SNAP Microwave Toolbox

SkyWatch (Canada)
Brockmann Consult (Germany)
AUTh (Greece)
ESA-ESRIN (Italy)

FRINGE 2023

University of Leeds, UK | 11 - 15 September 2023.

SNAP | Multi-mission Scientific Toolboxes

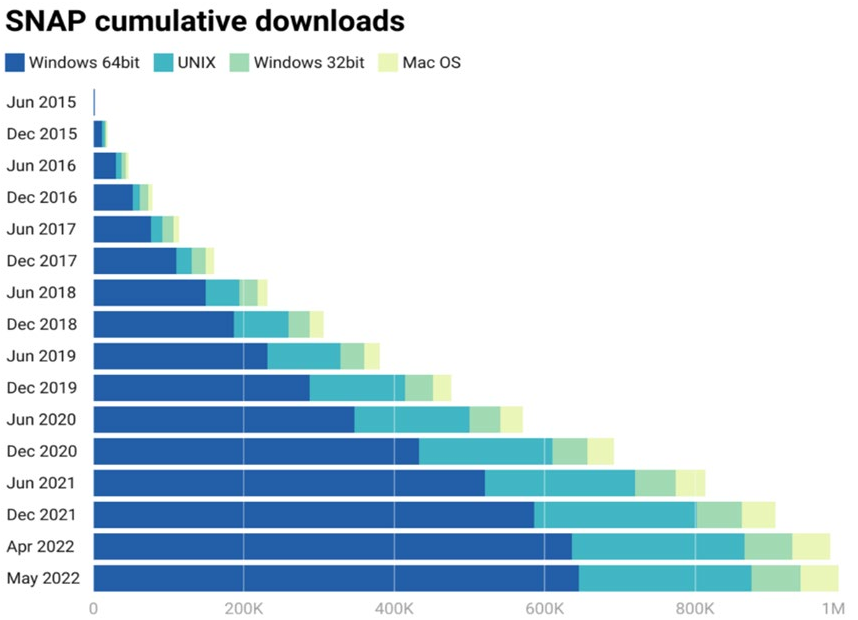
SNAP *Earth Observation Made Easy*

SNAP is

the open-source toolbox to analyse and process Earth Observation data
focus on Sentinels 1, 2 and 3
open source
scalable to run on notebooks up to large production clusters
cross-cutting tool within the FutureEO programme to support users, projects and applications

SNAP user base and uptake

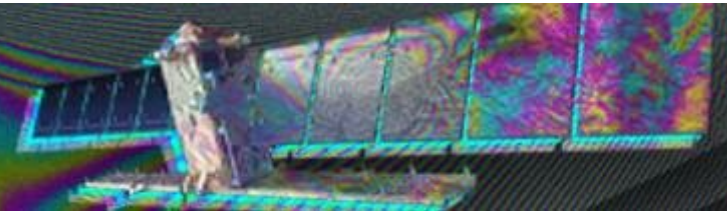
Over 1 million downloads
Over 10 000 registered forum users



SNAP Roadmap 2023 - 2024

06 / 2023:	Introduce **Optical** and **Microwave Toolboxes** & large software renovation – **making it technologically future proof**
12 / 2023:	Support to **new ESA missions**, preparing for hyperspectral CHIME and microwave CIMR
06 / 2024:	**Change detection** Toolbox
12 / 2024:	Support NISAR, BIOMASS, **time series** tools

The Development Team



BROCKMANN CONSULT GMBH

CS La force de l'innovation

SKYWATCH

CS ROMÂNIA

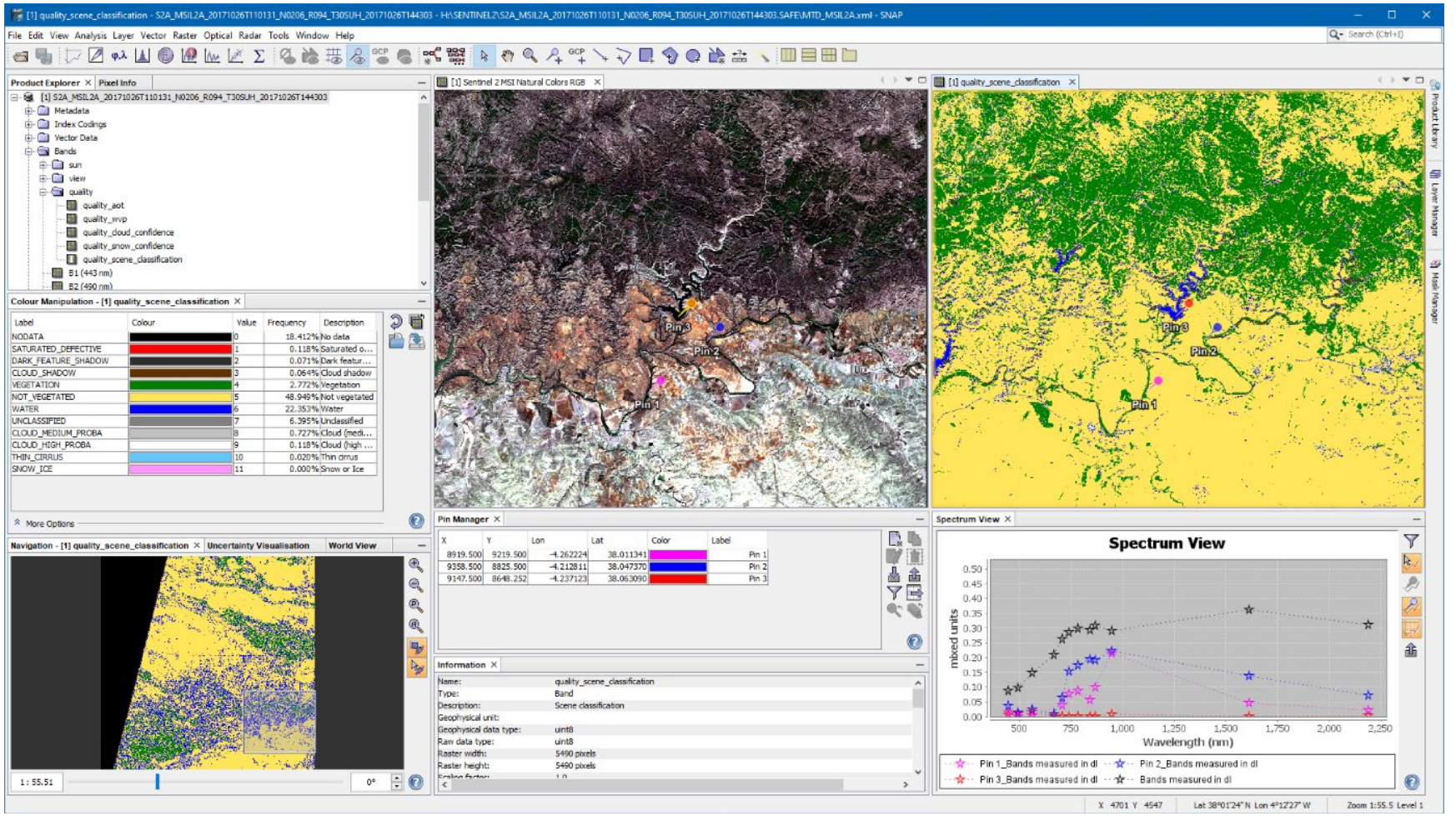
esa

Data Visualisation

SNAP Desktop is the GUI application which allows access to a large number of EO and generic raster data.

It provides various tools to display the data, and to visually analyse them.

