

WORKSHOP SESSION-2

LAND & OCEAN APPLICATION OF SAR IN BRIEF

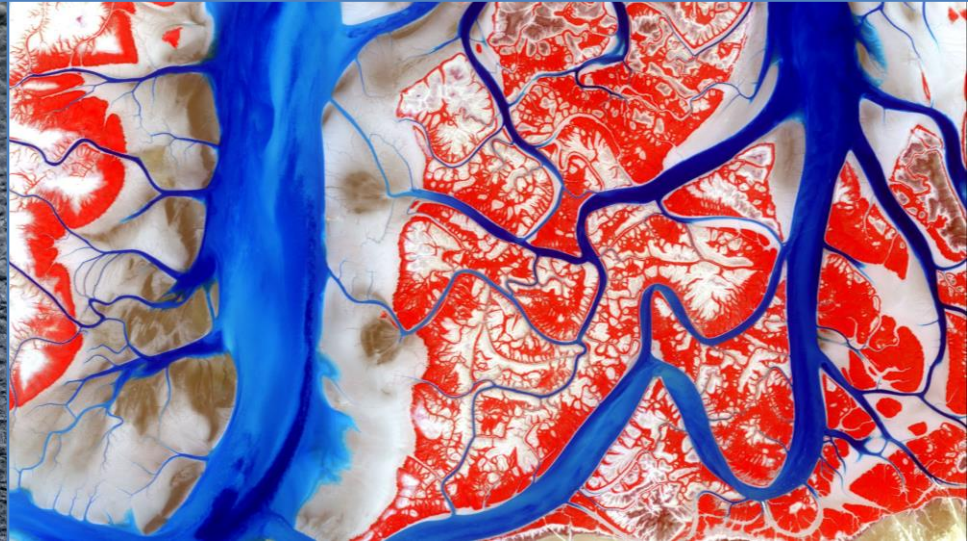
December 1, 2022

Dr Dipak Paudyal
Managing Director & Chief Scientist
APAC Geospatial
Fellow SSSI
Adjunct Associate Prof University of the Sunshine Coast

APAC Geospatial
Remote sensing of the real world

L3HARRIS™

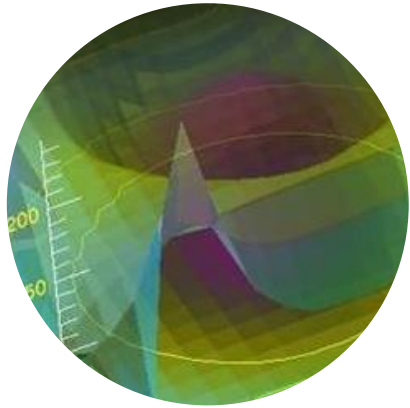
sarmap
your information gateway



- **Introductions**
- **Background on SAR**
- **Ocean Applications**
 - Ship Detection
 - Oil Spills
- **Land Applications**
 - Burn Area Analysis
 - Land Surface Deformation



Harris Geospatial Solutions – SW Portfolio



IDL



ENVI



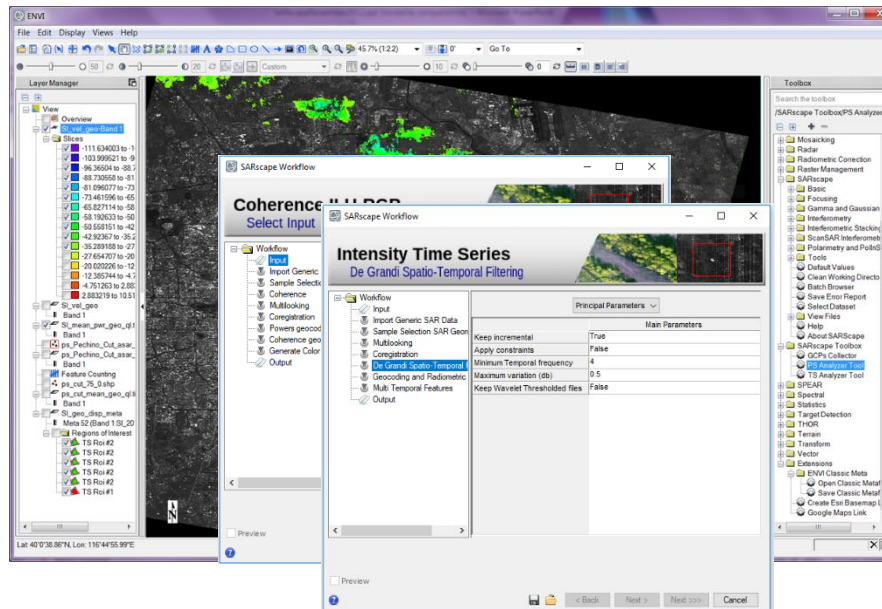
Geospatial Services
Framework



SARscape



An integrated software platform for operational processing of SAR data



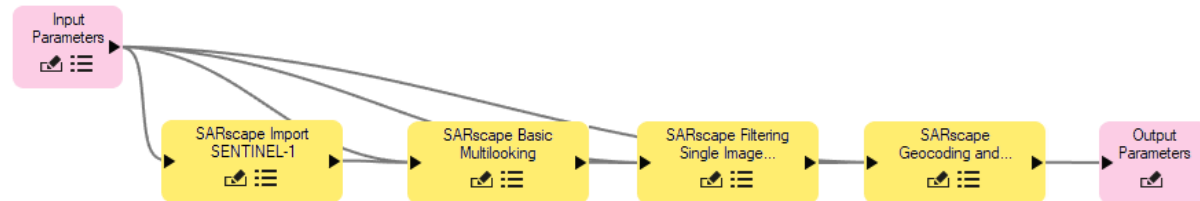
ENVI UI

ENVI Workflows

ENVI Modeler

ArcGIS Pro

Desktop-Enterprise-Cloud



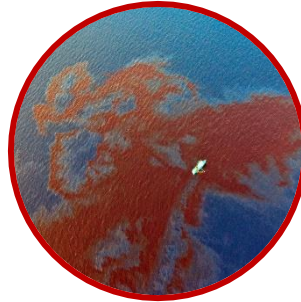
Synthetic Aperture Radar Applications



Landslides



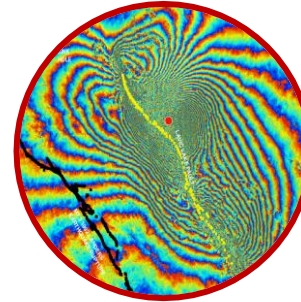
Glaciers and
permafrost



Oil spills



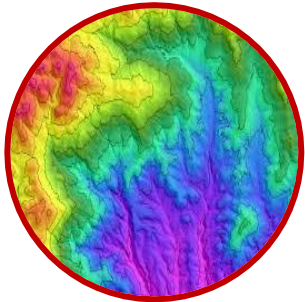
Subsidence



Earthquakes



Shipping



DEM
generation



Burn Area
Analysis



Deforestation



Flooding



Volcano
monitoring



Activity
monitoring

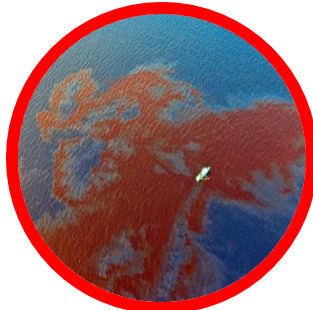
Synthetic Aperture Radar Applications



Landslides



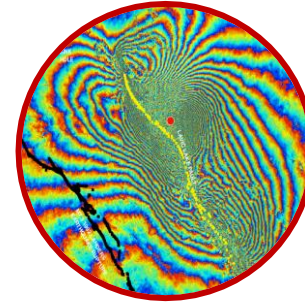
Glaciers and
permafrost



Oil spills



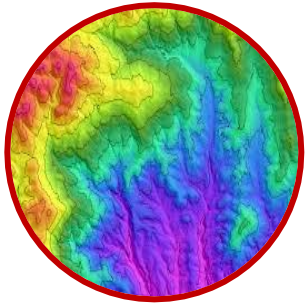
Subsidence



Earthquakes



Shipping



DEM
generation



**Burn Area
Analysis**



Deforestation



Flooding



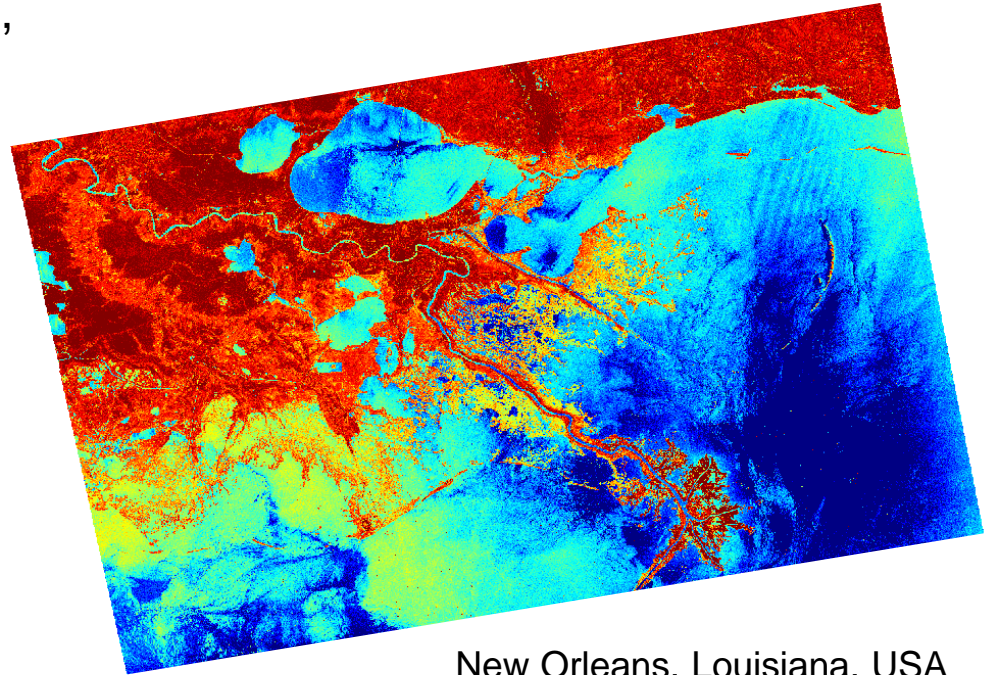
**Volcano
monitoring**



Activity
monitoring

SAR views the surface water conditions, allowing us to view important features such as:

