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satellittdata.no

Copernicus Sentinel Data in an Open Data Space

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Halsne, T., Ferrighi, L., Stefano, M., Budewitz, N., Dinessen, F., Saadatnedjad, B., Fernandez, E., and Wangensteen, B.



Courtesy of
Floor van der Heuvel @ SIOS
<https://sios-svalbard.org/>

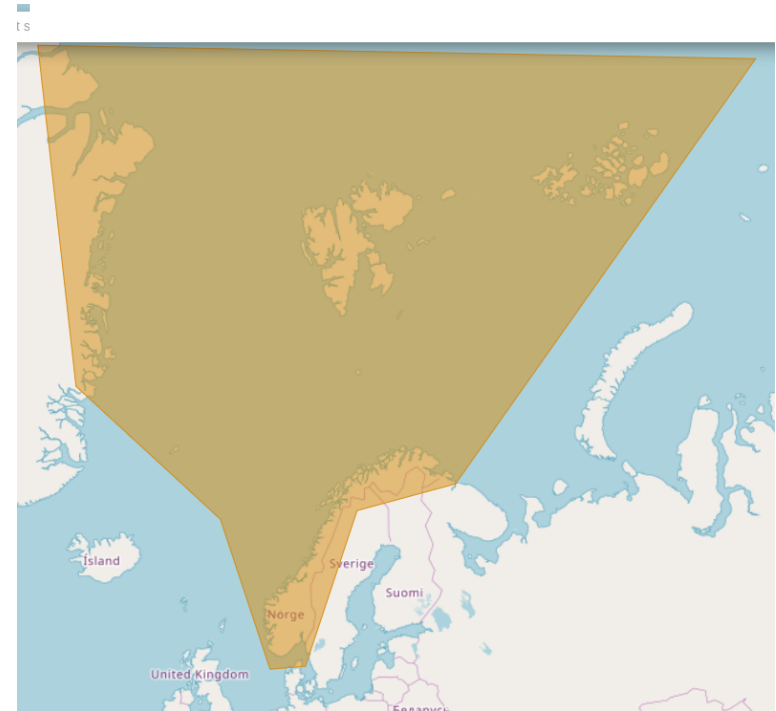
Space based Earth Observation is **one amongst many** “tools” in order to observe, understand and quantify the ongoing processes on the Earth.

*It (EO data) is not **the** solution for all problems, but **part of the** solution for many problems.*

- Dr. Anja Strømme

General information

- Organisation
 - Project owner
 - Norwegian Space Agency
 - Technical implementation
 - Norwegian Meteorological Institute
- Area of interest
 - Arctic and Antarctica
- Objectives
 - To simplify access to Copernicus Sentinel data for national users
 - To ensure support for national services
 - To preserve data in the Norwegian AOI
 - To integrate with decision support systems
 - To integrate data in an open data space
 - linking with other EO data, e.g. model, in-situ
 - To support the National ground Segment as a distributed network of data centres nationally
- <https://www.satellittdata.no/>



