2025

HDF to GeoTIFF Conversion Software Utility

DPA/ MDPG/ MPSDD

National Remote Sensing Centre,
Indian Space Research Organisation

DOCUMENT CONTROL SHEET

1.	**Security Classification**	Restricted			
2.	**Distribution**	Within ISRO			
3.	**Document Issue:**	**V1.0**	**(b) Revision:**	**R00**	
4.	**Report Type**	Technical Report			
5.	**Report No**	**NRSC-DPA-MDPG-MPSDD-OCT 2025-TR-0002921-V1.0**			
6.	**Title**	***HDF to GeoTIFF Conversion Software Utility***			
7.	**Collation**	**Pages**	**Figures**	**Tables**	**References**
		14	**1**	**0**	**0**
8.	**Project**	In-house			
9.	**Author(s)**	Aakashneel Basak, Niharika K., Sourav Sawhney, Samvram Sahu			
10.	**Reviewed By**	Sri. Sauvic Dutta, H, MPSDD/MDPG/DPA Smt. Usha Sundari Ryali H S V, GH, MDPG/DPA			
11.	**Approved By**	Dr. Murali Krishnan S., DD, DPA			
12.	**Originating unit**	MPSDD/MDPG/DPA/NRSC			
13.	**Sponsor(s) Name:**	NRSC			
14.	**Date of Project Initiation**	June, 2025			
15.	**Date of Publication**	October, 2025			
16.	**Abstract (with Keywords) :** The HDF to GeoTIFF Conversion Utility is a GUI-based application developed to streamline the extraction and conversion of satellite datasets stored in Hierarchical Data Format (HDF5) into standard GeoTIFF format. Designed primarily for handling data from the NISAR mission, the software supports multiple geocoded products such as GSLC, GCOV, GOFF, and GUNW. It enables both full-scene conversion and area-of-interest (AOI)-based extraction using user-defined central coordinates and bounding radius. With built-in metadata handling, EPSG-compliant projection support, and compatibility with GIS platforms like QGIS, SARScape, SNAP, and ArcGIS, the tool simplifies access to Earth Observation (EO) data for analysis, visualization, and integration into downstream workflows—without requiring complex command-line operations.				

Contents

1. Introduction 3
2. Purpose & Scope 3
3. Software Interface Overview 4
4. Input Requirements 4
5. Output Details 5
6. Step-by-Step Usage Instructions 5
7. System Requirements 6
9. Error Handling and Debugging 6
10. Best Practices 6
11. References 6
12. Contact & Attribution 6

1. Introduction

The HDF to GeoTIFF Conversion Utility is a graphical user interface (GUI)-based application developed at the National Remote Sensing Centre (NRSC), Indian Space Research Organisation (ISRO). This tool is specifically designed to support the NASA-ISRO Synthetic Aperture Radar (NISAR) mission by enabling users to efficiently convert satellite data archived in Hierarchical Data Format version 5 (HDF5) into GeoTIFF, a standardized raster format widely accepted across geospatial analysis platforms such as QGIS, SARScape, ArcGIS, and ESA SNAP. The output product also contains the Meta data in form of text files and xml file from the auxiliary information extracted from hdf5 file to facilitate the user for further analysis. A key feature of the software is its AOI-based cropping functionality, which allows users to extract targeted subsets of the data based on a user-defined central latitude and longitude along with a bounding radius (in kilometers) for NISAR geocoded products. This feature is particularly useful for handling large NISAR products, allowing users to isolate and export only the relevant geographic portion of the dataset, thereby optimizing both storage and analysis time. The software supports various NISAR products such as RSLC, GSLC, GCOV, RUNW, RIFG, GUNW, ROFF and GOFF and internally handles their differing HDF structures during extraction and transformation. This makes the tool robust and mission-compliant, serving as a critical interface between satellite products and downstream geospatial applications.

2. Purpose & Scope

- Simplify the extraction of scientific datasets from HDF5 files.
- Enable easy transformation into standard georeferenced raster files (GeoTIFFs**)** and meta data files.
- Provide a user-friendly GUI that avoids the need for complex command-line operations.
- Handle InSAR, SAR, and other EO data stored in structured HDF5 containers.

The **scope** of the utility includes support for key NISAR product families such as RSLC, RUNW, ROFF, RIFG, GSLC, GCOV, GOFF, and GUNW, and features like **AOI-based cropping for geocoded products, geo-transformation using embedded metadata, and metadata file creation from the meta data information of HDF5 file.** The tool is built for precise data conversion, user-friendly operation, and is seamlessly provided within data dissemination platform Bhoonidhi, for the benefit of end users.