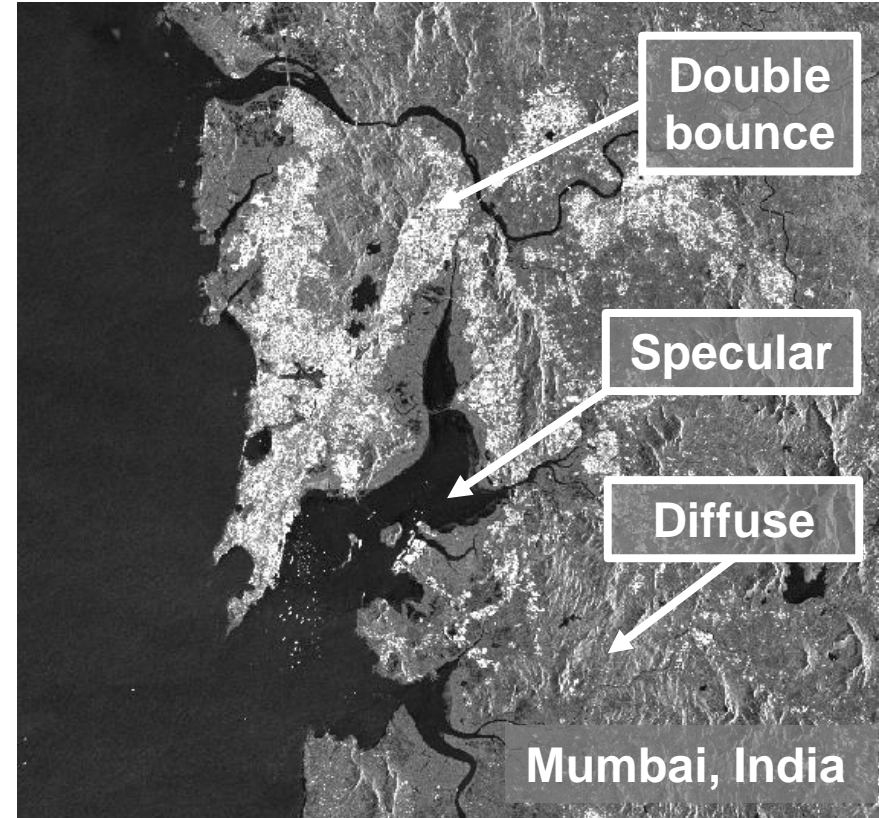
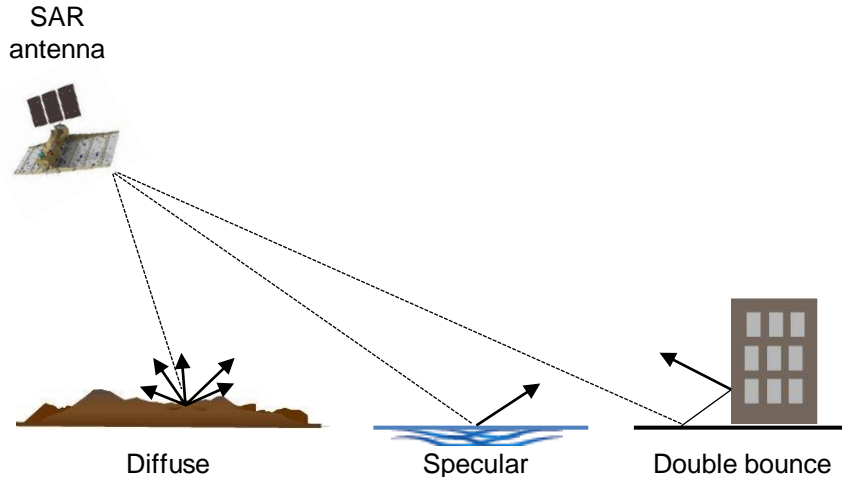
- Waves
- Tides and Currents
- Shallow Bathymetry
- Wind effects
- Oils or other surface coverings



New Orleans, Louisiana, USA
and the Gulf of Mexico
May 15, 2016 – Sentinel-1

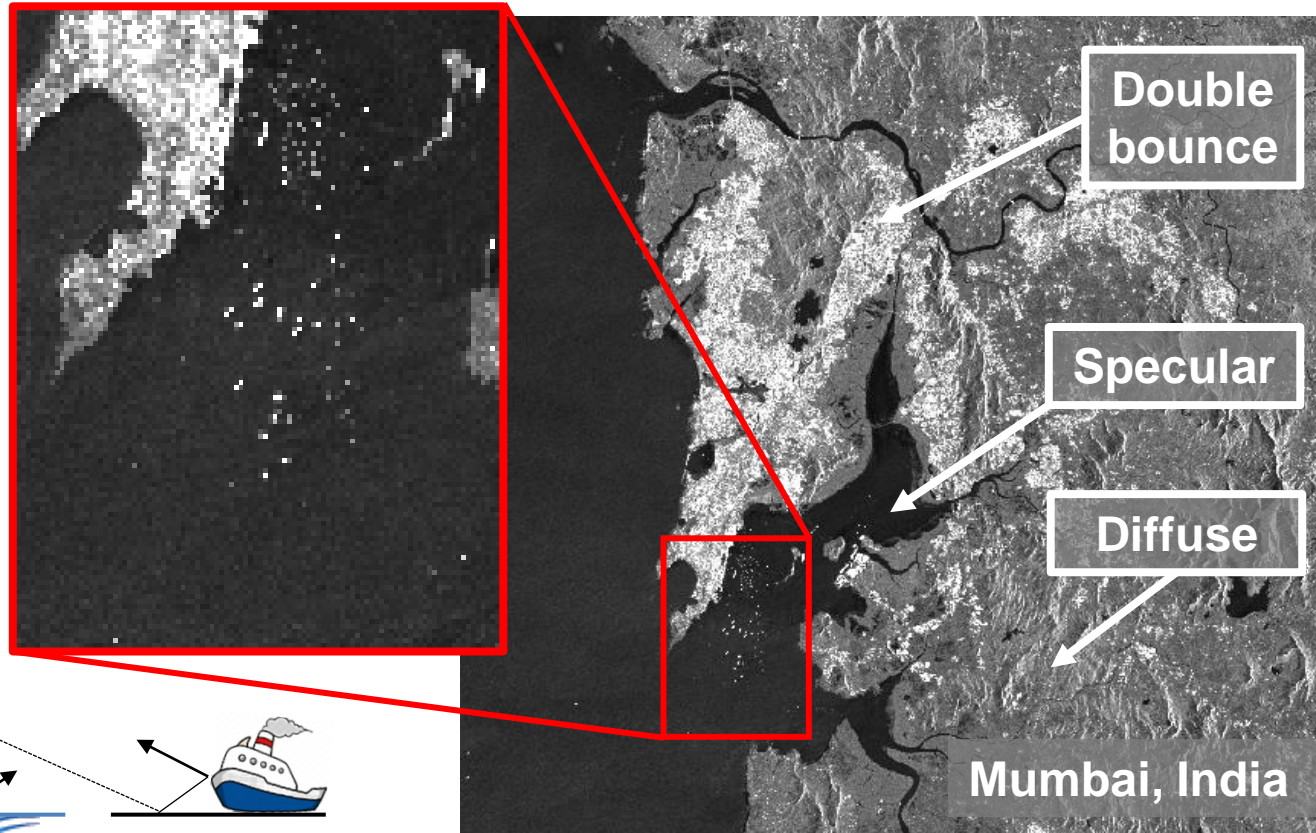
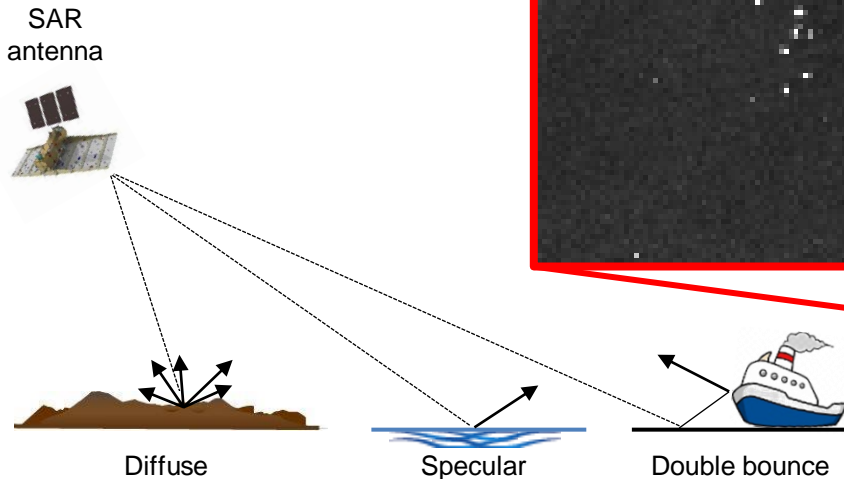
Ship Detection

Differences in radar backscatter highlight ships against water



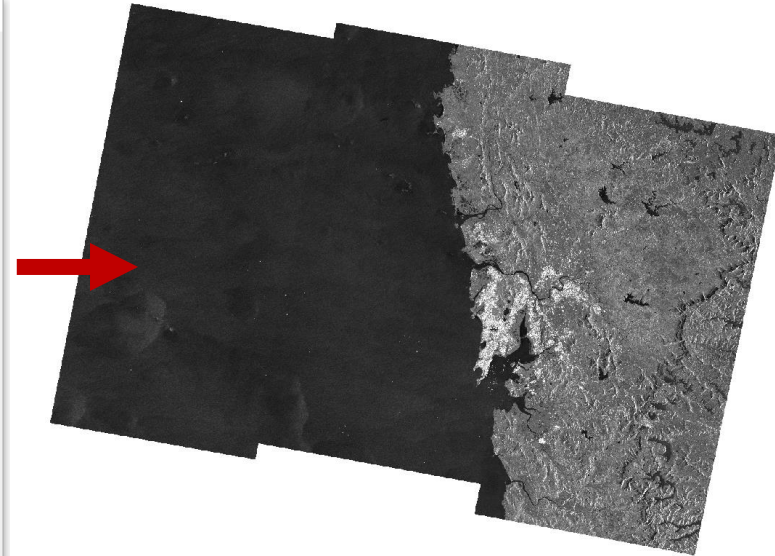
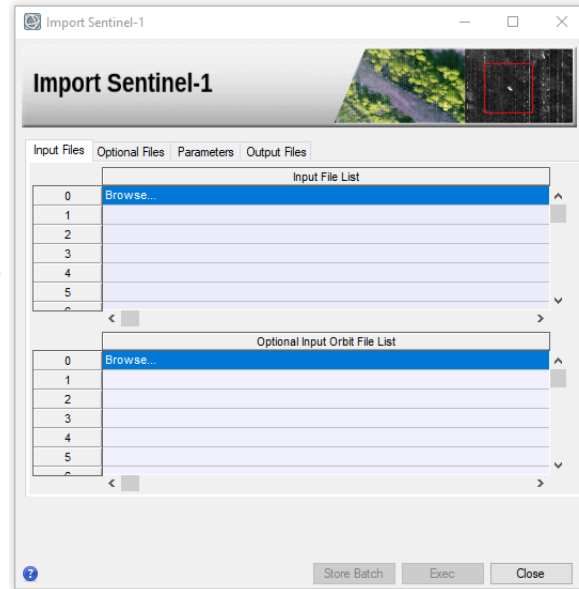
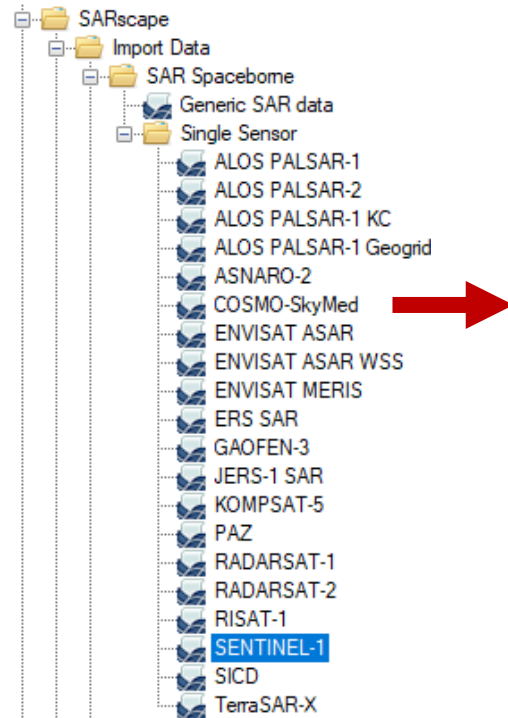
Ship Detection

