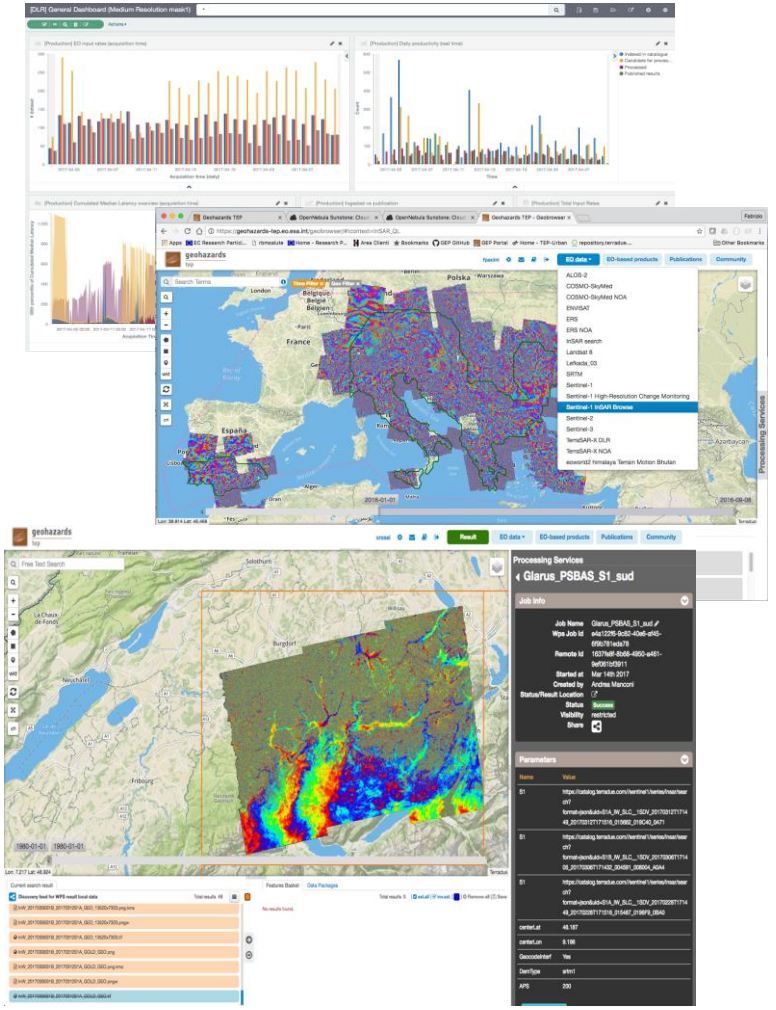
Towards SNAP-StaMPS Automatic PSI Processing Service for Research Applications on ESA GEP Cloud Infrastructure



MDIS 2019

Michael Foumelis, BRGM
Jose Manuel Delgado Blasco, RHEA c/o ESA
Andy Hooper, Univ. of Leeds
Fabrice Brito, Terradue s.r.l.
Philippe Bally, ESA
Fabrizio Pacini, Terradue s.r.l.

geohazards tep

Motivation

- Since the launch of Sentinel-1A, few open source InSAR processors were available for generating interferogram stacks compatible with StaMPS*.
- ESA Sentinel-1 toolbox had almost all the functionalities to fill that gap, but compatibility with StaMPS it was not initially designed.
- On the ESA STEP forum (https://forum.step.esa.int/) many threads, by the user community, address issues while trying to use SNAP as a pre-processing tool for PSI analysis.

→ This work was born as answer to this user community need

Design an optimal DInSAR processing chain & ensure compatibility with StaMPS PSI

* A. Hooper, D. Bekaert, K. Spaans and M. Arikan (2012). "Recent advances in SAR interferometry time series analysis for measuring crustal deformation". Tectonophysics, 2012.

- ESA Sentinel Application Platform | SNAP
- SNAP Interferometric Processing | Manual vs Batch mode
- snap2stamps | Python Scripts
- StaMPS PSI Processing Scheme
- SNAP-StaMPS PSI service on GEP

SNAP

- The common architecture for all **Sentinel Toolboxes** and **SMOS Toolbox** is called Sentinel Application Platform (SNAP).
- SNAP architecture is ideal for Earth Observation processing and analysis due the following technological innovations: Extensibility, Portability, Modular Rich Client Platform, Generic EO Data Abstraction, Tiled Memory Management and a Graph Processing Framework.

Activity initially funded through SEOM element of ESA's EOEP-4 (www.seom.esa.int)

seom
scientific exploitation
of operational missions

Sentinel Application Platform | SNAP

- **SAR Toolbox (S1TBX)**
  - Scientific toolbox for the handling and post-processing of data products from Sentinel-1 SAR mission
- **High Resolution Optical Toolbox (S2TBX)**
  - Toolbox for the visualisation, analysis and post-processing of data products from Sentinel-2 multi-spectral optical data
- **Medium Resolution Optical Toolbox (S3TBX)**
  - Toolbox for the processing and analysis of Sentinel 3 OLCI and SLSTR
- Developer forum
  - Requirements addressing a common platform issues
  - Define the platform roadmap
  - Coordinate horizontal activities across the three toolboxes

Multi-Mission Scientific Platform

Development Consortia

- ARRAY SYSTEMS COMPUTING INC.
  - Brockmann Consult GmbH
  - DLR
  - oceandatalab

- CS La force de l'innovation
  - CS ROMÂNIA
  - TELESPAZIO VEGA DEUTSCHLAND A Finmeccanica / Thales Company
  - INRA SCIENCE & IMPACT
  - UCL Université catholique de Louvain

- Brockmann Consult
  - University of Reading
  - CS La force de l'innovation
  - ACRI ST
  - ARRAY SYSTEMS COMPUTING INC.

seom scientific exploitation of operational missions

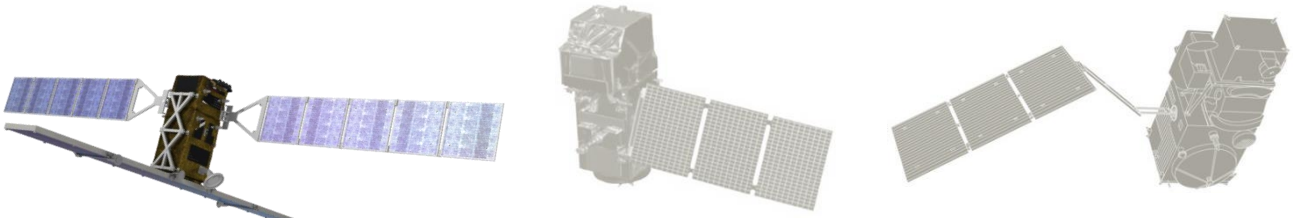
SNAP Development History

Built on prior toolbox development

nest
next esa sar toolbox

BEAM

SNAP Sentinel-1 First Release



Release v1
Sept 29 2014

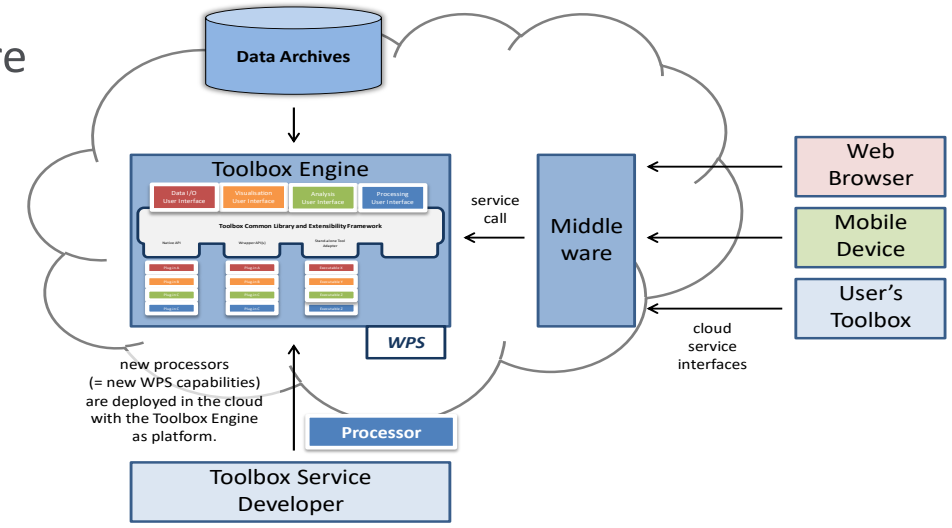
Empower the EO community to better exploit the large archives of the Sentinels and heritage missions in both research and operational usage.

Evolve the architecture to ensure that the software will be capable of supporting the large data products and ever growing volumes of EO data.

ESA SNAP Development Concept

- Developed as open source software
- Common Java core framework
- Joint development plan for Sentinel toolboxes
- Interchangeable Java/Python plugins
- Portable engine to Cloud infrastructure
- Single installer

SNAP "Server Configuration"



NetBeans

github SOCIAL CODING

GPL Free Software Free as in Freedom

Java

seom scientific exploitation of operational missions

TOPSAR InSAR Chain

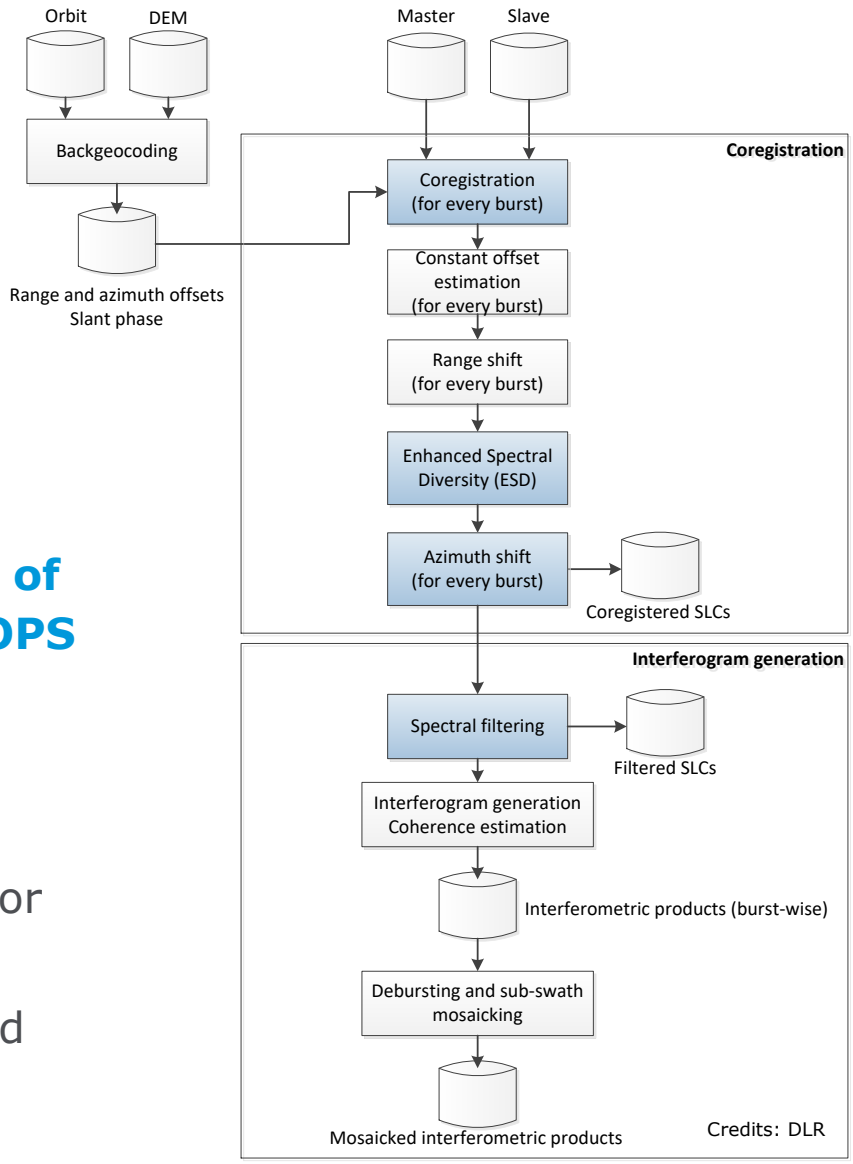
Support from
SEOM R&D projects

S1-INSARAP: SENTINEL-1 INSAR PERFORMANCE STUDY WITH TOPS

An ESA project kicked off in March 2014 after successful contract negotiations (www.seom.esa.int).

"Validation and scientific exploitation of the interferometric performance of TOPS mode on Sentinel-1 mission"

- Full exploitation of S-1 mission interferometric capacity
- Development of advanced algorithms for TOPS data
- Demonstrate continuity of ESA's C-band SAR observations



SNAP Sentinel-1 Interferometry | New Zealand Earthquake

Géosciences pour une Terre durable
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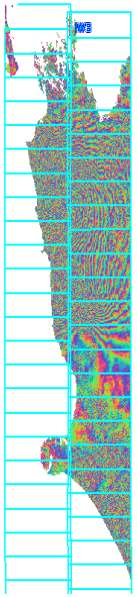
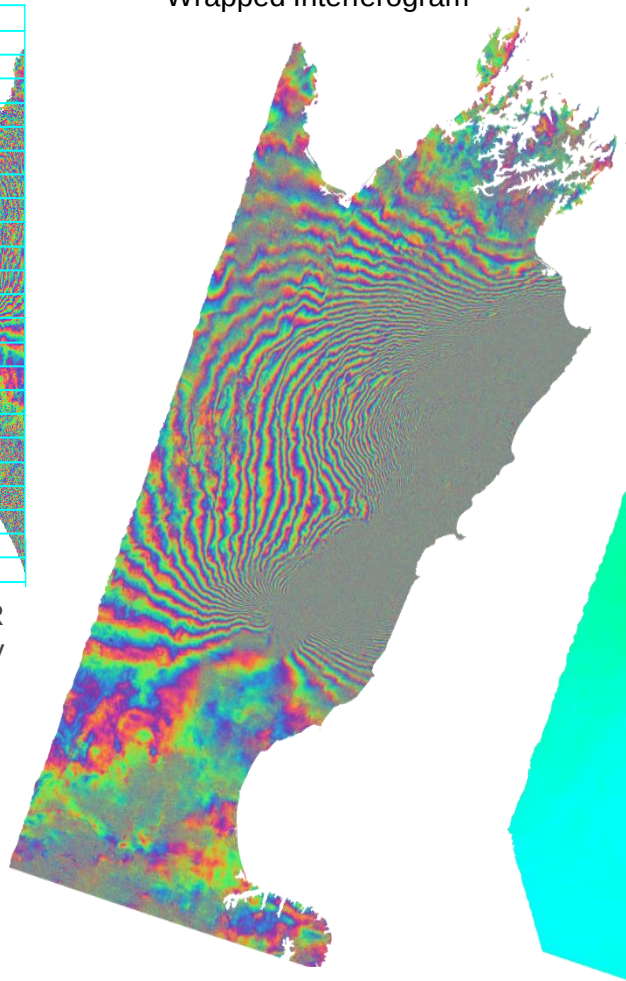
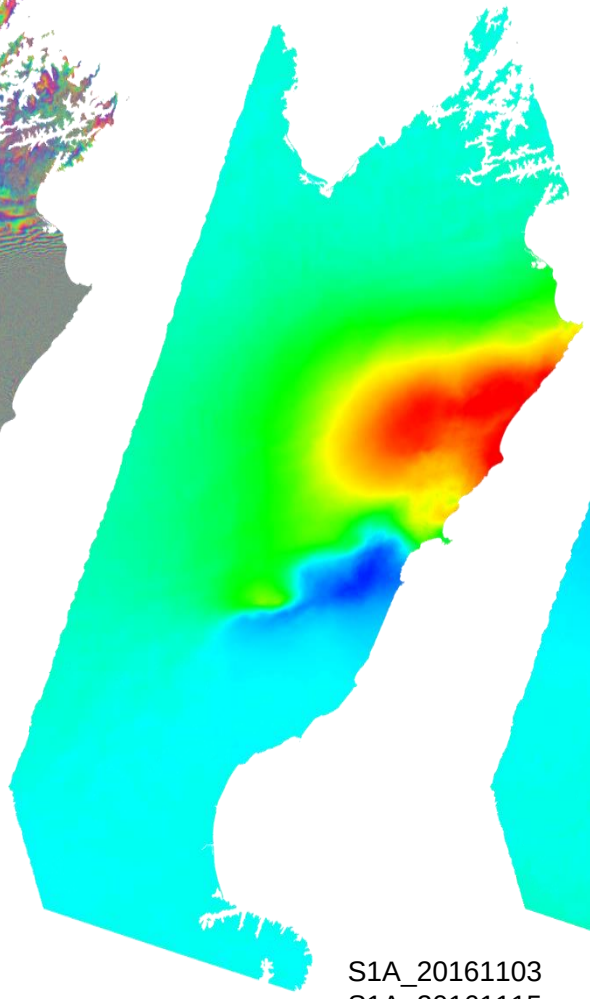


SAR geometry

Terrain Corrected
Wrapped Interferogram

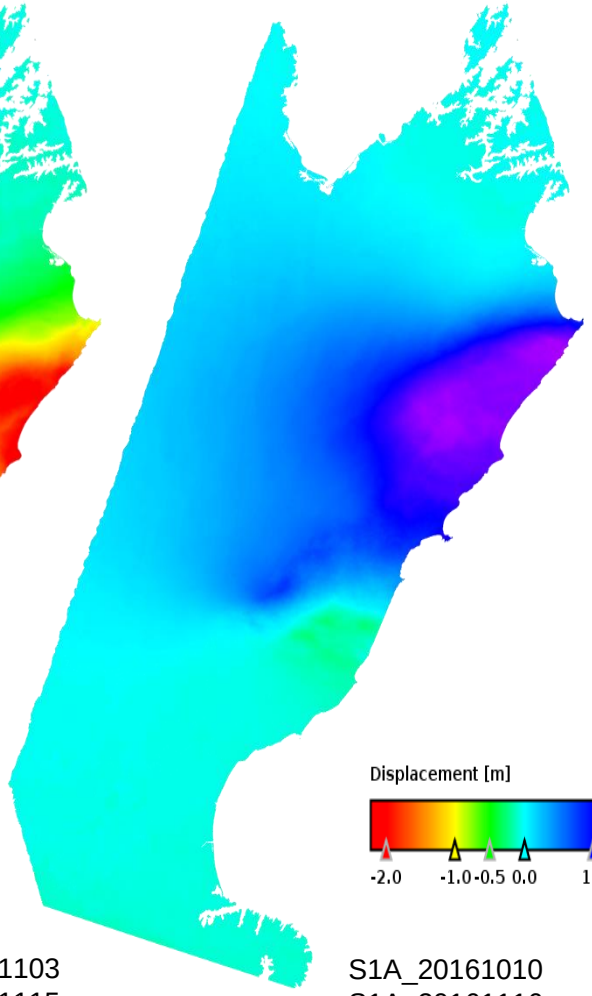


ASCENDING



S1A_20161103
S1A_20161115

DESCENDING



S1A_20161010
S1A_20161116

step.esa.int

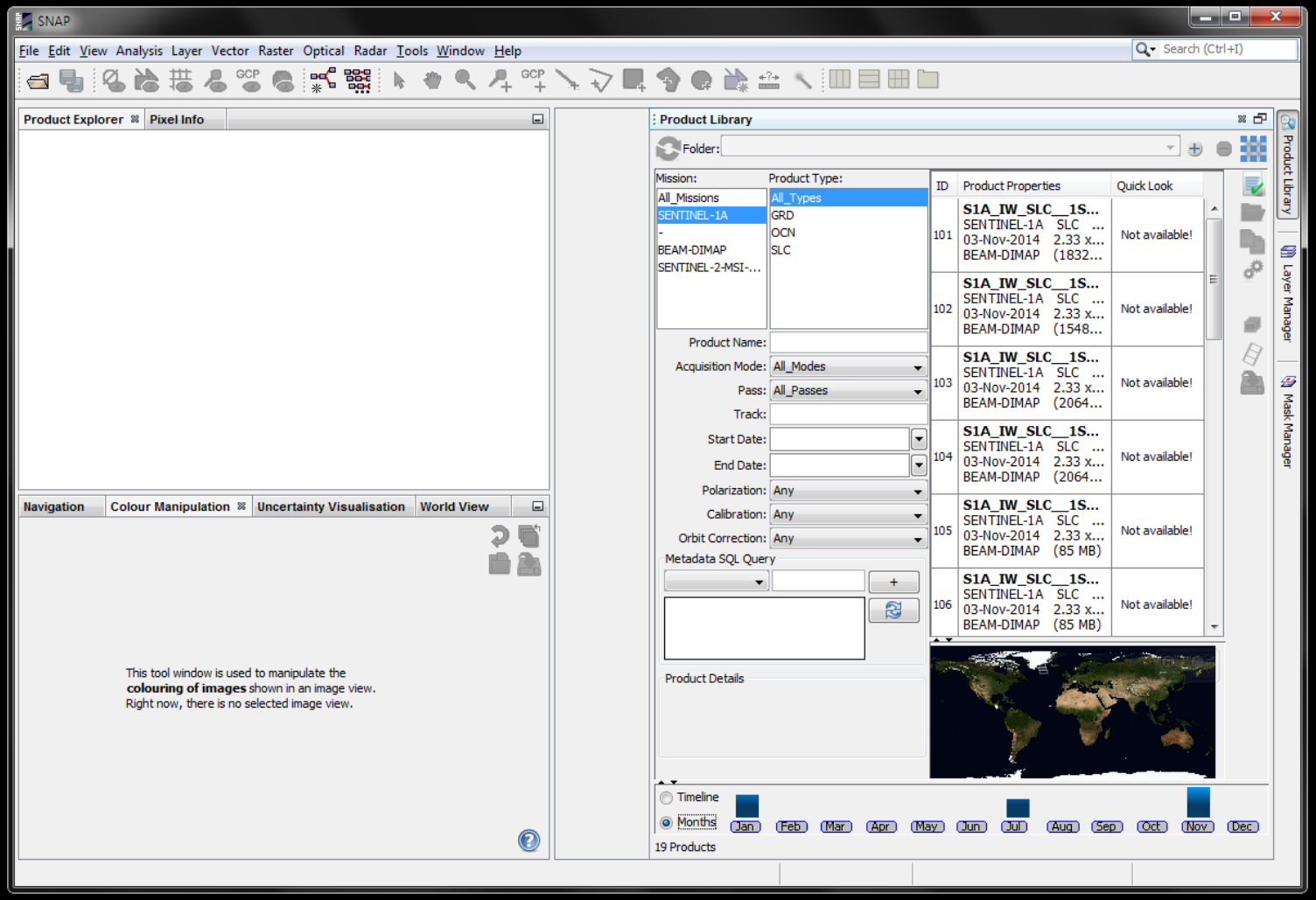
Science Toolbox Exploitation Platform

- SNAP Download page
- Access to Beta versions for testing
- Technical documentation for both end-users and developers
- Step-by-step tutorials including
- YouTube videos
- Technical forum, gathering user feedback and communicating results