3. Software Interface Overview

The software provides a clean and intuitive GUI built using Tkinter, allowing users to select input and output paths and trigger the conversion operation with a single click. Main Interface Components:

- Title Header
- Date Display
- Input File Selection
- Output Folder Selection
- Generate GeoTIFF Button

4. Input Requirements

Input File Format:

- Extension: .h5 (HDF5)
- Structure: The file must contain datasets in a hierarchical structure.

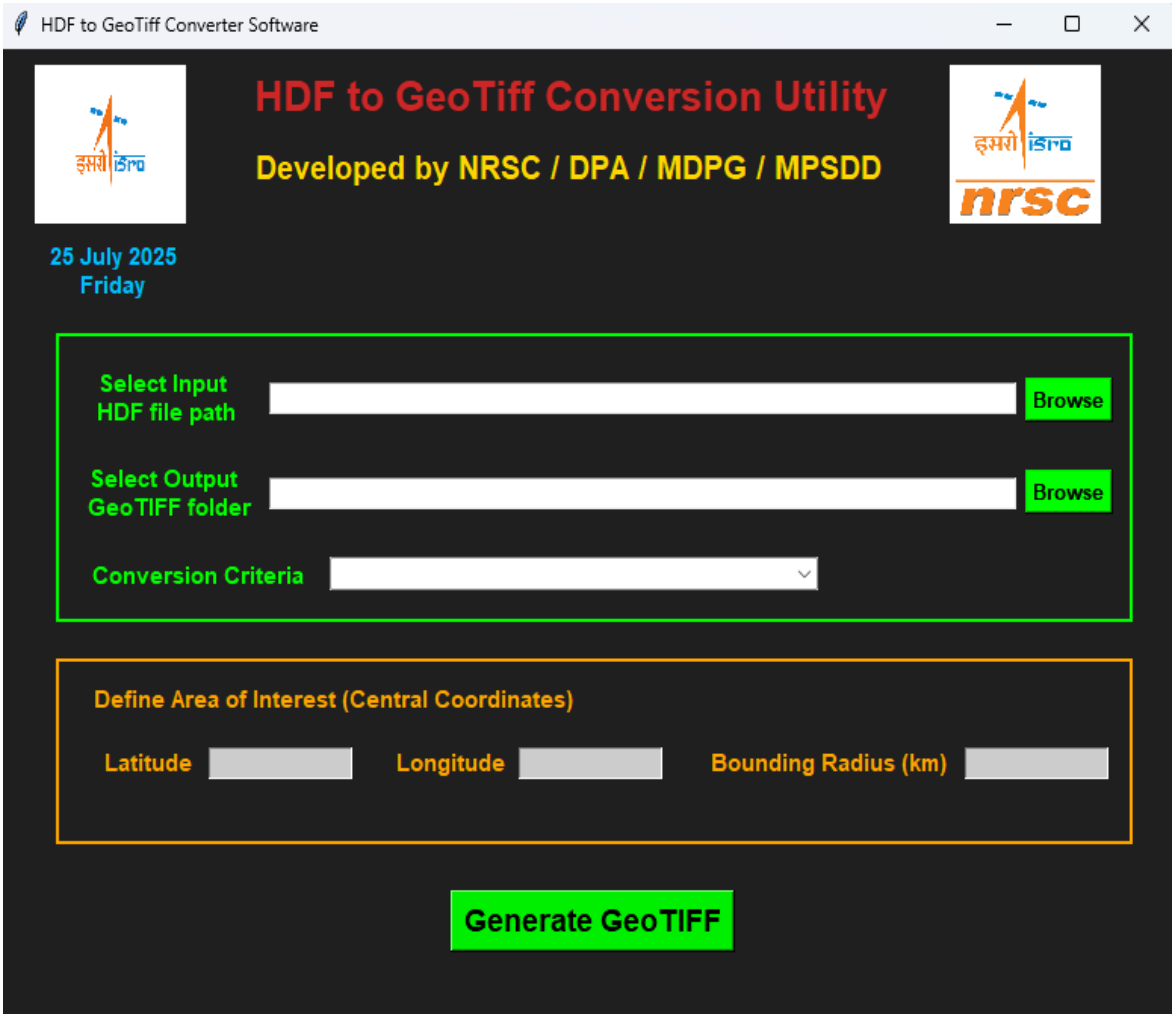

Figure 1 HDF to GeoTIFF converter Software GUI for NISAR Data Products

- Data Type: 2D raster image arrays. - Georeferencing: Should include either embedded geospatial metadata or associated geolocation arrays.

