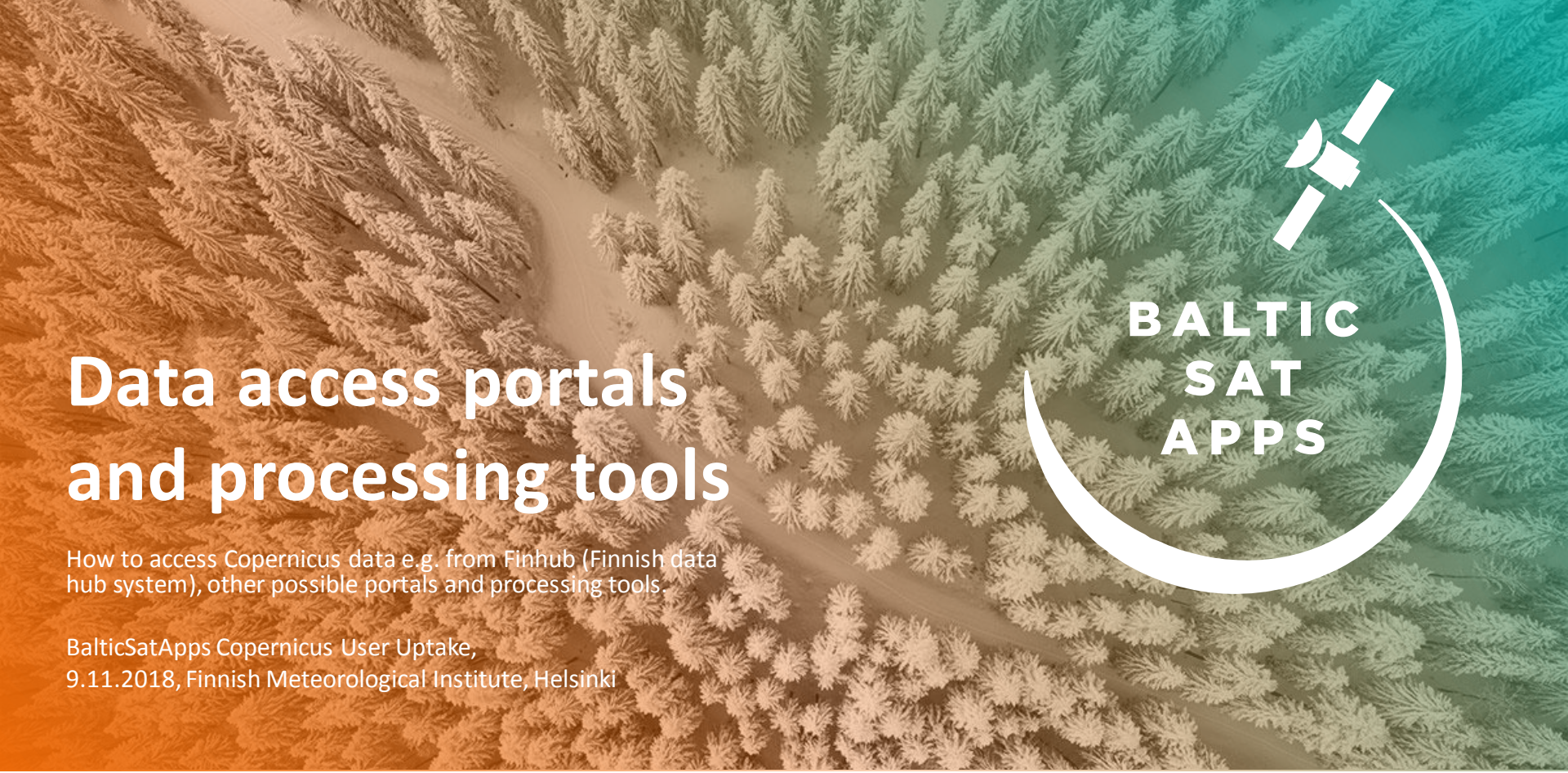

Data access portals and processing tools

How to access Copernicus data e.g. from Finhub (Finnish data hub system), other possible portals and processing tools.

BalticSatApps Copernicus User Uptake,
9.11.2018, Finnish Meteorological Institute, Helsinki

BALTIC SAT APPS

Interreg Baltic Sea Region

EUROPEAN UNION
EUROPEAN REGIONAL DEVELOPMENT FUND

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Finnish Meteorological Institute,
BalticSatApps Copernicus User Uptake,
9.11.2018, FMI, Helsinki

Copernicus Data Access Overview

Data Access

- 10 European Data Access points:
  - 4 for Satellite Datas
  - 6 for Services Data and Information
- Satellite data =
  - Access to images in NRT
  - Access to archives
- Services Data and Information=
  - Added value products, indicators
  - Models
  - Archives, Near Real Time and Forecasts products

Satellite data access

Finhub

- Finnish Meteorological Institute has the National Satellite Data Centre, NSDC, that maintains Finhub (Finnish Data Hub System) system https://finhub.nsdc.fmi.fi/#/home , where Sentinel data can be downloaded.

Copernicus Open Access Hub portal (previously SciHub)

- The Copernicus Open Access Hub (https://scihub.copernicus.eu/) portal is similar to FinHub portal for accessing the Sentinel Data. Therefore the steps are quite similar.

EUMETSAT CODA

Google Earth Engine

- Google Earth Engine (https://earthengine.google.com/) is free for research, education and nonprofit use. You have to sign in with your google account. In code editor platform you can use JavaScript/python to get data and make analysis. In code editor help there is information about the manual and user forum.

Amazon S3

Other national platforms

USGS Earth Explorer

DIAS (Data and Information Access Service)

COPERNICUS SERVICES

COPERNICUS SERVICES

BALTIC SAT APPS

Six thematic services

- Atmosphere
  https://atmosphere.copernicus.eu/
- Marine
  http://marine.copernicus.eu/
- Land
  https://land.copernicus.eu/
- Climate
  https://climate.copernicus.eu/
- Emergency
  http://emergency.copernicus.eu/
- Security
  https://copernicus.eu/main/security

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Overview of Sentinel data

- **Sentinel 1** has a C-band radar instrument on board. There are two Sentinel 1 satellites: Sentinel 1A and Sentinel 1B.
- **Sentinel 2** has a high resolution optical instrument on board. There are two Sentinel 2 satellites: Sentinel 2A and Sentinel 2B.
- **Sentinel 3** has several instruments on board: OLCI (Ocean and Land Colour Instrument), SLSTR (Sea and Land Surface Temperature Radiometer), SLAR (SAR Radar ALtimeter), MWR (MicroWave Radiometer), GNSS (Global Navigation Satellites Systems), DORIS (Doppler Orbit determination and Radio-positioning Integrated on Satellite) and LRR (Laser Retro-Reflector).
- Satellite data can be in different acquisition modes (for Sentinel 1: SM, IW, EW or WV), polarisations (for Sentinel 1: HH, VV, HH+HV or VV+VH) and product types (for Sentinel 1: SLC, GRD or OCN). There can be different levels of satellite data: For Sentinel 1 Level0 (raw data), Level1 (raw data with correction, in SLC or GRD modes) and Level2 (derived geophysical variables, in OCN mode). More information about Sentinel satellites can be found from http://www.copernicus.eu/main/sentinels .

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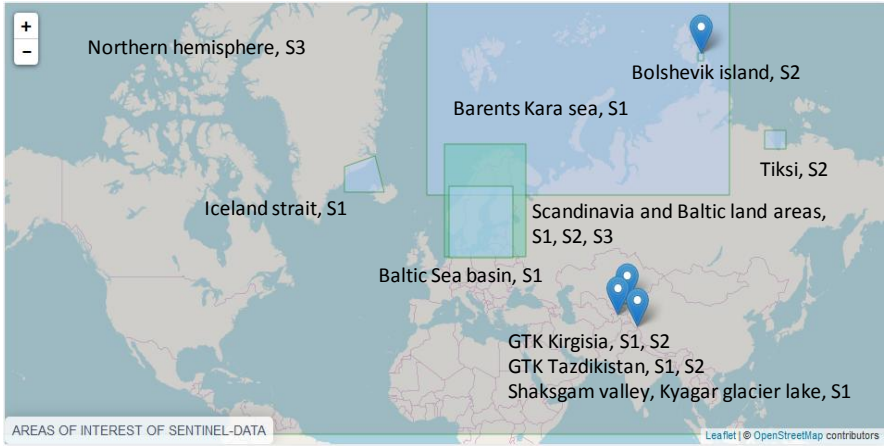
Finhub – Finnish Data Hub System