- ESA Sentinel Application Platform | SNAP
- SNAP Interferometric Processing | Manual vs Batch mode
- snap2stamps | Python Scripts
- StaMPS PSI Processing Scheme
- SNAP-StaMPS PSI service on GEP

SNAP

All-in-One Environment



ESA Grid Processing on Demand | G-POD

- **ERS 1/2 SAR Data Archive**
- **ENVISAT ASAR Data Archive**
- **SENTINEL-1 TOPS Data**

Cloud Toolbox

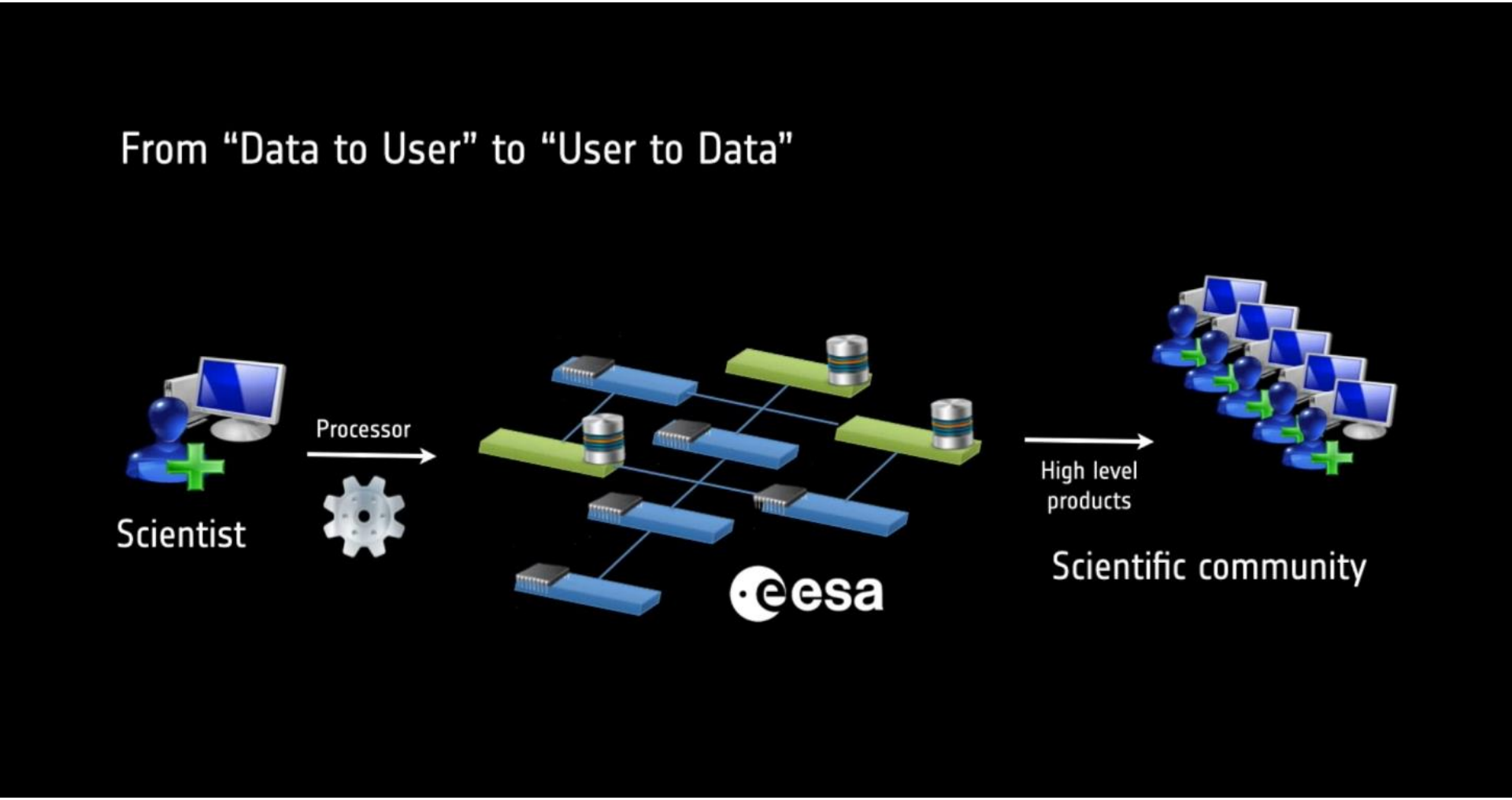
Direct access to **G-POD** and **Virtual Archive 4**
ERS 1/2 and ENVISAT SAR data

Sentinel-1 Data Hub connected to G-POD

- Supported catalogue search from G-POD GUI
- Automatic data retrieval from G-POD Worker Nodes
- Data cache of latest downloaded S-1 products

ESA Grid Processing on Demand | G-POD

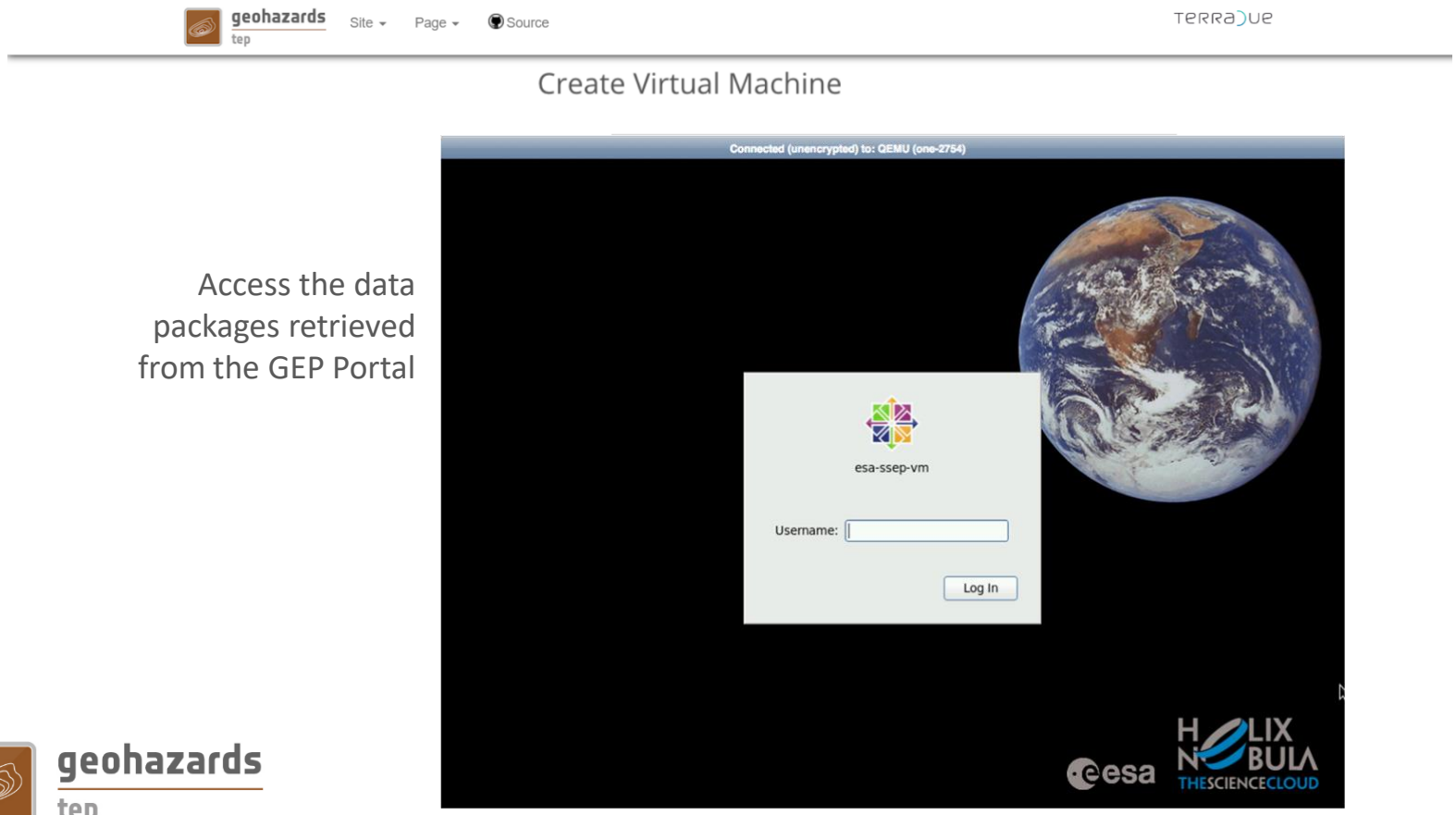
ESA G-POD service is provided by RSS
aiming to support the Earth Observation community in data exploitation



TerraDue Cloud ToolBox

The service offers configurable Virtual Machines (VM) tailored to scientific users' requirements.

https://terradue.github.io/doc-tep-geohazards/community-guide/cloud/esa_toolbox.html



Access the data packages retrieved from the GEP Portal

geohazards
tep

SNAP DInSAR Processing Chain

- Split IW Subswath (incl. Polarization) over AOI
- Update Orbit State Vectors
- Back-geocoding (DEM-assisted coregistration)
- Correct for Range and Azimuth Shifts (ESD algorithm)

  TOPS Coregistration
- Interferogram Generation (incl. Coherence)
- Goldstein Phase Filtering
- Phase Unwrapping (SNAPHU)
- Convert Phase to Displacement
- Terrain Correction Geocoding

SNAP DInSAR Pre-Processing Steps for StaMPS

- Split IW Subswath (incl. Polarization) over AOI
- Update Orbit State Vectors
- Back-geocoding (DEM-assisted coregistration)
- Correct for Range and Azimuth Shifts (ESD algorithm)

TOPS Coregistration

- Interferogram Generation ~~(incl. Coherence)~~
- ~~Goldstein Phase Filtering~~
- ~~Phase Unwrapping (SNAPHU)~~
- ~~Convert Phase to Displacement~~
- ~~Terrain Correction Geocoding~~

SNAP DInSAR Demo | Input Dataset

- A set of **Sentinel-1A SLCs** YYYYMMDDTHHMMSS

  S1A_IW_SLC__1SDV_20190817T171546_20190817T171613_028612_033C97_F4AE

  S1A_IW_SLC__1SDV_20190829T171546_20190829T171613_028787_0342BB_E70D

  [downloadable via Copernicus OpenHub, PEPS, ASF, etc.]

- Sentinel-1 **Precise Orbits** (PODs) for the corresponding S1A dates (*.EOF files are automatically downloaded via https://qc.sentinel1.eo.esa.int)

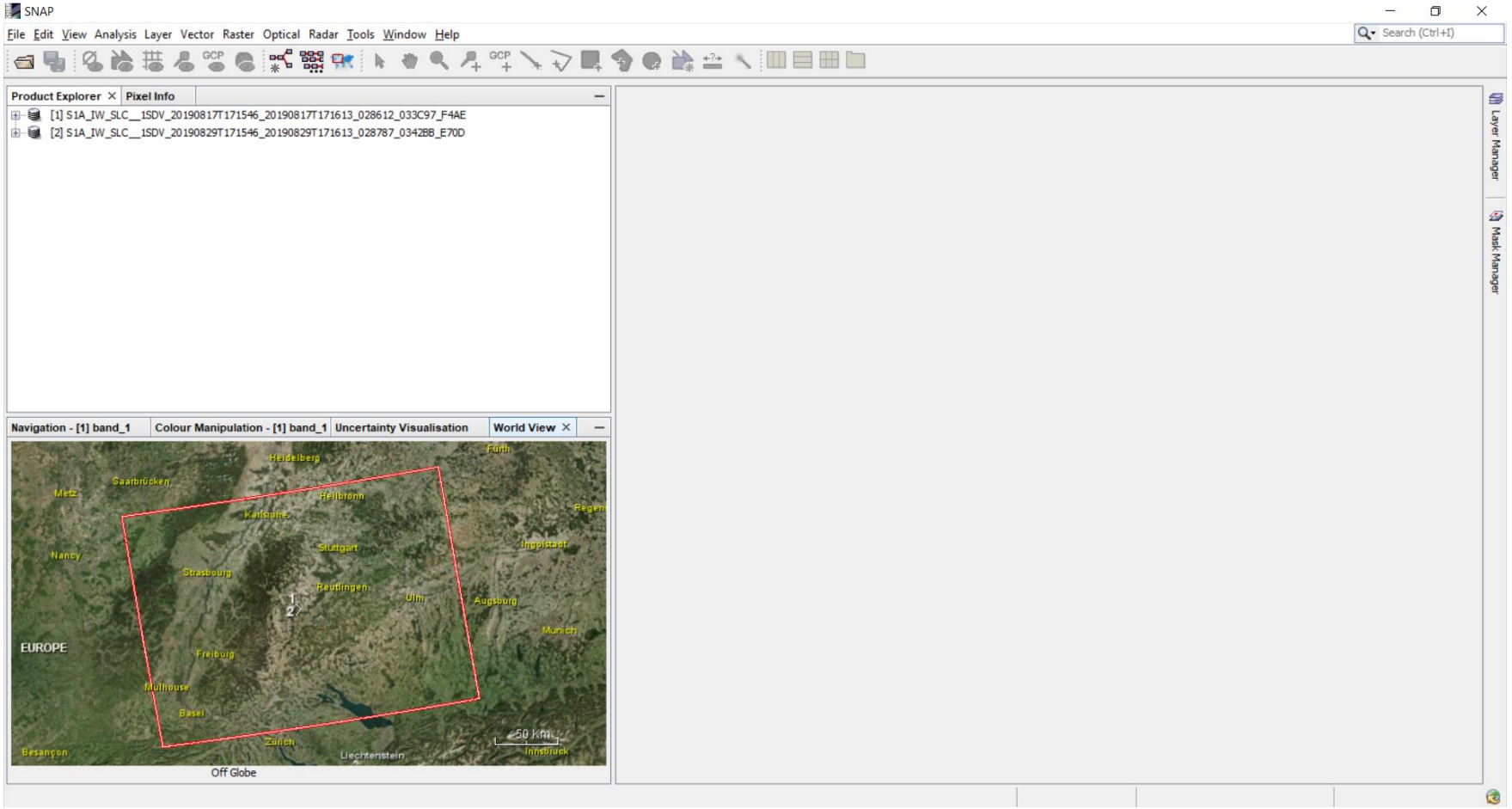
- **Digital Elevation Model** (DEM) dataset from SRTM 3 arc-sec covering the Area of Interest (automatically downloaded from the ESA SNAP repository)

VM configuration on ESA G-POD

OS: Ubuntu Linux
Number of Cores: **8**
RAM: **32 GB**
Dedicated Storage: **3 TB**

SNAP DInSAR Processing Scheme

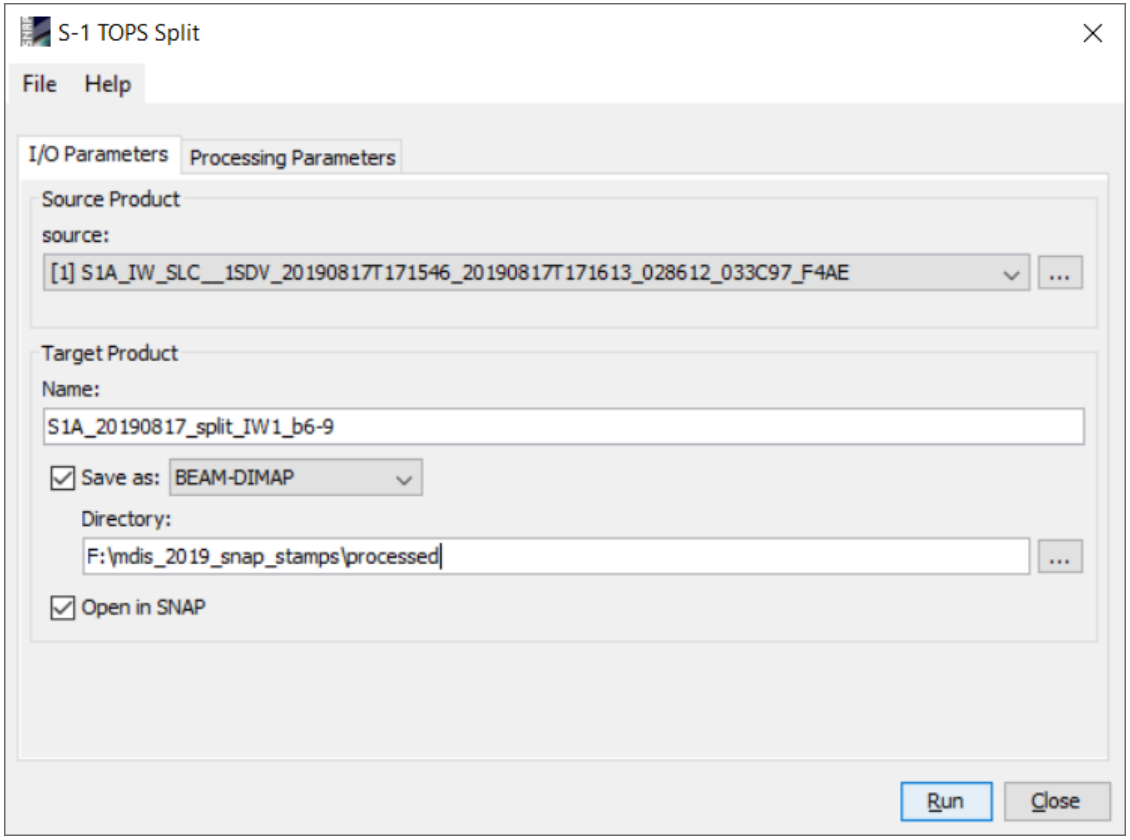
Read S1 SLC products



SNAP DInSAR Processing Scheme

Géosciences pour une Terre durable
brgm

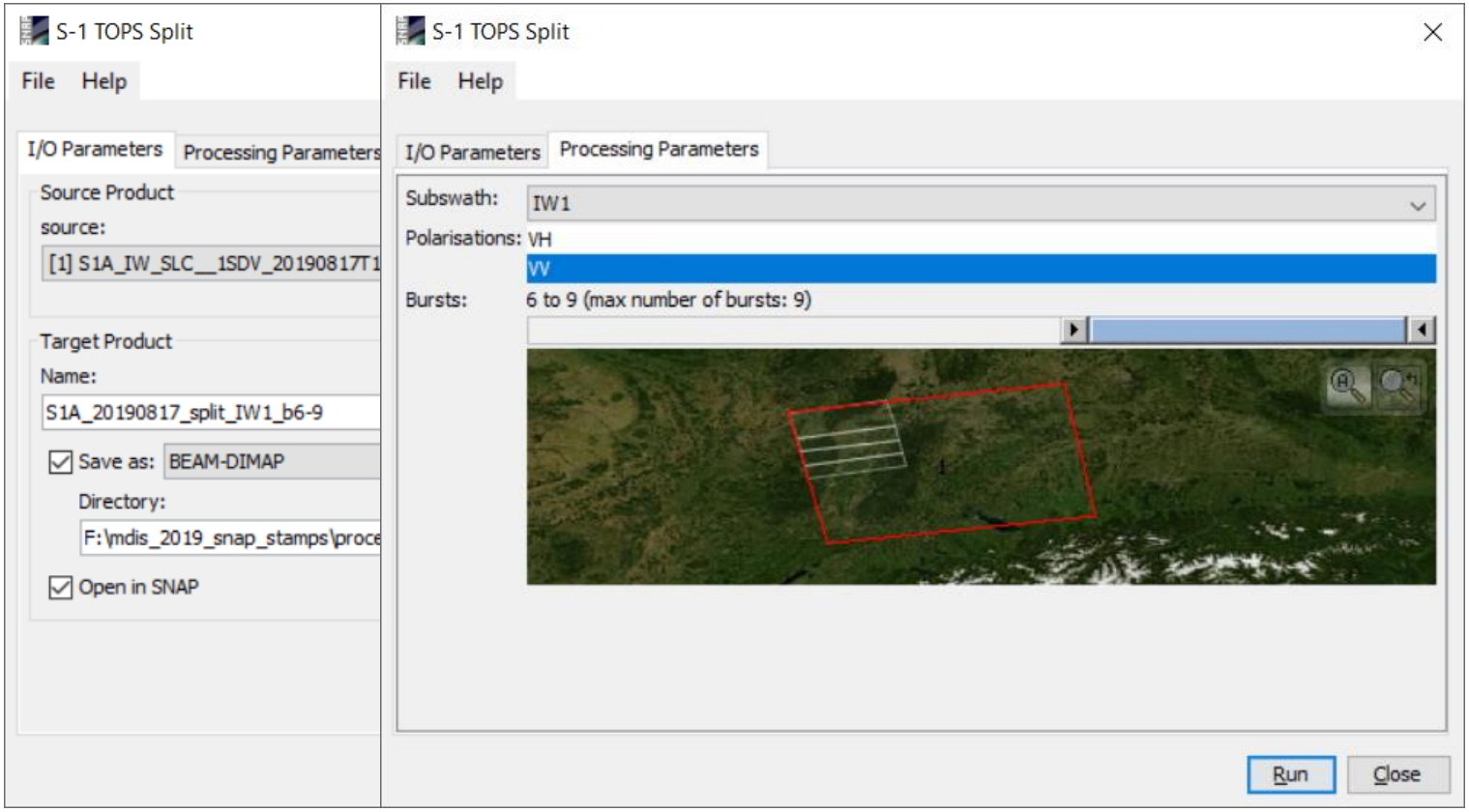
Master SLC Splitting (burst-level)



