

Ice surface velocities using SAR

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ESA Cryosphere Remote Sensing Training Course 2018 UNIS Longyearbyen, Svalbard 12th June 2018



Outline



Data access

- scihub.copernicus.eu/dhus
- Batch download

Software

ESA Sentinel-1 Toolbox in SNAP

Offset tracking

- Open the products in S1TBX
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- Apply orbit file
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- Create subset image containing Rink Glacier
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- Geocoding
- View the glacier velocity map in QGIS
- Compare map to Sentinel-2 velocity map

Data Access

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| Advanced Search | 1 | | | | Clear | ME TA | 2 | An Es | AL- | \$ |
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| » Order By: | Descer | iding | | | • | | | 5:1 | | |
| » Sensing period | From: 2018 | 8/05/0 | to: | 2018/05/0 | 1 | | | | \sim | |
| » Ingestion period | From: | | to: | | # | A CORE AN | AL PARTY | × 1 | | m |
| Mission: Sent | inel-1 | | | | | T Carlo | 1 march 1 | 05 | Ø | |
| Satellite Platform | | Product | Туре | | | 463 | | | | |
| | • | GRD | | | • | | (and a | Sales A. | | |
| Polarisation | | Sensor M | lode | | _ | | | | | |
| | • | IW | | | • | | THE F | | | |
| Relative Orbit Number | r (from 1 to | Collectio | n | | | | | | | |
| 1/0) | | | | | - | | | | 1 | |
| | | | | | ÷ | | | | | () |
| | Pan B | Box Pol | ygon | Clear | | | | | | |

https://scihub.copernicus.eu/dhus/#/home batch script: dhusget.sh https://forum.step.esa.int/c/s1tbx

Software

ESA Sentinel Application Platform (SNAP) Sentinel 1 Toolbox

- → SENTINEL-1, ERS-1&2, ENVISAT, ALOS PALSAR, TerraSAR-X, COSMO-SkyMed, RADARSAT-2
- → http://step.esa.int/main/toolboxes/sentinel-1-toolbox/
- \rightarrow http://step.esa.int/main/doc/tutorials/

Commercial SAR software: "Gamma Remote Sensing" and "Sarscape"





Open SNAP and load S1 raw data

Open SNAP Desktop

Restore Window Group by clicking in the upper left corner twice



File \rightarrow *Open Product*

Navigate to the folder 20151024_20151105

Select the S1A raw files (.zip) and click Open S1A_IW_GRDH_1SSH_20151024T150411zip S1A_IW_GRDH_1SSH_20151105T150411zip





View raw data

Unfold the first product

Unfold Bands

Double-click on Amplitude_HH

Play around with Colour Manipulation using Sliders

| Navigation - [1] A | Colour Manipul 8 | Uncertainty Visual | World View |
|-----------------------|------------------|--------------------|------------|
| Editor: 🔘 Basic 🏾 🇿 S | Sliders 🔘 Table | | |

What kind of features can you see?

