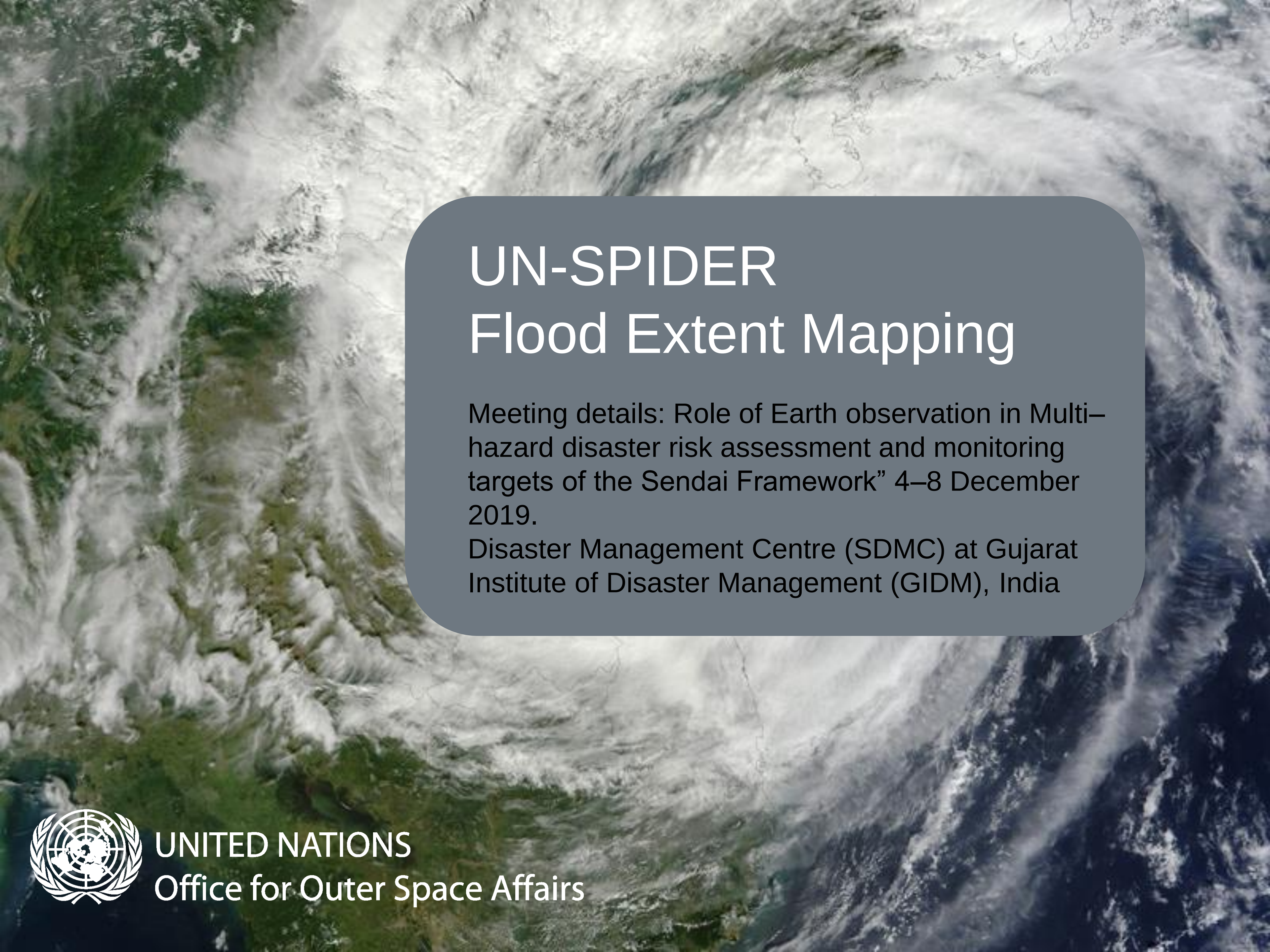

UN-SPIDER
Flood Extent Mapping

Meeting details: Role of Earth observation in Multi–hazard disaster risk assessment and monitoring targets of the Sendai Framework” 4–8 December 2019.
Disaster Management Centre (SDMC) at Gujarat Institute of Disaster Management (GIDM), India

UNITED NATIONS
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Objective of this practice

1. Determine the **extent** of flooded areas
2. SAR satellite imagery constitutes a viable solution to process images **quickly** determine the flooded areas
3. **Near real-time** flooding **information** to relief agencies
4. Flood extent information can be used for **damage assessment**
5. **Risk management**
6. Creating **scenarios** showing potential population, economic activities and the environment at potential risk from flooding
7. **No cost**


PEACE TIME
WAR

UNITED NATIONS
Office for Outer Space Affairs

Sentinel Synthetic Aperture Radar (SAR)

UN-SPIDER
www.un-spider.org

Information on Sentinel mission

Mission Orbit:

- Orbit Type: Sun-synchronous, near-polar, circular
- Orbit Height: 693 km
- Inclination: 98.18°
- Repeat Cycle: 175 orbits in 12 days

Payload:

C-SAR (C-band Synthetic Aperture Radar)

Resolution and Swath Width (Four modes):

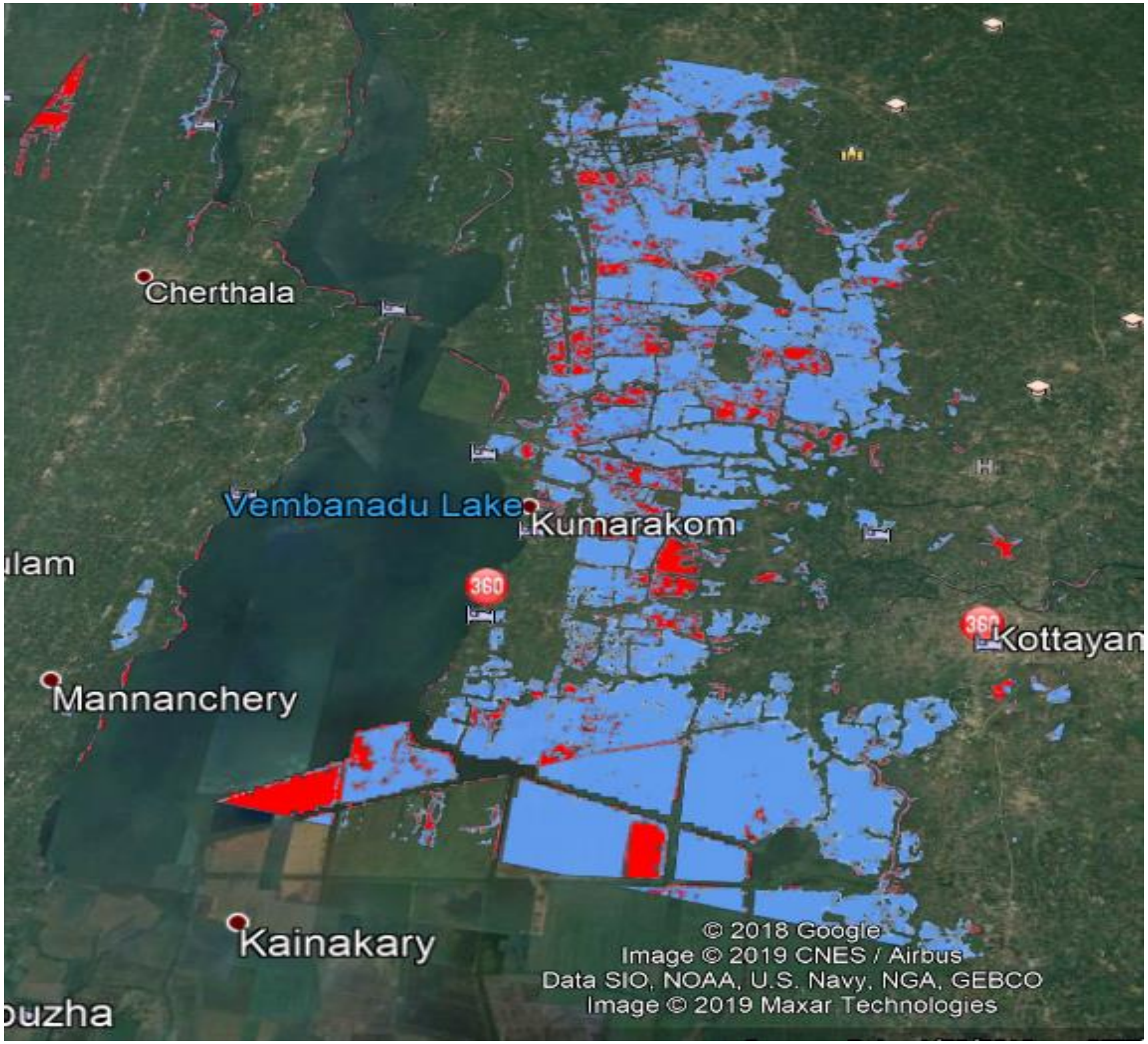
- Strip Map Mode: 80 km Swath, 5 x 5 m spatial resolution
- Interferometric Wide Swath: 250 km Swath, 5x20 m spatial resolution
- Extra-Wide Swath Mode: 400 km Swath, 25 x 100 m spatial resolution
- Wave-Mode: 20 km x 20 km, 5 x 20 m spatial resolution