SNAP DInSAR Processing Scheme

Géosciences pour une Terre durable
brgm

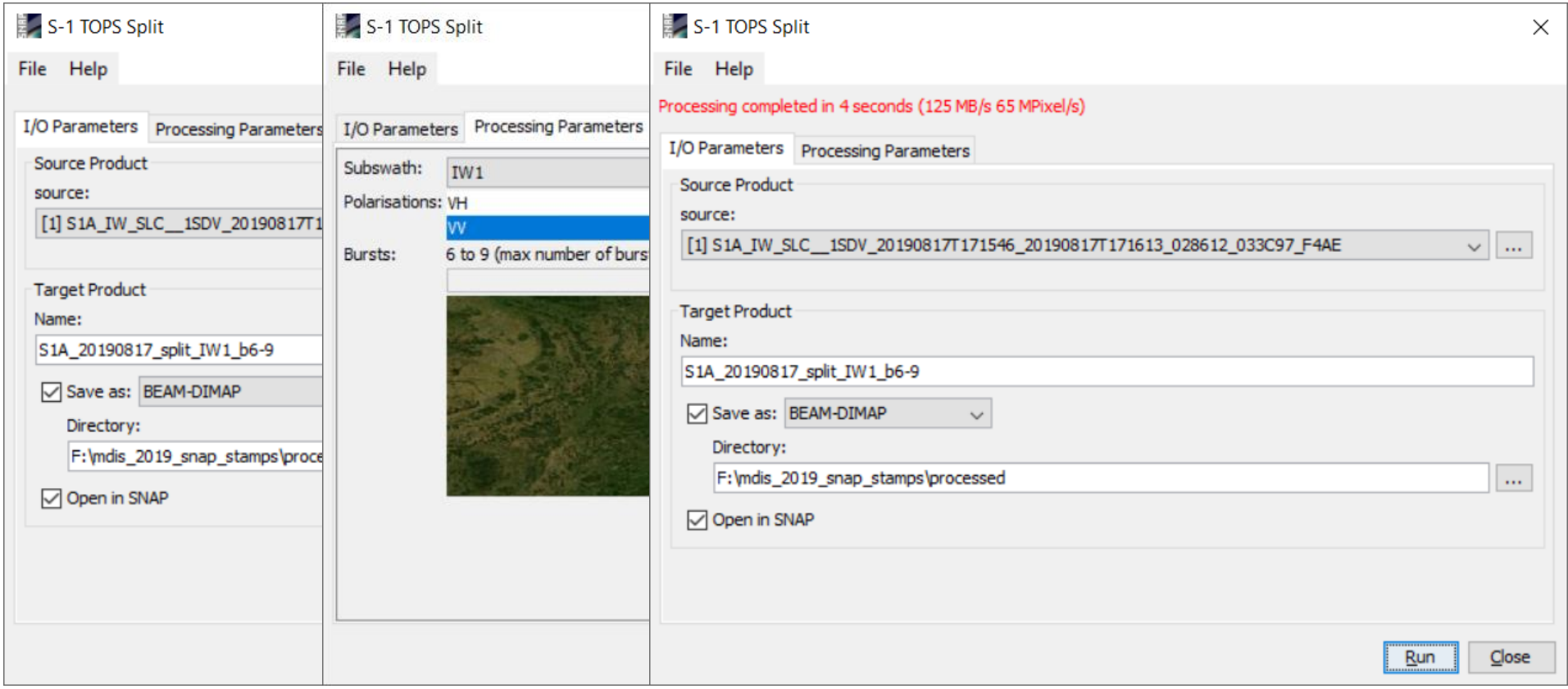
Master SLC Splitting (burst-level)



SNAP DInSAR Processing Scheme

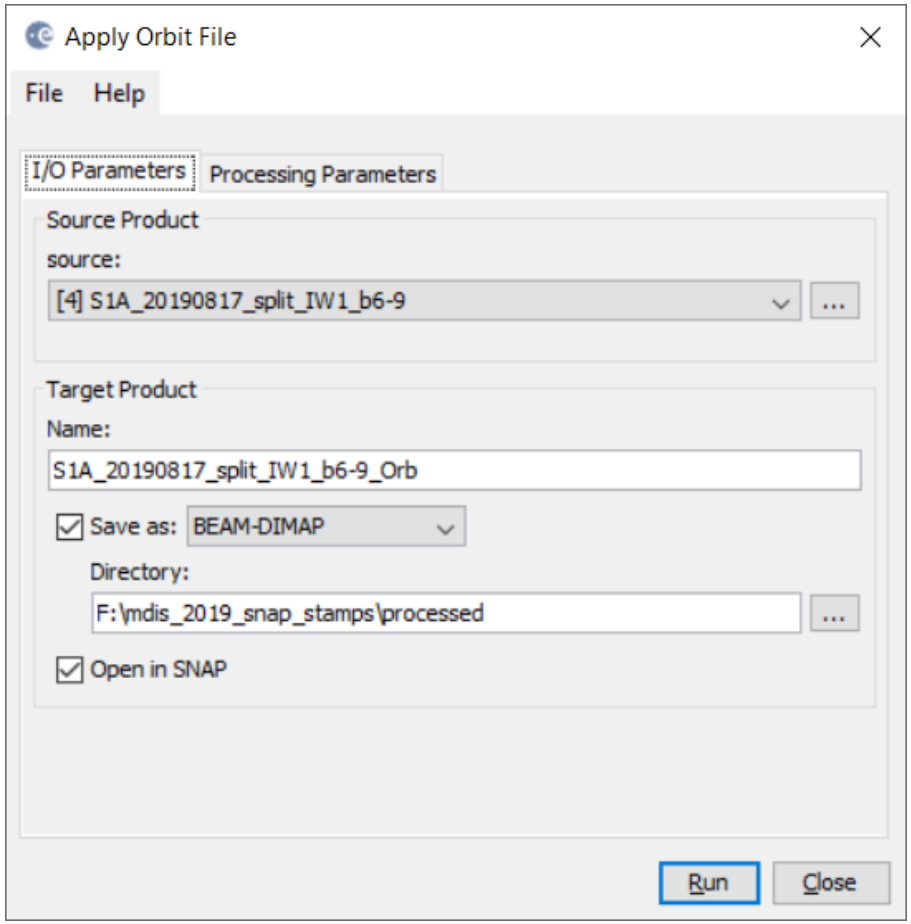
Géosciences pour une Terre durable
brgm

Master SLC Splitting (burst-level)



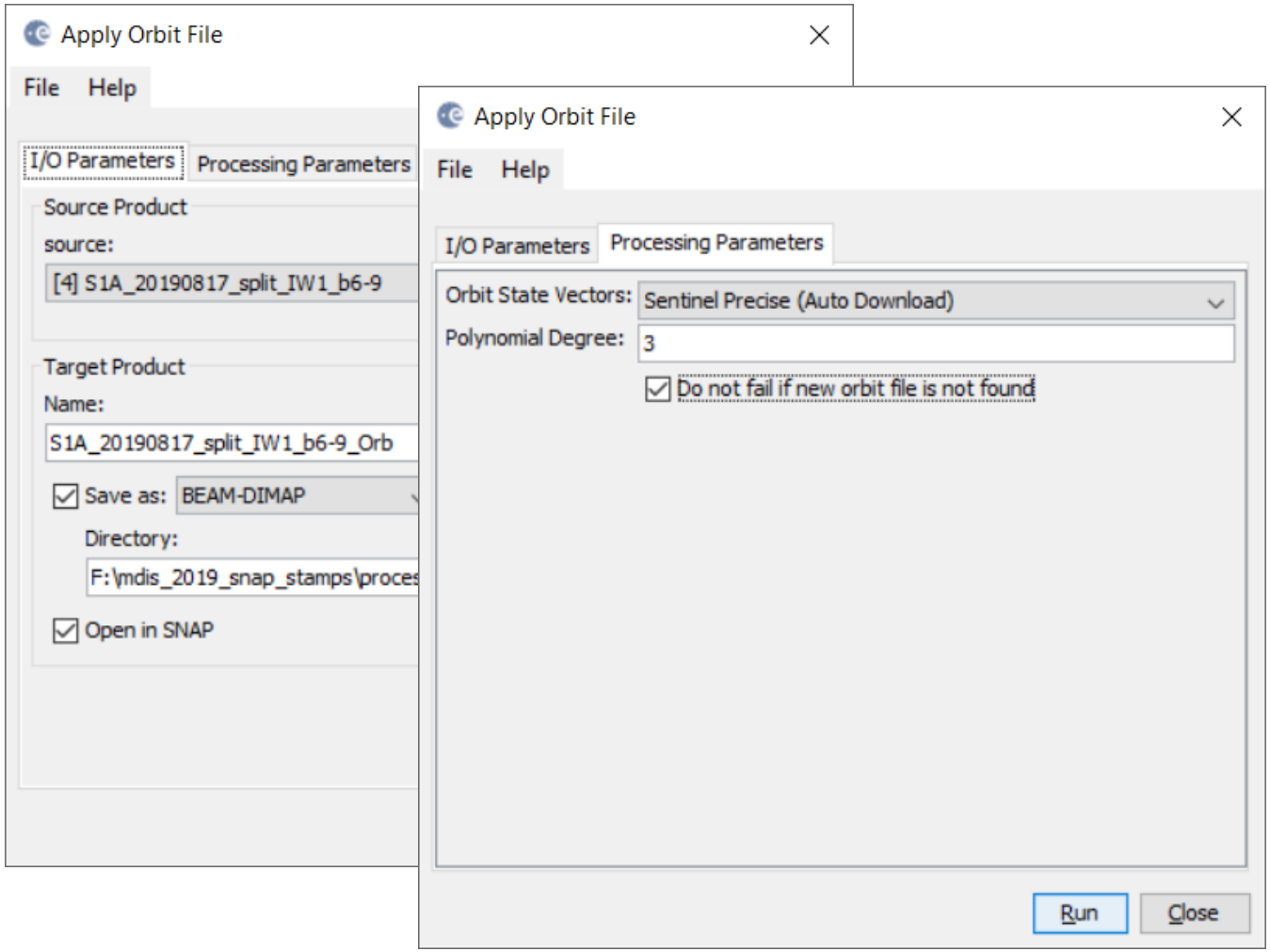
SNAP DInSAR Processing Scheme

Update Orbits (Restituted or Precise)



SNAP DInSAR Processing Scheme

Update Orbits (Restituted or Precise)



SNAP DInSAR Processing Scheme

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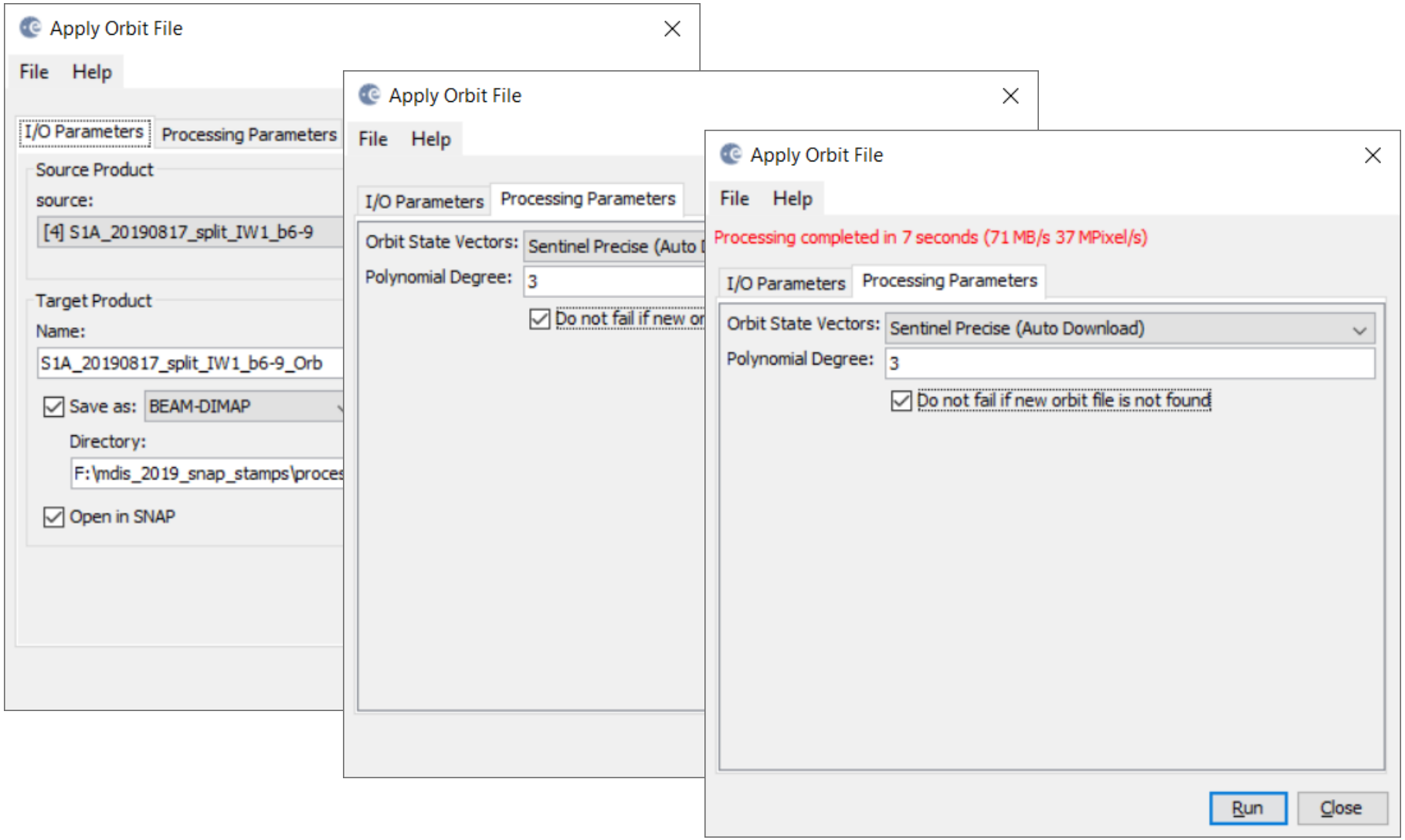
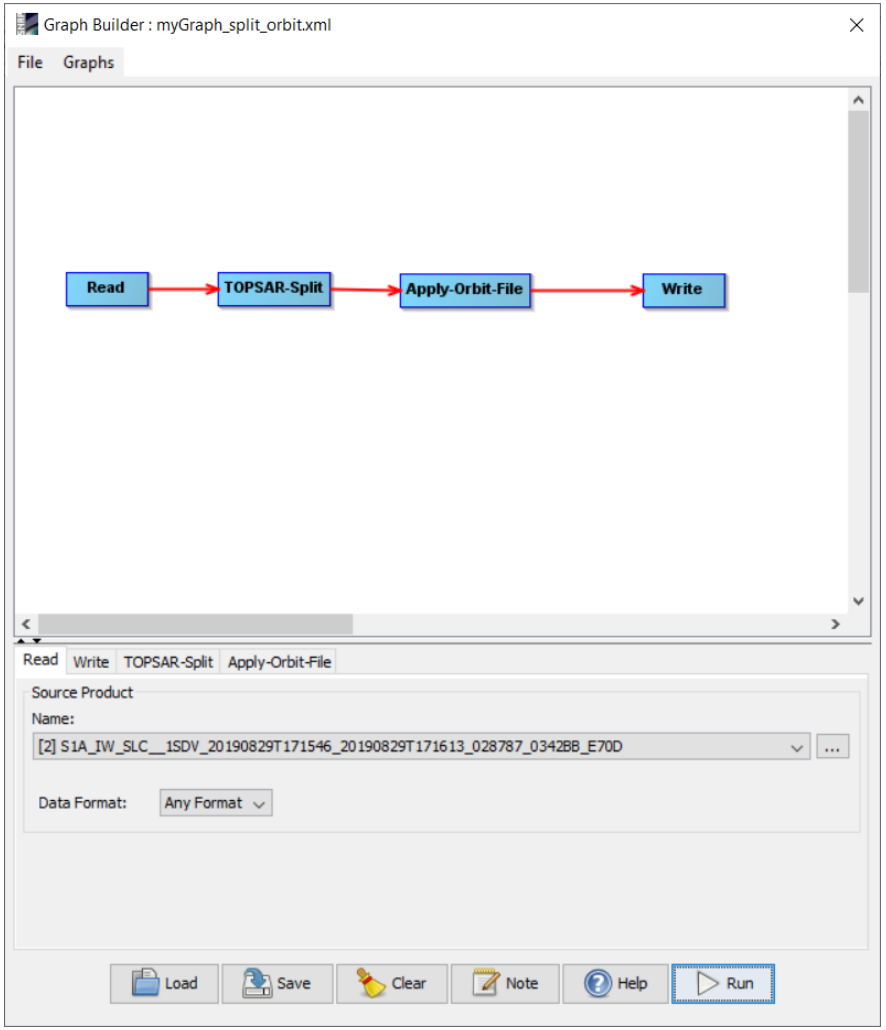