Differences in radar backscatter highlight ships against water



Ship Detection – Step 1: Data Import

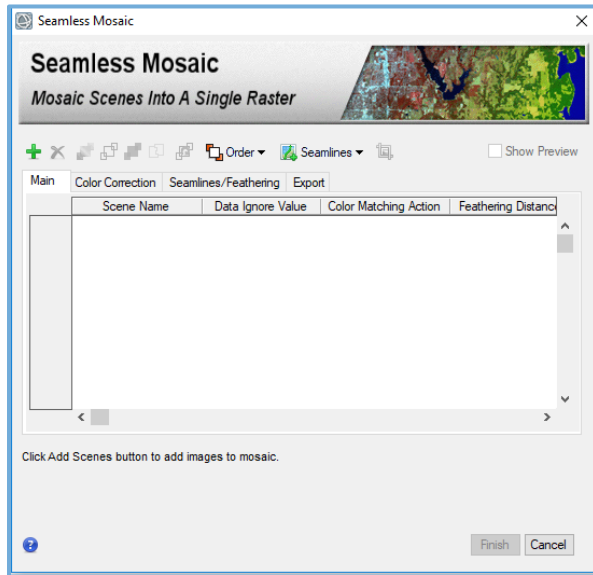
Import Sentinel-1 GRD Data



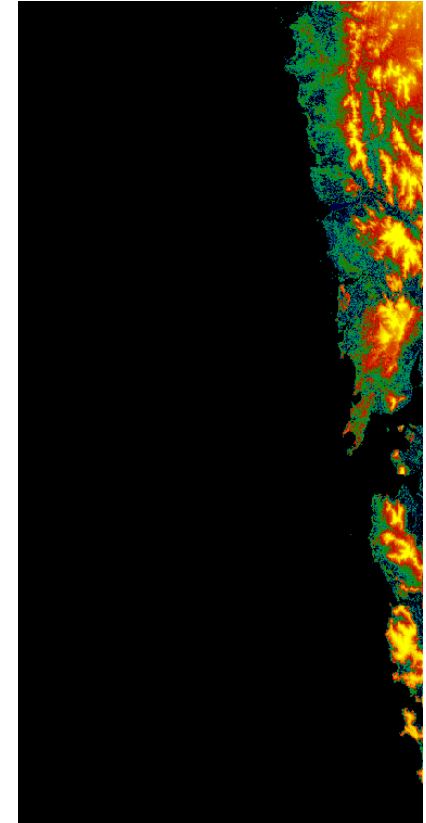
GRD data is already converted to ground range

Ship Detection – Step 2: DEM Import

ASTER DEM: allows for simple land mask creation

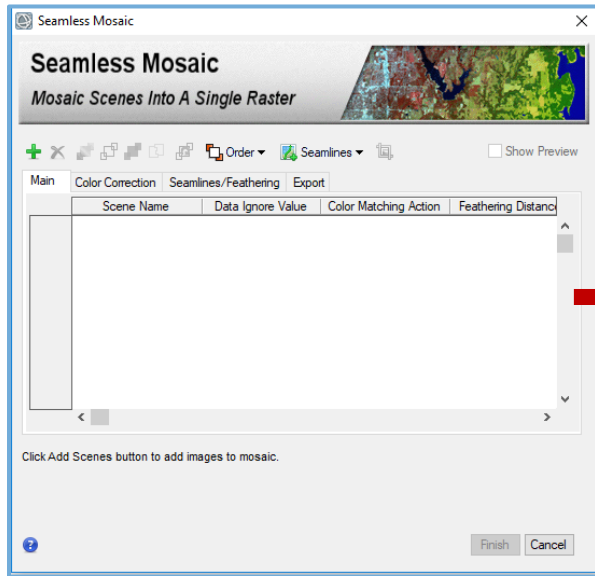


Mosaic DEM tiles
(if needed)

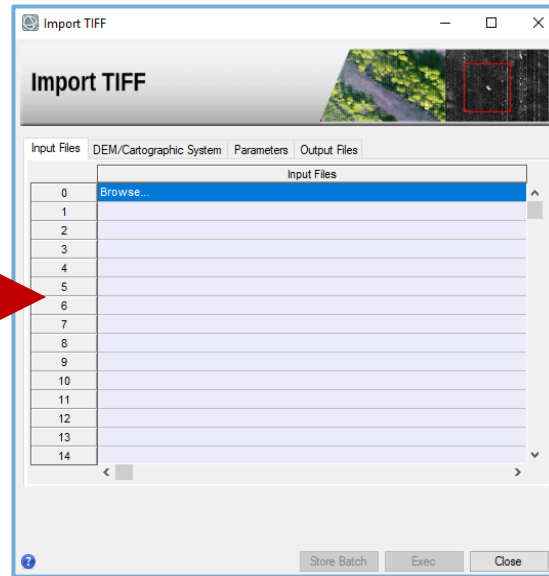


Ship Detection – Step 2: DEM Import

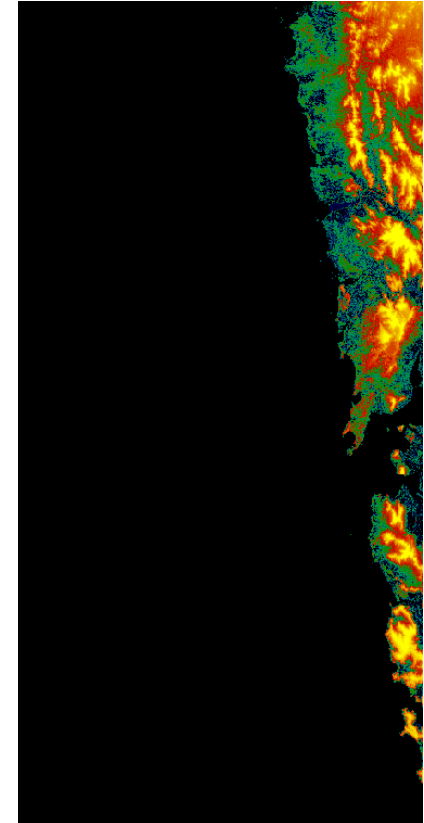
ASTER DEM: allows for simple land mask creation



Mosaic DEM tiles
(if needed)

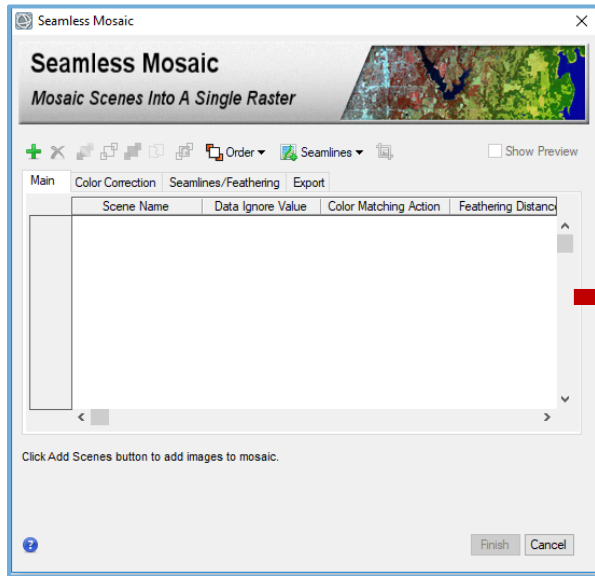


SARscape import Generic tiff

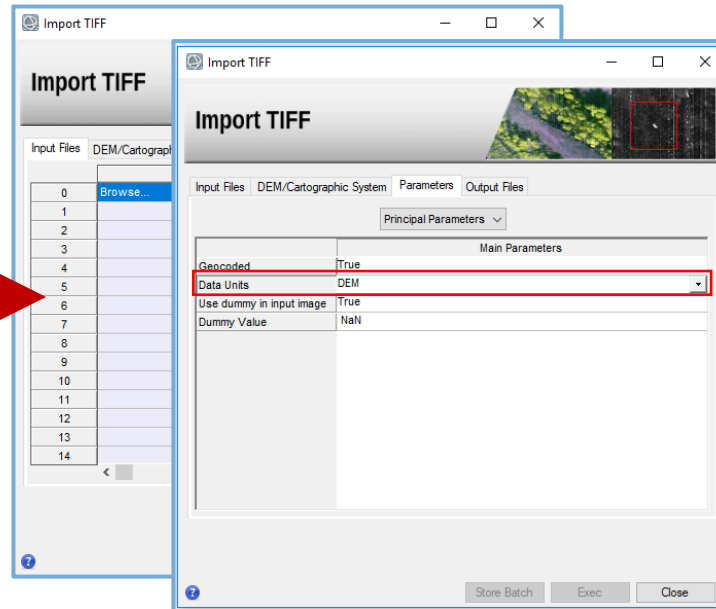


Ship Detection – Step 2: DEM Import

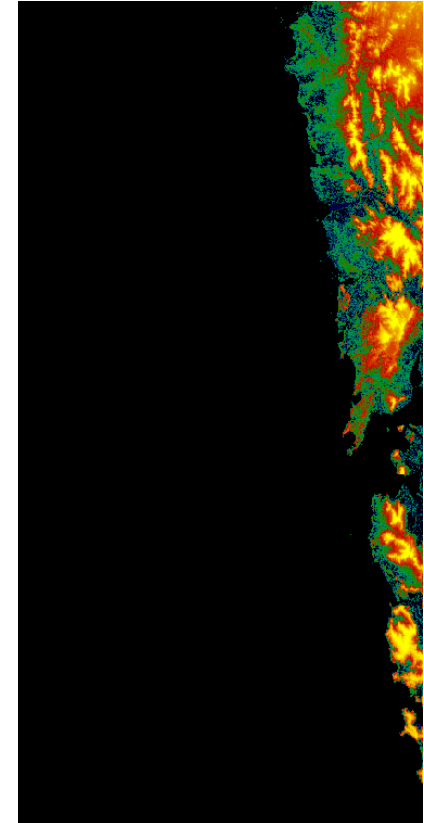
ASTER DEM: allows for simple land mask creation



Mosaic ASTER DEM tiles
(if needed)

