCorrectionApplied		
Type: string	**Shape: scalar**	
Description: Flag to indicate if the range ionospheric correction is applied to improve geolocation		
/science/SSAR/GUNW/metadata/processingInformation/parameters/geocoding/azimuthIonosphericCorrectionApplied		
Type: string	**Shape: scalar**	
Description: Flag to indicate if the azimuth ionospheric correction is applied to improve geolocation		
/science/SSAR/GUNW/metadata/processingInformation/parameters/geocoding/hydrostaticTroposphericCorrectionApplied		
Type: string	**Shape: scalar**	
Description: Flag to indicate if the hydrostatic tropospheric correction is applied to improve geolocation		
/science/SSAR/GUNW/metadata/processingInformation/parameters/geocoding/wetTroposphericCorrectionApplied		
Type: string	**Shape: scalar**	
Description: Flag to indicate if the wet tropospheric correction is applied to improve geolocation		
/science/SSAR/GUNW/metadata/processingInformation/parameters/pixelOffsets/frequencyA/alongTrackWindowSize		
Type: UInt32	**Shape: scalar**	
Description: Along-track cross-correlation window size in pixels		
	units	1
/science/SSAR/GUNW/metadata/processingInformation/parameters/pixelOffsets/frequencyA/slantRangeWindowSize		
Type: UInt32	**Shape: scalar**	
Description: Slant range cross-correlation window size in pixels		
	units	1
/science/SSAR/GUNW/metadata/processingInformation/parameters/pixelOffsets/frequencyA/alongTrackSearchWindowSize		
Type: UInt32	**Shape: scalar**	
Description: Along-track cross-correlation search window size in pixels		
	units	1
/science/SSAR/GUNW/metadata/processingInformation/parameters/pixelOffsets/frequencyA/slantRangeSearchWindowSize		
Type: UInt32	**Shape: scalar**	
Description: Slant range cross-correlation search window size in pixels		
	units	1
/science/SSAR/GUNW/metadata/processingInformation/parameters/pixelOffsets/frequencyA/alongTrackSkipWindowSize		
Type: UInt32	**Shape: scalar**	
Description: Along-track cross-correlation skip window size in pixels		
	units	1
/science/SSAR/GUNW/metadata/processingInformation/parameters/pixelOffsets/frequencyA/slantRangeSkipWindowSize		
Type: UInt32	**Shape: scalar**	

Description: Slant range cross-correlation skip window size in pixels		
	units	1
/science/SSAR/GUNW/metadata/processingInformation/parameters/pixelOffsets/frequencyA/correlationSurfaceOversampling		
Type: UInt32	**Shape: scalar**	
Description: Oversampling factor of the cross-correlation surface		
	units	1
/science/SSAR/GUNW/metadata/processingInformation/parameters/pixelOffsets/frequencyA/isOffsetsBlendingApplied		
Type: string	**Shape: scalar**	
Description: Flag to indicate if pixel offsets are the results of blending multi-resolution layers of pixel offsets		
/science/SSAR/GUNW/metadata/processingInformation/algorithms/softwareVersion		
Type: string	**Shape: scalar**	
Description: Software version used for processing		
/science/SSAR/GUNW/metadata/processingInformation/algorithms/coregistration/coregistrationMethod		
Type: string	**Shape: scalar**	
Description: RSLC coregistration method		
/science/SSAR/GUNW/metadata/processingInformation/algorithms/coregistration/geometryCoregistration		
Type: string	**Shape: scalar**	
Description: Geometry coregistration algorithm		
/science/SSAR/GUNW/metadata/processingInformation/algorithms/coregistration/crossCorrelation		
Type: string	**Shape: scalar**	
Description: Cross-correlation algorithm for sub-pixel offsets computation		
/science/SSAR/GUNW/metadata/processingInformation/algorithms/coregistration/resampling		
Type: string	**Shape: scalar**	
Description: Secondary RSLC resampling algorithm		
/science/SSAR/GUNW/metadata/processingInformation/algorithms/coregistration/crossCorrelationOutliers		
Type: string	**Shape: scalar**	
Description: Outliers identification algorithm		
/science/SSAR/GUNW/metadata/processingInformation/algorithms/coregistration/crossCorrelationFilling		
Type: string	**Shape: scalar**	
Description: Outliers data filling algorithm for cross-correlation offsets		
/science/SSAR/GUNW/metadata/processingInformation/algorithms/coregistration/crossCorrelationFilterKernel		
Type: string	**Shape: scalar**	
Description: Filtering algorithm for cross-correlation offsets		
/science/SSAR/GUNW/metadata/processingInformation/algorithms/interferogramFormation/multilooking		
Type: string	**Shape: scalar**	
Description: Multilooking algorithm		
/science/SSAR/GUNW/metadata/processingInformation/algorithms/interferogramFormation/wrappedInterferogramFiltering		
Type: string	**Shape: scalar**	
Description: Algorithm used to filter the wrapped interferogram prior to phase unwrapping		
/science/SSAR/GUNW/metadata/processingInformation/algorithms/interferogramFormation/flatteningMethod		
Type: string	**Shape: scalar**	
Description: Algorithm used to flatten the wrapped interferogram		
/science/SSAR/GUNW/metadata/processingInformation/algorithms/unwrapping/unwrappingAlgorithm		
Type: string	**Shape: scalar**	

Description: Algorithm used for phase unwrapping	
/science/SSAR/GUNW/metadata/processingInformation/algorithms/unwrapping/unwrappingInitializer	
Type: string	**Shape: scalar**
Description: Algorithm used to initialize phase unwrapping	
/science/SSAR/GUNW/metadata/processingInformation/algorithms/unwrapping/costMode	
Type: string	**Shape: scalar**
Description: Cost mode algorithm for phase unwrapping	
/science/SSAR/GUNW/metadata/processingInformation/algorithms/unwrapping/preprocessing/wrappedPhaseOutliers	
Type: string	**Shape: scalar**
Description: Algorithm identifying outliers in the wrapped interferogram	
/science/SSAR/GUNW/metadata/processingInformation/algorithms/unwrapping/preprocessing/wrappedPhaseFilling	
Type: string	**Shape: scalar**
Description: Outliers data filling algorithm for phase unwrapping slantRangeStart	
/science/SSAR/GUNW/metadata/processingInformation/algorithms/ionosphereEstimation/ionosphereAlgorithm	
Type: string	**Shape: scalar**
Description: Algorithm used to estimate ionosphere phase screen	
/science/SSAR/GUNW/metadata/processingInformation/algorithms/ionosphereEstimation/ionosphereOutliers	
Type: string	**Shape: scalar**
Description: Algorithm identifying outliers in unfiltered ionosphere phase screen	
/science/SSAR/GUNW/metadata/processingInformation/algorithms/ionosphereEstimation/ionosphereFilling	
Type: string	**Shape: scalar**
Description: Outliers data filling algorithm for ionosphere phase estimation	
/science/SSAR/GUNW/metadata/processingInformation/algorithms/ionosphereEstimation/ionosphereFiltering	
Type: string	**Shape: scalar**
Description: Filtering algorithm for ionosphere phase screen computation	
/science/SSAR/GUNW/metadata/processingInformation/algorithms/ionosphereEstimation/unwrappingErrorCorrection	
Type: string	**Shape: scalar**
Description: Algorithm correcting unwrapping errors in sub-band unwrapped interferograms	
/science/SSAR/GUNW/metadata/processingInformation/algorithms/geocoding/demInterpolation	
Type: string	**Shape: scalar**
Description: DEM interpolation algorithm	
/science/SSAR/GUNW/metadata/processingInformation/algorithms/geocoding/floatingGeocodingInterpolation	
Type: string	**Shape: scalar**
Description: Geocoding interpolation algorithm for floating point datasets	
/science/SSAR/GUNW/metadata/processingInformation/algorithms/geocoding/integerGeocodingInterpolation	
Type: string	**Shape: scalar**
Description: Geocoding interpolation algorithm for integer datasets	
/science/SSAR/GUNW/metadata/processingInformation/algorithms/geocoding/complexGeocodingInterpolation	
Type: string	**Shape: scalar**
Description: Geocoding interpolation algorithm for complex-valued datasets	
/science/SSAR/GUNW/metadata/processingInformation/inputs/l1ReferenceSlcGranules	
Type: string	**Shape: (numberOfInputL1Files)**
Description: List of input reference L1 RSLC products used	
/science/SSAR/GUNW/metadata/processingInformation/inputs/l1SecondarySlcGranules	
Type: string	**Shape: (numberOfInputL1Files)**
Description: List of input secondary L1 RSLC products used	

/science/SSAR/GUNW/metadata/processingInformation/inputs/orbitFiles	
Type: string	**Shape: (numberOfInputOrbitFiles)**
Description: List of input orbit files used	
/science/SSAR/GUNW/metadata/processingInformation/inputs/configFiles	
Type: string	**Shape: (numberOfInputConfigFiles)**
Description: List of input config files used	
/science/SSAR/GUNW/metadata/processingInformation/inputs/demSource	
Type: string	**Shape: scalar**
Description: Description of the input digital elevation model (DEM)	

10.4.5 Other Radar Metadata

Radar metadata-related variables		
/science/SSAR/GUNW/metadata/orbit/temporalBaseline		
Type: UInt16	**Shape: scalar**	
Description: Time interval between reference and secondary RSLCs		
	units	days
/science/SSAR/GUNW/metadata/orbit/reference/interpMethod		
Type: string	**Shape: scalar**	
Description: Orbit interpolation method, either "Hermite" or "Legendre"		
/science/SSAR/GUNW/metadata/orbit/reference/time		
Type: Float64	**Shape: (orbitListLength)**	
Description: Time vector record. This record contains the time since UTC epoch corresponding to position and velocity records		
	units	seconds since YYYY-mm-ddTHH:MM:SS
/science/SSAR/GUNW/metadata/orbit/reference/position		
Type: Float64	**Shape: (orbitListLength, tripletxyz)**	
Description: Position vector record. This record contains the platform position data with respect to WGS84 G1762 reference frame		
	units	meter
/science/SSAR/GUNW/metadata/orbit/reference/velocity		
Type: Float64	**Shape: (orbitListLength, tripletxyz)**	
Description: Velocity vector record. This record contains the platform velocity data with respect to WGS84 G1762 reference frame		
	units	meters / second
/science/SSAR/GUNW/metadata/orbit/reference/orbitType		
Type: string	**Shape: scalar**	
Description: Orbit product type, either "FOE", "NOE", "MOE", "POE", or "Custom", where "FOE" stands for Forecast Orbit Ephemeris, "NOE" is Near real-time Orbit Ephemeris, "MOE" is Medium precision Orbit Ephemeris, and "POE" is Precise Orbit Ephemeris		
/science/SSAR/GUNW/metadata/orbit/secondary/interpMethod		
Type: string	**Shape: scalar**	
Description: Orbit interpolation method, either "Hermite" or "Legendre"		
/science/SSAR/GUNW/metadata/orbit/secondary/time		
Type: Float64	**Shape: (orbitListLength)**	
Description: Time vector record. This record contains the time since UTC epoch corresponding to position and velocity records		
	units	seconds since YYYY-mm-ddTHH:MM:SS
/science/SSAR/GUNW/metadata/orbit/secondary/position		
Type: Float64	**Shape: (orbitListLength, tripletxyz)**	
Description: Position vector record. This record contains the platform position data with respect to WGS84 G1762 reference frame		
	units	meters
/science/SSAR/GUNW/metadata/orbit/secondary/velocity		

Type: Float64	**Shape: (orbitListLength, tripletxyz)**	
Description: Velocity vector record. This record contains the platform velocity data with respect to WGS84 G1762 reference frame		
	units	meters / second
/science/SSAR/GUNW/metadata/orbit/secondary/orbitType		
Type: string	**Shape: scalar**	
Description: Orbit product type, either "FOE", "NOE", "MOE", "POE", or "Custom", where "FOE" stands for Forecast Orbit Ephemeris, "NOE" is Near real-time Orbit Ephemeris, "MOE" is Medium precision Orbit Ephemeris, and "POE" is Precise Orbit Ephemeris		
/science/SSAR/GUNW/metadata/attitude/reference/time		
Type: Float64	**Shape: (attitudeListLength)**	
Description: Time vector record. This record contains the time since UTC epoch corresponding to attitude and quaternion records		
	units	seconds since YYYY-mm-ddTHH:MM:SS
/science/SSAR/GUNW/metadata/attitude/reference/quaternions		
Type: Float64	**Shape: (attitudeListLength, quaternions)**	
Description: Attitude quaternions (q0, q1, q2, q3)		
	units	1
/science/SSAR/GUNW/metadata/attitude/reference/eulerAngles		
Type: Float64	**Shape: (attitudeListLength, tripletxyz)**	
Description: Attitude Euler angles (roll, pitch, yaw)		
	units	degree
/science/SSAR/GUNW/metadata/attitude/reference/attitudeType		
Type: string	**Shape: scalar**	
Description: Attitude type, either "FRP", "NRP", "PRP, or "Custom", where "FRP" stands for Forecast Radar Pointing, "NRP" is Near Real-time Pointing, and "PRP" is Precise Radar Pointing		
/science/SSAR/GUNW/metadata/attitude/secondary/time		
Type: Float64	**Shape: (attitudeListLength)**	
Description: Time vector record. This record contains the time since UTC epoch corresponding to attitude and quaternion records		
	units	seconds since YYYY-mm-ddTHH:MM:SS
/science/SSAR/GUNW/metadata/attitude/secondary/quaternions		
Type: Float64	**Shape: (attitudeListLength, quaternions)**	
Description: Attitude quaternions (q0, q1, q2, q3)		
	units	1
/science/SSAR/GUNW/metadata/attitude/secondary/eulerAngles		
Type: Float64	**Shape: (attitudeListLength, tripletxyz)**	
Description: Attitude Euler angles (roll, pitch, yaw)		
	units	degree
/science/SSAR/GUNW/metadata/attitude/secondary/attitudeType		
Type: string	**Shape: scalar**	
Description: Attitude type, either "FRP", "NRP", "PRP, or "Custom", where "FRP" stands for Forecast Radar Pointing, "NRP" is Near Real-time Pointing, and "PRP" is Precise Radar Pointing		

10.4.6 Radar Grid

Metadata cube-related variables		
/science/SSAR/GUNW/metadata/radarGrid/referenceSlantRange		
Type: Float64	**Shape: (radarCubeHeight, radarCubeLength, radarCubeWidth)**	
Description: Slant range of the reference RSLC in meters		
	_FillValue	nan
	grid_mapping	projection
	long_name	Slant range
	units	meters

	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GUNW/metadata/radarGrid/hydrostaticTroposphericPhaseScreen		
Type: Float64	**Shape: (radarCubeHeight, radarCubeLength, radarCubeWidth)**	
Description: Hydrostatic component of the troposphere phase screen		
	units	radian
	_FillValue	nan
	grid_mapping	projection
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GUNW/metadata/radarGrid/wetTroposphericPhaseScreen		
Type: Float64	**Shape: (radarCubeHeight, radarCubeLength, radarCubeWidth)**	
Description: Wet component of the troposphere phase screen		
	units	radian
	_FillValue	nan
	grid_mapping	projection
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GUNW/metadata/radarGrid/slantRangeSolidEarthTidesPhase		
Type: Float64	**Shape: (radarCubeHeight, radarCubeLength, radarCubeWidth)**	
Description: Solid Earth tides phase along slant range direction		
	units	radian
	_FillValue	nan
	grid_mapping	projection
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GUNW/metadata/radarGrid/alongTrackSolidEarthTidesPhase		
Type: Float64	**Shape: (radarCubeHeight, radarCubeLength, radarCubeWidth)**	
Description: Solid Earth tides phase in along-track direction		
	units	radians
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GUNW/metadata/radarGrid/referenceZeroDopplerAzimuthTime		
Type: Float64	**Shape: (radarCubeHeight, radarCubeLength, radarCubeWidth)**	
Description: Zero Doppler azimuth time in seconds		
	units	seconds since YYYY-mm-ddTHH:MM:SS
	_FillValue	nan
	grid_mapping	projection
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction

	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GUNW/metadata/radarGrid/incidenceAngle		
Type: Float32	**Shape: (radarCubeHeight, radarCubeLength, radarCubeWidth)**	
Description: Incidence angle is defined as the angle between the LOS vector and the normal to the ellipsoid at the target height		
	valid_max	90.0
	valid_min	0.0
	_FillValue	nan
	grid_mapping	projection
	long_name	Incidence angle
	units	degree
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GUNW/metadata/radarGrid/losUnitVectorX		
Type: Float32	**Shape: (radarCubeHeight, radarCubeLength, radarCubeWidth)**	
Description: East component of unit vector of LOS from target to sensor		
	valid_max	1.0
	valid_min	-1.0
	_FillValue	nan
	grid_mapping	projection
	long_name	LOS unit vector X
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
	units	1
/science/SSAR/GUNW/metadata/radarGrid/losUnitVectorY		
Type: Float32	**Shape: (radarCubeHeight, radarCubeLength, radarCubeWidth)**	
Description: North component of unit vector of LOS from target to sensor		
	valid_max	1.0
	valid_min	-1.0
	_FillValue	nan
	grid_mapping	projection
	long_name	LOS unit vector Y
	units	1
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GUNW/metadata/radarGrid/alongTrackUnitVectorX		
Type: Float32	**Shape: (radarCubeHeight, radarCubeLength, radarCubeWidth)**	
Description: East component of unit vector along ground track		
	valid_max	1.0
	valid_min	-1.0
	_FillValue	nan
	grid_mapping	projection
	long_name	Along-track unit vector X

	units	1
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GUNW/metadata/radarGrid/alongTrackUnitVectorY		
Type: Float32	**Shape: (radarCubeHeight, radarCubeLength, radarCubeWidth)**	
Description: North component of unit vector along ground track		
	valid_max	1.0
	valid_min	-1.0
	_FillValue	nan
	grid_mapping	projection
	long_name	Along-track unit vector Y
	units	1
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GUNW/metadata/radarGrid/elevationAngle		
Type: Float32	**Shape: (radarCubeHeight, radarCubeLength, radarCubeWidth)**	
Description: Elevation angle is defined as the angle between the LOS vector and the normal to the ellipsoid at the sensor		
	valid_max	90.0
	valid_min	0.0
	_FillValue	nan
	grid_mapping	projection
	long_name	Elevation angle
	units	degree
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GUNW/metadata/radarGrid/groundTrackVelocity		
Type: Float64	**Shape: (radarCubeHeight,radarCubeLength, radarCubeWidth)**	
Description: Absolute value of the platform velocity scaled at the target height		
	_FillValue	nan
	grid_mapping	projection
	long_name	Ground-track velocity
	units	meters / second
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GUNW/metadata/radarGrid/secondaryZeroDopplerAzimuthTime		
Type: Float64	**Shape: (radarCubeHeight, radarCubeLength, radarCubeWidth)**	
Description: Zero Doppler azimuth time of corresponding pixel in secondary image		
	units	seconds since YYYY-mm-ddTHH:MM:SS
	_FillValue	nan
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction

	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GUNW/metadata/radarGrid/secondarySlantRange		
Type: Float64	**Shape: (radarCubeHeight, radarCubeLength, radarCubeWidth)**	
Description: Slant range of corresponding pixel in secondary image		
	units	meters
	_FillValue	nan
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GUNW/metadata/radarGrid/parallelBaseline		
Type: Float32	**Shape: (radarCubeHeight, radarCubeLength, radarCubeWidth)**	
Description: Parallel component of the InSAR baseline		
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points
	units	meters
	_FillValue	nan
	long_name	Parallel baseline
	grid_mapping	projection
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GUNW/metadata/radarGrid/perpendicularBaseline		
Type: Float32	**Shape: (radarCubeHeight, radarCubeLength, radarCubeWeight)**	
Description: Perpendicular component of the InSAR baseline		
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points
	units	meters
	_FillValue	nan
	grid_mapping	projection
	long_name	Perpendicular baseline
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GUNW/metadata/radarGrid/xCoordinates		
Type: Float64	**Shape: (radarCubeWidth)**	
Description: X coordinates in specified projection		
	units	meters
	long_name	projection_x_coordinate
	standard_name	X coordinates of projection
/science/SSAR/GUNW/metadata/radarGrid/yCoordinates		
Type: Float64	**Shape: (radarCubeLength)**	
Description: Y coordinates in specified projection		
	units	meters

	long_name	projection_y_coordinate
	standard_name	Y coordinates of projection
/science/SSAR/GUNW/metadata/radarGrid/heightAboveEllipsoid		
Type: Float64	**Shape: (radarCubeHeight)**	
Description: Height values above WGS84 Ellipsoid corresponding to the radar grid		
	standard_name	height_above_reference_ellipsoid
	units	meters
/science/SSAR/GUNW/metadata/radarGrid/projection		
Type: UInt32	**Shape: scalar**	
Description: Product map grid projection: EPSG code, with additional projection information as HDF5 Attributes		
	ellipsoid	Projection ellipsoid
	epsg_code	Projection EPSG code
	false_easting	The value added to all abscissa values in the rectangular coordinates for a map projection.
	false_northing	The value added to all ordinate values in the rectangular coordinates for a map projection.
	grid_mapping_name	Grid mapping variable name
	inverse_flattening	Inverse flattening of the ellipsoidal figure
	latitude_of_projection_origin	The latitude chosen as the origin of rectangular coordinates for a map projection.
	longitude_of_projection_origin	The longitude, with respect to Greenwich, of the prime meridian associated with the geodetic datum.
	semi_major_axis	Semi-major axis
	spatial_ref	Spatial reference
	utm_zone_number	UTM zone number
	longitude_of_central_meridian	The line of longitude at the center of a map projection generally used as the basis for constructing the projection.
	scale_factor_at_central_meridian	A multiplier for reducing a distance obtained from a map by computation or scaling to the actual distance along the central meridian.

10.4.7 Radar Grid True Height (Available Only in ISRO Generated Products)

Radar grid at true height is at a finer spacing as compared to the radar grid documented in section 10.4.6.

