

# → 7th ADVANCED TRAINING COURSE ON LAND REMOTE SENSING

4–9 September 2017 | Szent István University | Gödöllő, Hungary

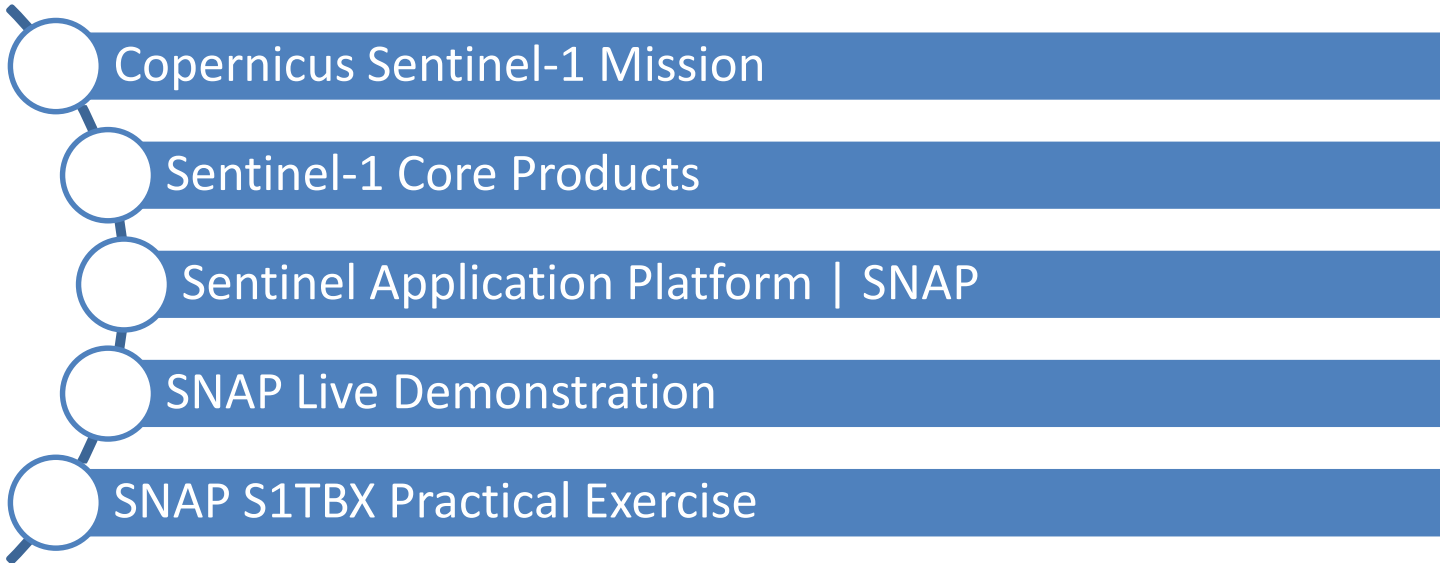




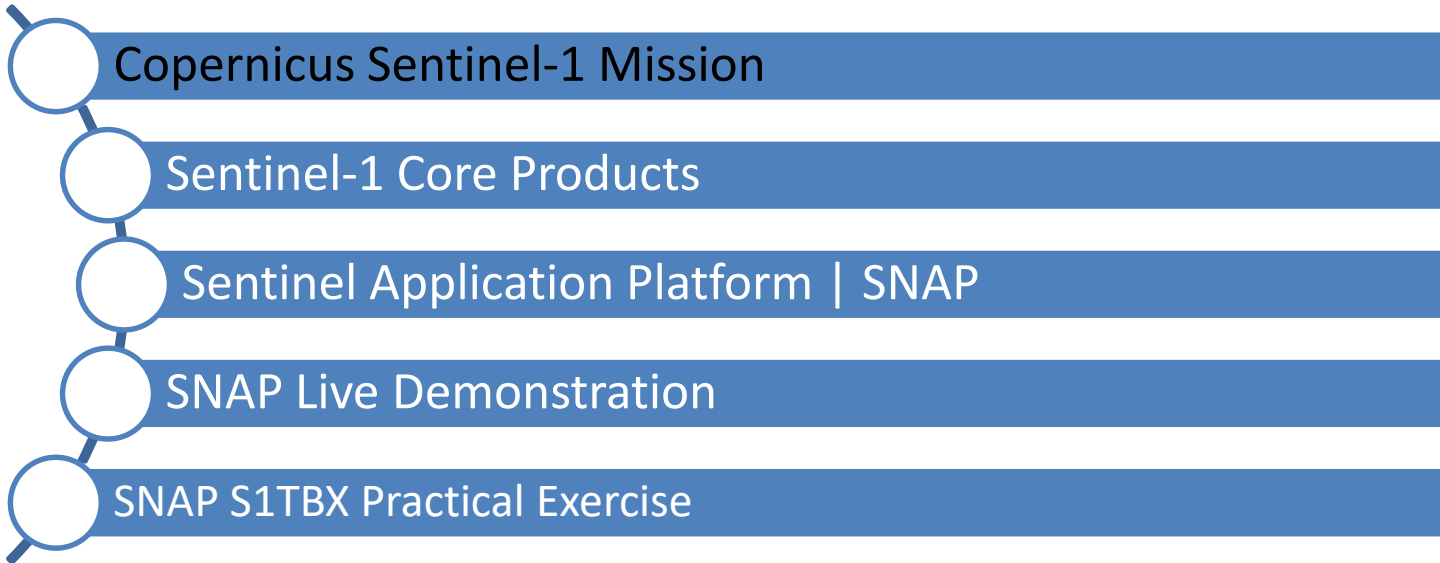
# ESA SNAP SENTINEL-1 TOOLBOX

Michael Foumelis  
French Geological Survey (BRGM), France

# Presentation Overview

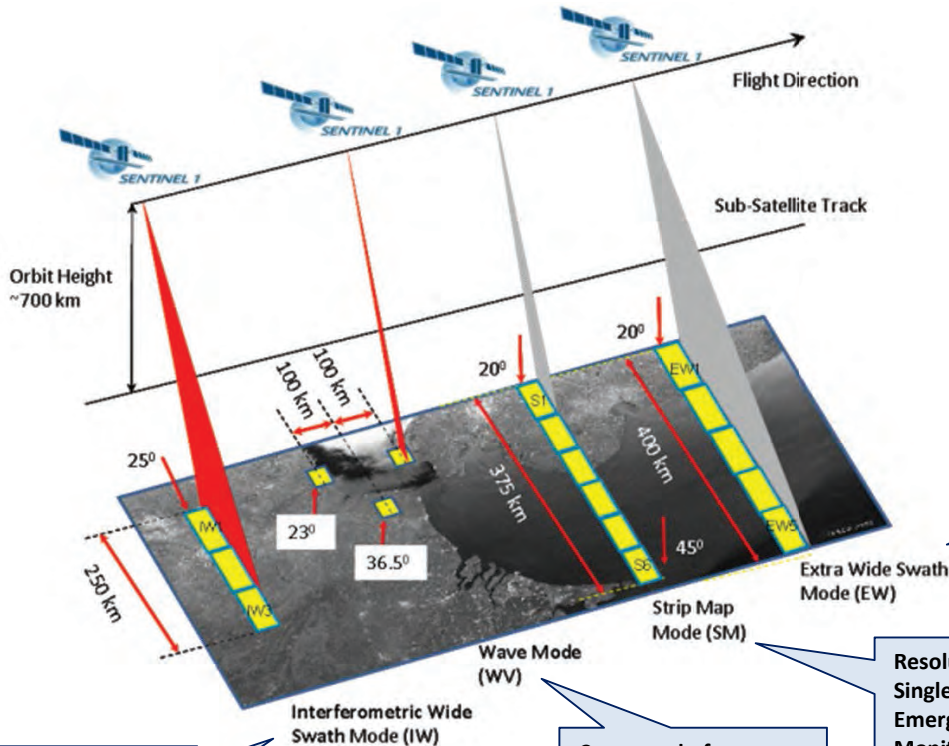


# Presentation Overview





# Sentinel-1 Mission Profile



S-1 SAR can be operated in 4 exclusive imaging modes with different resolution and coverages.

Resolution: 20 x 40m  
Single and dual Polarisation  
Polar areas, and ocean relevant areas  
Can be used for interferometry

Resolution: 5m x 5m  
Single and dual Polarisation  
Emergency Services-Disaster  
Monitoring

Resolution: 5m x 20m  
Single and dual Polarisation  
Pre-defined mode over Land

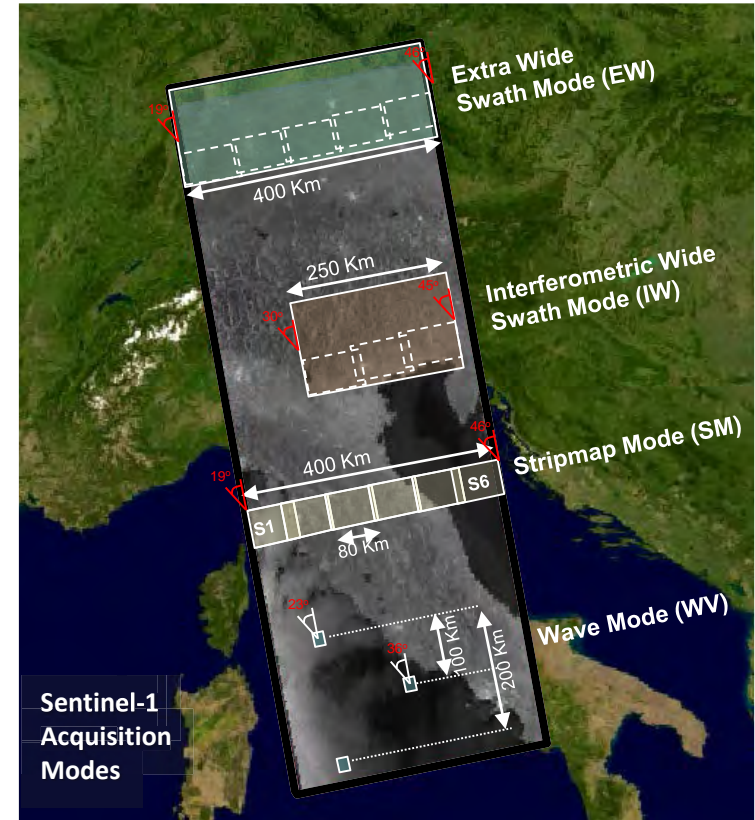
Composed of  
Stripmap imagettes  
Single polarisation  
Pre-defined mode  
over open oceans

# Sentinel-1 Acquisition Modes

For all of these operating modes, the same family of S-1 products is available to users from the S-1 Core PDGS.