- Finnish Meteorological Institute's (FMI) National Satellite Data Centre (NSDC) provides a portal called Finhub (Finnish Data Hub System)
- Finhub is the Finnish Sentinel collaborative ground segment
- Access to Sentinel data and products
  - Sentinel 1
    - Level-0 and Level-1: SM (strip map), IW (interferometric wide swath), EW (extra wide swath) modes
    - Level-2: Wv (wave) mode, IW, EW
  - Sentinel 2
    - Level-1C user products
  - Sentinel 3
    - Level-0, Level-1 and Level-2



The areas of interest in Finhub portal (http://nsdc.fmi.fi/services/service_finhub_area)

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Data access

- The data from Finhub can be downloaded after registration
  http://nsdc.fmi.fi/services/service_finhub_registration
- Products in .zip file format
  S1B_EW_GRDM_1SDH_20180227T155513_20180227T155617_009811_011BC1_DDB3.SAFE.zip (268 MB)
  S2A_MSIL1C_20180219T094031_N0206_R036_T34VFM_20180219T114031.SAFE.zip (431 MB)
  S3A_OL_1_EFR____20180219T092115_20180219T092415_20180220T131324_0180_028_093_1980_LN1_O_NT_002.SAFE.zip (651 MB)
- The data can be accessed
  - Graphical User Interface (GUI)
  - Batch scripting

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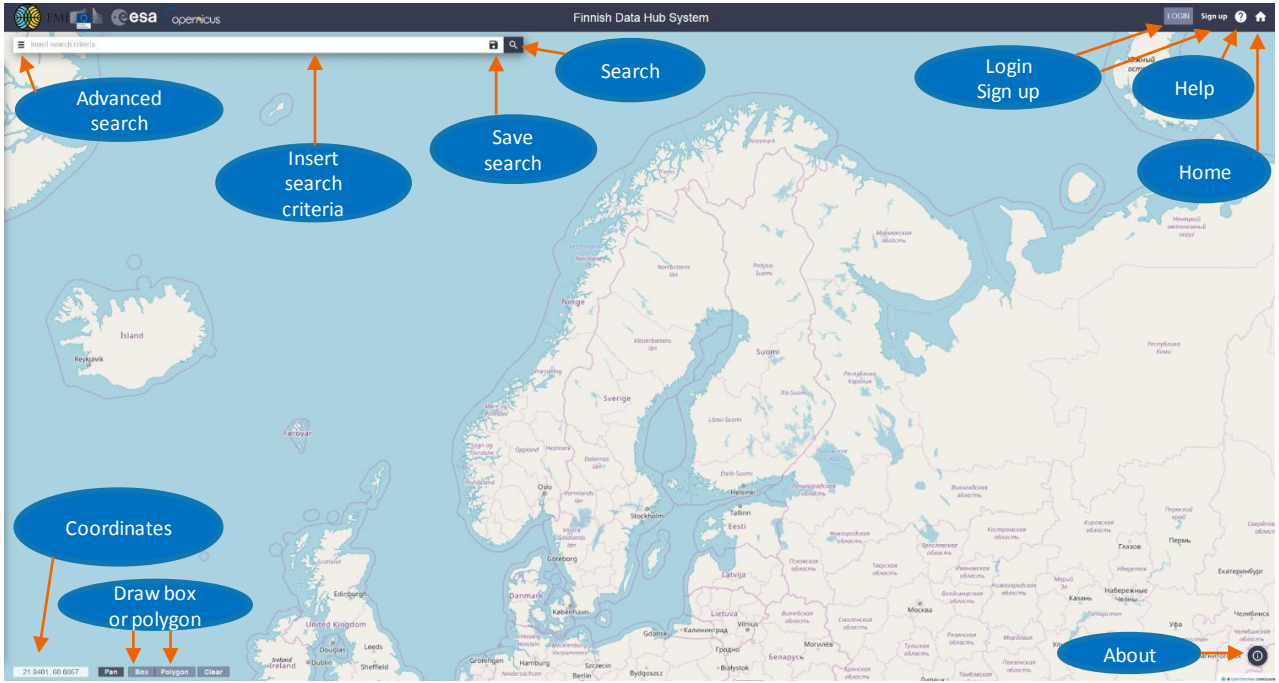
GUI

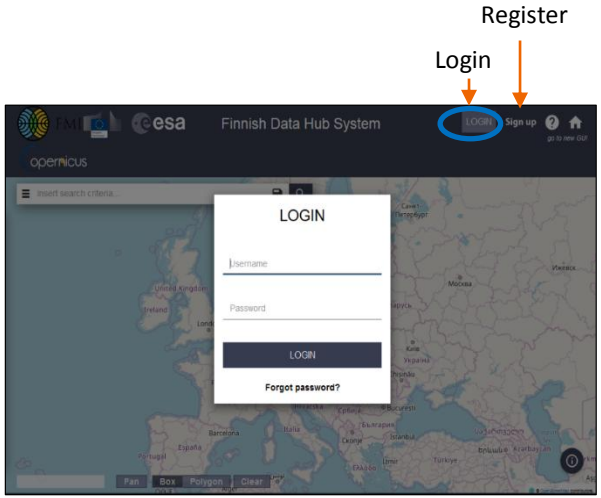
Graphical User Interface



- **Advanced search**: Opens a form where you can select your search criteria. You can close the form by clicking again.
- **Insert search criteria**: Here you can give the search criteria in full text (see Help)
- **Save search**: Here you can save your search
- **Search**: To start the search
- **Login**: To login to the system
- **Sign up**: To register to the system
- **Help**: Link to the User guide
- **Home**: Link to the homepage of Sodankylä national satellite data centre (nsdc.fmi.fi)
- **Coordinates**: Gives the coordinates on the map
- **Draw box or polygon**: Here you can click to draw a box or a polygon. You can also clear it.
- **About**: Information about Finhub

Steps to access data

1) **Register** as a user. In Finhub (Finnish Data Hub System) Graphical User Interface (GUI) portal https://finhub.nsdc.fmi.fi/#/home it can be done by clicking *Sign up* or using address http://nsdc.fmi.fi/services/service_finhub_registration
   - Fill out the form
   - Email is sent by the Finhub support team to the user
   - Confirmation by the user
2) **Login** the Finhub portal (https://finhub.nsdc.fmi.fi/#/home) by clicking the *Login*.



Step 2

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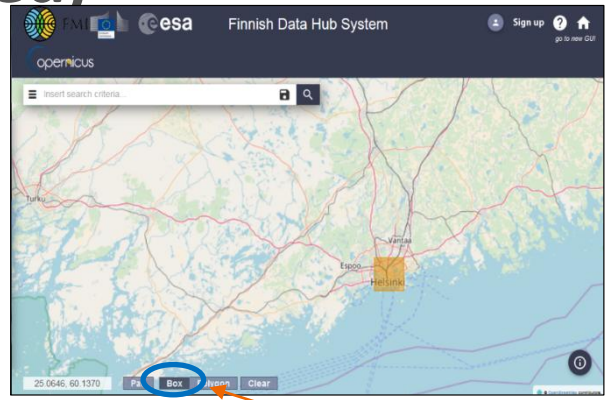
26.12.2018

Steps to access data (continued)

3) **Draw the area** of interest as a box or a polygon (by clicking *Box* or *Polygon* and drawing the area). You can clear the area by clicking *Clear*. (If drawing a box is not working, try Chrome instead of Firefox)

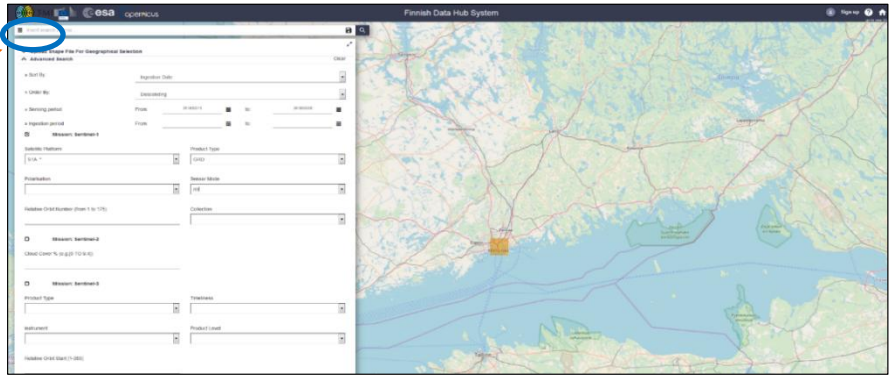
4) **Search criteria** can be given by clicking *Advanced Search* to define sensing time period and the satellite mission (S1, S2 or S3) with different parameters (such as product type, Instrument and product level). In advanced search you can give the area of interest also as a shape file. You can also save your search by clicking *Save search*.