Metadata cube-related variables		
/science/SSAR/GUNW/metadata/radarGridTrueHeight/referenceSlantRange		
Type: Float64	**Shape: (radarCubeHeightTrueHeight, radarCubeLengthTrueHeight, radarCubeWidthTrueHeight)**	
Description: Slant range of the reference RSLC in meters		
	_FillValue	nan
	grid_mapping	projection
	long_name	Slant range
	units	meters
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GUNW/metadata/radarGridTrueHeight/hydrostaticTroposphericPhaseScreen		
Type: Float64	**Shape: (radarCubeHeightTrueHeight, radarCubeLengthTrueHeight, radarCubeWidthTrueHeight)**	

Description: Hydrostatic component of the troposphere phase screen		
	units	radian
	_FillValue	nan
	grid_mapping	projection
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GUNW/metadata/radarGridTrueHeight/wetTroposphericPhaseScreen		
Type: Float64	**Shape: (radarCubeHeightTrueHeight, radarCubeLengthTrueHeight, radarCubeWidthTrueHeight)**	
Description: Wet component of the troposphere phase screen		
	units	radian
	_FillValue	nan
	grid_mapping	projection
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GUNW/metadata/radarGridTrueHeight/slantRangeSolidEarthTidesPhase		
Type: Float64	**Shape: (radarCubeHeightTrueHeight, radarCubeLengthTrueHeight, radarCubeWidthTrueHeight)**	
Description: Solid Earth tides phase along slant range direction		
	units	radian
	_FillValue	nan
	grid_mapping	projection
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GUNW/metadata/radarGridTrueHeight/alongTrackSolidEarthTidesPhase		
Type: Float64	**Shape: (radarCubeHeightTrueHeight, radarCubeLengthTrueHeight, radarCubeWidthTrueHeight)**	
Description: Solid Earth tides phase in along-track direction		
	units	radian
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GUNW/metadata/radarGridTrueHeight/referenceZeroDopplerAzimuthTime		
Type: Float64	**Shape: (radarCubeHeightTrueHeight, radarCubeLengthTrueHeight, radarCubeWidthTrueHeight)**	
Description: Zero Doppler azimuth time in seconds		
	units	seconds since YYYY-mm-ddTHH:MM:SS
	_FillValue	nan
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GUNW/metadata/radarGridTrueHeight/incidenceAngle		

Type: Float32	**Shape: (radarCubeHeightTrueHeight, radarCubeLengthTrueHeight, radarCubeWidthTrueHeight)**	
Description: Incidence angle is defined as the angle between the LOS vector and the normal to the ellipsoid at the target height		
	valid_max	90.0
	valid_min	0.0
	_FillValue	nan
	grid_mapping	projection
	long_name	Incidence angle
	units	degree
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GUNW/metadata/radarGridTrueHeight/losUnitVectorX		
Type: Float32	**Shape: (radarCubeHeightTrueHeight, radarCubeLengthTrueHeight, radarCubeWidthTrueHeight)**	
Description: East component of unit vector of LOS from target to sensor		
	valid_max	1.0
	valid_min	-1.0
	_FillValue	nan
	grid_mapping	projection
	long_name	LOS unit vector X
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
	units	1
/science/SSAR/GUNW/metadata/radarGridTrueHeight/losUnitVectorY		
Type: Float32	**Shape: (radarCubeHeightTrueHeight, radarCubeLengthTrueHeight, radarCubeWidthTrueHeight)**	
Description: North component of unit vector of LOS from target to sensor		
	valid_max	1.0
	valid_min	-1.0
	_FillValue	nan
	grid_mapping	projection
	long_name	LOS unit vector Y
	units	1
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GUNW/metadata/radarGridTrueHeight/alongTrackUnitVectorX		
Type: Float32	**Shape: (radarCubeHeightTrueHeight, radarCubeLengthTrueHeight, radarCubeWidthTrueHeight)**	
Description: East component of unit vector along ground track		
	valid_max	1.0
	valid_min	-1.0
	_FillValue	nan
	grid_mapping	projection
	long_name	Along-track unit vector X

	units	1
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GUNW/metadata/radarGridTrueHeight/alongTrackUnitVectorY		
Type: Float32	**Shape: (radarCubeHeightTrueHeight, radarCubeLengthTrueHeight, radarCubeWidthTrueHeight)**	
Description: North component of unit vector along ground track		
	valid_max	1.0
	valid_min	-1.0
	_FillValue	nan
	grid_mapping	projection
	long_name	Along-track unit vector Y
	units	1
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GUNW/metadata/radarGridTrueHeight/elevationAngle		
Type: Float32	**Shape: (radarCubeHeightTrueHeight, radarCubeLengthTrueHeight, radarCubeWidthTrueHeight)**	
Description: Elevation angle is defined as the angle between the LOS vector and the normal to the ellipsoid at the sensor		
	valid_max	90.0
	valid_min	0.0
	_FillValue	nan
	grid_mapping	projection
	long_name	Elevation angle
	units	degree
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GUNW/metadata/radarGridTrueHeight/groundTrackVelocity		
Type: Float64	**Shape: (radarCubeHeightTrueHeight,radarCubeLengthTrueHeight, radarCubeWidthTrueHeight)**	
Description: Absolute value of the platform velocity scaled at the target height		
	_FillValue	nan
	grid_mapping	projection
	long_name	Ground-track velocity
	units	meters / second
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GUNW/metadata/radarGridTrueHeight/secondaryZeroDopplerAzimuthTime		
Type: Float64	**Shape: (radarCubeHeightTrueHeight, radarCubeLengthTrueHeight, radarCubeWidthTrueHeight)**	
Description: Zero Doppler azimuth time of corresponding pixel in secondary image		
	units	seconds since YYYY-mm-ddTHH:MM:SS

	_FillValue	nan
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GUNW/metadata/radarGridTrueHeight/secondarySlantRange		
Type: Float64	**Shape: (radarCubeHeightTrueHeight, radarCubeLengthTrueHeight, radarCubeWidthTrueHeight)**	
Description: Slant range of corresponding pixel in secondary image		
	units	meters
	_FillValue	nan
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GUNW/metadata/radarGridTrueHeight/parallelBaseline		
Type: Float32	**Shape: (radarCubeHeightTrueHeight, radarCubeLengthTrueHeight, radarCubeWidthTrueHeight)**	
Description: Parallel component of the InSAR baseline		
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points
	units	meters
	_FillValue	nan
	long_name	Parallel baseline
	grid_mapping	projection
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GUNW/metadata/radarGridTrueHeight/perpendicularBaseline		
Type: Float32	**Shape: (radarCubeHeightTrueHeight, radarCubeLengthTrueHeight, radarCubeWidthTrueHeight)**	
Description: Perpendicular component of the InSAR baseline		
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points
	units	meters
	_FillValue	nan
	long_name	Perpendicular baseline
	grid_mapping	projection
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GUNW/metadata/radarGridTrueHeight/xCoordinates		
Type: Float64	**Shape: (radarCubeWidthTrueHeight)**	
Description: X coordinates in specified projection		
	units	meters

	long_name	X coordinates of projection
	standard_name	projection_x_coordinate
/science/SSAR/GUNW/metadata/radarGridTrueHeight/yCoordinates		
Type: Float64	**Shape: (radarCubeLengthTrueHeight)**	
Description: Y coordinates in specified projection		
	units	meters
	long_name	Y coordinates of projection
	standard_name	projection_y_coordinate
/science/SSAR/GUNW/metadata/radarGridTrueHeight/projection		
Type: UInt32	**Shape: scalar**	
Description: Product map grid projection: EPSG code, with additional projection information as HDF5 Attributes		
	ellipsoid	Projection ellipsoid
	epsg_code	Projection EPSG code
	false_easting	The value added to all abscissa values in the rectangular coordinates for a map projection.
	false_northing	The value added to all ordinate values in the rectangular coordinates for a map projection.
	grid_mapping_name	Grid mapping variable name
	inverse_flattening	Inverse flattening of the ellipsoidal figure
	latitude_of_projection_origin	The latitude chosen as the origin of rectangular coordinates for a map projection.
	longitude_of_projection_origin	The longitude, with respect to Greenwich, of the prime meridian associated with the geodetic datum.
	semi_major_axis	Semi-major axis
	spatial_ref	Spatial reference
	utm_zone_number	UTM zone number
	longitude_of_central_meridian	The line of longitude at the center of a map projection generally used as the basis for constructing the projection.
	scale_factor_at_central_meridian	A multiplier for reducing a distance obtained from a map by computation or scaling to the actual distance along the central meridian.

CHAPTER-11

Range Doppler Pixel Offsets (ROFF) Data Product

11 Range Doppler Pixel Offsets (ROFF) Data Product

ROFF product is defined as unfiltered and un-culled layers of pixel offsets in Range Doppler coordinates with different resolutions obtained from incoherent speckle tracking. It is generated with nearest pair in time copol and circular pol channels only. The ROFF product is primarily meant for cryosphere applications, and it is only generated for acquisitions over Antarctica, Greenland, and selected mountain glaciers and for certain bandwidth combinations. Table 11-1 summarizes the combination of Bandwidth (BW) and area for which ROFF product is generated for L & S Band.

Band	BW (MHz)	Antartica /Greenland (Ice sheets) [IS]	Mountain Glaciers (MG)
S	10	-	-
	25	ROFF	ROFF
	37.5	ROFF	ROFF
	75	-	-
L	5	-	-
	20	-	ROFF
	40	ROFF	ROFF
	77	ROFF	-

Table 11-1 ROFF product generation for BW and Area combination

11.1 ROFF Overview

The ROFF product contains a collection of dense pixel offsets layers obtained from applying incoherent cross-correlation on a pair of coarsely coregistered Level-1 Range Doppler Single Look Complex (RSLC) products in the Range-Doppler geometry of the earlier (i.e., "reference") RSLC product. The pair of RSLCs used to produce ROFF is first coarsely aligned with geometrical coregistration using the best available sensor orbit ephemeris and a Digital Elevation Model (DEM).

The spacing, the window size, and the search radius used to generate the ROFF offsets layers for differerent Bandwidths of L & S Band and Area of observation(Antartic/Greenland (Ice Sheets) or Mountain Glaciers) is summarized from Table 11-2 to Table 11-9. The IL stands for incoherent speckle tracking layer.

Irrespective of the mode, the pixel offsets layers are provided with a nominal posting of 90 m on the ground. It is assumed that pixel offsets layers within ROFF share the same spacing and the same starting pixel along slant range and azimuth directions. Each pixel offset layer is distributed without performing any conventional post-processing operation i.e., layers might contain offset outliers, and are not low-pass filtered to reduce noise in the data. The three offset layers provided in the product can be blended into a single offset layer too, as described in Annexures-5: Offset Layer Blending Methodology.

Layer	Range Bandwidth (MHz)	Sample spacing in slant range (pixels)	Sample spacing in along-track (pixels)	Window size in slant-range (pixels)	Window size in along-track (pixels)	Search radius in slant range (pixels)	Search radius in along-track (pixels)
IL1_80IS	80	30	15	64	32	64	33
IL2_80IS	80	30	15	96	64	64	33
IL3_80IS	80	30	15	196	128	8	8

Table 11-2 L-Band Pixel offset layers: 80 MHz, Antarctica, and Greenland. (IS)

Layer	Range Bandwidth (MHz)	Sample spacing in slant range (pixels)	Sample spacing in along-track (pixels)	Window size in slant range(pixels)	Window size in alongtrack (pixels)	Search radius in slant range (pixels)	Search radius in along-track (pixels)
IL1_40IS	40	15	15	32	32	8	8
IL2_40IS	40	15	15	64	64	8	8
IL3_40IS	40	15	15	128	128	8	8

Table 11-3 L-Band Pixel offset layers: 40 MHz, Antarctica, and Greenland. (IS)

Layer	Range Bandwidth (MHz)	Sample spacing in slant range (pixels)	Sample spacing along-track (pixels)	Window size in slant range (pixels)	Window size in alongtrack (pixels)	Search radius in slant range (pixels)	Search radius in along-track (pixels)
IL1_20MG	20	8	15	32	32	16	32
IL2_20MG	20	8	15	32	64	16	32
IL3_20MG	20	8	15	64	128	16	32

Table 11-4 L-Band Pixel offset layers: 20 MHz, Mountain Glaciers. (MG)

Layer	Range Bandwidth (MHz)	Sample spacing in slant range (pixels)	Sample spacing along-track (pixels)	Window size in slant range (pixels)	Window size in alongtrack (pixels)	Search radius in slant range (pixels)	Search radius in along-track (pixels)
IL1_40MG	40	15	15	32	32	32	32
IL2_40MG	40	15	15	64	64	32	32
IL3_40MG	40	15	15	128	128	32	32

Table 11-5 L-Band Pixel offset layers: 40 MHz, Mountain Glaciers. (MG)

Layer	Range Bandwidth (MHz)	Sample spacing in slant range (pixels)	Sample spacing in along-track (pixels)	Window size in slant-range (pixels)	Window size in along-track (pixels)	Search radius in slant range (pixels)	Search radius in along-track (pixels)
IL1_25IS	25	8	15	32	32	8	16
IL2_25IS	25	8	15	32	64	8	16
IL3_25IS	25	8	15	64	128	8	16

Table 11-6 S-Band Pixel offset layers: 25 MHz, Antarctica, and Greenland. (IS)

Layer	Range Bandwidth (MHz)	Sample spacing in slant range (pixels)	Sample spacing in along-track (pixels)	Window size in slant range(pixels)	Window size in alongtrack (pixels)	Search radius in slant range (pixels)	Search radius in along-track (pixels)
IL1_37IS	37.5	12	15	32	32	8	8
IL2_37IS	37.5	12	15	64	64	8	8
IL3_37IS	37.5	12	15	128	128	8	8

Table 11-7 S-Band Pixel offset layers: 37.5 MHz, Antarctica, and Greenland. (IS)

Layer	Range Bandwidth (MHz)	Sample spacing in slant range (pixels)	Sample spacing along-track (pixels)	Window size in slant range (pixels)	Window size in alongtrack (pixels)	Search radius in slant range (pixels)	Search radius in along-track (pixels)
IL1_25MG	25	8	15	32	32	16	32
IL2_25MG	25	8	15	32	64	16	32
IL3_25MG	25	8	15	64	128	16	32

Table 11-8 S-Band Pixel offset layers: 25 MHz, Mountain Glaciers. (MG)

Layer	Range Bandwidth (MHz)	Sample spacing in slant range (pixels)	Sample spacing along-track (pixels)	Window size in slant range (pixels)	Window size in alongtrack (pixels)	Search radius in slant range (pixels)	Search radius in along-track (pixels)
IL1_37MG	37.5	12	15	32	32	32	32
IL2_37MG	37.5	12	15	64	64	32	32
IL3_37MG	37.5	12	15	128	128	32	32

Table 11-9 S-Band Pixel offset layers: 37.5 MHz, Mountain Glaciers. (MG)

11.2 ROFF Product Organization

11.2.1 Granule Definition

NISAR ROFF granules will conform to the Tiling Scheme being developed for the mission and are expected to have a ground footprint of 240 km x 240 km. (except in L-Band for 77 MHz data, which cover half of the swath in range direction).

11.2.2 File Naming Convention

NISAR GCOV Granule names will conform to the SDS L-SAR Product File Naming Conventions as discussed in section 2.2.2.

11.2.3 Temporal Organization

The ROFF data are arranged on a uniformly spaced, increasing Zero-Doppler azimuth time grid. Using row-major order convention of representing 2D raster arrays, Zero-Doppler azimuth time is represented by the row direction or the slowest changing dimension.

11.2.4 Spatial Organization

The ROFF data are arranged on a uniformly spaced, increasing Zero-Doppler azimuth time in the row direction and increasing slant range grid in the column direction following the row-major order convention of representing 2D raster arrays.

11.2.5 Spatial Sampling and Resolution

NISAR mission uses a non-uniformly spaced sequence of pulses in SweepSAR mode to collect radar data, to overcome the limitations imposed by transmit gaps affecting the wide imaging swath. Processing software accounts for the nonuniform sampling to generate the final ROFF product on a uniform grid. Some salient features of the output grid for the ROFF product are:

1) The center of the top-left pixel will correspond to the same Zero-Doppler azimuth time and slant range for all imagery layers in an S/L-SAR ROFF product.

2) The main imaging band ("frequency") is spatially averaged to the same posting, irrespective of the imaging mode Table 11-2 to Table 11-9. This allows for spatial mosaicking operations across instrument mode changes.

11.2.5.1 Along Track Mosaicking

The spatial sampling of the output grid has also been designed to facilitate along-track mosaicking of contiguous ROFF product granules if the user desires. The following features simplify the implementation of along-track mosaicking

1) The slow time sampling frequency (inverse of the zero Doppler time spacing between consecutive lines) will be chosen to be an integer, to allow synchronization between adjacent granules at integer second boundaries without the need for resampling in the azimuth time direction.

2) The slant range to the first pixel will be a multiple of the lowest sampling frequency (corresponding to 5MHz) to enable concatenation of adjacent granules with simple integer shifts of imagery in the slant range direction.

Currently, it is not possible to mosaic products generated using data acquired with different bandwidths (different wavelengths) in the along-track direction.

11.2.5.2 Partially compressed SLC data

Partially compressed data in RSLC files will not be used to produce ROFF products. Spatially averaged pixels with any partially compressed or missing data in SLCs will be set to the value specified by _FillValue attribute.

11.3 ROFF Product Description

In this section, we briefly describe the layout of ROFF data and associated metadata within the NISAR HDF5 file. Detailed description of Group and Dataset names can be found in section 11.4. In this section, we focus on the organization of S-SAR instrument data within the file under the Group name "/science/SSAR". The same product description will hold true for L-Band products too.

11.3.1 Shapes and Dimensions of Data

Information on the shapes and dimensions of the data items in various data tables are described as part of the metadata. This information is useful both as part of the product identification and for setting up further processing, i.e., dimensioning arrays.

11.3.2 Product Identification

Information needed to identify this product is given under the Group

"/science/SSAR/identification". This includes information such as orbit number, cycle number, track-frame number, acquisition times, a polygon representing the bounding box of the included imagery in geographic coordinates, product version, and product specification version (i.e., the version number of this document).

11.3.3 Radar Imagery

The ROFF product's imagery layers and associated datasets are initially organized based on the center frequency within the Group "/science/SSAR/ROFF/swaths/frequencyA/". For L-Band, only the main NISAR imaging band ("frequencyA") will be processed for ROFF products. The pixel offset layers and associated datasets are situated under the group

"/science/SSAR/ROFF/swaths/frequencyA/pixelOffsets/". This group is further organized by polarization (TxRx). For example, the Pixel Offsets Group could contain the Group "/science/SSAR/ROFF/swaths/frequencyA/pixelOffsets/HH/". Each polarization Group is further organized in distinct Groups, one for each generated offset layer, and by a final grouping. These Pixel Offset Layers Groups are assigned monotonically increasing numbers, where the minimum index number (i.e., "layer1") contains the pixel offset layers and associated datasets at the finest resolution while the maximum index number (i.e., "layer3") contains the offset layers and associated datasets at the coarsest resolution. As an example, the Dataset "/science/SSAR/ROFF/swaths/frequencyA/pixelOffsets/HH/layer1/slantRangeOffset" corresponds to the slant range sub-pixel offset estimate at the finest resolution derived from the "frequencyA" and "HH" polarization imagery layers within the reference and secondary input RSLCs.

The same description holds true for all polarization channels present in the product and the same convention holds true for L-Band products.

11.3.4 Radar Metadata

The Group "/science/SSAR/ROFF/metadata/" includes a list of miscellaneous metadata needed to interpret the geolocation and the imagery (e.g., layers of slant range and along-track pixel offsets) included in the ROFF product.

11.3.4.1 Processing Information

The Group "/science/SSAR/ROFF/metadata/processingInformation/" includes the processing parameters, algorithms, and the inputs granules and files used to produce ROFF. For a complete description of this group, refer to section 11.4.4.

11.3.4.2 Parameters

The Group "/science/SSAR/ROFF/metadata/processingInformation/parameters"

is further organized in four Groups:

1) *reference*: including the effective velocity and the reference terrain height of the reference RSLC. This subgroup is further organized by frequency and includes some relevant parameters of the reference RSLC such as the slant range and zero Doppler time, the slant range and the azimuth bandwidth, the azimuth FM rate, and the Doppler centroid

2) *secondary*: this subgroup follows the same organization of *reference* but includes the corresponding metadata for the secondary RSLC

3) *common*: organized by frequency, and including the parameters derived by combining the information from the reference and secondary RSLC such as common Doppler Centroid and the common Doppler bandwidth

4) *pixelOffsets*: including the parameters used to generate the individual layers of dense pixel offsets in the radar geometry. This group is further organized by frequency. The subgroup *frequencyA* contains the offsets parameter common to each layer of offsets i.e., the offset spacings in slant range and along-track direction, the correlation surface oversampling factor. The offsets parameters specific for each offset layer are further organized in the *layer* subgroups. Each *layer* subgroup contains the along-track and slant range window and search window sizes used to generate the pixel offsets for that specific layer

The Group *parameters* also contains the Dataset *runConfigurationContents* which includes a copy of the run configuration file used for processing populated with all the processing options, parameter values, and input files.

11.3.4.3 Algorithms

The Group algorithms "/science/SSAR/ROFF/metadata/processingInformation/algorithms/" includes the name and the version of the software used to generate the product. The Group is further organized by distinct Groups identifying the processing steps used to generate the ROFF product:

1) *coregistration*: including the algorithms used to perform the coarse and fine coregistration of the reference and secondary RSLCs (e.g., geometry coregistration, cross-correlation algorithm).

2) *crossCorrelation*: further organized by offset layer and including the cross-correlation algorithm used to generate each individual layer of pixel offset.

11.3.4.4 Input Files

The Group inputs "/science/SSAR/ROFF/metadata/processingInformation/inputs/" includes the filenames of the input RSLC granules, configuration files, orbit files, and a description of the DEM used for processing.

11.3.5 Other Radar Metadata

11.3.5.1 Orbit

The reference RSLC orbit ephemeris used for generating the ROFF product is provided under the Group "/science/SSAR/ROFF/metadata/orbit/" and further detailed in section 11.4.5. This Group includes time-tagged antenna phase center position and velocity vectors in Earth Centered Earth Fixed (ECEF) cartesian coordinates and information on the used orbit fidelity.

11.3.5.2 Attitude

The attitude state vectors of the reference RSLC used for generating the ROFF product can be found under the Group "/science/SSAR/ROFF/metadata/attitude/". This Group includes time-tagged quaternions and Euler angles representing the slant range plane from the antenna phase center in an ECEF Cartesian system.

11.3.6 Geolocation Grid

The Group "/science/SSAR/ROFF/metadata/geolocationGrid/" contains information on the radar geometry of the reference RSLC. The Datasets within this Group (i.e., the geolocation grid cubes) are referenced over the radar-grid which is defined by the coordinate vectors "slantRange", "zeroDopplerTime", and "heightAboveEllipsoid". Normals are with respect to the WGS84 ellipsoid.

The "geolocationGrid" Group also include the Datasets:

1) "coordinateX" and "coordinateY" containing the mapping of the zero-Doppler grid to the geographic grid in the units defined by the Dataset "epsg" within the same Group

2) "losUnitVectorX" and "losUnitVectorY" identifying the East and North components of the Line-Of-Sight (LOS) unit vector (i.e., the vector from the target to the sensor) in the East-North-Up (ENU) coordinate system for each point of the geographic grid. The Up component of the LOS unit vector can be simply derived from the East and North components as:

$$losUnitVectorZ = \sqrt{1 - losUnitVectorX^2 - losUnitVectorY^2}$$

3) "alongTrackUnitVectorX" and "alongTrackUnitVectorY" containing the East and North components of the along-track unit vector (i.e., the projection of the along-track vector at the ground height) in ENU coordinate.

4) "incidenceAngle" containing the incidence angle, i.e., the angle between the LOS vector and the normal to the ellipsoid at the target height

5) "elevationAngle" containing the elevation angle i.e., the angle between the LOS vector and the normal to the ellipsoid at the sensor

6) "groundTrackVelocity" containing the ground track velocity i.e., the absolute value of the platform velocity scaled at the target height

7) "perpendicularBaseline" and "parallelBaseline" containing the perpendicular and parallel component of the baseline between the reference and secondary RSLCs.

The details of the usage of metadata cube are given in

Annexure-2: Metadata Cube.

In ISRO generated L and S Band products, a separate layer is defined in a separate sub-group for all these parameters at true height:

"/science/SSAR/RSLC/metadata/geolocationGridTrueHeight/".

In this group all the parameters of metadata will be generated at true height (meaning they will be generated at actual height of terrain) and will be a part of the product. This layer will be at a finer sampling than the actual meta data cube layers. The number of dimensions, description and datatype will be same as that of actual metadata cube layer.

The details of this are present in Annexure-3: Metadata Cube at True Height.

11.4 ROFF Product Specification

In this section, actual datasets are defined in tabular form. They contain the dataset information available in ROFF product, which comprises of name, datatype, shape, and information corresponding to attributes. In product there are few datasets or few sub-groups that are per polarization. For representation, here only one polarization is used; in product, the layers/datasets/groups will be present as per the number of polarizations available in the product. The same holds true for frequency A for L-Band products.

11.4.1 Dimensions and Shapes

To simplify the description of the layout of data within the HDF5 file, we will use a table of dimensions and shapes to represent the relationship between similarly sized datasets. The entries in this table do not present actual datasets in the HDF5. This table is meant to be a guide to interpreting the shapes of the datasets in subsequent subsections.