Mode Rate	SAR Mode
High Bit Rate (HBR)	IW
	EW
	SM (S1 -> S6)
Low Bit Rate (LBR)	WV

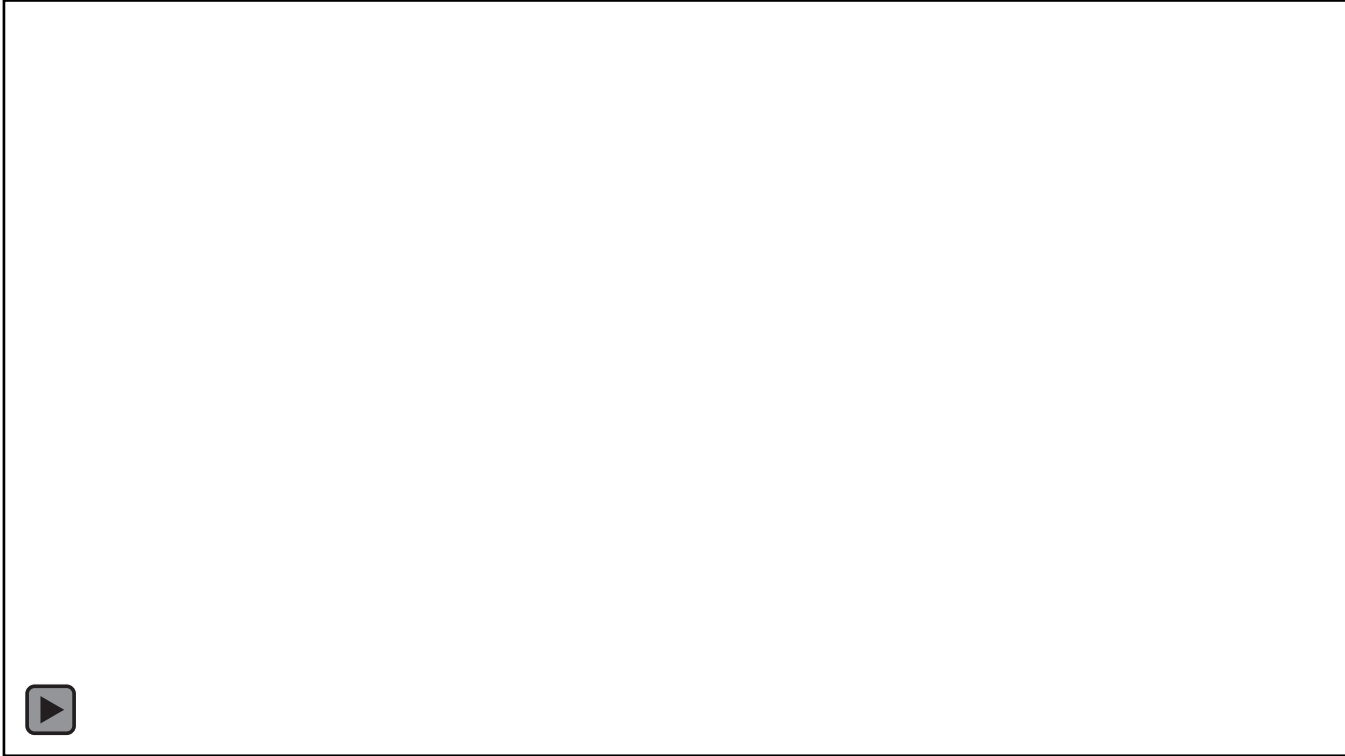
The systematic processing into specific product type is done according to pre-defined areas definition (cf. HLOP) while other product types will be available on request in offline (see processing concept tables)



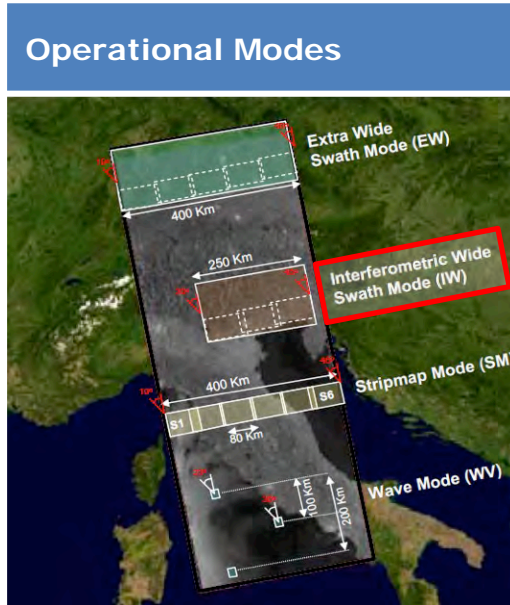


# Image Acquisition in TOPS

## Interferometric Wide Swath mode (IW)



# Sentinel-1 Operational Modes



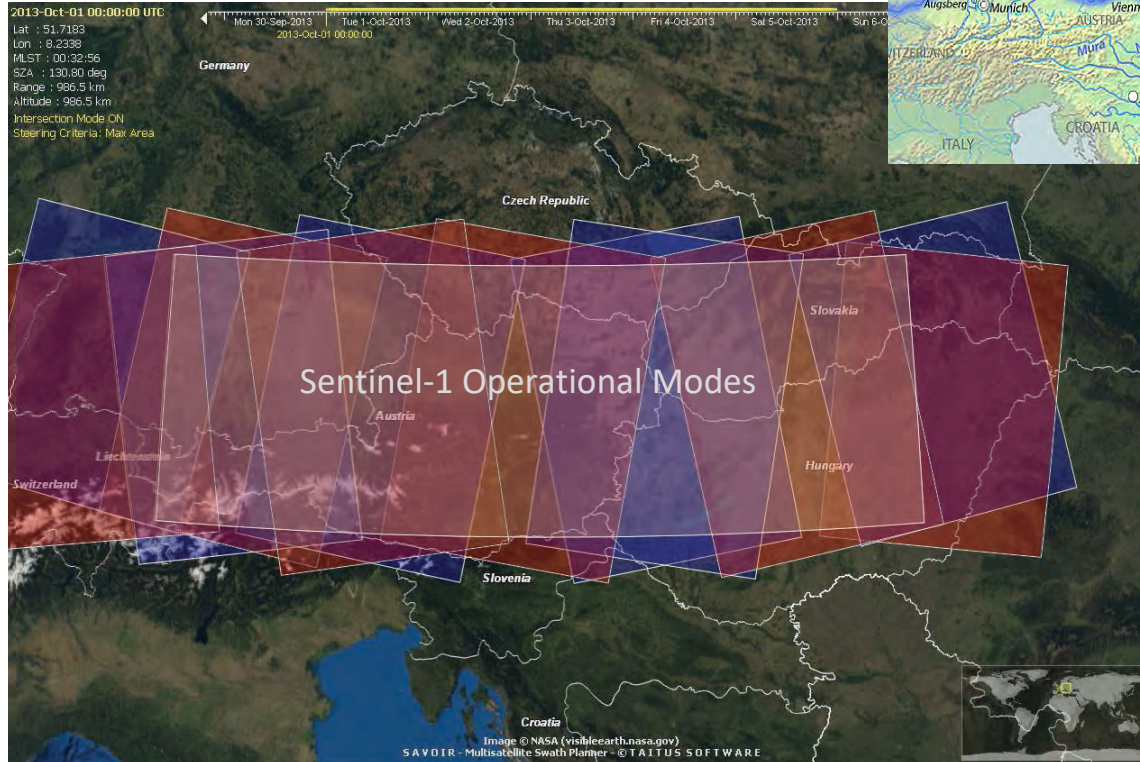
GRD Level 1 product resolution	Swath Width	Polarisation
50m (3 ENL)	> 400 km	HH+HV or VV+VH
20m (5 ENL)	> 250 km	HH+HV or VV+VH
9m (4 ENL)	> 80 km	HH+HV or VV+VH
50m (140 ENL)	20x20 km <sup>2</sup> at 100 km spacing	HH or VV