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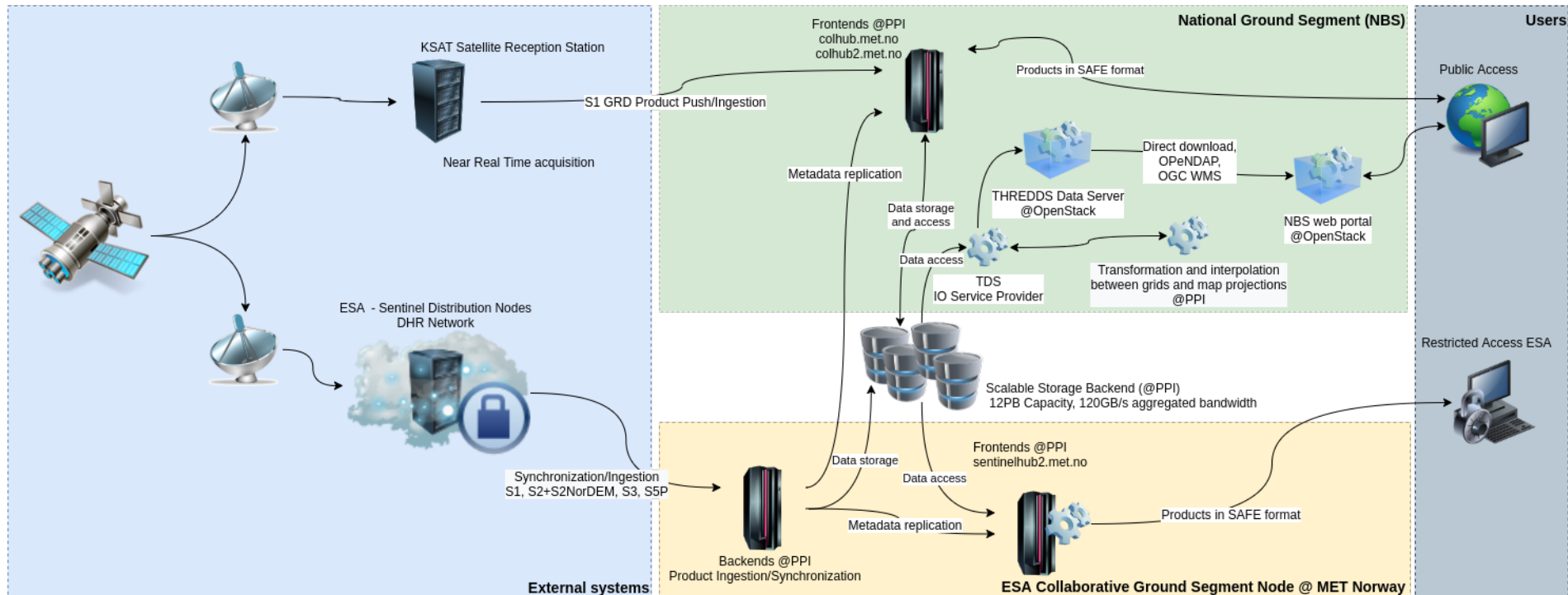


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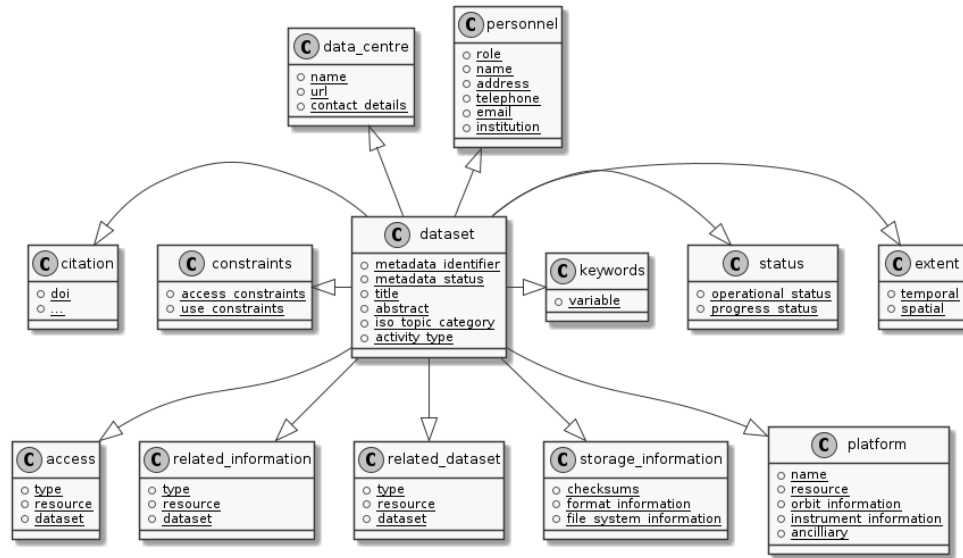
Implementation

National Ground Segment (NBS)

Sub systems and data flow



Technical framework



- Infrastructure

- High Performance Computer (@PPI), Virtual Machines (@OpenStack), Containers (currently only in staging)
- High Performance Data Storage
- High Performance Network Connection

- Metadata

- OAI-PMH, (OpenSearch, OGC CSW)

- Data

- Access mechanisms
 - Direct download, OData, OPeNDAP, OGC WMS, OGC WPS
 - Aligned with ESGF, CMEMS, C3S etc.
- File formats
 - SAFE, NetCDF-CF, GeoTIFF