Name	Shape	Description
scalar	scalar	Scalar values
numberOfDatatakes	scalar	Number of datatakes in product
numberOfObservations	scalar	Number of observations in product
numberOfFrequencies	scalar	Number of S/L-SAR frequencies in product
numberOfFrequencyAPolarizations	scalar	Number of polarization layers associated with S/L-SAR frequency A

numberOfFrequencyAOffsetLayers	scalar	Number of pixel offset layers associated with S/L-SAR frequency A
offsetShape	(offsetZeroDopplerTimeLength, offsetSlantRangeWidth)	Shape associated with S/L-SAR datasets in the pixelOffsets group
offsetSlantRangeWidth	scalar	Number of pixels in all S/L-SAR datasets within the pixelOffsets group
offsetZeroDopplerTimeLength	scalar	Number of lines in all S/L-SAR datasets within the pixelOffsets group
geolocationCubeShape	(geolocationCubeHeight, geolocationCubeLength, geolocationCubeWidth)	Shape associated with metadata cube
geolocationCubeShapeTrueHeight	(1, geolocationCubeLengthTrueHeight, geolocationCubeWidthTrueHeight)	Shape associated with metadata cube at true height
geolocationCubeHeight	scalar	Height dimension of the metadata cube
geolocationCubeLength	scalar	Length dimension of the metadata cube
geolocationCubeWidth	scalar	Width dimension of the metadata cube

geolocationCubeWidthTrueHeight	scalar	Width dimension of the metadata cube at true height
geolocationCubeLengthTrueHeight	scalar	Length dimension of the metadata cube at true height
geolocationCubeHeightTrueHeight	scalar	Height dimension of the metadata cube at True Height. The value will be one.
dopplerCentroidTimeLength	scalar	Length dimension of Doppler centroid grid
dopplerCentroidSlantRangeWidth	scalar	Length dimension of Doppler centroid grid
dopplerCentroidShape	(dopplerCentroidTimeLength, dopplerCentroidSlantRangeWidth)	Shape of the Doppler centroid grid
orbitListLength	scalar	Number of orbit state vectors
orbitShape	(orbitListLength, 3)	Shape of orbit state vector triplets dataset
attitudeListLength	scalar	Number of attitude state vectors
attitudeQuaternionShape	(attitudeListLength, 4)	Shape of attitude quaternion dataset

attitudeShape	(attitudeListLength, 3)	Shape of attitude Euler angle triplets dataset
numberOfInputReferenceL1Files	scalar	Number of input reference L1 granules
numberOfInputSecondaryL1Files	scalar	Number of input secondary L1 granules
numberOfInputConfigFiles	scalar	Number of input configuration files
numberOfInputOrbitFiles	scalar	Number of input orbit files

11.4.2 Product Identification

Product identification variables	
/science/SSAR/identification/referenceAbsoluteOrbitNumber	
Type: UInt32	**Shape: scalar**
Description: Absolute orbit number for the reference SLC	
/science/SSAR/identification/secondaryAbsoluteOrbitNumber	
Type: UInt32	**Shape: scalar**
Description: Absolute orbit number for the secondary SLC	
/science/SSAR/identification/referenceIsJointObservation	
Type: string	**Shape: scalar**
Description: "True" if any portion of the reference RSLC was acquired in a joint observation mode (e.g., L-band and S-band simultaneously), "False" otherwise	
/science/SSAR/identification/secondaryIsJointObservation	
Type: string	**Shape: scalar**
Description: "True" if any portion of the reference RSLC was acquired in a joint observation mode (e.g., L-band and S-band simultaneously), "False" otherwise	
/science/SSAR/identification/trackNumber	
Type: UInt32	**Shape: scalar**
Description: Track number	
/science/SSAR/identification/frameNumber	
Type: UInt16	**Shape: scalar**
Description: Frame number	
/science/SSAR/identification/missionId	
Type: string	**Shape: scalar**
Description: Mission identifier	
/science/SSAR/identification/processingCenter	
Type: string	**Shape: scalar**
Description: Data processing center	
/science/SSAR/identification/productType	
Type: string	**Shape: scalar**
Description: Product type	
/science/SSAR/identification/granuleId	
Type: string	**Shape: scalar**

Description: Unique granule identification name	
/science/SSAR/identification/productDoi	
Type: string	**Shape: scalar**
Description: Digital Object Identifier (DOI) for the product	
/science/SSAR/identification/productVersion	
Type: string	**Shape: scalar**
Description: Product version which represents the structure of the product and the science content governed by the algorithm, input data, and processing parameters	
/science/SSAR/identification/productSpecificationVersion	
Type: string	**Shape: scalar**
Description: Product specification version which represents the schema of this product	
/science/SSAR/identification/lookDirection	
Type: string	**Shape: scalar**
Description: Look direction, either "Left" or "Right"	
/science/SSAR/identification/orbitPassDirection	
Type: string	**Shape: scalar**
Description: Orbit direction, either "Ascending" or "Descending"	
/science/SSAR/identification/referenceZeroDopplerStartTime	
Type: string	**Shape: scalar**
Description: Azimuth stop time (in UTC) of reference RSLC product in the format YYYY-mm-ddTHH:MM:SS.sssssssss	
/science/SSAR/identification/referenceZeroDopplerEndTime	
Type: string	**Shape: scalar**
Description: Azimuth stop time (in UTC) of reference RSLC product in the format YYYY-mm-ddTHH:MM:SS.sssssssss	
/science/SSAR/identification/secondaryZeroDopplerStartTime	
Type: string	**Shape: scalar**
Description: Azimuth start time (in UTC) of secondary RSLC product in the format YYYY-mm-ddTHH:MM:SS.sssssssss	
/science/SSAR/identification/secondaryZeroDopplerEndTime	
Type: string	**Shape: scalar**
Description: Azimuth stop time (in UTC) of secondary RSLC product in the format YYYY-mm-ddTHH:MM:SS.sssssssss	
/science/SSAR/identification/plannedDatatakeId	
Type: string	**Shape: (numberOfDatatakes)**
Description: List of planned datatakes included in the product	
/science/SSAR/identification/plannedObservationId	
Type: string	**Shape: (numberOfObservations)**
Description: List of planned observations included in the product	
/science/SSAR/identification/isUrgentObservation	
Type: string	**Shape: scalar**
Description: Flag indicating if observation is nominal ("False") or urgent ("True")	
/science/SSAR/identification/listOfFrequencies	
Type: string	**Shape: (numberOfFrequencies)**
Description: List of frequency layers available in the product	
/science/SSAR/identification/diagnosticModeFlag	
Type: UByte	**Shape: scalar**
Description: Indicates if the radar operation mode is a diagnostic mode (1-2) or DBFed science (0): 0, 1, or 2	
/science/SSAR/identification/productLevel	
Type: string	**Shape: scalar**
Description: Product level. L0A: Unprocessed instrument data; L0B: Reformatted, unprocessed instrument data; L1: Processed instrument data in radar coordinates system; and L2: Processed instrument data in geocoded coordinates system	
/science/SSAR/identification/isGeocoded	
Type: string	**Shape: scalar**

Description: Flag to indicate if the product data is in the radar geometry ("False") or in the map geometry ("True")		
/science/SSAR/identification/boundingPolygon		
Type: string	**Shape: scalar**	
Description: OGR compatible WKT representing the bounding polygon of the image. Horizontal coordinates are WGS84 longitude followed by latitude (both in degrees), and the vertical coordinate is the height above the WGS84 ellipsoid in meters. The first point corresponds to the start-time, near-range radar coordinate, and the perimeter is traversed in counterclockwise order on the map. This means the traversal order in radar coordinates differs for left-looking and right-looking sensors. The polygon includes the four corners of the radar grid, with equal numbers of points distributed evenly in radar coordinates along each edge		
	ogr_geometry	polygon
	epsg	4326
/science/SSAR/identification/processingDateTime		
Type: string	**Shape: scalar**	
Description: Processing date and time (in UTC) in the format YYYY-mm-ddTHH:MM:SS		
/science/SSAR/identification/radarBand		
Type: string	**Shape: scalar**	
Description: Acquired frequency band, either "L" or "S"		
/science/SSAR/identification/platformName		
Type: string	**Shape: scalar**	
Description: Name of the platform used to collect the remote sensing data provided in this product		
/science/SSAR/identification/instrumentName		
Type: string	**Shape: scalar**	
Description: Name of the instrument used to collect the remote sensing data provided in this product		
/science/SSAR/identification/processingType		
Type: string	**Shape: scalar**	
Description: Nominal (or) Urgent (or) Custom (or) Undefined		
/science/SSAR/identification/isDithered		
Type: string	**Shape: scalar**	
Description: "True" if the pulse timing was varied (dithered) during acquisition, "False" otherwise		
/science/SSAR/identification/isMixedMode		
Type: string	**Shape: scalar**	
Description: "True" if this product is generated from reference and secondary RSLCs with different range bandwidths, "False" otherwise		
/science/SSAR/identification/isFullFrame		
Type: string	**Shape: scalar**	
Description: "True" if this product fully covers a NISAR frame**,** "False" if partial coverage.		
	frameCoveragePercentage	Percentage of NISAR frame containing processed data
	thresholdPercentage	Threshold percentage used to determine if the product is full frame or partial frame
/science/SSAR/identification/compositeReleaseId		
Type: string	**Shape: scalar**	
Description: Unique version identifier of the science data production system		

11.4.3 Radar Imagery

Product imagery variables		
/science/SSAR/ROFF/swaths/frequencyA/listOfPolarizations		
Type: string	**Shape: (numberOfFrequencyAPolarizations)**	
Description: List of processed polarization layers with frequencyA		
/science/SSAR/ROFF/swaths/frequencyA/centerFrequency		
Type: Float64	**Shape: scalar**	
Description: Center frequency of the processed image in hertz		
	units	hertz

/science/SSAR/ROFF/swaths/frequencyA/listOfLayers		
Type: string		**Shape: (numberOfFrequencyAOffsetLayers)**
Description: List of pixel offsets layers		
/science/SSAR/ROFF/swaths/frequencyA/sceneCenterAlongTrackSpacing		
Type: Float64		**Shape: scalar**
Description: Nominal along-track spacing in meters between consecutive lines near mid-swath of the product images		
	units	meters
/science/SSAR/ROFF/swaths/frequencyA/sceneCenterGroundRangeSpacing		
Type: Float64		**Shape: scalar**
Description: Nominal ground range spacing in meters between consecutive pixels near mid-swath of the product images		
	units	meters
/science/SSAR/ROFF/swaths/frequencyA/pixelOffsets/slantRangeSpacing		
Type: Float64		**Shape: scalar**
Description: Slant range spacing of the offset grid		
	units	meters
/science/SSAR/ROFF/swaths/frequencyA/pixelOffsets/zeroDopplerTimeSpacing		
Type: Float64		**Shape: scalar**
Description: Along-track spacing of the offset grid		
	units	second
/science/SSAR/ROFF/swaths/frequencyA/pixelOffsets/digitalElevationModel		
Type: Float32		**Shape: (offsetZeroDopplerTimeLength, offsetSlantRangeWidth)**
Description: Digital Elevation Model (DEM) in radar coordinates. This dataset is produced using Copernicus WorldDEM-30 Copyright DLR e.V. 2010-2014 and Copyright Airbus Defence and Space GmbH 2014-2018 provided under COPERNICUS by the European Union and ESA; all rights reserved. This dataset is generated by referencing the Copernicus DEM elevations to the WGS84 ellipsoid and projecting them onto a range/Doppler grid		
	_FillValue	nan
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points
	units	meters
/science/SSAR/ROFF/swaths/frequencyA/pixelOffsets/mask		
Type: UByte		**Shape: (offsetZeroDopplerTimeLength, offsetSlantRangeWidth)**
Description: Mask indicating the subswaths of valid samples in the reference RSLC and geometrically-coregistered secondary RSLC. Each pixel value is a two-digit number: the least significant digit represents the subswath number of that pixel in the secondary RSLC, and the most significant digit represents the subswath number of that pixel in the reference RSLC. A value of '0' in either digit indicates an invalid sample in the corresponding RSLC		
	_FillValue	255
	valid_min	0
	long_name	Valid samples subswath mask
	percentage_water	Percentage of pixels over water bodies and ocean
/science/SSAR/ROFF/swaths/frequencyA/pixelOffsets/HH/layer1/slantRangeOffset		
Type: Float32		**Shape: (offsetZeroDopplerTimeLength, offsetSlantRangeWidth)**
Description: Raw (unculled, unfiltered) slant range pixel offsets		
	_FillValue	nan
	mean_value	Arithmetic average of the numeric data points

	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points
	units	meters
/science/SSAR/ROFF/swaths/frequencyA/pixelOffsets/HH/layer1/alongTrackOffset		
Type: Float32		**Shape: (offsetZeroDopplerTimeLength, offsetSlantRangeWidth)**
Description: Raw (unculled, unfiltered) along-track pixel offsets		
	_FillValue	nan
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points
	units	meters
/science/SSAR/ROFF/swaths/frequencyA/pixelOffsets/HH/layer1/snr		
Type: Float32		**Shape: (offsetZeroDopplerTimeLength, offsetSlantRangeWidth)**
Description: Pixel offsets signal-to-noise ratio		
	_FillValue	nan
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points
	units	1
/science/SSAR/ROFF/swaths/frequencyA/pixelOffsets/HH/layer1/correlationSurfacePeak		
Type: Float32		**Shape: (offsetZeroDopplerTimeLength, offsetSlantRangeWidth)**
Description: Normalized correlation surface peak		
	_FillValue	nan
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points
	units	1
/science/SSAR/ROFF/swaths/frequencyA/pixelOffsets/HH/layer1/slantRangeOffsetVariance		
Type: Float32		**Shape: (offsetZeroDopplerTimeLength, offsetSlantRangeWidth)**
Description: Slant range pixel offsets variance		
	_FillValue	nan
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points
	units	meters^2
/science/SSAR/ROFF/swaths/frequencyA/pixelOffsets/HH/layer1/alongTrackOffsetVariance		
Type: Float32		**Shape: (offsetZeroDopplerTimeLength, offsetSlantRangeWidth)**
Description: Along-track pixel offsets variance		
	_FillValue	nan
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points

	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points
	units	meters^2
/science/SSAR/ROFF/swaths/frequencyA/pixelOffsets/HH/layer1/crossOffsetVariance		
Type: Float32		**Shape: (offsetZeroDopplerTimeLength, offsetSlantRangeWidth)**
Description: Off-diagonal term of the pixel offsets covariance matrix		
	_FillValue	nan
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points
	units	meters^2
/science/SSAR/ROFF/swaths/frequencyA/pixelOffsets/HH/layer2/slantRangeOffset		
Type: Float32		**Shape: (offsetZeroDopplerTimeLength, offsetSlantRangeWidth)**
Description: Raw (unculled, unfiltered) slant range pixel offsets		
	_FillValue	nan
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points
	units	meters
/science/SSAR/ROFF/swaths/frequencyA/pixelOffsets/HH/layer2/alongTrackOffset		
Type: Float32		**Shape: (offsetZeroDopplerTimeLength, offsetSlantRangeWidth)**
Description: Raw (unculled, unfiltered) along-track pixel offsets		
	_FillValue	nan
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points
	units	meters
/science/SSAR/ROFF/swaths/frequencyA/pixelOffsets/HH/layer2/snr		
Type: Float32		**Shape: (offsetZeroDopplerTimeLength, offsetSlantRangeWidth)**
Description: Pixel offsets signal-to-noise ratio		
	_FillValue	nan
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points
	units	1
/science/SSAR/ROFF/swaths/frequencyA/pixelOffsets/HH/layer2/correlationSurfacePeak		
Type: Float32		**Shape: (offsetZeroDopplerTimeLength, offsetSlantRangeWidth)**
Description: Normalized correlation surface peak		
	_FillValue	nan
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points

	sample_stddev	Standard deviation of the numeric data points
	units	1
/science/SSAR/ROFF/swaths/frequencyA/pixelOffsets/HH/layer2/slantRangeOffsetVariance		
Type: Float32		**Shape: (offsetZeroDopplerTimeLength, offsetSlantRangeWidth)**
Description: Slant range pixel offsets variance		
	_FillValue	nan
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points
	units	meters^2
/science/SSAR/ROFF/swaths/frequencyA/pixelOffsets/HH/layer2/alongTrackOffsetVariance		
Type: Float32		**Shape: (offsetZeroDopplerTimeLength, offsetSlantRangeWidth)**
Description: Along-track pixel offsets variance		
	_FillValue	nan
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points
	units	meters^2
/science/SSAR/ROFF/swaths/frequencyA/pixelOffsets/HH/layer2/crossOffsetVariance		
Type: Float32		**Shape: (offsetZeroDopplerTimeLength, offsetSlantRangeWidth)**
Description: Off-diagonal term of the pixel offsets covariance matrix		
	_FillValue	nan
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points
	units	meters^2

/science/SSAR/ROFF/swaths/frequencyA/pixelOffsets/HH/layer3/slantRangeOffset		
Type: Float32		**Shape: (offsetZeroDopplerTimeLength, offsetSlantRangeWidth)**
Description: Raw (unculled, unfiltered) slant range pixel offsets		
	_FillValue	nan
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points
	units	meters
/science/SSAR/ROFF/swaths/frequencyA/pixelOffsets/HH/layer3/alongTrackOffset		
Type: Float32		**Shape: (offsetZeroDopplerTimeLength, offsetSlantRangeWidth)**
Description: Raw (unculled, unfiltered) along-track pixel offsets		
	_FillValue	nan
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points

	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points
	units	meters
/science/SSAR/ROFF/swaths/frequencyA/pixelOffsets/HH/layer3/snr		
Type: Float32		**Shape: (offsetZeroDopplerTimeLength, offsetSlantRangeWidth)**
Description: Pixel offsets signal-to-noise ratio		
	_FillValue	nan
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points
	units	1
/science/SSAR/ROFF/swaths/frequencyA/pixelOffsets/HH/layer3/correlationSurfacePeak		
Type: Float32		**Shape: (offsetZeroDopplerTimeLength, offsetSlantRangeWidth)**
Description: Normalized correlation surface peak		
	_FillValue	nan
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points
	units	1
/science/SSAR/ROFF/swaths/frequencyA/pixelOffsets/HH/layer3/slantRangeOffsetVariance		
Type: Float32		**Shape: (offsetZeroDopplerTimeLength, offsetSlantRangeWidth)**
Description: Slant range pixel offsets variance		
	_FillValue	nan
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points
	units	meters^2
/science/SSAR/ROFF/swaths/frequencyA/pixelOffsets/HH/layer3/alongTrackOffsetVariance		
Type: Float32		**Shape: (offsetZeroDopplerTimeLength, offsetSlantRangeWidth)**
Description: Along-track pixel offsets variance		
	_FillValue	nan
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points
	units	meters^2
/science/SSAR/ROFF/swaths/frequencyA/pixelOffsets/HH/layer3/crossOffsetVariance		
Type: Float32		**Shape: (offsetZeroDopplerTimeLength, offsetSlantRangeWidth)**
Description: Off-diagonal term of the pixel offsets covariance matrix		
	_FillValue	nan
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points

	sample_stddev	Standard deviation of the numeric data points
	units	meters^2
/science/SSAR/ROFF/swaths/frequencyA/pixelOffsets/slantRange		
Type: Float64	**Shape: (offsetSlantRangeWidth)**	
Description: Slant range vector		
	units	meters
/science/SSAR/ROFF/swaths/frequencyA/pixelOffsets/zeroDopplerTime		
Type: Float64	**Shape: (offsetZeroDopplerTimeLength)**	
Description: Zero Doppler azimuth time vector since UTC epoch vector		
	units	seconds since YYYY-mm-ddTHH:MM:SS

11.4.4 Processing Information

Processing-related variables		
/science/SSAR/ROFF/metadata/processingInformation/parameters/runConfigurationContents		
Type: string	**Shape: scalar**	
Description: Contents of the run configuration file with parameters used for processing		
/science/SSAR/ROFF/metadata/processingInformation/parameters/reference/referenceTerrainHeight		
Type: Float32	**Shape: (dopplerCentroidTimeLength, dopplerCentroidSlantRangeWidth)**	
Description: Reference Terrain Height as a function of time for reference RSLC		
	units	meters
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (second)
/science/SSAR/ROFF/metadata/processingInformation/parameters/reference/isMixedMode		
Type: string	**Shape: scalar**	
Description: "True" if reference RSLC is a composite of data collected in multiple radar modes, "False" otherwise		
/science/SSAR/ROFF/metadata/processingInformation/parameters/reference/rfiMitigationApplied		
Type: string	**Shape: scalar**	
Description: Flag to indicate if RFI mitigation has been applied to reference RSLC		
/science/SSAR/ROFF/metadata/processingInformation/parameters/reference/frequencyA/slantRangeStart		
Type: Float64	**Shape: scalar**	
Description: Slant range start distance for the reference RSLC		
	units	meters
/science/SSAR/ROFF/metadata/processingInformation/parameters/reference/frequencyA/numberOfRangeSamples		
Type: UInt64	**Shape: scalar**	
Description: Number of slant range samples for each azimuth line within the reference RSLC		
	units	1
/science/SSAR/ROFF/metadata/processingInformation/parameters/reference/frequencyA/numberOfAzimuthLines		
Type: UInt64	**Shape: scalar**	
Description: Number of azimuth lines within the reference RSLC		
	units	1
/science/SSAR/ROFF/metadata/processingInformation/parameters/reference/frequencyA/slantRangeSpacing		
Type: Float64	**Shape: scalar**	
Description: Slant range spacing of reference RSLC		
	units	meters

/science/SSAR/ROFF/metadata/processingInformation/parameters/reference/frequencyA/zeroDopplerTimeSpacing		
Type: Float64	**Shape: scalar**	
Description: Time interval in the along-track direction for reference RSLC raster layers		
	units	seconds
/science/SSAR/ROFF/metadata/processingInformation/parameters/reference/frequencyA/zeroDopplerStartTime		
Type: String	**Shape: scalar**	
Description: Azimuth start time (in UTC) of the reference RSLC product in the format YYYY-mm-ddTHH:MM:SS.sssssssss		
/science/SSAR/ROFF/metadata/processingInformation/parameters/reference/frequencyA/zeroDopplerEndTime		
Type: string	**Shape: scalar**	
Description: Azimuth stop time (in UTC) of the reference RSLC product in the format YYYY-mm-ddTHH:MM:SS.sssssssss		
/science/SSAR/ROFF/metadata/processingInformation/parameters/reference/frequencyA/rangeBandwidth		
Type: Float64	**Shape: scalar**	
Description: Processed slant range bandwidth for reference RSLC		
	units	hertz
/science/SSAR/ROFF/metadata/processingInformation/parameters/reference/frequencyA/azimuthBandwidth		
Type: Float64	**Shape: scalar**	
Description: Processed azimuth bandwidth for reference RSLC		
	units	hertz
/science/SSAR/ROFF/metadata/processingInformation/parameters/reference/frequencyA/dopplerCentroid		
Type: Float64	**Shape: (dopplerCentroidTimeLength, dopplerCentroidSlantRangeWidth)**	
Description: 2D LUT of Doppler centroid for frequency A		
	units	hertz
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (second)
/science/SSAR/ROFF/metadata/processingInformation/parameters/secondary/referenceTerrainHeight		
Type: Float32	**Shape: (dopplerCentroidTimeLength, dopplerCentroidSlantRangeWidth)**	
Description: Reference Terrain Height as a function of time for secondary RSLC		
	units	meters
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (second)
/science/SSAR/ROFF/metadata/processingInformation/parameters/secondary/rfiMitigationApplied		
Type: string	**Shape: scalar**	
Description: Flag to indicate if RFI mitigation has been applied to secondary RSLC		
/science/SSAR/ROFF/metadata/processingInformation/parameters/secondary/isMixedMode		
Type: string	**Shape: scalar**	
Description: "True" if secondary RSLC is a composite of data collected in multiple radar modes, "False" otherwise		
/science/SSAR/ROFF/metadata/processingInformation/parameters/secondary/frequencyA/slantRangeStart		
Type: Float64	**Shape: scalar**	
Description: Slant range start distance for the reference RSLC		

	units	meters
/science/SSAR/ROFF/metadata/processingInformation/parameters/secondary/frequencyA/numberOfRangeSamples		
Type: UInt64	**Shape: scalar**	
Description: Number of slant range samples for each azimuth line within the reference RSLC		
	units	1
/science/SSAR/ROFF/metadata/processingInformation/parameters/secondary/frequencyA/numberOfAzimuthLines		
Type: UInt64	**Shape: scalar**	
Description: Number of azimuth lines within the reference RSLC		
	units	1
/science/SSAR/ROFF/metadata/processingInformation/parameters/secondary/frequencyA/slantRangeSpacing		
Type: Float64	**Shape: scalar**	
Description: Slant range spacing of reference RSLC		
	units	meters
/science/SSAR/ROFF/metadata/processingInformation/parameters/secondary/frequencyA/zeroDopplerTimeSpacing		
Type: Float64	**Shape: scalar**	
Description: Time interval in the along-track direction for reference RSLC raster layers		
	units	seconds
/science/SSAR/ROFF/metadata/processingInformation/parameters/secondary/frequencyA/zeroDopplerStartTime		
Type: String	**Shape: scalar**	
Description: Azimuth start time (in UTC) of the reference RSLC product in the format YYYY-mm-ddTHH:MM:SS.sssssssss		
/science/SSAR/ROFF/metadata/processingInformation/parameters/secondary/frequencyA/zeroDopplerEndTime		
Type: string	**Shape: scalar**	
Description: Azimuth stop time (in UTC) of the reference RSLC product in the format YYYY-mm-ddTHH:MM:SS.sssssssss		
/science/SSAR/ROFF/metadata/processingInformation/parameters/secondary/frequencyA/rangeBandwidth		
Type: Float64	**Shape: scalar**	
Description: Processed slant range bandwidth for secondary RSLC		
	units	hertz
/science/SSAR/ROFF/metadata/processingInformation/parameters/secondary/frequencyA/azimuthBandwidth		
Type: Float64	**Shape: scalar**	
Description: Processed azimuth bandwidth for secondary RSLC		
	units	hertz
/science/SSAR/ROFF/metadata/processingInformation/parameters/secondary/frequencyA/dopplerCentroid		
Type: Float64	**Shape: (dopplerCentroidTimeLength, dopplerCentroidSlantRangeWidth)**	
Description: 2D LUT of Doppler centroid for frequency A		
	units	hertz
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (second)
/science/SSAR/ROFF/metadata/processingInformation/parameters/common/frequencyA/dopplerCentroid		
Type: Float64	**Shape: (dopplerCentroidTimeLength, dopplerCentroidSlantRangeWidth)**	