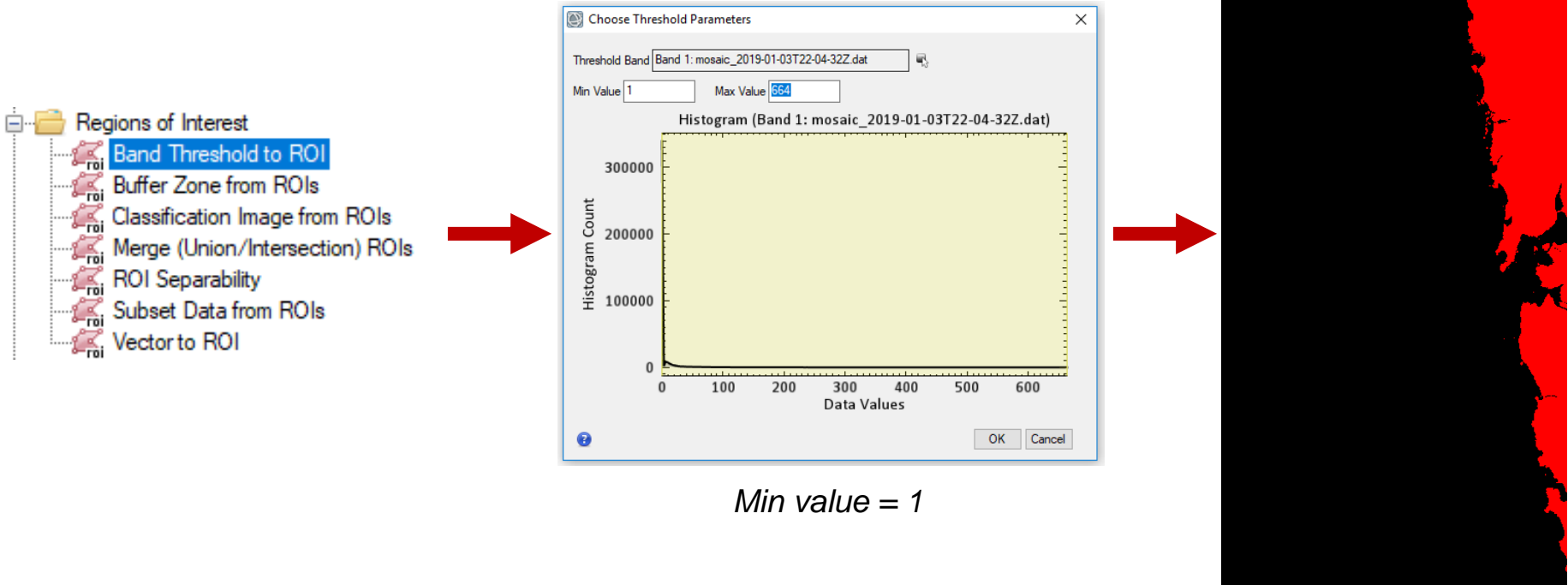


SARscape import Generic tiff

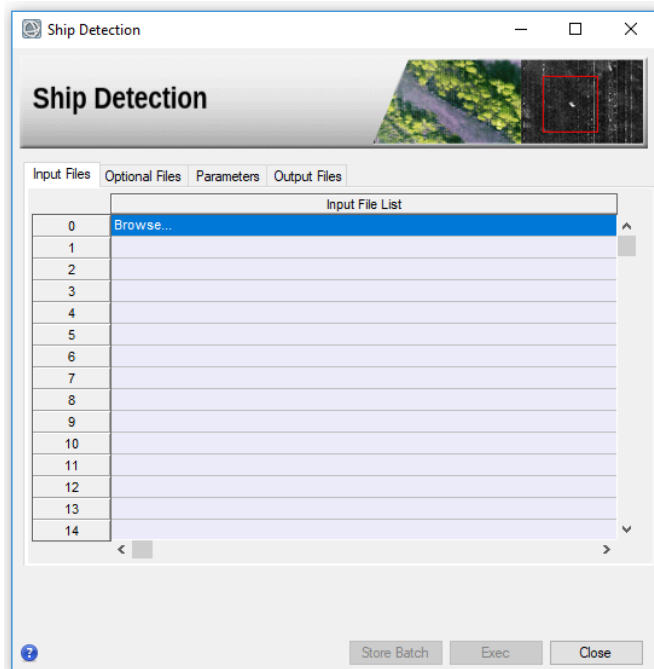
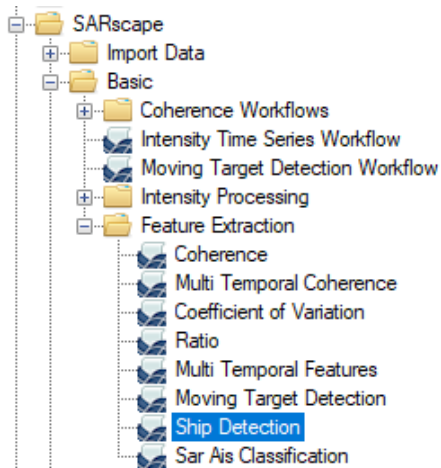


Ship Detection – Step 3: Land Mask

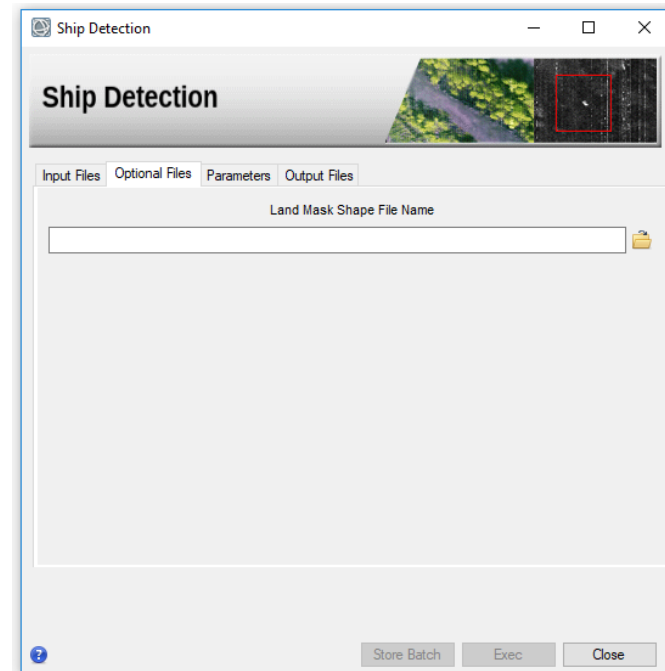
Threshold DEM to ROI



Ship Detection – Step 4: Ship Detection Tool



SAR Data input



Mask from DEM

Ship Detection – Step 4: Ship Detection Tool



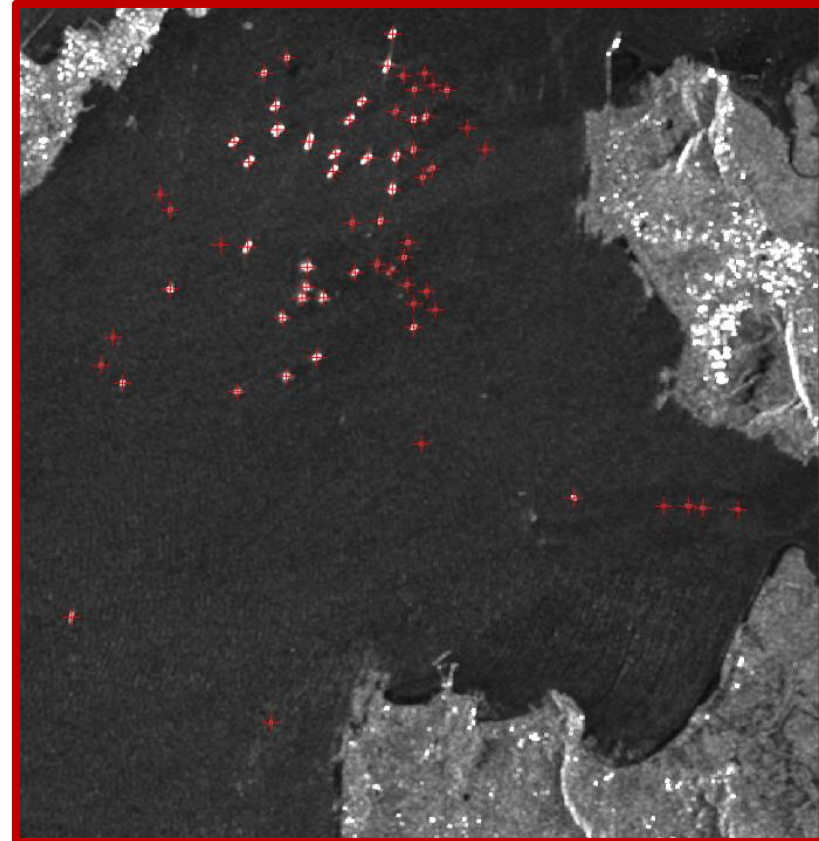
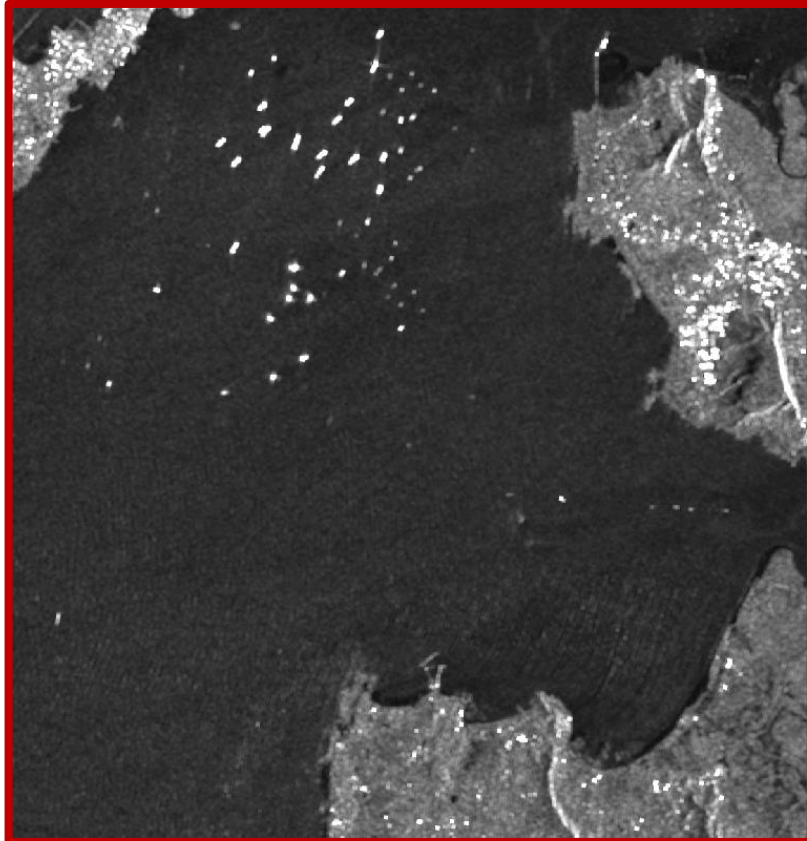
Parameter	Significance
Target window	Size of target
Guard window size	Buffer around target
Background window size	Background value calculation
Land mask buffer size	Buffer around land mask to reduce noise

The screenshot shows the 'Ship Detection' software interface. At the top, there is a window title 'Ship Detection' and standard window controls. Below the title is a header area with the text 'Ship Detection' and a small preview image of a SAR image with a red bounding box around a target. The main area contains a tabbed interface with 'Parameters' selected. Underneath, there is a dropdown menu for 'Principal Parameters' and a table of 'Main Parameters'.

Main Parameters	
Target Window Size [m]	75
Guard Window Size [m]	400
Background Window Size [m]	1000
Probability Of False Alarm [0-1]	0.001
Minimum Mean Sigma0 [dB]	-10
Minimum Ship Size [pixels]	1
Generate KML	True
Land Mask Buffer Size [m]	0