TABLE 1. COMMONLY USED FREQUENCY BANDS FOR SAR SYSTEMS AND THE CORRESPONDING FREQUENCY AND WAVELENGTH RANGES. APPLICATION EXAMPLES ARE: 1) FOLIAGE PENETRATION, SUBSURFACE IMAGING AND BIOMASS ESTIMATION IN P- AND L-BAND; 2) AGRICULTURE, OCEAN, ICE OR SUBSIDENCE MONITORING IN L-, C-, S- AND X-BAND; 3) SNOW MONITORING IN X- AND KU-BAND; AND 4) VERY HIGH-RESOLUTION IMAGING IN X- AND KA-BAND. MOST USED FREQUENCY BANDS ARE L-, C- AND X-BAND.

Frequency Band	Ka	Ku	X	C	S	L	P
Frequency [GHz]	40–25	17.6–12	12–7.5	7.5–3.75	3.75–2	2–1	0.5–0.25
Wavelength [cm]	0.75–1.2	1.7–2.5	2.5–4	4–8	8–15	15–30	60–120

Mode	Incidence Angle	Resolution	Swath Width	Polarization (H = Horizontal V = Vertical)
Stripmap	20 - 45	5 x 5 m	80 km	HH+HV, VH+VV, HH, VV
Interferometric Wide swath	29 - 46	5 x 20 m	250 km	HH+HV, VH+VV, HH, VV
Extra Wide swath	19 - 47	20 x 40 m	400 km	HH+HV, VH+VV, HH, VV
Wave	22 - 35 35 - 38	5 x 5 m	20 x 20 km	HH, VV

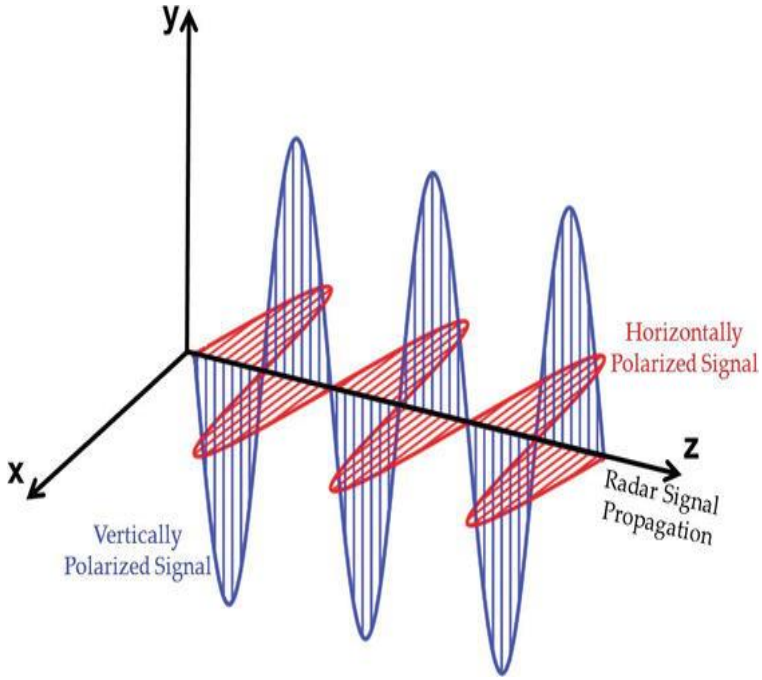
Flood Mapping around Vembanadu Lake Karala

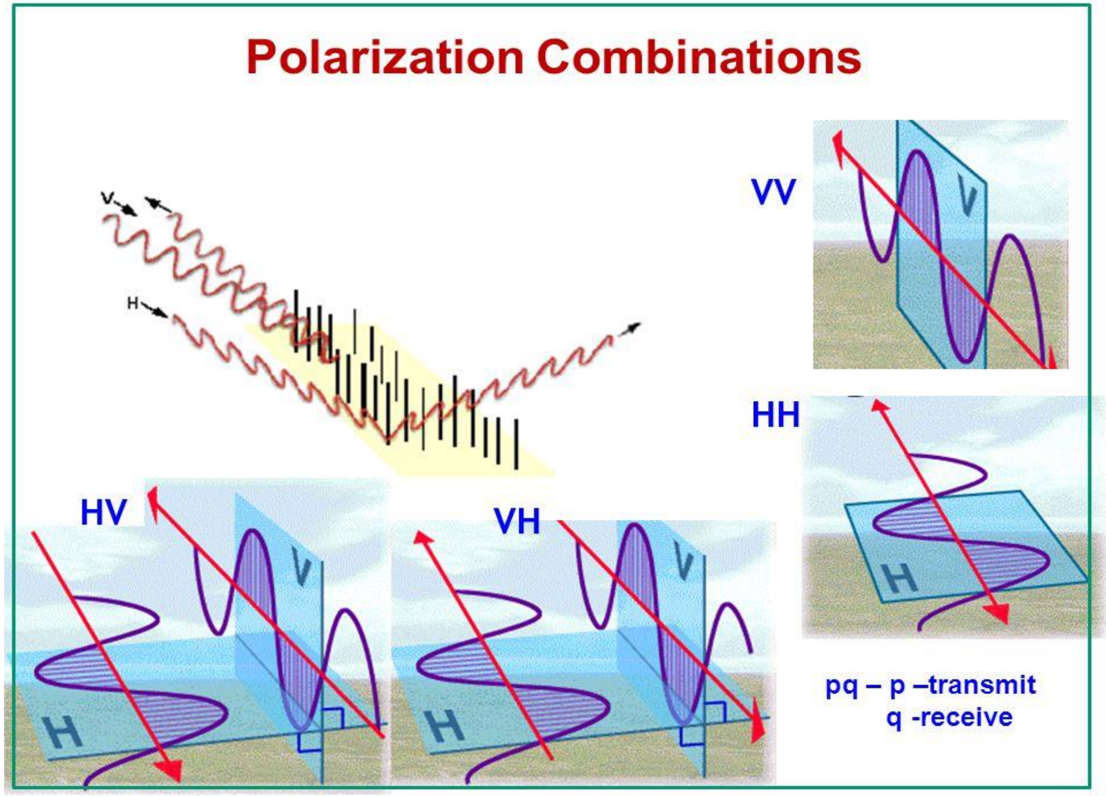


Flooded Area 21 Aug 2018

Flooded Area 7 Dec 2018

Radar Polarisation





Strengths of SAR

Cloud independent images.