Description: 2D LUT of common Doppler centroid between reference and secondary RSLCs		
	units	hertz
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (second)
/science/SSAR/ROFF/metadata/processingInformation/parameters/common/frequencyA/dopplerBandwidth		
Type: Float64		**Shape: scalar**
Description: Common Doppler bandwidth between reference and secondary RSLCs		
	units	hertz
/science/SSAR/ROFF/metadata/processingInformation/parameters/pixelOffsets/frequencyA/rangeBandwidth		
Type: Float64		**Shape: scalar**
Description: Processed slant range bandwidth for frequency A pixel offsets layers		
	units	hertz
/science/SSAR/ROFF/metadata/processingInformation/parameters/pixelOffsets/frequencyA/azimuthBandwidth		
Type: Float64		**Shape: scalar**
Description: Processed azimuth bandwidth for frequency A pixel offsets layers		
	units	hertz
/science/SSAR/ROFF/metadata/processingInformation/parameters/pixelOffsets/frequencyA/correlationSurfaceOversampling		
Type: UInt32		**Shape: scalar**
Description: Oversampling factor of the cross-correlation surface		
	units	1
/science/SSAR/ROFF/metadata/processingInformation/parameters/pixelOffsets/frequencyA/margin		
Type: UInt32		**Shape: scalar**
Description: Margin in pixels around reference RSLC edges excluded during cross-correlation computation		
	units	1
/science/SSAR/ROFF/metadata/processingInformation/parameters/pixelOffsets/frequencyA/slantRangeStartPixel		
Type: UInt32		**Shape: scalar**
Description: Reference RSLC start pixel in slant range		
	units	1
/science/SSAR/ROFF/metadata/processingInformation/parameters/pixelOffsets/frequencyA/alongTrackStartPixel		
Type: UInt32		**Shape: scalar**
Description: Reference RSLC start pixel in along-track		
	units	1
/science/SSAR/ROFF/metadata/processingInformation/parameters/pixelOffsets/frequencyA/slantRangeSkipWindowSize		
Type: UInt32		**Shape: scalar**
Description: Slant range cross-correlation skip window size in pixels		
	units	1
/science/SSAR/ROFF/metadata/processingInformation/parameters/pixelOffsets/frequencyA/alongTrackSkipWindowSize		
Type: UInt32		**Shape: scalar**
Description: Along-track cross-correlation skip window size in pixels		
	units	1
/science/SSAR/ROFF/metadata/processingInformation/parameters/pixelOffsets/frequencyA/layer1/alongTrackWindowSize		
Type: UInt32		**Shape: scalar**
Description: Along-track cross-correlation window size in pixels		

	units	1
/science/SSAR/ROFF/metadata/processingInformation/parameters/pixelOffsets/frequencyA/layer1/slantRangeWindowSize		
Type: UInt32	**Shape: scalar**	
Description: Slant range cross-correlation window size in pixels		
	units	1
/science/SSAR/ROFF/metadata/processingInformation/parameters/pixelOffsets/frequencyA/layer1/alongTrackSearchWindowSize		
Type: UInt32	**Shape: scalar**	
Description: Along-track cross-correlation search window size in pixels		
	units	1
/science/SSAR/ROFF/metadata/processingInformation/parameters/pixelOffsets/frequencyA/layer1/slantRangeSearchWindowSize		
Type: UInt32	**Shape: scalar**	
Description: Slant range cross-correlation search window size in pixels		
	units	1
/science/SSAR/ROFF/metadata/processingInformation/parameters/pixelOffsets/frequencyA/layer2/alongTrackWindowSize		
Type: UInt32	**Shape: scalar**	
Description: Along-track cross-correlation window size in pixels		
	units	1
/science/SSAR/ROFF/metadata/processingInformation/parameters/pixelOffsets/frequencyA/layer2/slantRangeWindowSize		
Type: UInt32	**Shape: scalar**	
Description: Slant range cross-correlation window size in pixels		
	units	1
/science/SSAR/ROFF/metadata/processingInformation/parameters/pixelOffsets/frequencyA/layer2/alongTrackSearchWindowSize		
Type: UInt32	**Shape: scalar**	
Description: Along-track cross-correlation search window size in pixels		
	units	1
/science/SSAR/ROFF/metadata/processingInformation/parameters/pixelOffsets/frequencyA/layer2/slantRangeSearchWindowSize		
Type: UInt32	**Shape: scalar**	
Description: Slant range cross-correlation search window size in pixels		
	units	1
/science/SSAR/ROFF/metadata/processingInformation/parameters/pixelOffsets/frequencyA/layer3/alongTrackWindowSize		
Type: UInt32	**Shape: scalar**	
Description: Along-track cross-correlation window size in pixels		
	units	1
/science/SSAR/ROFF/metadata/processingInformation/parameters/pixelOffsets/frequencyA/layer3/slantRangeWindowSize		
Type: UInt32	**Shape: scalar**	
Description: Slant range cross-correlation window size in pixels		
	units	1
/science/SSAR/ROFF/metadata/processingInformation/parameters/pixelOffsets/frequencyA/layer3/alongTrackSearchWindowSize		
Type: UInt32	**Shape: scalar**	
Description: Along-track cross-correlation search window size in pixels		
	units	1
/science/SSAR/ROFF/metadata/processingInformation/parameters/pixelOffsets/frequencyA/layer3/slantRangeSearchWindowSize		
Type: UInt32	**Shape: scalar**	

Description: Slant range cross-correlation search window size in pixels		
	units	1
/science/SSAR/ROFF/metadata/processingInformation/algorithms/softwareVersion		
Type: string	**Shape: scalar**	
Description: Software version used for processing		
/science/SSAR/ROFF/metadata/processingInformation/algorithms/coregistration/coregistrationMethod		
Type: string	**Shape: scalar**	
Description: RSLC coregistration method		
/science/SSAR/ROFF/metadata/processingInformation/algorithms/coregistration/geometryCoregistration		
Type: string	**Shape: scalar**	
Description: Geometry coregistration algorithm		
/science/SSAR/ROFF/metadata/processingInformation/algorithms/coregistration/resampling		
Type: string	**Shape: scalar**	
Description: Secondary RSLC resampling algorithm		
/science/SSAR/ROFF/metadata/processingInformation/algorithms/crossCorrelation/layer1/crossCorrelationAlgorithm		
Type: string	**Shape: scalar**	
Description: Cross-correlation algorithm for layer 1		
/science/SSAR/ROFF/metadata/processingInformation/algorithms/crossCorrelation/layer2/crossCorrelationAlgorithm		
Type: string	**Shape: scalar**	
Description: Cross-correlation algorithm for layer 2		
/science/SSAR/ROFF/metadata/processingInformation/algorithms/crossCorrelation/layer3/crossCorrelationAlgorithm		
Type: string	**Shape: scalar**	
Description: Cross-correlation algorithm for layer 3		
/science/SSAR/ROFF/metadata/processingInformation/inputs/l1ReferenceSlcGranules		
Type: string	**Shape: (numberOfInputReferenceL1Files)**	
Description: List of input reference L1 RSLC products used		
/science/SSAR/ROFF/metadata/processingInformation/inputs/l1SecondarySlcGranules		
Type: string	**Shape: (numberOfInputSecondaryL1Files)**	
Description: List of input secondary L1 RSLC products used		
/science/SSAR/ROFF/metadata/processingInformation/inputs/configFiles		
Type: string	**Shape: (numberOfInputConfigFiles)**	
Description: List of input config files used		
/science/SSAR/ROFF/metadata/processingInformation/inputs/demSource		
Type: string	**Shape: scalar**	
Description: Description of the input digital elevation model (DEM)		
/science/SSAR/ROFF/metadata/processingInformation/inputs/orbitFiles		
Type: string	**Shape: (numberOfInputOrbitFiles)**	
Description: List of input orbit files used		

11.4.5 Other Radar Metadata

Radar metadata-related variables		
/science/SSAR/ROFF/metadata/orbit/temporalBaseline		
Type: UInt16	**Shape: scalar**	
Description: Time interval between reference and secondary RSLCs		
	units	day
/science/SSAR/ROFF/metadata/orbit/reference/interpMethod		
Type: string	**Shape: scalar**	
Description: Orbit interpolation method, either "Hermite" or "Legendre"		
/science/SSAR/ROFF/metadata/orbit/reference/time		

Type: Float64	**Shape: (orbitListLength)**	
Description: Time vector record. This record contains the time since UTC epoch corresponding to position and velocity records		
	units	seconds since YYYY-mm-ddTHH:MM:SS
/science/SSAR/ROFF/metadata/orbit/reference/position		
Type: Float64	**Shape: (orbitListLength, tripletxyz)**	
Description: Position vector record. This record contains the platform position data with respect to WGS84 G1762 reference frame		
	units	meters
/science/SSAR/ROFF/metadata/orbit/reference/velocity		
Type: Float64	**Shape: (orbitListLength, tripletxyz)**	
Description: Velocity vector record. This record contains the platform velocity data with respect to WGS84 G1762 reference frame		
	units	meter / second
/science/SSAR/ROFF/metadata/orbit/reference/orbitType		
Type: string	**Shape: scalar**	
Description: Orbit product type, either "FOE", "NOE", "MOE", "POE", or "Custom", where "FOE" stands for Forecast Orbit Ephemeris, "NOE" is Near real-time Orbit Ephemeris, "MOE" is Medium precision Orbit Ephemeris, and "POE" is Precise Orbit Ephemeris		
/science/SSAR/ROFF/metadata/orbit/secondary/interpMethod		
Type: string	**Shape: scalar**	
Description: Orbit interpolation method, either "Hermite" or "Legendre"		
/science/SSAR/ROFF/metadata/orbit/secondary/time		
Type: Float64	**Shape: (orbitListLength)**	
Description: Time vector record. This record contains the time since UTC epoch corresponding to position and velocity records		
	units	seconds since YYYY-mm-ddTHH:MM:SS
/science/SSAR/ROFF/metadata/orbit/secondary/position		
Type: Float64	**Shape: (orbitListLength, tripletxyz)**	
Description: Position vector record. This record contains the platform position data with respect to WGS84 G1762 reference frame		
	units	meters
/science/SSAR/ROFF/metadata/orbit/secondary/velocity		
Type: Float64	**Shape: (orbitListLength, tripletxyz)**	
Description: Velocity vector record. This record contains the platform velocity data with respect to WGS84 G1762 reference frame		
	units	meter / second
/science/SSAR/ROFF/metadata/orbit/secondary/orbitType		
Type: string	**Shape: scalar**	
Description: Orbit product type, either "FOE", "NOE", "MOE", "POE", or "Custom", where "FOE" stands for Forecast Orbit Ephemeris, "NOE" is Near real-time Orbit Ephemeris, "MOE" is Medium precision Orbit Ephemeris, and "POE" is Precise Orbit Ephemeris		
/science/SSAR/ROFF/metadata/attitude/reference/time		
Type: Float64	**Shape: (attitudeListLength)**	
Description: Time vector record. This record contains the time since UTC epoch corresponding to attitude and quaternion records		
	units	seconds since YYYY-mm-ddTHH:MM:SS
/science/SSAR/ROFF/metadata/attitude/reference/quaternions		
Type: Float64	**Shape: (attitudeListLength, quaternions)**	
Description: Attitude quaternions (q0, q1, q2, q3)		
	units	1
/science/SSAR/ROFF/metadata/attitude/reference/eulerAngles		
Type: Float64	**Shape: (attitudeListLength, tripletxyz)**	
Description: Attitude Euler angles (roll, pitch, yaw)		
	units	degree

/science/SSAR/ROFF/metadata/attitude/reference/attitudeType		
Type: string	**Shape: scalar**	
Description: Attitude type, either "FRP", "NRP", "PRP, or "Custom", where "FRP" stands for Forecast Radar Pointing, "NRP" is Near Real-time Pointing, and "PRP" is Precise Radar Pointing		
/science/SSAR/ROFF/metadata/attitude/secondary/time		
Type: Float64	**Shape: (attitudeListLength)**	
Description: Time vector record. This record contains the time since UTC epoch corresponding to attitude and quaternion records		
	units	seconds since YYYY-mm-ddTHH:MM:SS
/science/SSAR/ROFF/metadata/attitude/secondary/quaternions		
Type: Float64	**Shape: (attitudeListLength, quaternions)**	
Description: Attitude quaternions (q0, q1, q2, q3)		
	units	1
/science/SSAR/ROFF/metadata/attitude/secondary/eulerAngles		
Type: Float64	**Shape: (attitudeListLength, tripletxyz)**	
Description: Attitude Euler angles (roll, pitch, yaw)		
	units	degree
/science/SSAR/ROFF/metadata/attitude/secondary/attitudeType		
Type: string	**Shape: scalar**	
Description: Attitude type, either "FRP", "NRP", "PRP, or "Custom", where "FRP" stands for Forecast Radar Pointing, "NRP" is Near Real-time Pointing, and "PRP" is Precise Radar Pointing		

11.4.6 Geolocation Grid

Metadata cube-related variables		
/science/SSAR/ROFF/metadata/geolocationGrid/epsg		
Type: Int32	**Shape: scalar**	
Description: EPSG code corresponding to the coordinate system used for representing the geolocation grid		
	long_name	EPSG code
/science/SSAR/ROFF/metadata/geolocationGrid/coordinateY		
Type: Float64	**Shape: (geolocationCubeHeight, geolocationCubeLength, geolocationCubeWidth)**	
Description: Y coordinates in specified EPSG code		
	_FillValue	nan
	grid_mapping	projection
	long_name	Coordinate Y
	units	degree
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (second)
/science/SSAR/ROFF/metadata/geolocationGrid/coordinateX		
Type: Float64	**Shape: (geolocationCubeHeight, geolocationCubeLength, geolocationCubeWidth)**	
Description: X coordinates in specified EPSG code		
	_FillValue	nan
	grid_mapping	projection
	long_name	Coordinate X
	units	degree
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)

	azimuth_spacing	The spacing in Azimuth direction (second)
/science/SSAR/ROFF/metadata/geolocationGrid/incidenceAngle		
Type: Float32	**Shape: (geolocationCubeHeight, geolocationCubeLength, geolocationCubeWidth)**	
Description: Incidence angle is defined as the angle between the LOS vector and the normal to the ellipsoid at the target height		
	valid_max	90.0
	valid_min	0.0
	_FillValue	nan
	grid_mapping	projection
	long_name	Incidence angle
	units	degree
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (second)
/science/SSAR/ROFF/metadata/geolocationGrid/losUnitVectorX		
Type: Float32	**Shape: (geolocationCubeHeight, geolocationCubeLength, geolocationCubeWidth)**	
Description: East component of unit vector of LOS from target to sensor		
	valid_max	1.0
	valid_min	-1.0
	_FillValue	nan
	grid_mapping	projection
	long_name	LOS unit vector X
	units	1
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (second)
/science/SSAR/ROFF/metadata/geolocationGrid/losUnitVectorY		
Type: Float32	**Shape: (geolocationCubeHeight, geolocationCubeLength, geolocationCubeWidth)**	
Description: North component of unit vector of LOS from target to sensor		
	valid_max	1.0
	valid_min	-1.0
	_FillValue	nan
	grid_mapping	projection
	long_name	LOS unit vector Y
	units	1
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (second)
/science/SSAR/ROFF/metadata/geolocationGrid/alongTrackUnitVectorX		
Type: Float32	**Shape: (geolocationCubeHeight, geolocationCubeLength, geolocationCubeWidth)**	
Description: East component of unit vector along ground track		
	valid_max	1.0
	valid_min	-1.0

	_FillValue	nan
	grid_mapping	projection
	long_name	Along-track unit vector X
	units	1
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (second)
/science/SSAR/ROFF/metadata/geolocationGrid/alongTrackUnitVectorY		
Type: Float32	**Shape: (geolocationCubeHeight, geolocationCubeLength, geolocationCubeWidth)**	
Description: North component of unit vector along ground track		
	valid_max	1.0
	valid_min	-1.0
	_FillValue	nan
	grid_mapping	projection
	long_name	Along-track unit vector Y
	units	1
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (second)
/science/SSAR/ROFF/metadata/geolocationGrid/elevationAngle		
Type: Float32	**Shape: (geolocationCubeHeight, geolocationCubeLength, geolocationCubeWidth)**	
Description: Elevation angle is defined as the angle between the LOS vector and the normal to the ellipsoid at the sensor		
	valid_max	90.0
	valid_min	0.0
	_FillValue	nan
	grid_mapping	projection
	long_name	Elevation angle
	units	degree
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (second)
/science/SSAR/ROFF/metadata/geolocationGrid/parallelBaseline		
Type: Float32	**Shape: (geolocationCubeHeight, geolocationCubeLength, geolocationCubeWidth)**	
Description: Parallel component of the InSAR baseline		
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points
	units	meters
	_FillValue	nan
	grid_mapping	projection
	long_name	Parallel baseline
	pixel_interval	The interval in Pixel direction

	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (second)
/science/SSAR/ROFF/metadata/geolocationGrid/perpendicularBaseline		
Type: Float32	**Shape: (geolocationCubeHeight, geolocationCubeLength, geolocationCubeWidth)**	
Description: Perpendicular component of the InSAR baseline		
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points
	units	meters
	grid_mapping	projection
	_FillValue	nan
	long_name	Perpendicular baseline
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (second)
/science/SSAR/ROFF/metadata/geolocationGrid/groundTrackVelocity		
Type: Float64	**Shape: (geolocationCubeHeight, geolocationCubeLength, geolocationCubeWidth)**	
Description: Absolute value of the platform velocity scaled at the target height		
	_FillValue	nan
	grid_mapping	projection
	long_name	Ground track velocity
	units	meters / second
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (second)
/science/SSAR/ROFF/metadata/geolocationGrid/slantRange		
Type: Float64	**Shape: (geolocationCubeWidth)**	
Description: Slant range values corresponding to the geolocation grid		
	units	meters
	long_name	Slant range
/science/SSAR/ROFF/metadata/geolocationGrid/zeroDopplerTime		
Type: Float64	**Shape: (geolocationCubeLength)**	
Description: Zero Doppler time since UTC epoch values corresponding to the geolocation grid		
	units	seconds since YYYY-mm-ddTHH:MM:SS
	long_name	Zero Doppler time
/science/SSAR/ROFF/metadata/geolocationGrid/heightAboveEllipsoid		
Type: Float64	**Shape: (geolocationCubeHeight)**	
Description: Height values above WGS84 Ellipsoid corresponding to the location grid		
	standard_name	height_above_reference_ellipsoid
	units	meters

11.4.7 Geolocation Grid True Height (Available Only in ISRO Generated Products)

Geolocation grid at true height is at a finer spacing as compared to the radar grid documented in section 11.4.6.

Metadata cube-related variables		
/science/SSAR/ROFF/metadata/geolocationGridTrueHeight/epsg		
Type: Int32	**Shape: scalar**	
Description: EPSG code corresponding to the coordinate system used for representing the geolocation grid		
	long_name	EPSG code
/science/SSAR/ROFF/metadata/geolocationGridTrueHeight/coordinateY		
Type: Float64	**Shape: (geolocationCubeHeightTrueHeight, geolocationCubeLengthTrueHeight, geolocationCubeWidthTrueHeight)**	
Description: Y coordinates in specified EPSG code		
	_FillValue	nan
	grid_mapping	projection
	long_name	Coordinate Y
	units	degree
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (second)
/science/SSAR/ROFF/metadata/geolocationGridTrueHeight/coordinateX		
Type: Float64	**Shape: (geolocationCubeHeightTrueHeight, geolocationCubeLengthTrueHeight, geolocationCubeWidthTrueHeight)**	
Description: X coordinates in specified EPSG code		
	_FillValue	nan
	grid_mapping	projection
	long_name	Coordinate X
	units	degree
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (second)
/science/SSAR/ROFF/metadata/geolocationGridTrueHeight/incidenceAngle		
Type: Float32	**Shape: (geolocationCubeHeightTrueHeight, geolocationCubeLengthTrueHeight, geolocationCubeWidthTrueHeight)**	
Description: Incidence angle is defined as the angle between the LOS vector and the normal to the ellipsoid at the target height		
	valid_max	90.0
	valid_min	0.0
	_FillValue	nan
	grid_mapping	projection
	long_name	Incidence angle
	units	degree
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (second)
/science/SSAR/ROFF/metadata/geolocationGridTrueHeight/losUnitVectorX		
Type: Float32	**Shape: (geolocationCubeHeightTrueHeight, geolocationCubeLengthTrueHeight, geolocationCubeWidthTrueHeight)**	
Description: East component of unit vector of LOS from target to sensor		

	valid_max	1.0
	valid_min	-1.0
	_FillValue	nan
	grid_mapping	projection
	long_name	LOS unit vector X
	units	1
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (second)
/science/SSAR/ROFF/metadata/geolocationGridTrueHeight/losUnitVectorY		
Type: Float32	**Shape: (geolocationCubeHeightTrueHeight, geolocationCubeLengthTrueHeight, geolocationCubeWidthTrueHeight)**	
Description: North component of unit vector of LOS from target to sensor		
	valid_max	1.0
	valid_min	-1.0
	_FillValue	nan
	grid_mapping	projection
	long_name	LOS unit vector Y
	units	1
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (second)
/science/SSAR/ROFF/metadata/geolocationGridTrueHeight/alongTrackUnitVectorX		
Type: Float32	**Shape: (geolocationCubeHeightTrueHeight, geolocationCubeLengthTrueHeight, geolocationCubeWidthTrueHeight)**	
Description: East component of unit vector along ground track		
	valid_max	1.0
	valid_min	-1.0
	_FillValue	nan
	grid_mapping	projection
	long_name	Along-track unit vector X
	units	1
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (second)
/science/SSAR/ROFF/metadata/geolocationGridTrueHeight/alongTrackUnitVectorY		
Type: Float32	**Shape: (geolocationCubeHeightTrueHeight, geolocationCubeLengthTrueHeight, geolocationCubeWidthTrueHeight)**	
Description: North component of unit vector along ground track		
	valid_max	1.0
	valid_min	-1.0
	_FillValue	nan
	grid_mapping	projection
	long_name	Along-track unit vector Y

	units	1
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (second)
/science/SSAR/ROFF/metadata/geolocationGridTrueHeight/elevationAngle		
Type: Float32	**Shape: (geolocationCubeHeightTrueHeight, geolocationCubeLengthTrueHeight, geolocationCubeWidthTrueHeight)**	
Description: Elevation angle is defined as the angle between the LOS vector and the normal to the ellipsoid at the sensor		
	valid_max	90.0
	valid_min	0.0
	_FillValue	nan
	grid_mapping	projection
	long_name	Elevation angle
	units	degree
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (second)
/science/SSAR/ROFF/metadata/geolocationGridTrueHeight/parallelBaseline		
Type: Float32	**Shape: (geolocationCubeHeightTrueHeight, geolocationCubeLengthTrueHeight, geolocationCubeWidthTrueHeight)**	
Description: Parallel component of the InSAR baseline		
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points
	units	meters
	grid_mapping	projection
	_FillValue	nan
	long_name	Parallel baseline
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (second)
/science/SSAR/ROFF/metadata/geolocationGridTrueHeight/perpendicularBaseline		
Type: Float32	**Shape: (geolocationCubeHeightTrueHeight, geolocationCubeLengthTrueHeight, geolocationCubeWidthTrueHeight)**	
Description: Perpendicular component of the InSAR baseline		
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points
	units	meters
	grid_mapping	projection
	_FillValue	nan
	long_name	Perpendicular baseline

	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (second)
/science/SSAR/ROFF/metadata/geolocationGridTrueHeight/groundTrackVelocity		
Type: Float64	**Shape: (geolocationCubeHeightTrueHeight, geolocationCubeLengthTrueHeight, geolocationCubeWidthTrueHeight)**	
Description: Absolute value of the platform velocity scaled at the target height		
	_FillValue	nan
	grid_mapping	projection
	long_name	Ground track velocity
	units	meters / second
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (second)
/science/SSAR/ROFF/metadata/geolocationGridTrueHeight/slantRange		
Type: Float64	**Shape: (geolocationCubeWidthTrueHeight)**	
Description: Slant range values corresponding to the geolocation grid		
	units	meters
	long_name	Slant range
/science/SSAR/ROFF/metadata/geolocationGridTrueHeight/zeroDopplerTime		
Type: Float64	**Shape: (geolocationCubeLengthTrueHeight)**	
Description: Zero Doppler time since UTC epoch values corresponding to the geolocation grid		
	units	seconds since YYYY-mm-ddTHH:MM:SS
	long_name	Zero Doppler time

CHAPTER-12

Geocoded Pixel Offsets (GOFF) Data Product

12 Geocoded Pixel Offset Product (GOFF) Data Product

The Geocoded Pixel Offset Product (GOFF) is the geocoded version of unfiltered and un-culled layers of pixel offsets for different resolutions obtained from incoherent speckle tracking. The geocoding is done using the MOE state vectors and a DEM. It is generated with nearest pair in time copol and circular pol channels only. The GOFF product is primarily meant for cryosphere applications, and it is only generated for acquisitions over Antarctica, Greenland, and selected mountain glaciers and for certain bandwidth combinations. Table 12-1 summarizes the combination of Bandwidth (BW) and area for which GOFF product is generated for L & S Band.

Band	BW (MHz)	Antartica /Greenland (Ice sheets) [IS]	Mountain Glaciers (MG)
S	10	-	-
	25	GOFF	GOFF
	37.5	GOFF	GOFF
	75	-	-
L	5	-	-
	20	-	GOFF
	40	GOFF	GOFF
	77	GOFF	-

Table 12-1 GOFF Product Generation for BW and Area Combination

12.1 GOFF Overview

The GOFF product is a L2 product derived from the ROFF product by geocoding the pixel offsets layers and its associated data layers (i.e., SNR) on a geographical grid at 80 m posting. Geocoding is performed using the orbit of the reference RSLC product and a Digital Elevation Model (DEM) to project the data onto a pre-defined Universal Transverse Mercator (UTM) or Polar stereographic projection system map grid Annexure-4: Geocoded Product Grids. The geocoding algorithm uses a bilinear interpolation for interpolating data layers with floating-point data types.