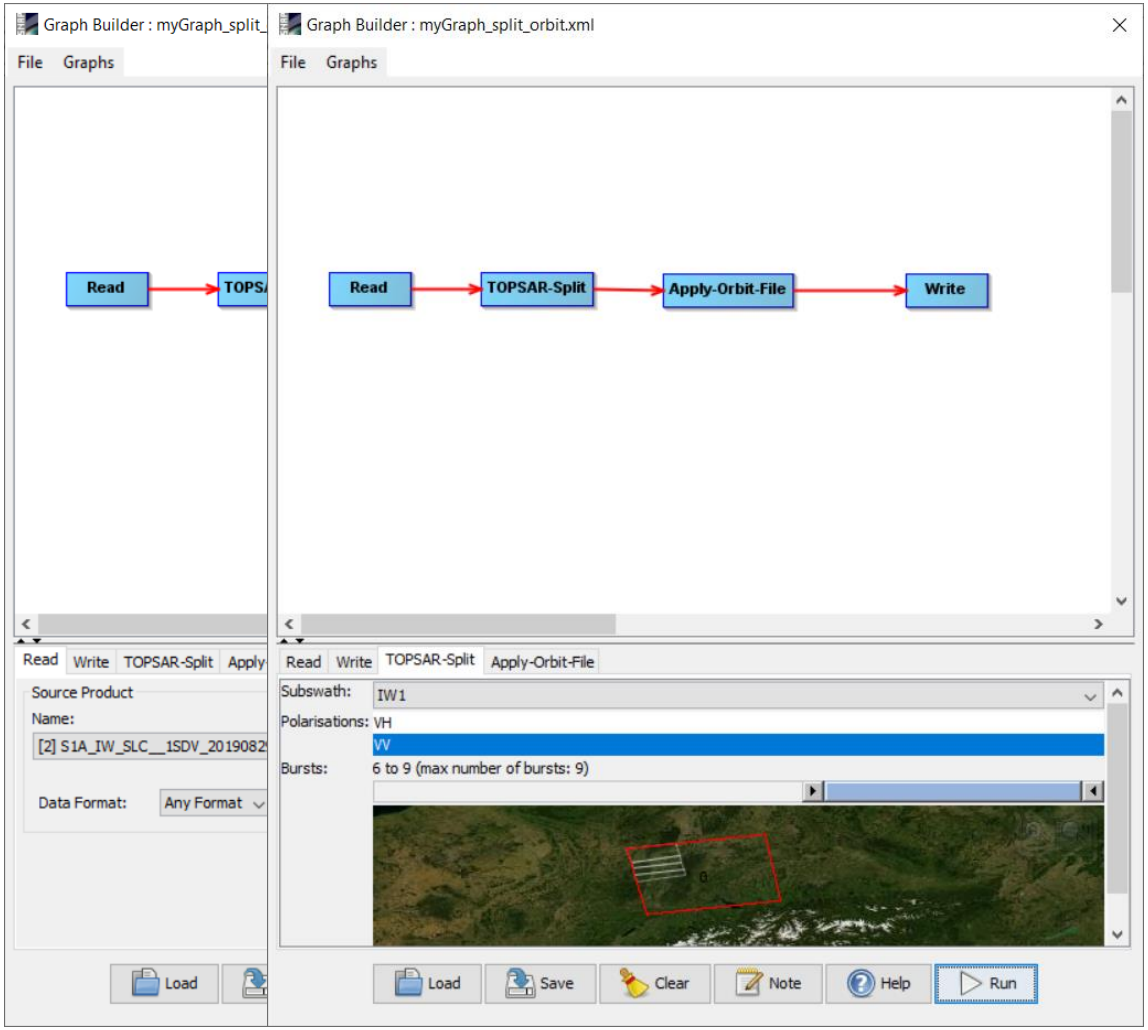
SNAP DInSAR Processing Scheme

Splitting & Orbits for Slave SLCs



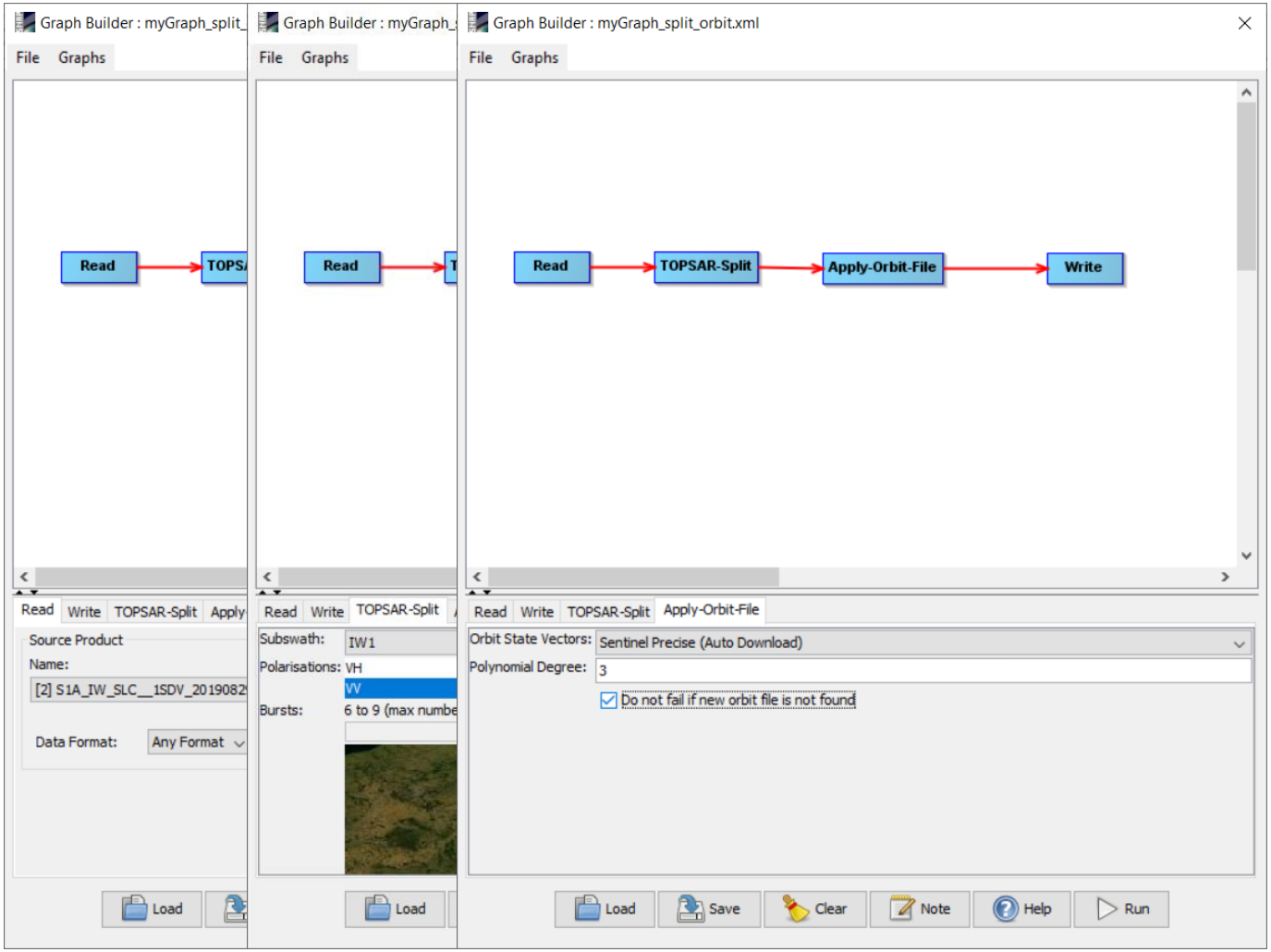
SNAP DInSAR Processing Scheme

Splitting & Orbits for Slave SLCs



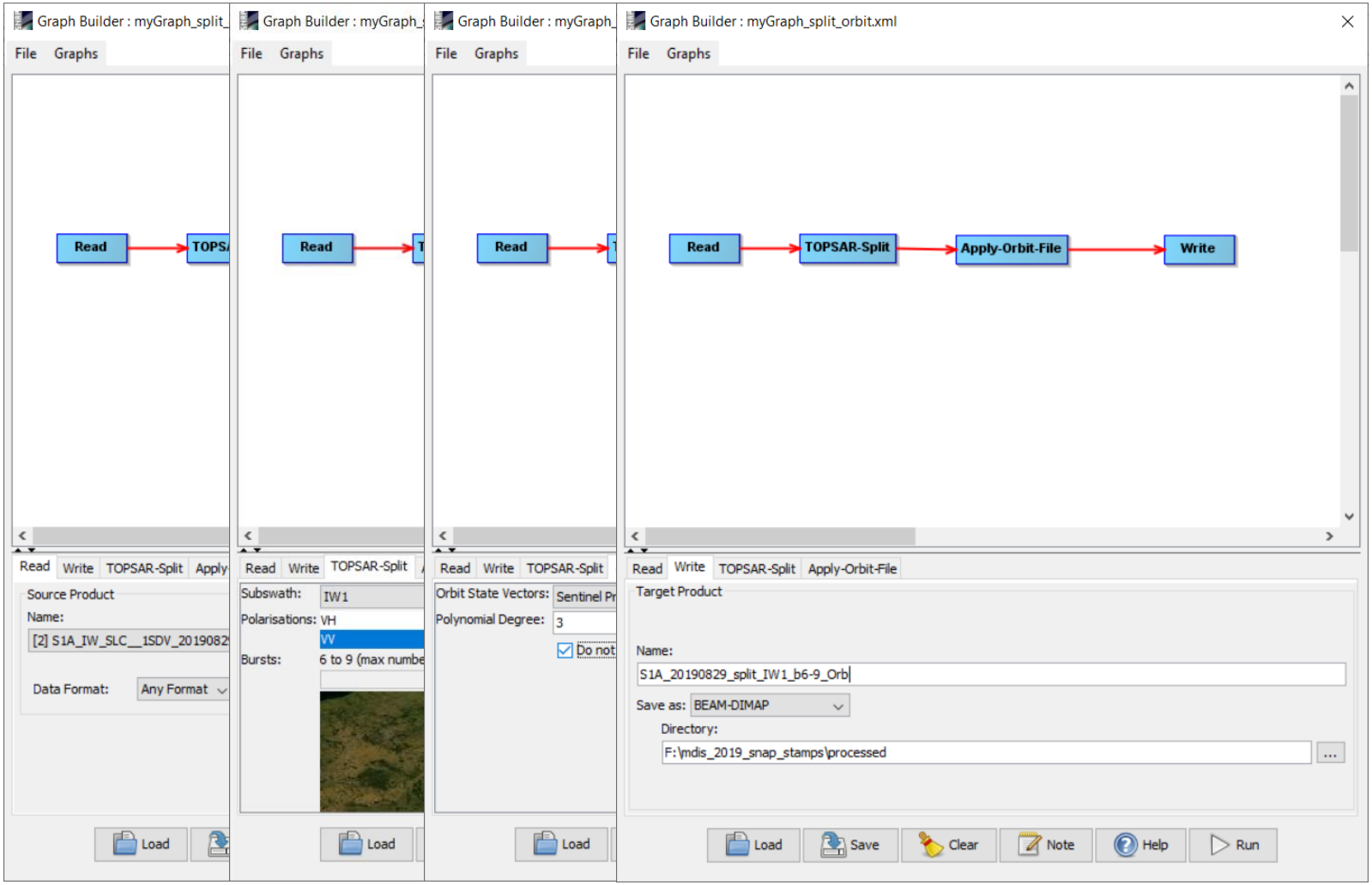
SNAP DInSAR Processing Scheme

Splitting & Orbits for Slave SLCs



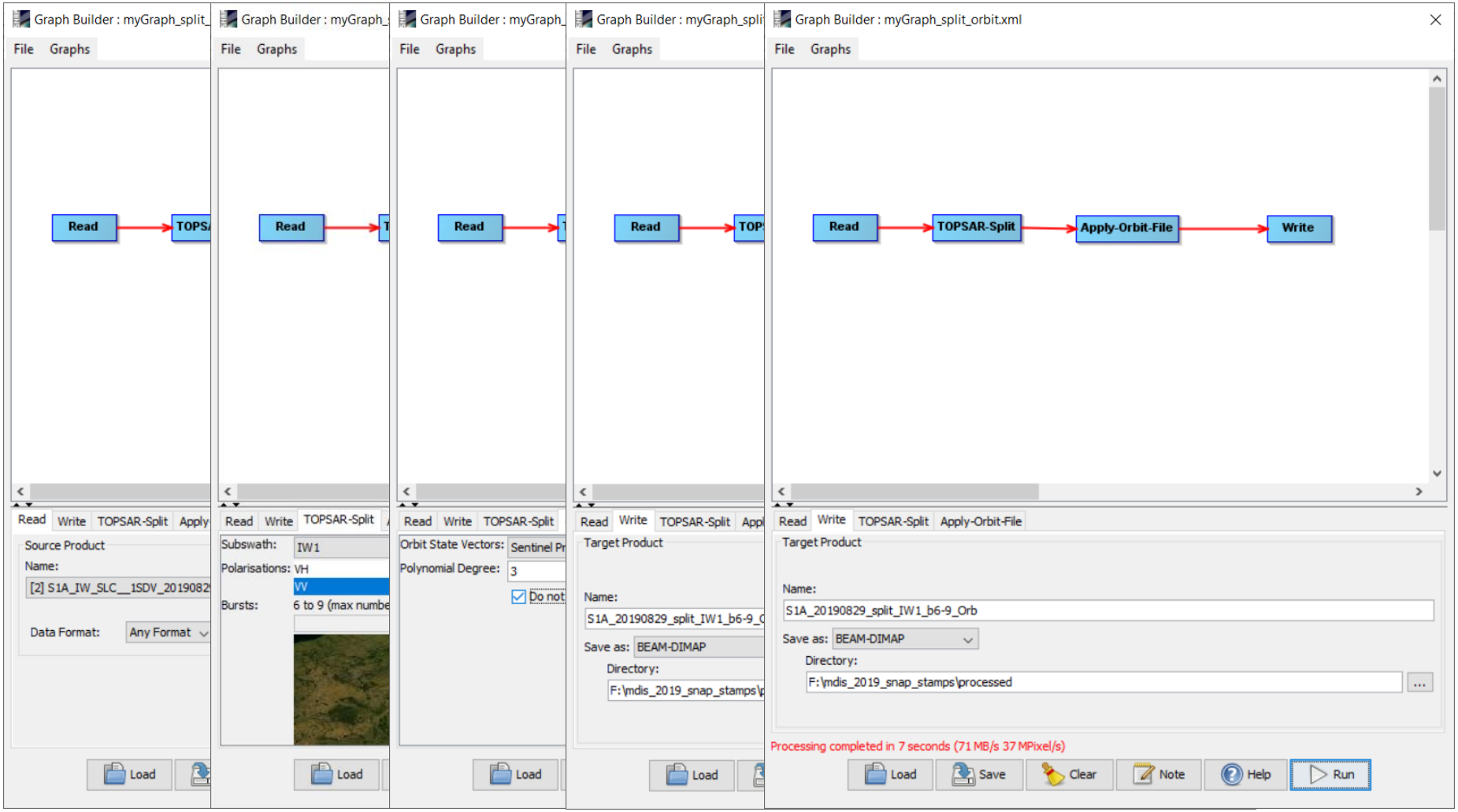
SNAP DInSAR Processing Scheme

Splitting & Orbits for Slave SLCs



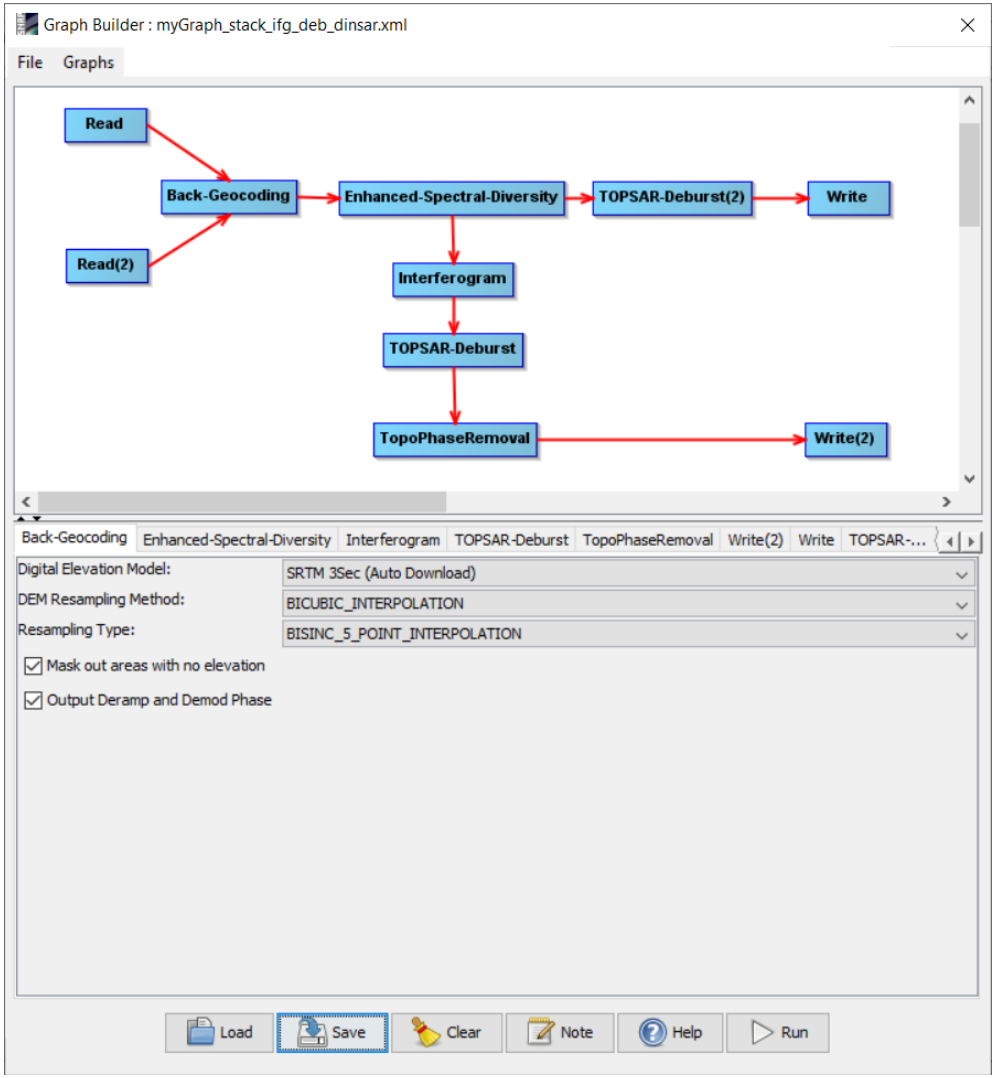
SNAP DInSAR Processing Scheme

Splitting & Orbits for Slave SLCs



SNAP DInSAR Processing Scheme

Co-registration & Interferogram generation



SNAP DInSAR Processing Scheme

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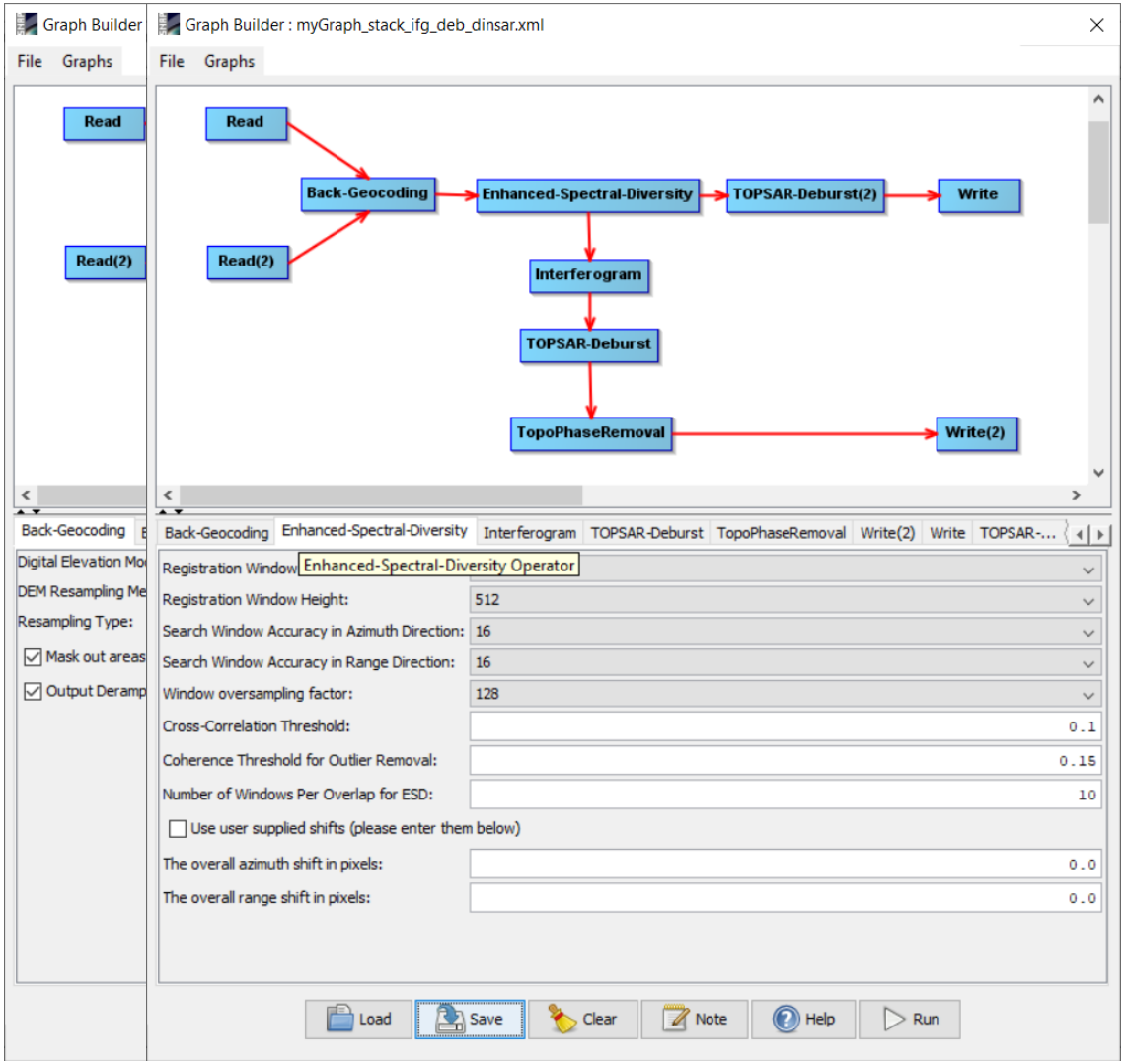

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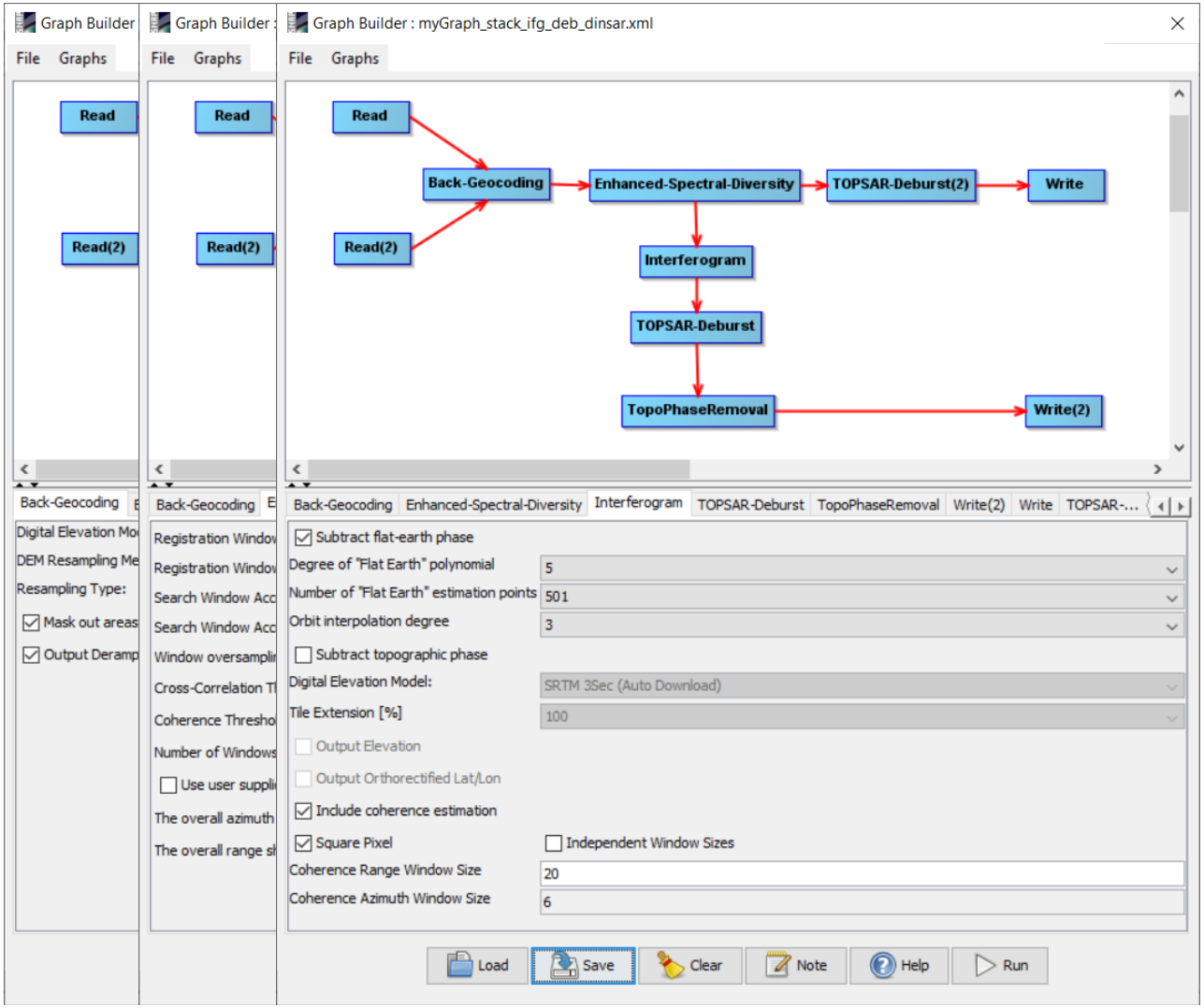
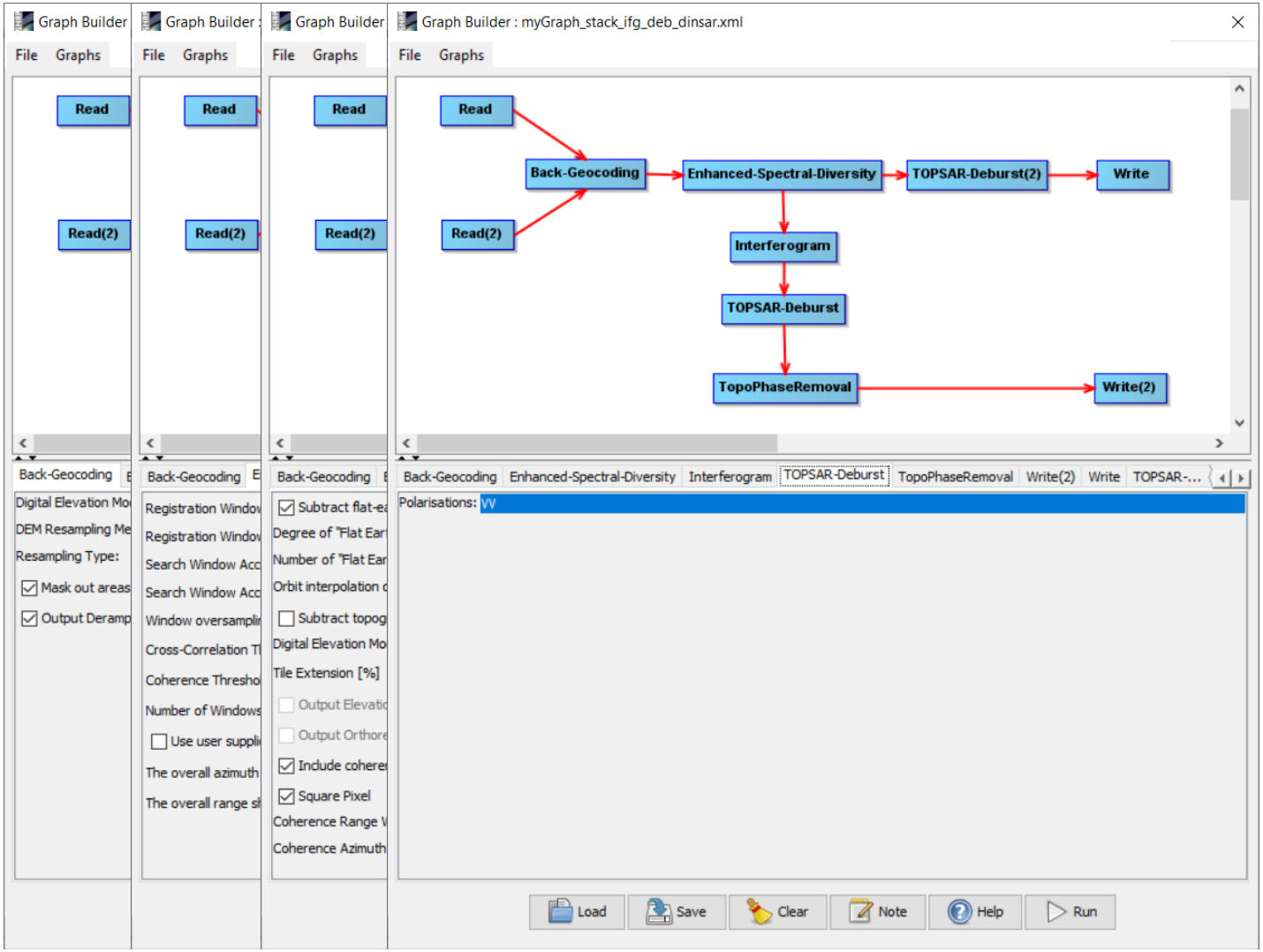