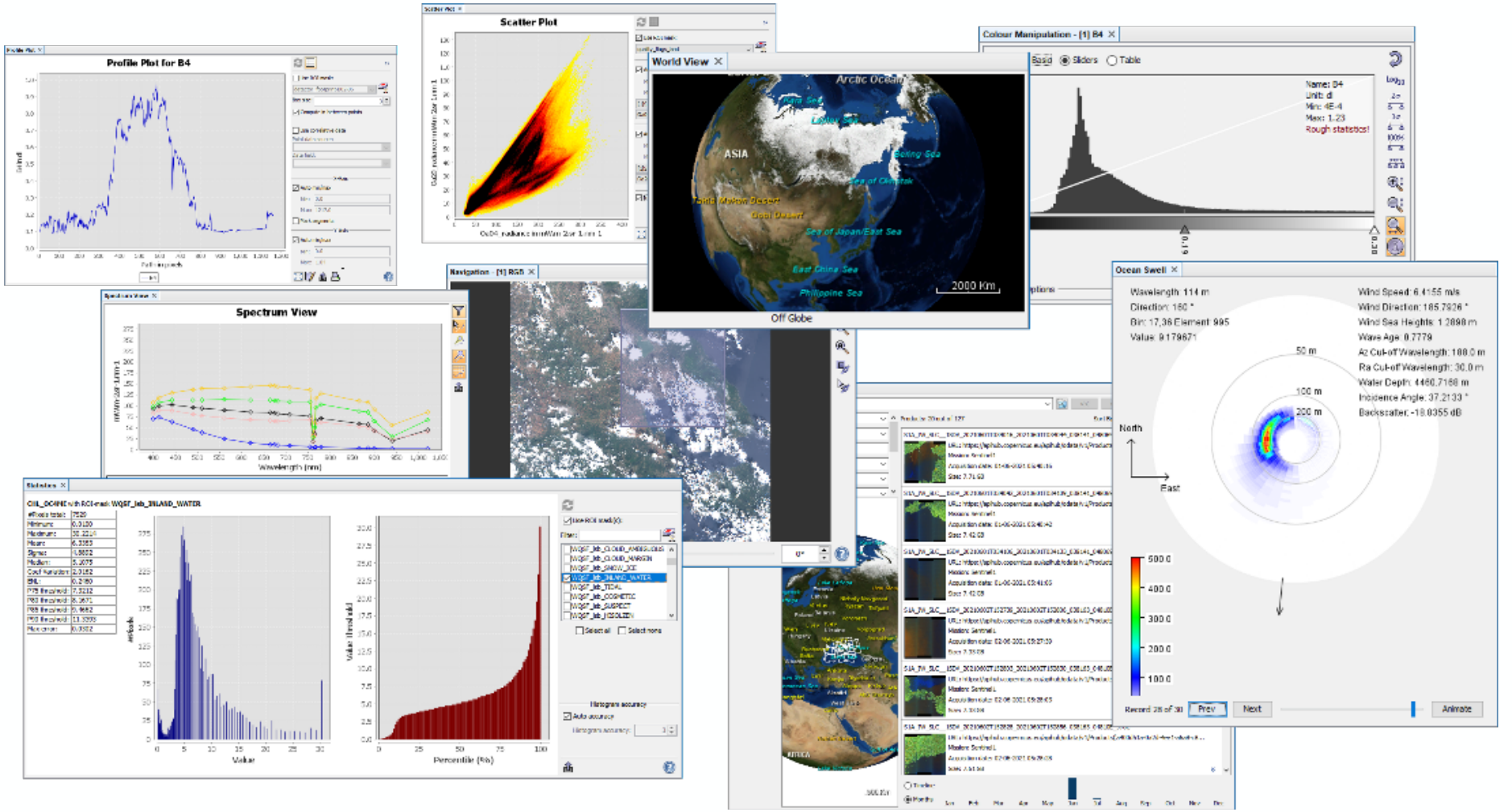
The figure on the right shows an RGB of a Sentinel 2 product (centre) together with a visualisation of the scene classification layer (right panel). Bottom right show the spectral plots at places marked by PINs.



Data Analysis

SNAP provides a rich suite of tools for data analysis, including profile and spectrum plots, statistical analysis, extraction of points through time series, and comparison with reference data (match-ups).

The figure shows some of the graphical analysis tools included in SNAP.



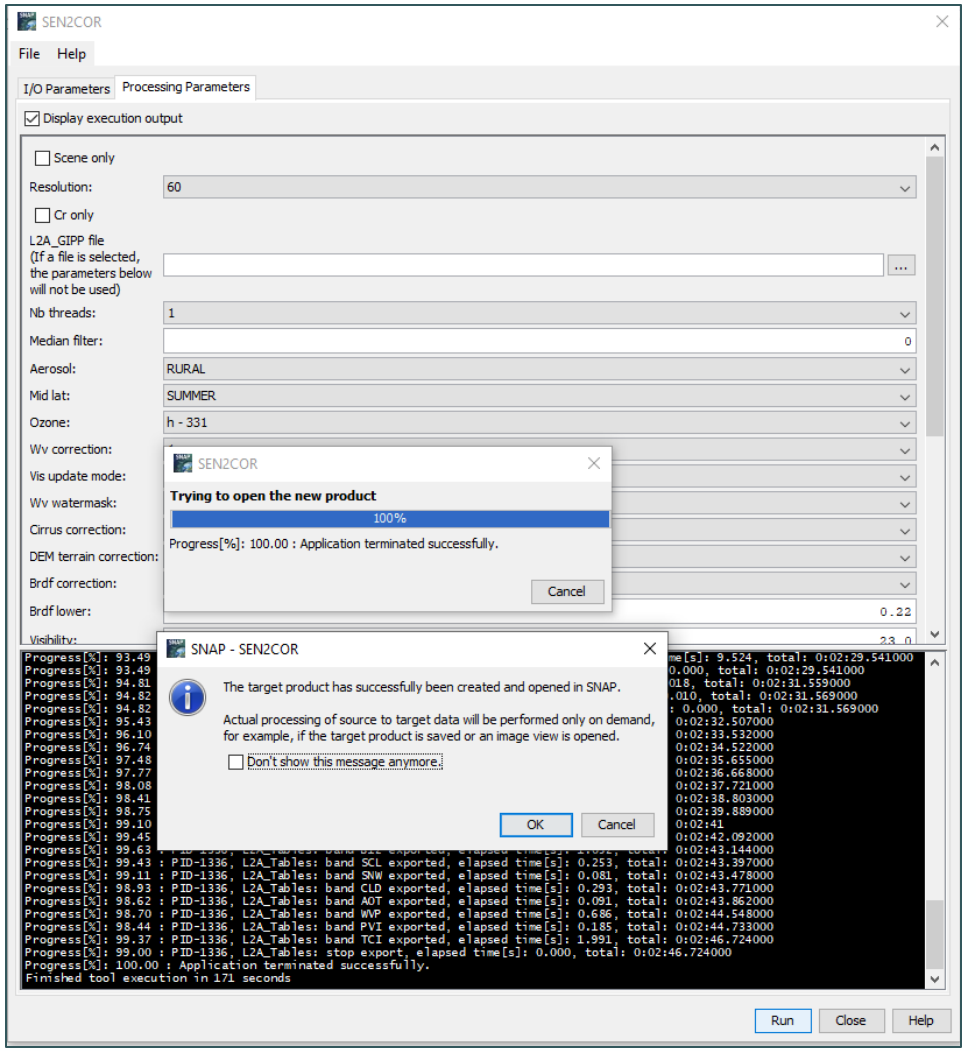
Data Processing

SNAP Data Processors analyse one or more input products and generate a new output product.

Processors exist for generic operations such as band arithmetic, map projection or temporal aggregation.

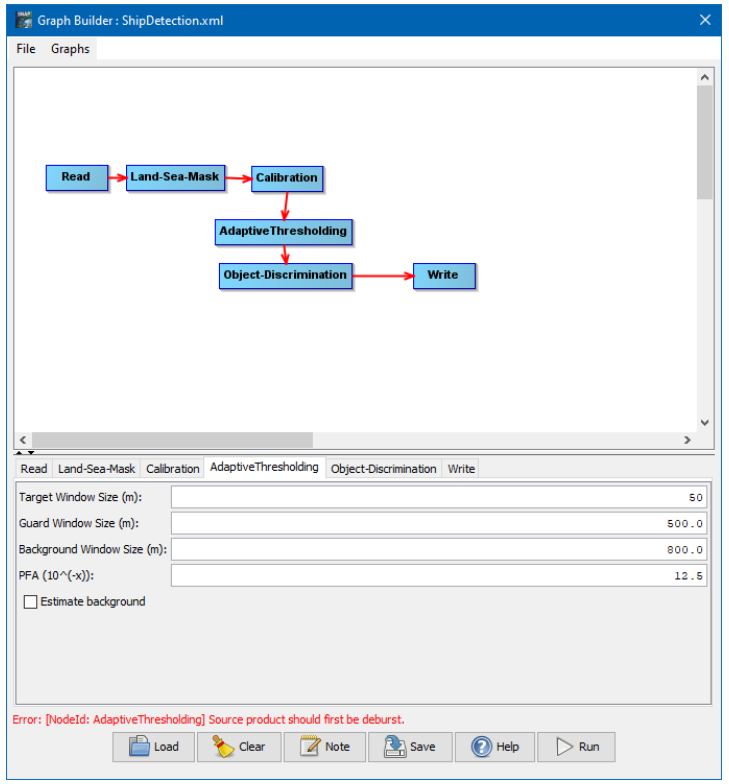
SNAP provides a very large number of thematic processors, e.g. for atmospheric correction, biophisical indices calculation or retrieval of water quality.

SNAP supports special calibration of correction of satellite instruments with dedicated processors.