The GOFF product contains a collection of data layers representing the pixel offset shifts between a pair of coarsely coregistered RSLC granules. The spacing, the window size, and the search radius used to generate the ROFF offsets layers for differerent Bandwidths of L & S Band and Area of observation(Antartic/Greenland (Ice Sheets) or Mountain Glaciers) is summarized from Table 12-2 to Table 12-9. The IL stands for incoherent speckle tracking layer.

Pixel offset layers are distributed without performing any conventional post-processing operation i.e., layers might contain offsets outliers and are not low pass filtered to reduce noise in the data. The three offset layers provided in the product can be blended into a single offset layer too, as described in Annexures-5: Offset Layer Blending Methodology.

Layer	Range Bandwidth (MHz)	Sample spacing in slant range (pixels)	Sample spacing in along-track (pixels)	Window size in slant-range (pixels)	Window size in along-track (pixels)	Search radius in slant range (pixels)	Search radius in along-track (pixels)
IL1_80IS	80	30	15	64	32	64	33
IL2_80IS	80	30	15	96	64	64	33
IL3_80IS	80	30	15	196	128	8	8

Table 12-2 L-Band Pixel offset layers: 80 MHz, Antarctica, and Greenland. (IS)

Layer	Range Bandwidth (MHz)	Sample spacing in slant range (pixels)	Sample spacing in along-track (pixels)	Window size in slant range(pixels)	Window size in alongtrack (pixels)	Search radius in slant range (pixels)	Search radius in along-track (pixels)
IL1_40IS	40	15	15	32	32	8	8
IL2_40IS	40	15	15	64	64	8	8
IL3_40IS	40	15	15	128	128	8	8

Table 12-3 L-Band Pixel offset layers: 40 MHz, Antarctica, and Greenland. (IS)

Layer	Range Bandwidth (MHz)	Sample spacing in slant range (pixels)	Sample spacing along-track (pixels)	Window size in slant range (pixels)	Window size in alongtrack (pixels)	Search radius in slant range (pixels)	Search radius in along-track (pixels)
IL1_20MG	20	8	15	32	32	16	32
IL2_20MG	20	8	15	32	64	16	32
IL3_20MG	20	8	15	64	128	16	32

Table 12-4 L-Band Pixel offset layers: 20 MHz, mountain glaciers. (MG)

Layer	Range Bandwidth (MHz)	Sample spacing in slant range (pixels)	Sample spacing along-track (pixels)	Window size in slant range (pixels)	Window size in alongtrack (pixels)	Search radius in slant range (pixels)	Search radius in along-track (pixels)
IL1_40MG	40	15	15	32	32	32	32
IL2_40MG	40	15	15	64	64	32	32
IL3_40MG	40	15	15	128	128	32	32

Table 12-5 L-Band Pixel offset layers: 40 MHz, mountain glaciers. (MG)

Layer	Range Bandwidth (MHz)	Sample spacing in slant range (pixels)	Sample spacing in along-track (pixels)	Window size in slant-range (pixels)	Window size in along-track (pixels)	Search radius in slant range (pixels)	Search radius in along-track (pixels)
IL1_25IS	25	8	15	32	32	8	16
IL2_25IS	25	8	15	32	64	8	16
IL3_25IS	25	8	15	64	128	8	16

Table 12-6 S-Band Pixel offset layers: 25 MHz, Antarctica, and Greenland. (IS)

Layer	Range Bandwidth (MHz)	Sample spacing in slant range (pixels)	Sample spacing in along-track (pixels)	Window size in slant range(pixels)	Window size in alongtrack (pixels)	Search radius in slant range (pixels)	Search radius in along-track (pixels)
IL1_37IS	37.5	12	15	32	32	8	8
IL2_37IS	37.5	12	15	64	64	8	8
IL3_37IS	37.5	12	15	128	128	8	8

Table 12-7 S-Band Pixel offset layers: 37.5 MHz, Antarctica, and Greenland. (IS)

Layer	Range Bandwidth (MHz)	Sample spacing in slant range (pixels)	Sample spacing along-track (pixels)	Window size in slant range (pixels)	Window size in alongtrack (pixels)	Search radius in slant range (pixels)	Search radius in along-track (pixels)
IL1_25MG	25	8	15	32	32	16	32
IL2_25MG	25	8	15	32	64	16	32
IL3_25MG	25	8	15	64	128	16	32

Table 12-8 S-Band Pixel offset layers: 25 MHz, mountain glaciers. (MG)

Layer	Range Bandwidth (MHz)	Sample spacing in slant range (pixels)	Sample spacing along-track (pixels)	Window size in slant range (pixels)	Window size in alongtrack (pixels)	Search radius in slant range (pixels)	Search radius in along-track (pixels)
IL1_37MG	37.5	12	15	32	32	32	32
IL2_37MG	37.5	12	15	64	64	32	32
IL3_37MG	37.5	12	15	128	128	32	32

Table 12-9 S-Band Pixel offset layers: 37.5 MHz, mountain glaciers. (MG)

12.2 GOFF Product Organization

12.2.1 Granule Definition

NISAR GOFF granules will conform to the Tiling Scheme being developed for the mission and are expected to have a ground footprint of approximately 240 km x 240 km. (except in L-Band for 77 MHz data, which cover half of the swath in range direction.)

12.2.2 File Naming Convention

NISAR GOFF Granule names will conform to the S/L-SAR Product File Naming Conventions as discussed in section 2.2.2.

12.2.3 Temporal Organization

Temporal organization is not specifically applicable to the GOFF product.

12.2.4 Spatial Organization

The L2 data are arranged on a uniformly spaced, North-up and West-left grid – i.e., decreasing North or Y coordinate in the row direction and increasing East or X coordinate in the column direction following the row-major order convention of representing 2D raster arrays. Pixel-isarea convention Annexure-4: Geocoded Product Grids is used to tag the raster layers with coordinate information.

12.2.5 Spatial Sampling and Resolution

Some salient features of the output grid for GOFF products are:

1. The top-left corner of the top-left pixel will correspond to the same geo-graphic coordinate for all the pixel offsets layers in a GOFF product.

12.2.6 Mosaicking

The spatial sampling of the output grid has been designed to facilitate along-track mosaicking of contiguous GOFF product granules if the user desires. See Appendix 13.4 : Geocoded Product Grids for details on the common output grid used for all L2 products.

Note that GOFF products generated from RSLC products with different central frequencies cannot be mosaicked for applications that expect phase continuity.

12.2.7 Partially compressed SLC data

Partially compressed data in RSLC files will not be used to produce GOFF products.

12.3 GOFF Product Specification

In this section, we briefly describe the layout of GOFF data and associated metadata within the NISAR HDF5 file. Detailed description of Group and Dataset names can be found in section 12.4. In this section, we focus on the organization of S-SAR instrument data within the file under the Group name "/science/SSAR". The same holds true for LSAR products too.

12.3.1 Shapes and Dimensions of Data

Information on the shapes and dimensions of the data items in various data tables are described as part of the metadata (section 12.4.1). This information is useful both as part of the product identification and for setting up further processing, i.e., dimensioning arrays.

12.3.2 Product Identification

Information needed to identify this product is given under the Group

"/science/SSAR/identification". This includes information such as orbit, cycle, track, and frame numbers, acquisition times, a polygon representing the bounding box of the included imagery in geographic coordinates, product version, and a product specification version (i.e., the version number of this document).

12.3.3 Radar Imagery

The GOFF product's imagery layers and associated datasets are initially organized based on the center frequency within the Group "/science/SSAR/GOFF/grids/frequencyA/". Only the main NISAR imaging band ("frequencyA") will be processed for GOFF products. The pixel offset layers and associated Datasets are situated under the Group "/science/SSAR/GOFF/grids/frequencyA/pixelOffsets/". This group is further organized by polarization (TxRx). For example, the Pixel Offsets Group could contain the Group "/science/SSAR/GOFF/grids/frequencyA/pixelOffsets/HH/". Each polarization Group is further organized in distinct Groups, one for each generated offset layer, and by a final grouping. These Pixel Offset Layers Groups are assigned monotonically increasing numbers, where the minimum index number (i.e., "layer1") contains the pixel offset layers and associated dataset at the finest resolution while the maximum index number (i.e., "layer3") contains the offset layers and associated datasets at the coarsest resolution. As an example, the Dataset "/science/SSAR/GOFF/grids/frequencyA/pixelOffsets/HH/layer1/slantRangeOffset" correspond to the geocoded slant range sub-pixel offset estimate at the finest resolution derived from the "frequencyA" and "HH" polarization imagery layers within the reference and secondary input RSLCs. The same description holds true for all polarization channels present in the product. The same convention holds true for L-Band products.

12.3.4 Radar Metadata

The *metadata* group under "/science/SSAR/GOFF/metadata" includes a list of miscellaneous metadata needed to interpret the imagery (e.g., layers of slant range and along-track pixel offsets) included in the GOFF product.

12.3.4.1 Processing Information

The Group "/science/SSAR/GOFF/metadata/processingInformation/ includes the processing parameters used to generate the GOFF product. This group also include a list of the used algorithms, and the inputs granules and files used to produce GOFF. For a complete description of this group, refer to section 12.4.4

12.3.4.2 Parameters

The Group "/science/SSAR/GOFF/metadata/processingInformation/parameters/" is further organized in five Groups:

1. *reference*: including the reference terrain height of the reference RSLC and Boolean flags to indicate if the RSLC is the results of mixed mode processing and if RFI correction has been applied. This Group is further organized by frequency and includes some relevant parameters of the reference RSLC such as the slant range and zero Doppler time spacings, the slant range and the azimuth bandwidths, and the Doppler centroid.

2. *secondary*: this Group follows the same organization of *reference* but includes the corresponding metadata for the secondary RSLC.

3. *common*: organized by frequency, and including the parameters derived by combining the information from the reference and secondary RSLC such as the Doppler Centroid and the Doppler bandwidth.

4. *pixelOffsets*: including the parameters used to generate the individual layers of dense pixel offsets in the radar geometry. This group is further organized by frequency. The Group *frequencyA* contains the offsets parameter common to each layer of offsets i.e., the offset spacings in slant range and along-track direction, the correlation surface oversampling factor. The offsets parameters specific for each offset layer are further organized in the *layer* Groups. Each *layer* Group contains the along-track and slant

range window and search window sizes used to generate the pixel offsets for that specific layer.

5. *geocoding:* including a set of flags indicating the corrections that have been applied while geocoding the pixel offsets layers from radar to geographical coordinates i.e., wet and dry troposphere corrections, slant range and azimuth ionosphere corrections.

The Group *parameters* also contains the Dataset *runConfigurationContents* which includes a copy of the run configuration file used for processing populated with all the processing options, parameter values, and input files.

12.3.4.3 Algorithms

The Group "/science/SSAR/GOFF/metadata/processingInformation/algorithms/" includes the name and the version of the software used to generate the product. The Group is further organized by distinct Groups identifying the processing steps used to generate the GOFF product:

1. *coregistration*: including the algorithms used to perform the coarse and fine coregistration of the reference and secondary RSLCs (e.g., geometry coregistration, cross-correlation algorithm).

2. *crossCorrelation*: further organized by offset layer and including the cross-correlation algorithm used to generate each individual layer of pixel offset.

3. *geocoding*: including the algorithms used to perform the geocoding of the data layers within the GOFF product.

12.3.4.4 Input Files

The Group "/science/SSAR/GOFF/metadata/processingInformation/inputs/" includes the filenames of the input RSLC granules, configuration files, orbit files, and a description of the DEM used for processing.

12.3.5 Other Radar Metadata

12.3.5.1 Orbit

The reference RSLC orbit ephemeris used for generating the GOFF product is provided under the Group "/science/SSAR/GOFF/metadata/orbit/". This group includes time-tagged antenna phase center position and velocity vectors in Earth Centered Earth Fixed (ECEF) Cartesian coordinates and information on the used orbit fidelity (e.g., Medium Orbit Ephemeris).

12.3.5.2 Attitude

The attitude state vectors of the reference RSLC used for generating the RIFG product can be found under the Group "/science/SSAR/GOFF/metadata/attitude/". This group includes time-tagged quaternions and Euler angles representing the slant range plane from the antenna phase center in an ECEF Cartesian system.

12.3.6 Radar Grid

The group "/science/SSAR/GOFF/metadata/radarGrid/" contains information on the radar geometry of the reference RSLCs. The Datasets within this Group are given in the form of metadata cubes, referred to as radar grid cubes, that are organized over a three-dimensional geographic grid. The representation as data cubes, rather than two-dimensional rasters, is used to reduce the amount of space required to store radar geometry values within NISAR L2 products. This is possible because each radar grid cube contains slowly varying values in space that can be described by a low-resolution three-dimensional grid with sufficient accuracy.

These values, however, are usually required at the terrain height, often characterized by a fast-varying surface representing the local topography. A higher-resolution DEM can then be used to interpolate radar grid cubes and generate high-resolution maps of the corresponding radar geometry variable. Further information on metadata cubes along with examples on how to interpolate them using a reference DEM is provided in Annexure-4: Geocoded Product Grids.

Radar grid cubes (for geocoded products) are provided in the same coordinate system as the product imagery with similar extents (bounding box) but coarser pixel spacing. The three-dimensional geographic grid is defined by the HDF5 Datasets “xCoordinates” (defining the east component), “yCoordinates” (north component), and “heightAboveEllipsoid” (height above the WGS84 ellipsoid), common to all radar grid cubes, and following the CF-1.7 convention.

The “radarGrid” Group also included the Datasets:

1. “referenceSlantRange” (“secondarySlantRange”) and “referenceZeroDopplerAzimuthTime” (“secondaryZeroDopplerAzimuthTime”) defining the Zero-Doppler radar grid of the reference (secondary) RSLC. These Datasets contain respectively the range position in meters and the Zero-Doppler azimuth time in seconds for each point of the geographical grid

2. “losUnitVectorX” and “losUnitVectorY” identifying the East and North components of the Line-Of-Sight (LOS) unit vector (i.e., the vector from the target to the sensor) in the East-North-Up (ENU) coordinate system for each point of the geographic grid. The Up component of the LOS unit vector can be simply derived from the East and North components as:

$$losUnitVectorZ = \sqrt{1 - losUnitVectorX^2 - losUnitVectorY^2}$$

3. “alongTrackUnitVectorX” and “alongTrackUnitVectorY” containing the East and North components of the along-track unit vector (i.e., the projection of the along-track vector at the ground height) in ENU coordinates

4. “incidenceAngle” containing the incidence angle, i.e., the angle between the LOS vector and the normal to the ellipsoid at the target height

5. “elevationAngle” containing the elevation angle i.e., the angle between the LOS vector and the normal to the ellipsoid at the sensor

6. “groundTrackVelocity” containing the ground track velocity i.e., the absolute value of the platform velocity scaled at the target height

7. “perpendicularBaseline” and “parallelBaseline” containing the perpendicular and parallel component of the baseline between the reference and secondary RSLCs.

The details of the usage of metadata cube are given in

Annexure-2: Metadata Cube.

In ISRO generated L and S Band products, a separate layer is defined in a separate sub-group for all these parameters at true height:

"/science/SSAR/RSLC/metadata/geolocationGridTrueHeight/”.

In this group all the parameters of metadata will be generated at true height (meaning they will be generated at actual height of terrain) and will be a part of the product. This layer will be at a finer sampling than the actual meta data cube layers. The number of dimensions, description and datatype will be same as that of actual metadata cube layer.

The details of this are present in Annexure-3: Metadata Cube at True Height.

12.4 GOFF Product Specification

In this section, actual datasets are defined in tabular form. They contain the dataset information available in ROFF product, which comprises of name, datatype, shape, and information corresponding to attributes. In product there are few datasets or few sub-groups that are per polarization. For representation, here only one polarization is used; in product, the layers/datasets/groups will be present as per the number of polarizations available in the product. The same holds true for frequency A for L-Band products.

12.4.1 Dimensions and Shapes

To simplify the description of the layout of data within the HDF5 file, we will use a table of dimensions and shapes to represent the relationship between similarly sized datasets. The entries in this table do not present actual datasets in the HDF5. This table is meant to be a guide to interpreting the shapes of the datasets in subsequent subsections.

Name	Shape	Description
scalar	scalar	Scalar values
numberOfDatatakes	scalar	Number of datatakes in product
numberOfObservations	scalar	Number of observations in product
numberOfFrequencies	scalar	Number of S/L-SAR frequencies in product
numberOfFrequencyAPolarizations	scalar	Number of polarization layers associated with S/L-SAR frequency A
numberOfFrequencyAOffsetLayers	scalar	Number of pixel offset layers associated with S/L-SAR frequency A

offsetShape	(offsetLength, offsetWidth)	Shape associated with S/L-SAR datasets in the pixelOffset groups
offsetWidth	scalar	Number of pixels in all S/L-SAR datasets within the pixelOffsets group
offsetLength	scalar	Number of lines in all S/L-SAR datasets within the pixelOffsets group
radarCubeShape	(radarCubeHeight, radarCubeLength, radarCubeWidth)	Shape associated with metadata cube
radarCubeShapeTrueHeight	(1, radarCubeTrueHeightLength, radarCubeTrueHeightWidth)	Shape associated with metadata cube at true height
radarCubeHeight	scalar	Height dimension of the metadata cube
radarCubeLength	scalar	Length dimension of the metadata cube
radarCubeWidth	scalar	Width dimension of the metadata cube
radarCubeLengthTrueHeight	scalar	Length dimension of the metadata cube at true height
radarCubeWidthTrueHeight	scalar	Width dimension of the metadata cube at true height
radarCubeHeightTrueHeight	scalar	Height dimension of the metadata cube at true height. The value will be one.
dopplerCentroidLength	scalar	Length dimension of Doppler centroid grid
dopplerCentroidWidth	scalar	Width dimension of Doppler centroid grid
dopplerCentroidShape	(dopplerCentroidLength, dopplerCentroidWidth)	Shape of the Doppler centroid grid
orbitListLength	scalar	Number of orbit state vectors

orbitShape	(orbitListLength, 3)	Shape of orbit state vector triplets dataset
attitudeListLength	scalar	Number of attitude state vectors
attitudeQuaternionShape	(attitudeListLength, 4)	Shape of attitude quaternion dataset
attitudeShape	(attitudeListLength, 3)	Shape of attitude Euler angle triplets dataset
numberOfInputReferenceL1Files	scalar	Number of input reference L1 granules
numberOfInputSecondaryL1Files	scalar	Number of input secondary L1 granules
numberOfInputOrbitFiles	scalar	Number of input orbit files
numberOfInputConfigFiles	scalar	Number of configuration files

12.4.2 Product Identification

Product identification variables	
/science/SSAR/identification/referenceAbsoluteOrbitNumber	
Type: UInt32	**Shape: scalar**
Description: Absolute orbit number for the reference SLC	
/science/SSAR/identification/secondaryAbsoluteOrbitNumber	
Type: UInt32	**Shape: scalar**
Description: Absolute orbit number for the secondary SLC	
/science/SSAR/identification/referenceIsJointObservation	
Type: string	**Shape: scalar**
Description: "True" if any portion of the reference RSLC was acquired in a joint observation mode (e.g., L-band and S-band simultaneously), "False" otherwise	
/science/SSAR/identification/secondaryIsJointObservation	
Type: string	**Shape: scalar**
Description: "True" if any portion of the reference RSLC was acquired in a joint observation mode (e.g., L-band and S-band simultaneously), "False" otherwise	
/science/SSAR/identification/trackNumber	
Type: UInt32	**Shape: scalar**
Description: Track number	
/science/SSAR/identification/frameNumber	
Type: UInt16	**Shape: scalar**
Description: Frame number	
/science/SSAR/identification/missionId	
Type: string	**Shape: scalar**
Description: Mission identifier	
/science/SSAR/identification/processingCenter	
Type: string	**Shape: scalar**
Description: Data processing center	
/science/SSAR/identification/productType	
Type: string	**Shape: scalar**
Description: Product type	
/science/SSAR/identification/granuleId	

Type: string	**Shape: scalar**
Description: Unique granule identification name	
/science/SSAR/identification/productDoi	
Type: string	**Shape: scalar**
Description: Digital Object Identifier (DOI) for the product	
/science/SSAR/identification/productVersion	
Type: string	**Shape: scalar**
Description: Product version which represents the structure of the product and the science content governed by the algorithm, input data, and processing parameters	
/science/SSAR/identification/productSpecificationVersion	
Type: string	**Shape: scalar**
Description: Product specification version which represents the schema of this product	
/science/SSAR/identification/lookDirection	
Type: string	**Shape: scalar**
Description: Look direction, either "Left" or "Right"	
/science/SSAR/identification/orbitPassDirection	
Type: string	**Shape: scalar**
Description: Orbit direction, either "Ascending" or "Descending"	
/science/SSAR/identification/referenceZeroDopplerStartTime	
Type: string	**Shape: scalar**
Description: Azimuth stop time (in UTC) of reference RSLC product in the format YYYY-mm-ddTHH:MM:SS.sssssssss	
/science/SSAR/identification/referenceZeroDopplerEndTime	
Type: string	**Shape: scalar**
Description: Azimuth stop time (in UTC) of reference RSLC product in the format YYYY-mm-ddTHH:MM:SS.sssssssss	
/science/SSAR/identification/secondaryZeroDopplerStartTime	
Type: string	**Shape: scalar**
Description: Azimuth start time (in UTC) of secondary RSLC product in the format YYYY-mm-ddTHH:MM:SS.sssssssss	
/science/SSAR/identification/secondaryZeroDopplerEndTime	
Type: string	**Shape: scalar**
Description: Azimuth stop time (in UTC) of secondary RSLC product in the format YYYY-mm-ddTHH:MM:SS.sssssssss	
/science/SSAR/identification/plannedDatatakeId	
Type: string	**Shape: (numberOfDatatakes)**
Description: List of planned datatakes included in the product	
/science/SSAR/identification/plannedObservationId	
Type: string	**Shape: (numberOfObservations)**
Description: List of planned observations included in the product	
/science/SSAR/identification/isUrgentObservation	
Type: string	**Shape: scalar**
Description: Flag indicating if observation is nominal ("False") or urgent ("True")	
/science/SSAR/identification/listOfFrequencies	
Type: string	**Shape: (numberOfFrequencies)**
Description: List of frequency layers available in the product	
/science/SSAR/identification/diagnosticModeFlag	
Type: UByte	**Shape: scalar**
Description: Indicates if the radar operation mode is a diagnostic mode (1-2) or DBFed science (0): 0, 1, or 2	
/science/SSAR/identification/productLevel	
Type: string	**Shape: scalar**
Description: Product level. L0A: Unprocessed instrument data; L0B: Reformatted, unprocessed instrument data; L1: Processed instrument data in radar coordinates system; and L2: Processed instrument data in geocoded coordinates system	
/science/SSAR/identification/isGeocoded	

Type: string	**Shape: scalar**	
Description: Flag to indicate if the product data is in the radar geometry ("False") or in the map geometry ("True")		
/science/SSAR/identification/boundingPolygon		
Type: string	**Shape: scalar**	
Description: OGR compatible WKT representing the bounding polygon of the image. Horizontal coordinates are WGS84 longitude followed by latitude (both in degrees), and the vertical coordinate is the height above the WGS84 ellipsoid in meters. The first point corresponds to the start-time, near-range radar coordinate, and the perimeter is traversed in counterclockwise order on the map. This means the traversal order in radar coordinates differs for left-looking and right-looking sensors. The polygon includes the four corners of the radar grid, with equal numbers of points distributed evenly in radar coordinates along each edge		
	ogr_geometry	polygon
	epsg	4326
/science/SSAR/identification/processingDateTime		
Type: string	**Shape: scalar**	
Description: Processing UTC date and time in the format YYYY-mm-ddTHH:MM:SS		
/science/SSAR/identification/radarBand		
Type: string	**Shape: scalar**	
Description: Acquired frequency band, either "L" or "S"		
/science/SSAR/identification/platformName		
Type: string	**Shape: scalar**	
Description: Name of the platform used to collect the remote sensing data provided in this product		
/science/SSAR/identification/instrumentName		
Type: string	**Shape: scalar**	
Description: Name of the instrument used to collect the remote sensing data provided in this product		
/science/SSAR/identification/processingType		
Type: string	**Shape: scalar**	
Description: Nominal (or) Urgent (or) Custom (or) Undefined		
/science/SSAR/identification/isDithered		
Type: string	**Shape: scalar**	
Description: "True" if the pulse timing was varied (dithered) during acquisition, "False" otherwise		
/science/SSAR/identification/isMixedMode		
Type: string	**Shape: scalar**	
Description: "True" if this product is generated from reference and secondary RSLCs with different range bandwidths, "False" otherwise		
/science/SSAR/identification/isFullFrame		
Type: string	**Shape: scalar**	
Description: "True" if this product fully covers a NISAR frame**,** "False" if partial coverage.		
	frameCoveragePercentage	Percentage of NISAR frame containing processed data
	thresholdPercentage	Threshold percentage used to determine if the product is full frame or partial frame
/science/SSAR/identification/compositeReleaseId		
Type: string	**Shape: scalar**	
Description: Unique version identifier of the science data production system		