5. Output Details

Output Format:

- Extension: .tif (GeoTIFF)
- Type: Raster image(s)
- Location: Stored in the folder selected by the user
- Projection: If metadata is available, raster will be georeferenced.
- Naming Convention: Derived from dataset names within the HDF5 file
- Auxillary Information: All aux information or Meta data will be written in layer_metadata.txt, calibration_data.txt and metadata.xml files.

6. Step-by-Step Usage Instructions

a) **Launch the Application:** Start the HDF to GeoTIFF Conversion Utility by running the executable file.

b) **Select Input HDF5 File:** Use the file browser to choose the NISAR or other compatible HDF5 file containing the desired satellite dataset.

c) **Choose Output Folder:** Select or create a directory where the converted GeoTIFF files and metadata will be saved.

d) **Set Conversion Mode:** Choose the appropriate conversion mode:
   - **Entire Scene**: Converts all available datasets in the HDF file for the full scene.
   - **AOI-Based Conversion**: Enables targeted extraction for a specific Area of Interest (AOI).

e) **Define Area of Interest (If AOI Mode Selected):** When AOI mode is enabled, fill in the following:
   - **Latitude and Longitude**: Enter the central coordinates (in EPSG:4326) around which data needs to be extracted.
   - **Bounding Radius (in km)**: Specify the radius that defines the extent of the bounding box from the center point.

f) **Run the Conversion:** Click the **"Run Conversion"** button to begin processing. The application will extract the relevant data and convert it to GeoTIFF format based on your selection.

g) **Verify Output:** Upon completion, check the output folder for:
   - Generated **GeoTIFF files** for each dataset/layer.
   - **Metadata text files** summarizing calibration and swath georeferencing parameters.
   - BBOX **shape files** outlining AOI extents (if AOI conversion was selected).

h) Metadata.xml file (Annexure-1) summarizing the auxiliary information required for further analysis. (Xml structure is similar to the EOS-04 mission).

i) Users can compute the sigma0, Gamma0, beta0 using the DN values in Geotiff file and LUTs (look up tables) in calibration information tag as per the format document. (Ref 1).

j) Auxiliary file information is corresponding to full extent of HDF5 file, for AOI based option, user can extract the auxiliary information based on the AOIExtent, Reference start and end row, column values mentioned in the xml file.

7. System Requirements

- **Operating System: Windows / Linux**
- **Python Version: 3.6 or later**
- **RAM: Minimum 4GB (8GB+ recommended)**
- **Disk Space: Enough to store input and output files**

9. Error Handling and Debugging

Common issues:

- HDF5 file structure not supported → Check dataset structure
- Permission denied → Verify output directory access
- GeoTIFF not generated → Validate input data

10. Best Practices

- Ensure input files are valid and complete.
- Use virtual environments for dependency management.
- Consider batch conversion feature for future upgrades.

11. References

1. NISAR Data product format document. (https://bhoonidhi.nrsc.gov.in)

2.https://bhoonidhi.nrsc.gov.in/bhoonidhi_resources/help/docs/EOS_04_Data_Products_Format_Document.pdf

12. Contact & Attribution

National Remote Sensing Centre (NRSC)