Step 3

Draw the area

Search criteria



Step 4

26.12.2018

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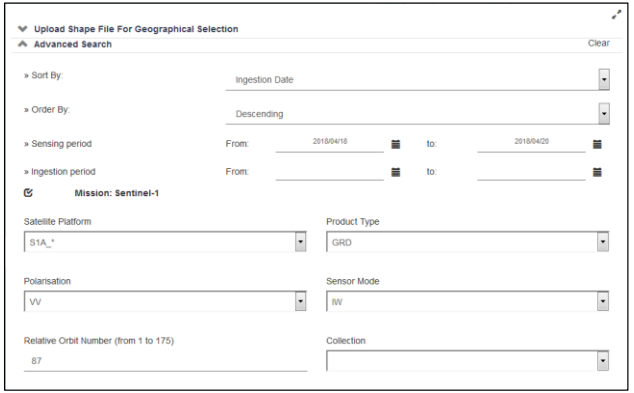
More about search criteria

1) Using Advanced search form

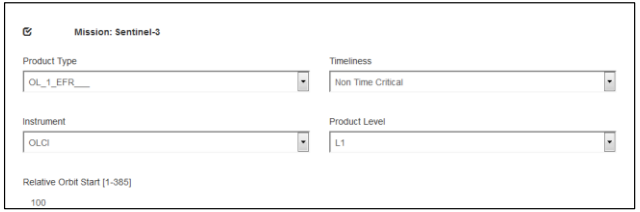
Defined parameters:

- Sort by Ingestion date/Sensing date/Cloud coverage
- Order by Descending/Ascending
- Give Sensing period
- Give Ingestion period
- Select Mission: Sentinel 1
    - Satellite platform: S1A/S1B
    - Product type: SLC/GRD/OCN
    - Polarisation: HH/VV/HV/VH/HH+HV/VV+VH
    - Sensor mode: SM/IW/EW/WV
    - Relative orbit number: 1 to 175
    - Collection: S1B_24AUG2016
- Select Mission: Sentinel 2
    - Cloud cover % (e.g. 0 to 9.4)
- Select Mission: Sentinel 3
    - Product type:DO_0_DOP/DO_0_NAV/GN_0_GNS/MW_0_MWR/MW_1_CAL/MW_1_MWR/OL_0_CR0/OL_0_CR1/OL_0_EFR/OL_1_EFR/OL_1_EFR_BW/OL_1_ERR/OL_1_ERR_BW/OL_1_RAC/OL_1_SPC/OL_2_LFR
    - Timeliness: Near Real Time/Short Time Critical/Non Time Critical
    - Instrument: OLCI/SLSTR/SRAL/DORIS/MWR/GNSS/SYNERGY/HKTM/NAVATT
    - Product level: L0/L1/L2
    - Relative orbit start: 1-385



Sentinel 1

Sentinel 2



Sentinel 3

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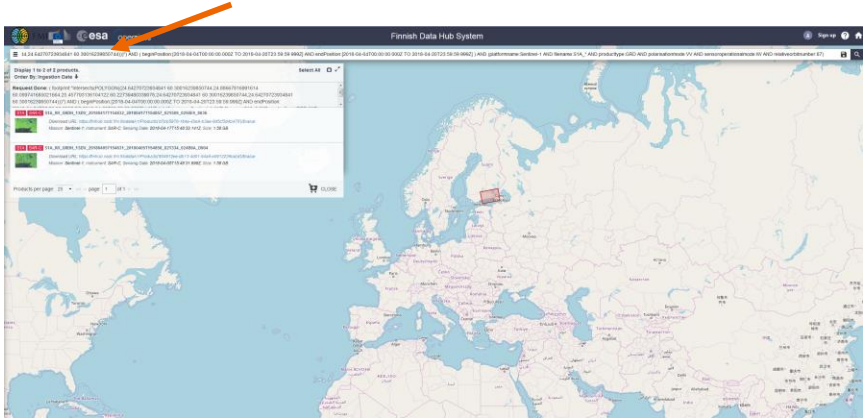
More about search criteria (continued)

2) Using Insert search criteria bar

Defining parameters:

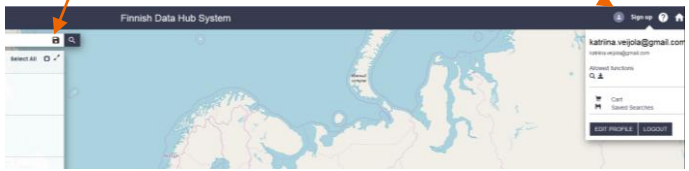
- In the *Insert Search criteria* bar you can give searching parameters in full text and change for example the track number to make a new search with different parameters.

(footprint:"Intersects(POLYGON((24.64270723934841 60.30016239850744,24.88667816991614 60.089741685021664,25.457793136104122 60.22739480339078,24.64270723934841 60.30016239850744,24.64270723934841 60.30016239850744)))") AND (beginPosition:[2018-04-04T00:00:00.000Z TO 2018-04-20T23:59:59.999Z] AND endPosition:[2018-04-04T00:00:00.000Z TO 2018-04-20T23:59:59.999Z]) AND (platformname:Sentinel-1 AND filename:S1A_* AND producttype:GRD AND polarisationmode:VV AND sensoroperationalmode:IW AND relativeorbitnumber:87)



Profile with cart and saved searches

Save search parameters

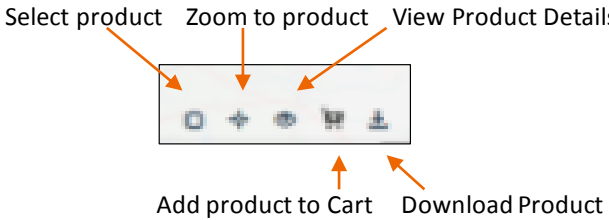


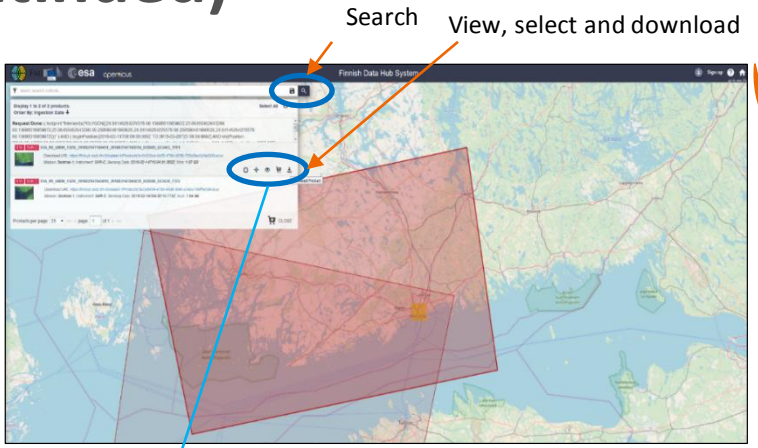
- List of possible text queries used in full text search are given in http://nsdc.fmi.fi/services/service_finhub_full_text. Those can also be used in batch scripting.

Steps to access data (continued)

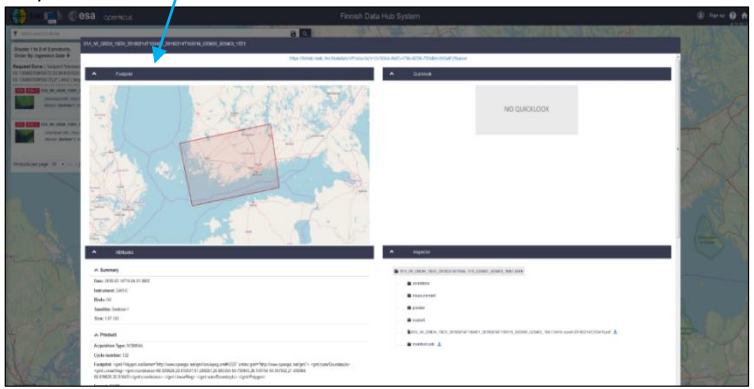
5) **Search** is started by clicking the *Search* button (magnifying glass). The list of results with quicklooks are retrieved and shown on the left and the footprints of the satellite images are shown on the map.

6) **View, select and download**: From the list, the ones you want can be selected, zoomed to the product, viewed product details, added to chart or downloaded to your computer. It's possible to first save the results to a chart and then download later several products at the same time. In chart panel you can see the products you have added there.





Step 5



Step 6

APIs and batch scripting (1/2)

- Another option is to use **APIs and batch scripting** if you prefer more automated way to download and process data.
- There are two Application Program Interfaces (APIs) to browse and access the Earth Observation (EO) data:
    - Open Data Protocol (OData)
    - Open Search (Solr).