12.4.3 Radar Imagery

Product imagery variables	
/science/SSAR/GOFF/grids/frequencyA/listOfPolarizations	
Type: string	**Shape: (numberOfFrequencyAPolarizations)**
Description: List of processed polarization layers with frequency A	
/science/SSAR/GOFF/grids/frequencyA/centerFrequency	
Type: Float64	**Shape: scalar**
Description: Center frequency of the processed image in hertz	

	units	hertz
/science/SSAR/GOFF/grids/frequencyA/listOfLayers		
Type: string		**Shape: (numberOfFrequencyAOffsetLayers)**
Description: List of pixel offset layers		
/science/SSAR/GOFF/swaths/frequencyA/pixelOffsets/mask		
Type: UByte		**Shape: (offsetLength, offsetWidth)**
Description: Combination of water mask and a mask of subswaths of valid samples in the reference RSLC and geometrically coregistered secondary RSLC. Each pixel value is a three-digit number: the most significant digit represents the water flag of that pixel the reference RSLC, where 1 is water and 0 is non-water; the second digit represents the subswath number of that pixel in the reference RSLC; the least significant digit represents the subswath number of that pixel in the secondary RSLC. A value of '0' in either subswath digit indicates an invalid sample in the corresponding RSLC		
	_FillValue	255
	valid_min	0
	grid_mapping	projection
	percentage_water	Percentage of pixels over water bodies and ocean
/science/SSAR/GOFF/grids/frequencyA/pixelOffsets/projection		
Type: UInt32		**Shape: scalar**
Description: Product map grid projection: EPSG code, with additional projection information as HDF5 Attributes		
	ellipsoid	Projection ellipsoid
	epsg_code	Projection EPSG code
	false_easting	The value added to all abscissa values in the rectangular coordinates for a map projection.
	false_northing	The value added to all ordinate values in the rectangular coordinates for a map projection.
	grid_mapping_name	Grid mapping variable name
	inverse_flattening	Inverse flattening of the ellipsoidal figure
	latitude_of_projection_origin	The latitude chosen as the origin of rectangular coordinates for a map projection.
	longitude_of_projection_origin	The longitude, with respect to Greenwich, of the prime meridian associated with the geodetic datum.
	semi_major_axis	Semi-major axis
	spatial_ref	Spatial reference
	utm_zone_number	UTM zone number
	longitude_of_central_meridian	The line of longitude at the center of a map projection generally used as the basis for constructing the projection.
	scale_factor_at_central_meridian	A multiplier for reducing a distance obtained from a map by computation or scaling to the actual distance along the central meridian.
/science/SSAR/GOFF/grids/frequencyA/pixelOffsets/yCoordinateSpacing		
Type: Float64		**Shape: scalar**
Description: Nominal spacing in meters between consecutive lines		
	long_name	Y coordinates spacing
	units	meters
/science/SSAR/GOFF/grids/frequencyA/pixelOffsets/xCoordinateSpacing		
Type: Float64		**Shape: scalar**
Description: Nominal spacing in meters between consecutive pixels		
	long_name	X coordinates spacing
	units	meters
/science/SSAR/GOFF/grids/frequencyA/pixelOffsets/HH/layer1/projection		
Type: UInt32		**Shape: scalar**

Description: Product map grid projection: EPSG code, with additional projection information as HDF5 Attributes		
	ellipsoid	Projection ellipsoid
	epsg_code	Projection EPSG code
	false_easting	The value added to all abscissa values in the rectangular coordinates for a map projection.
	false_northing	The value added to all ordinate values in the rectangular coordinates for a map projection.
	grid_mapping_name	Grid mapping variable name
	inverse_flattening	Inverse flattening of the ellipsoidal figure
	latitude_of_projection_origin	The latitude chosen as the origin of rectangular coordinates for a map projection.
	longitude_of_projection_origin	The longitude, with respect to Greenwich, of the prime meridian associated with the geodetic datum.
	semi_major_axis	Semi-major axis
	spatial_ref	Spatial reference
	utm_zone_number	UTM zone number
	longitude_of_central_meridian	The line of longitude at the center of a map projection generally used as the basis for constructing the projection.
	scale_factor_at_central_meridian	A multiplier for reducing a distance obtained from a map by computation or scaling to the actual distance along the central meridian.
/science/SSAR/GOFF/grids/frequencyA/pixelOffsets/HH/layer1/yCoordinateSpacing		
Type: Float64		**Shape: scalar**
Description: Nominal spacing in meters between consecutive lines		
	long_name	Y coordinates spacing
	units	meters
/science/SSAR/GOFF/grids/frequencyA/pixelOffsets/HH/layer1/xCoordinateSpacing		
Type: Float64		**Shape: scalar**
Description: Nominal spacing in meters between consecutive pixels		
	long_name	X coordinates spacing
	units	meters
/science/SSAR/GOFF/grids/frequencyA/pixelOffsets/HH/layer2/projection		
Type: UInt32		**Shape: scalar**
Description: Product map grid projection: EPSG code, with additional projection information as HDF5 Attributes		
	ellipsoid	Projection ellipsoid
	epsg_code	Projection EPSG code
	false_easting	The value added to all abscissa values in the rectangular coordinates for a map projection.
	false_northing	The value added to all ordinate values in the rectangular coordinates for a map projection.
	grid_mapping_name	Grid mapping variable name
	inverse_flattening	Inverse flattening of the ellipsoidal figure
	latitude_of_projection_origin	The latitude chosen as the origin of rectangular coordinates for a map projection.
	longitude_of_projection_origin	The longitude, with respect to Greenwich, of the prime meridian associated with the geodetic datum.
	semi_major_axis	Semi-major axis
	spatial_ref	Spatial reference
	utm_zone_number	UTM zone number
	longitude_of_central_meridian	The line of longitude at the center of a map projection generally used as the basis for constructing the projection.

	scale_factor_at_central_meridian	A multiplier for reducing a distance obtained from a map by computation or scaling to the actual distance along the central meridian.
/science/SSAR/GOFF/grids/frequencyA/pixelOffsets/HH/layer2/yCoordinateSpacing		
Type: Float64		**Shape: scalar**
Description: Nominal spacing in meters between consecutive lines		
	long_name	Y coordinates spacing
	units	meters
/science/SSAR/GOFF/grids/frequencyA/pixelOffsets/HH/layer2/xCoordinateSpacing		
Type: Float64		**Shape: scalar**
Description: Nominal spacing in meters between consecutive pixels		
	long_name	X coordinates spacing
	units	meters
/science/SSAR/GOFF/grids/frequencyA/pixelOffsets/HH/layer3/projection		
Type: UInt32		**Shape: scalar**
Description: Product map grid projection: EPSG code, with additional projection information as HDF5 Attributes		
	ellipsoid	Projection ellipsoid
	epsg_code	Projection EPSG code
	false_easting	The value added to all abscissa values in the rectangular coordinates for a map projection.
	false_northing	The value added to all ordinate values in the rectangular coordinates for a map projection.
	grid_mapping_name	Grid mapping variable name
	inverse_flattening	Inverse flattening of the ellipsoidal figure
	latitude_of_projection_origin	The latitude chosen as the origin of rectangular coordinates for a map projection.
	longitude_of_projection_origin	The longitude, with respect to Greenwich, of the prime meridian associated with the geodetic datum.
	semi_major_axis	Semi-major axis
	spatial_ref	Spatial reference
	utm_zone_number	UTM zone number
	longitude_of_central_meridian	The line of longitude at the center of a map projection generally used as the basis for constructing the projection.
	scale_factor_at_central_meridian	A multiplier for reducing a distance obtained from a map by computation or scaling to the actual distance along the central meridian.
/science/SSAR/GOFF/grids/frequencyA/pixelOffsets/HH/layer3/yCoordinateSpacing		
Type: Float64		**Shape: scalar**
Description: Nominal spacing in meters between consecutive lines		
	long_name	Y coordinates spacing
	units	meters
/science/SSAR/GOFF/grids/frequencyA/pixelOffsets/HH/layer3/xCoordinateSpacing		
Type: Float64		**Shape: scalar**
Description: Nominal spacing in meters between consecutive pixels		
	long_name	X coordinates spacing
	units	meters
/science/SSAR/GOFF/grids/frequencyA/pixelOffsets/xCoordinates		
Type: Float64		**Shape: (offsetWidth)**
Description: X coordinates in specified projection		
	long_name	X coordinates of projection
	standard_name	projection_x_coordinate
	units	meters

/science/SSAR/GOFF/grids/frequencyA/pixelOffsets/yCoordinates		
Type: Float64		**Shape: (offsetLength)**
Description: Y coordinates in specified projection		
	long_name	Y coordinates of projection
	standard_name	projection_y_coordinate
	units	meters
/science/SSAR/GOFF/grids/frequencyA/pixelOffsets/HH/layer1/xCoordinates		
Type: Float64		**Shape: (offsetWidth)**
Description: X coordinates in specified projection		
	long_name	X coordinates of projection
	standard_name	projection_x_coordinate
	units	meters
/science/SSAR/GOFF/grids/frequencyA/pixelOffsets/HH/layer1/yCoordinates		
Type: Float64		**Shape: (offsetLength)**
Description: Y coordinates in specified projection		
	long_name	Y coordinates of projection
	standard_name	projection_y_coordinate
	units	meters
/science/SSAR/GOFF/grids/frequencyA/pixelOffsets/HH/layer2/xCoordinates		
Type: Float64		**Shape: (offsetWidth)**
Description: X coordinates in specified projection		
	long_name	X coordinates of projection
	standard_name	projection_x_coordinate
	units	meters
/science/SSAR/GOFF/grids/frequencyA/pixelOffsets/HH/layer2/yCoordinates		
Type: Float64		**Shape: (offsetLength)**
Description: Y coordinates in specified projection		
	long_name	Y coordinates of projection
	standard_name	projection_y_coordinate
	units	meters
/science/SSAR/GOFF/grids/frequencyA/pixelOffsets/HH/layer3/xCoordinates		
Type: Float64		**Shape: (offsetWidth)**
Description: X coordinates in specified projection		
	long_name	X coordinates of projection
	standard_name	projection_x_coordinate
	units	meters
/science/SSAR/GOFF/grids/frequencyA/pixelOffsets/HH/layer3/yCoordinates		
Type: Float64		**Shape: (offsetLength)**
Description: Y coordinates in specified projection		
	long_name	Y coordinates of projection
	standard_name	projection_y_coordinate
	units	meters
/science/SSAR/GOFF/grids/frequencyA/pixelOffsets/HH/layer1/alongTrackOffset		
Type: Float32		**Shape: (offsetLength, offsetWidth)**
Description: Raw (unculled, unfiltered) along-track pixel offsets		
	_FillValue	nan
	grid_mapping	projection
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points

	units	meters
/science/SSAR/GOFF/grids/frequencyA/pixelOffsets/HH/layer1/slantRangeOffset		
Type: Float32		**Shape: (offsetLength, offsetWidth)**
Description: Raw (unculled, unfiltered) slant range pixel offsets		
	_FillValue	nan
	grid_mapping	projection
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points
	units	meters
/science/SSAR/GOFF/grids/frequencyA/pixelOffsets/HH/layer1/correlationSurfacePeak		
Type: Float32		**Shape: (offsetLength, offsetWidth)**
Description: Normalized correlation surface peak		
	_FillValue	nan
	grid_mapping	projection
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points
	units	1
/science/SSAR/GOFF/grids/frequencyA/pixelOffsets/HH/layer1/crossOffsetVariance		
Type: Float32		**Shape: (offsetLength, offsetWidth)**
Description: Off-diagonal term of the pixel offsets covariance matrix		
	_FillValue	nan
	grid_mapping	projection
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points
	units	meters^2
/science/SSAR/GOFF/grids/frequencyA/pixelOffsets/HH/layer1/slantRangeOffsetVariance		
Type: Float32		**Shape: (offsetLength, offsetWidth)**
Description: Slant range pixel offsets variance		
	units	meters^2
	_FillValue	nan
	grid_mapping	projection
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points
/science/SSAR/GOFF/grids/frequencyA/pixelOffsets/HH/layer1/alongTrackOffsetVariance		
Type: Float32		**Shape: (offsetLength, offsetWidth)**
Description: Along-track pixel offsets variance		
	_FillValue	nan
	grid_mapping	projection
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points

	units	meters^2
/science/SSAR/GOFF/grids/frequencyA/pixelOffsets/HH/layer1/snr		
Type: Float32		**Shape: (offsetLength, offsetWidth)**
Description: Pixel offsets signal-to-noise ratio		
	_FillValue	nan
	grid_mapping	projection
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points
	units	1
/science/SSAR/GOFF/grids/frequencyA/pixelOffsets/HH/layer2/alongTrackOffset		
Type: Float32		**Shape: (offsetLength, offsetWidth)**
Description: Raw (unculled, unfiltered) along-track pixel offsets		
	_FillValue	nan
	grid_mapping	projection
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points
	units	meters
/science/SSAR/GOFF/grids/frequencyA/pixelOffsets/HH/layer2/slantRangeOffset		
Type: Float32		**Shape: (offsetLength, offsetWidth)**
Description: Raw (unculled, unfiltered) slant range pixel offsets		
	_FillValue	nan
	grid_mapping	projection
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points
	units	meters
/science/SSAR/GOFF/grids/frequencyA/pixelOffsets/HH/layer2/correlationSurfacePeak		
Type: Float32		**Shape: (offsetLength, offsetWidth)**
Description: Normalized correlation surface peak		
	_FillValue	nan
	grid_mapping	projection
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points
	units	1
/science/SSAR/GOFF/grids/frequencyA/pixelOffsets/HH/layer2/crossOffsetVariance		
Type: Float32		**Shape: (offsetLength, offsetWidth)**
Description: Off-diagonal term of the pixel offsets covariance matrix		
	_FillValue	nan
	grid_mapping	projection
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points

	units	meters^2
/science/SSAR/GOFF/grids/frequencyA/pixelOffsets/HH/layer2/slantRangeOffsetVariance		
Type: Float32		**Shape: (offsetLength, offsetWidth)**
Description: Slant range pixel offsets variance		
	_FillValue	nan
	grid_mapping	projection
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points
	units	meters^2
/science/SSAR/GOFF/grids/frequencyA/pixelOffsets/HH/layer2/alongTrackOffsetVariance		
Type: Float32		**Shape: (offsetLength, offsetWidth)**
Description: Along-track pixel offsets variance		
	_FillValue	nan
	grid_mapping	projection
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points
	units	meters^2
/science/SSAR/GOFF/grids/frequencyA/pixelOffsets/HH/layer2/snr		
Type: Float32		**Shape: (offsetLength, offsetWidth)**
Description: Pixel offsets signal-to-noise ratio		
	_FillValue	nan
	grid_mapping	projection
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points
	units	1
/science/SSAR/GOFF/grids/frequencyA/pixelOffsets/HH/layer3/alongTrackOffset		
Type: Float32		**Shape: (offsetLength, offsetWidth)**
Description: Raw (unculled, unfiltered) along-track pixel offsets		
	_FillValue	nan
	grid_mapping	projection
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points
	units	meters
/science/SSAR/GOFF/grids/frequencyA/pixelOffsets/HH/layer3/slantRangeOffset		
Type: Float32		**Shape: (offsetLength, offsetWidth)**
Description: Raw (unculled, unfiltered) slant range pixel offsets		
	_FillValue	nan
	grid_mapping	projection
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points

	units	meters
/science/SSAR/GOFF/grids/frequencyA/pixelOffsets/HH/layer3/correlationSurfacePeak		
Type: Float32		**Shape: (offsetLength, offsetWidth)**
Description: Normalized correlation surface peak		
	_FillValue	nan
	grid_mapping	projection
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points
	units	1
/science/SSAR/GOFF/grids/frequencyA/pixelOffsets/HH/layer3/crossOffsetVariance		
Type: Float32		**Shape: (offsetLength, offsetWidth)**
Description: Off-diagonal term of the pixel offsets covariance matrix		
	_FillValue	nan
	grid_mapping	projection
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points
	units	meters^2
/science/SSAR/GOFF/grids/frequencyA/pixelOffsets/HH/layer3/slantRangeOffsetVariance		
Type: Float32		**Shape: (offsetLength, offsetWidth)**
Description: Slant range pixel offsets variance		
	_FillValue	nan
	grid_mapping	projection
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points
	units	meters^2
/science/SSAR/GOFF/grids/frequencyA/pixelOffsets/HH/layer3/alongTrackOffsetVariance		
Type: Float32		**Shape: (offsetLength, offsetWidth)**
Description: Along-track pixel offsets variance		
	_FillValue	nan
	grid_mapping	projection
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points
	units	meters^2
/science/SSAR/GOFF/grids/frequencyA/pixelOffsets/HH/layer3/snr		
Type: Float32		**Shape: (offsetLength, offsetWidth)**
Description: Pixel offsets signal-to-noise ratio		
	_FillValue	nan
	grid_mapping	projection
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points

	units	1

12.4.4 Processing Information

Processing-related variables		
/science/SSAR/GOFF/metadata/processingInformation/parameters/runConfigurationContents		
Type: string	**Shape: scalar**	
Description: Contents of the run configuration file with parameters used for processing		
/science/SSAR/GOFF/metadata/processingInformation/parameters/reference/referenceTerrainHeight		
Type: Float32	**Shape: (dopplerCentroidLength, dopplerCentroidWidth)**	
Description: Reference Terrain Height as a function of map coordinates for reference RSLC		
	units	meters
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (second)
/science/SSAR/GOFF/metadata/processingInformation/parameters/reference/rfiMitigationApplied		
Type: string	**Shape: scalar**	
Description: Flag to indicate if RFI mitigation has been applied to reference RSLC		
/science/SSAR/GOFF/metadata/processingInformation/parameters/reference/isMixedMode		
Type: string	**Shape: scalar**	
Description: "True" if reference RSLC is a composite of data collected in multiple radar modes, "False" otherwise		
/science/SSAR/GOFF/metadata/processingInformation/parameters/reference/frequencyA/slantRangeStart		
Type: Float64	**Shape: scalar**	
Description: Slant range start distance for the reference RSLC		
	units	meters
/science/SSAR/GOFF/metadata/processingInformation/parameters/reference/frequencyA/numberOfRangeSamples		
Type: UInt64	**Shape: scalar**	
Description: Number of slant range samples for each azimuth line within the reference RSLC		
	units	1
/science/SSAR/GOFF/metadata/processingInformation/parameters/reference/frequencyA/numberOfAzimuthLines		
Type: UInt64	**Shape: scalar**	
Description: Number of azimuth lines within the reference RSLC		
	units	1
/science/SSAR/GOFF/metadata/processingInformation/parameters/reference/frequencyA/slantRangeSpacing		
Type: Float64	**Shape: scalar**	
Description: Slant range spacing of reference RSLC		
	units	meters
/science/SSAR/GOFF/metadata/processingInformation/parameters/reference/frequencyA/zeroDopplerTimeSpacing		
Type: Float64	**Shape: scalar**	
Description: Time interval in the along-track direction for reference RSLC raster layers		
	units	seconds
/science/SSAR/GOFF/metadata/processingInformation/parameters/reference/frequencyA/zeroDopplerStartTime		
Type: String	**Shape: scalar**	

Description: Azimuth start time (in UTC) of the reference RSLC product in the format YYYY-mm-ddTHH:MM:SS.sssssssss		
/science/SSAR/GOFF/metadata/processingInformation/parameters/reference/frequencyA/zeroDopplerEndTime		
Type: string	**Shape: scalar**	
Description: Azimuth stop time (in UTC) of the reference RSLC product in the format YYYY-mm-ddTHH:MM:SS.sssssssss		
/science/SSAR/GOFF/metadata/processingInformation/parameters/reference/frequencyA/rangeBandwidth		
Type: Float64	**Shape: scalar**	
Description: Processed slant range bandwidth for reference RSLC		
	units	hertz
/science/SSAR/GOFF/metadata/processingInformation/parameters/reference/frequencyA/azimuthBandwidth		
Type: Float64	**Shape: scalar**	
Description: Processed azimuth bandwidth for reference RSLC		
	units	hertz
/science/SSAR/GOFF/metadata/processingInformation/parameters/reference/frequencyA/dopplerCentroid		
Type: Float64	**Shape: (dopplerCentroidLength, dopplerCentroidWidth)**	
Description: 2D LUT of Doppler centroid for frequency A		
	units	hertz
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (second)
/science/SSAR/GOFF/metadata/processingInformation/parameters/secondary/rfiMitigationApplied		
Type: string	**Shape: scalar**	
Description: Flag to indicate if RFI mitigation has been applied to secondary RSLC		
/science/SSAR/GOFF/metadata/processingInformation/parameters/secondary/isMixedMode		
Type: string	**Shape: scalar**	
Description: "True" if secondary RSLC is a composite of data collected in multiple radar modes, "False" otherwise		
/science/SSAR/GOFF/metadata/processingInformation/parameters/secondary/referenceTerrainHeight		
Type: Float32	**Shape: (dopplerCentroidLength, dopplerCentroidWidth)**	
Description: Reference Terrain Height as a function of map coordinates for secondary RSLC		
	units	meters
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (second)
/science/SSAR/GOFF/metadata/processingInformation/parameters/secondary/frequencyA/dopplerCentroid		
Type: Float64	**Shape: (dopplerCentroidLength, dopplerCentroidWidth)**	
Description: 2D LUT of Doppler centroid for frequency A		
	units	hertz
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (second)

/science/SSAR/GOFF/metadata/processingInformation/parameters/secondary/frequencyA/slantRangeStart		
Type: Float64	**Shape: scalar**	
Description: Slant range start distance for the reference RSLC		
	units	meters
/science/SSAR/GOFF/metadata/processingInformation/parameters/secondary/frequencyA/numberOfRangeSamples		
Type: UInt64	**Shape: scalar**	
Description: Number of slant range samples for each azimuth line within the reference RSLC		
	units	1
/science/SSAR/GOFF/metadata/processingInformation/parameters/secondary/frequencyA/numberOfAzimuthLines		
Type: UInt64	**Shape: scalar**	
Description: Number of azimuth lines within the reference RSLC		
	units	1
/science/SSAR/GOFF/metadata/processingInformation/parameters/secondary/frequencyA/slantRangeSpacing		
Type: Float64	**Shape: scalar**	
Description: Slant range spacing of reference RSLC		
	units	meters
/science/SSAR/GOFF/metadata/processingInformation/parameters/secondary/frequencyA/zeroDopplerTimeSpacing		
Type: Float64	**Shape: scalar**	
Description: Time interval in the along-track direction for reference RSLC raster layers		
	units	seconds
/science/SSAR/GOFF/metadata/processingInformation/parameters/secondary/frequencyA/zeroDopplerStartTime		
Type: String	**Shape: scalar**	
Description: Azimuth start time (in UTC) of the reference RSLC product in the format YYYY-mm-ddTHH:MM:SS.sssssssss		
/science/SSAR/GOFF/metadata/processingInformation/parameters/secondary/frequencyA/zeroDopplerEndTime		
Type: string	**Shape: scalar**	
Description: Azimuth stop time (in UTC) of the reference RSLC product in the format YYYY-mm-ddTHH:MM:SS.sssssssss		
/science/SSAR/GOFF/metadata/processingInformation/parameters/secondary/frequencyA/rangeBandwidth		
Type: Float64	**Shape: scalar**	
Description: Processed slant range bandwidth for secondary RSLC		
	units	hertz
/science/SSAR/GOFF/metadata/processingInformation/parameters/secondary/frequencyA/azimuthBandwidth		
Type: Float64	**Shape: scalar**	
Description: Processed azimuth bandwidth for secondary RSLC		
	units	hertz
/science/SSAR/GOFF/metadata/processingInformation/parameters/common/frequencyA/dopplerCentroid		
Type: Float64	**Shape: (dopplerCentroidLength, dopplerCentroidWidth)**	
Description: 2D LUT of Doppler centroid between reference and secondary RSLCs		
	units	hertz
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (second)