**Interferometric Wide (IW)**  
default mode over land



# Sentinel-1 Enhanced Spatial Coverage

## Sentinel-1 vs ENVISAT 5-day coverage



Until 2012:  
ENVISAT

2014+:  
Sentinel1A

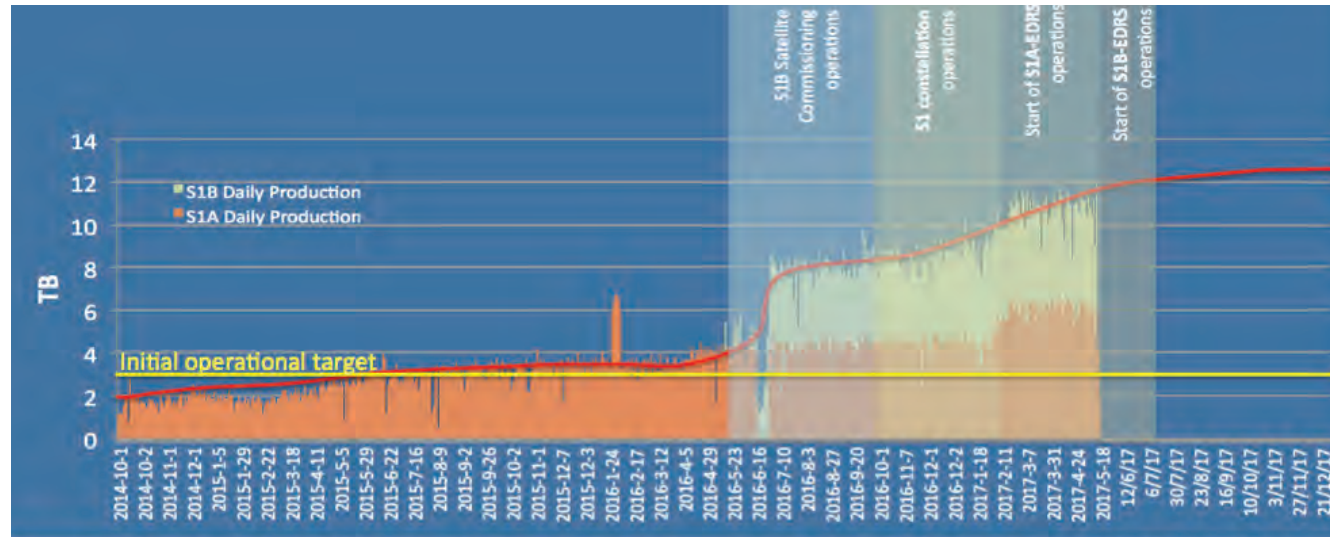
2016+:  
Sentinel1A/B

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# Sentinel-1 Constellation Operations Status

## SAR daily production volume evolution



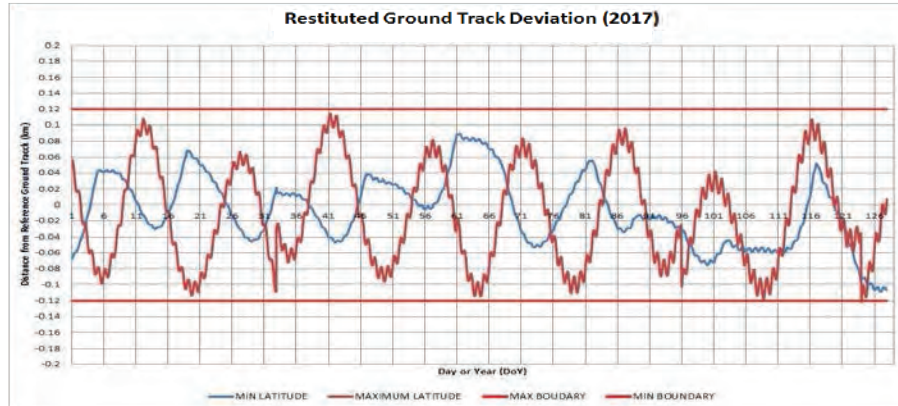
Sentinel-1 operational daily production volume has now exceeded 10TB/day with the routine operations of EDRS-A/S1A.

The production volume is foreseen to reach 12TB/day with the routine operations of EDRS-A/S1B and fine-tuning of the constellation observation scenario before end 2017.

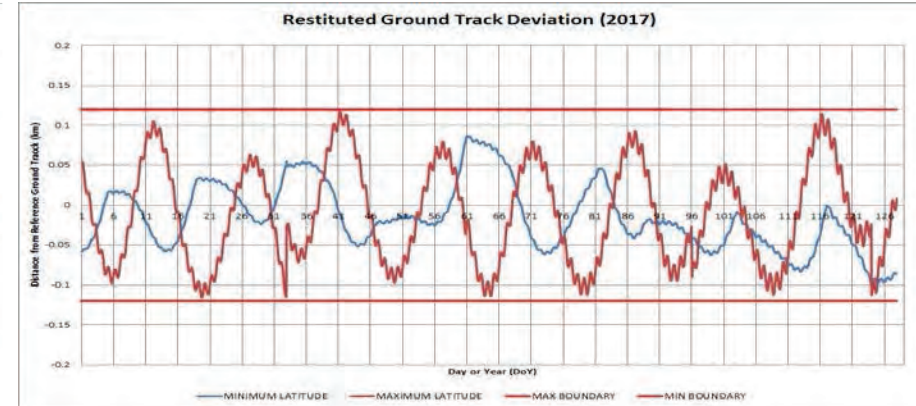


# S1A & S1B Orbit Maintenance

S1A



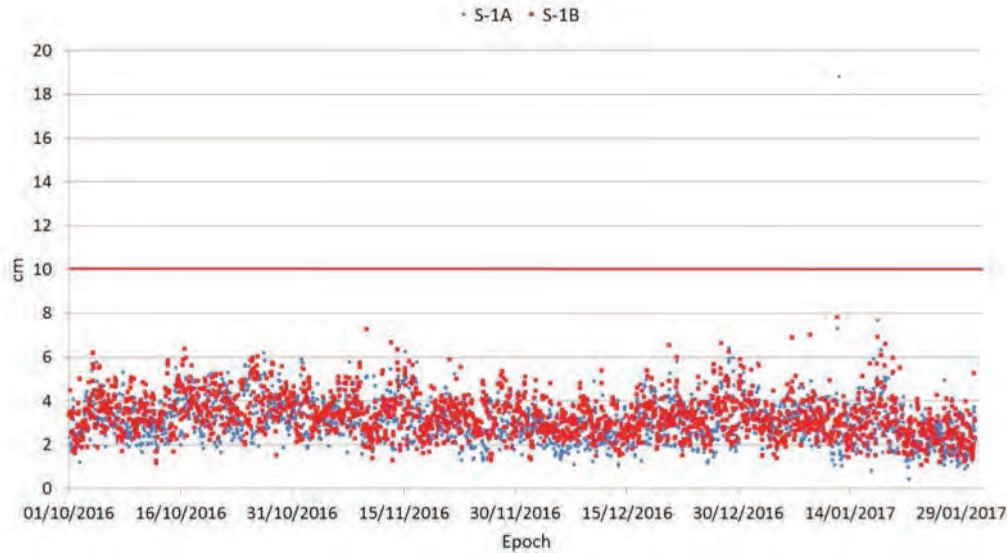
S1B



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# Sentinel-1 Precise Orbit Determination | Restituted Orbits

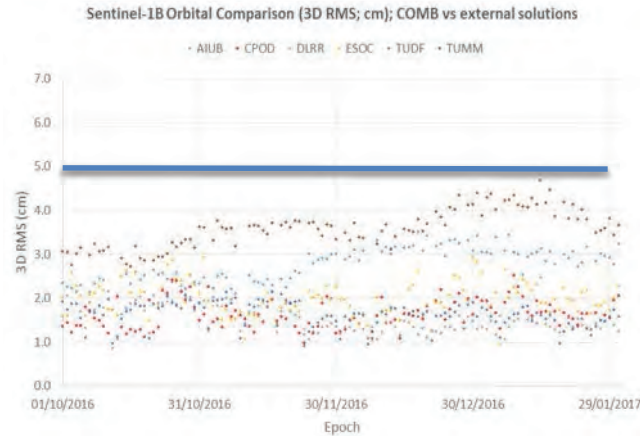
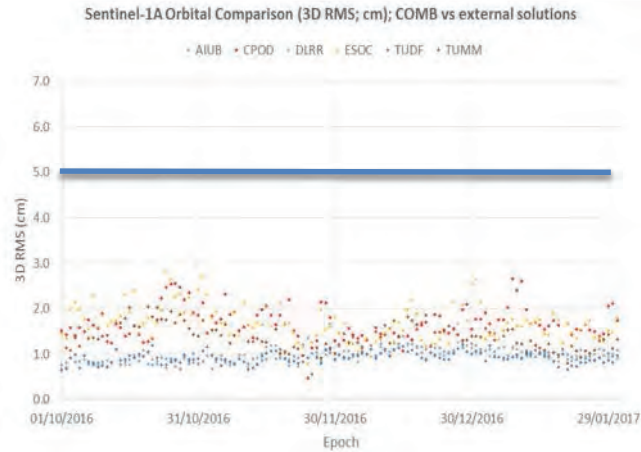


Average of daily 2D rms [cm]		
	S1A	S1B
< 3 cm	51.10%	39.50%
< 5 cm	96.90%	94.30%
< 10 cm	99.80%	99.60%
< 20 cm	99.90%	99.60%

Restituted orbit products (**AUX\_RESORB**)  
2D rms is about 5cm, well below the 10cm specifications



# Sentinel-1 Precise Orbit Determination | Precise Orbits



Precise orbit  
products  
**(AUX\_POEORB)**  
3D rms is about  
2cm, well below the  
5cm specifications