- Here are a couple of examples how to use wget to access Sentinel data or how to use a script called dhusget.

Using wget to querying and downloading data

- The following finds the latest 10 Sentinel 1 GRD IW images from FinHub over greater Helsinki area and saves the result to search.xml file:

```
wget --user=username --password=password -O search.xml "https://finhub.nsdc.fmi.fi/search?q=platformname:\"Sentinel-1\"+producttype:GRD+AND+swathIdentifier:\"IW\"+AND+footprint:\"Intersects(24.95+60.24)\"&rows=10"
```

APIs and batch scripting (2/2)

- The following finds the latest 10 Sentinel 2 images from FinHub over greater Helsinki area and saves the result to search.xml file:
  - wget --user=username --password=password -O search.xml "https://finhub.nsdc.fmi.fi/search?q=platformname:\"Sentinel-2\"+AND+footprint:\"Intersects(24.95+60.24)\"&rows=10“

- After querying the data, the download URL and the actual file name need to be parsed from search.
- From the search.xml file we can find for instance one example of S1 file: S1A_IW_GRDH_1SDV_20180214T160451_20180214T160516_020605_023463_1EE1 with UUID e10430bd-4b85-479b-9256-785d8ec6b5a9. We can load the file with this code in wget:
  - wget --user=username --password=password -O S1A_IW_GRDH_1SDV_20180214T160451_20180214T160516_020605_023463_1EE1.SAFE.zip https://finhub.nsdc.fmi.fi/odata/v1/Products('e10430bd-4b85-479b-9256-785d8ec6b5a9')/\$value/

Using dhusget script

- There is also a script called dhusget (http://nsdc.fmi.fi/services/dhusget.sh), which illustrates how to use OData and OpenSearch to data query and product download from DHuS (Data Hub Software). It enables to search products over the area of interest, to filter by product type and/or ingestion time and to download the products or manifest files only. It requires installation of wget.

Processing tools

- SNAP

Processing with SNAP software

- After the file has been downloaded, it can be further processed for example in SNAP software (http://step.esa.int/main/toolboxes/snap/). SNAP has both Graphical User Interface (GUI) and API interface for batch processing purposes.

Using SNAP GUI

- There are several good tutorials showing how to use SNAP tool for processing satellite data of different satellites and for different purposes. One example of using SAR (from Sentinel 1) data with SNAP tool is in this tutorial (http://sentinel1.s3.amazonaws.com/docs/S1TBX%20SAR%20Basics%20Tutorial.pdf). Another example of using high resolution optical data (from Sentinel 2) is given in (https://www.youtube.com/watch?v=fhQfuznO85I&feature=youtu.be). Information about using medium resolution optical Sentinel 3 data can be found from (http://step.esa.int/main/wp-content/uploads/2015/06/Sentinel-3-Toolbox-Basic-Tutorial.pdf). More tutorials can be found in http://step.esa.int/main/doc/tutorials/ . Graph building can be used to make processing with SNAP GUI more automatic (https://www.youtube.com/watch?v=J4I6K1jTCHk).

SNAP API and command line processing

- SNAP's API is a Java API and it is possible to be used from Python. Either standard python or SNAP's Jython can be used for that (see advantages and disadvantages in https://senbox.atlassian.net/wiki/spaces/SNAP/pages/19300362/How+to+use+the+SNAP+API+from+Python).
- In your python scripts, you can call SNAP code and SNAP can be extended by plugins that are written in Python. SNAP has a Python module called snappy to access SNAP API from python (see http://step.esa.int/main/community/developers/). Examples of codes to use SNAP API in Python are found from <snappy-dir>/examples and testdata from <snappy-dir>/testdata.
- Information about command line processing can be found from here http://sentinel1.s3.amazonaws.com/docs/SNAP_CommandLine_Tutorial.pdf

Python plugins

- New raster data processor plugins (operators) can be used from the command line or using SNAP GUI and used as nodes in processing XML graphs.

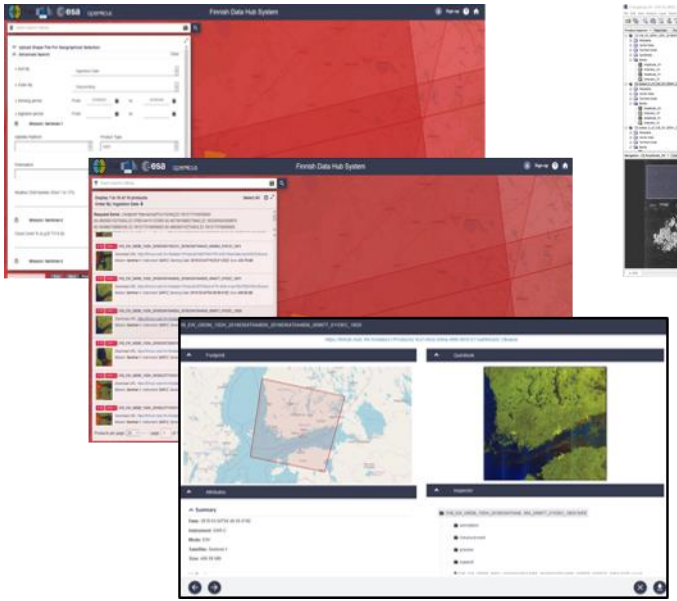
Processing tools cont.

- QGIS
  - One way to view and process Sentinel data is to use QGIS (https://qgis.org/). It is a free and open source software.
  - There is also a plugin for QGIS https://qgis.org/ (SCP Semi-Automatic Classification Plugin) that can be used to download and process satellite images https://fromgistors.blogspot.com/p/semi-automatic-classification-plugin.html .
  - After processing and exporting the satellite image from SNAP, it can be opened in QGIS to view and process further. It can be opened e.g. on top of Google maps or OpenStreetMap.
- ESRI
  - http://www.arcgis.com
- Pytroll
  - One way to process Sentinel data is to use Pytroll (http://pytroll.github.io/). It is a free and open source python framework to process Earth Observation (EO) satellite data. The packages, supported satellites, tutorials and examples can be found from the home page of Pytroll.
- SatPy
  - With SatPy package you can read many Level-1 and Level-2 products, resample, make RGB images and save e.g. as netcdf, GeoTIFF or png images. The documentation for SatPy can be found from http://satpy.readthedocs.io/en/latest/ .
- Google Earth Engine
- DIAS platforms

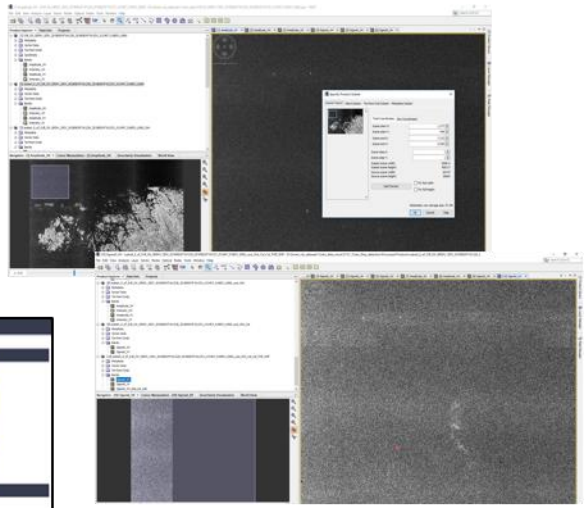
Example of ship detection

- Sentinel 1 data used, 24.8.2018,
  S1B_IW_GRDH_1SDV_20180824T161226_20180824T161251_012407_016E01_6560.data