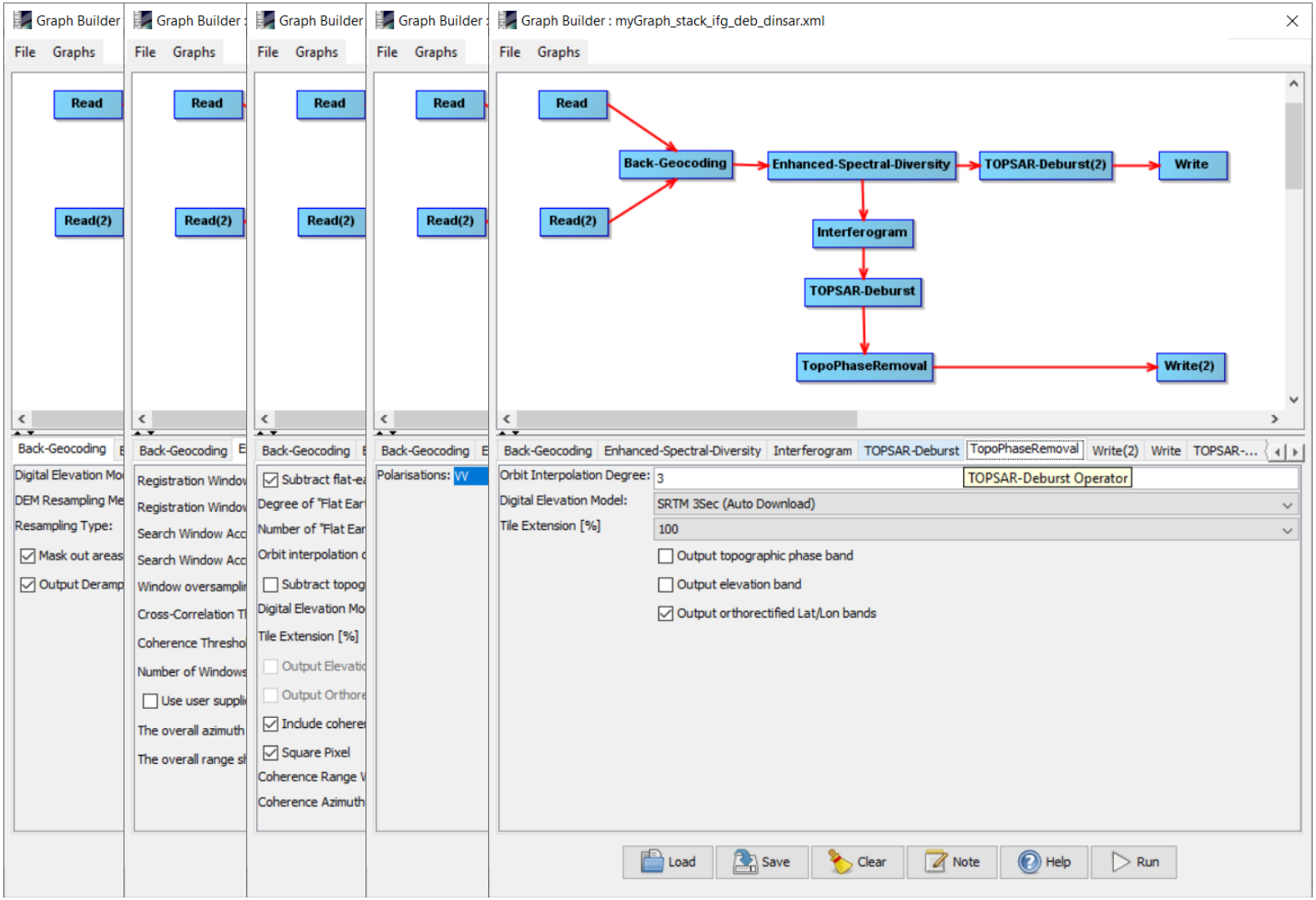
SNAP DInSAR Processing Scheme

Co-registration & Interferogram generation



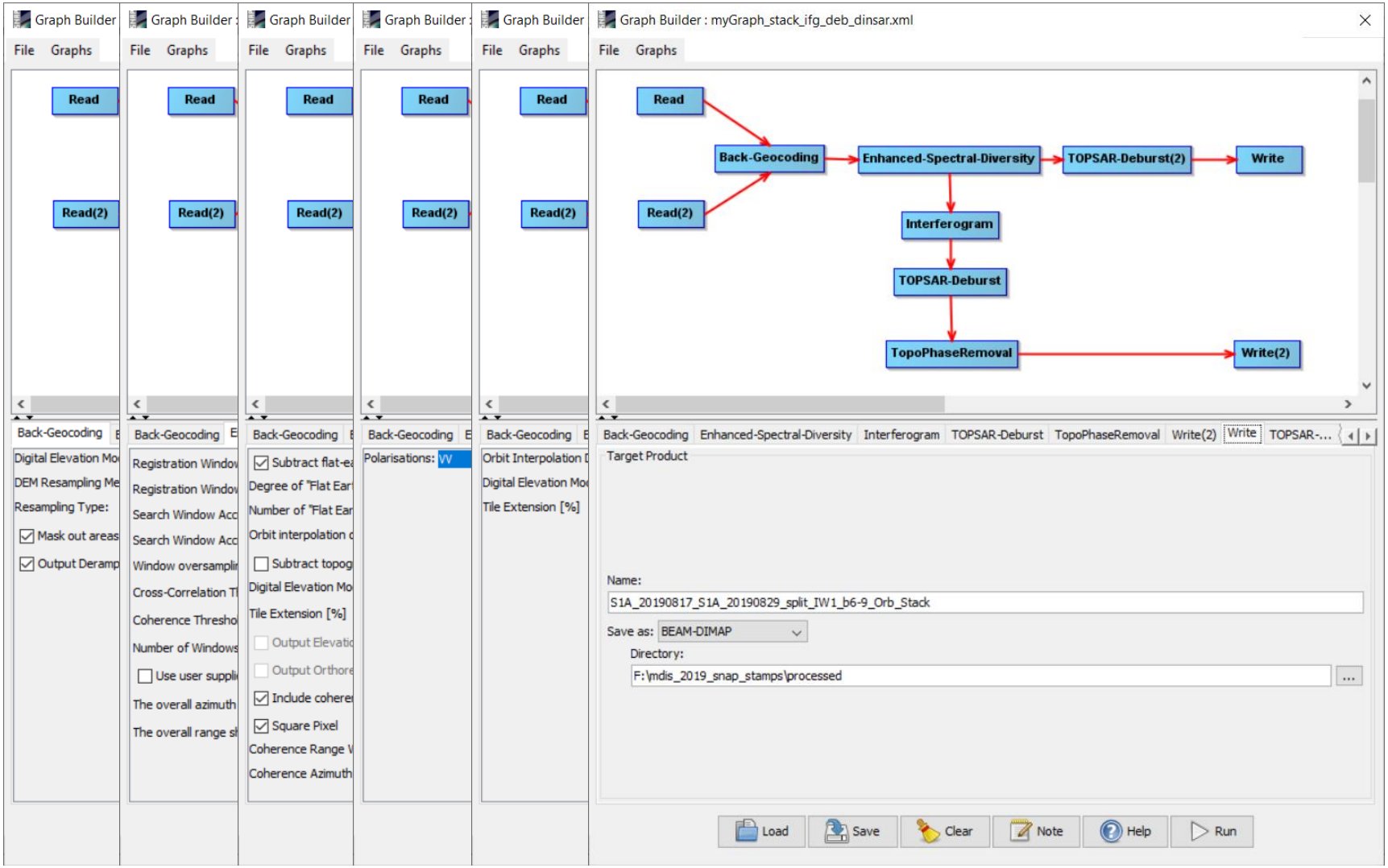
SNAP DInSAR Processing Scheme

Co-registration & Interferogram generation



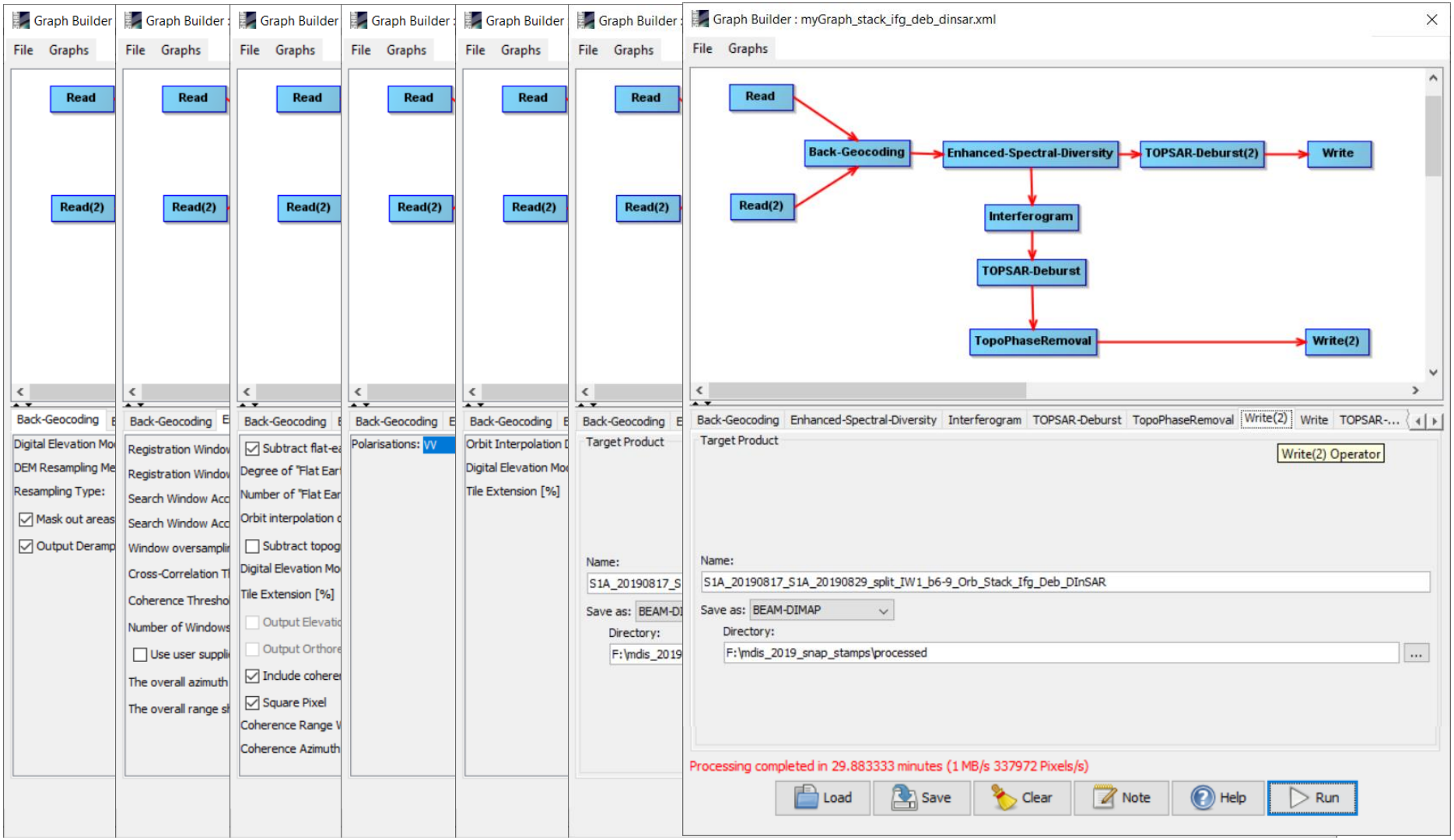
SNAP DInSAR Processing Scheme

Co-registration & Interferogram generation



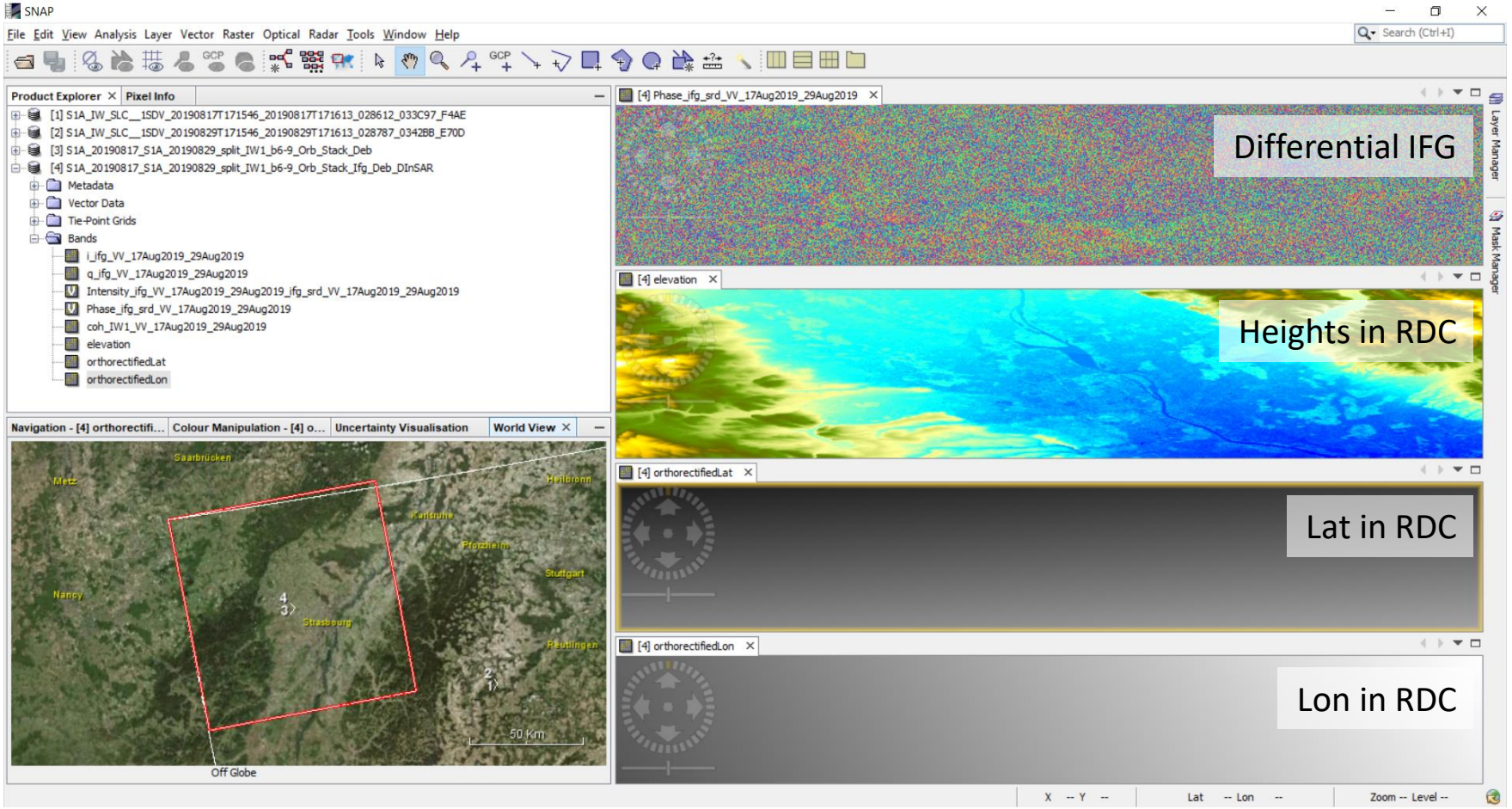
SNAP DInSAR Processing Scheme

Co-registration & Interferogram generation



SNAP DInSAR Processing Scheme

Overview of processing outputs



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SNAP InSAR processing

Demo

Géosciences pour une Terre durable
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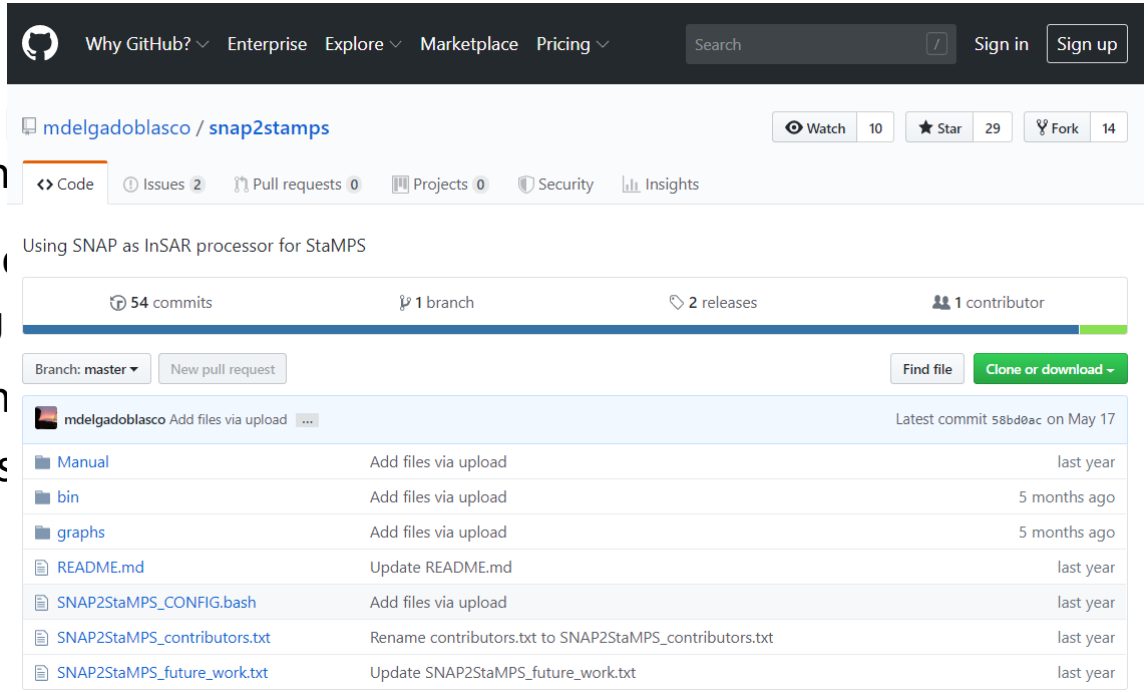
- ESA Sentinel Application Platform | SNAP
- SNAP Interferometric Processing | Manual vs Batch mode
- snap2stamps | Python Scripts
- StaMPS PSI Processing Scheme
- SNAP-StaMPS PSI service on GEP

snap2stamps | Software Package

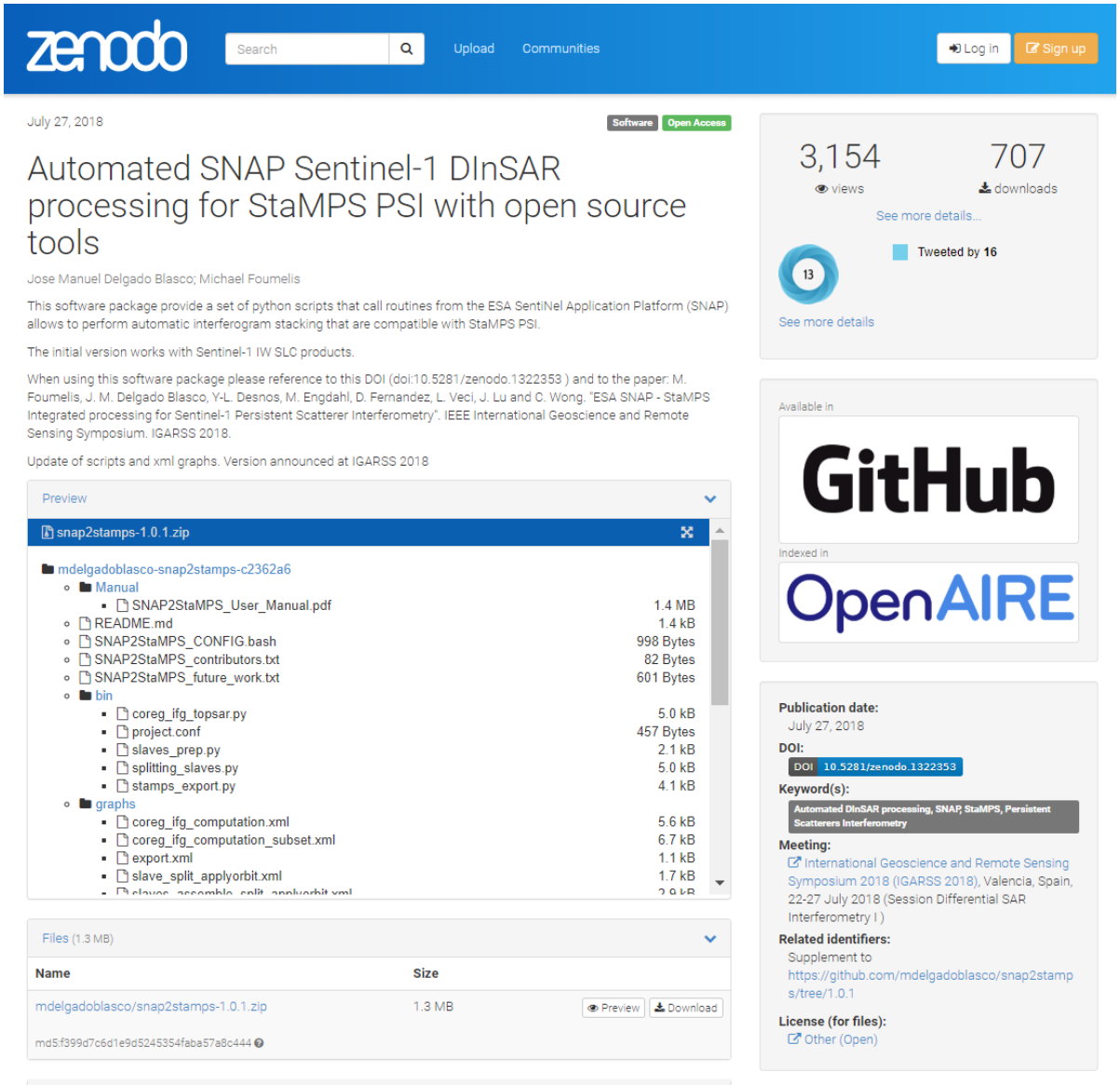
- Created as a response to the user community needs (SNAP Forum)
- Open source and available on Zenodo repository DOI 10.5281/zenodo.1308835
- Python scripts and pre-define xml graphs which uses SNAP to create stacks of interferograms compatible with StaMPS PSI
- Currently supports Sentinel-1 TOPSAR SLC data

Several
for runn

- Proj
- CPU
- Path
- Subs



snap2stamps software package | Zenodo DOI



zenodo

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July 27, 2018

Software Open Access

Automated SNAP Sentinel-1 DInSAR processing for StaMPS PSI with open source tools

Jose Manuel Delgado Blasco; Michael Foumelis

This software package provide a set of python scripts that call routines from the ESA SentiNel Application Platform (SNAP) allows to perform automatic interferogram stacking that are compatible with StaMPS PSI.