Check coverage of the scene under World View





View metadata

Unfold the first product

Unfold Metadata

Double-click on Abstracted Metadata

Find the geometric resolution in range and azimuth

| NAP | | | | | O - Sauch Port of | Al- |
|--|---------------------------------|-----------------------------------|---------|------|--------------------------------|-----|
| Edit Yiew Analysis Layer Vector Raster Optical Radar Loois Window Help | | A start branch starts in the | | | (d. search (rai +1) | - |
| 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 | ノションの言い | | | | | |
| duct Explorer # Pixel Info Layer Manager | 😡 🔲 (1) Amplitude_HH 💷 [1] A | ostracted_Metadata III | | | H.A. | 31 |
| 51024T150411_20151024T150436_008296_00681E_772F | Name | VAUE | Туре | Unit | Description | |
| 🗃 🖼 Metadata | H Orbit_State_Vectors | | | | | 1 |
| Abstracted Metadat | E SRGR_Coefficients | | | | | |
| Vector Data | H Doppler_Centroid_Coefficients | | | | | |
| Tie-Point Grids | Band_IW_HH | | | | | |
| Quicitoeks | PRODUCT | S1A_TW_GRDH_199H_20151024T15 | ALCI. | | Product name | |
| Bands | PRODUCT_TYPE | GRD | asci | | Product type | |
| . 151 2 19 2 19 2 19 2 20 20 20 20 20 20 20 20 20 20 20 20 2 | SPH_DESCRIPTOR | Sentinel-1 TW Level-1 GRD Product | asci | | Description | |
| | MISSION | SENTINEL-1A | asci | | Satelite mission | |
| | ACQUISITION_MODE | EW | asci | | Acquisition mode | |
| tion Colour Manipulation Uncertainty Visualisation World View # | antenna_pointing | right | 80 | | Right or left facing | |
| | BEAMS | | asci | | Beams used | |
| | SWATH | | asci | | Swath name | |
| | PROC_TIME | 24-OCT-2015 17:39:30.848550 | unt32 | utc | Processed time | |
| | Processing_system_identifier | DUR Sentinel-1 IPF 002.53 | asci | | Processing system identifier | |
| 101 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 | orbit_cycle | 61 | int32 | | Cyde | |
| | REL_ORBIT | 174 | int32 | | Track | |
| | ABS_ORBIT | 8296 | int32 | | Orbit | |
| | STATE_VECTOR_TIME | 24-OCT-2015 15:04:09.965000 | unt32 | utc. | Time of orbit state vector | |
| 1 Bre de la | VECTOR_SOURCE | | asci | | State vector source | |
| | incidence_near | 30.201 | float64 | deg | | |
| | incidence_far | 45.435 | float64 | deg | | |
| | sice_rum | 4 | int32 | | Sice number | |
| | data_take_id | 47902 | int32 | | Data take identifier | |
| | frst_ine_time | 24-OCT-2015 15:04:11.964810 | unt32 | utc | First zero doppier azmuth time | |
| Syatta | last_line_time | 24-OCT+2015 15:04:36.963445 | uint32 | utc | Last zero doppler azimuth time | |
| | first_near_lat | 77.95 | ficató4 | deg | | |
| | first_near_long | 20.944 | float64 | deg | | |
| | first_far_lat | 78.722 | float64 | deg | | |
| | first_far_long | 31.477 | ficató4 | deg | | |
| | last_near_lat | 79.304 | float64 | deg | | |
| | last_near_long | 17.506 | float64 | deg | | |
| 100 Km | last_far_lat | 80.158 | float64 | deg | | 1 |
| officia | last_fai_long | 29.265 | float64 | deg | | |

Apply Orbit File

5

Product Explorer % Pixel Info

1 01_20151024

1 2 01_20151105

Apply Orbit File

Speckle Filtering

Coregistration

Interferometric

Radiometric

File Edit View Analysis Layer Vector Raster Optical Radar Tools Window Help

Layer Manager

**

Radar \rightarrow Apply Orbit File

Select first file 20151024 file as source

Set Name of Target Product: 02_20151024_5_Orb.dim

Choose your *Directory*

Press Run



DEM Assisted co-registration with XCorr

| 0 5 8 8 # 4 ° 6 * 1 | Apply Orbit File | | | | |
|---|-------------------|---|-------------------------------|--|--|
| Product Explorer 📽 Pixel Info Layer Manager | Speckle Filtering | + | | | |
| [1] 01_20151024 | Coregistration | | Coregistration | | |
| E [2] 01_20151105 | Interferometric | | S1 TOPS Coregistration | | |
| 6] 02_20151105_Orb | Polarimetric | • | DEM-Assisted Coregistration > | DEM Assisted Coregistration | |
| | Geometric | * | Stack Tools | DEM Assisted Coregistration with XCorr | |
| | ENVISAT ASAR | | Cross InSAR resampling | | |

Please DO NOT press Run!!!



DEM Assisted Coregistration with XCorr

Number of GCPs:

Test GCPs are on land

Estimate Initial Coarse Offset

Coarse Registration

Coarse Window Width:

Coarse Window Height:

Max Iterations:

GCP Tolerance:

Row Interpolation Factor:

Column Interpolation Factor:

ProductSet-Reader DEM-Assisted-Coregistration Cross-Correlation Warp Write

128 -

128 .

4 +

0.25

200

Apply Fine Registration for SLCs

Fine Window Height:

Coherence Threshold:

Fine Accuracy in Azmuth:

Fine Accuracy in Range:

Cross Correlation based reg

Fine Window oversampling factor:

Coherence based registration

Fine Registration Fine Window Width:

🕐 Help 🛛 🕞 Run



🕜 Help 🛛 🕞 Run

Load co-registered stack "03_20151024_20151105_orbit_Stack.dim"

Close the four files

File \rightarrow *Open Product*

Navigate to the folder "20151024_20151105"