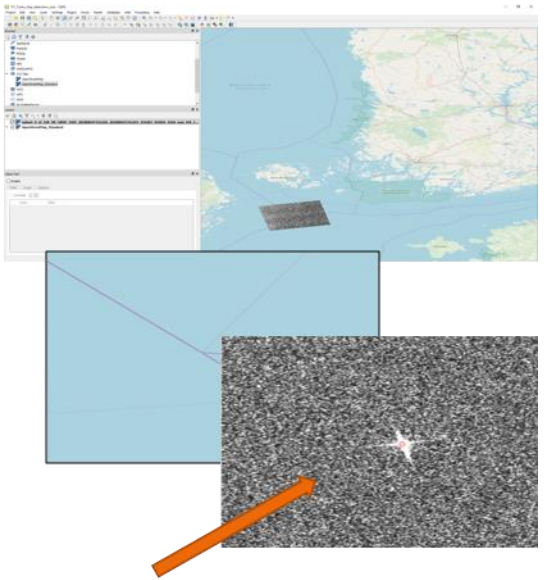
Finhub



SNAP



QGIS



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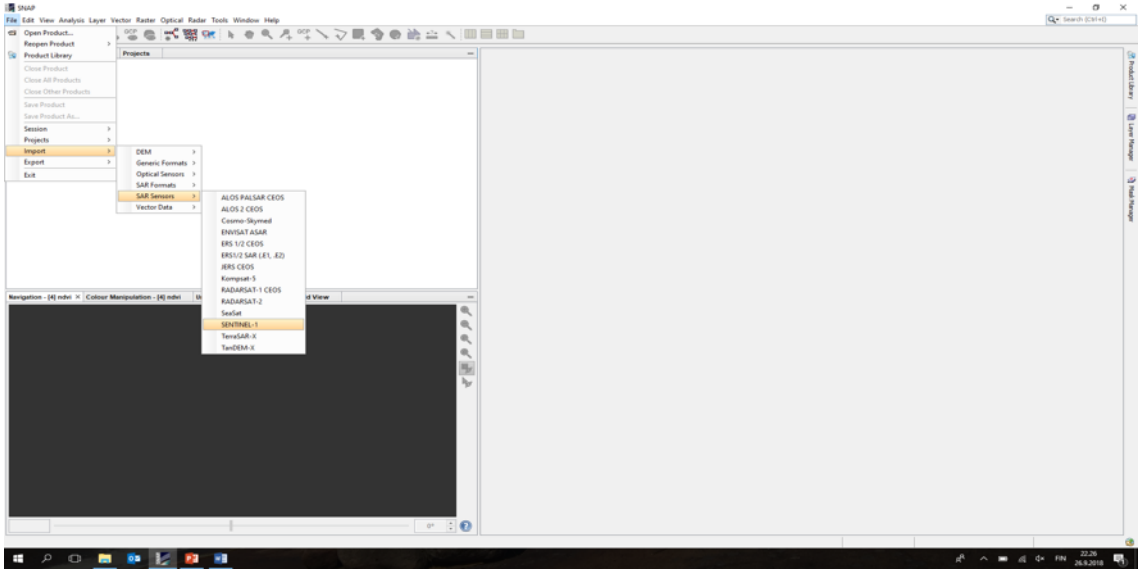
Ship detection

1) **We import the data that we have downloaded from Finhub to SNAP (Sentinel Application Platform) software**

S1B_IW_GRDH_1SDV_20180824T161226_20180824T161251_012407_016E01_6560.data



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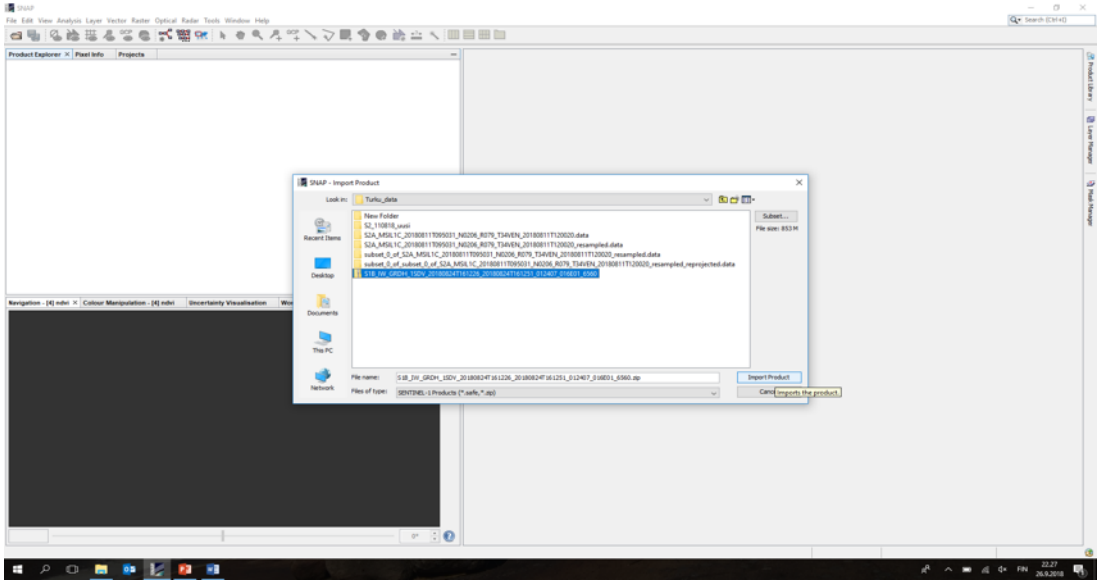
Ship detection

2) **We browse for the product and open it.**



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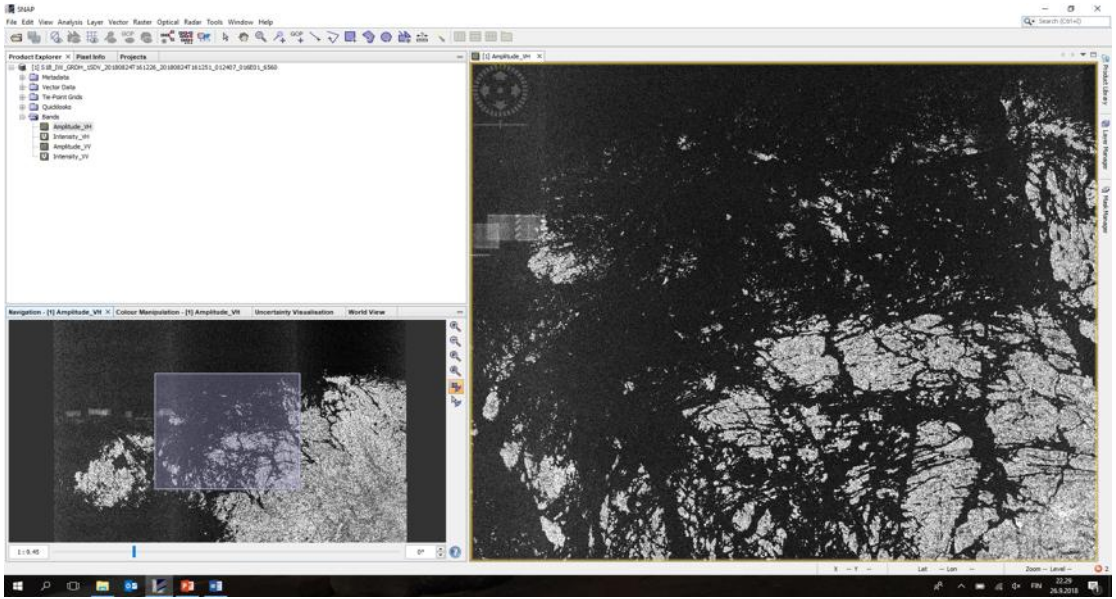
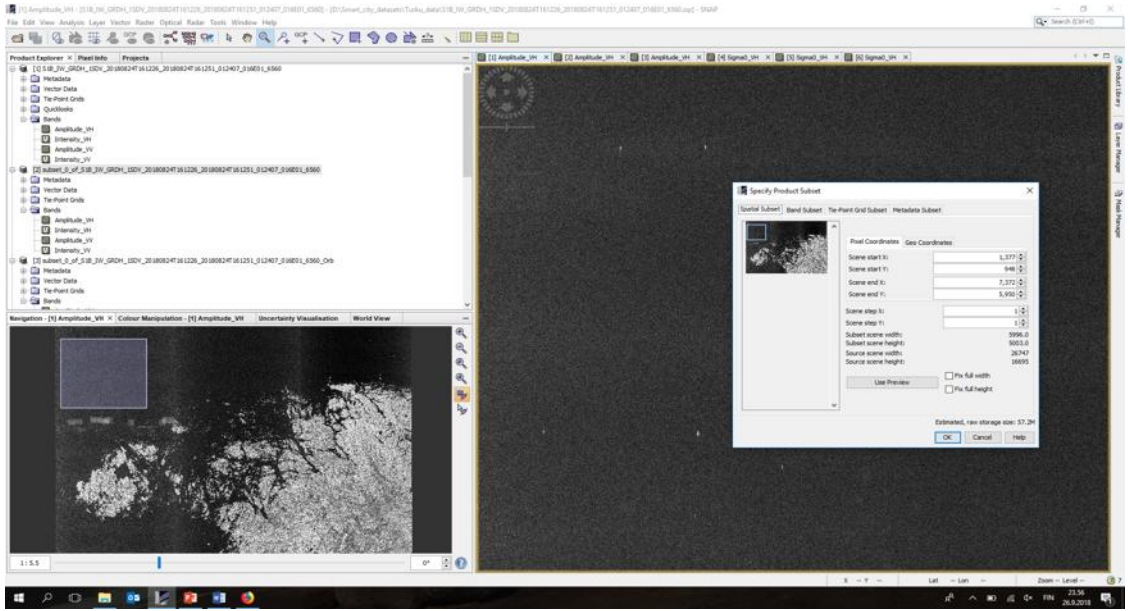
Ship detection

3) We open the Amplitude_VH band to view the image.