The initial version works with Sentinel-1 IW SLC products.

When using this software package please reference to this DOI (doi:10.5281/zenodo.1322353) and to the paper: M. Foumelis, J. M. Delgado Blasco, Y-L. Desnos, M. Engdahl, D. Fernandez, L. Veci, J. Lu and C. Wong. "ESA SNAP - StaMPS Integrated processing for Sentinel-1 Persistent Scatterer Interferometry". IEEE International Geoscience and Remote Sensing Symposium. IGARSS 2018.

Update of scripts and xml graphs. Version announced at IGARSS 2018

Preview

snap2stamps-1.0.1.zip

mdelgadoblasco-snap2stamps-c2362a6

Manual	
SNAP2StaMPS_User_Manual.pdf	1.4 MB
README.md	1.4 kB
SNAP2StaMPS_CONFIG.bash	998 Bytes
SNAP2StaMPS_contributors.txt	82 Bytes
SNAP2StaMPS_future_work.txt	601 Bytes
bin	
coreg_ifg_topsar.py	5.0 kB
project.conf	457 Bytes
slaves_prep.py	2.1 kB
splitting_slaves.py	5.0 kB
stamps_export.py	4.1 kB
graphs	
coreg_ifg_computation.xml	5.6 kB
coreg_ifg_computation_subset.xml	6.7 kB
export.xml	1.1 kB
slave_split_applyorbit.xml	1.7 kB

Files (1.3 MB)

Name	Size	
mdelgadoblasco/snap2stamps-1.0.1.zip	1.3 MB	Preview Download

md5:f399d7c6d1e9d5245354faba57a8c444

3,154 views

707 downloads

See more details...

Tweeted by 16

13

See more details

Available in

GitHub

Indexed in

OpenAIRE

Publication date:
July 27, 2018

DOI:
DOI 10.5281/zenodo.1322353

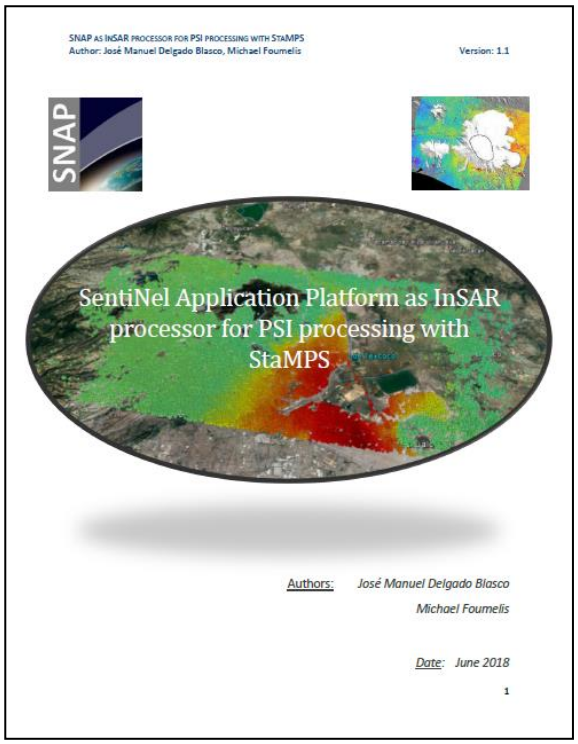
Keyword(s):
Automated DInSAR processing, SNAP, StaMPS, Persistent Scatterers Interferometry

Meeting:
International Geoscience and Remote Sensing Symposium 2018 (IGARSS 2018), Valencia, Spain, 22-27 July 2018 (Session Differential SAR Interferometry I)

Related identifiers:
Supplement to https://github.com/mdelgadoblasco/snap2stamps/tree/1.0.1

License (for files):
Other (Open)

snap2stamps | Documentation (User Manual)



Processing Steps:

1. Sort slave images in separated folders corresponding to their acquisition time.

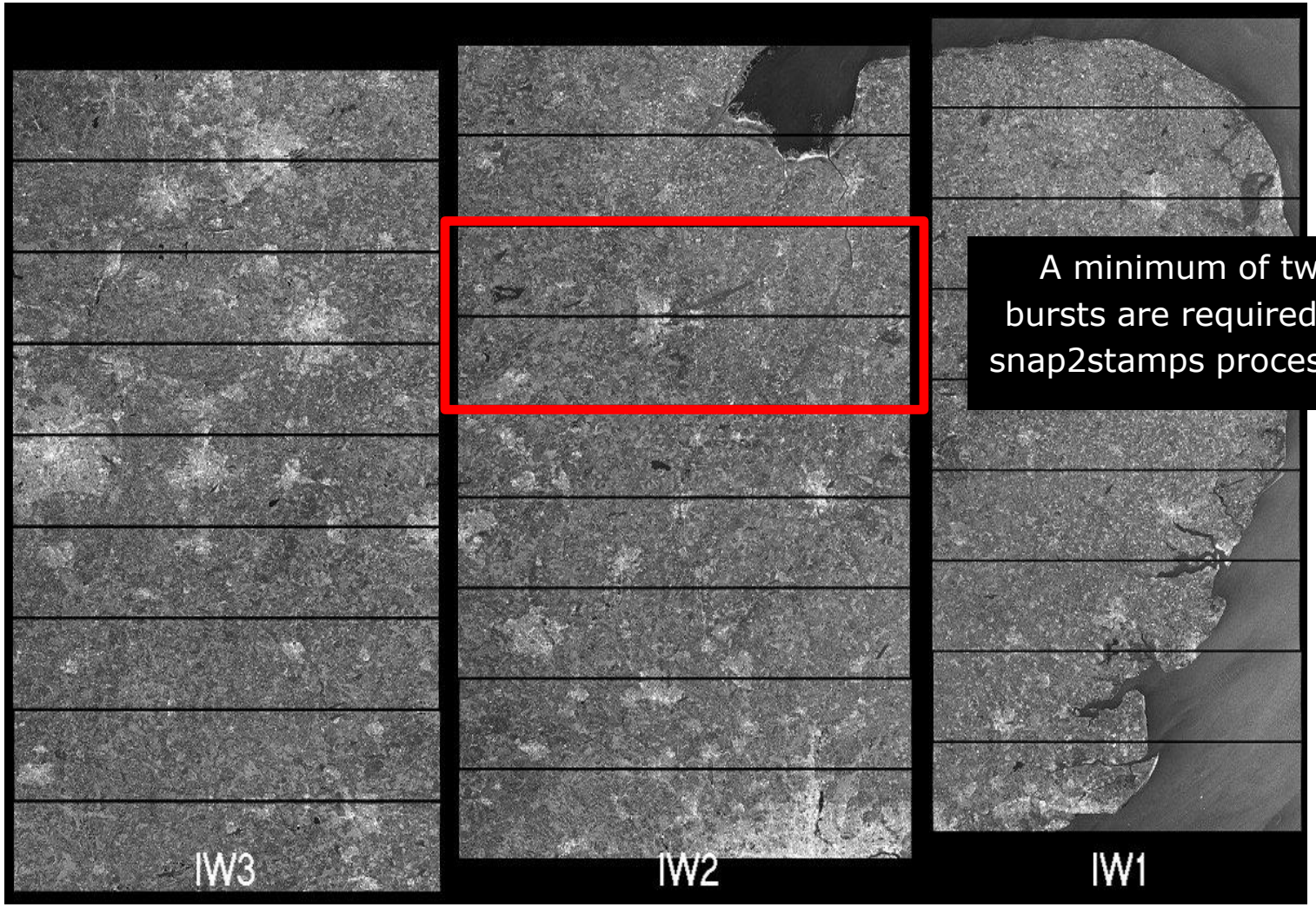
2. Slave splitting (incl. slice assembling, if needed) and updating orbits (Precise or Restituted).

3. Coregistration and interferogram generation per slave and subswath. A subset option using a bounding box is now available.

4. StaMPS export is done providing for each pair coregistered stack and interferogram generated StaMPS compatible products.

Foumelis, M., Delgado Blasco, J. M., Desnos, Y. L., Engdahl, M., Fernández, D., Veci, L. Lu, J. and Wong, C. **"SNAP - StaMPS Integrated processing for Sentinel-1 Persistent Scatterer Interferometry"**. In Geoscience and Remote Sensing Symposium (IGARSS), 2018 IEEE International, IEEE

snap2stamps | Master Scene Splitting



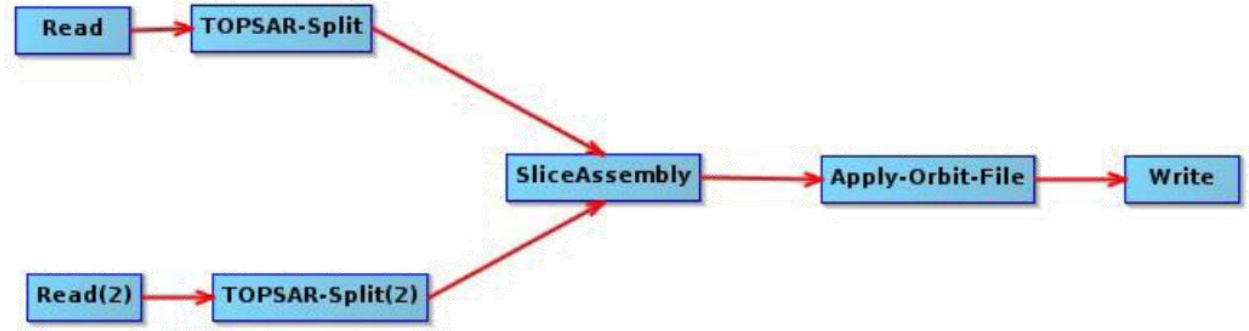
For 2-burst image approx. 2-3 min of processing time area needed per interferogram.
Exponential increase by adding more bursts.

snap2stamps | SNAP Processing Graphs 1/2

Image Splitting and Update of Orbits

* We suggest to proceed with master scene selection and sub-setting using SNAP GUI

master scene



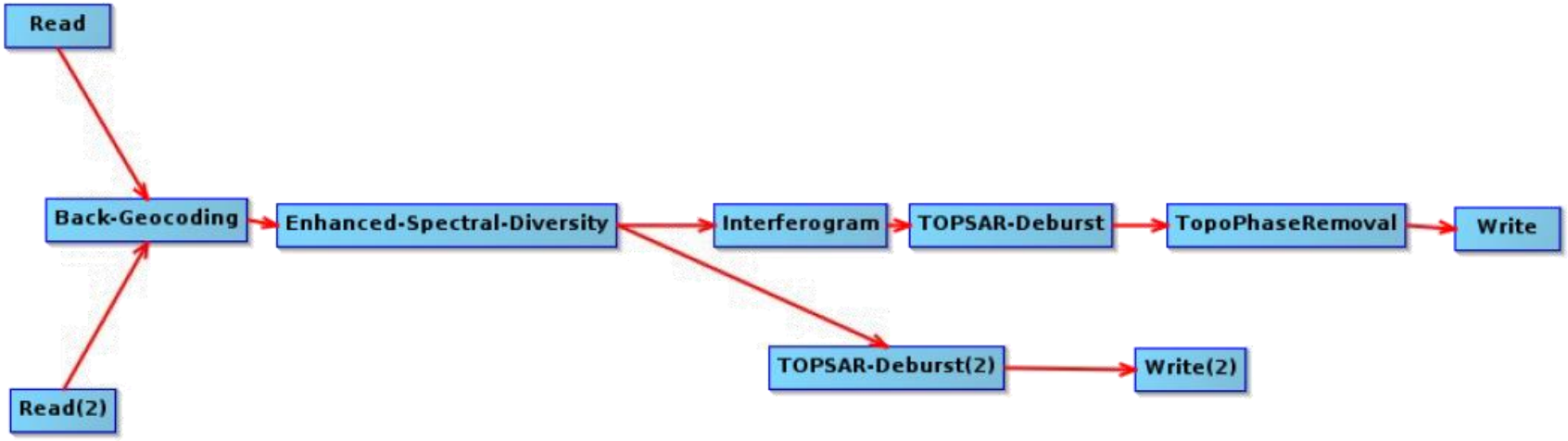
slave scenes

Auxiliary files as DEM and Orbit State Vectors are automatically downloaded by SNAP.

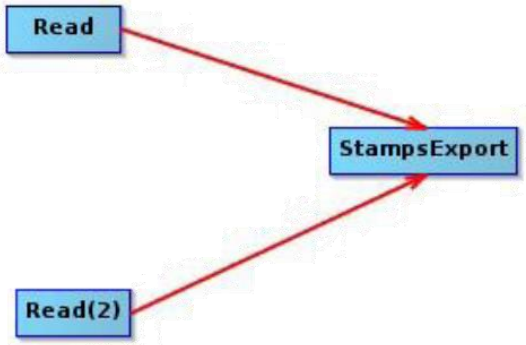
Subsetting over an AOI using a bounding box is supported in version 1.0.1

snap2stamps | SNAP Processing Graphs 2/2

TOPS Co-registration and Interferogram formation

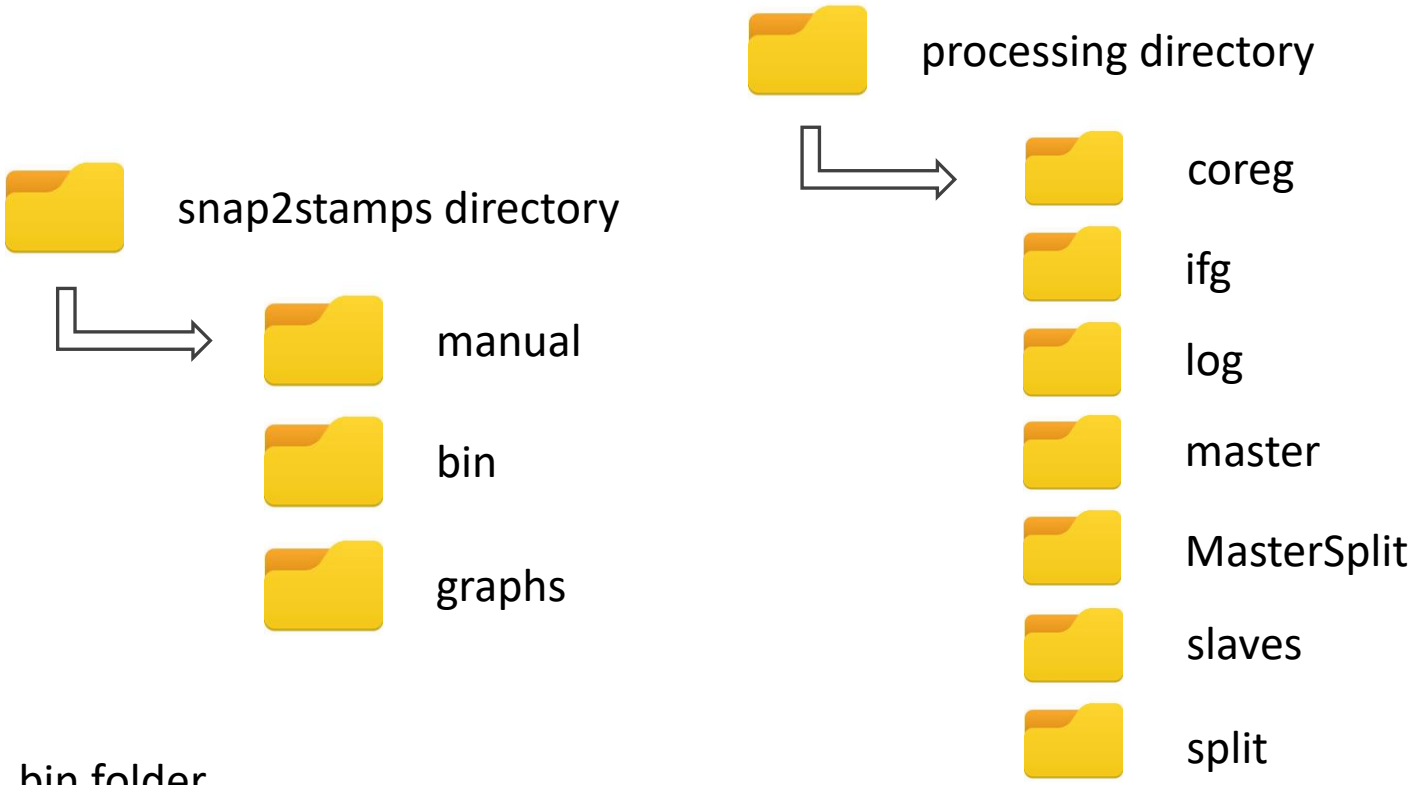


SNAP export to StaMPS format



Both amplitude coregistered master-slaves stack and interferograms, including heights and orthorectified latitude and longitude images are saved as output.

snap2stamps | Directory Structure



bin folder

- **project.conf** – file with parameters and paths needed for the processing
- **slaves_prep.py** – script for slave sortering in the expected folder structure
- **splitting_slaves_logging.py** – script for slave splitting (and assembling is needed) and orbit correction.
- **coreg_ifg_topsar.py** – script for master-slave coregistration and interferometric generation
- **stamps_export.py** – script for ouput data generation in StaMPS compatible format for PSI processing.

snap2stamps | Configuration File

```
[pi@CToolbox /application/workdir/Rome/] $
                                                cat project.conf
##### CONFIGURATION FILE ####
##############################
# PROJECT DEFINITION
PROJECTFOLDER=/application/workdir/PROC_dir
GRAPHSFOLDER=/application/graphs
##############################
# PROCESSING PARAMTERS
IW1=IW2
MASTER=/application/workdir/PROC_dir/master/S1A_IW_SLC__1SDV_20150402T155633_20150402T155700_022180_02662B_7085_split_Orb.dim
################################
# AOI BBOX DEFINITION
LONMIN=
NATMIN=
LONMAX=
LATMAX=
################################
# SNAP GPT
GPTBIN_PATH=/application/pi/snap/bin/gpt
################################
# COMPUTING RESOURCES TO EMPLOY
CPU=8
CACHE=16G
########################################
[pi@CToolbox /application/workdir/PROC_dir/] $
```

snap2stamps | Step-by-Step commands

Preparing slave folders

```
$ python slaves_prep.py project.conf
```

Requirements: Sentinel-1 data downloaded in zip format on the folder : /<PROJECTFOLDER>/slaves/

Slave splitting and apply orbit

```
$ python splitting_slaves.py project.conf
```

Note: current scripts support up to 2 slaves images with same acquisition day (for slice assembling) and only precise orbits are used.
In near future also restituted orbits will be supported.

Coregistration and Interferogram generation

```
$ python coreg_ifg_topsar.py project.conf
```

Note: SRTM1 arc second is used for both Backgeocoding and TopoPhaseRemoval computation. In the future more DEM will be supported via configuration file.