High re-visit time

Easy detection of smooth water.
Accuracy: up to 95%

Limitation of SAR

Potential false alarm from shadows smooth objects e.g. roads & sand

Difficult detection floods in urban areas

Difficulties in detecting flooded vegetation

Methodology and software

The practice shows the use of **ESA's SNAP software** for pre-processing and processing of SAR imagery

Threshold method for deriving the **flood extent**

Google Earth is used to **visualize** the results of image processing

Space Research Institute NASU-SSAU, Ukraine.

Data Access

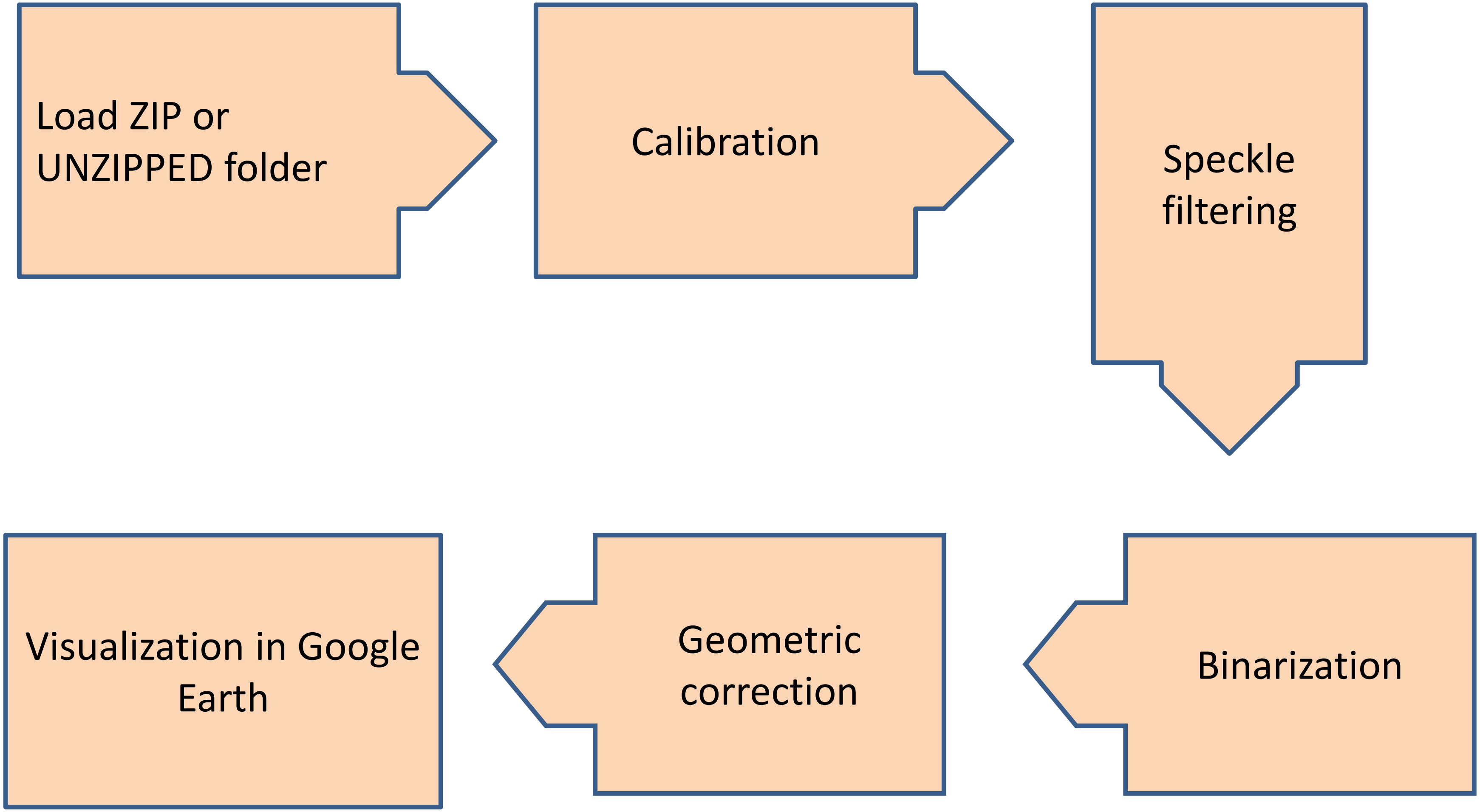
SAR data from ***Sentinel-1*** is what we want

The Sentinels Scientific Data Hub ***free,*** but requires ***registration***

Specify data; product type, sensor mode, sensing period; using web preview draw extent of interest/region

download

Steps to follow



Data preparation

- Read ZIP sentinel-1 data from the directory

- View product explorer for

  i. Metadata (orbit and image);
  ii. Tie-points grid (interpolated latitude, longitude, incident angle and slant range time values);
  iii. Bands (actual image bands)
  iv. By right clicking on the Product, Properties can be opened which include information on mission, acquisition date, pass, etc.Double click