S1A	Average of daily 3D rms [cm]
min	0.9
average	1.7
max	1.3
specification	5

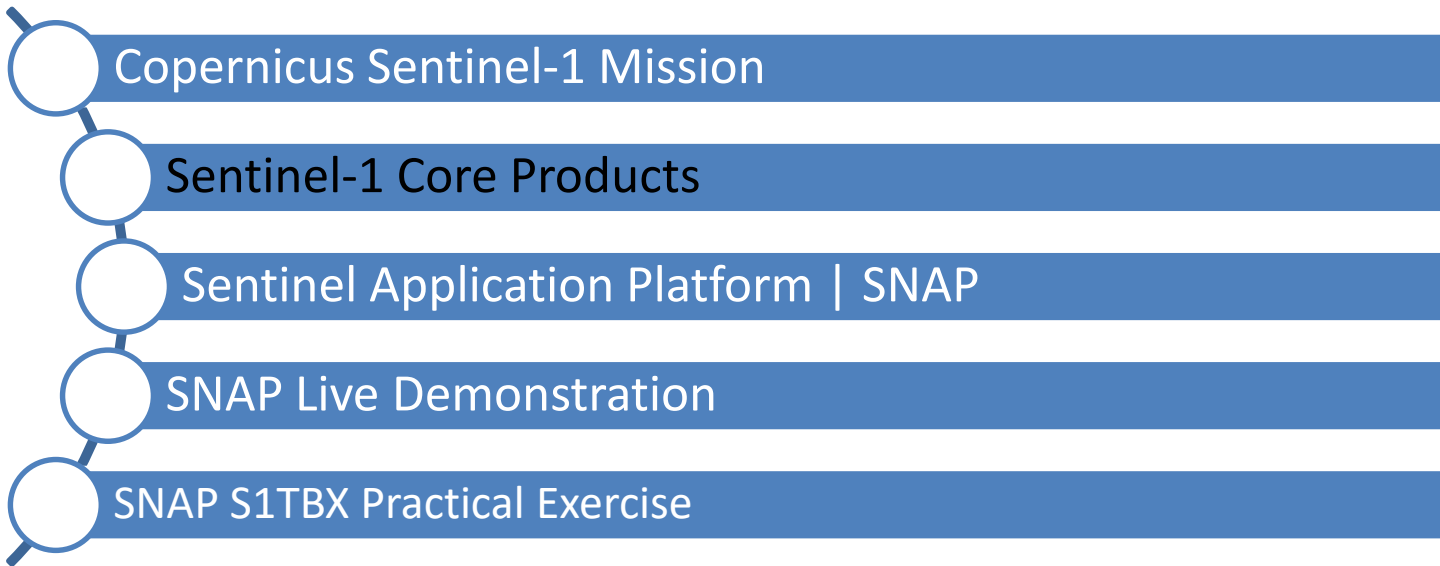
S1B	Average of daily 3D rms [cm]
min	1.6
average	2.0
max	1.7
specification	5

# Operational enhancements relevant to "InSAR users"

## Ease user access to S1 orbital information: Q3 2017

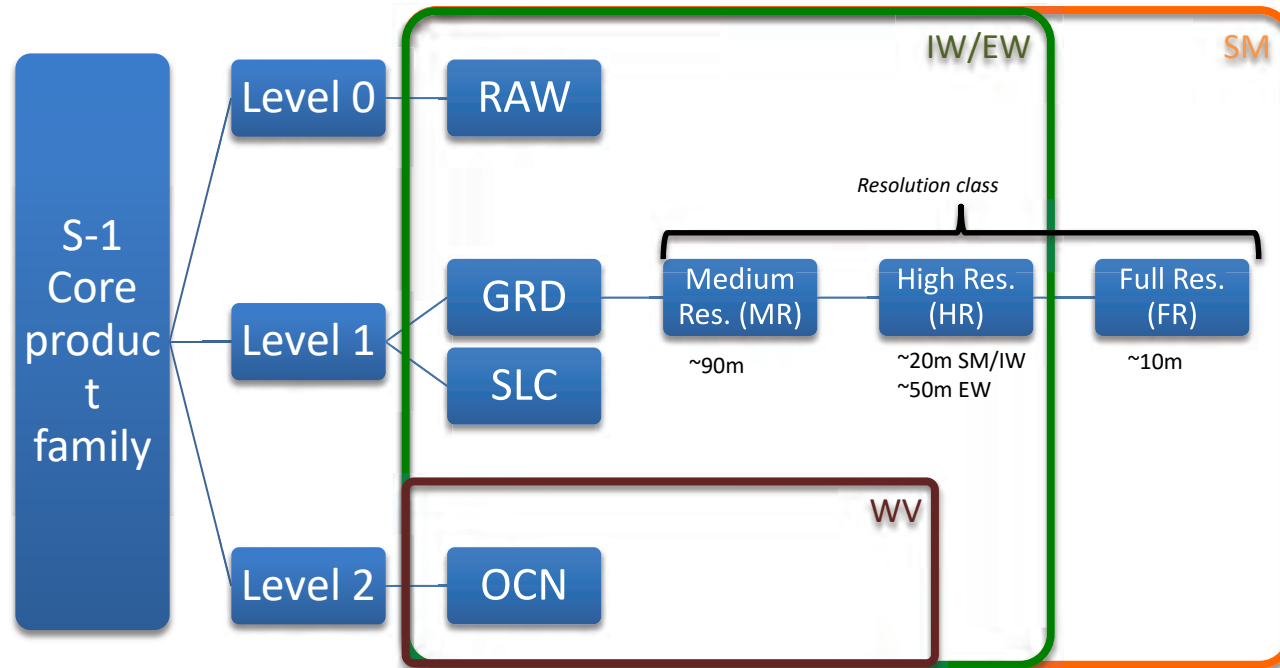
Watch the Sentinels On-line News

- ☐ Orbit information is currently available at:
  - [https://qc.sentinel1.eo.esa.int/mpl\\_orbpre/](https://qc.sentinel1.eo.esa.int/mpl_orbpre/)
  - [https://qc.sentinel1.eo.esa.int/aux\\_resorb/](https://qc.sentinel1.eo.esa.int/aux_resorb/)
- ☐ A simplified FTP access to the S1 auxiliary files (processing and orbital information) will be available to all users in the coming weeks.
- ☐ Both accesses will be available contemporarily for sufficient time to allow users to migrate to the new access point.
- ☐ The availability of the new access will be announced on the Sentinels on-line (<https://sentinel.esa.int/>)





# Sentinel-1 Operational Product Family



# Sentinel-1 Operational Product Family

## LEVEL-0 PRODUCTS

**Level-0** products contain the compressed, unprocessed instrument source packets, with additional annotations and auxiliary information to support the processing.

SAR Level-0 products for SAR SM, IW and EW modes are made available to the S-1 users.

## LEVEL-1 PRODUCTS

**Level-1 Slant-Range Single-Look Complex Products (SLC):**

SLC products provide focused data in slant-range geometry, single look, containing phase and amplitude information.

**Level-1 Ground Range Detected Geo-referenced Products (GRD):**

Focused data is projected to ground range, detected (phase information is lost) and multi-looked.

Data is projected to ground range using an Earth ellipsoid model, maintaining the original satellite path direction and including complete geo-reference information.

## LEVEL-2 PRODUCTS

**Level-2 (waves, wind, radial velocity) products**

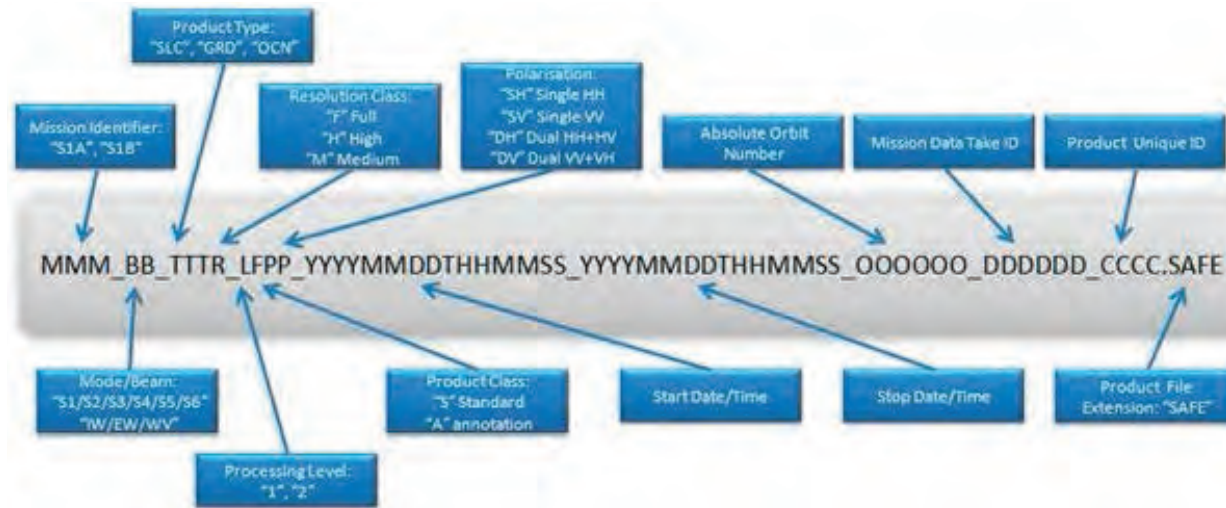
Ocean wind field, swell wave spectra and surface radial velocity information as derived from SAR data. L2 ocean products are available for all modes (although information content may slightly vary per mode)

# S-1 Operational Product Family

Instrument Mode	Product Type	Resolution Class	Spatial Resolution [m]
SM	SLC		[1.7 x 4.3] to [3.6 x 4.9]
	GRD	FR	< 10 m
		HR	< 25 m
		MR	< 100m
IW	SLC		[2.7 x 22] to [3.5 x 22]
	GRD	HR	< 25m
		MR	<100m
EW	SLC		[7.9 x 42] to [14.4 x 44]
	GRD	HR	< 50m
		MR	<100m