StaMPS export

```
$ python stamps_export.py project.conf
```

snap2stamps | Outputs

Parent directory

```
drwxrwxr-x 11 pi pi 4096 Okt  9 08:50 ./
drwxrwxr-x  8 pi pi 4096 Okt  8 23:53 ../
drwxrwxr-x  5 pi pi 4096 Okt  9 01:09 coreg/
drwxrwxr-x  2 pi pi 4096 Okt  8 23:58 graphs/
drwxrwxr-x  5 pi pi 4096 Okt  9 01:09 ifg/
drwxrwxr-x  6 pi pi 4096 Okt  9 08:52 INSAR_20190817/
drwxrwxr-x  2 pi pi 4096 Okt  9 08:50 logs/
drwxrwxr-x  2 pi pi 4096 Okt  8 23:35 master/
drwxrwxr-x  3 pi pi 4096 Okt  8 23:53 MasterSplit/
drwxrwxr-x  5 pi pi 4096 Okt  8 23:53 slaves/
drwxrwxr-x  5 pi pi 4096 Okt  9 00:29 split/
```

StaMPS processing directory

```
(base) pi@CToolbox-Foumelis:/application2/workdir/mdis/zip$ ll INSAR_20190817/
total 24
drwxrwxr-x  6 pi pi 4096 Okt  9 08:52 ./
drwxrwxr-x 11 pi pi 4096 Okt  9 08:50 ../
drwxrwxr-x  2 pi pi 4096 Okt  9 08:54 dem/
drwxrwxr-x  2 pi pi 4096 Okt  9 08:56 diff0/
drwxrwxr-x  2 pi pi 4096 Okt  9 08:52 geo/
drwxrwxr-x  2 pi pi 4096 Okt  9 08:56 rslc/
```

./rslc/yyyymmdd.rslc

Master SLC and a resampled SLC for every

./rslc/yyyymmdd.slc.par

SLC parameter file for the master scene

./diff0/yyyymmdd.diff

A single master interferogram for every slave image

./diff0/yyyymmdd.base

A baseline file for every interferogram pair

./geo/yyyymmdd dem.rdc

DEM in master RDC coordinates

./geo/yyyymmdd.lon & ./geo/yyyymmdd.lat

Longitude and latitude images for every pixel in the master RDC geometry

snap2stamps | Authors' Comments

- In the framework of snap2stamps development several bugs on SNAP v5 were identified and corrected (other issues to be addressed in future versions).
- SNAP from v6 onwards is able to provide interferogram stacks compatible with StaMPS PSI.
- End-to-end PSI processing using SNAP & StaMPS PSI showed consistent results with already published studies.
- The open and free snap2stamps software package provides the community with an easy way to automatize the single master bulk DInSAR processing.
- Further developments shall be done to fulfill other user community needs.

snap2stamps | Future Updates

- Add more sensor support, specifically for STRIMAP SAR data
- External DEM support configurable via python scripts. Already possible by directly modifying provided graphs.
- Applied Orbit configurable via python scripts. Already possible by directly modifying provided graphs.
- Include script for downloading orbit files directly from ESA server to avoid problem with 3rd party dependencies.
- Include script for Sentinel-1 data automatic download via the Copernicus Open Data Hub and PEPS (registration needed by the user).
- Multi sub-swath integration (sub-swath merging). Current scripts support single sub-swath interferometric processing.
- Prepare scripts for StaMPS SBAS (dependency on SNAP development)

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snap2stamps python scripts

Demo

- ESA Sentinel Application Platform | SNAP
- SNAP Interferometric Processing | Manual vs Batch mode
- snap2stamps | Python Scripts
- StaMPS PSI Processing Scheme
- SNAP-StaMPS PSI service on GEP

StaMPS/MTI Software

Since July 2018 (version announced at IGARSS 2018) the software is distributed via GiHub repository

Why GitHub? Enterprise Explore Marketplace Pricing Search Sign in Sign up

dbekaert / StaMPS

Watch 37 Star 64 Fork 34

Code Issues 6 Pull requests 1 Projects 0 Security Insights

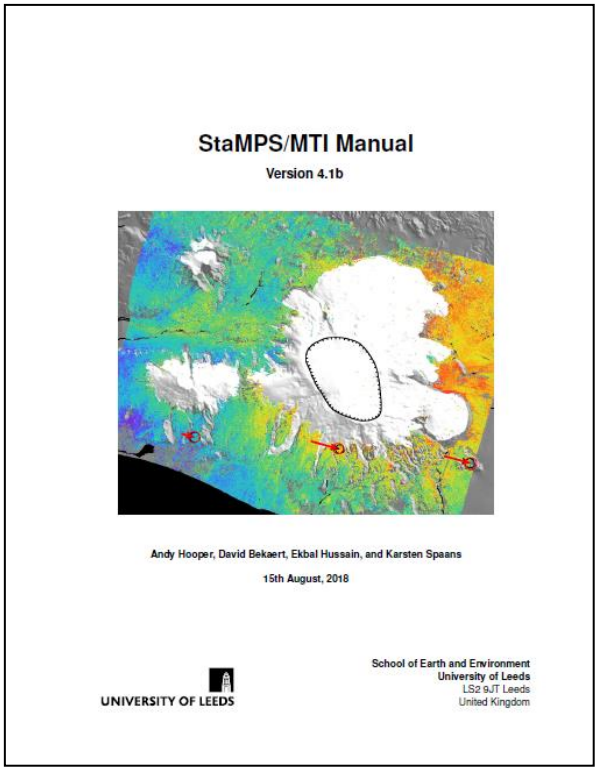
Stanford Method for Persistent Scatterers http://homepages.see.leeds.ac.uk/~ear...

495 commits 1 branch 1 release 10 contributors GPL-3.0

Branch: master New pull request Find file Clone or download

dbekaert Merge pull request #17 from scivision/master ... Latest commit c159eb8 on Sep 12

DORIS_SCR	update the files to be executables and remove the dos hidden feature ...	4 years ago
Manual	Update StaMPS_Manual.bbl	last year
ROI_PAC_SCR	adding missing script make_raw_ers.pl	8 years ago
bin	add mt_prep_snap	last year
matlab	Add files via upload	4 months ago
src	put files at right location	last year
.gitattributes	metadata	last month
INSTALL	remove duplicate StaMPS from directory structure	10 years ago
LICENSE	Create LICENSE	2 years ago
README.md	Update README.md	6 months ago
StaMPS_CONFIG.bash	APS plots and other stuff	6 years ago
StaMPS_CONFIG.tcsh	APS plots and other stuff	6 years ago
snaphu.conf	remove duplicate StaMPS from directory structure	10 years ago



Hooper, A., A multi-temporal InSAR method incorporating both persistent scatterer and small baseline approaches, Geophys. Res. Lett., 35, L16,302, doi:10.1029/2008GL03465, 2008.

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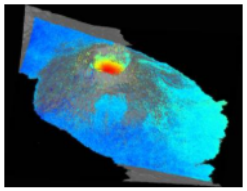
StaMPS/MTI | Development History



STAMPS

A software package to extract ground displacements from time series of synthetic aperture radar (SAR) acquisitions.

The original version was developed at Stanford University but subsequent development has taken place at the University of Iceland, Delft University of Technology and the University of Leeds.

The package incorporates persistent scatterer and small baseline methods plus an option to combine both approaches.

Andy Hooper
School of Earth and Environment
University of Leeds
Leeds LS2 9JT

15th August, 2018

A new beta release version of StaMPS/MTI (version 4.1b1) is available from Github (extract with `tar -zxvf`).

The manual of StaMPS/MTI (version 4.1b1) is available as a pdf file

12th September, 2013

A new beta release version of StaMPS/MTI (version 3.3b1) is available as StaMPS_v3.3b1.tar.gz (extract with `tar -zxvf`).

The manual of StaMPS/MTI (version 3.3b1) is available as a pdf file

24th November, 2010

A new release version of StaMPS/MTI (version 3.2) is available as a .tar.gz file* (extract with `tar -zxvf`).

* StaMPS/MTI version 3.2 is updated to version 3.2.1 on 26th November, 2010.

3rd March, 2010

A new beta version of StaMPS/MTI (version 3.2b4) is available as a .tar.gz file (extract with `tar -zxvf`).

9th December, 2009

A new beta version of StaMPS/MTI (version 3.2b3) is available as a .tar.gz file (extract with `tar -zxvf`). An updated manual is included in the zip file.

15th July, 2009

StaMPS/MTI (version 3.1) is available as a .tar.gz file (uncompress with `gunzip`, then extract with `tar -xvf`). This software may be downloaded freely for non-commercial applications.

If you use this code, please join the user group MAINSAR to be informed of any updates/issues. Also, please post any questions or advice to this group rather than directly to me.

Andy Hooper

Ingestion of SNAP outputs into StaMPS

In the **INSAR_masterdate** directory run **mt_prep_snap** command

For example:

mt_prep_snap 0.4 3 3 50 200

where

0.4 = amplitude dispersion (0.4-0.42 are reasonable values)

3 = number of patches in range (default 1)

3 = number of patches in azimuth, (default 1)

50 = overlapping pixels between patches in range (default 50)

200 = overlapping pixels between patches in azimuth (default 200)

Ingestion of SNAP outputs into StaMPS

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Preparation for StaMPS PSI inputs: mt_prep_snap command

```
$ mt_prep_snap 20150419 /application/workdir/Rome/export/PSI/INSAR_20150419 0.35 3 3
```

```
pi@CToolbox:/application/workdir/Rome/export/PSI/INSAR_20150419$ ls -l
drwxrwxr-x 22 pi pi  4096 Jun 21 20:41 ./
drwxrwxr-x  3 pi pi  4096 Jun 21 20:22 ../
-rw-rw-r--  1 pi pi  6880 Jun 21 20:22 calamp.in
-rw-rw-r--  1 pi pi  7558 Jun 21 20:41 calamp.out
drwxrwxr-x  2 pi pi  4096 Jun 21 15:25 dem/
drwxrwxr-x  2 pi pi 20480 Jun 21 17:31 diff0/
drwxrwxr-x  2 pi pi  4096 Jun 21 15:25 geo/
-rw-rw-r--  1 pi pi     5 Jun 21 20:22 len.txt
drwxrwxr-x  2 pi pi  4096 Jun 21 20:46 PATCH_1/
drwxrwxr-x  2 pi pi  4096 Jun 21 20:59 PATCH_2/
drwxrwxr-x  2 pi pi  4096 Jun 21 21:22 PATCH_3/
drwxrwxr-x  2 pi pi  4096 Jun 21 21:41 PATCH_4/
drwxrwxr-x  2 pi pi  4096 Jun 21 22:01 PATCH_5/
drwxrwxr-x  2 pi pi  4096 Jun 21 22:19 PATCH_6/
drwxrwxr-x  2 pi pi  4096 Jun 21 22:40 PATCH_7/
drwxrwxr-x  2 pi pi  4096 Jun 21 23:00 PATCH_8/
drwxrwxr-x  2 pi pi  4096 Jun 21 23:20 PATCH_9/
-rw-rw-r--  1 pi pi   135 Jun 21 20:41 patch.list
-rw-rw-r--  1 pi pi     6 Jun 21 20:22 processor.txt
-rw-rw-r--  1 pi pi    89 Jun 21 20:41 pscdem.in
-rw-rw-r--  1 pi pi   162 Jun 21 20:41 psclonlat.in
-rw-rw-r--  1 pi pi  7656 Jun 21 20:41 pscphase.in
-rw-rw-r--  1 pi pi    84 Jun 21 20:22 rsc.txt
drwxrwxr-x  2 pi pi 12288 Jun 21 17:31 rslc/
-rw-rw-r--  1 pi pi  7568 Jun 21 20:41 selpsc.in
-rw-rw-r--  1 pi pi     6 Jun 21 20:22 width.txt
```

StaMPS Processing Parameters

The parameters that control the processing can be viewed in matlab

>> getparm

Modify any parameters from the default

>> setparm('param_name', param_value)

Setting param_value to nan resets the parameter to the default value.

Commands for running StaMPS processing with or without APS correction (step 8)

>> stamps(1,7)

or with APS

>> stamps(1,8)

```
                  Created: '05-May-2018'
               clap_alpha: 1
                clap_beta: 0.3000
clap_low_pass_wavelength: 800
                clap_win: 32
            density_rand: 1
          drop_ifg_index: []
        filter_grid_size: 50
        filter_weighting: 'P-square'
gamma_change_convergence: 1.0000e-04
    gamma_max_iterations: 25
      gamma_stdev_reject: 0
                 heading: 350.0375
       insar_processor: 'gamma'
                  lambda: 0.0555
          lonlat_offset: [0 0]
           max_topo_err: 15
     merge_resample_size: 20
      merge_standard_dev: 1
                 n_cores: 8
           percent_rand: 1
               platform: 'SENTINEL-1A'
     plot_color_scheme: 'inflation'
      plot_dem_posting: 90
   plot_pixels_scatterer: 3
     plot_scatterer_size: 120
    quick_est_gamma_flag: 'y'
       ref_centre_lonlat: []
                 ref_lat: [-Inf Inf]
                 ref_lon: [-Inf Inf]
              ref_radius: 20
            ref_velocity: 0
             scla_deramp: 'n'
        scla_drop_index: []
            scla_method: 'L2'
         scn_deramp_ifg: []
        scn_kriging_flag: 'n'
            scn_time_win: 120
          scn_wavelength: 100
           select_method: 'DENSITY'
  select_reest_gamma_flag: 'y'
          shade_rel_angle: [90 45]
                 slc_osf: 1
      small_baseline_flag: 'n'
              subtr_tropo: 'y'
            tropo_method: 'a_l'
            unwrap_alpha: 8
       unwrap_gold_alpha: 0.8000
       unwrap_gold_n_win: 32
        unwrap_grid_size: 200
  unwrap_hold_good_values: 'n'
     unwrap_la_error_flag: 'y'
           unwrap_method: '3D_NEW'
      unwrap_patch_phase: 'n'
    unwrap_prefilter_flag: 'y'
unwrap_spatial_cost_func_flag: 'n'
          unwrap_time_win: 120
           weed_max_noise: Inf
        weed_neighbours: 'n'
       weed_standard_dev: 1
           weed_time_win: 120
```

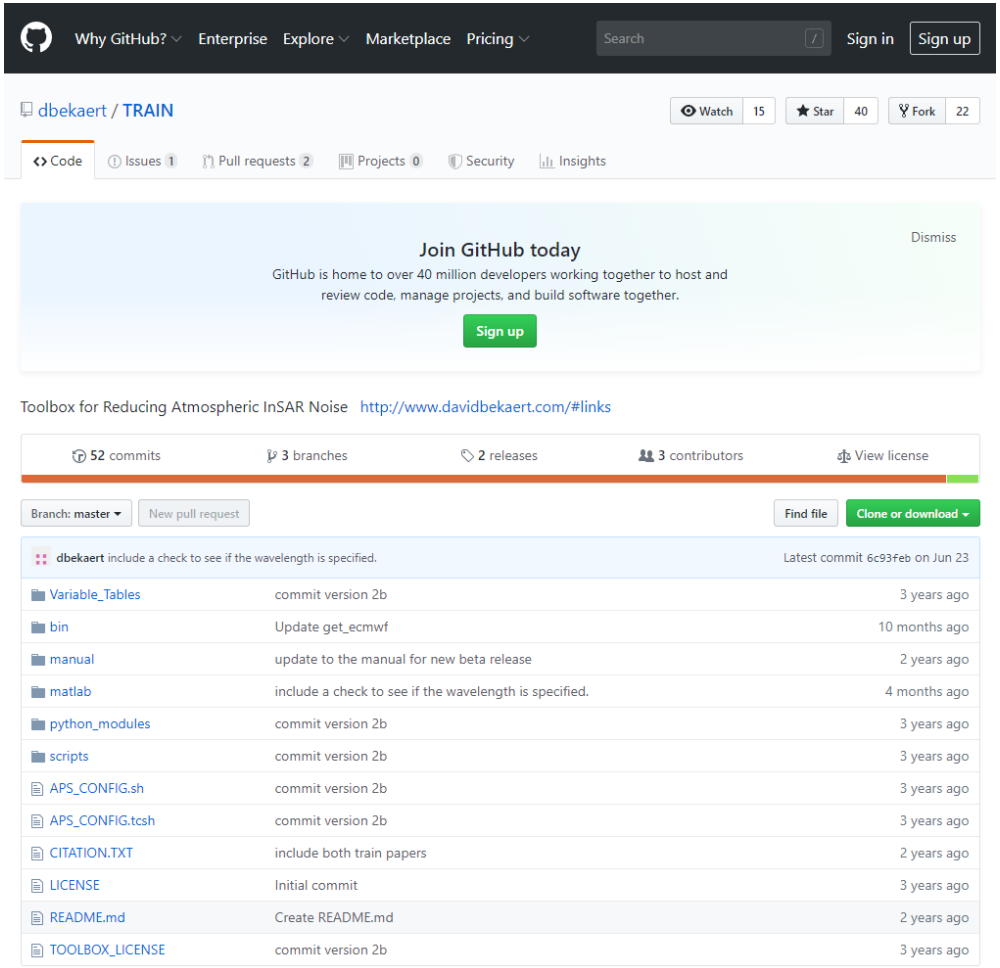
No iterative improvement of results for GEP implementation

TRAIN - Toolbox for Reducing Atmospheric InSAR Noise

The Toolbox for Reducing Atmospheric InSAR Noise – TRAIN – is developed in an effort to include current state of the art tropospheric correction methods into the default InSAR processing chain. Initial development was performed at the University of Leeds.

TRAIN toolbox is integrated in the default processing chain of StaMPS.

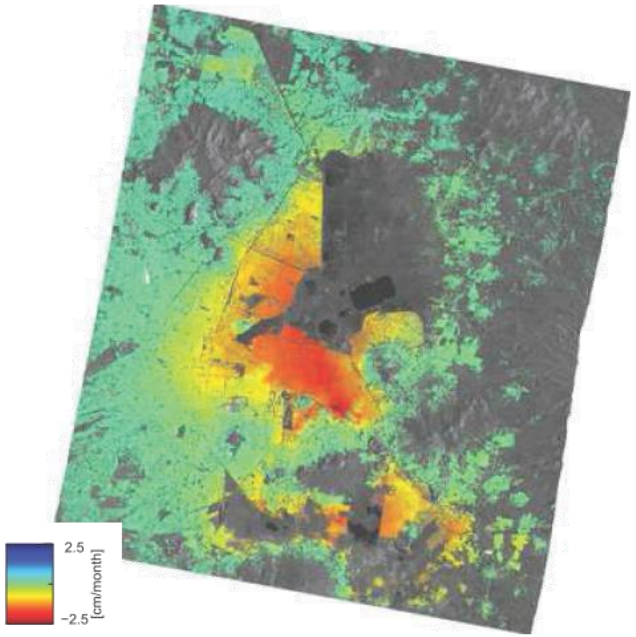
Spectrometer - MERIS (ENVISAT data) & MODIS
Weather model - ERA-I, MERRA, MERRA-2, GACOS
Weather Research and Forecasting Model (WRF)
Power-law correction for tropospheric delays
Linear phase-topography correction



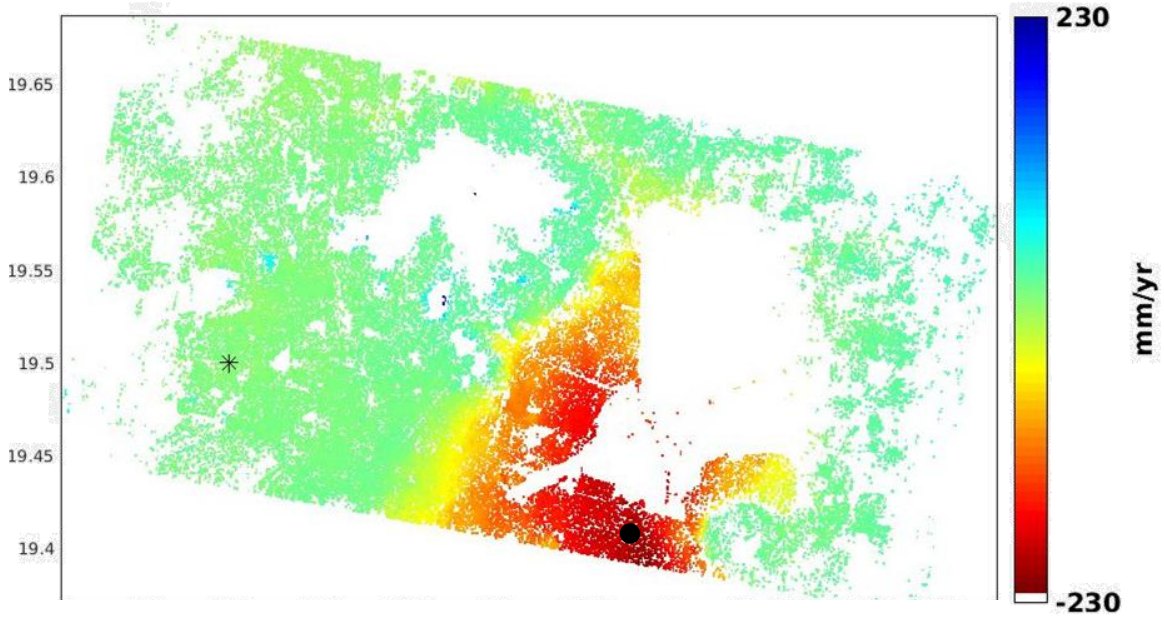
Bekaert, D.P.S., Walters, R.J., Wright, T.J., Hooper, A.J., and Parker, D.J. (2015c), Statistical comparison of InSAR tropospheric correction techniques, Remote Sensing of Environment, doi: 10.1016/j.rse.2015.08.035

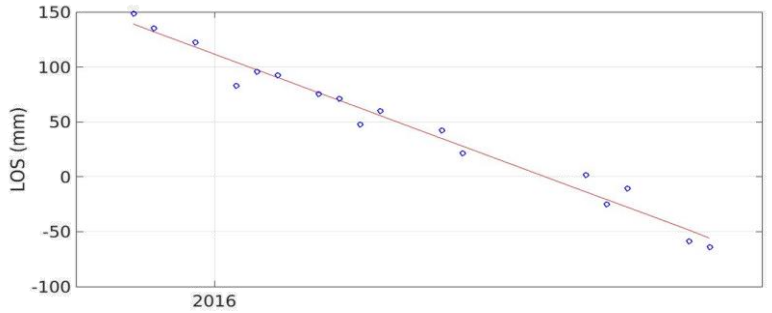
SNAP-StaMPS vs ESA InSARap project | Mexico City

PSI Sentinel-1 results over pilot site of Mexico City obtained with the DLR-HR TAXI PSI processor



SNAP-StaMPS PSI processing



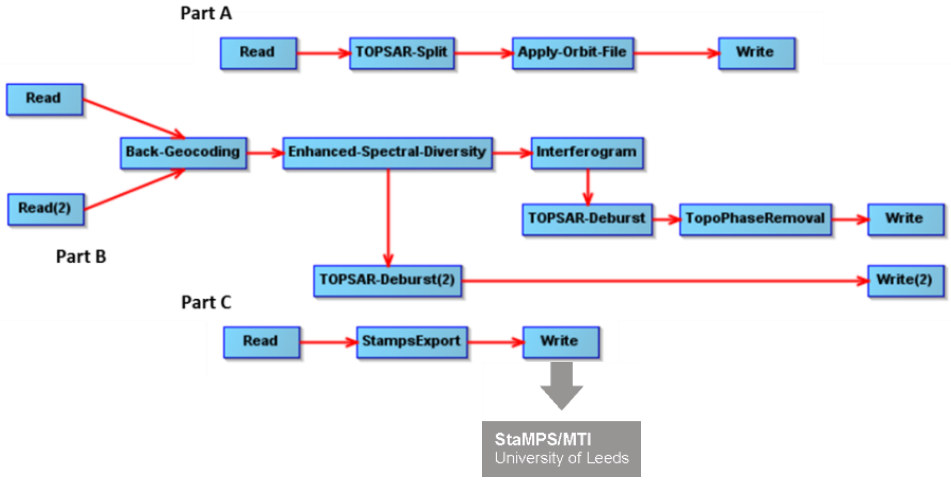


ESA InSARap project

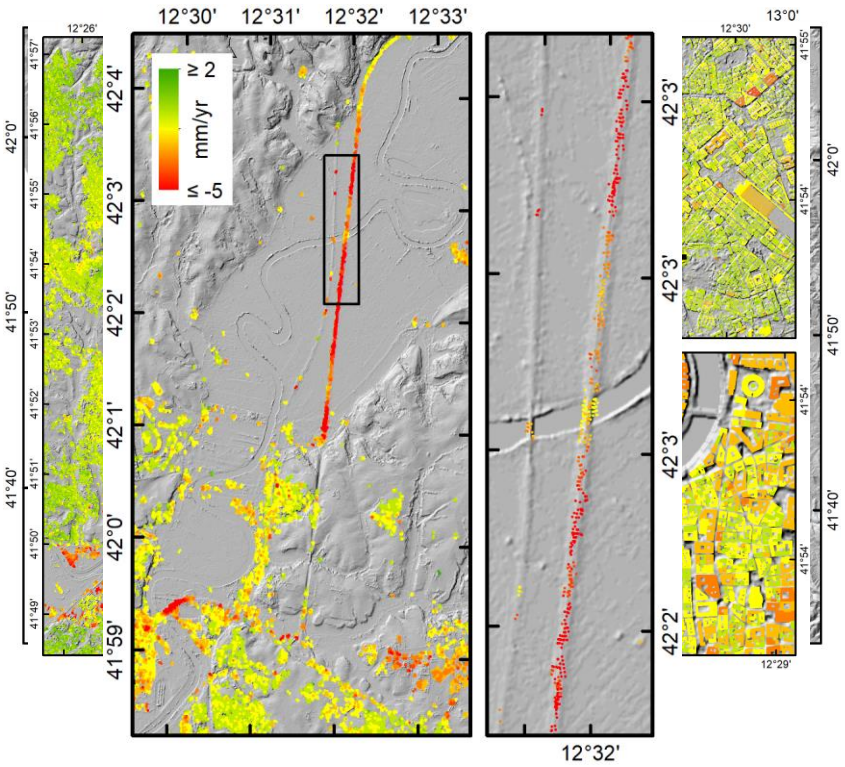
Nannini, M., Prats–Iraola, P., Scheiber, R., Yague–Martinez, N., Minati, F., Vecchioli, F., Costantini M., Borgstrom, S., De Martino, P., Siniscalchi, V., Walter, T., Foumelis, M. & Desnos, Y-L., 2016. Sentinel-1 mission: results of the InSARap project. 11th European Conference on Synthetic Aperture Radar (EuSAR 2016), Hamburg, Germany, 6-9 June.