Image display

- Click on bands to display bands to

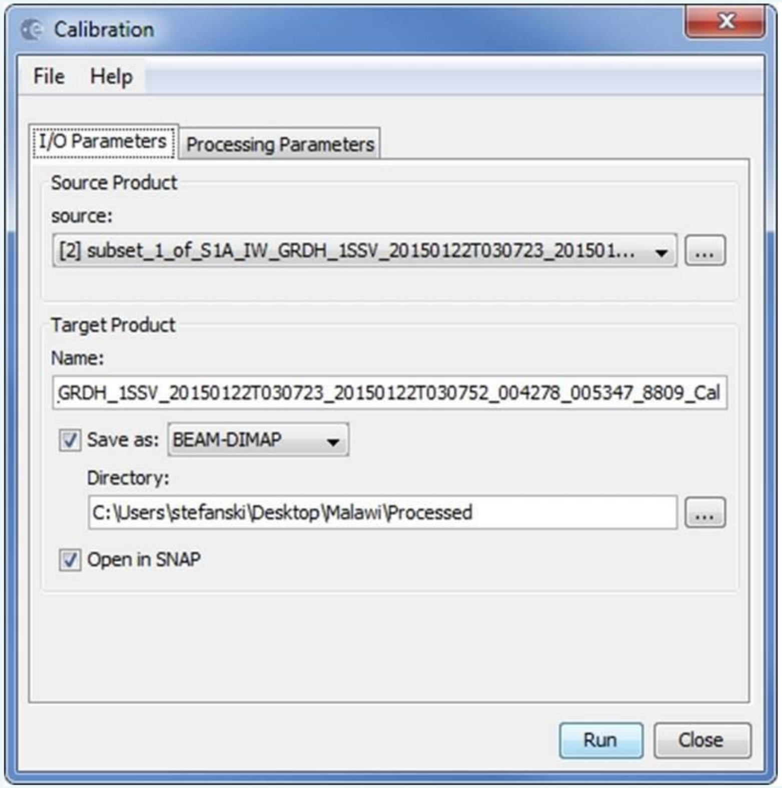
a. Amplitude
b. Intensity

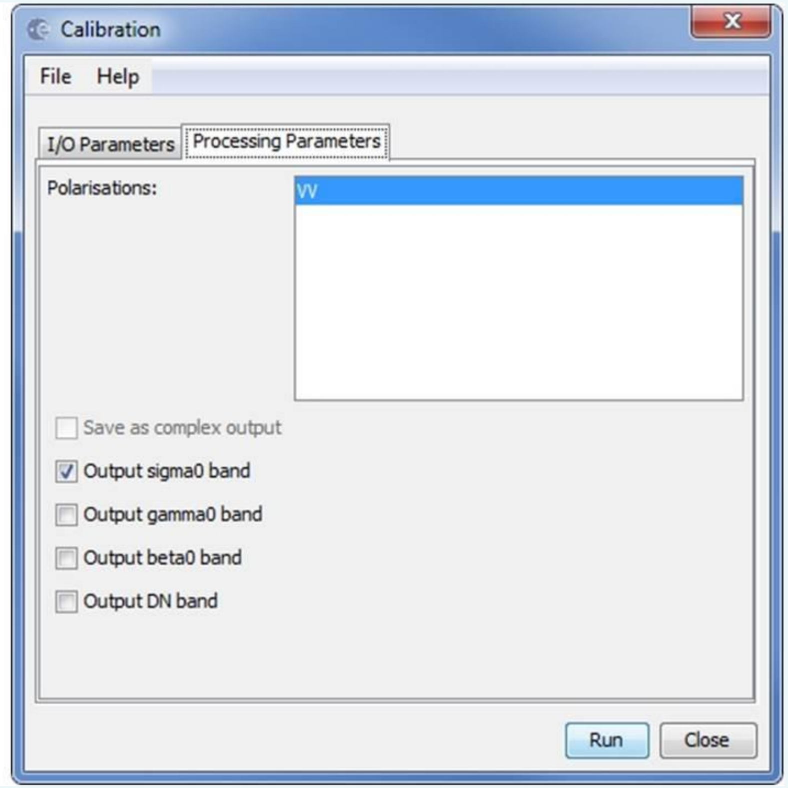
- Double click on amplitude or Intensity to display image
- To subset, select on Menu panel 'Raster' --> 'Subset'. Specify region of interest and click OK button.

Load ZIP or UNZIPPED folder → Calibration →

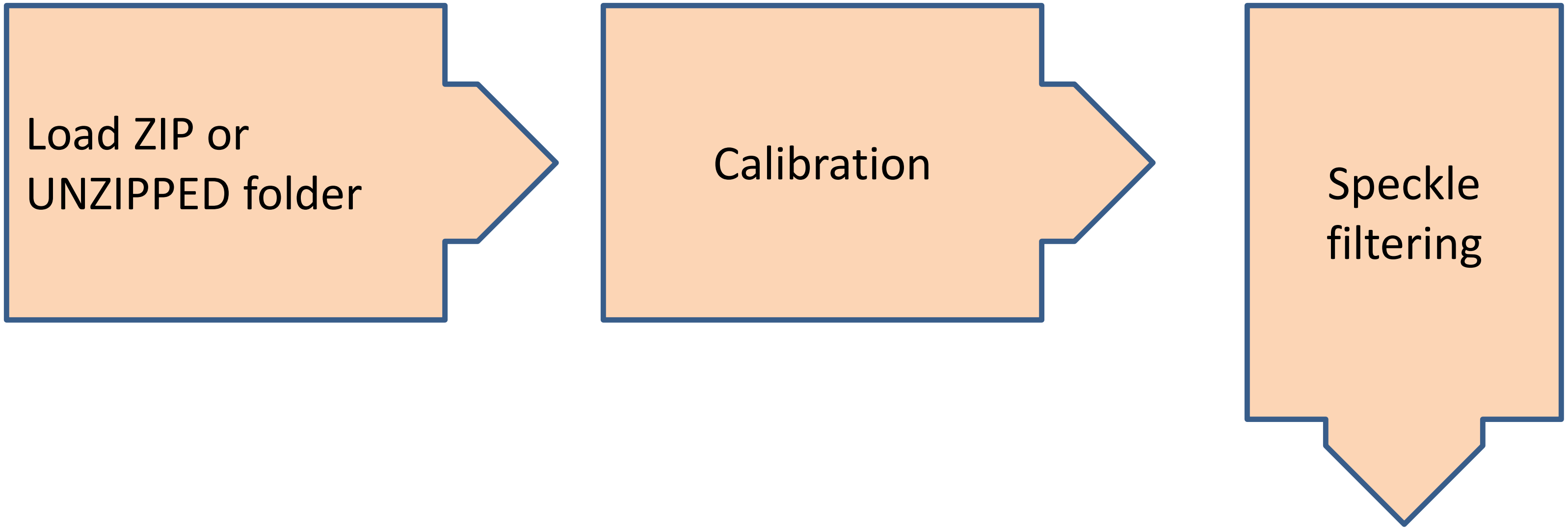
Calibration

Menu panel ==> ‘Radar’ --> ‘Radiometric’ --> ‘Calibrate’