# Sentinel-1 Products Name Formatting



# Sentinel-1 Level 1 Product Formatting

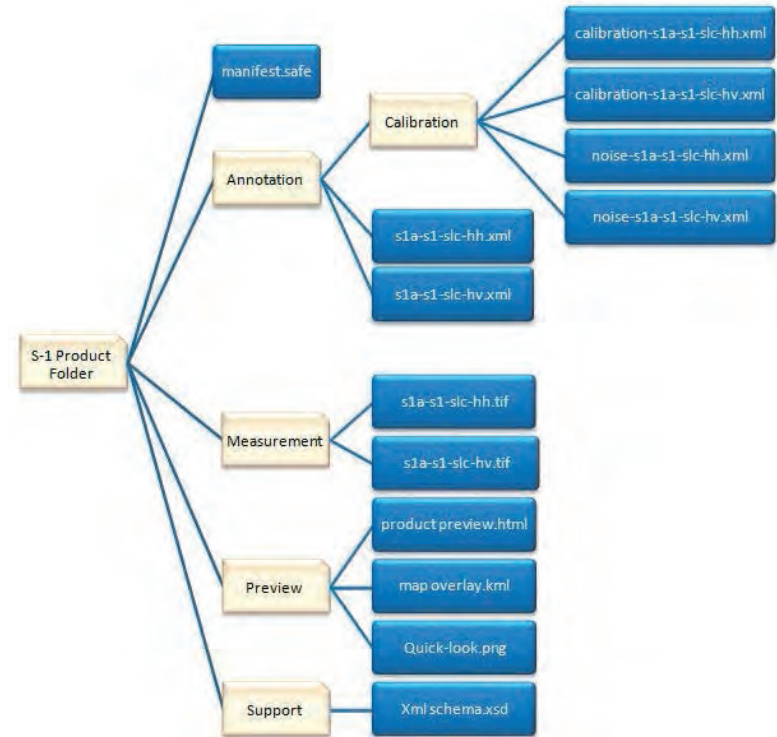
Sentinel-1 data products are distributed using a SENTINEL-specific variation of the **Standard Archive Format for Europe (SAFE)** specification.

The SAFE format has been designed to act as a common format for archiving and conveying data within ESA Earth Observation archiving facilities.

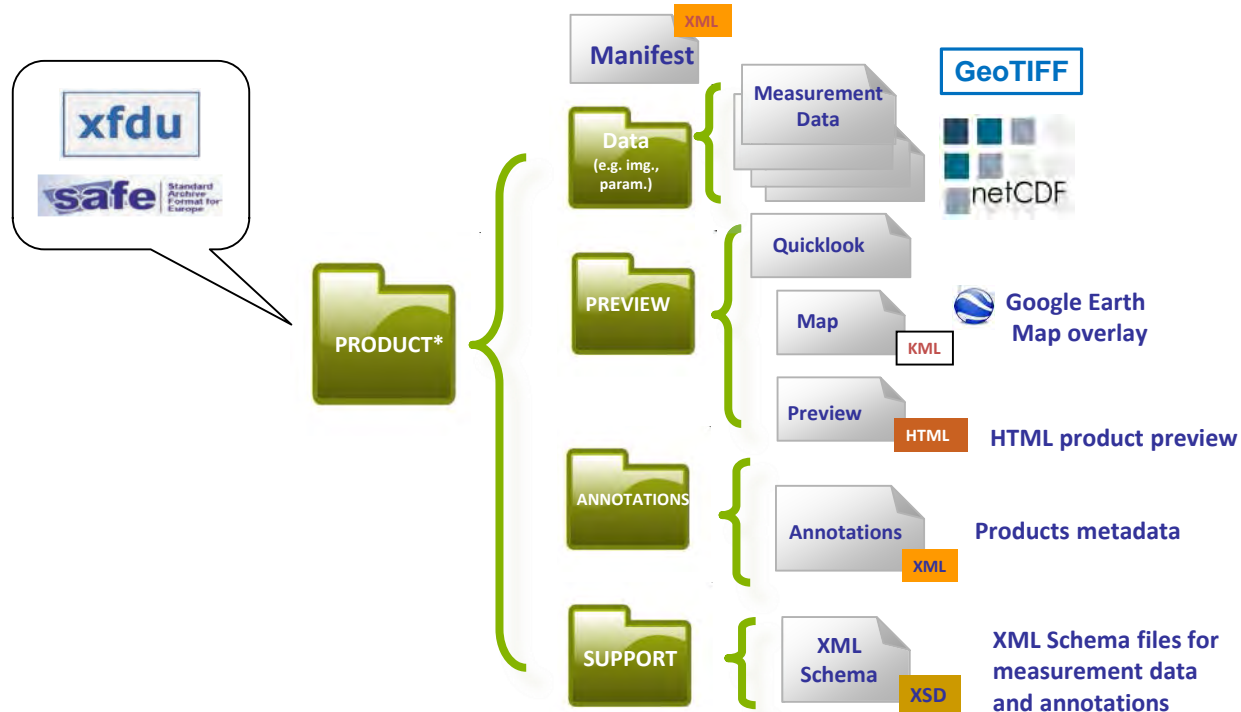
The SENTINEL-SAFE format wraps a folder containing *image data in a binary data format and product metadata in XML*

A SENTINEL product refers to a directory folder that contains a collection of information. It includes:

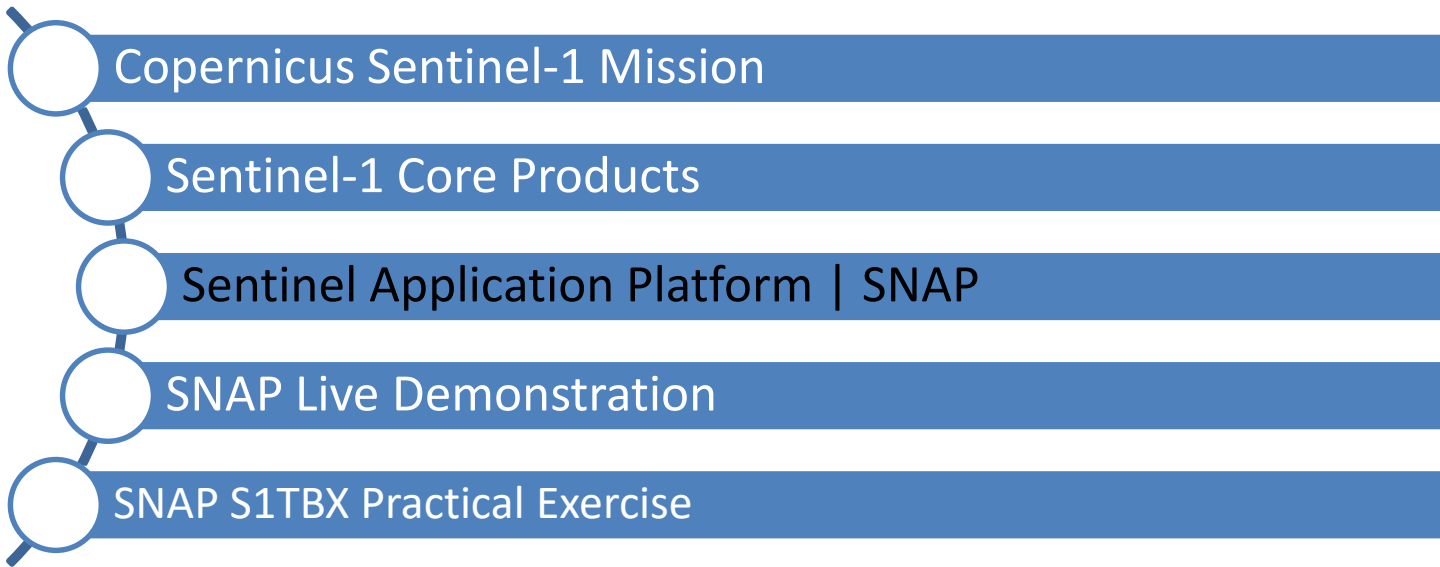
- a **manifest.safe** file
- subfolders for measurement data
- a preview folder containing KML and HTML preview files
- an annotation folder
- a support folder containing the XML schemes



# Sentinel-1 Operational User Products Format







## 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](http://www.seom.esa.int))

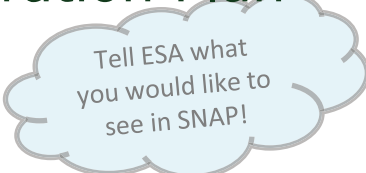


# How to Measure Success

- ❑ The success of the Toolboxes can only be measured in terms of **user acceptance**.
- ❑ User acceptance is gained
  - if we provide the **tools that users need**;
  - if users **enjoy working with tools** we provide;
  - if we ensure that **these tools grow, improve and evolve** while they are being used;
  - if we **support and train the users** in using the tools;
  - if we **maintain the tools** and retain the efforts users already invested in understanding and applying the tools;
  - if we **let users participate** in a sustainable Toolbox development.



# Iteration Plan



Tell ESA what  
you would like to  
see in SNAP!

## ☐ **Release 1 (Sept 2014)**

- TOPS GRD processing and coregistration
- All basic support for S1 (Read/Write, Calibrate, Orbits, Slice Assembly, etc.)