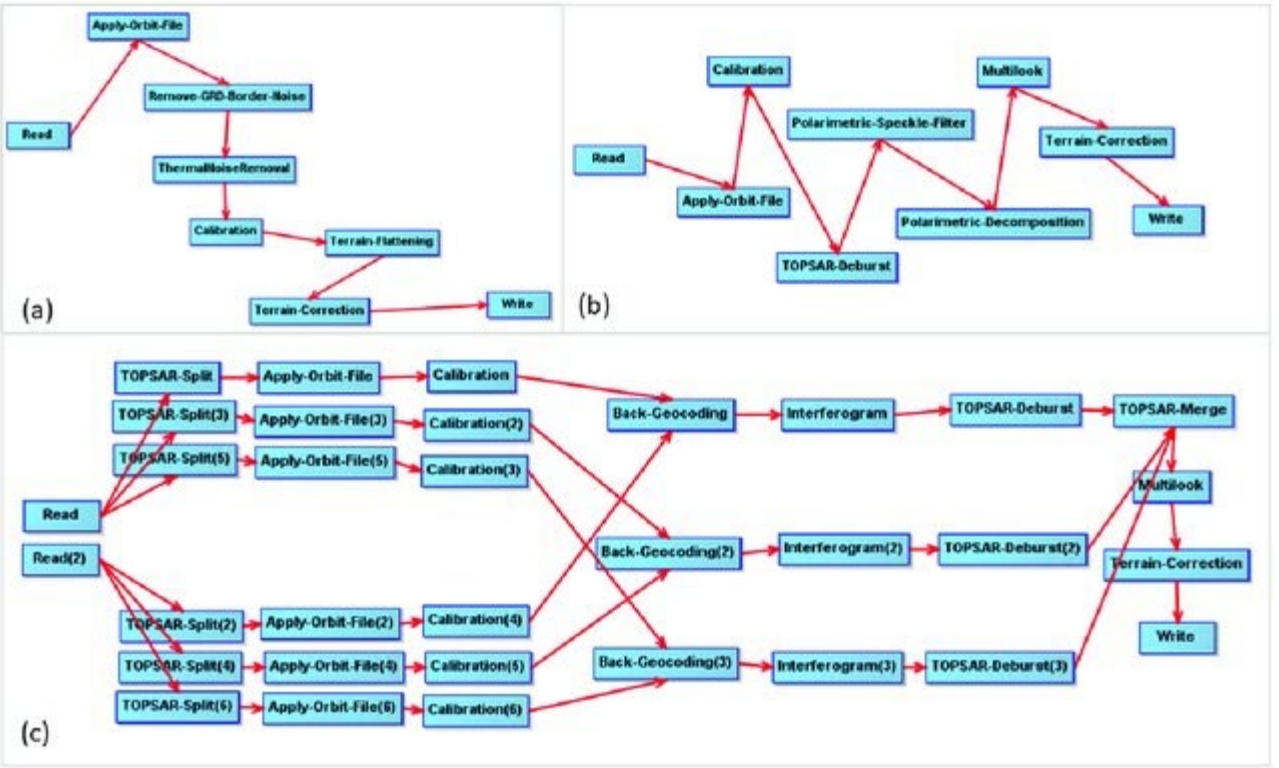


The figure shows the GUI for the Sentinel-2 Atmospheric Correction Processor sen2cor. The screenshot was taken when the processor was successfully executed. The black background shows the logging information during execution of the processor.

Graph Building and Batch Processing

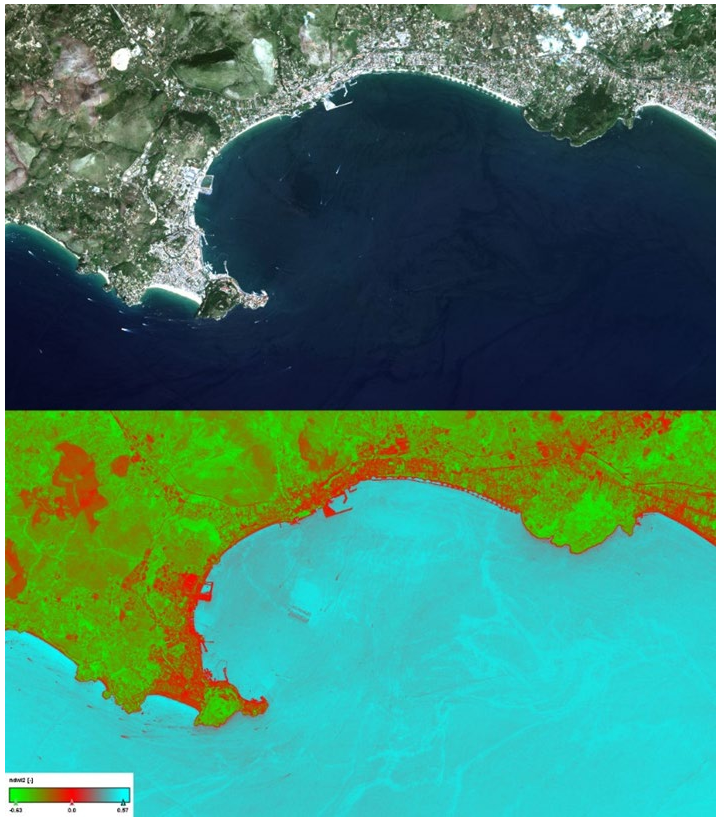


The SNAP graph builder allows to connect SNAP operators in processing graphs. These can be executed locally or in large clusters and cloud systems.



Example: Workflows in the SNAP graph builder tool for producing Synthetic Aperture Radar (SAR) anlysis ready data (ARD) products . From Ticehurst , et al (2019). Building a SAR-Enabled Data Cube Capability in Australia Using SAR Analysis Ready Data. Data. 4. 100. 10.3390/data4030100.

Application Examples

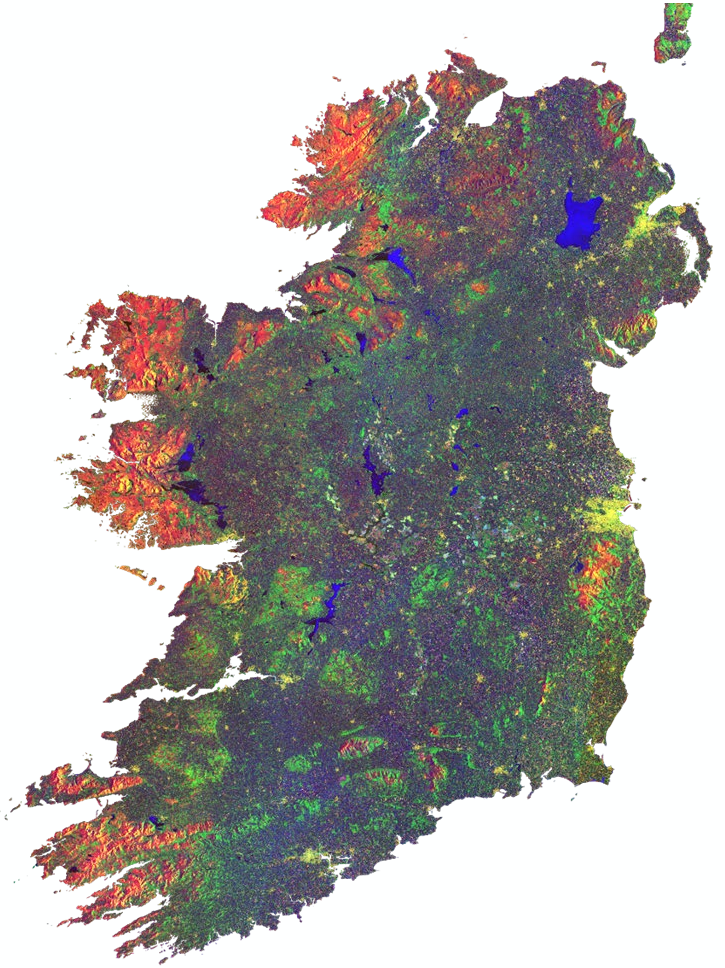


Sentinel-2 second Normalized Difference Water Index (NDWI2) included in SNAP. In the NDWI2 product, it is easy to distinguish the aquaculture facilities in the Gulf of Gaeta (Lazio, Italy).

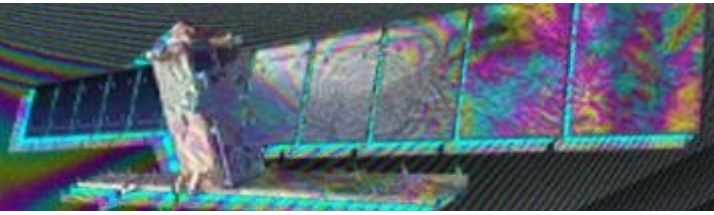
Sentinel-1A featuring land coverage and use across Ireland.