/science/SSAR/GOFF/metadata/processingInformation/parameters/common/frequencyA/dopplerBandwidth		
Type: Float64		**Shape: scalar**
Description: Common Doppler Bandwidth between reference and secondart RSLCs		
	units	hertz
/science/SSAR/GOFF/metadata/processingInformation/parameters/pixelOffsets/frequencyA/rangeBandwidth		
Type: Float64		**Shape: scalar**
Description: Processed slant range bandwidth for frequency A pixel offsets layers		
	units	hertz
/science/SSAR/GOFF/metadata/processingInformation/parameters/pixelOffsets/frequencyA/azimuthBandwidth		
Type: Float64		**Shape: scalar**
Description: Processed azimuth bandwidth for frequency A pixel offsets layers		
	units	hertz
/science/SSAR/GOFF/metadata/processingInformation/parameters/pixelOffsets/frequencyA/correlationSurfaceOversampling		
Type: UInt32		**Shape: scalar**
Description: Oversampling factor of the cross-correlation surface		
	units	1
/science/SSAR/GOFF/metadata/processingInformation/parameters/pixelOffsets/frequencyA/margin		
Type: UInt32		**Shape: scalar**
Description: Margin in pixels around reference RSLC edges excluded during cross-correlation computation		
	units	1
/science/SSAR/GOFF/metadata/processingInformation/parameters/pixelOffsets/frequencyA/slantRangeStartPixel		
Type: UInt32		**Shape: scalar**
Description: Reference RSLC start pixel in slant range		
	units	1
/science/SSAR/GOFF/metadata/processingInformation/parameters/pixelOffsets/frequencyA/alongTrackStartPixel		
Type: UInt32		**Shape: scalar**
Description: Reference RSLC start pixel in along-track		
	units	1
/science/SSAR/GOFF/metadata/processingInformation/parameters/pixelOffsets/frequencyA/slantRangeSkipWindowSize		
Type: UInt32		**Shape: scalar**
Description: Slant range cross-correlation skip window size in pixels		
	units	1
/science/SSAR/GOFF/metadata/processingInformation/parameters/pixelOffsets/frequencyA/alongTrackSkipWindowSize		
Type: UInt32		**Shape: scalar**
Description: Along-track cross-correlation skip window size in pixels		
	units	1
/science/SSAR/GOFF/metadata/processingInformation/parameters/pixelOffsets/frequencyA/layer1/alongTrackWindowSize		
Type: UInt32		**Shape: scalar**
Description: Along-track cross-correlation window size in pixels		
	units	1
/science/SSAR/GOFF/metadata/processingInformation/parameters/pixelOffsets/frequencyA/layer1/slantRangeWindowSize		
Type: UInt32		**Shape: scalar**
Description: Slant range cross-correlation window size in pixels		
	units	1

/science/SSAR/GOFF/metadata/processingInformation/parameters/pixelOffsets/frequencyA/layer1/alongTrackSearchWindowSize	
Type: UInt32	**Shape: scalar**
Description: Along-track cross-correlation search window size in pixels	
units	1
/science/SSAR/GOFF/metadata/processingInformation/parameters/pixelOffsets/frequencyA/layer1/slantRangeSearchWindowSize	
Type: UInt32	**Shape: scalar**
Description: lant range cross-correlation search window size in pixels	
units	1
/science/SSAR/GOFF/metadata/processingInformation/parameters/pixelOffsets/frequencyA/layer2/alongTrackWindowSize	
Type: UInt32	**Shape: scalar**
Description: Along-track cross-correlation window size in pixels	
units	1
/science/SSAR/GOFF/metadata/processingInformation/parameters/pixelOffsets/frequencyA/layer2/slantRangeWindowSize	
Type: UInt32	**Shape: scalar**
Description: Slant range cross-correlation window size in pixels	
units	1
/science/SSAR/GOFF/metadata/processingInformation/parameters/pixelOffsets/frequencyA/layer2/alongTrackSearchWindowSize	
Type: UInt32	**Shape: scalar**
Description: Along-track cross-correlation search window size in pixels	
units	1
/science/SSAR/GOFF/metadata/processingInformation/parameters/pixelOffsets/frequencyA/layer2/slantRangeSearchWindowSize	
Type: UInt32	**Shape: scalar**
Description: Slant range cross-correlation search window size in pixels	
units	1
/science/SSAR/GOFF/metadata/processingInformation/parameters/pixelOffsets/frequencyA/layer3/alongTrackWindowSize	
Type: UInt32	**Shape: scalar**
Description: Along-track cross-correlation window size in pixels	
units	1
/science/SSAR/GOFF/metadata/processingInformation/parameters/pixelOffsets/frequencyA/layer3/slantRangeWindowSize	
Type: UInt32	**Shape: scalar**
Description: Slant range cross-correlation window size in pixels	
units	1
/science/SSAR/GOFF/metadata/processingInformation/parameters/pixelOffsets/frequencyA/layer3/alongTrackSearchWindowSize	
Type: UInt32	**Shape: scalar**
Description: Along-track cross-correlation search window size in pixels	
units	1
/science/SSAR/GOFF/metadata/processingInformation/parameters/pixelOffsets/frequencyA/layer3/slantRangeSearchWindowSize	
Type: UInt32	**Shape: scalar**
Description: Slant range cross-correlation search window size in pixels	
units	1
/science/SSAR/GOFF/metadata/processingInformation/parameters/geocoding/rangeIonosphericCorrectionApplied	
Type: string	**Shape: scalar**
Description: Flag to indicate if the range ionospheric correction is applied to improve geolocation	

/science/SSAR/GOFF/metadata/processingInformation/parameters/geocoding/azimuthIonosphericCorrectionApplied	
Type: string	**Shape: scalar**
Description: Flag to indicate if the azimuth ionospheric correction is applied to improve geolocation	
/science/SSAR/GOFF/metadata/processingInformation/parameters/geocoding/hydrostaticTroposphericCorrectionApplied	
Type: string	**Shape: scalar**
Description: Flag to indicate if the hydrostatic tropospheric correction is applied to improve geolocation	
/science/SSAR/GOFF/metadata/processingInformation/parameters/geocoding/wetTroposphericCorrectionApplied	
Type: string	**Shape: scalar**
Description: Flag to indicate if the wet tropospheric correction is applied to improve geolocation	
/science/SSAR/GOFF/metadata/processingInformation/algorithms/softwareVersion	
Type: string	**Shape: scalar**
Description: Software version used for processing	
/science/SSAR/GOFF/metadata/processingInformation/algorithms/geocoding/complexGeocodingInterpolation	
Type: string	**Shape: scalar**
Description: Geocoding interpolation algorithm for complex-valued datasets	
/science/SSAR/GOFF/metadata/processingInformation/algorithms/geocoding/integerGeocodingInterpolation	
Type: string	**Shape: scalar**
Description: Geocoding interpolation algorithm for integer datasets	
/science/SSAR/GOFF/metadata/processingInformation/algorithms/geocoding/floatingGeocodingInterpolation	
Type: string	**Shape: scalar**
Description: Geocoding interpolation algorithm for floating point datasets	
/science/SSAR/GOFF/metadata/processingInformation/algorithms/geocoding/demInterpolation	
Type: string	**Shape: scalar**
Description: DEM interpolation algorithm	
/science/SSAR/GOFF/metadata/processingInformation/algorithms/coregistration/coregistrationMethod	
Type: string	**Shape: scalar**
Description: RSLC coregistration method	
/science/SSAR/GOFF/metadata/processingInformation/algorithms/coregistration/geometryCoregistration	
Type: string	**Shape: scalar**
Description: Geometry coregistration algorithm	
/science/SSAR/GOFF/metadata/processingInformation/algorithms/coregistration/resampling	
Type: string	**Shape: scalar**
Description: Secondary RSLC resampling algorithm	
/science/SSAR/GOFF/metadata/processingInformation/algorithms/crossCorrelation/layer1/crossCorrelationAlgorithm	
Type: string	**Shape: scalar**
Description: Cross-correlation algorithm for layer 1	
/science/SSAR/GOFF/metadata/processingInformation/algorithms/crossCorrelation/layer2/crossCorrelationAlgorithm	
Type: string	**Shape: scalar**
Description: Cross-correlation algorithm for layer 2	
/science/SSAR/GOFF/metadata/processingInformation/algorithms/crossCorrelation/layer3/crossCorrelationAlgorithm	
Type: string	**Shape: scalar**
Description: Cross-correlation algorithm for layer 3	
/science/SSAR/GOFF/metadata/processingInformation/inputs/l1ReferenceSlcGranules	
Type: string	**Shape: (numberOfInputReferenceL1Files)**
Description: List of input reference L1 RSLC products used	

/science/SSAR/GOFF/metadata/processingInformation/inputs/l1SecondarySlcGranules	
Type: string	**Shape: (numberOfInputSecondaryL1Files)**
Description: List of input secondary L1 RSLC products used	
/science/SSAR/GOFF/metadata/processingInformation/inputs/orbitFiles	
Type: string	**Shape: (numberOfInputOrbitFiles)**
Description: List of input orbit files used	
/science/SSAR/GOFF/metadata/processingInformation/inputs/configFiles	
Type: string	**Shape: (numberOfInputConfigFiles)**
Description: List of input config files used	
/science/SSAR/GOFF/metadata/processingInformation/inputs/demSource	
Type: string	**Shape: scalar**
Description: Description of the input digital elevation model (DEM)	

12.4.5 Other Radar Metadata

Radar metadata-related variables		
/science/SSAR/GOFF/metadata/orbit/temporalBaseline		
Type: UInt16	**Shape: scalar**	
Description: Time interval between reference and secondary RSLCs		
	units	days
/science/SSAR/GOFF/metadata/orbit/reference/interpMethod		
Type: string	**Shape: scalar**	
Description: Orbit interpolation method, either "Hermite" or "Legendre"		
/science/SSAR/GOFF/metadata/orbit/reference/time		
Type: Float64	**Shape: (orbitListLength)**	
Description: Time vector record. This record contains the time since UTC epoch corresponding to position and velocity records		
	units	seconds since YYYY-mm-ddTHH:MM:SS
/science/SSAR/GOFF/metadata/orbit/reference/position		
Type: Float64	**Shape: (orbitListLength, tripletxyz)**	
Description: Position vector record. This record contains the platform position data with respect to WGS84 G1762 reference frame		
	units	meters
/science/SSAR/GOFF/metadata/orbit/reference/velocity		
Type: Float64	**Shape: (orbitListLength, tripletxyz)**	
Description: Velocity vector record. This record contains the platform velocity data with respect to WGS84 G1762 reference frame		
	units	meters / second
/science/SSAR/GOFF/metadata/orbit/reference/orbitType		
Type: string	**Shape: scalar**	
Description: Orbit product type, either "FOE", "NOE", "MOE", "POE", or "Custom", where "FOE" stands for Forecast Orbit Ephemeris, "NOE" is Near real-time Orbit Ephemeris, "MOE" is Medium precision Orbit Ephemeris, and "POE" is Precise Orbit Ephemeris		
/science/SSAR/GOFF/metadata/orbit/secondary/interpMethod		
Type: string	**Shape: scalar**	
Description: Orbit interpolation method, either "Hermite" or "Legendre"		
/science/SSAR/GOFF/metadata/orbit/secondary/time		
Type: Float64	**Shape: (orbitListLength)**	
Description: Time vector record. This record contains the time since UTC epoch corresponding to position and velocity records		
	units	seconds since YYYY-mm-ddTHH:MM:SS
/science/SSAR/GOFF/metadata/orbit/secondary/position		
Type: Float64	**Shape: (orbitListLength, tripletxyz)**	
Description: Position vector record. This record contains the platform position data with respect to WGS84 G1762 reference frame		

	units	meters
/science/SSAR/GOFF/metadata/orbit/secondary/velocity		
Type: Float64	**Shape: (orbitListLength, tripletxyz)**	
Description: Velocity vector record. This record contains the platform velocity data with respect to WGS84 G1762 reference frame		
	units	meter / second
/science/SSAR/GOFF/metadata/orbit/secondary/orbitType		
Type: string	**Shape: scalar**	
Description: Orbit product type, either "FOE", "NOE", "MOE", "POE", or "Custom", where "FOE" stands for Forecast Orbit Ephemeris, "NOE" is Near real-time Orbit Ephemeris, "MOE" is Medium precision Orbit Ephemeris, and "POE" is Precise Orbit Ephemeris		
/science/SSAR/GOFF/metadata/attitude/reference/time		
Type: Float64	**Shape: (attitudeListLength)**	
Description: Time vector record. This record contains the time since UTC epoch corresponding to attitude and quaternion records		
	units	seconds since YYYY-mm-ddTHH:MM:SS
/science/SSAR/GOFF/metadata/attitude/reference/quaternions		
Type: Float64	**Shape: (attitudeListLength, quaternions)**	
Description: Attitude quaternions (q0, q1, q2, q3)		
	units	1
/science/SSAR/GOFF/metadata/attitude/reference/eulerAngles		
Type: Float64	**Shape: (attitudeListLength, tripletxyz)**	
Description: Attitude Euler angles (roll, pitch, yaw)		
	units	degree
/science/SSAR/GOFF/metadata/attitude/reference/attitudeType		
Type: string	**Shape: scalar**	
Description: Attitude type, either "FRP", "NRP", "PRP, or "Custom", where "FRP" stands for Forecast Radar Pointing, "NRP" is Near Real-time Pointing, and "PRP" is Precise Radar Pointing		
/science/SSAR/GOFF/metadata/attitude/secondary/time		
Type: Float64	**Shape: (attitudeListLength)**	
Description: Time vector record. This record contains the time since UTC epoch corresponding to attitude and quaternion records		
	units	seconds since YYYY-mm-ddTHH:MM:SS
/science/SSAR/GOFF/metadata/attitude/secondary/quaternions		
Type: Float64	**Shape: (attitudeListLength, quaternions)**	
Description: Attitude quaternions (q0, q1, q2, q3)		
	units	1
/science/SSAR/GOFF/metadata/attitude/secondary/eulerAngles		
Type: Float64	**Shape: (attitudeListLength, tripletxyz)**	
Description: Attitude Euler angles (roll, pitch, yaw)		
	units	degree
/science/SSAR/GOFF/metadata/attitude/secondary/attitudeType		
Type: string	**Shape: scalar**	
Description: Attitude type, either "FRP", "NRP", "PRP, or "Custom", where "FRP" stands for Forecast Radar Pointing, "NRP" is Near Real-time Pointing, and "PRP" is Precise Radar Pointing		

12.4.6 Radar Grid

Metadata cube-related variables		
/science/SSAR/GOFF/metadata/radarGrid/referenceSlantRange		
Type: Float64	**Shape: (radarCubeHeight, radarCubeLength, radarCubeWidth)**	
Description: Slant range of the reference RSLC in meters		
	units	meters
	grid_mapping	projection

	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
	_FillValue	nan
/science/SSAR/GOFF/metadata/radarGrid/referenceZeroDopplerAzimuthTime		
Type: Float64	**Shape: (radarCubeHeight, radarCubeLength, radarCubeWidth)**	
Description: Zero Doppler azimuth time in seconds since UTC epoch of the reference RSLC		
	units	seconds since YYYY-mm-ddTHH:MM:SS
	grid_mapping	projection
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
	_FillValue	nan
/science/SSAR/GOFF/metadata/radarGrid/xCoordinates		
Type: Float64	**Shape: (radarCubeWidth)**	
Description: X coordinates in specified projection		
	long_name	X coordinates of projection
	standard_name	projection_x_coordinate
	units	meters
/science/SSAR/GOFF/metadata/radarGrid/yCoordinates		
Type: Float64	**Shape: (radarCubeLength)**	
Description: Y coordinates in specified projection		
	long_name	Y coordinates of projection
	standard_name	projection_y_coordinate
	units	meters
/science/SSAR/GOFF/metadata/radarGrid/incidenceAngle		
Type: Float32	**Shape: (radarCubeHeight, radarCubeLength, radarCubeWidth)**	
Description: Incidence angle is defined as the angle between the LOS vector and the normal to the ellipsoid at the target height		
	valid_max	90.0
	valid_min	0.0
	_FillValue	nan
	grid_mapping	projection
	long_name	Incidence angle
	units	degree
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GOFF/metadata/radarGrid/losUnitVectorX		
Type: Float32	**Shape: (radarCubeHeight, radarCubeLength, radarCubeWidth)**	
Description: East component of unit vector of LOS from target to sensor		
	valid_max	1.0
	valid_min	-1.0
	_FillValue	nan
	grid_mapping	projection
	long_name	LOS unit vector X
	units	1

	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GOFF/metadata/radarGrid/losUnitVectorY		
Type: Float32	**Shape: (radarCubeHeight, radarCubeLength, radarCubeWidth)**	
Description: North component of unit vector of LOS from target to sensor		
	valid_max	1.0
	valid_min	-1.0
	_FillValue	nan
	grid_mapping	projection
	long_name	LOS unit vector Y
	units	1
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GOFF/metadata/radarGrid/alongTrackUnitVectorX		
Type: Float32	**Shape: (radarCubeHeight, radarCubeLength, radarCubeWidth)**	
Description: East component of unit vector along ground track		
	valid_max	1.0
	valid_min	-1.0
	_FillValue	nan
	grid_mapping	projection
	long_name	Along-track unit vector X
	units	1
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GOFF/metadata/radarGrid/alongTrackUnitVectorY		
Type: Float32	**Shape: (radarCubeHeight, radarCubeLength, radarCubeWidth)**	
Description: North component of unit vector along ground track		
	valid_max	1.0
	valid_min	-1.0
	_FillValue	nan
	grid_mapping	projection
	long_name	Along-track unit vector Y
	units	1
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GOFF/metadata/radarGrid/elevationAngle		
Type: Float32	**Shape: (radarCubeHeight, radarCubeLength, radarCubeWidth)**	
Description: Elevation angle is defined as the angle between the LOS vector and the normal to the ellipsoid at the sensor		
	valid_max	90.0
	valid_min	0.0
	_FillValue	nan

	grid_mapping	projection
	long_name	Elevation angle
	units	degree
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GOFF/metadata/radarGrid/groundTrackVelocity		
Type: Float64	**Shape: (radarCubeHeight, radarCubeLength, radarCubeWidth)**	
Description: Absolute value of the platform velocity scaled at the target height		
	_FillValue	nan
	grid_mapping	projection
	long_name	Ground track velocity
	units	meters / second
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GOFF/metadata/radarGrid/secondaryZeroDopplerAzimuthTime		
Type: Float64	**Shape: (radarCubeHeight, radarCubeLength, radarCubeWidth)**	
Description: Zero Doppler azimuth time in seconds since UTC epoch of the secondary RSLC image		
	units	seconds since YYYY-mm-ddTHH:MM:SS
	grid_mapping	projection
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
	_FillValue	nan
/science/SSAR/GOFF/metadata/radarGrid/secondarySlantRange		
Type: Float64	**Shape: (radarCubeHeight, radarCubeLength, radarCubeWidth)**	
Description: Slant range of the secondary RSLC in meters		
	units	meters
	grid_mapping	projection
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
	_FillValue	nan
/science/SSAR/GOFF/metadata/radarGrid/parallelBaseline		
Type: Float32	**Shape: (radarCubeHeight, radarCubeLength, radarCubeWidth)**	
Description: Parallel component of the InSAR baseline		
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points
	_FillValue	nan
	units	meters
	grid_mapping	projection
	long_name	Parallel baseline
	pixel_interval	The interval in Pixel direction

	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GOFF/metadata/radarGrid/perpendicularBaseline		
Type: Float32	**Shape: (radarCubeHeight, radarCubeLength, radarCubeWidth)**	
Description: Perpendicular component of the InSAR baseline		
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points
	units	meters
	grid_mapping	projection
	_FillValue	nan
	long_name	Perpendicular baseline
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GOFF/metadata/radarGrid/projection		
Type: UInt32	**Shape: scalar**	
Description: Product map grid projection: EPSG code, with additional projection information as HDF5 Attributes		
	ellipsoid	Projection ellipsoid
	epsg_code	Projection EPSG code
	false_easting	The value added to all abscissa values in the rectangular coordinates for a map projection.
	false_northing	The value added to all ordinate values in the rectangular coordinates for a map projection.
	grid_mapping_name	Grid mapping variable name
	inverse_flattening	Inverse flattening of the ellipsoidal figure
	latitude_of_projection_origin	The latitude chosen as the origin of rectangular coordinates for a map projection.
	longitude_of_projection_origin	The longitude, with respect to Greenwich, of the prime meridian associated with the geodetic datum.
	semi_major_axis	Semi-major axis
	spatial_ref	Spatial reference
	utm_zone_number	UTM zone number
	longitude_of_central_meridian	The line of longitude at the center of a map projection generally used as the basis for constructing the projection.
	scale_factor_at_central_meridian	A multiplier for reducing a distance obtained from a map by computation or scaling to the actual distance along the central meridian.
/science/SSAR/GOFF/metadata/radarGrid/heightAboveEllipsoid		
Type: Float64	**Shape: (radarCubeHeight)**	
Description: Height values above WGS84 Ellipsoid corresponding to the radar grid		
	standard_name	height_above_reference_ellipsoid
	units	meters

12.4.7 Radar Grid True Height (Available Only in ISRO Generated Products)

Radar grid at true height is at a finer spacing as compared to the radar grid documented in section 12.4.6.

Metadata cube-related variables		
/science/SSAR/GOFF/metadata/radarGridTrueHeight/referenceSlantRange		
Type: Float64	**Shape: (radarCubeHeightTrueHeight, radarCubeLengthTrueHeight, radarCubeWidthTrueHeight)**	
Description: Slant range of the reference RSLC in meters		
	units	meters
	grid_mapping	projection
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
	_FillValue	nan
/science/SSAR/GOFF/metadata/radarGridTrueHeight/referenceZeroDopplerAzimuthTime		
Type: Float64	**Shape: (radarCubeHeightTrueHeight, radarCubeLengthTrueHeight, radarCubeWidthTrueHeight)**	
Description: Zero Doppler azimuth time in seconds since UTC epoch of the reference image		
	units	seconds since YYYY-mm-ddTHH:MM:SS
	grid_mapping	projection
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
	_FillValue	nan
/science/SSAR/GOFF/metadata/radarGridTrueHeight/xCoordinates		
Type: Float64	**Shape: (radarCubeWidthTrueHeight)**	
Description: X coordinates in specified projection		
	long_name	X coordinates of projection
	standard_name	projection_x_coordinate
	units	meters
/science/SSAR/GOFF/metadata/radarGridTrueHeight/yCoordinates		
Type: Float64	**Shape: (radarCubeLengthTrueHeight)**	
Description: Y coordinates in specified projection		
	long_name	Y coordinates of projection
	standard_name	projection_y_coordinate
	units	meters
/science/SSAR/GOFF/metadata/radarGridTrueHeight/incidenceAngle		
Type: Float32	**Shape: (radarCubeHeightTrueHeight, radarCubeLengthTrueHeight, radarCubeWidthTrueHeight)**	
Description: Incidence angle is defined as the angle between the LOS vector and the normal to the ellipsoid at the target height		
	valid_max	90.0
	valid_min	0.0
	_FillValue	nan
	grid_mapping	projection
	long_name	Incidence angle
	units	degree
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GOFF/metadata/radarGridTrueHeight/losUnitVectorX		

Type: Float32	**Shape: (radarCubeHeightTrueHeight, radarCubeLengthTrueHeight, radarCubeWidthTrueHeight)**	
Description: East component of unit vector of LOS from target to sensor		
	valid_max	1.0
	valid_min	-1.0
	_FillValue	nan
	grid_mapping	projection
	long_name	LOS unit vector X
	units	1
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GOFF/metadata/radarGridTrueHeight/losUnitVectorY		
Type: Float32	**Shape: (radarCubeHeightTrueHeight, radarCubeLengthTrueHeight, radarCubeWidthTrueHeight)**	
Description: North component of unit vector of LOS from target to sensor		
	valid_max	1.0
	valid_min	-1.0
	_FillValue	nan
	grid_mapping	projection
	long_name	LOS unit vector Y
	units	1
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GOFF/metadata/radarGridTrueHeight/alongTrackUnitVectorX		
Type: Float32	**Shape: (radarCubeHeightTrueHeight, radarCubeLengthTrueHeight, radarCubeWidthTrueHeight)**	
Description: East component of unit vector along ground track		
	valid_max	1.0
	valid_min	-1.0
	_FillValue	nan
	grid_mapping	projection
	long_name	Along-track unit vector X
	units	1
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GOFF/metadata/radarGridTrueHeight/alongTrackUnitVectorY		
Type: Float32	**Shape: (radarCubeHeighTrueHeightt, radarCubeLengthTrueHeight, radarCubeWidthTrueHeight)**	
Description: North component of unit vector along ground track		
	valid_max	1.0
	valid_min	-1.0
	_FillValue	nan
	grid_mapping	projection
	long_name	Along-track unit vector Y

	units	1
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GOFF/metadata/radarGridTrueHeight/elevationAngle		
Type: Float32	**Shape: (radarCubeHeightTrueHeight, radarCubeLengthTrueHeight, radarCubeWidthTrueHeight)**	
Description: Elevation angle is defined as the angle between the LOS vector and the normal to the ellipsoid at the sensor		
	valid_max	90.0
	valid_min	0.0
	_FillValue	nan
	grid_mapping	projection
	long_name	Elevation angle
	units	degree
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GOFF/metadata/radarGridTrueHeight/groundTrackVelocity		
Type: Float64	**Shape: (radarCubeHeightTrueHeight, radarCubeLengthTrueHeight, radarCubeWidthTrueHeight)**	
Description: Absolute value of the platform velocity scaled at the target height		
	_FillValue	nan
	grid_mapping	projection
	long_name	Ground track velocity
	units	meters / second
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GOFF/metadata/radarGridTrueHeight/secondaryZeroDopplerAzimuthTime		
Type: Float64	**Shape: (radarCubeHeightTrueHeight, radarCubeLengthTrueHeight, radarCubeWidthTrueHeight)**	
Description: Zero Doppler azimuth time in seconds since UTC epoch of the secondary RSLC image		
	units	seconds since YYYY-mm-ddTHH:MM:SS
	grid_mapping	projection
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
	_FillValue	nan
/science/SSAR/GOFF/metadata/radarGridTrueHeight/secondarySlantRange		
Type: Float64	**Shape: (radarCubeHeightTrueHeight, radarCubeLengthTrueHeight, radarCubeWidthTrueHeight)**	
Description: Slant range of the secondary RSLC in meters		
	units	meters
	grid_mapping	projection
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction

	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
	_FillValue	nan
/science/SSAR/GOFF/metadata/radarGridTrueHeight/parallelBaseline		
Type: Float32	**Shape: (radarCubeHeightTrueHeight, radarCubeLengthTrueHeight, radarCubeWidthTrueHeight)**	
Description: Parallel component of the InSAR baseline		
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points
	units	meters
	grid_mapping	projection
	_FillValue	nan
	long_name	Parallel baseline
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GOFF/metadata/radarGridTrueHeight/perpendicularBaseline		
Type: Float32	**Shape: (radarCubeHeightTrueHeight, radarCubeLengthTrueHeight, radarCubeWidthTrueHeight)**	
Description: Perpendicular component of the InSAR baseline		
	mean_value	Arithmetic average of the numeric data points
	min_value	Minimum value of the numeric data points
	max_value	Maximum value of the numeric data points
	sample_stddev	Standard deviation of the numeric data points
	units	meters
	grid_mapping	projection
	_FillValue	nan
	long_name	Perpendicular baseline
	pixel_interval	The interval in Pixel direction
	azimuth_interval	The interval in Azimuth direction
	pixel_spacing	The spacing in Pixel direction (meters)
	azimuth_spacing	The spacing in Azimuth direction (meters)
/science/SSAR/GOFF/metadata/radarGridTrueHeight/projection		
Type: UInt32	**Shape: scalar**	
Description: Product map grid projection: EPSG code, with additional projection information as HDF5 Attributes		
	ellipsoid	Projection ellipsoid
	epsg_code	Projection EPSG code
	false_easting	The value added to all abscissa values in the rectangular coordinates for a map projection.
	false_northing	The value added to all ordinate values in the rectangular coordinates for a map projection.
	grid_mapping_name	Grid mapping variable name
	inverse_flattening	Inverse flattening of the ellipsoidal figure
	latitude_of_projection_origin	The latitude chosen as the origin of rectangular coordinates for a map projection.
	longitude_of_projection_origin	The longitude, with respect to Greenwich, of the prime meridian associated with the geodetic datum.

	semi_major_axis	Semi-major axis
	spatial_ref	Spatial reference
	utm_zone_number	UTM zone number
	longitude_of_central_meridian	The line of longitude at the center of a map projection generally used as the basis for constructing the projection.
	scale_factor_at_central_meridian	A multiplier for reducing a distance obtained from a map by computation or scaling to the actual distance along the central meridian.