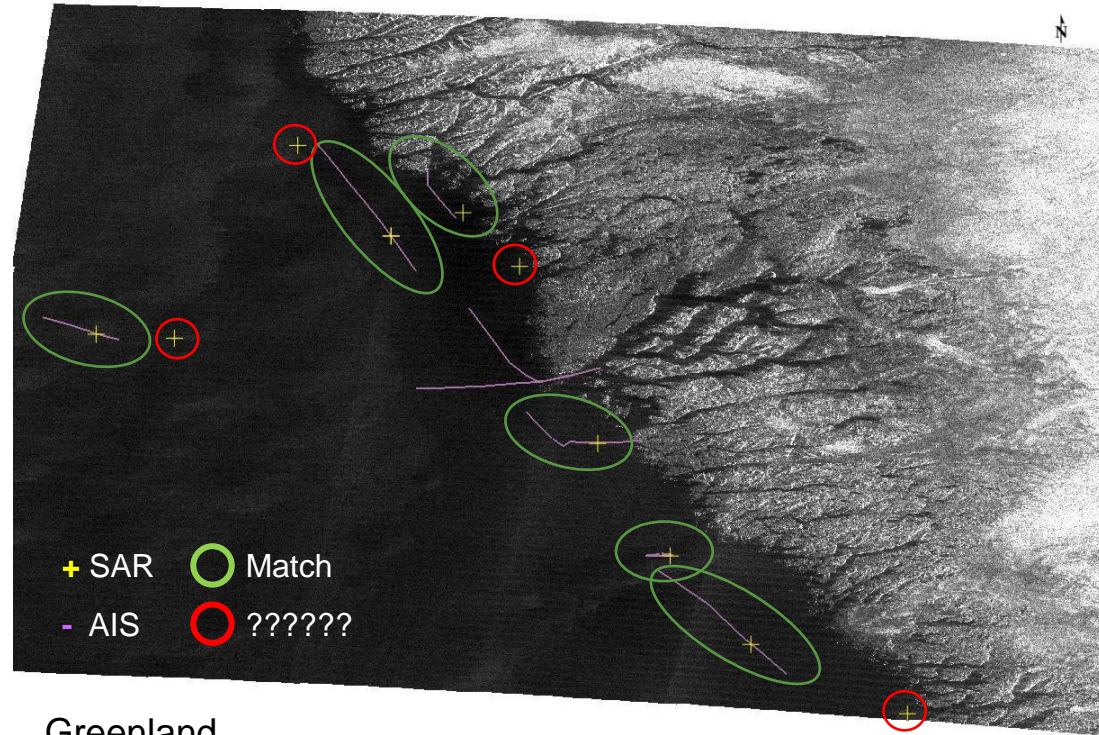
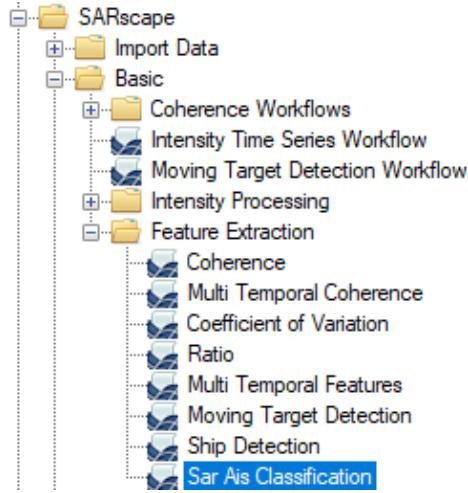
At the bottom of the window, there are three buttons: 'Store Batch', 'Exec', and 'Close'.

Ship Detection: Output



Ship Detection with AIS

AIS (Automatic Identification Systems) documentation for ships can be used with the ship detection tool



Greenland
Radarsat-2 data
SAR & AIS matching

Oil creates a heavy sheen on the water surface, differentiating it from surrounding water.



Background – Ennore and Gotland Island

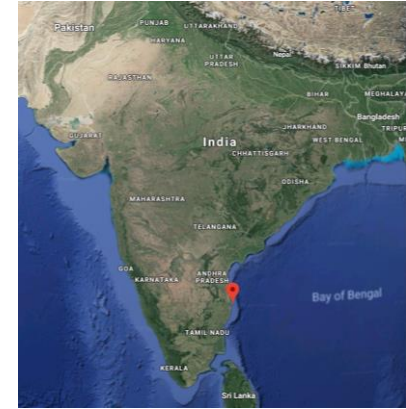


Ennore Oil Spill

Date: 28 January 2017

Cause: BW Maple collided with Dawn Kanchipuram

Where: Kamarajar Port, Ennore India



Gotland Island

Date: May 2005

Cause: Unknown

Where: Gotland Island, Sweden



Data:

Sentinel-1 SLC

Process:

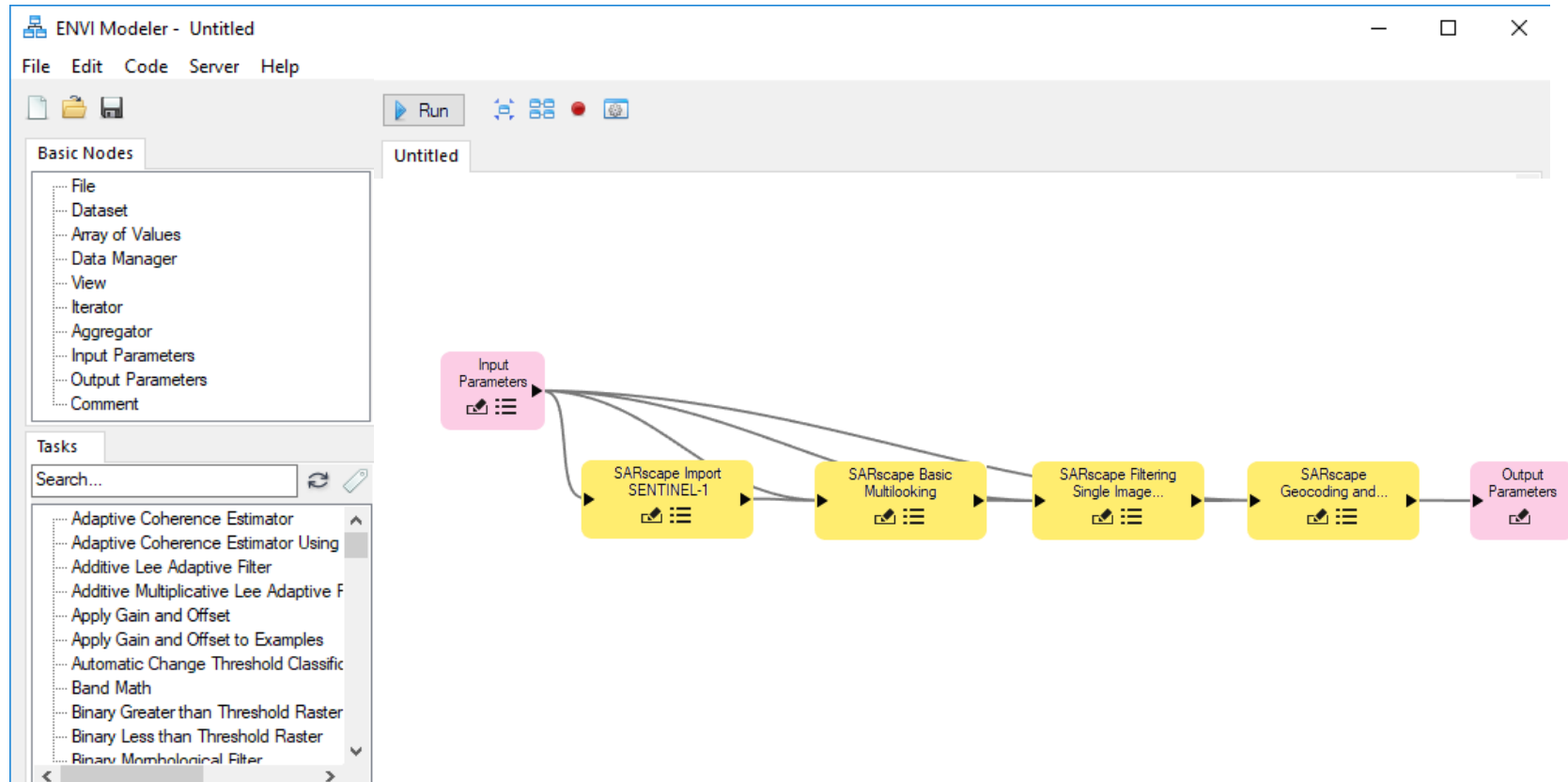
Import Sentinel-1 SLC

Preprocess

Create ROI



Oil Spills Workflow



Multilook

Filter

Geocode



Multilook

Filter

Geocode



Multilook

Filter

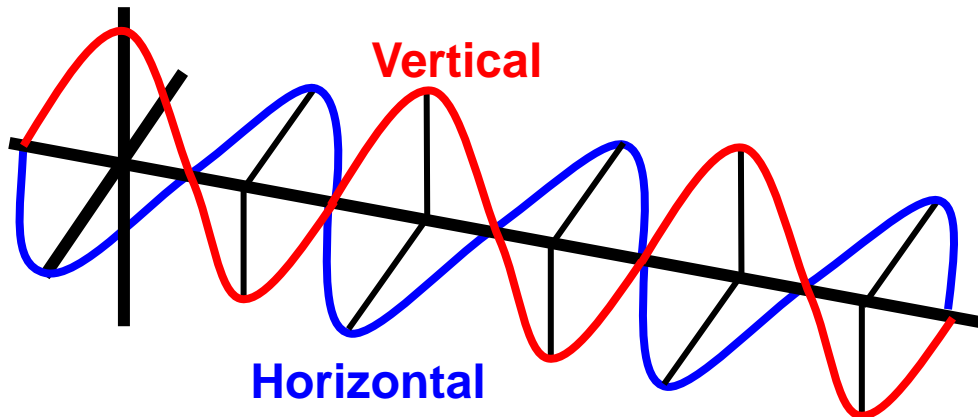
Geocode



Polarization Choices

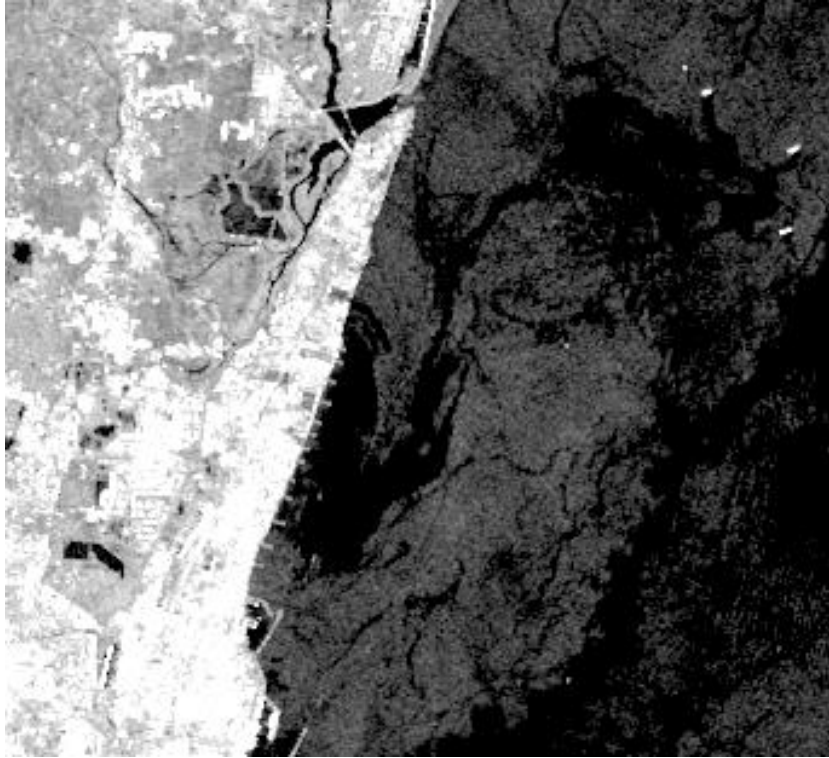
SAR satellites have multiple polarizations, from single pole (such as only VV or HH) to quad-pole (which returns all variations)

Each polarization interacts differently with the surface it hits, adding information to the scene



Polarization	Physical Meaning
VV	Vertical wave, outgoing and incoming
HH	Horizontal wave, outgoing and incoming
VH	Vertical Wave outgoing, Horizontal Wave incoming
HV	Horizontal Wave outgoing, Vertical Wave incoming