SNAP processing:

- Stitching 16 scenes
- InSAR coherence (red)
- Avg. backscatter (green)
- Backscatter intensity difference (blue)



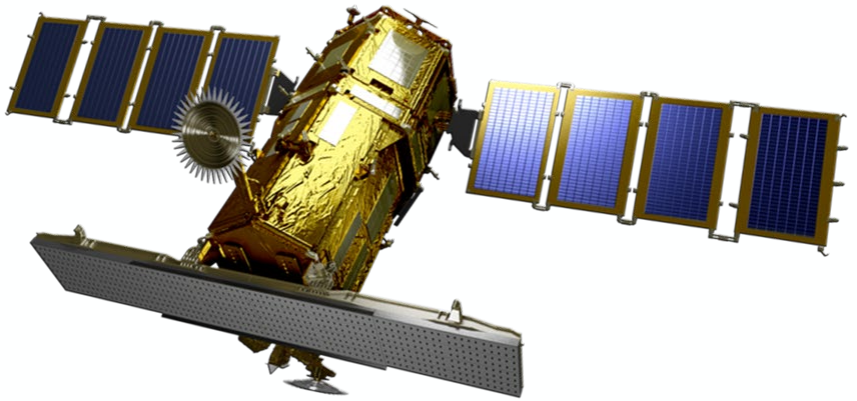
SAR Functionality



- Calibration
- Precise orbits
- Speckle Filtering
- Terrain Correction
- Terrain Flattening
- Ellipsoid Correction
- SAR Simulation
- Mosaicking
- Reprojection
- Multilooking
- Coregistration
  - Cross Correlation
  - DEM Assisted
  - TOPSAR
- Interferometry
- Differential Interferometry
- Phase filtering
- DEM/Displacement
- Automatic DEMs
- Integration with PolSARPro
- Integration with SNAPHU
- Integration with STAMPS
- Integration with PyRate
- Polarimetric Tools
- Thermal Noise Removal
- Slice Assembly
- TOPSAR Deburst and Merge
- Soil Moisture

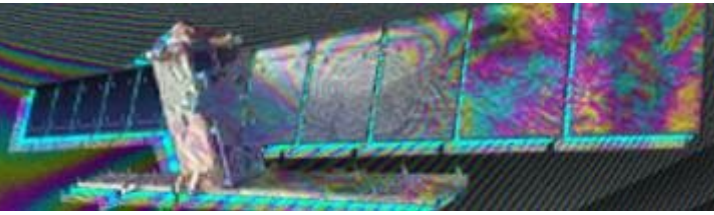
Supported SAR Missions

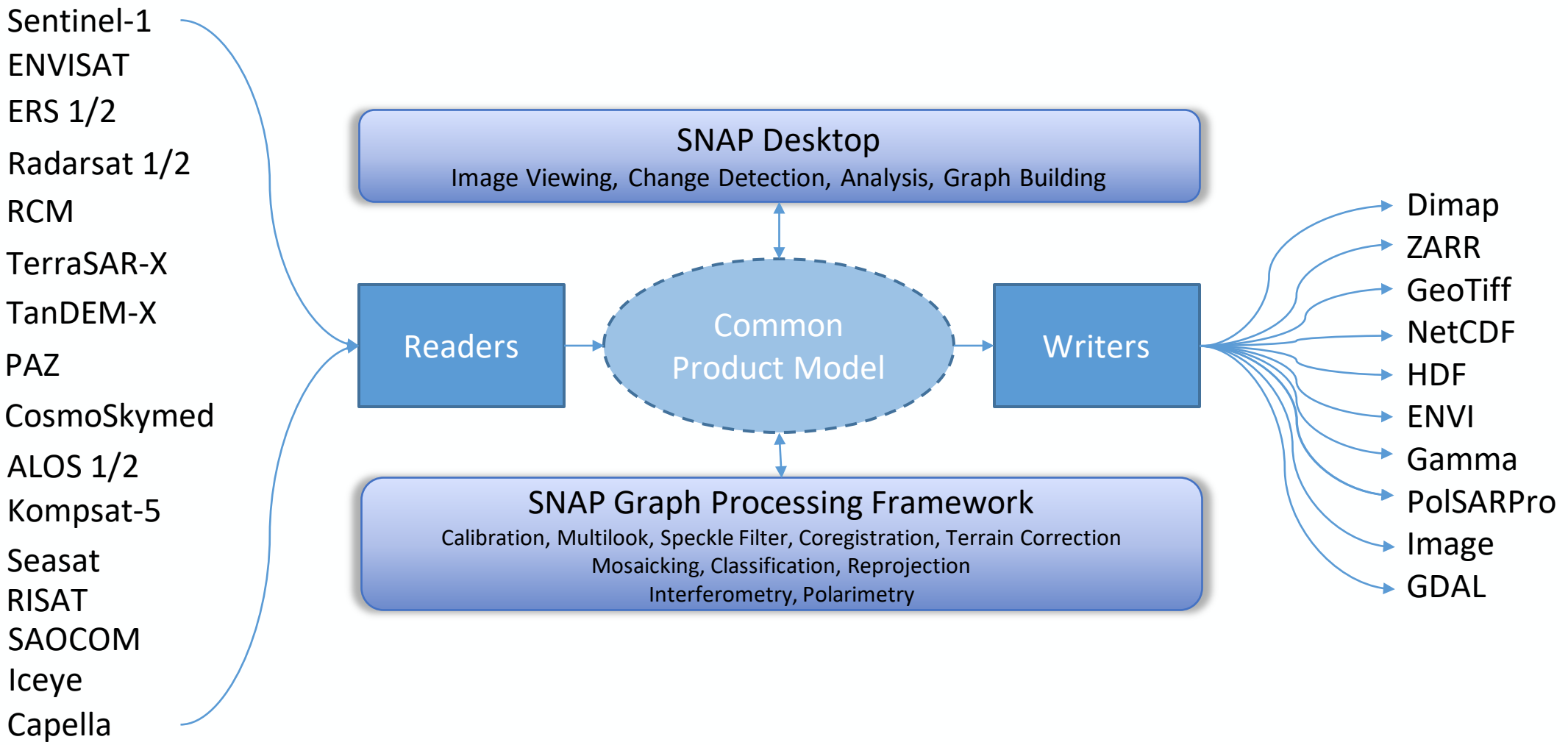
- ALOS 1&2
- Capella
- Cosmo-Skymed NG *
- ENVISAT
- ERS 1&2
- Gaofen-3
- Iceye
- Kompsat-5
- Paz
- NovaSAR
- Radarsat 1&2
- RCM
- Risat-1
- SAOCOM *
- Seasat
- Sentinel-1
- Spacety *
- StriX *
- TerraSAR-X/TanDem-X
- UAVSAR