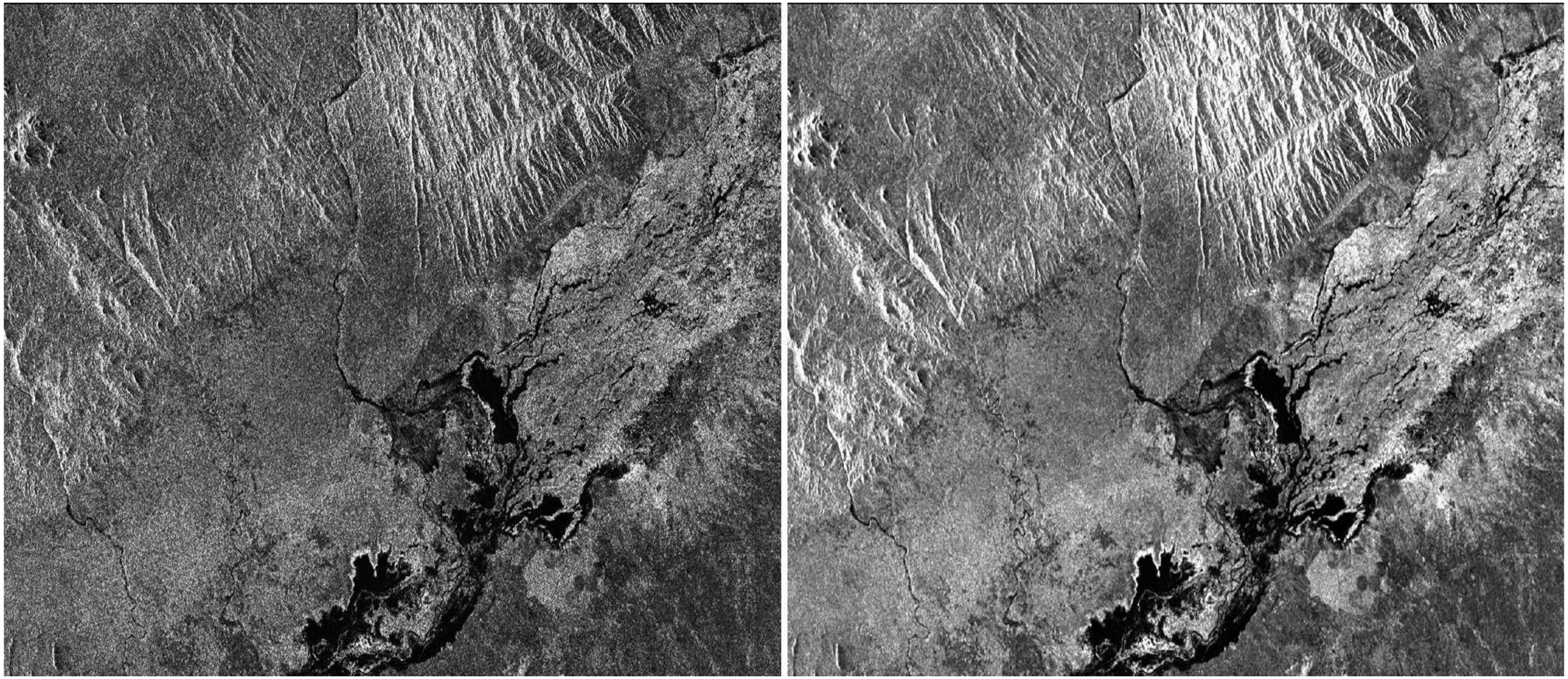


A new product with calibrated values of the backscatter coefficient

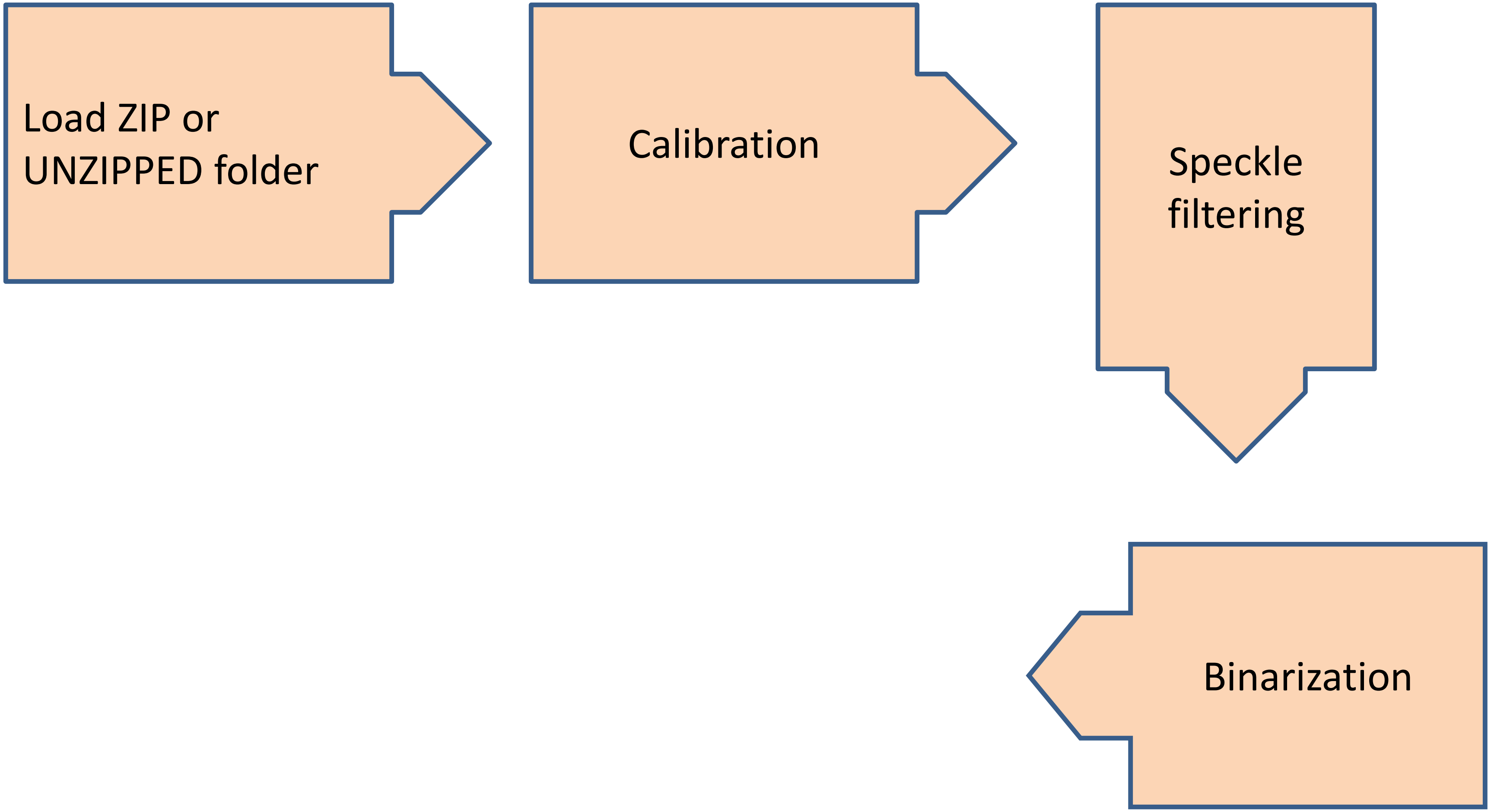

Load ZIP or UNZIPPED folder
Calibration
Speckle filtering

Speckle Filtering

Menu panel ==> 'Radar' -> 'Speckle Filtering' -> 'Single Product Speckle Filter'