Oil Spill – Why Polarization is Important

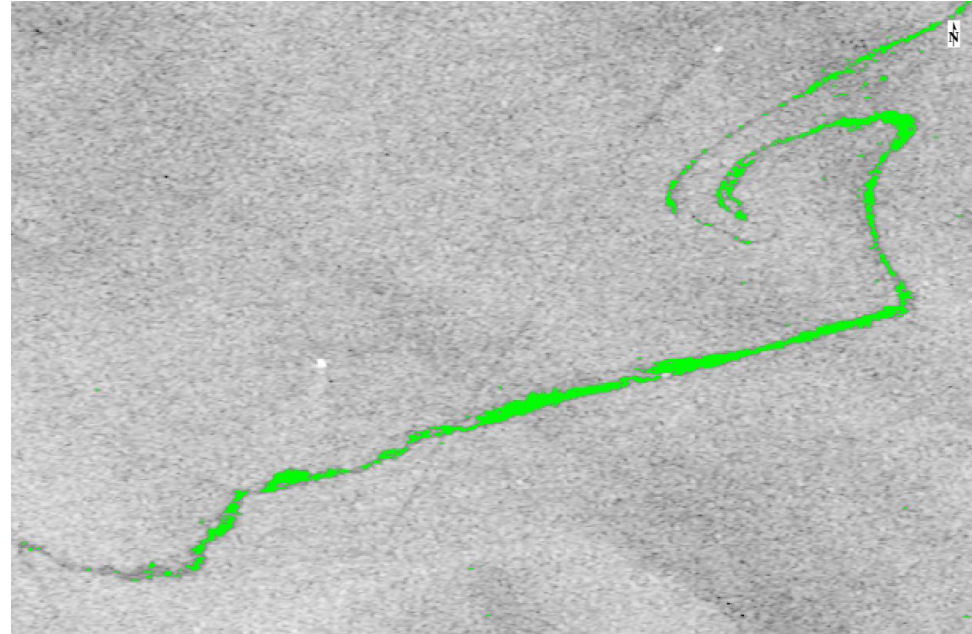


VV

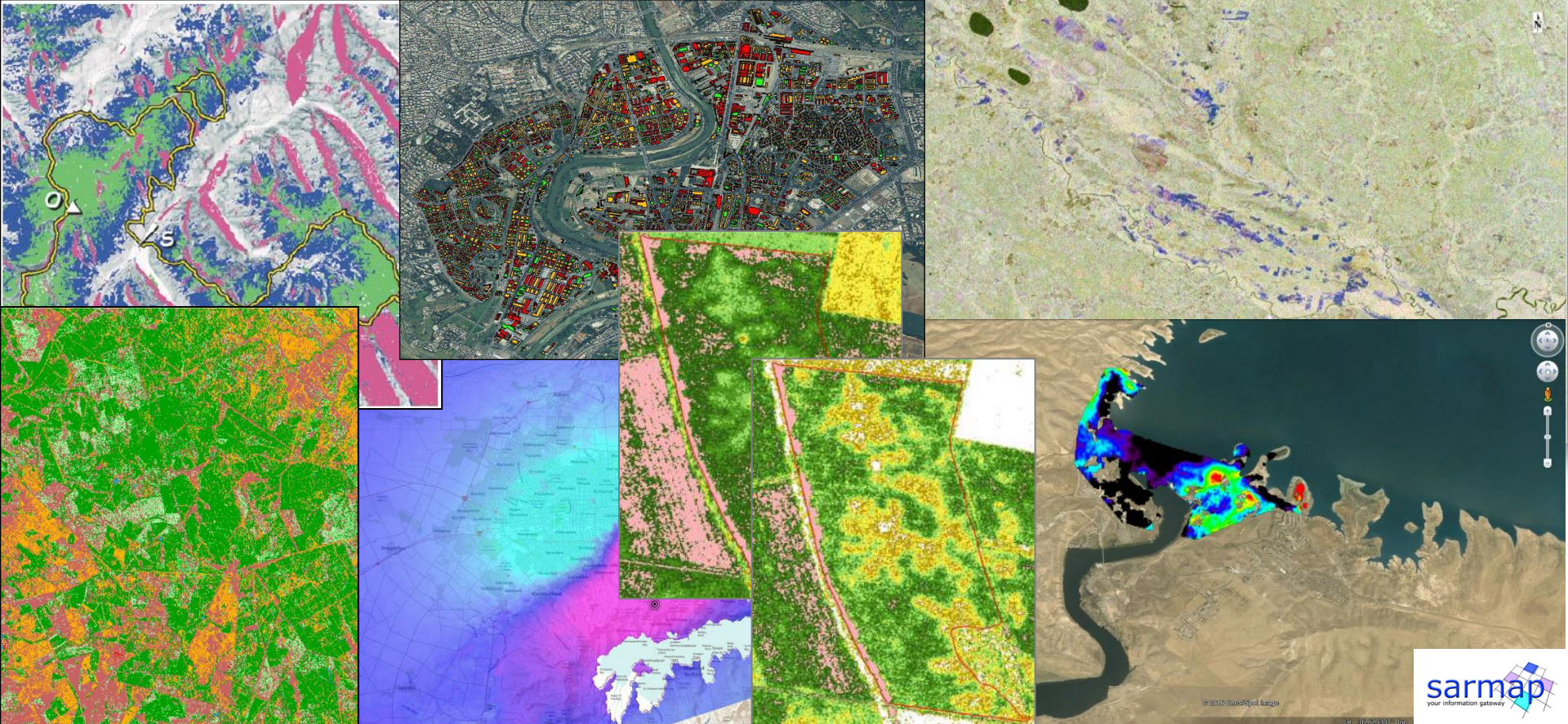


VH

Oil Spills – Area with ROI/Classification



Land Applications

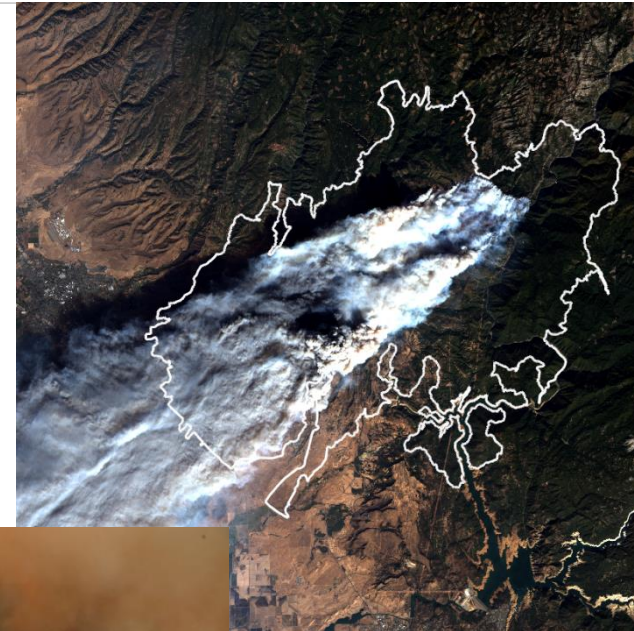


Burn Area Analysis – Camp Fire

Camp Fire, Butte County California USA
November 8th – November 25th

The Camp fire is the deadliest wildfire that has ever occurred in California, with 88 people were killed, and 18,000 buildings were destroyed.

The smoke of the Camp Fire inundated the Bay Area of California, causing the worst air pollution globally for days.



Data:

Sentinel-1 SLC scenes

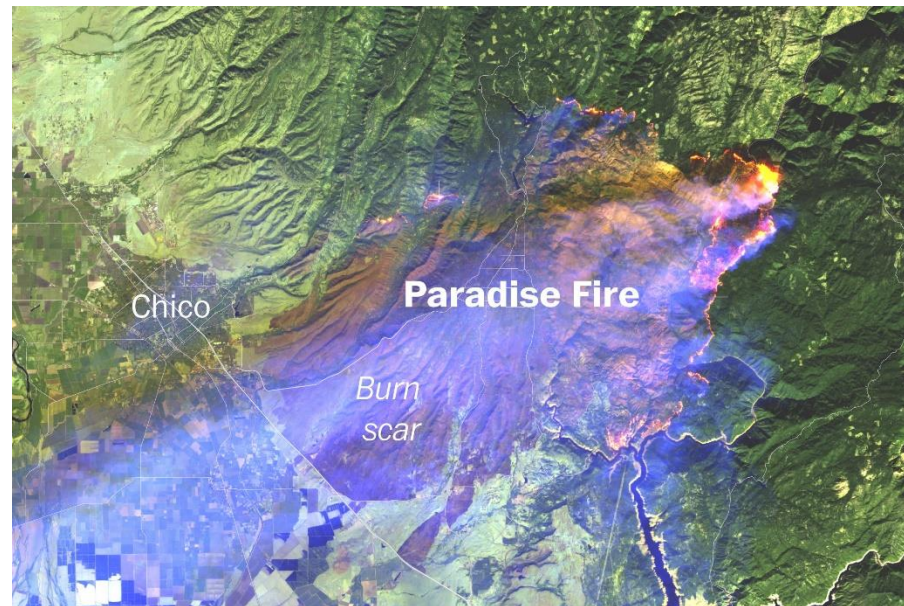
DEM GTOPO 30

Camp Fire Shapefile

Process:

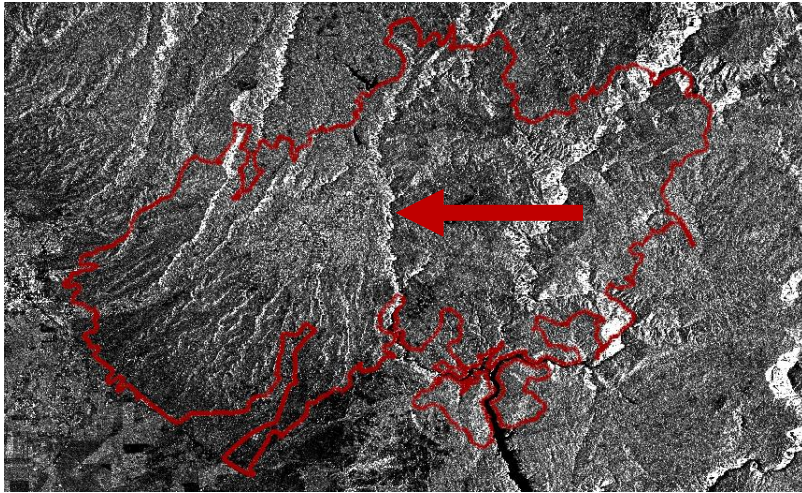
Import SAR SLC data

Run Coherent Change Detection Timeline Workflow

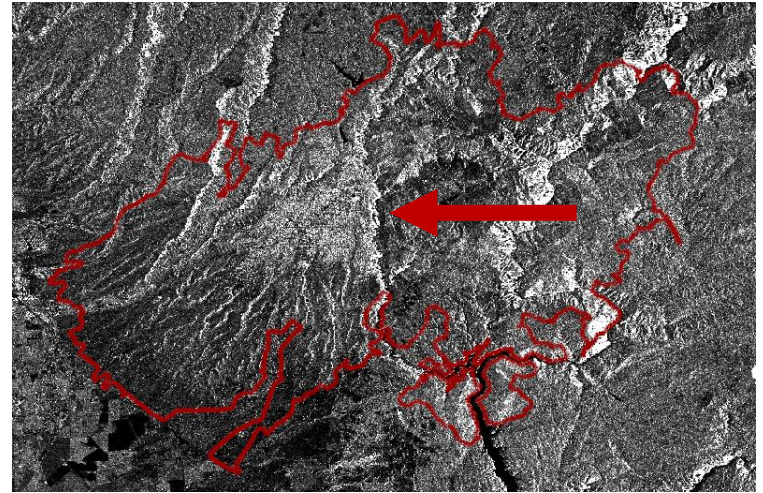


Coherence Change Detection uses the similarities between the phase responses of multiple images.

The phase is influenced greatly by surface roughness and changes in surface features.