Select 03_20151024_20151105_orbit_Stack.dim and click Open

Unfold the product

Unfold Bands

Double-click on Amplitude_HH_mst_24Oct2015



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Subsetting

Right-click in Viewer \rightarrow Spatial Subset from view

Go to the *Geo Coordinates* Tab and enter boundaries \rightarrow Press *OK*

Check also the other parameters in Band Subset, etc

Find the subset in the Product Explorer immediately

Check coverage by opening to viewer





| Pixel Coordinates Geo Coordinat | ies | |
|---------------------------------|-----|---------|
| North latitude bound: | | 79.10 ≑ |
| West longitude bound: | | 23.90 ≑ |
| South latitude bound: | | 79.90 ≑ |
| East longitude bound: | | 25.30 ≑ |

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Save subset

Select subset in Product Explorer

Right-click \rightarrow Save Product

Choose filename, e.g. 04_20151024_20151105_Orb_Stack_subset.dim

Press Save





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SAR offset tracking

 $Radar \rightarrow SAR Applications \rightarrow Offset Tracking$

Adjust I/O Parameters and Processing Parameters

→ filename: 05_20151024_20151105_orbit_Stack_subset_vel.dim

- → set Grid Azimuth Spacing to 50
- \rightarrow set Grid Range Spacing to 50
- \rightarrow set Max Velocity (m/day) to 15.0
- → uncheck *Fill Holes*
- \rightarrow Optionally: *File* \rightarrow *Save Parameters*

Press Run

| C Offset Tracking |
|---|
| File Help |
| |
| I/O Parameters Processing Parameters |
| Source Product |
| Source product: |
| [1] 04_20151024_20151105_Orb_Stack_subset |
| |
| Target Product |
| Name |
| |
| 05_20151024_20151105_Orb_Stack_subset_vei |
| Save as: BEAM-DIMAP 👻 |
| Directory: |
| 20151024_20151105 |
| |
| V Openni Sivar |
| |
| |
| |
| |
| Run Close |
| |
| |



| Offset Tracking | | | X |
|-----------------------------------|----------|------------------------------|----------|
| File Help | | | _ |
| I/O Parameters Processing Param | neters | - Desistration | |
| Grid Azimuth Spacing (in pixels): | 50 | Registration Window Width: | 64 |
| Grid Range Spacing (in pixels): | 50 | Registration Window Height: | 64 🗸 |
| Grid Azimuth Spacing (in meters): | 499.9676 | Cross-Correlation Threshold: | 0.1 |
| Grid Range Spacing (in meters): | 500.0 | Average Box Size: | <u> </u> |
| Grid Azimuth Dimension: | 144 | Max Velocity (m/day): | 10.0 |
| Grid Range Dimension: | 117 | Radius for Hole Filling: | 4 |
| Total Grid Points: | 16848 | | |
| Resampling Type: | | BICUBIC_INTERPOLATION | - |
| | | Z Spatial Average | |
| | | 💭 Fill Holes | |
| ROI Vector Mask: | | | • |
| | | Run | Close |

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Displacement

SAR offset tracking

SAR intensity



Velocity



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Velocity direction

$Layer \rightarrow Layer Manager$

Deselect Vector data

Click on the 🕣 button to open the Add Layer window

Select Coregistered GCP Movement Vector

Press Finish

Play around with Colour Manipulation using Sliders

| Navigation - [1] A | Colour Manipul 🕷 | Uncertainty Visual | World View |
|-----------------------|------------------|--------------------|------------|
| Editor: 🔘 Basic 🏾 💿 S | ilders 🔘 Table | | |



| File Edit View Analysis | Layer Ve | ctor Raster Optica | I Radar To | ols Window | v Help | |
|-------------------------|--|--------------------|------------|------------|-------------|----|
| 9988 | # | GCP S * | | Sen d | P+ GCP + | ++ |
| Product Explorer Pl | el Info | Layer Manager 🕺 | | | | |
| | Edit View Analysis Layer Vector Raster Optical Radar Tools Window Help | | | | | |
| 🛛 📝 🛊 [2] Velocity | _slv1_05N | ov2015 | | | | |



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Geocoding Velocity

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 $Radar \rightarrow Geometric \rightarrow Ellipsoid correction \rightarrow Geolocation Grid$

Adjust I/O Parameters

 \rightarrow set filename: 06_20151024_20151105_Orb_Stack_subset_vel_EC

Adjust Processing Parameters → choose Map Projection → UTM /WGS 84 (Automatic)