Departments: DPA / MDPG / MPSDD

Contact for any Feedback or Queries: feedback_mpsdd@nrsc.gov.in

ANNEXURE-1

1. Sample Metadata xml file for RSLC:

```
<?xml version="1.0" ?>
<Product>
  <ProductType/>
  <ProductID/>
  <DocumentIdentifier/>
  <ProductExtent type="FullExtent"/>
  <SourceAttributes>
    <Satellite/>
    <Instrument/>
    <RadarBand/>
    <InputDatasetFacilityId/>
    <DatatakeID/>
    <ObservationID/>
    <SourceDataAcquisitionParameters>
      <ObservationMode/>
      <ListOfFrequencies/>
      <Polarizations/>
      <frequencyA>
        <RadarCenterFrequency units="Hz"/>
        <PulseRepetitionFrequency units="Hz"/>
        <PulseBandwidth units="Hz"/>
      </frequencyA>
      <AntennaPointing/>
      <TrackNumber/>
      <FrameNumber/>
      <NumberOfSubSwaths/>
    </SourceDataAcquisitionParameters>
    <OrbitAndAttitude>
      <OrbitInformation>
        <PassDirection/>
        <OrbitDataSource/>
        <StateVector>
          <TimeStamp/>
          <xPosition units="m"/>
          <yPosition units="m"/>
          <zPosition units="m"/>
          <xVelocity units="m/s"/>
          <yVelocity units="m/s"/>
          <zVelocity units="m/s"/>
        </StateVector>
        <!-- ... more StateVector entries ... -->
      </OrbitInformation>
      <AttitudeInformation>
        <AttitudeDataSource/>
        <AttitudeAngles>
          <TimeStamp/>
          <yaw units="deg"/>
          <roll units="deg"/>
          <pitch units="deg"/>
```

```
      </AttitudeAngles>
      <!-- ... more AttitudeAngles entries ... -->
    </AttitudeInformation>
  </OrbitAndAttitude>
</SourceAttributes>
<ImageGenerationParameters>
  <GeneralProcessingInformation>
    <ProductType/>
    <ProcessingFacility/>
    <ProcessingTime/>
    <SoftwareVersion/>
    <IsUrgentObservation/>
  </GeneralProcessingInformation>
  <SarProcessingInformation>
    <ElevationPatternCorrection/>
    <ZeroDopplerTimeFirstLine/>
    <ZeroDopplerTimeLastLine/>
    <frequencyA>
      <RangeLookBandwidth units="Hz"/>
      <TotalProcessedRangeBandwidth units="Hz"/>
      <TotalProcessedAzimuthBandwidth units="Hz"/>
    </frequencyA>
    <IncidenceAngleNearRange units="deg"/>
    <IncidenceAngleFarRange units="deg"/>
    <slantRangeNearEdge units="m"/>
    <IsDithered/>
    <IsGeocoded/>
    <IsMixedMode/>
  </SarProcessingInformation>
</ImageGenerationParameters>
<ImageAttributes>
  <ProductFormat/>
  <OutputMediaInterleaving/>
  <RasterAttributes>
    <DataType/>
    <BitsPerSample datastream="Real"/>
    <BitsPerSample datastream="Imaginary"/>
    <frequencyA>
      <NumberOfSamplesPerLine/>
      <NumberOfLines/>
      <SampledPixelSpacing units="m"/>
      <SampledLineSpacing units="m"/>
    </frequencyA>
  </RasterAttributes>
  <GeographicInformation>
    <ImageTiePoint>
      <ImageCoordinate>
        <Line/>
        <Pixel/>
      </ImageCoordinate>
      <GeodeticCoordinate>
```

```
            <Latitude units="deg"/>
            <Longitude units="deg"/>
          </GeodeticCoordinate>
        </ImageTiePoint>
        <ReferenceEllipsoidParameters>
          <Epsg/>
        </ReferenceEllipsoidParameters>
        <!-- ... more ImageTiePoint entries ... -->
      </GeographicInformation>
      <CalibrationInformation>
        <CalibrationInfo>
          <ImageCoordinate>
            <Line/>
            <Pixel/>
          </ImageCoordinate>
          <Lut_beta0/>
          <Lut_gamma0/>
          <Lut_sigma0/>
        </CalibrationInfo>
        <!-- ... more CalibrationInfo entries ... -->
      </CalibrationInformation>
    </ImageAttributes>
  </Product>
```