Annexure-1: Meta File Format Parameter Description

The following table describes about the parameters available in .met file.
The fill value for different datatypes is as follow:

1. Character String - NA
2. Integer Number - (-9999)
3. Float Number - (-999.9999999)

Field Name	Field Description	Field Datatype	Field Unit
AcquistionMode	Joint Mode or S-Alone or L-Alone	Character String	-
Coverage	Represents whether the product is full or partial wrt to track Frame database	Character String	-
CycleNumber	Represents 12 day repeat number	Integer Number	-
DEMCorrection	Whether DEM correction applied in product Image (Applicable for Level-2 Products)	Character String	-
DEMSource	Source of DEM Used	Character String	-
DateOfDump	Date of Dump of Acquisition	Character String	-
DateOfPass	Date of Pass of Acquisition	Character String	-
Datum	Datum Description String	Character String	-
DumpingOrbitNumber	Dumping Orbit Number of Acquisition	Integer Number	-
EPSG	European Petroleum Survey Group Code	Integer Number	-
Ellipsoid	Ellipsoid Description String	Character String	-
Ephemeris	Type of Orbit Used	Character String	-
EllipsoidalFlatteningApplied	Flag to indicate whether Ellipsoidal flattening is applied (Available in INSAR Products only)	Character String	-
FalseEasting	False Easting for Map Projection (Applicable for Level-2 Products)	Float Number	meters
FalseNorthing	False Northing for Map Projection (Applicable for Level-2 Products)	Float Number	meters
FrameNumber	Represents frame number	Integer Number	-
GeneratingAgency	Agency Generating Data Products	Character String	-
GenerationDateTime	Generation Date Time of the Data Product	Character String	-

GroundTrackVelocity	Ground Track Velocity	Float Number	meters /sec
HydrostaticTroposphericCorrection Applied	Flag to indicate whether Hydrostatic Tropospheric Correction is applied (Available in INSAR Products only)	Character String	-
ImageFormat	Image Fomat Type	Character String	-
ImageHeadingAngle	Product-Image Heading Angle (O degree. for Geo-Referenced Images)	Float Number	degree
ImageLLLat	Image Lower Left (LL) Latitude (Significant for Level-2 Products : same as Product Corners for Level-1 Products)	Float Number	degree
ImageLLLon	Image Lower Left (LL) Longitude (Significant for Level-2 Products : same as Product Corners for Level-1 Products)	Float Number	degree
ImageLLMapX	Image Lower Left (LL) Easting (Applicable for Level-2 Products)	Float Number	meters
ImageLLMapY	Image Lower Left (LL) Northing (Applicable for Level-2 Products)	Float Number	meters
ImageLRLat	Image Lower Right (LR) Latitude (Significant for Level-2 Products : same as Product Corners for Level-1 Products)	Float Number	degree
ImageLRLon	Image Lower Right (LR) Longitude (Significant for Level-2 Products : same as Product Corners for Level-1 Products)	Float Number	degree
ImageLRMapX	Image Lower Right (LR) Easting (Applicable for Level-2 Products)	Float Number	meters
ImageLRMapY	Image Lower RIght (LR) Northing (Applicable for Level-2 Products)	Float Number	meters
ImageTraceHeadingAngle	Image Trace Heading Angle	Float Number	degree
ImageULLat	Image Upper Left (UL) Latitude (Significant for Level-2 Products : same as Product Corners for Level-1 Products)	Float Number	degree
ImageULLon	Image Upper Left (UL) Longitude (Significant for Level-2 Products : same as Product Corners for Level-1 Products)	Float Number	degree
ImageULMapX	Image Upper Left (UL) Easting (Applicable for Level-2 Products)	Float Number	meters
ImageULMapY	Image Upper Left (UL) Northing (Applicable for Level-2 Products)	Float Number	meters
ImageURLat	Image Upper Right (UR) Latitude (Significant for Level-2 Products : same as Product Corners for Level-1 Products)	Float Number	degree

ImageURLon	Image Upper Right (UR) Longitude (Significant for Level-2 Products : same as Product Corners for Level-1 Products)	Float Number	degree
ImageURMapX	Image Upper Right (UR) Easting (Applicable for Level-2 Products)	Float Number	meters
ImageURMapY	Image Upper Right (UR) Northing (Applicable for Level-2 Products)	Float Number	meters
ImagingMode	Type of Acquistion Mode	Character String	-
ImagingOrbitNumber	Imaging Orbit Number of Acquisition	Integer Number	-
IncidenceAngle	Incidence Angle at Acquisition Center	Float Number	degree
InputResolutionAcross	Range Resolution of Input Data	Float Number	meters
InputResolutionAlong	Azimuth Resolution of Input Data	Float Number	meters
IonospherePhaseCorrectionApplied	Flag to indicate whether Ionosphere Phase Correction is applied (Available in INSAR Products only)	Character String	-
IonosphericPhaseScreenAvailable	Flag to indicate whether Ionosphere Phase Correction is available (Available in INSAR Products only)	Character String	-
IsOffsetBendingApplied	Flag to indicate whether offset blending is applied (Available in INSAR Products only)	Character String	-
L1RSLCReferenceName	Name of the Reference RSLC used for INSAR generation (Available in INSAR Products only)	Character String	-
L1RSLCSecondaryName	Name of the Secondary RSLC used for INSAR generation (Available in INSAR Products only)	Character String	-
LookAngle	Look angle (w.r.t Roll Angle)	Float Number	degree
MapOriginLat	Map-Projection Center Latitude (Applicable for Level-2 Products)	Float Number	degree
MapOriginLon	Map-Projection Center Longitude (Applicable for Level-2 Products)	Float Number	degree
MapProjection	Product Map Projection (Applicable for Level-2 Products)	Character String	-
MissingFramesFlag	Flag to indicate missing frames	Integer Number	-
NoOfAzimuthLooks	Number of Azimuth Looks applied	Integer Number	-
NoOfPolarizations	Number of Polarization available in the product	Integer Number	-
NoOfRangeLooks	Number of Range Looks applied	Integer Number	-
NoPixels	Number of Pixels (Columns) in Product Image	Integer Number	-

NoScans	Number of Scans (Rows) in Product Image	Integer Number	-
Node	Node (Ascending/Descending)	Character String	-
OTSProductID	Identity for Archiving Products	Character String	-
ObservationID	Acquisition Observation Id	Character String	-
OutputLineSpacing	Scan/Line (Rows) Spacing of output Product	Float Number	meters
OutputPixelSpacing	Pixel (Columns) Spacing of output Product	Float Number	meters
PRF	Pulse Repeatetion Frequency of the image	Float Number	hertz
ParallelBaseline	Parallel Baseline at image center (Available in INSAR Products only)	Float Number	meters
PerpendicularBaseline	Perpendicular Baseline at image center (Available in INSAR Products only)	Float Number	meters
ProcessingLevel	Processing Level of Products: URGENT/NOMINAL/NRT	Character String	-
ProcessingNode	Processing Server on which product is generated	Character String	-
ProdCode	Product Code Based on Format and Product Level	Character String	-
ProdLLLat	Product Lower Left (LL) Latitude	Float Number	degree
ProdLLLon	Product Lower Left (LL) Longitude	Float Number	degree
ProdLLMapX	Product Lower Left (LL) Easting (Applicable for Level-2 Products)	Float Number	meters
ProdLLMapY	Product Lower Left (LL) Northing (Applicable for Level-2 Products)	Float Number	meters
ProdLRLat	Product Lower Right (LR) Latitude	Float Number	degree
ProdLRLon	Product Lower Right (LR) Longitude	Float Number	degree
ProdLRMapX	Product Lower Right (LR) Easting (Applicable for Level-2 Products)	Float Number	meters
ProdLRMapY	Product Lower Right (LR) Northing (Applicable for Level-2 Products)	Float Number	meters
ProdULLat	Product Upper Left (UL) Latitude (Lat)	Float Number	degree
ProdULLon	Product Upper Left (UL) Longitude (Lon)	Float Number	degree
ProdULMapX	Product Upper Left (UL) Easting (MapX) (Applicable for Level-2 Products)	Float Number	meters
ProdULMapY	Product Upper Left (UL) Northing (MapY) (Applicable for Level-2 Products)	Float Number	meters

ProdURLat	Product Upper Right (UR) Latitude	Float Number	degree
ProdURLon	Product Upper Right (UR) Longitude	Float Number	degree
ProdURMapX	Product Upper Right (UR) Easting (Applicable for Level-2 Products)	Float Number	meters
ProdURMapY	Product Upper Right (UR) Northing (Applicable for Level-2 Products)	Float Number	meters
ProductID	Work Order for Product	Character String	-
ProductType	Product Type: RSLC/GSLC/GCOV/RIFG/RUNW /GUNW/ROFF/GOFF	Character String	-
RTCApplyFlag	Flag to indicate whether Radiometric Terrain Correctin (RTC) is applied	Character String	-
SatID	Satellite Identifier of NISAR	Character String	-
SatelliteAltitude	Satellite Altitude	Float Number	meters
SatelliteHeadingAngle	Satellite Heading Angle	Float Number	degree
SceneCenterLat	Scene Center Latitude	Float Number	degree
SceneCenterLon	Scene Center Longitude	Float Number	degree
SceneCenterPitch	Pitch at Acquisition Center	Float Number	degree
SceneCenterTime	Acquisition Center Time	Character String	-
SceneCenterRoll	Roll at Acquisition Center	Float Number	degree
SceneCenterYaw	Yaw at Acquisition Center	Float Number	degree
SceneEndTime	Acquisition End Time	Character String	-
SceneNumber	Acquisition Scene Number	Integer Number	-
SceneStartTime	Acquisition Start Time	Character String	-
Sensor	Instrument Identifier for Synthetic Aperture Radar (SAR) (LSAR/SSAR)	Character String	-
SensorOrientation	Sensor Orientation (Left/Right)	Character String	-
SessionNumber	Acquisition Session Number	Integer Number	-
SoftwareVersion	Processing Software Version	Character String	-
SourceOfAttitude	Source of Attitude	Integer Number	-
SourceOfOrbit	Source of Orbit	Integer Number	-

StationID	Data Downlink station Identifier	Character String	-
StripNumber	Acquisition Strip Number	Integer Number	-
TemporalBaseline	Temporal Baseline of Product	Integer Number	-
TerrainHeightApplied	Flag to indicate which terrain height is applied (Applicable for Basic Products)	Character String	-
TopographicFlatteningApplied	Flag to indicate whether Topographic flattening is applied (Available in INSAR Products only)	Character String	-
TrackNumber	Represents Track Number	Integer Number	-
TxRxPol1	Transmit Receive Polarization present in the product	Character String	-
UnwrappingAlgorithm	Unwrapping Algorithm used (Available in INSAR Products only)	Character String	-
WetTroposphericCorrectionApplied	Flag to indicate whether Wet Topographic correction is applied (Available in INSAR Products only)	Character String	-
ZoneNo	Zone Number for UTM Projection (Applicable for Level-2 Products)	Integer Number	-

Annexure-2: Metadata Cube

In this section, we provide an overview of the metadata cubes used to store spatially-varying ancillary data in the secondary layers of the NISAR S-SAR & L-SAR product HDF5 granules. Note that this sparse representation is to assist users in ingesting and analyzing NISAR products within existing GIS software and is not meant to replace traditional representations of SAR data within the product granules or traditional processing approaches with radar geometry-aware software.

Metadata cubes are represented as three-dimensional arrays in the NISAR product HDF5 modules (Figure A2.1). The axes of the array are interpreted as (height, increasing azimuth time, and increasing slant range) in case of radar geometry products and as (height, decreasing northing, and increasing easting) in case of geocoded products. The data is organized with height as the first axis, as this allows one to directly ingest data as GCPs or rasters into existing GIS software. Each height layer is the same size. Metadata cubes will have fixed grid spacing (3 km in azimuth/northing x 1 km in slant range/easting x 1.5 km in height and will allow for easy merging when multiple products along the same imaging track are to be concatenated. The metadata fields on this coarse resolution grid will be evaluated using traditional radar processing approaches without approximations. The metadata cube will also span a field slightly larger than the original image product to allow users to interpolate data without introducing edge effects. Such low-resolution representation of slowly varying parameters has been demonstrated for InSAR products and processing.

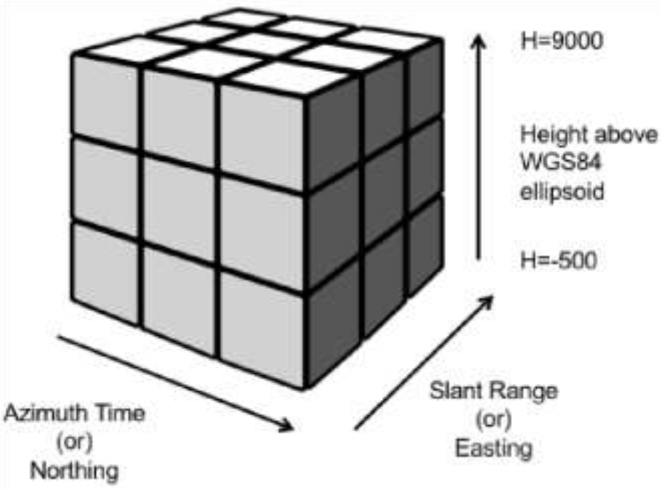


Figure A2-1 Metadata Cube Layer Schematic

A2.1 Metadata Cube Interpolation Example

We provide here a conceptual example of how these metadata cubes can be used within an existing GIS framework. Let us consider a L2_GUNW product on a UTM Zone 10 grid (Table A2.1). We use a geocoded product for the demonstration but the presented approach can be easily extended to radar coordinate products by replacing northing axis by azimuth time and easting axis by slant range.

Name	Value	Description
Primary layer properties		
xmin	100000.0	Easting of the first column (m)
xmax	340000.0	Easting of the last column (m)
dx	30.0	Column spacing in Easting (m)
Nx	8001	Number of columns
ymax	570000.0	Northing of first row (m)
ymin	330000.0	Northing of last row (m)
dy	-30.0	Row spacing in Northing (m). Negative to emphasize North-up imagery in geocoded products
Ny	8001	Number of rows
Metadata cube properties		
Cxmin	97000.0	Easting of first column (m)
Cxmax	343000.0	Easting of last column (m)
Cdx	1000.0	Column spacing in Easting (m)
CNx	247	Number of columns
Cymax	579000.0	Northing of first row (m)
Cymin	321000.0	Northing of last row(m)
Cdy	-3000.0	Row spacing in Northing (m). Negative to emphasize North-up imagery in geocoded products
CNy	87	Number of rows
Czmin	-1500	Height of the first layer (m)
Czmax	9000	Height of the last layer (m)

Cdz	1500	Layer spacing in height (m)
CNz	8	Number of height layers

Table A2-1 Example metadata cube properties

Suppose we are interested in computing the Perpendicular Baseline (Bperp) at a pixel of interest located at UTM coordinates point (Px,Py). Since these are coordinates on a map domain, we can look up a DEM to get the height at this point. The three-dimensional point of interest then becomes (Px, Py, h(Px,Py)).

The metadata cube for Perpendicular baseline can be thought of as a three-dimensional field

Bperp(x,y,z) – even though it is oriented as (Nz,Ny,Nx) in the HDF5 file for ease of use with a GIS. The user can use standard built-in regular grid three-dimensional interpolation routines in languages like MATLAB (e.g, interp3), IDL or Python (e.g, RegularGridInterpolator) to interpolate the Bperp array. We recommend cubic interpolation for best results. If a threedimensional interpolator is not available, one could use two-dimensional cubic interpolation for each height layer followed by a one-dimensional cubic interpolation in the following manner:

1) Populate f(i), i=0,…Nz-1 by two-dimensional cubic interpolation of each height layer:

$$f(i) = Bperp\left[i, \frac{Py - Cymax}{Cdy}, \frac{Px - Cxmax}{Cdx}\right]$$

Where the numbers in the square brackets indicate indices into the three-dimensional cube. For example, if we are interested in the point (107590.0 East, 555870.0 North, 300.0 Height), we would interpolate at Row 7.71 and Column 10.59 for each height layer.

2) Interpolate f(i) using one-dimensional cubic interpolation:

$$Bperp\big(Px, Py, h(Px, Py)\big) = f\left[\frac{h(Px, Py) - Czmin}{Cdz}\right]$$

Where the number in the square bracket indicates an index into a one-dimensional array. For example, for a height value of 200.0, we would interpolate at an index of 1.2.

A2.2 Metadata Cube Usage Note

Note that the metadata cubes are designed to accommodate one double-precision cube within 1 MB of memory, allowing for information to be easily stored in memory for on-the-fly computation within GIS frameworks or software without much overhead. The metadata cubes are not a replacement for traditional SAR processing approaches or very high-resolution analyses. They are meant to facilitate rapid processing and analysis by non-experts and will serve the needs for most SAR applications. Analyses show that the geolocation error is on the order of 1.5 cm due to interpolation which is significantly smaller than errors from sources such as DEM, orbits, and atmospheric path delay.

The interval and spacing at which metadata cube is provided is part of all datasets of the metadata cube layer.

For range doppler domain products Table A2-2 provide the attribute description and for Geocoded products Table A2-3 provide the attribute description for all datasets present in metadata layer.

Attribute	Description
pixel_spacing	The interval in Pixel direction
azimuth_interval	The interval in azimuth direction
pixel_spacing	The spacing in pixel direction (meters)
azimuth_spacing	The spacing in azimuth direction (second)

Table A2-2 Attribute description for datasets in metadata cube for range Doppler products

Attribute	Description
pixel_spacing	The interval in Pixel direction
azimuth_interval	The interval in azimuth direction
pixel_spacing	The spacing in pixel direction (meters)
azimuth_spacing	The spacing in azimuth direction (meters)

Table A2-3 Attribute description for datasets in meta data cube for geocoded products

Annexure-3: Metadata Cube at True Height

The metadata cube described in Annexure-2 is given at different heights. This is done to provide the user to choose their own choice of DEM. In case where values at true height is required another metadata cube layer is added in all ISRO generated products, with directory name as radarGridTrueHeight (in Geocoded products) and geolocationGridTrueHeight (in Range-Doppler products)
This layer is provided at a finer sampling with respect to the sampling of metadata cube.
To get value of any dataset (for example latitude or longitude), at any particular pixel, a simple 2D-interpolation is required.

The interval and spacing at which metadata cube is provided is part of all datasets of the metadata cube layer.

For range Doppler domain products Table A3-1 provide the attribute description and for Geocoded products Table A3-2 provide the attribute description for all datasets present in metadata layer.

Attribute	Description
pixel_spacing	The interval in Pixel direction
azimuth_interval	The interval in azimuth direction

pixel_spacing	The spacing in pixel direction (meters)
azimuth_spacing	The spacing in azimuth direction (second)

Table A3-1 Attribute description for datasets in metadata cube for range Doppler products

Attribute	Description
pixel_spacing	The interval in Pixel direction
azimuth_interval	The interval in azimuth direction
pixel_spacing	The spacing in pixel direction (meters)
azimuth_spacing	The spacing in azimuth direction (meters)

Table A3-2 Attribute description for datasets in metadata cube for Geocoded products

Annexure-4: Geocoded Product Grids

NISAR Level-2 products will be generated on a pre-defined Track/Frame system. The projection system for a particular frame will be available to the users as a predefined map and will be held constant through the life of the system. Each Level-2 HDF5 granule itself will include information indicating the projection used for the product.

A4.1 Map Projections

For Geocoding NISAR products, Digital Elevation Model is used, whose vertical datum represents height above the WGS84 Ellipsoid and the horizontal datum is represented by the European Petroleum Standards Group (EPSG) code. Table A4-1 lists the various projection systems used to output Level-2 geocoded products.

EPSG code	PROJ.4 string	Common Name	Geographical scope
3031	+proj=stere +lat_0=-90 +lat_ts=-71 +lon_0=0 +k=1 +x_0=0 +y_0=0 +datum=WGS84 +units=m +no_defs	Antarctic Polar Stereographic	Antarctica and Southern Hemisphere Sea Ice
3413	+proj=stere +lat_0=90 +lat_ts=70 +lon_0=-45 +k=1 +x_0=0 +y_0=0 +datum=WGS84 +units=m +no_defs	NSIDC Sea Ice Polar Stereographic North	Greenland and Northern Hemisphere Sea Ice
32601-32660	+proj=utm +zone=X-32600 +datum=WGS84 +units=m +no_defs	UTM Zone North	Northern Hemisphere Land except Greenland
32701-32760	+proj=utm +zone=X-32700 +south +datum=WGS84 +units=m +no_defs	UTM Zone South	Southern Hemisphere Land except Antarctica

Table A4-1 Projection Systems for NISAR L2 Products.

A4.2 Grid Alignment

NISAR Level-2 products will use a “pixel is area” convention

(http://geotiff.maptools.org/spec/geotiff2.5.html, “The "PixelIsArea" raster grid space R, which is the default, uses coordinates I and J, with (0,0) denoting the upper-left corner of the image, and increasing I to the right, increasing J down. The first pixel-value fills the square grid cell with the bounds: top-left = (0,0), bottom-right = (1,1)”).

Annexures-5: Offset Layer Blending Methodology

The slant range and azimuth offsets produced by the cross-correlation algorithm may be affected by outliers and noise. In cases where the offset products ROFF and GOFF are generated, the available offset layers at different resolutions can be blended into a single offset layer. This annexure describes the methodology to blend different offset layers into a single layer. During the blending step, inaccurate offset estimates are removed and replaced with newly computed estimates in a neighborhood.

Starting from the offset layers at the finest resolution (i.e., with the smallest chip size), the implementation of the blending step follows a pyramidal filling algorithm consisting the following steps:

1. Identify offset outliers using a median filter and median absolute deviation thresholding:
    a. At each offset location, apply a median filter with a kernel size of the same shape of the features that need to be removed (e.g., 9x9).
    b. Remove all the offsets having an absolute median deviation over a certain threshold (e.g., 1-3 standard deviations).
    c. Remove all the offsets having SNR and correlation peak value below a certain threshold (e.g., 4 and 0.3 respectively).

2. Fill each outlier location by using the offset layers at coarser resolution. For each outlier location:
    a. Select a neighborhood in coarser offset layers centered at the same location of the offset outlier.
    b. Average all the valid offset estimates in the neighborhood and assign this value to the outlier location in the offset layer at fine resolution.

3. Average offset estimates of the different multi-resolution layers for all the locations containing valid offset estimates.

4. Filter the culled and filled high resolution offset maps with a moving average filter with a kernel size of 5x5 in slant range and azimuth directions.

References

RD1: NISAR Data Products Algorithms, *SAC/SIPA/MDPG/NISAR/ATBD/ OCT/2023/V1.0*