Ship detection

4) **We take a subset of the image from the sea area.**



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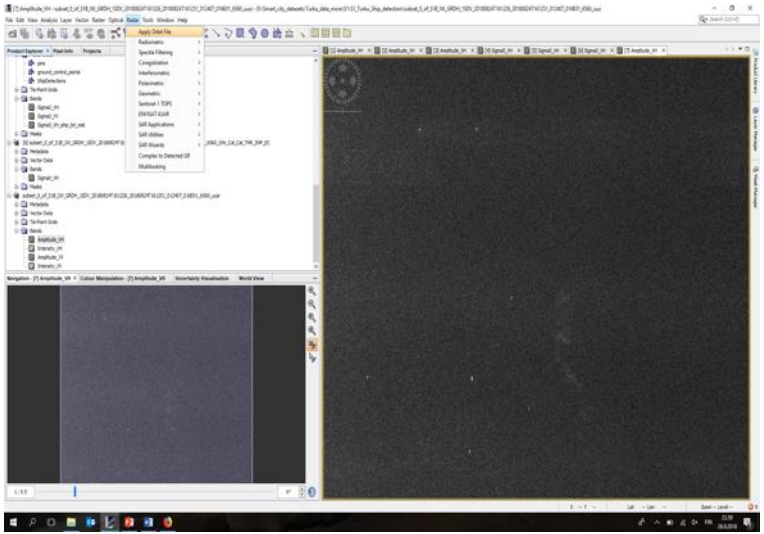
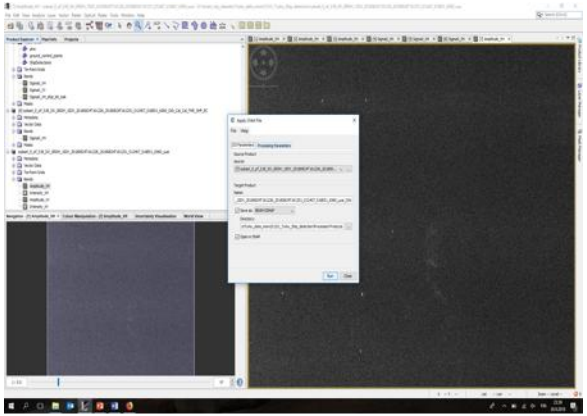
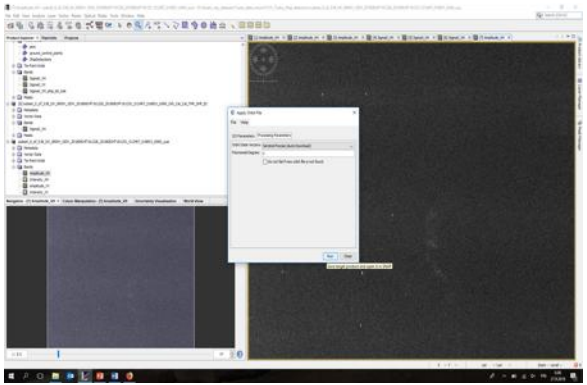
Ship detection

5) **We apply orbit file.**







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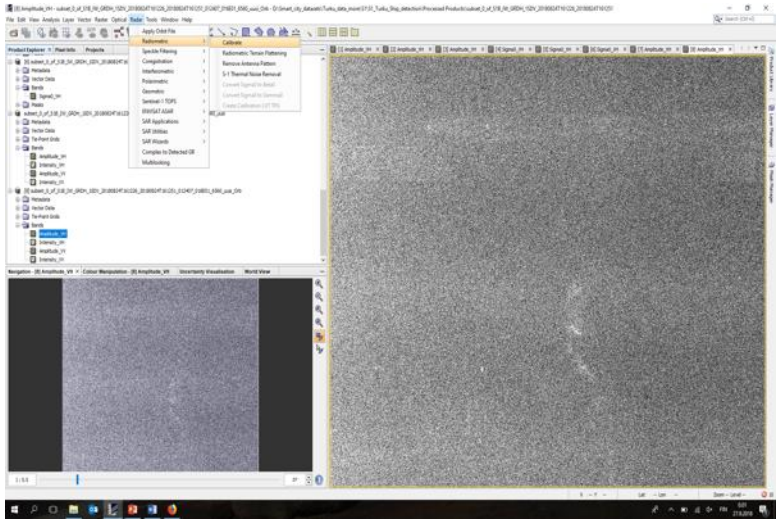
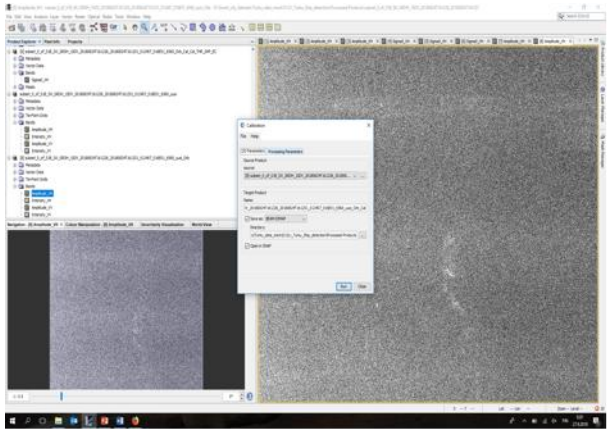
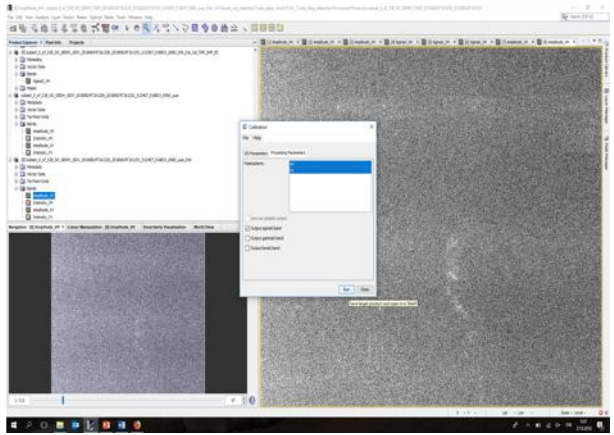
6) **We make radiometric calibration.**







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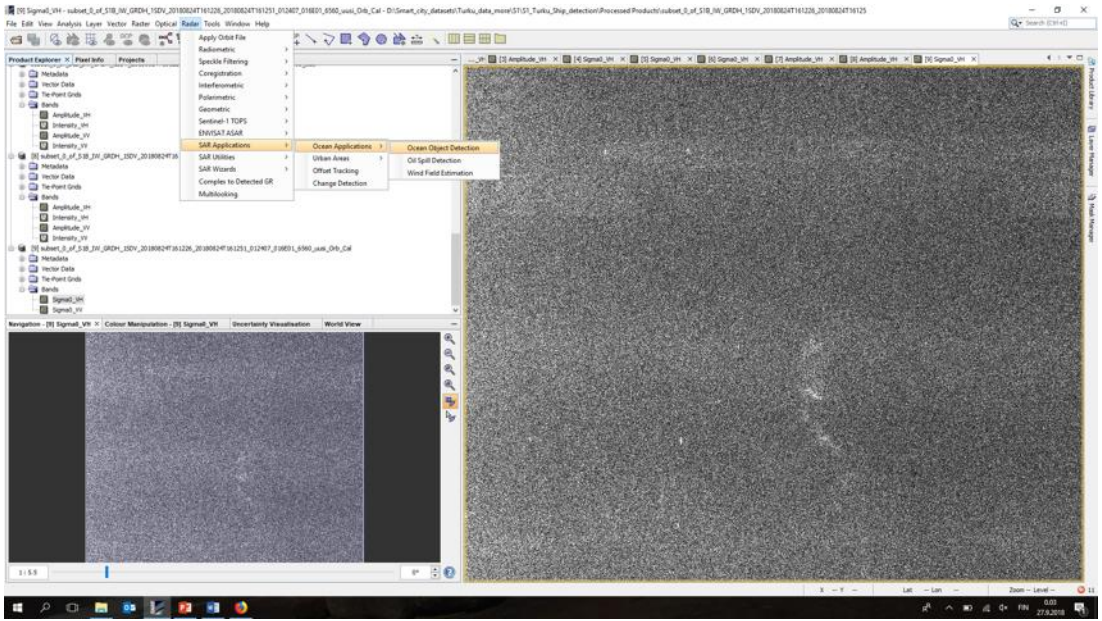
7) We use Ocean object detection SAR application of SNAP.