2. Sample Metadata xml file for GSLC:

```
<?xml version="1.0" ?>
<Product>
  <ProductType/>
  <ProductID/>
  <DocumentIdentifier/>
  <ProductExtent type="AOI">
    <AOIExtent>
      <ReferenceStartRow/>
      <ReferenceStartColoumn/>
      <ReferenceEndRow/>
      <ReferenceEndColoumn/>
    </AOIExtent>
  </ProductExtent>
  <SourceAttributes>
    <Satellite/>
    <Instrument/>
    <RadarBand/>
    <InputDatasetFacilityId/>
    <DatatakeID/>
    <ObservationID/>
    <SourceDataAcquisitionParameters>
      <ObservationMode/>
      <ListOfFrequencies/>
      <Polarizations/>
      <frequencyA>
```

```
      <RadarCenterFrequency units="Hz"/>
      <PulseBandwidth units="Hz"/>
    </frequencyA>
    <AntennaPointing/>
    <TrackNumber/>
    <FrameNumber/>
    <NumberOfSubSwaths/>
  </SourceDataAcquisitionParameters>
  <OrbitAndAttitude>
    <OrbitInformation>
      <PassDirection/>
      <OrbitDataSource/>
      <StateVector>
        <TimeStamp/>
        <xPosition units="m"/>
        <yPosition units="m"/>
        <zPosition units="m"/>
        <xVelocity units="m/s"/>
        <yVelocity units="m/s"/>
        <zVelocity units="m/s"/>
      </StateVector>
      <!-- ... more StateVector entries ... -->
    </OrbitInformation>
    <AttitudeInformation>
      <AttitudeDataSource/>
      <AttitudeAngles>
        <TimeStamp/>
        <yaw units="deg"/>
        <roll units="deg"/>
        <pitch units="deg"/>
      </AttitudeAngles>
      <!-- ... more AttitudeAngles entries ... -->
    </AttitudeInformation>
  </OrbitAndAttitude>
</SourceAttributes>
<ImageGenerationParameters>
  <GeneralProcessingInformation>
    <ProductType/>
    <ProcessingFacility/>
    <ProcessingTime/>
    <SoftwareVersion/>
    <IsUrgentObservation/>
  </GeneralProcessingInformation>
  <SarProcessingInformation>
    <ElevationPatternCorrection/>
    <ZeroDopplerTimeFirstLine/>
    <ZeroDopplerTimeLastLine/>
    <frequencyA>
      <RangeBandwidth units="Hz"/>
      <AzimuthBandwidth units="Hz"/>
    </frequencyA>
```

```
    <IncidenceAngleNearRange units="deg"/>
    <IncidenceAngleFarRange units="deg"/>
    <IsDithered/>
    <IsGeocoded/>
    <IsMixedMode/>
  </SarProcessingInformation>
</ImageGenerationParameters>
<ImageAttributes>
  <ProductFormat/>
  <OutputMediaInterleaving/>
  <RasterAttributes>
    <DataType/>
    <BitsPerSample datastream="Real"/>
    <BitsPerSample datastream="Imaginary"/>
    <frequencyA>
      <NumberOfSamplesPerLine/>
      <NumberOfLines/>
      <SampledPixelSpacing units="m"/>
      <SampledLineSpacing units="m"/>
    </frequencyA>
  </RasterAttributes>
  <GeographicInformation>
    <GeolocationGrid>
      <ImageTiePoint>
        <ImageCoordinate>
          <Line/>
          <Pixel/>
        </ImageCoordinate>
        <GeodeticCoordinate>
          <Latitude units="deg"/>
          <Longitude units="deg"/>
        </GeodeticCoordinate>
        <MapCoordinate>
          <Northing units="m"/>
          <Easting units="m"/>
        </MapCoordinate>
      </ImageTiePoint>
      <!-- ... more ImageTiePoint entries ... -->
    </GeolocationGrid>
    <ReferenceEllipsoidParameters>
      <Epsg/>
      <EllipsoidName/>
      <SemiMajorAxis units="m"/>
      <latitude_of_projection_origin/>
      <longitude_of_projection_origin/>
      <UtmZoneNumber/>
    </ReferenceEllipsoidParameters>
    <MapProjection>
      <MapCorners>
        <UpperLeftCorner>
          <Latitude units="deg"/>
```

```
            <Longitude units="deg"/>
            <Northing units="m"/>
            <Easting units="m"/>
          </UpperLeftCorner>
          <UpperRightCorner>
            <Latitude units="deg"/>
            <Longitude units="deg"/>
            <Northing units="m"/>
            <Easting units="m"/>
          </UpperRightCorner>
          <LowerRightCorner>
            <Latitude units="deg"/>
            <Longitude units="deg"/>
            <Northing units="m"/>
            <Easting units="m"/>
          </LowerRightCorner>
          <LowerLeftCorner>
            <Latitude units="deg"/>
            <Longitude units="deg"/>
            <Northing units="m"/>
            <Easting units="m"/>
          </LowerLeftCorner>
        </MapCorners>
      </MapProjection>
    </GeographicInformation>
    <CalibrationInformation>
      <CalibrationInfo>
        <ImageCoordinate>
          <Line/>
          <Pixel/>
        </ImageCoordinate>
        <Lut_beta0/>
        <Lut_gamma0/>
        <Lut_sigma0/>
      </CalibrationInfo>
      <!-- ... more CalibrationInfo entries ... -->
    </CalibrationInformation>
  </ImageAttributes>
</Product>
```