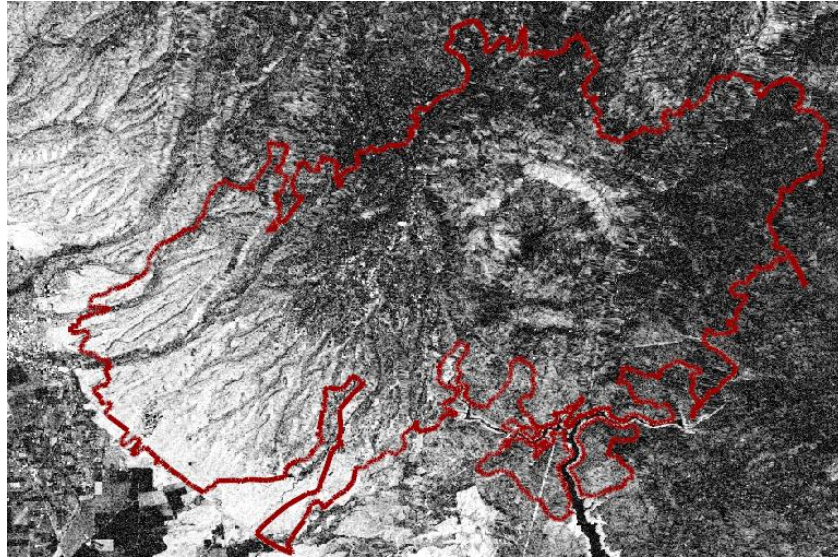


Pre-Fire Intensity

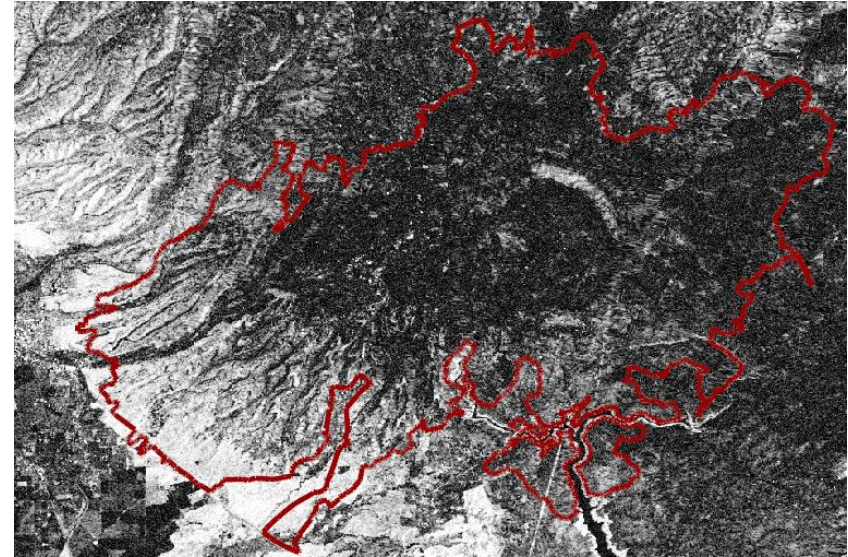


Co-Fire Intensity

Burn Area Analysis- CCD



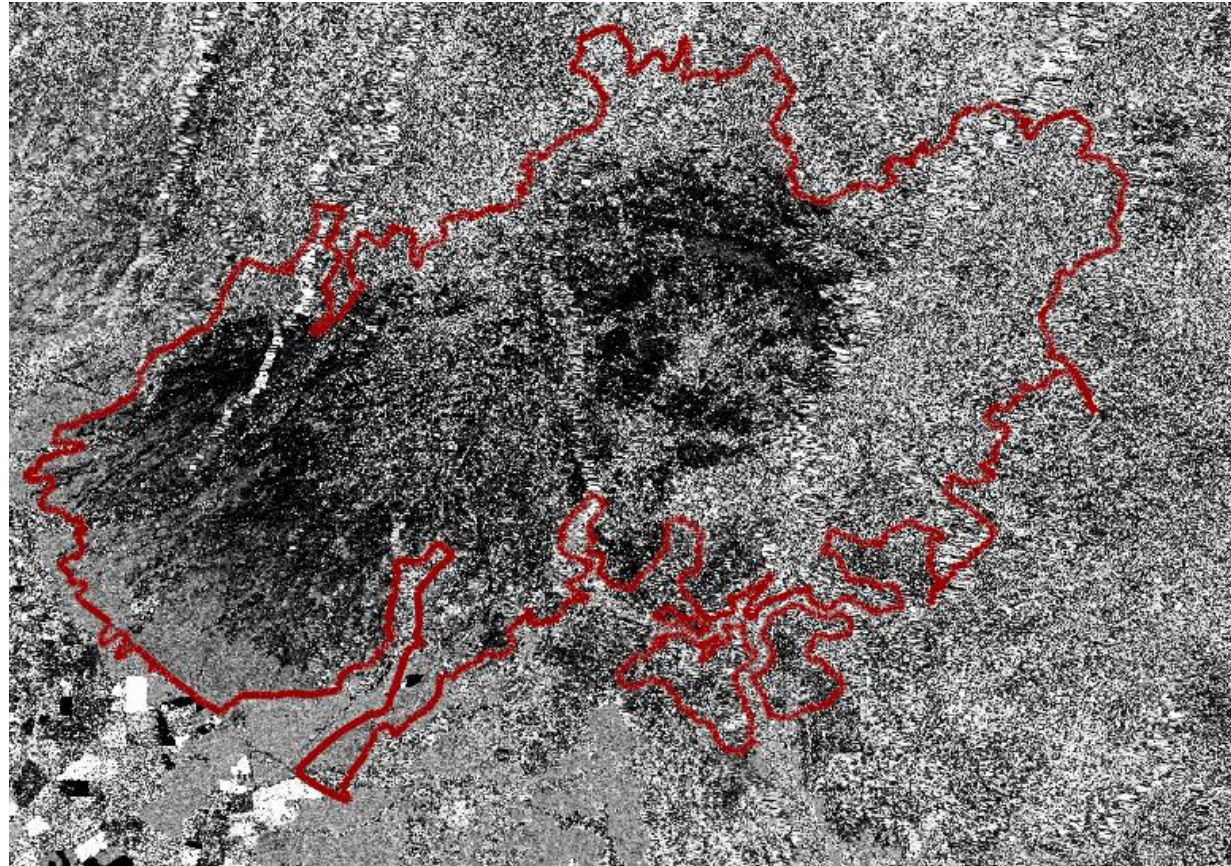
Pre-Fire Coherence:
October 16th and 28th

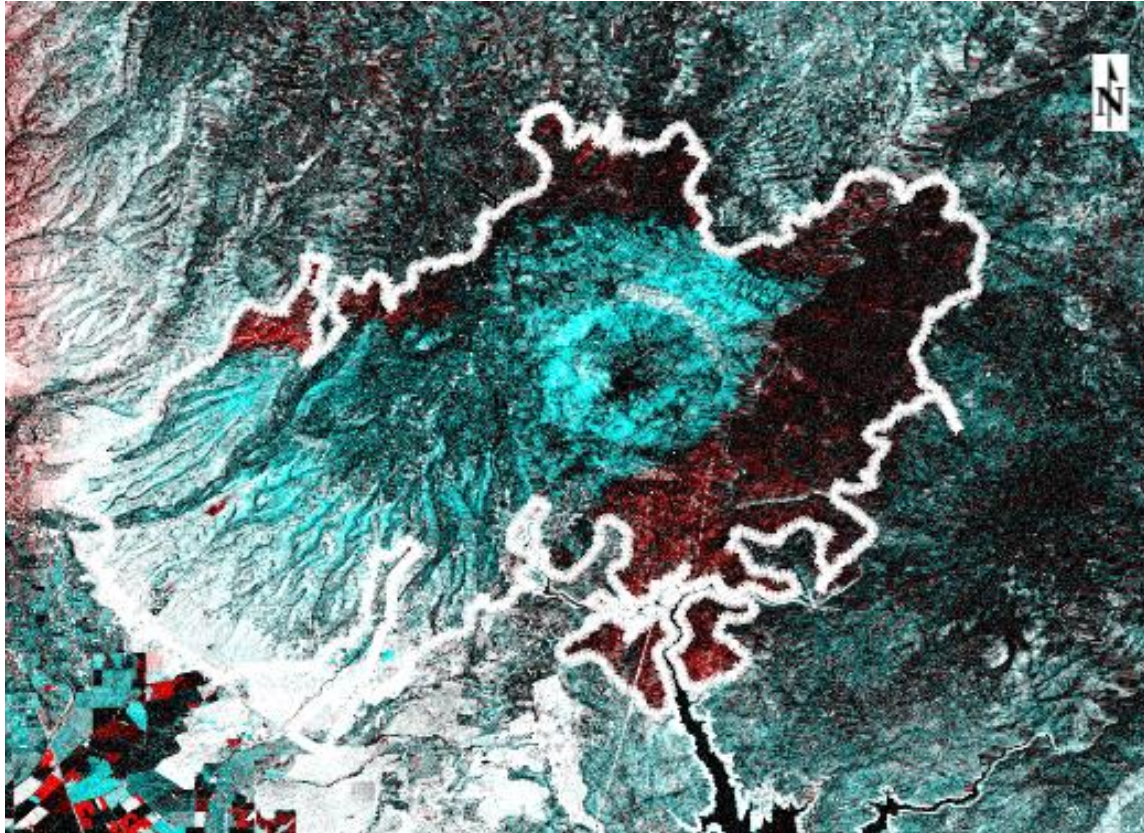


Co-Fire Coherence:
October 28th and November 9th

Burn Area Analysis- CCD

Coherence change between
pre- and co-fire pairs





3 Sentinel-1 scenes

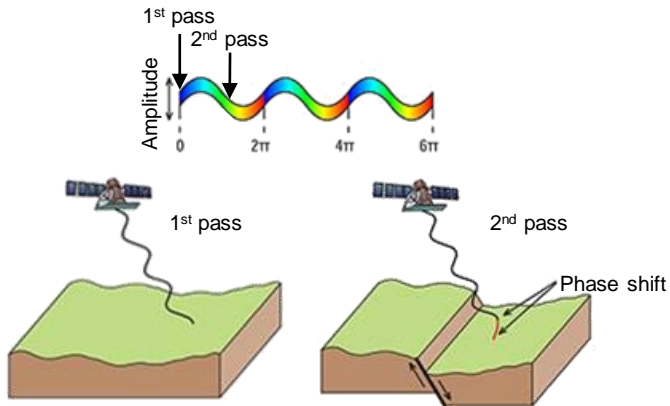
Blue/Green is large change between October 28 and November 9

Red is change between November 9 and November 21

DInSAR Displacement

- Detect mm displacement
- Volcanoes & Earthquakes
- Ongoing subsidence

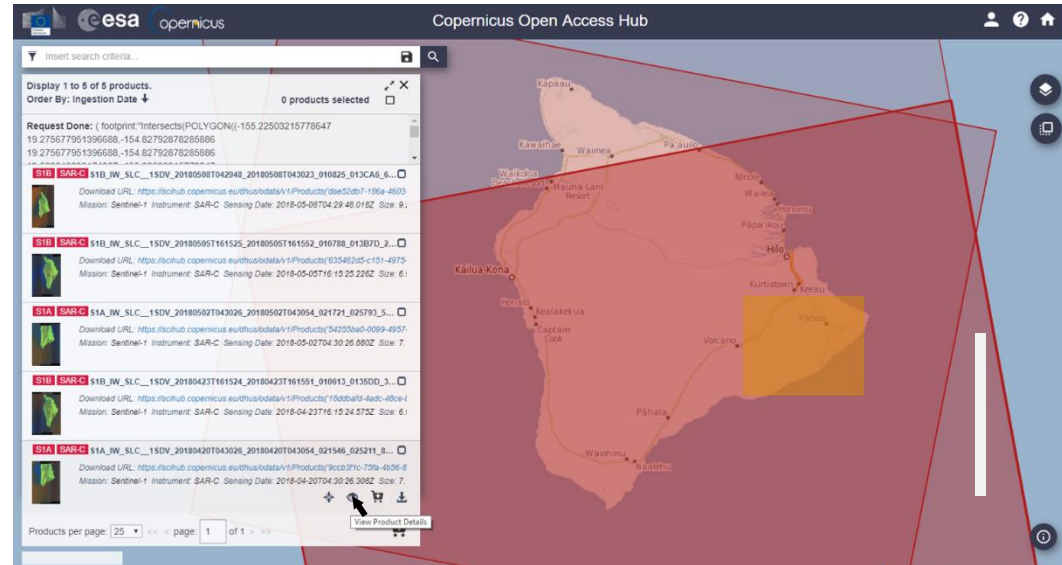
Change in phase from T1 to T2



Hawaii, USA – 2018

Important things to consider when preparing your data:

- Don't mix
 - satellites
 - relative orbit numbers
 - acquisition geometries
- Only use co-polarized data for interferometry
- Low coherence = trouble



DInSAR Displacement Workflow

The screenshot displays the SARscape software interface. On the left, a tree view shows the project structure under 'SARscape', with 'DInSAR Displacement Workflow' highlighted in blue. A red arrow points from this workflow to the main configuration window. The main window is titled 'DInSAR Displacement' and 'Select Input'. It features a workflow tree on the left with 'Input' selected. The right side contains input parameters:

- Input File**: Includes tabs for 'DEM/Cartographic System' and 'Parameters'.
- Input Master File (Mandatory)**: A text box containing 'sentinel1_124_20180420_043026308_IW_SIW1_A_VV_slc_list'.
- Input Slave File (Mandatory)**: A text box containing 'sentinel1_124_20180502_043026880_IW_SIW1_A_VV_slc_list'.
- Area of Interest (Optional)**: A text box containing 'Hawaii_ROI.shp'.