SNAP-StaMPS integrated Sentinel-1 PSI | Rome

ESA SeNtinel Application Platform SNAP
Graph Builder Processing Chains



Sentinel-1 vertical displacement rates



Contains modified Copernicus Sentinel data (2018)

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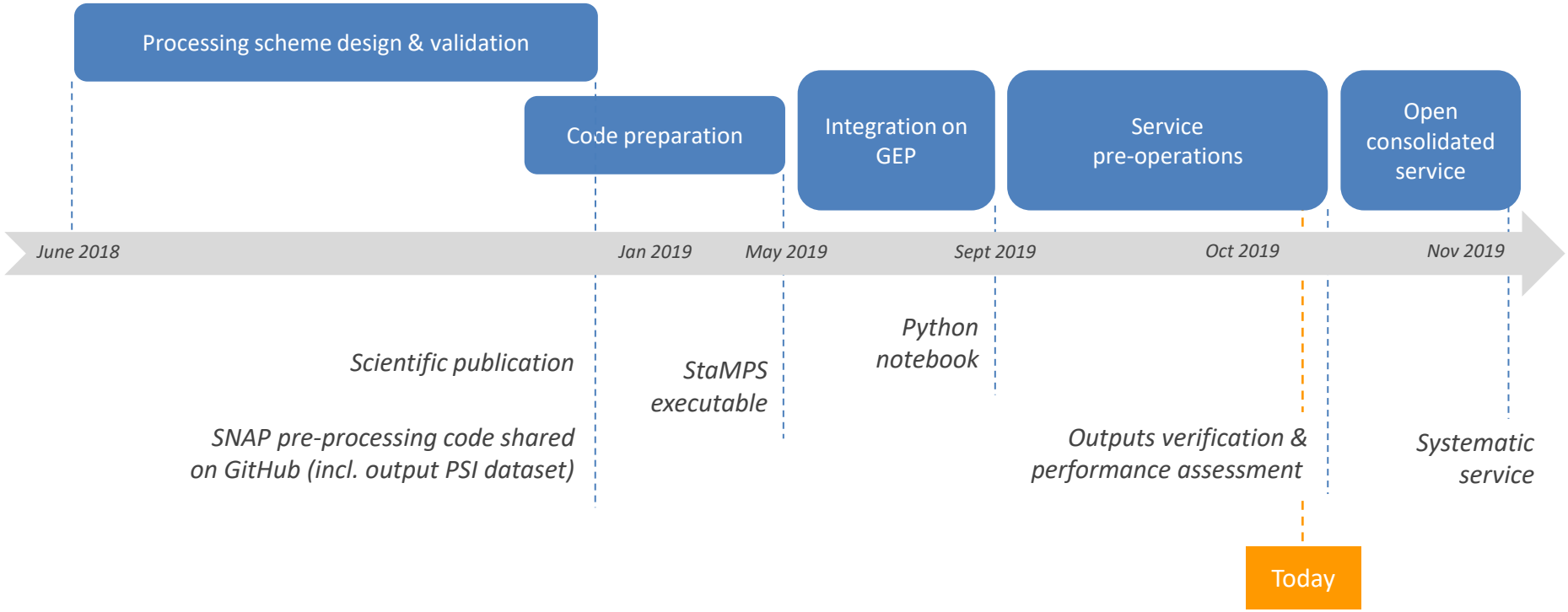
StaMPS PSI Processing Scheme

Demo

- ESA Sentinel Application Platform | SNAP
- SNAP Interferometric Processing | Manual vs Batch mode
- snap2stamps | Python Scripts
- StaMPS PSI Processing Scheme
- SNAP-StaMPS PSI service on GEP

SNAP-StaMPS PSI Service
Timeline of GEP Integration



Want to apply for the GEP Early Adopters Programme?

contact@geohazards-tep.eu

Sentinel-1 PSI with SNAP-StaMPS on GEP

It’s a two step process.

The first consists in setting-up a data processing pipeline to generate the interferogram stack:

- You select a stack of Sentinel-1 SLC with the same orbit
- You select the swath(s)
- You select a tag for the stack
- The data pipeline generates a set of data items

In the second step the interferogram stack is channeled to the PSI pipeline for SNAP-StaMPS PSI time series analysis.

Sentinel-1 PSI with SNAP-StaMPS on GEP

The goal is to create data processing pipelines to:

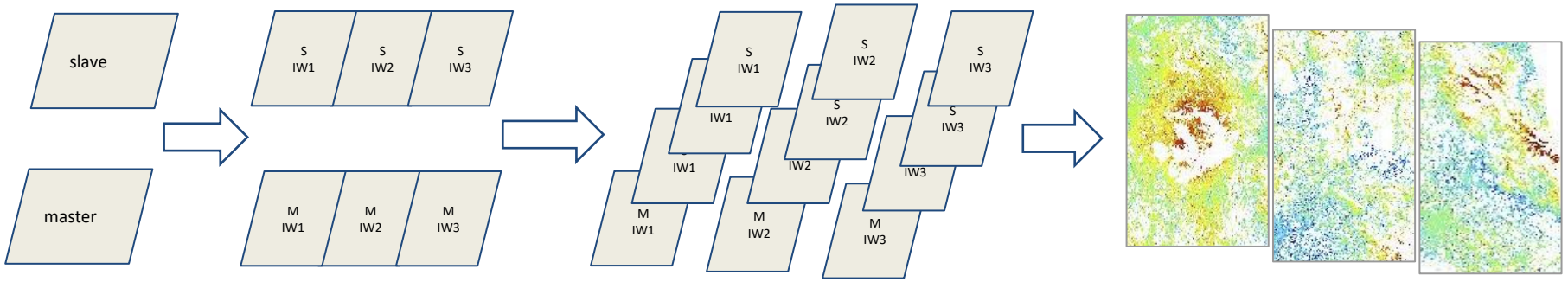
- Generate stacks of interferograms derived from Sentinel-1 SLC data
- Generate PSI time series with StaMPS out of those interferograms stacks

Interferograms stack data processing pipeline

For each slave paired with a defined master, the data processing pipeline generates one processing request per swath.

PSI processing pipeline

For each swath stack of interferograms, the data processing pipeline triggers a StaMPS PSI processing request



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SNAP-StaMPS PSI | Processing Modes on GEP

Systematic processing

- Systematically generate stacks of interferograms derived from Sentinel-1 SLC data
- Automatically generate PS time-series with StaMPS out of those interferograms stacks when certain conditions are reached (e.g. size of the stack

On-demand processing

- Via Geobrowser or API, create stack of interferograms with a defined list of Sentinel-1 SLC products
- Wait for it's automatic production
- Via Geobrowser or API, select a stack of interferograms and generate PS time-series with StaMPS

Advanced usage

- Via Jupyter Notebooks or scripting, select a stack of interferograms, do its stage-in and do the StaMPS processing steps interactively allowing the incremental processing and check on intermediate data

GEP SNAP-StaMPS PSI service | Outputs

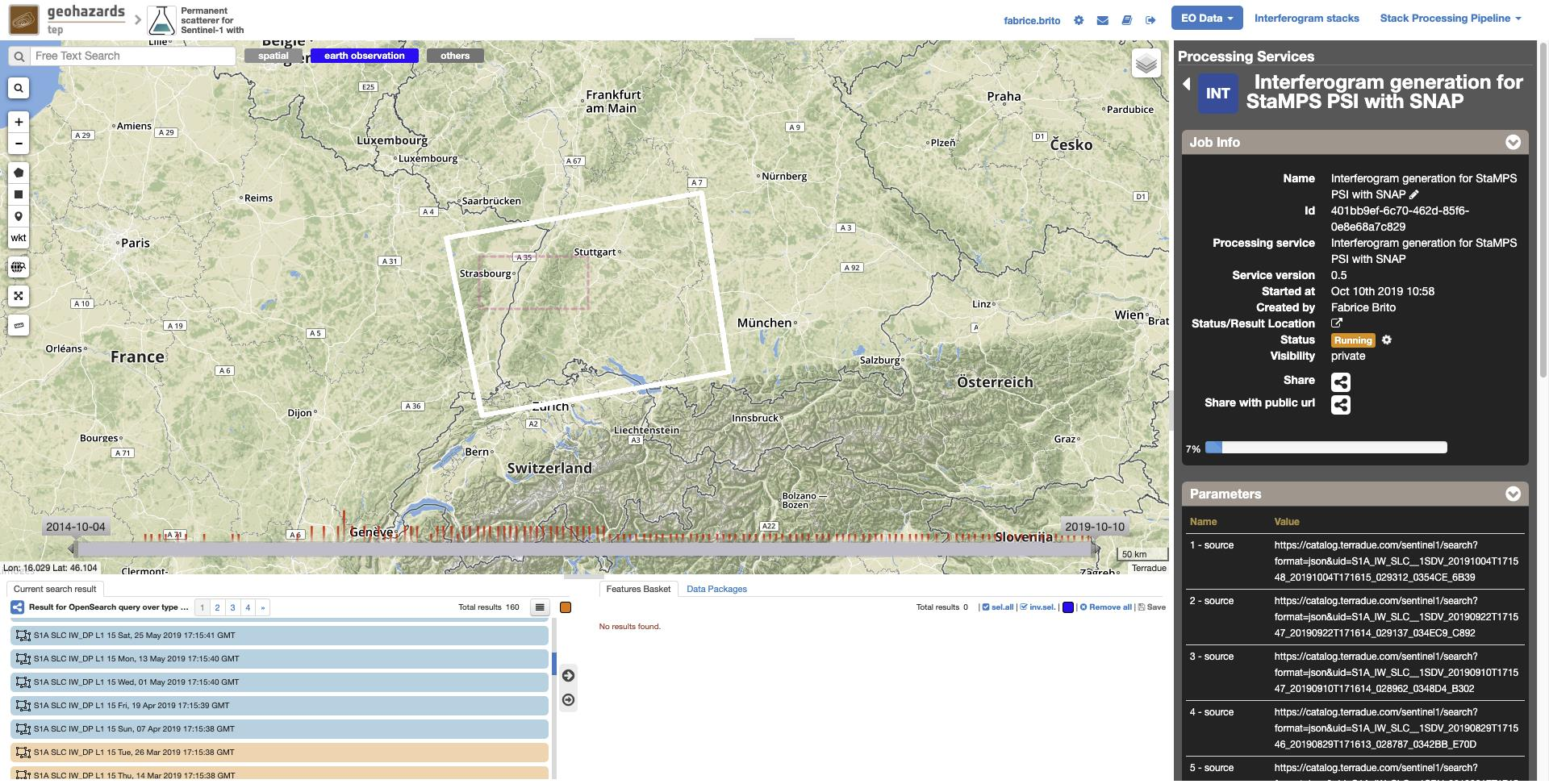
The service outputs correspond to the generic outputs of StaMPS, which is a set of files in ASCII format, for the estimated velocities, corresponding uncertainties and the actual displacement time series.

ps_mean_v.xy (longitude, latitude, mean velocity deformation information)
ps_data.xy (longitude, latitude, mean_v, mean_v_std, dem height, dem_error, inc_angle
ps_u-dm.1.xy : longitude, latitude, phase minus dem error and master aps in mm
ps_u-dm.N.xy, with N equal of each interferogram

Default corrections applied include DEM error and master APS (v-dm), while atmospheric screen correction is optional.

Outputs at reduced spatial resolution of 100m

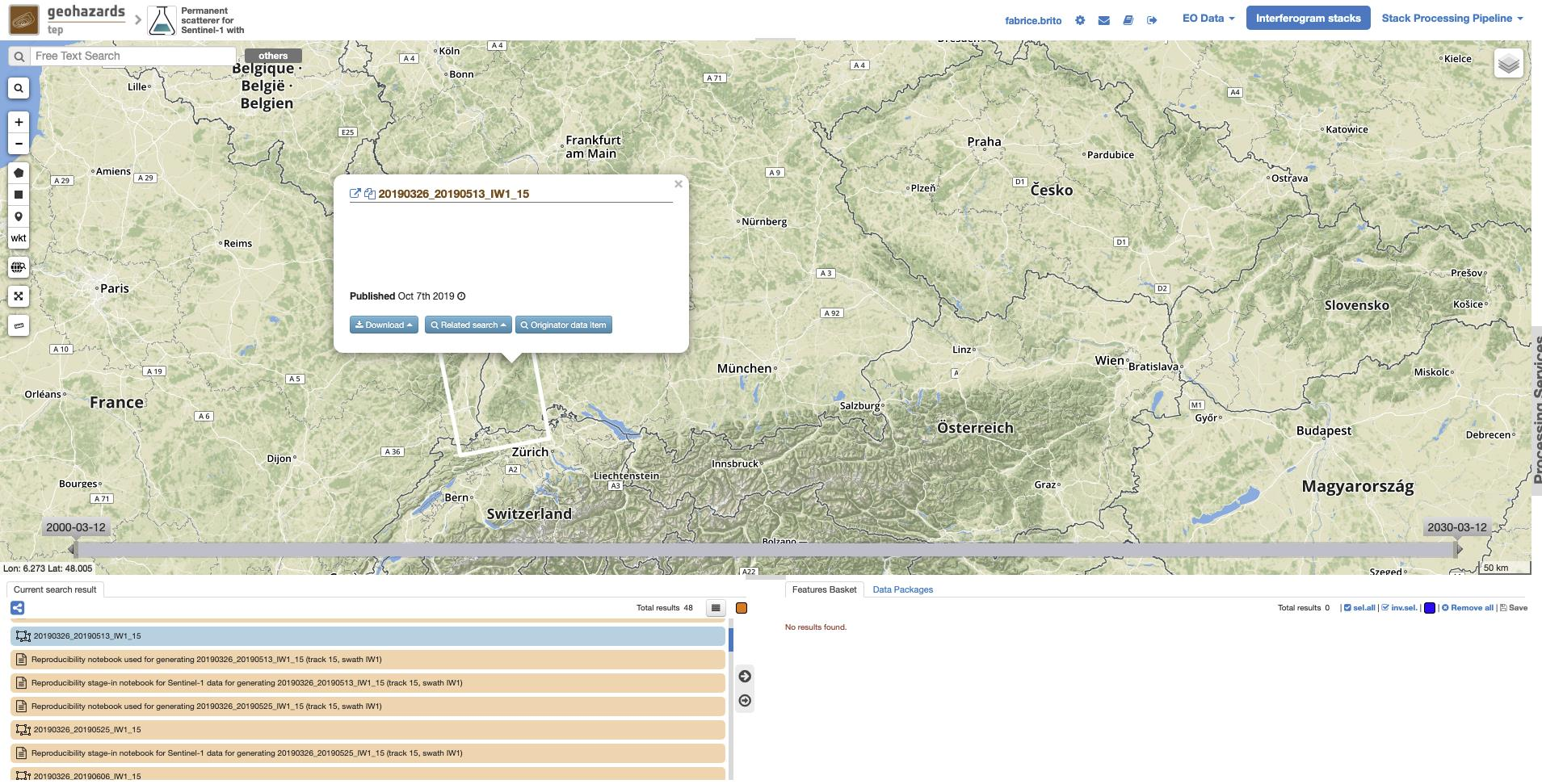
SNAP-StaMPS PSI | GEP User Interface (on-going development)



geohazards tep

Géosciences pour une Terre durable brgm

SNAP-StaMPS PSI | GEP User Interface (on-going development)



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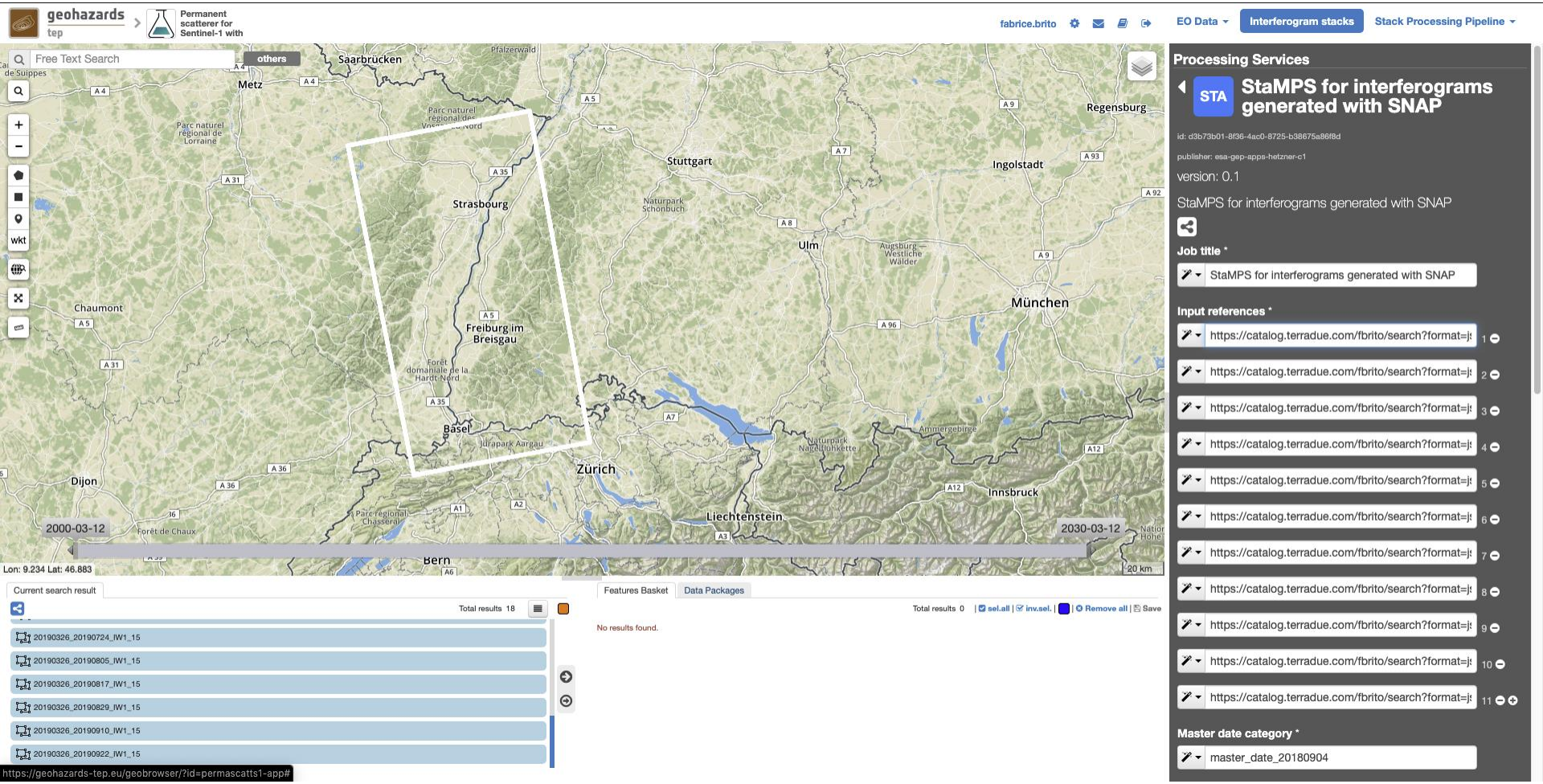
SNAP-StaMPS PSI | GEP User Interface (on-going development)



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SNAP-StaMPS service on GEP

Demo

Thank you