## ☐ **Release 2 (Jan 2015)**

- TOPS SLC Coregistration, TOPS INSAR, Smart Installer, L2 Visualisation

## ☐ **Release 3 (May 2015)**

- Processing Previews, Task Queue

## ☐ **Release 4 (Sept 2015)**

- Basic Polarimetric tools, Supervised Classification, Multi-resolution S2 products support

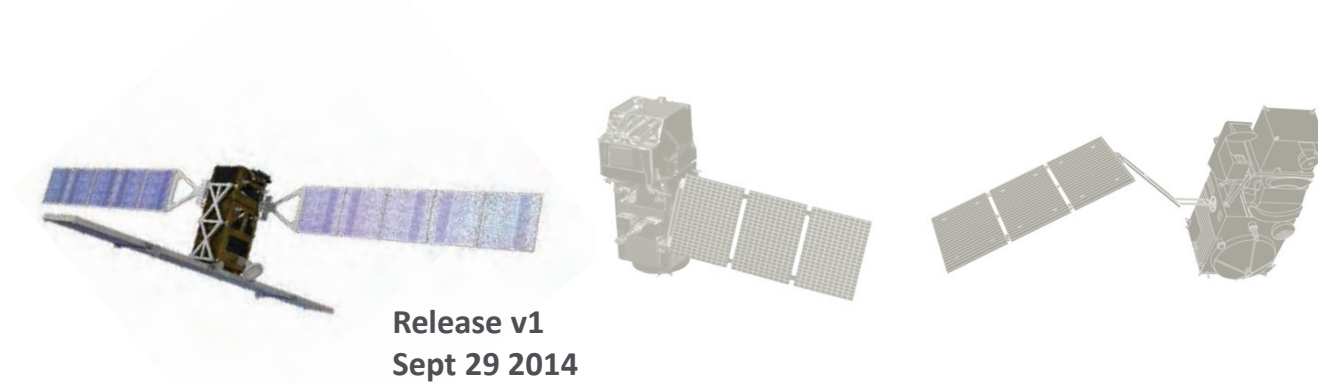
## ☐ **Release 5 (Nov 2016)**

- Change detection, Offset tracking, further optimizations, odds and ends

## ☐ **Release 6 (Sept 2017) – Long Time Support (LTC) version**

- Performance optimization, PSI pre-processing, etc.

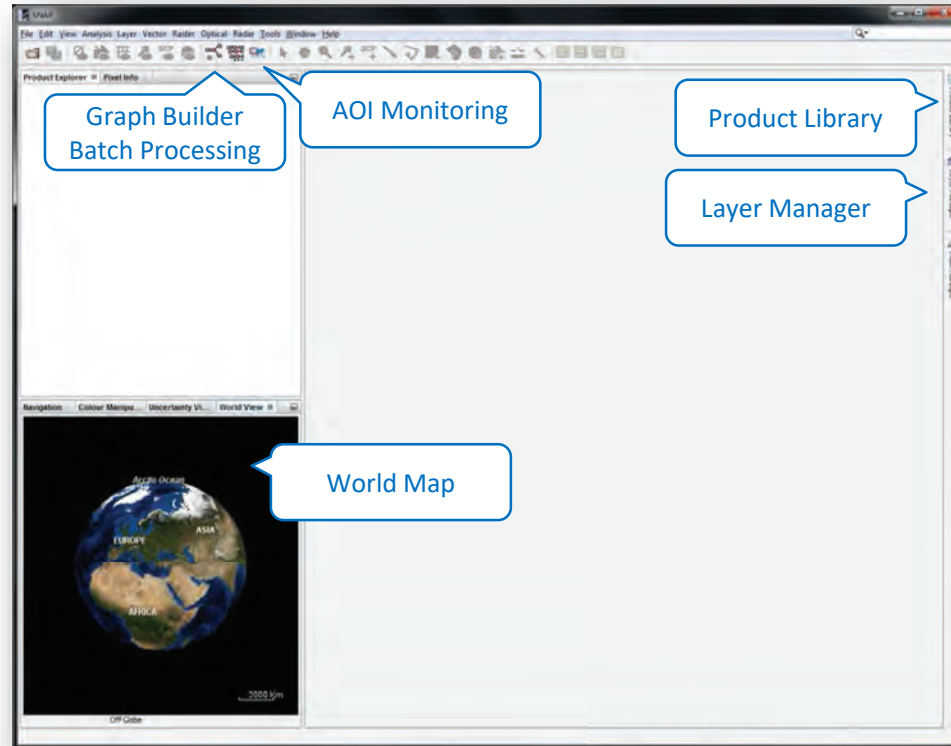
# SNAP Sentinel-1 First Release



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.

# SNAP | Familiar **but** Enhanced Look and Feel





# SNAP SAR Toolbox (S1TBX)

## Evolution of ESA's NEST SAR Toolbox

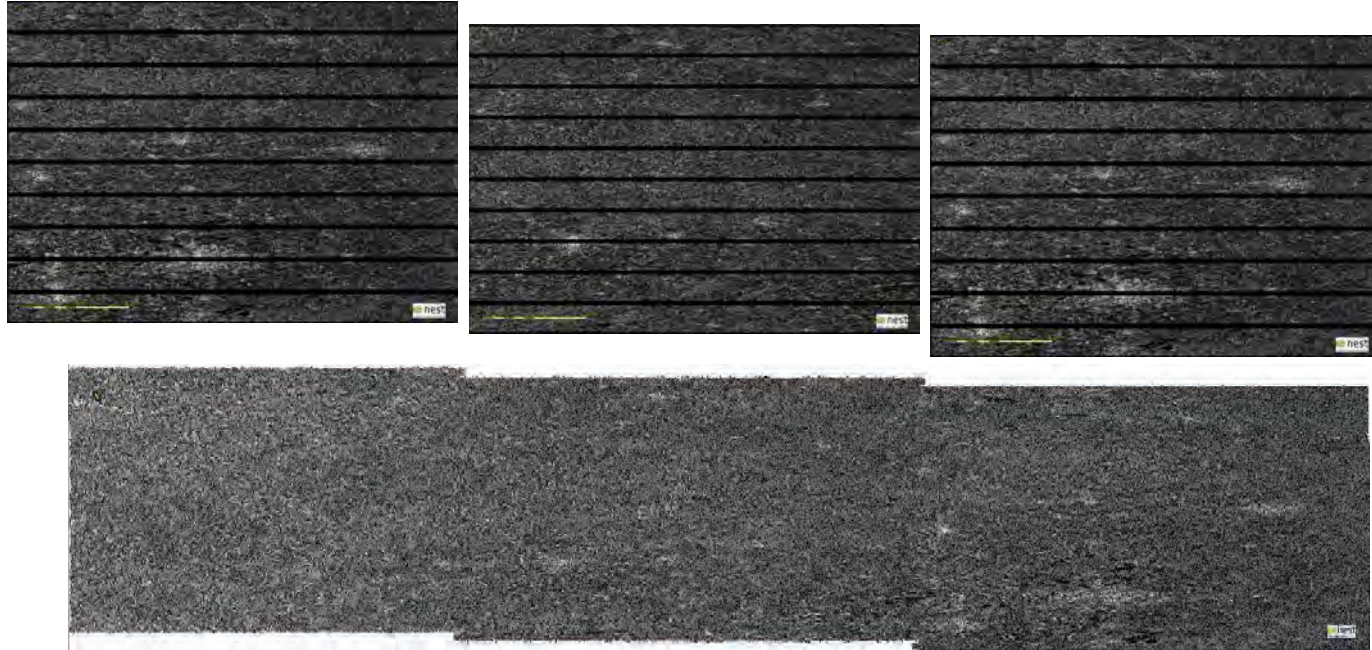
### **Maintain and enhance existing functionality from NEST**

- Calibration
- Speckle Filtering
- Terrain Correction
- Ellipsoid Correction
- SAR Simulation
- Mosaicking
- Re-projection
- Co-registration
- Interferometry