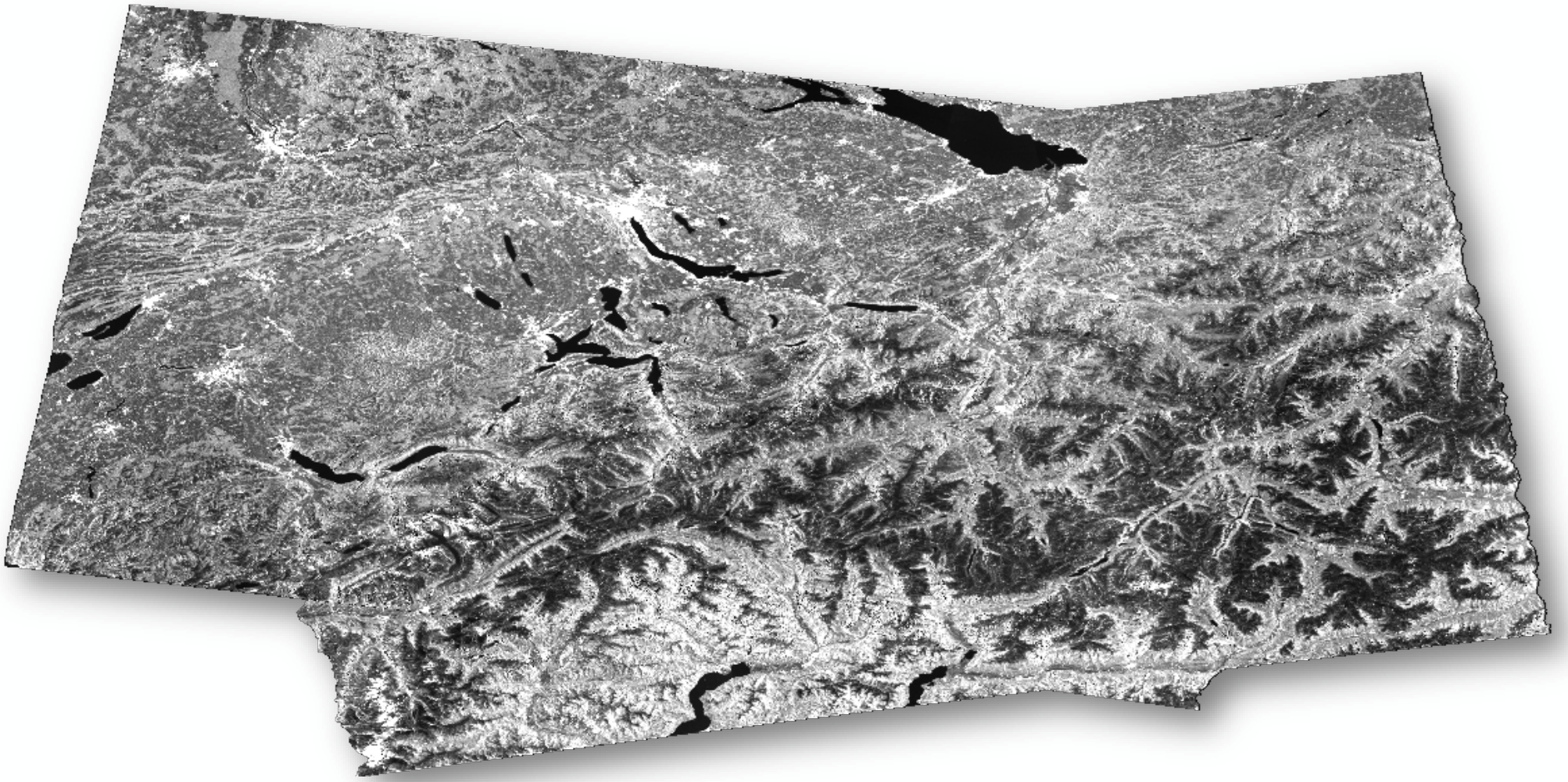
* New or Updated Support

Common Product Model

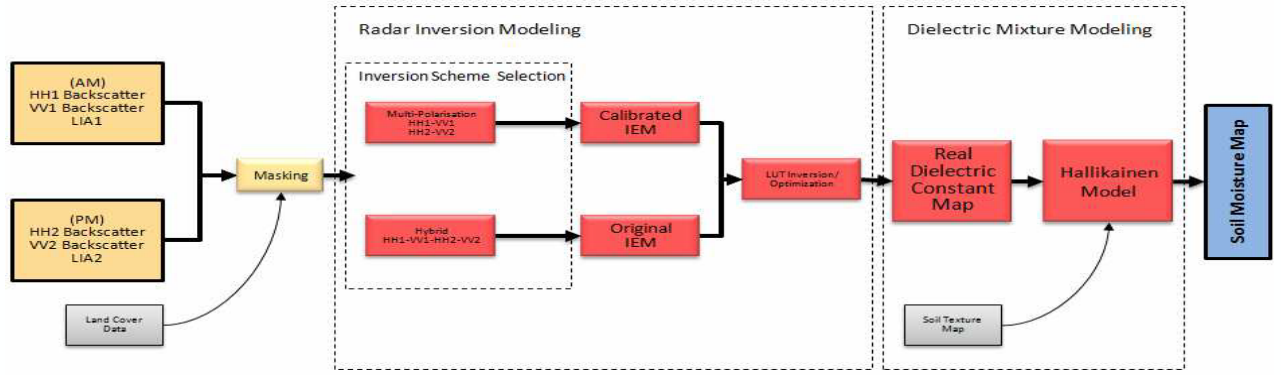


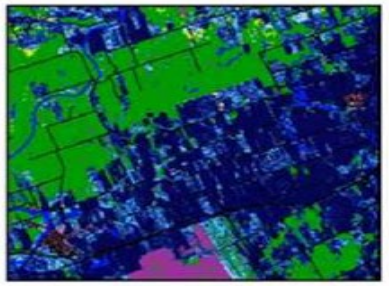


Multitemporal Composite of RTC Images

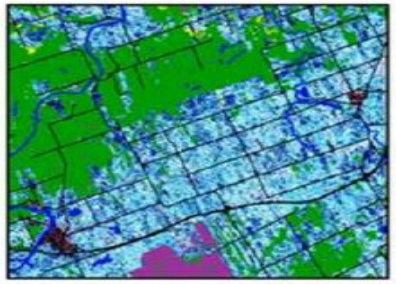


Soil Moisture Toolkit

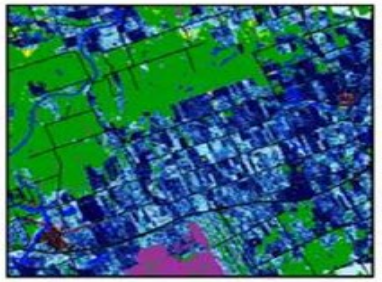




April 17, 2011



June 4, 2011



October 26, 2011

Automatic Processing of RADARSAT-2 Quad-Pol Products to apply AAFC's Soil Moisture retrieval models