At the bottom, there is a 'Preview' checkbox, a help icon, and navigation buttons: '< Back', 'Next >', 'Next >>>', and 'Cancel'.

DInSAR Displacement Workflow

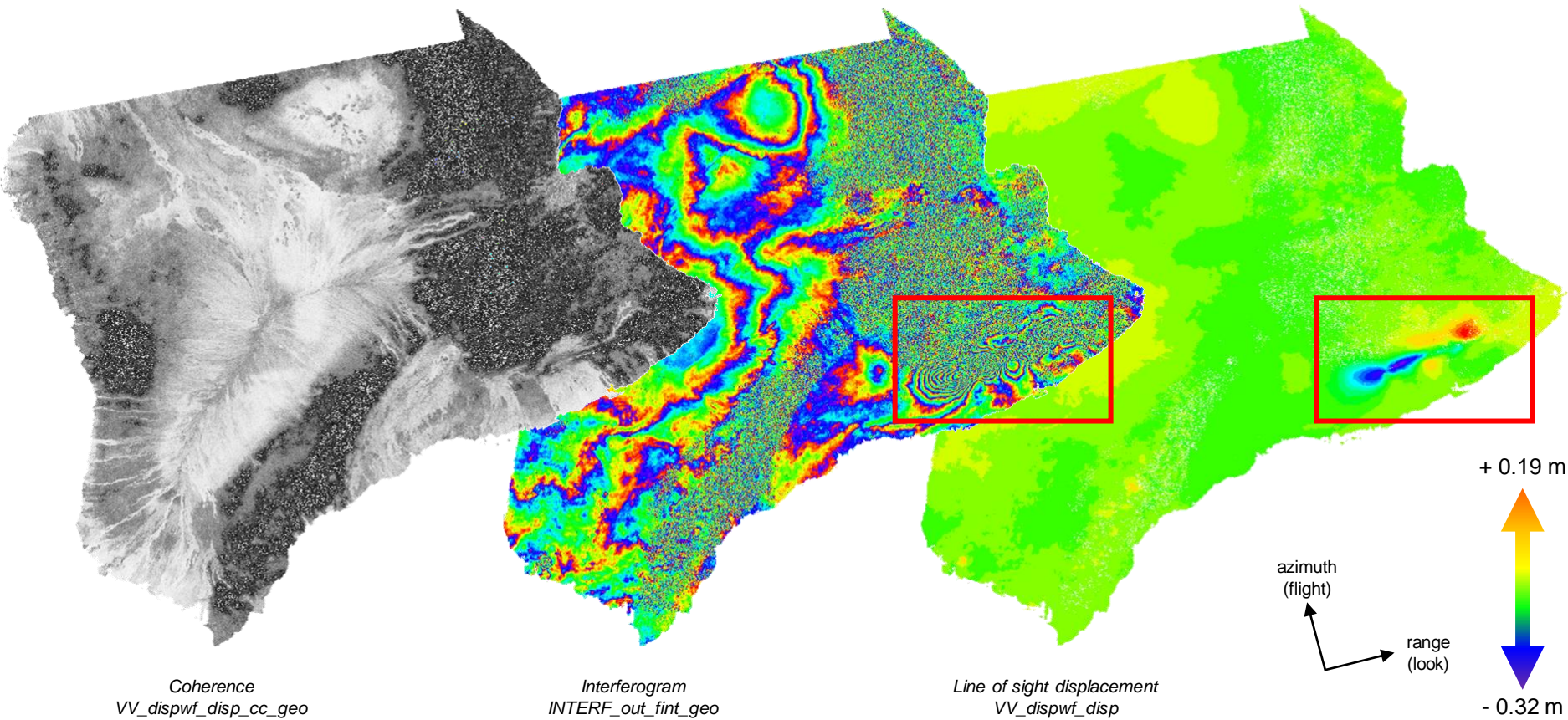
The screenshot displays the SARscape Workflow interface. On the left, the 'DInSAR Displacement' workflow is shown with steps: Input, Import Generic SAR Data, Sample Selection SAR Geon, Interferogram Generation, Adaptive Filter and Coherenc, Phase Unwrapping, **GCP Selection**, Refinement and Re-flattening, Phase to Displacement Conv, and Output. The 'GCP Selection' step is active, showing a 'Refinement GCP File (Mandatory)' field. A red arrow points from this field to the 'Generate Ground Control Points' dialog box.

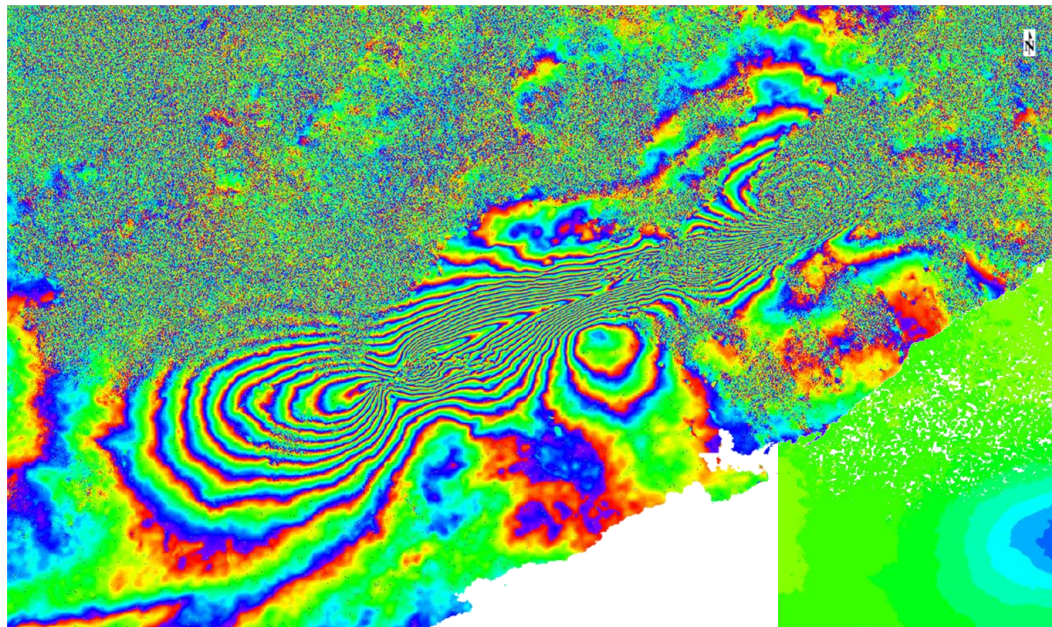
The 'Generate Ground Control Points' dialog box has a 'File Selection' section with the instruction 'Select Input and DEM'. It contains fields for 'Input File:' (INTERF_out_upha) and 'DEM File:'. A 'Browse...' button is next to the Input File field.

The main window shows a grayscale SAR image with a red dashed line indicating a displacement measurement path. A red rectangle highlights a specific area of interest, and a yellow rectangle highlights another area. The 'Layer Manager' on the left shows the 'Generate Ground Control Points' layer is active.

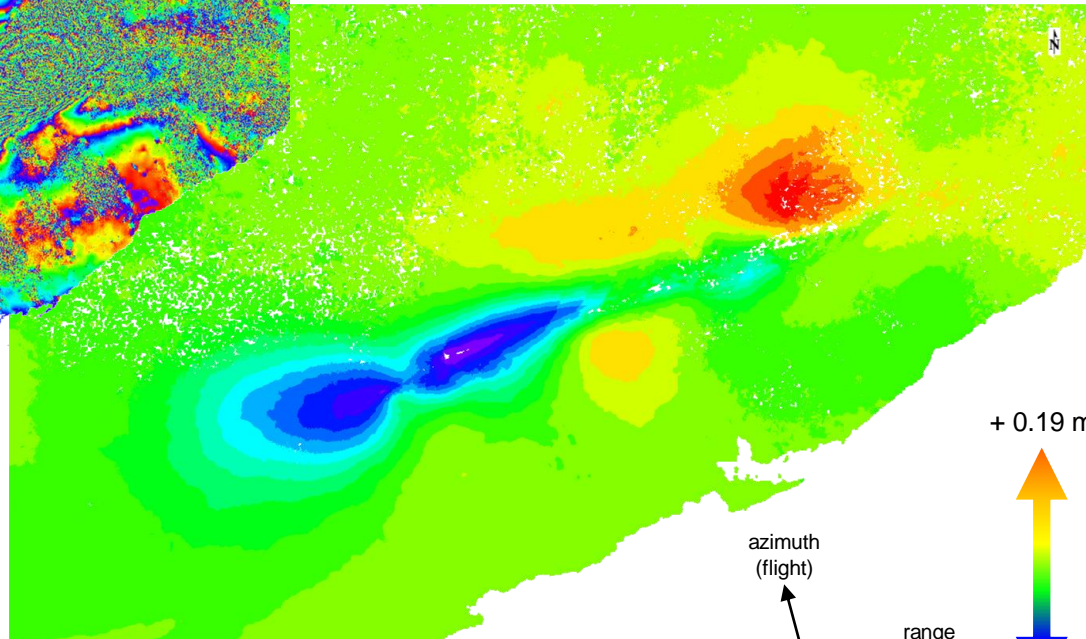
On the right, a 'DInSAR Displacement' dialog box is open, showing the 'Select GCPs...' step. It includes a table for 'GCP Properties' with columns for Name, Map X, Map Y, Weight, Image X, Image Y, Vel. X (mm/y), Vel. Y (mm/y), and Date.

Ground Control Points: 41		GCP Properties	
GCP_41	0	Name	GCP_41
GCP_32	0	Map X	
GCP_33	0	Map Y	
GCP_34	0	Weight	
GCP_35	0	Image X	3538.83+1035156
GCP_36	0	Image Y	2019.4822988047
GCP_37	0	Vel. X (mm/y)	0
GCP_38	0	Vel. Y (mm/y)	0
GCP_39	0	Date	
GCP_40	0		
GCP_41	0		





Interferogram
INTERF_out_fint_geo



Line of sight displacement
VV_dispwf_disp

Thank you!

Dipak Paudyal, APAC Geospatial

Email:

dpaudyal@apacgeospatial.com

M: 045 000 4946