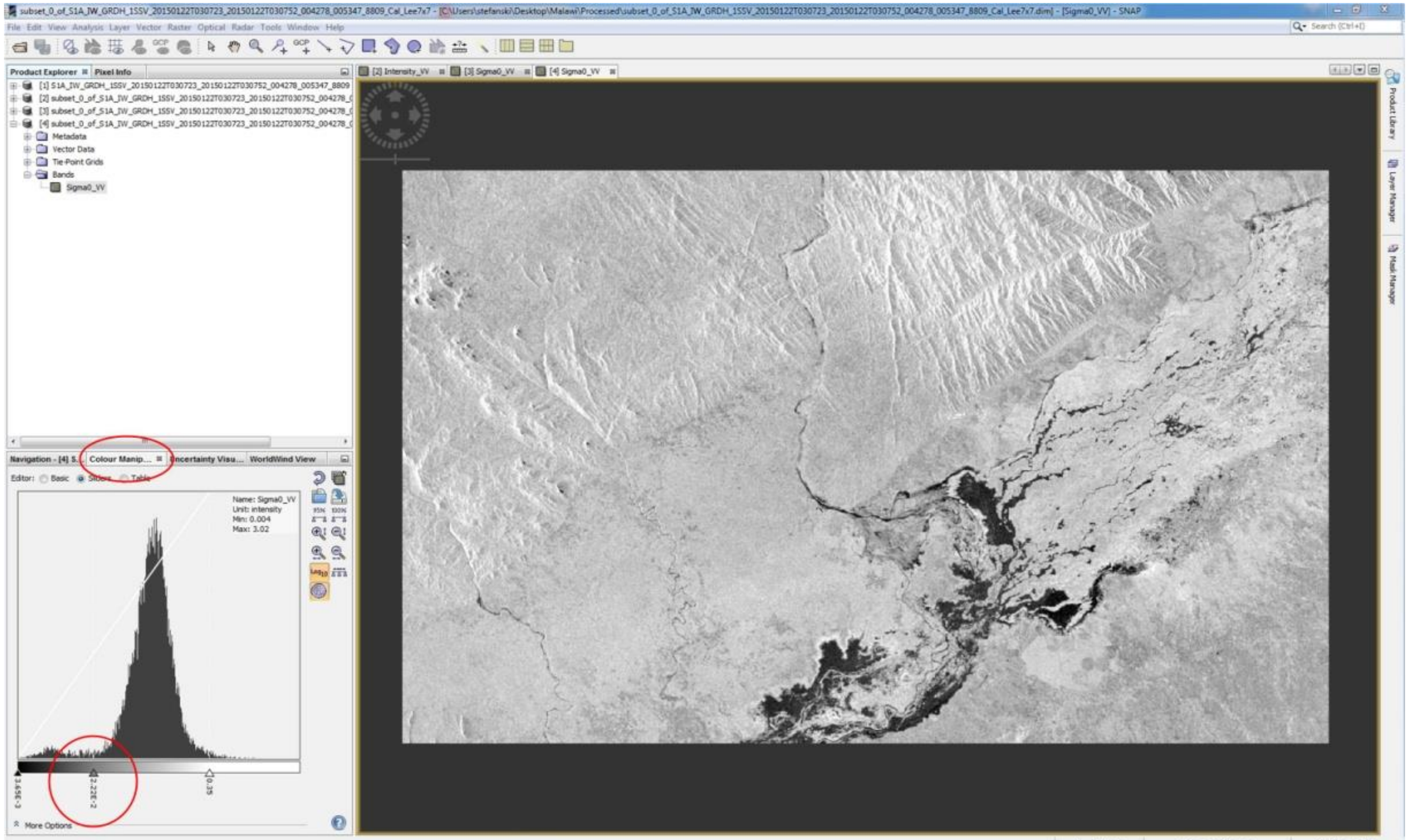


A new filtered band will be created


Load ZIP or UNZIPPED folder
Calibration
Speckle filtering
Binarization

Binarization

To separate water from non-water a threshold can be selected select 'Colour Manipulation tab'-> view histogram



low values= water & high values=non-water

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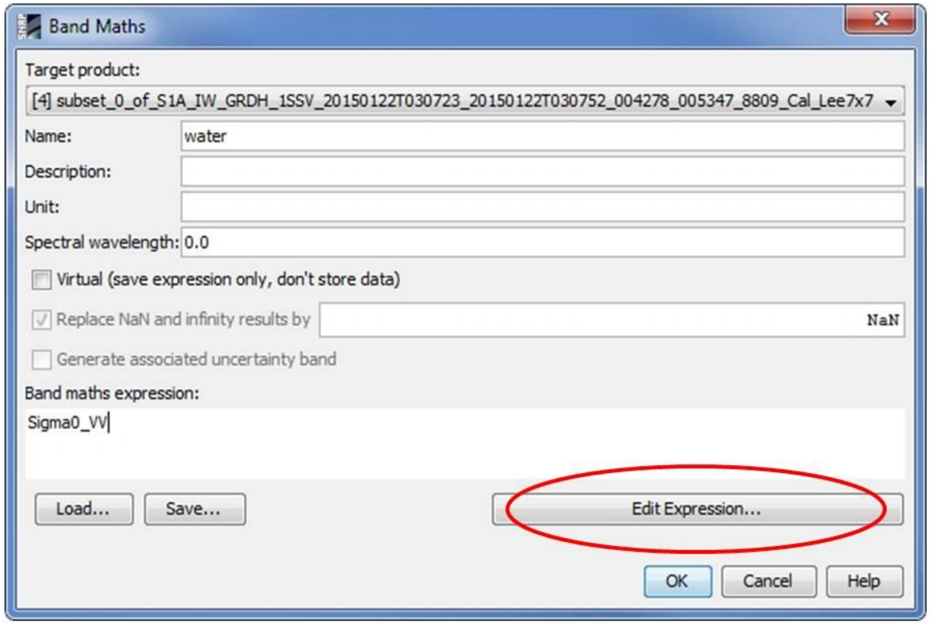
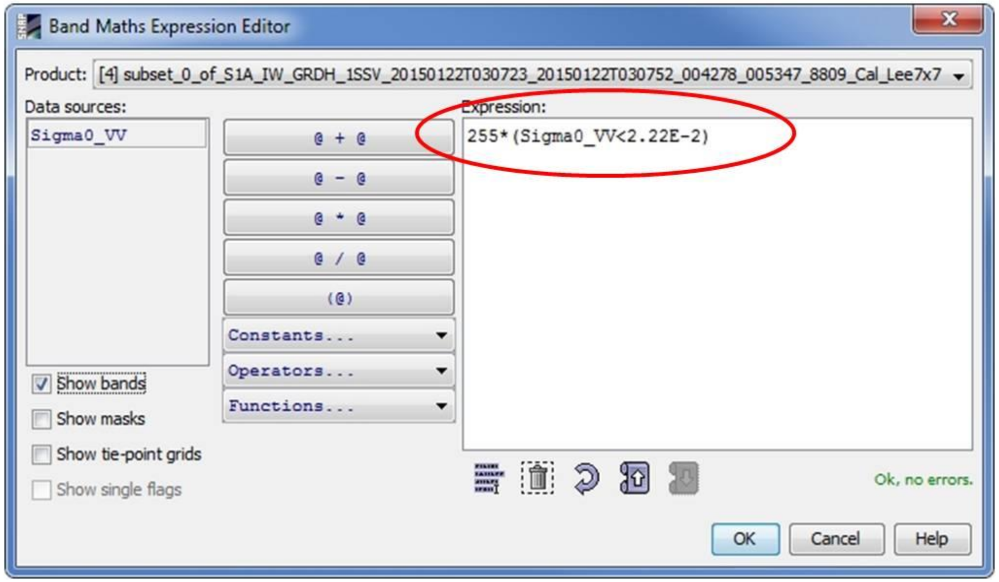
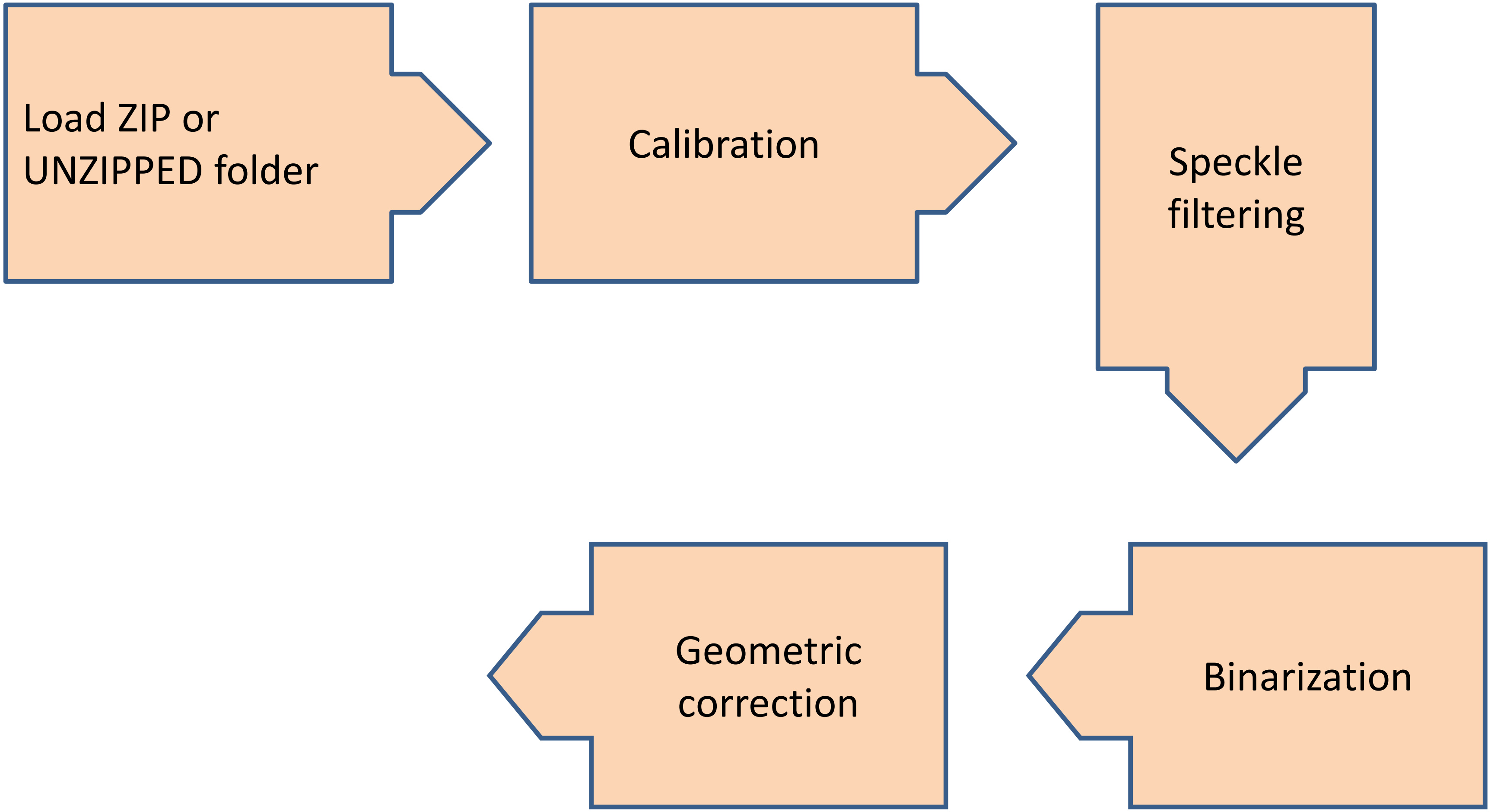
To Binarize:

Menu panel =>‘Raster’ --> ‘Band Math’





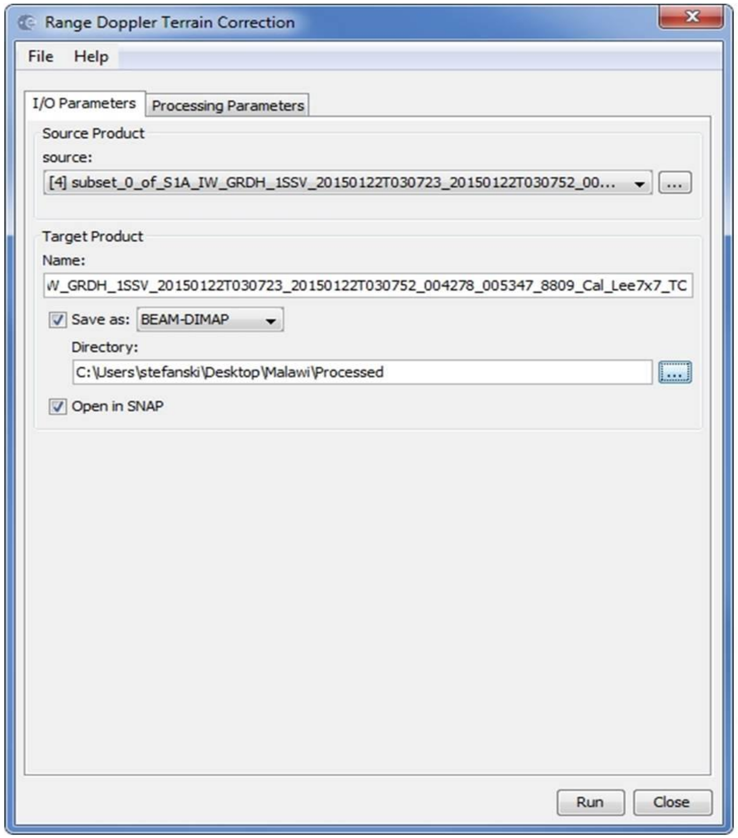

Load ZIP or UNZIPPED folder
Calibration
Speckle filtering
Binarization
Geometric correction

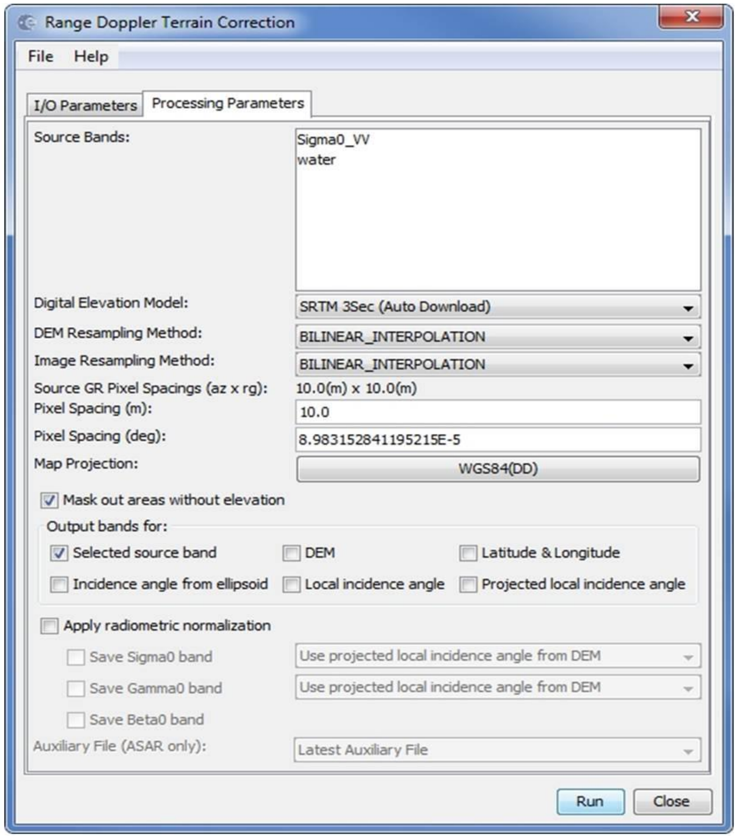
https://scihub.copernicus.eu/dhus/#/self-registration