Generation of Soil Moisture Products

Canadian Space Agency | Agence spatiale canadienne

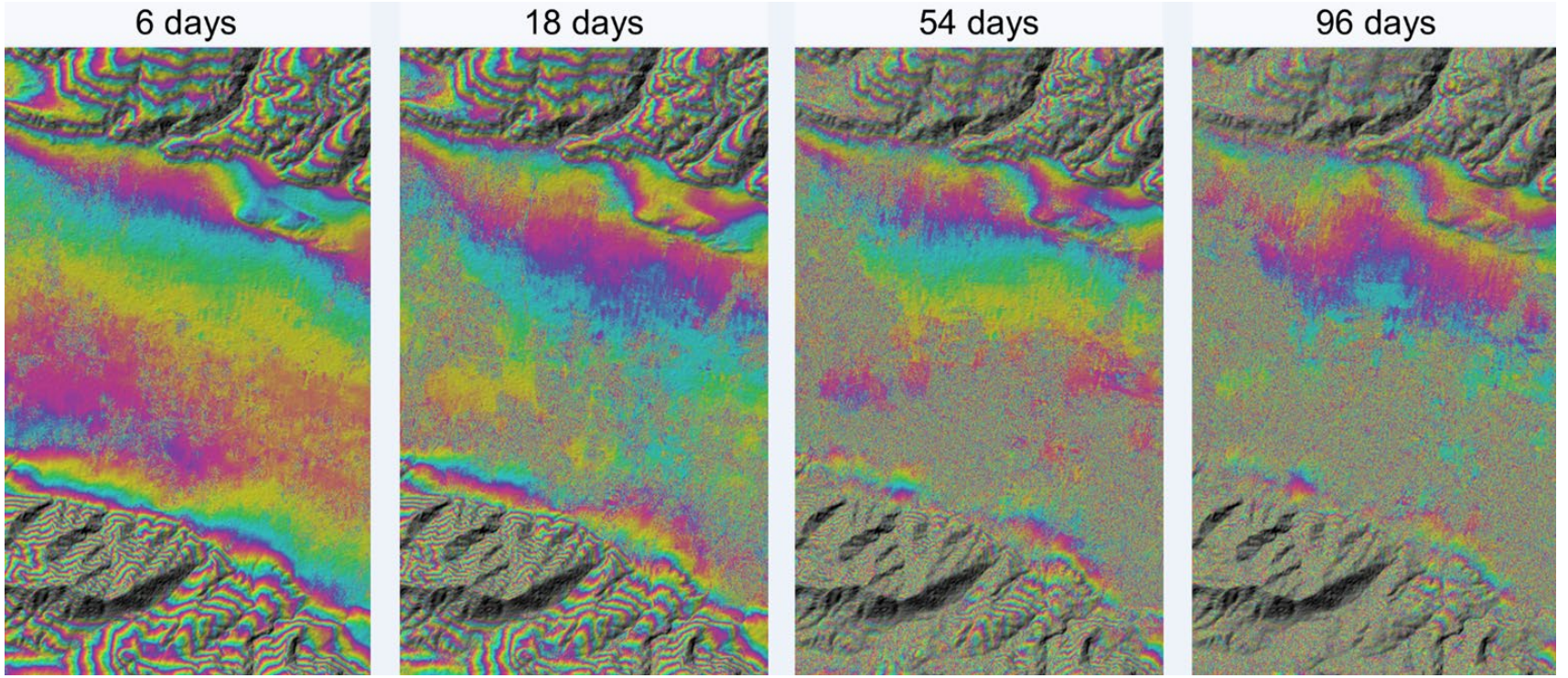
Agriculture and Agri-Food Canada

Latest tutorials

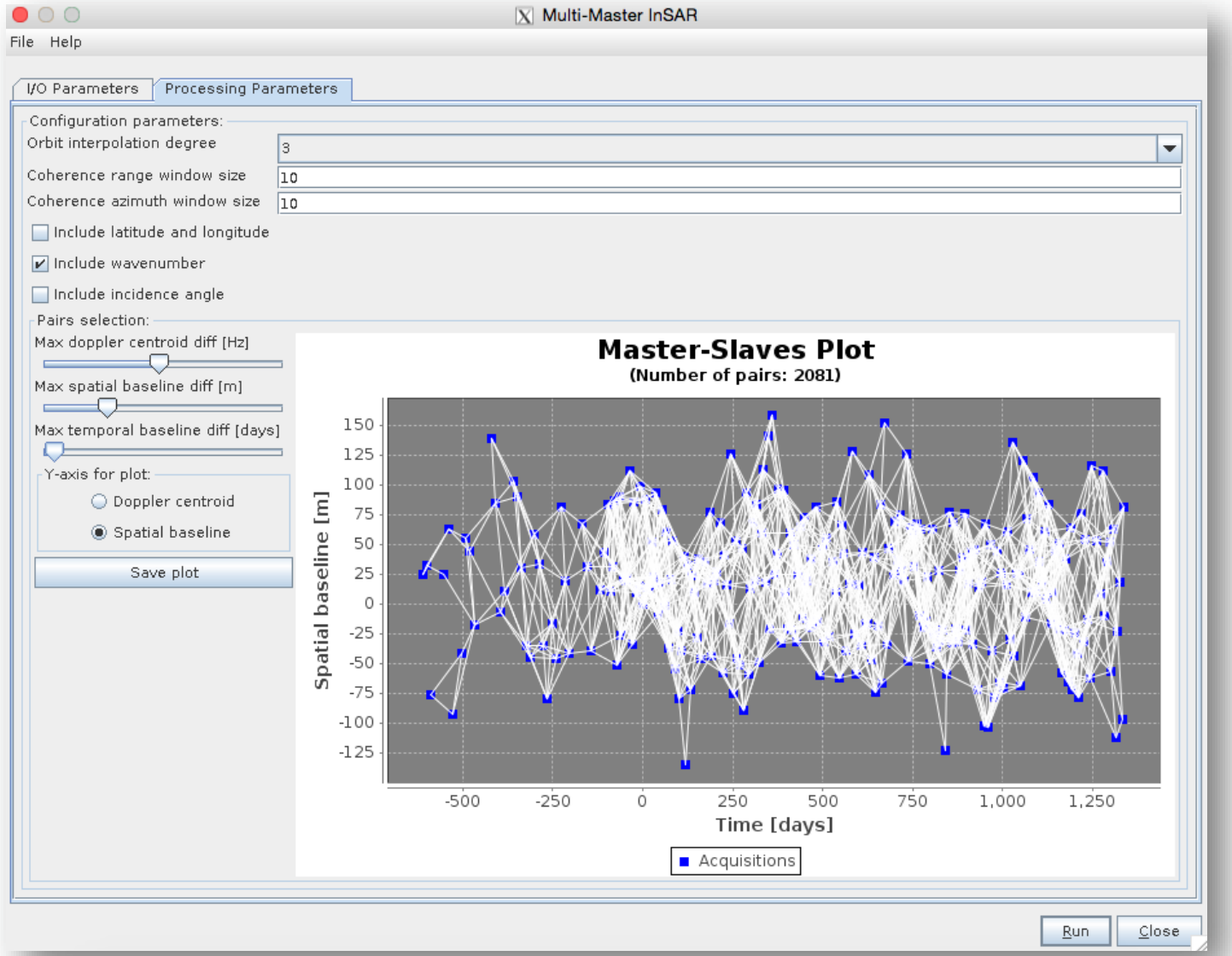
Multi-temporal displacement mapping with DInSAR

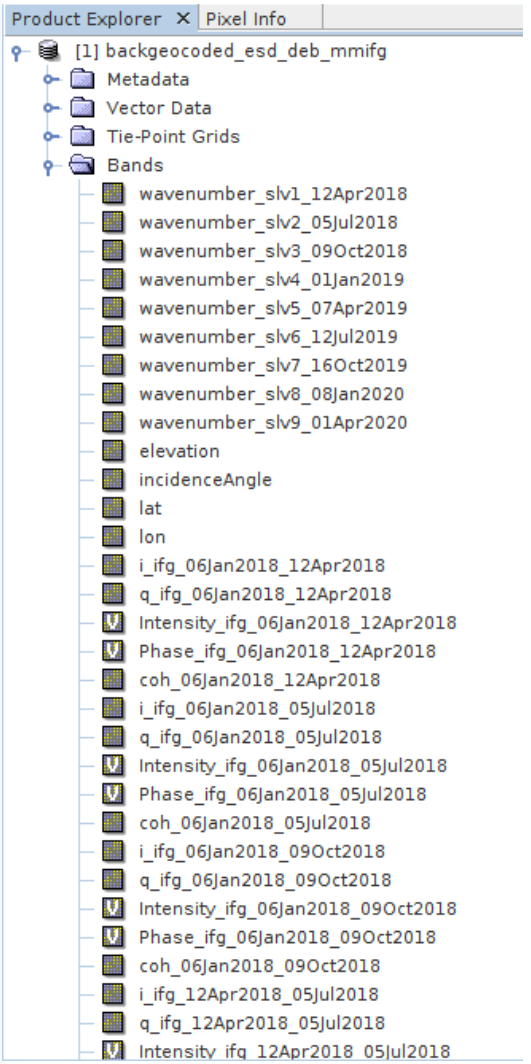
Many users still don't grasp the importance of temporal decorrelation

Users with basic knowledge/skills are not comfortable with coding (PyRate, StaMPS)