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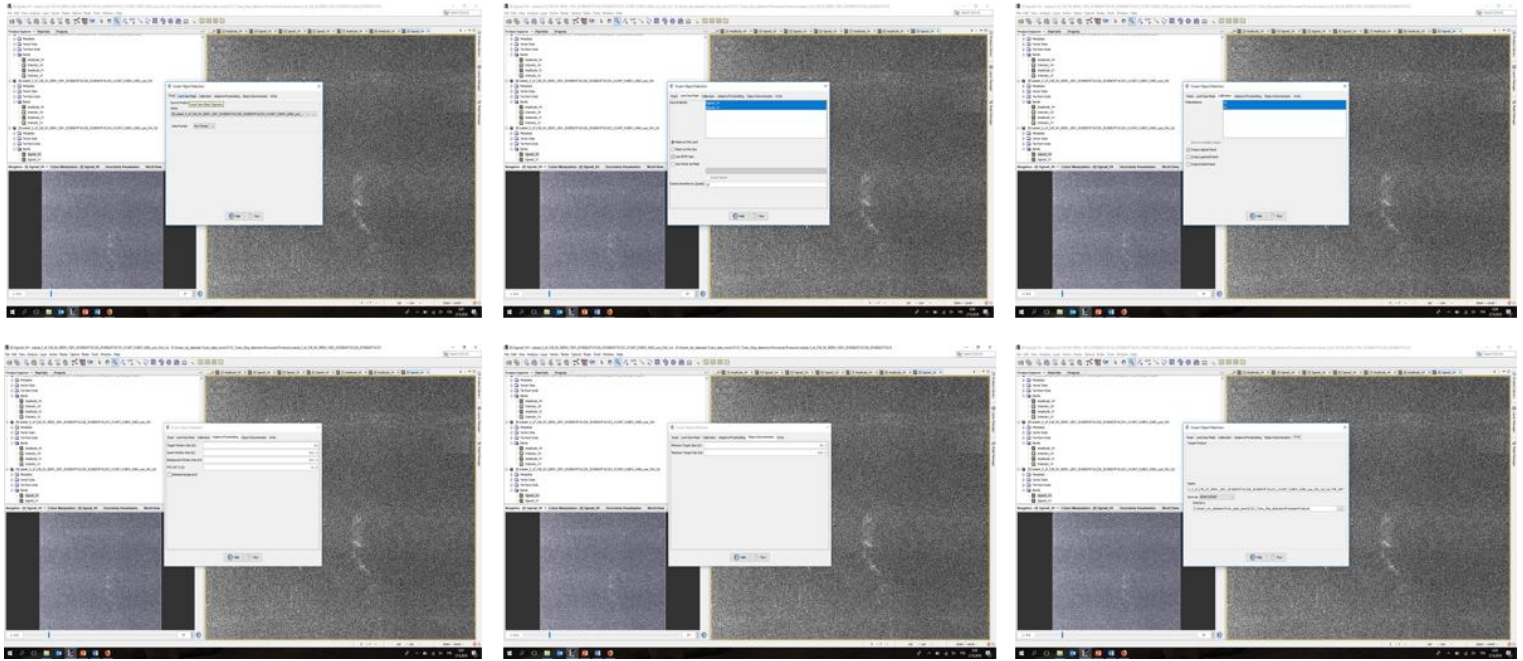
8) We go through the windows.



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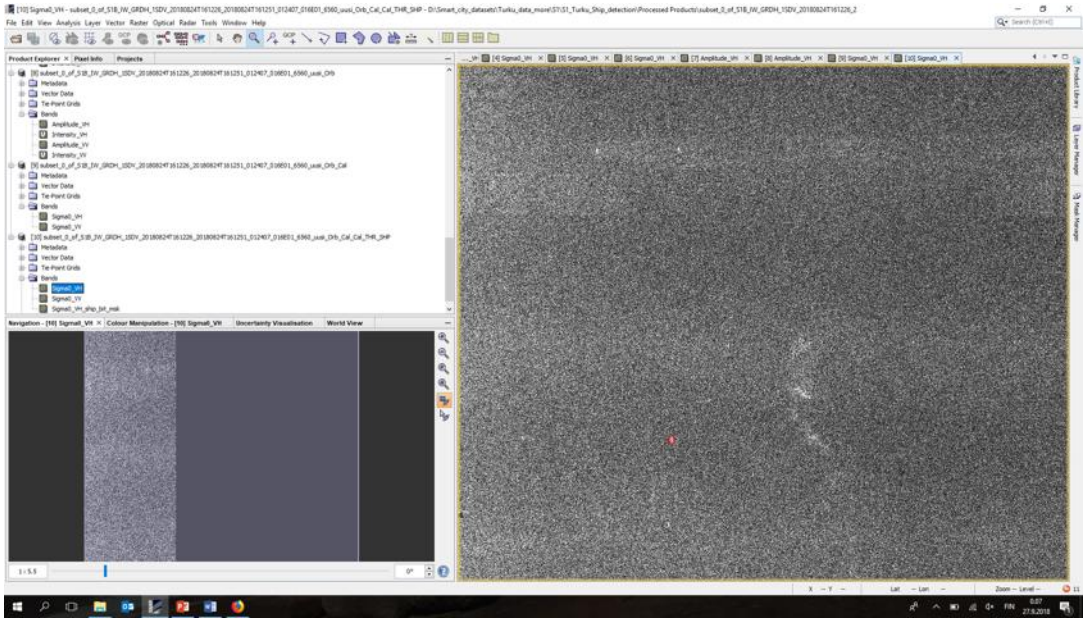
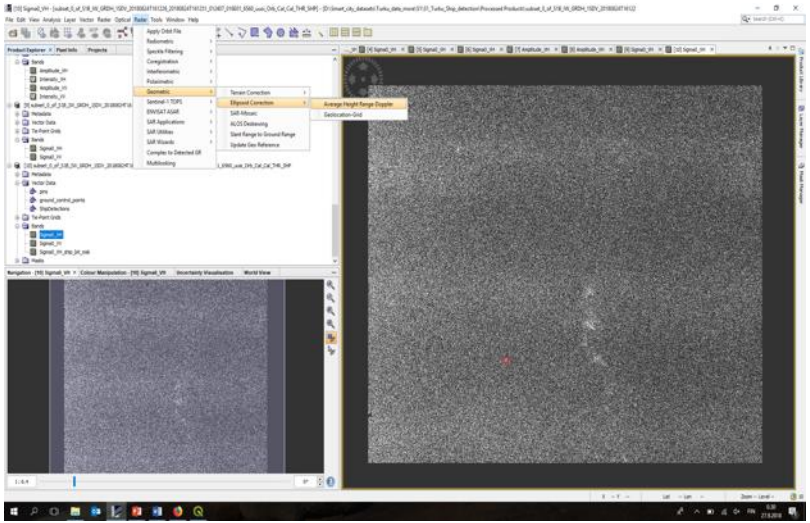
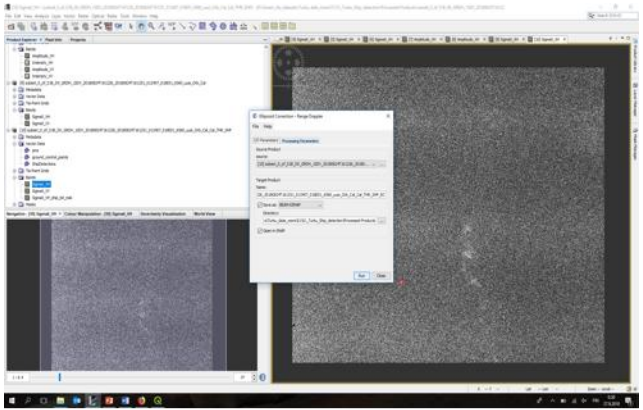
9) **The detected ship is shown with a red mark.**