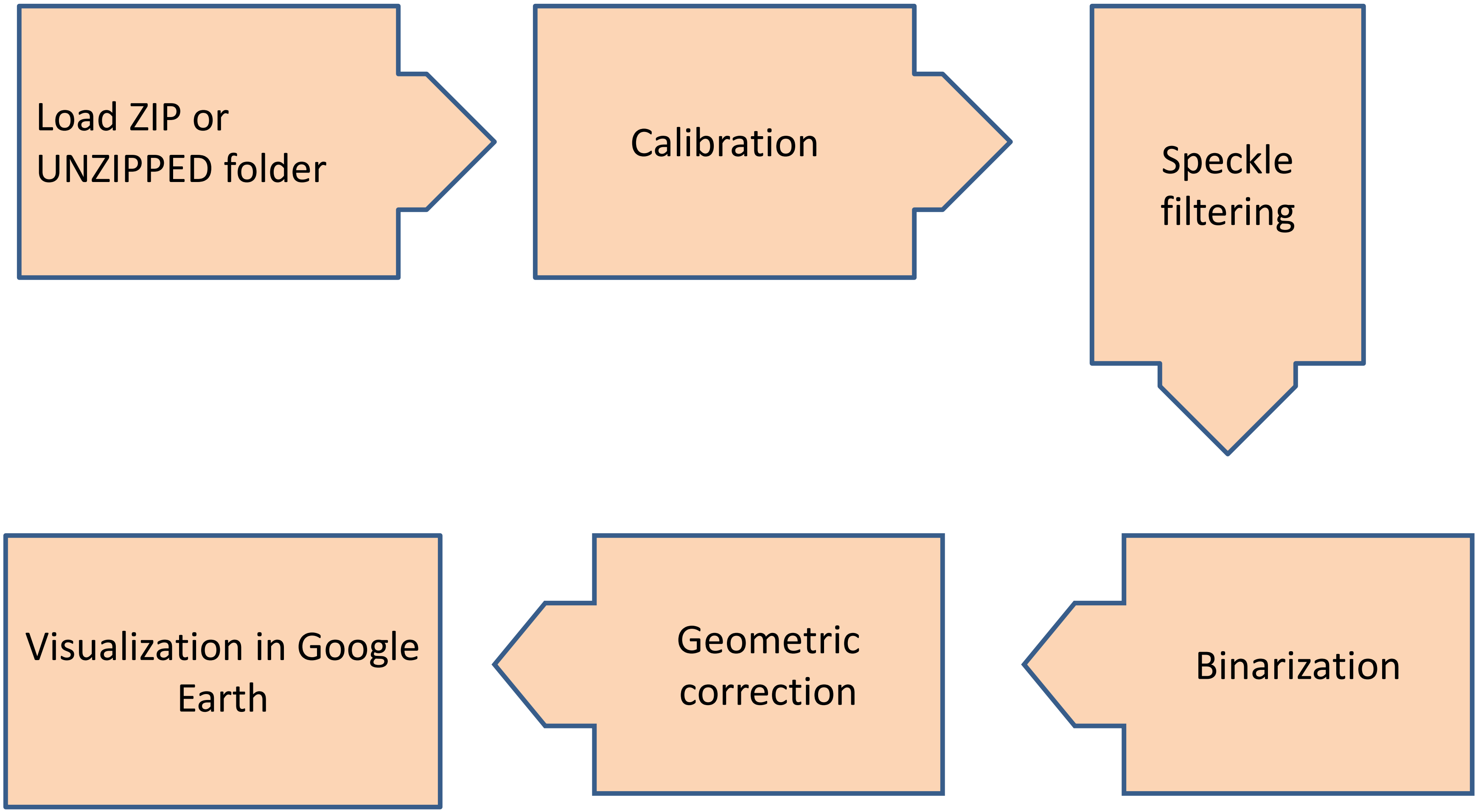
Geometric Correction

Re-project the image to a geographic projection

Radar --> Geometric --> Terrain Correction --> Range-Doppler Terrain Correction





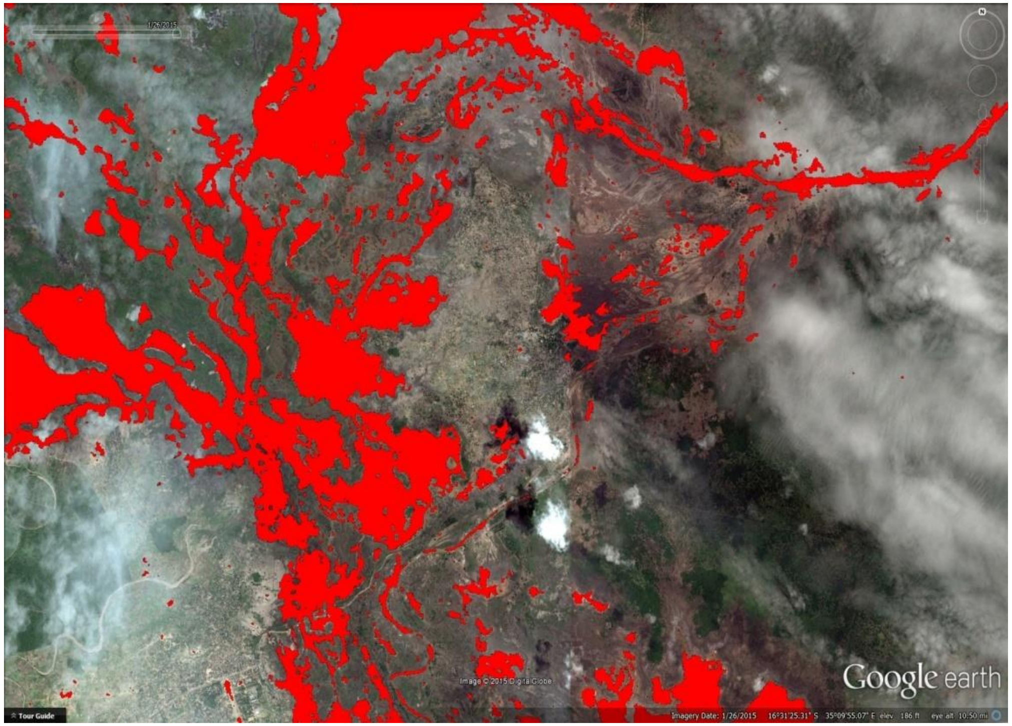

Load ZIP or UNZIPPED folder
Calibration
Speckle filtering
Binarization
Geometric correction
Visualization in Google Earth

Visualization

Menu panel==>

File --> Export --> Other --> View as Google Earth KMZ.

The KMZ file will be directly imported to Google Earth



To display solely the water pixels

unzip the KMZ file from SNAP; the resulting folder will include an *overlay.kml* file and an *overlay.png*

Unzip KMZ from SNAP

- Overlay KML
- Overlay PNG (needed)
- IrfanView
  - background color to transparent
  - override the overlay.png and import the overlay.kml to Google
    - change the mask color via the Menu panel Image --> Replace Color
    - check ‘Save Transparent Color’, Save Transparency as Alpha channel,use main window color transparecy

Mission Objectives:

- Land monitoring of forests, water, soil and agriculture
- Emergency mapping support in the event of natural disasters
- Marine monitoring of the maritime environment
- Sea ice observations and iceberg monitoring
- Production of high resolution ice charts
- Forecasting ice conditions at sea
- Mapping oil spills
- Sea vessel detection
- Climate change monitoring

Bibliography:

Kussul N., Shelestov A., Skakun S. "**Flood Monitoring on the Basis of SAR Data**", In: F. Kogan, A. Powell, O. Fedorov (Eds.) "Use of Satellite and In-Situ Data to Improve Sustainability". NATO Science for Peace and Security Series C: Environmental Security, 2011, pp. 19-29. (http://dx.doi.org/10.1007/978-90-481-9618-0_3)

Kussul N., Shelestov A., Skakun S. (2008) "**Grid System for Flood Extent Extraction from Satellite Images**", Earth Science Informatics, 1(3-4), pp. 105-117. (http://dx.doi.org/10.1007/s12145-008-0014-3)