### **Continue to support ESA and TPM**

- SENTINEL-1
- ENVISAT ASAR
- ERS-1 & 2
- RADARSAT-2
- TerraSAR-X/TanDEM-X
- ALOS PALSAR
- COSMO-Skymed

# Deburst and Merge S-1 TOPS Data (Level 1 SLCs)



# TOPSAR InSAR Processing Chain

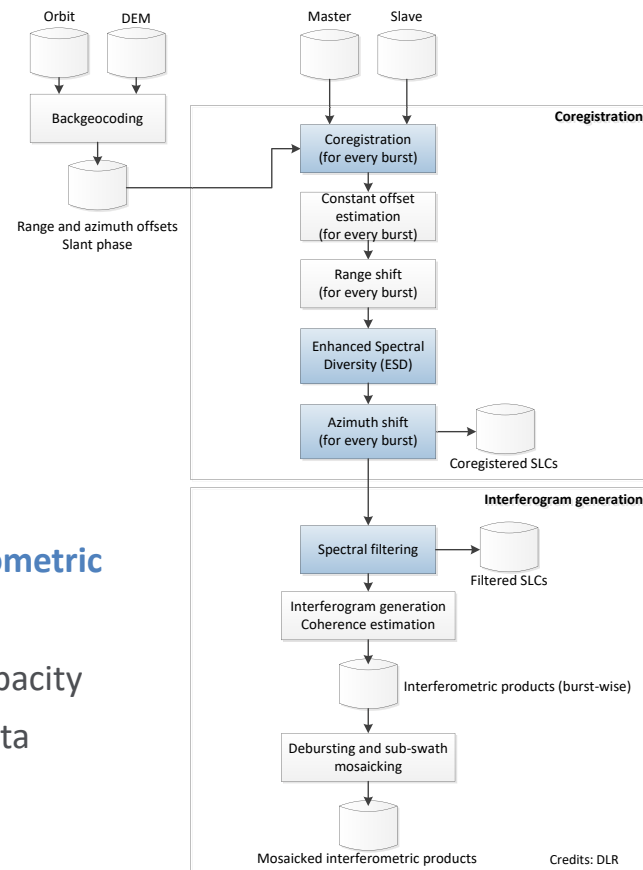
Support from  
**SEOM R&D projects**

## 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](http://www.seom.esa.int)).

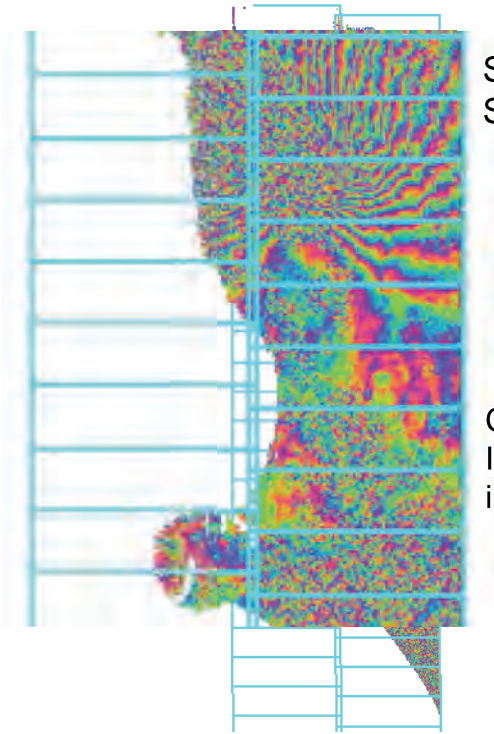
**“Validation and scientific exploitation of the interferometric  
performance of TOPS mode on Sentinel-1 mission”**

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



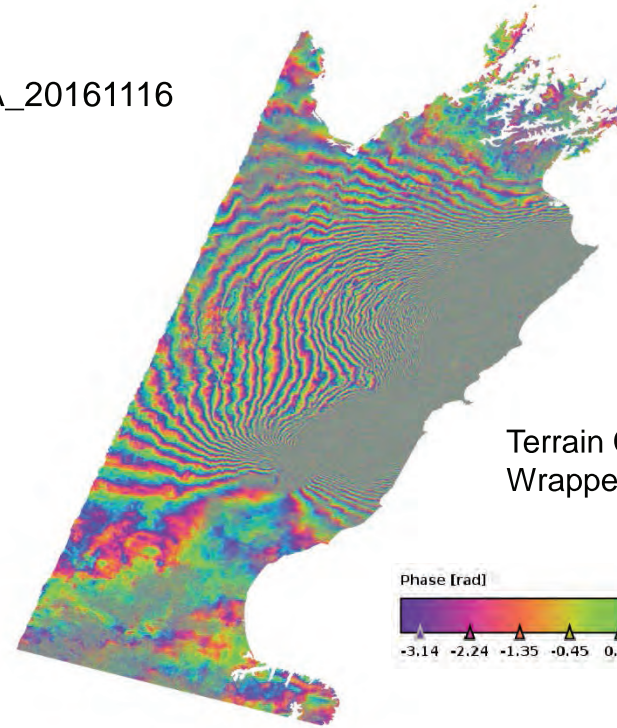


# SNAP Sentinel-1 Interferometry | New Zealand Earthquake

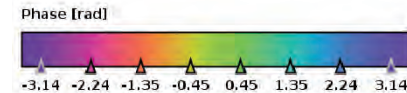


S-1 TOPS DInSAR  
S1A\_20161010\_S1A\_20161116

Co-seismic  
Interferogram  
in SAR geometry

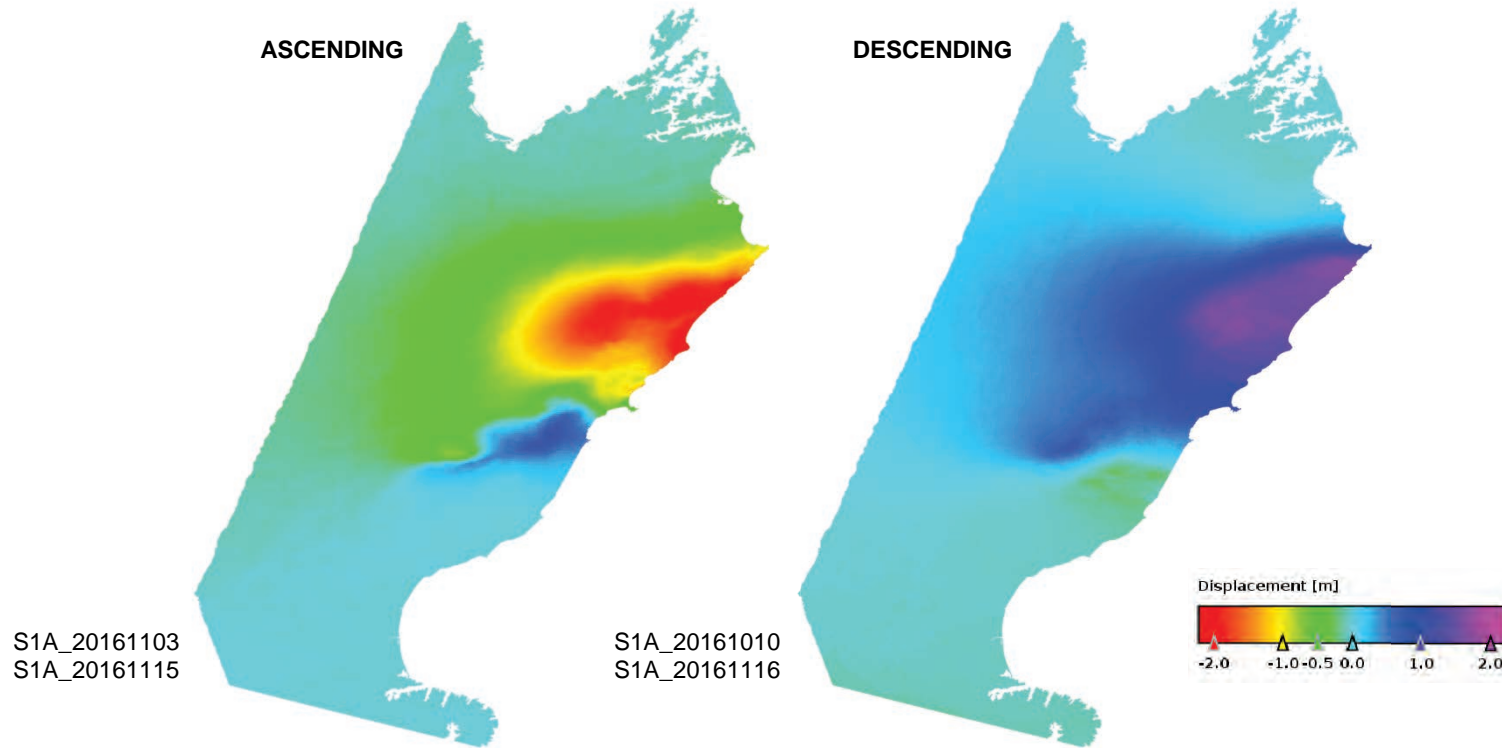


Terrain Corrected  
Wrapped Interferogram





# Sentinel-1 LOS Displacements | New Zealand Earthquake



[step.esa.int](http://step.esa.int)



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# SNAP | Download Page

step  
science toolbox exploitation platform

ESASTEPTOOLBOXESDOWNLOADGALLERYDOCUMENTATIONCOMMUNITYTHIRD PARTY PLUGINS

SNAP  
Sentinel 1 Toolbox  
Sentinel 2 Toolbox  
Sentinel 3 Toolbox  
SMOS Toolbox  
Download  
Community  
Useful Links



Home > Download

Download

Here you can download the latest installers for SNAP and the Sentinel Toolboxes.

Data provision is available to all users via the [Sentinel Data Hub](#).

**Important notes:** While the current official version is still SNAP 5.0, the new SNAP 6.0 beta release is available to be downloaded and tested at your own risk. The beta version is not fully tested, but it contains new features and fixes to many issues found in SNAP 5.0. The SNAP 6.0 beta release is provided "as is" and is not supported, but we are interested in your feedback and bug reports and intend to fix the reported bugs in the SNAP 6.0 official version. The details and download links for SNAP 5.0 and SNAP 6.0 beta are below.

**Current Version**

The current version is **5.0.0** (05.12.2016 14:40).

For detailed information about changes made for this release please have a look at the release notes of the different projects: [SNAP](#), [S1TBX](#), [S2TBX](#), [S3TBX](#), [SMOS Box](#), [PROBA-V Toolbox](#).

We offer three different installers for your convenience. Choose the one from the following table which suits your needs. During the installation process each toolbox can be excluded from the installation. Toolboxes which are not initially installed via the installer can be later downloaded and installed using the plugin manager. Please note that SNAP and the individual Sentinel Toolboxes also support numerous sensors other than Sentinel.