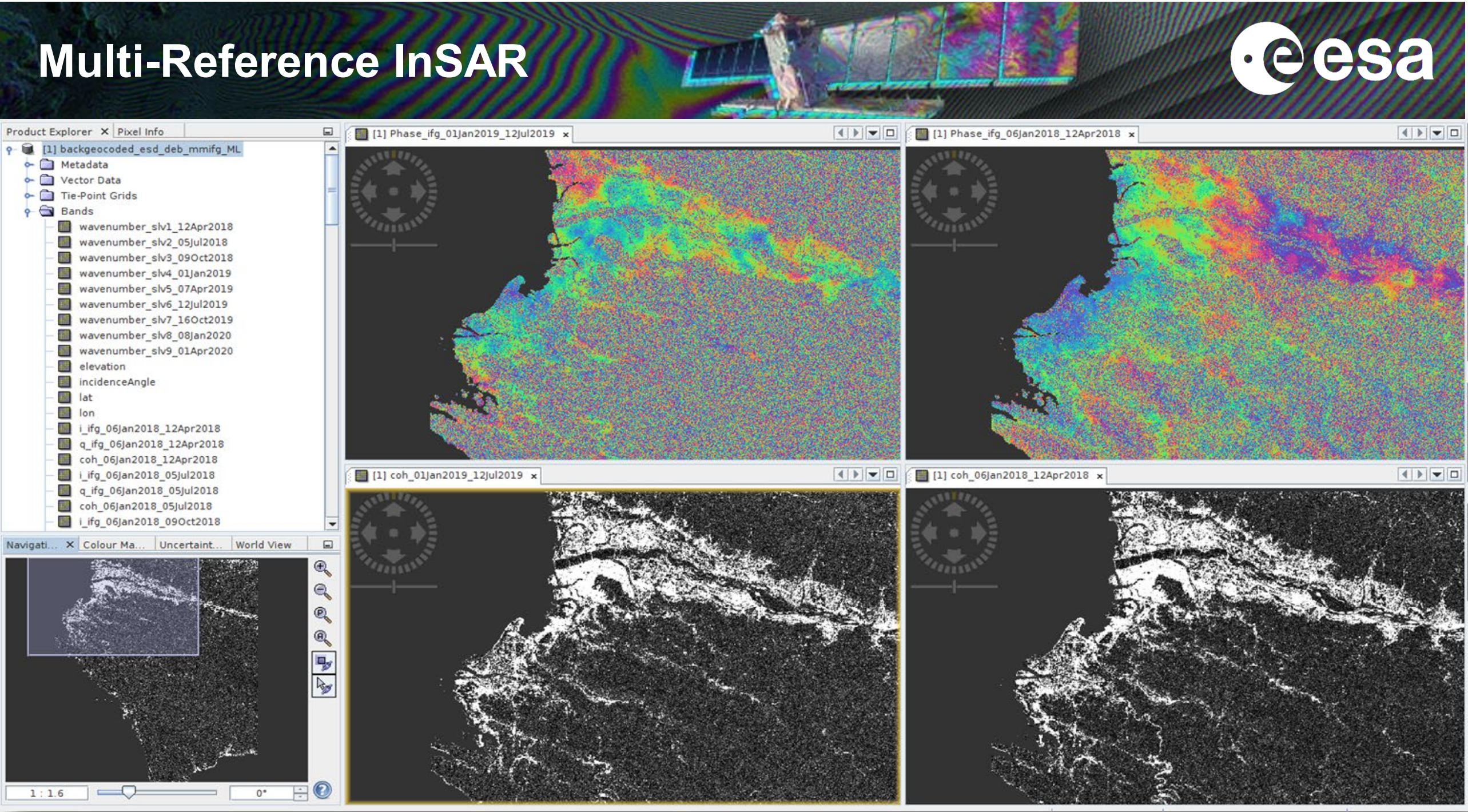


Multi-Reference InSAR

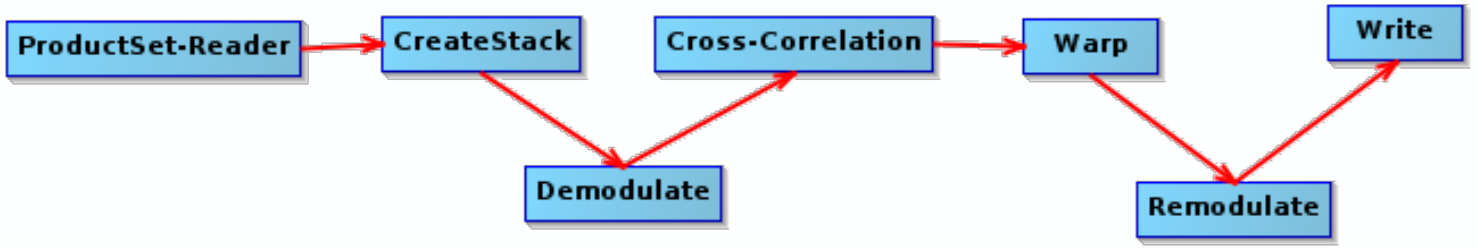


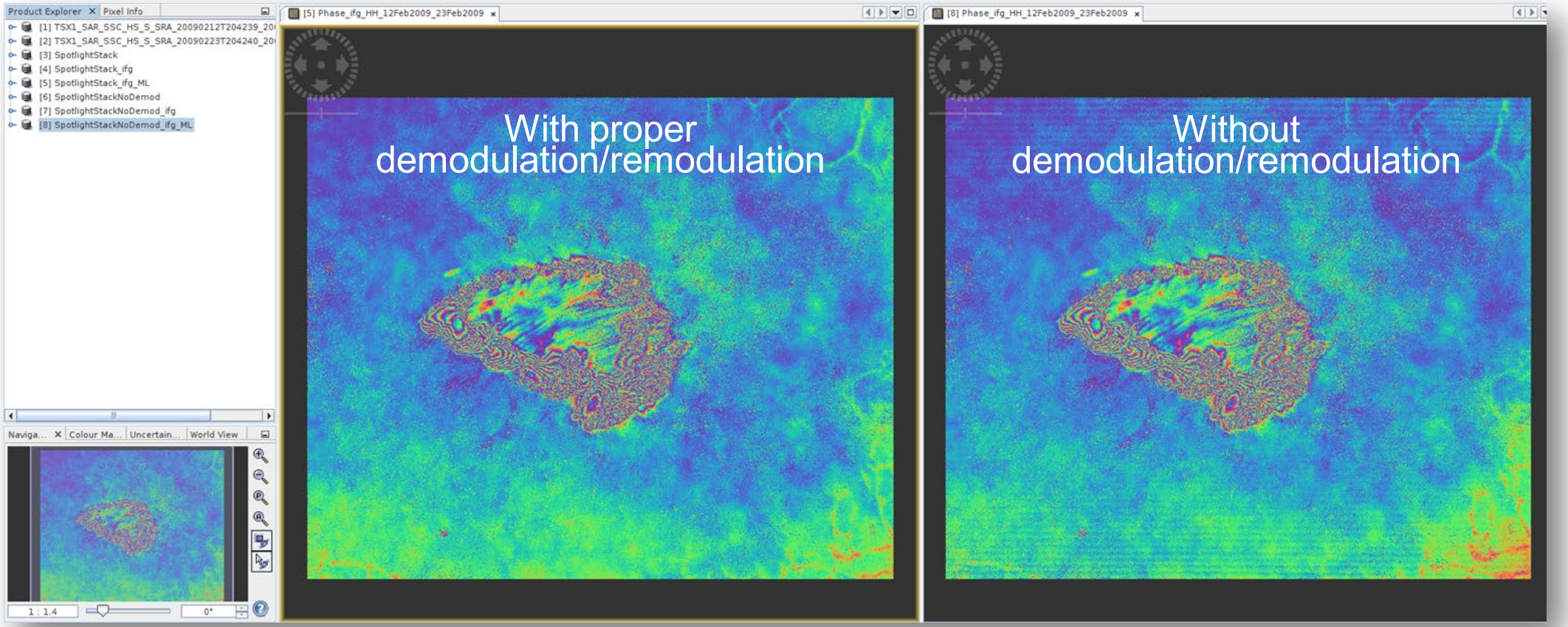


Multi-Reference InSAR



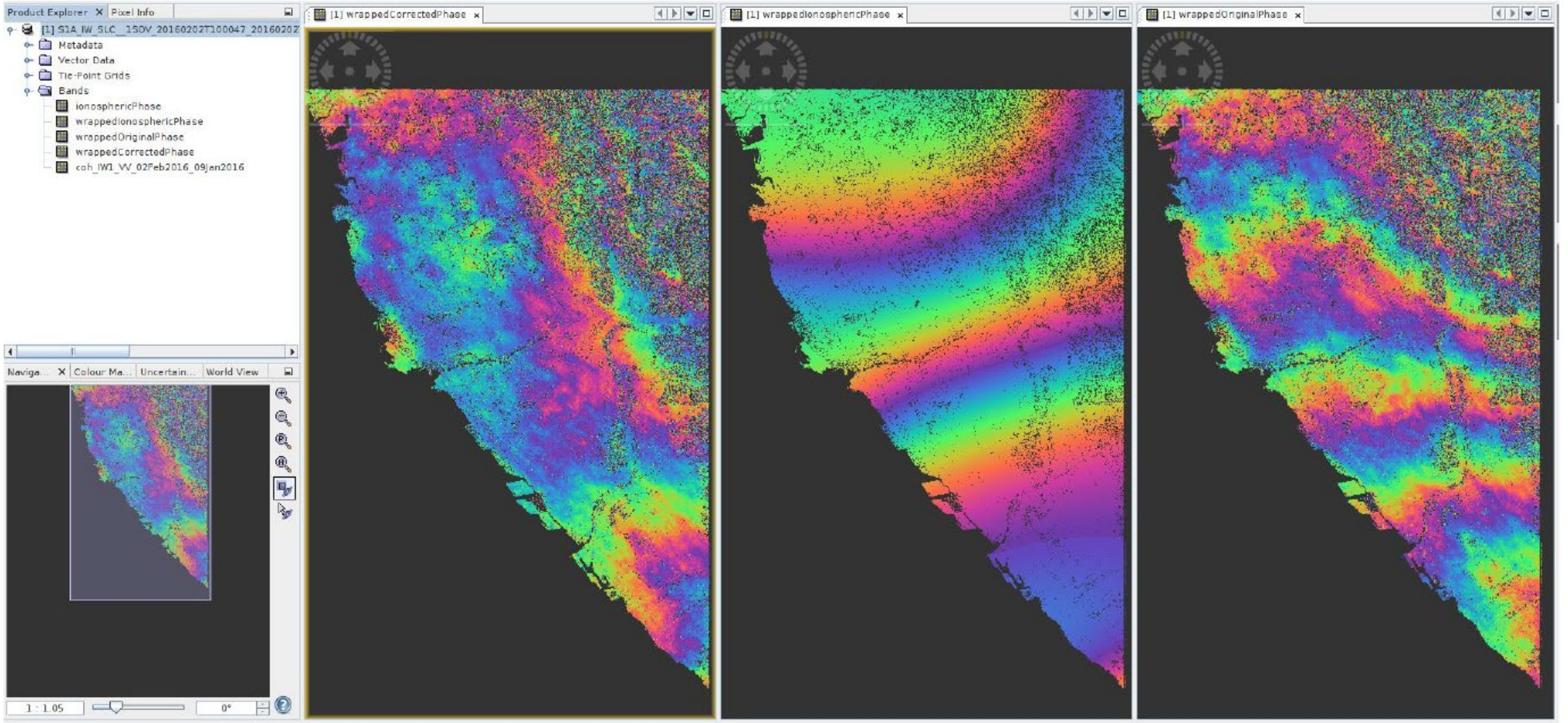
Spotlight Coregistration



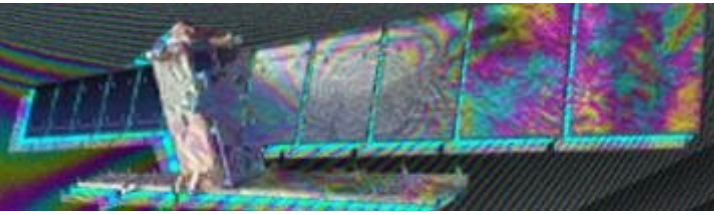


Ionospheric Correction using a Split-bandwidth Approach

Corrected | Ionospheric phase | Original



SNAP PyRate Workflow



PyRate is an open source InSAR tool that calculates surface velocity from a SBAS network of unwrapped interferograms

Created and maintained by GeoScience Australia

Integration Improvements:

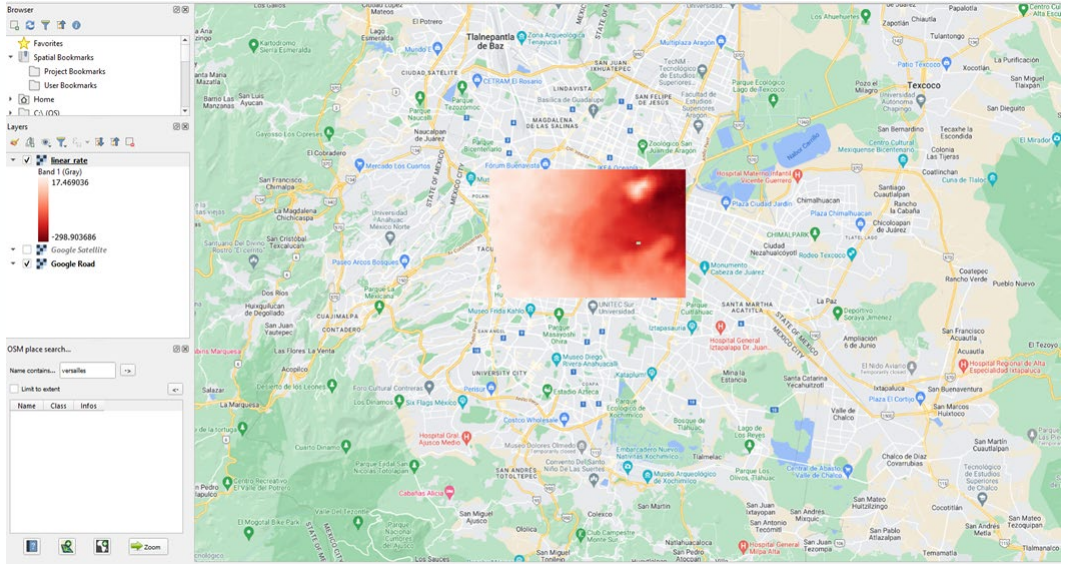
- SNAPHU Export now produces SNAPHU conf files for each interferogram in a multi-reference SBAS interferogram stack
- Batch SNAPHU Unwrap operator will batch unwrap all wrapped phase interferograms using SNAPHU, and assemble them back together into a single stack within SNAP
- Improved PyRate writer with additional data validation checks have been put in place in the PyRate writer.