Press OK and Run

| C Ellipsoid Correction - Geolocation-Grid | C Ellipsoid Correction - Geolocation-Grid | 🙆 Map Projection |
|---|---|--|
| File Help | File Help | Coordinate Reference System (CRS) |
| I/O Parameters Processing Parameters Source Product source: [2] 04_20151024_20151105_Orb_Stack_subset_vel | I/O Parameters Processing Parameters Source Bands: Velocity_slv1_05Nov2015 Image Resampling Method: BILINEAR_INTERPOLATION Map Projection: UTM Zone 35 / World Geodetic System 1984 | Custom CRS Geodetic datum: World Geodetic System 1984 Projection: UTM / WGS 84 (Automatic) Projection Parameters Projection Parameters Projection Parameters CMPredefined CRS Select |
| Run Close | Run Glose | |



Export to GeoTIFF

Unfold 06_20151024_20151105_Orb_Stack_subset_vel_EC

Unfold Bands

Click on Velocity_slv1_05Nov2015 to select

 $\textit{File} \rightarrow \textit{Export} \rightarrow \textit{GeoTIFF}$

Filename: 07_20151024_20151105_Orb_Stack_subset_vel_EC_Geo.tif

| 0 | Open Product Reopen Product | |
|-----|---|---|
| 8 | Product Library | Layer Manager |
| | Close Product Close All Products Close Other Products | Orb_Stack_subset_vel Orb_Stack_subset_vel Orb_Stack_subset_vel_EC |
| | Save Product Save Product As | 015 |
| | Session Projects Import | |
| | Export | Other + |
| | Exit | SAR Formats CSV |
| Nav | igation Colour Manipulatio | GeoTIFF / BigTIFF n World View BEAM-DIMAP ENVI |
| - | CARLES STR | GeoTIFF |
| | 4 | HDF5 NetCDF4-BEAM NetCDF4-CF NetCDF-BEAM |

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QGIS

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Open QGIS

 $Project \rightarrow New$

Navigate to folder and open the following files (or drag and drop) 07_20151024_20151105_Orb_Stack_subset_vel_EC_Geo.tif 02_20151024_intensity.tif 02_20151105_intensity.tif





QGIS - Layer Properties

Double-click the velocity file to open *Layer Properties*

Change settings: *Render Type: Singleband pseudocolor Min: O Max: 9 Interpolation: Linear Color: Spectral* Check Invert *Mode: Equal interval Classes: 19*

| Band rende | ring | | | | |
|-------------------------|--|-----------|------|--------|----------|
| Render type | Singleband pseu | docolor 🔫 | | | |
| Band B | and 1 (Gray) | | | | |
| Mi | n | 0 | Max | 9 | |
| Load min/r | nax values – | | | | |
| Interpolation L | inear | | | | |
| Color | Spect | ral 🔹 | Edit | Invert | |
| Labelunit | oper | | Luit | | |
| suffix | | | | | |
| Min / max Us origin: | er defined | | | | |
| Value | Color | Label | | | 1 |
| 0.5 | | 5.5 | | | |
| - 1 | | 1 | | | |
| 1.5 | _ | 1.5 | | | |
| 2.5 | | 2.5 | | | |
| 3 | | 3 | | | |
| 3.5 | | 3.5 | | | |
| 4 | | 9 8 E | | | |
| | | 5 | | | |
| 5.5 | | 5.5 | | | |
| - 6 | 6 | 5 | | | |
| 6.5 | | 5.5 | | | |
| 7 | 1 | 7 | | | 7 |
| 7.5 | in the second se | 7.5 | | | 1 |
| 8 | - | | | | |
| Mode Equal inte | rval 🔻 | | | Cla | isses 19 |
| | | | | | |
| Classify | | | | | |
| Classify | # = | | | | |

QGIS – Profile Tool



Comparison to optical offset tracking

Plugins \rightarrow Manage and Install Plugins

| 🌠 QGIS | 2.18.1 | 2 - 201 | 51024_20 | 151105 | | | | | | | | |
|---------------|--------|---------|----------------|----------------------------|---------|--------|-------|--------|------|-------|------------|------|
| Project | Edit | View | Layer Settings | | Plugins | Vector | Raste | r Data | base | Web | Processing | Help |
| | | 8 | | Manage and Install Plugins | | | | | | Alt+P | | P |
| : <i>II</i> . | 1 | 6 | °°° | 6+ - | å /% | Ô | 00 | | 8 | abc | 1 (1) ab | aby |

Search: Profile tool



Select Profile Tool and press Install plugin



QGIS – Profile Tool

Draw line

Add Layer

How does the intensity look like?





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Thank you!

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