	Windows 64-Bit	Windows 32-Bit	Mac OS X	Unix 64-bit
<b>Sentinel Toolboxes</b>	These installers contain the <b>Sentinel-1</b> , <b>Sentinel-2</b> , <b>Sentinel-3</b> Toolboxes			
	<a href="#">Download</a>	<a href="#">Download</a>	<a href="#">Download</a>	<a href="#">Download</a>
<b>SMOS Toolbox</b>	This installer contains only the <b>SMOS Toolbox</b> . Download also the <a href="#">Format Conversion Tool</a> (Earth Explorer to NetCDF) and the <a href="#">user manual</a> .			
	<a href="#">Download</a>	<a href="#">Download</a>	<a href="#">Download</a>	<a href="#">Download</a>
<b>All Toolboxes</b>	These installers contain the <b>Sentinel-1</b> , <b>Sentinel-2</b> , <b>Sentinel-3</b> Toolboxes, <b>SMOS</b> and <b>PROBA-V</b> Toolbox			
	<a href="#">Download</a>	<a href="#">Download</a>	<a href="#">Download</a>	<a href="#">Download</a>

If you later decide to install an additional toolbox to your installation you can follow this [step-by-step guide](#).

We are happy to **get your feedback** on the software installation procedure, functionalities, encountered issues, etc on the [Forum](#). You may also watch the [Blog](#) to be informed about SNAP news such as new software releases or interesting events.

**Release Notes**

[SNAP](#), [S1TBX](#), [S2TBX](#), [S3TBX](#), [SMOS Box](#), [PROBA-V Toolbox](#)

## Beta Version

The new version is **6.0 beta** (09.08.2017 18:00). The version is not completely tested, not supported, and may be installed on your own risk. Please read the release notes below and evaluate if this version suits your needs.

For detailed information about changes made for this release please have a look at the release notes of the different projects: [SNAP](#), [S1TBX](#), [S2TBX](#), [S3TBX](#).

We offer three different installers for your convenience. Choose the one from the following table which suits your needs. During the installation process each toolbox can be excluded from the installation. Toolboxes which are not initially installed via the installer can be later downloaded and installed using the plugin manager. Please note that SNAP and the individual Sentinel Toolboxes also support numerous sensors other than Sentinel.

	Windows 64-Bit	Windows 32-Bit	Mac OS X	Unix 64-bit
<b>Sentinel Toolboxes</b>	These installers contain the <b>Sentinel-1</b> , <b>Sentinel-2</b> , <b>Sentinel-3</b> Toolboxes			
	<a href="#">Download</a>	<a href="#">Download</a>	<a href="#">Download</a>	<a href="#">Download</a>
<b>SMOS Toolbox</b>	This installer contains only the <b>SMOS Toolbox</b> . Download also the <a href="#">Format Conversion Tool</a> (Earth Explorer to NetCDF) and the <a href="#">user manual</a> .			
	<a href="#">Download</a>	<a href="#">Download</a>	<a href="#">Download</a>	<a href="#">Download</a>
<b>All Toolboxes</b>	These installers contain the <b>Sentinel-1</b> , <b>Sentinel-2</b> , <b>Sentinel-3</b> Toolboxes, <b>SMOS</b> and <b>PROBA-V</b> Toolbox			
	<a href="#">Download</a>	<a href="#">Download</a>	<a href="#">Download</a>	<a href="#">Download</a>

If you later decide to install an additional toolbox to your installation you can follow this [step-by-step guide](#).

We are happy to **get your feedback** on the software installation procedure, functionalities, encountered issues, etc on the [Forum](#). Please note that, specifically for this beta version, a new category was added – **SNAP 6 beta issues**. Please use this category for questions or issues related to the beta version. Otherwise, use the other categories of the forum. You may also watch the [Blog](#) to be informed about SNAP news such as new software releases or interesting events.

## Release Notes for beta version

[SNAP](#), [S1TBX](#), [S2TBX](#), [S3TBX](#).

## Previous Versions

Former releases can be downloaded from the [Previous Versions](#) page.

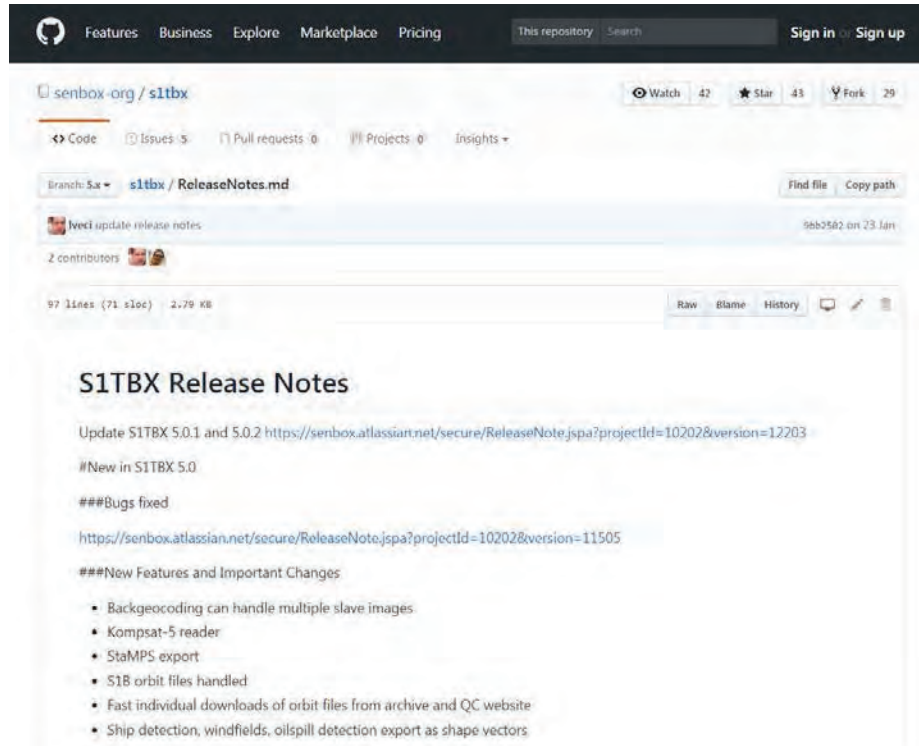
## Sources

All software is published under the [GPL-3](#) license and its sources are available on [GitHub](#).

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# SNAP Sentinel-1 Toolbox | Release Notes



The screenshot shows the GitHub interface for the repository `senbox-org / s1tbx`. The file `ReleaseNotes.md` is selected, showing a commit titled "I'veci update release notes" by user "Iveci" from 2023. The file content is as follows:

## S1TBX Release Notes

Update S1TBX 5.0.1 and 5.0.2 <https://senbox.atlassian.net/secure/ReleaseNote.jspa?projectId=10202&version=12203>

##New in S1TBX 5.0

###Bugs fixed

<https://senbox.atlassian.net/secure/ReleaseNote.jspa?projectId=10202&version=11505>

###New Features and Important Changes

- Backgeocoding can handle multiple slave images
- Komsat-5 reader
- StaMPS export
- S1B orbit files handled
- Fast individual downloads of orbit files from archive and QC website
- Ship detection, windfields, oilspill detection export as shape vectors

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# SNAP Sentinel-1 Toolbox | Release Notes

Edit/Copy Release Notes

Configure Release Notes

## Bug

- [SITBX-364] - ALOS lat lon coefficients can be empty in some SLC products
- [SITBX-369] - Freeman-Durden decomposition produces NaN for some pixels
- [SITBX-370] - InSAR processing chain stops when ESD fails in estimating range offset
- [SITBX-371] - S1 Remove Thermal Noise Operator cannot handle complex sigma0
- [SITBX-372] - Warp operator cannot handle intensity band in SLC product
- [SITBX-374] - Exception for RESORB shown when applying POEORB
- [SITBX-375] - TOP Split slider affected by laf
- [SITBX-376] - Terrain Correction not handling UTM Auto
- [SITBX-379] - Remove antenna pattern not validating mission
- [SITBX-380] - Noisy fringe borders after geocoding
- [SITBX-381] - Slice Assembly does not work on S1 splitted products
- [SITBX-390] - Displacement sign should be updated
- [SITBX-391] - Phase to Displacement missing help
- [SITBX-394] - Report better error message when calibration vectors are not found
- [SITBX-395] - Retrieve orbit files individually from step auxdata to reduce download times
- [SITBX-399] - Checking for orbits when building a graph can freeze SNAP for tens of seconds
- [SITBX-401] - DEM nodata value of NaN causes infinite loop
- [SITBX-402] - TOPS Merge error: data is not an instance of String, char[] or byte[] or the length is less than one
- [SITBX-403] - Stamps cannot read par files properly with windows line endings
- [SITBX-404] - Gamma writer not handling very large raster data
- [SITBX-408] - NaN values in coherence product for calibrated SLC (complex)
- [SITBX-409] - Create stack should validate the resampling method
- [SITBX-410] - Offset Tracking still fills holes when "Fill Holes" option is not selected
- [SITBX-411] - Polarimetric decomposition and classification do not work with ALOS2 product
- [SITBX-413] - Offset Tracking produces empty result if newer image is used as master
- [SITBX-416] - Geocoding in assembled multilooked slices is wrong
- [SITBX-417] - Parameters not stored to xml for Range Doppler Terrain Correction
- [SITBX-420] - Komsat-5 A products should be read as Float16
- [SITBX-424] - DateFormat is not thread safe
- [SITBX-425] - Projects not handling name without extension
- [SITBX-429] - Gamma reader not handling tabs

## New Feature

- [SITBX-232] - Restituted orbits available later than from GS
- [SITBX-383] - Export ship detections, oil spills and wind fields as shape files
- [SITBX-384] - Offset tracking velocities should be exported as shape files

## Improvement

- [SITBX-322] - IRM 6: Gamma/Stamps export requires the DEM
- [SITBX-373] - Wind field estimation shall be exported to file
- [SITBX-397] - Add calibration to ocean tools graphs
- [SITBX-398] - Calibration to handle nodatavalue
- [SITBX-421] - Backgeocoding needs to support more than two input products

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