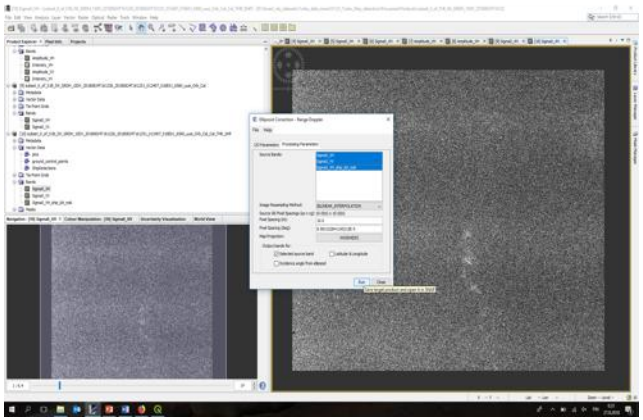


Ship detection

10) **We make ellipsoid correction**







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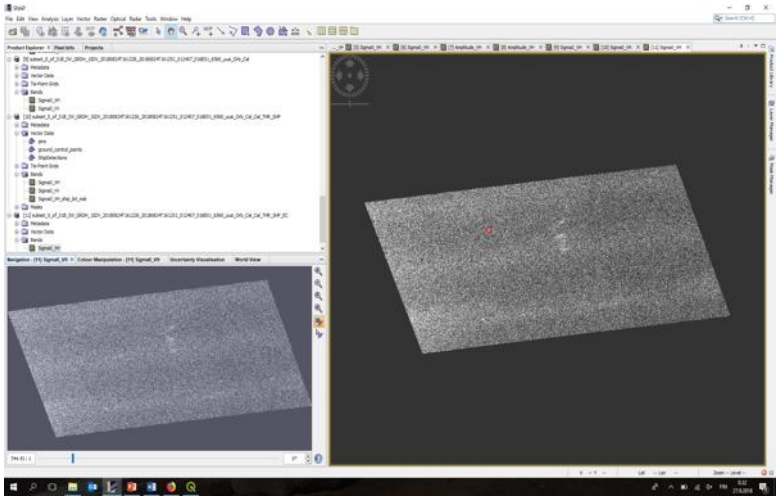
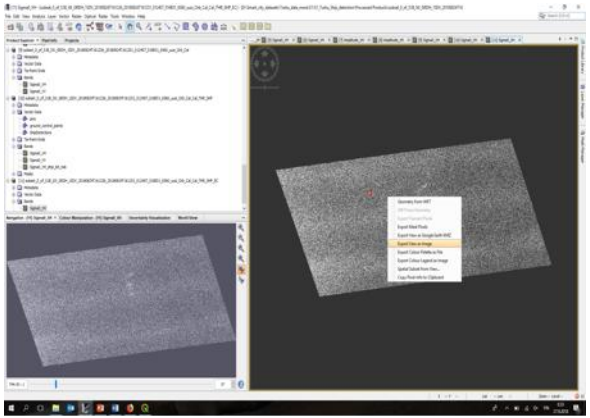
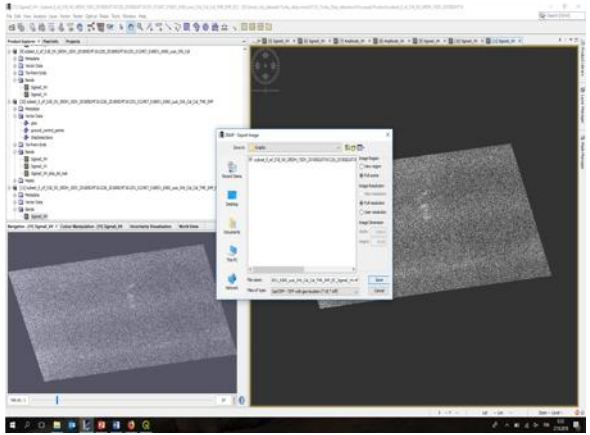
11) **We get the ellipsoid corrected image and export the view as image.**

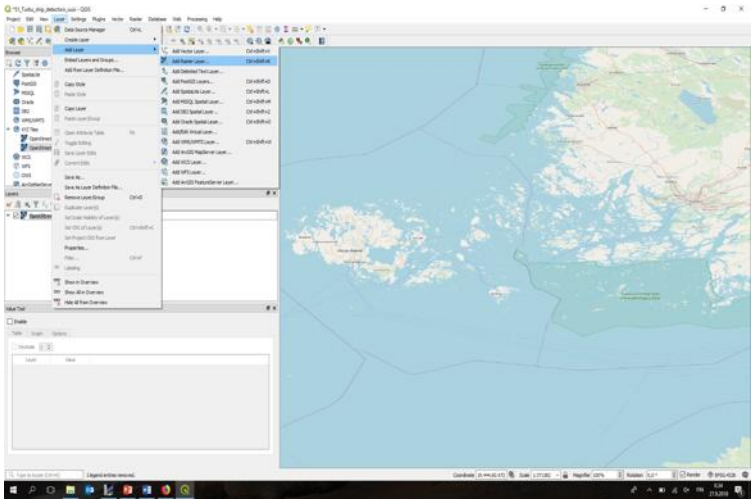


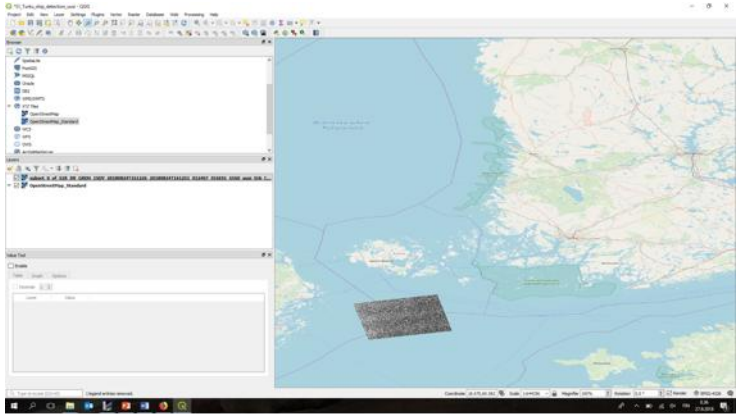


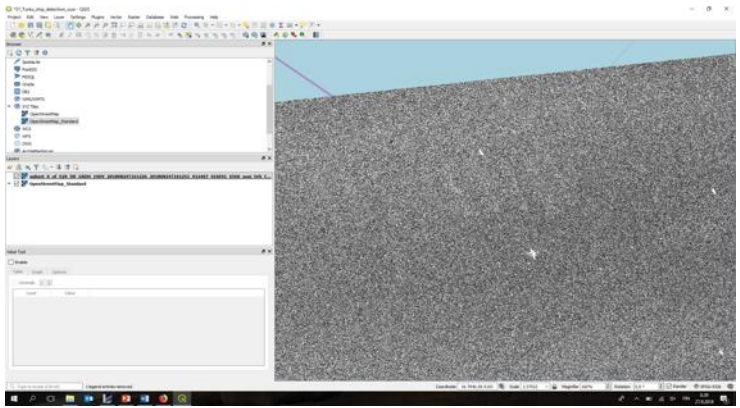


Ship detection

12) **We open the image layer in QGIS software.**







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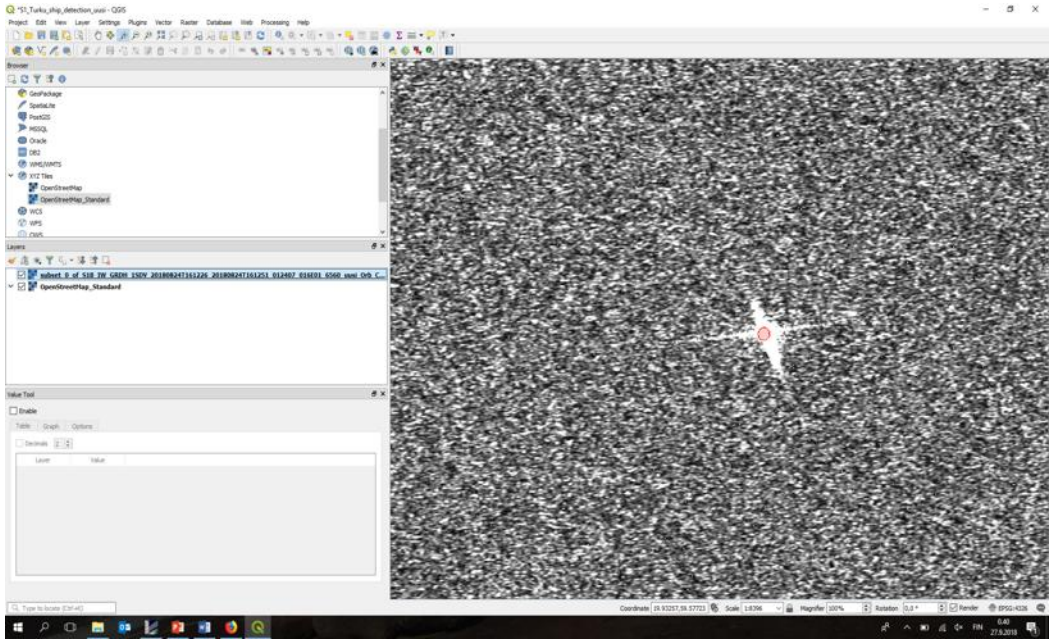
13) **We have now detected the ship on the sea.**



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Thank you!

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