PyRate Orchestration Script

The included tutorial on SNAP <> PyRate now includes an orchestration script

A BASH script as well as a Batch script is provided so it can run on both Windows and UNIX systems

Provide a folder of Sentinel-1 images, specify subsetting commands, and it will process your data automatically

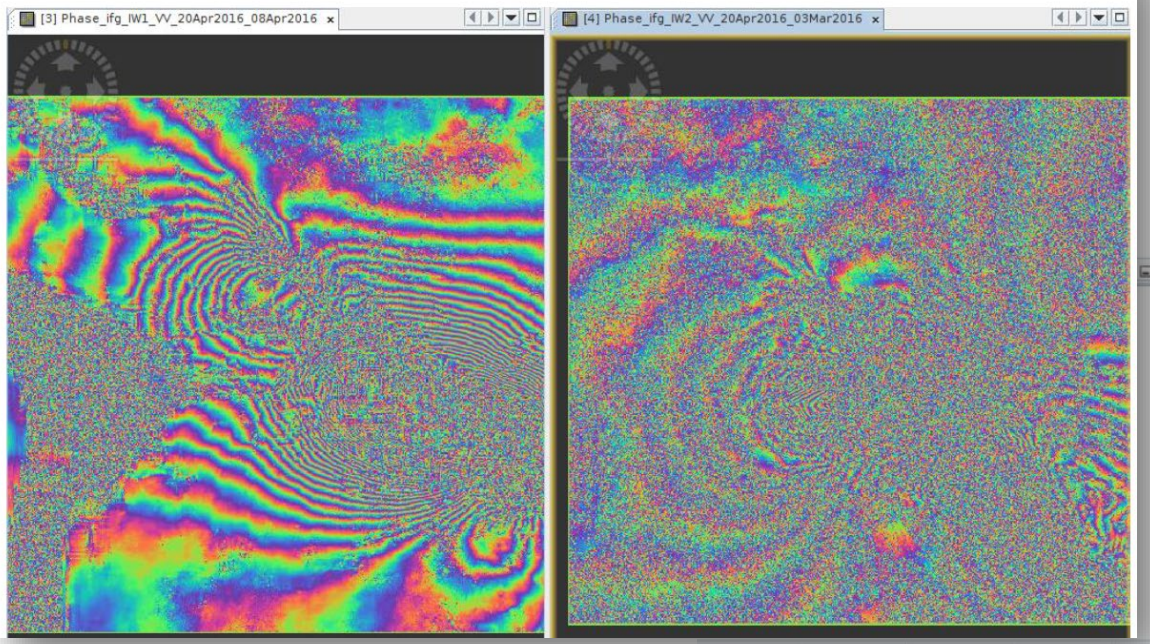


```
# Apply orbital file correction and split into subswath & burst range.
for a in input/*.zip; do \
    aOut=$(echo "$a" | sed 's/input/intermediateProcessing\/0/g')
    gpt "00_Orb_Split.xml" -PsourceProduct="$a" -Pswath="$sentinel1_sw

# Create a file listing for all the files created in the previous step
file_list=""

# Loop through the files in the directory ending with .dim
for file in intermediateProcessing/0/*.dim; do
    # Check if the file exists and is a regular file
    if [ -f "$file" ]; then
        # Concatenate the file name to the list, delimited by semi-col
        file_list+=",$file"
    fi
done

# Remove the leading semi-colon (if any) from the file list
file_list=${file_list#","}

# Perform stack creation
gpt "01_Create_Stack.xml" -PinputFileList="$file_list" -PoutputFile="$

delete_folder $intermediate_processing_location/0

# Perform SNAPHU export preparation and interferogram generation
gpt "02_00_Create_Interferograms.xml" -PinputProduct="$intermediate_pr

# Clear out image stack
delete_folder intermediateProcessing/1
```

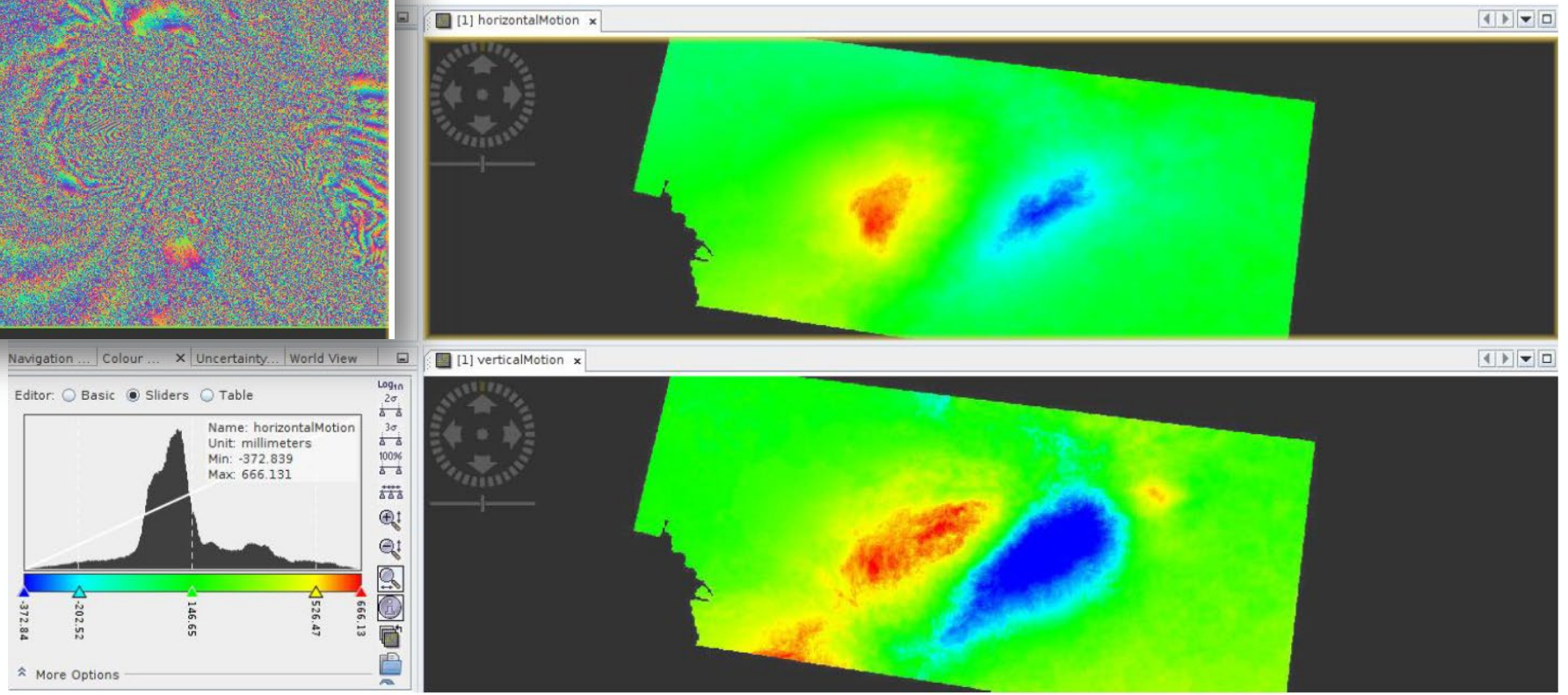
Retrieval of Vertical and E-W Motion Components

Ascending interferogram

Descending interferogram



Horizontal/vertical motion



Current in SNAP 10 (Sept 2023)

- Refactoring from S1TBX to Microwave Toolbox
- Support for updated Sentinel-1 COG format
- Support for Cosmo Skymed Second Generation
- Updated support for ALOS-2
- Updated support for SAOCOM
- ETAD Reading and Visualization
- ETAD GRD and SM SLC Correction

Coming up in SNAP 11 (Mar 2024)

- ETAD Corrected SLC/GRD
- ETAD Improved Coregistration
- Model based Decompositions of Dual Pol SLC
- SpatioTemporal Asset Catalog (STAC)
- New Classification Algorithms

Science Toolbox Exploitation Platform

http://step.esa.int

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