Data served

SAFE

Products	13 967 955
Users	673

Product overview total		
S1A		1 296 879
	GRD	490 765
	SLC	298 367
	OCN	158 923
	RAW	348 824
S1B		1 108 472
	GRD	445 589
	SLC	238 215
	OCN	123 035
	RAW	301 647
S2A		4 616 341
S2B		4 389 989
S2 DTER		30 658
S3A		1 333 974
S3B		1 208 143

NetCDF-CF

Products	454 769
Users	284

Product overview total		
S1A		50 058
	GRD	50 058
	SLC	
	OCN	
	RAW	
S1B		63 674
	GRD	63 674
	SLC	
	OCN	
	RAW	
S2A		215 368
S2B		125 482
S2 DTER		29 032
S3A		0
S3B		0

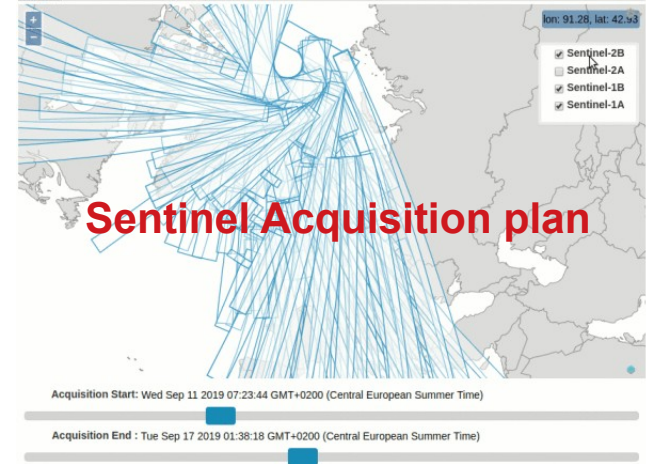
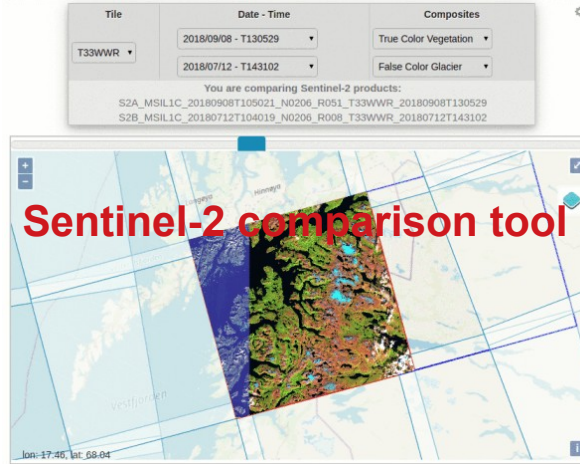
- Users from
 - Norway
 - Germany
 - USA
 - .net/.org/.com/.us/.eu domains
- About 1000 user requests each month
 - In addition a factor 25 ineligible requests
- About 100 users actively accessing data over OPeNDAP each month



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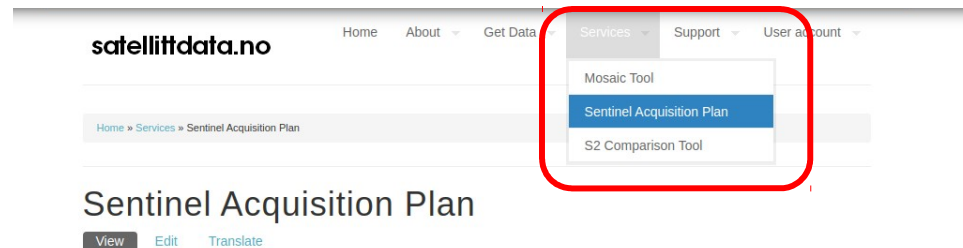


Geonorge Sentinel-2 Mosaic

The Norwegian Mapping Authority @ (Kartverket) has produced a cloud free national mosaic from Copernicus Sentinel-2 Level-2A data which has free access and is openly available. The dataset is found [here](#). The mosaic is composed of Sentinel-2 data from June 30 to July 31, 2018. The mosaic consists of the frequency bands B2 to B6, B8A, B11, and B12. The data type is unsigned integer 16. Ancillary vector data is included yielding the dates for the individual tiles.

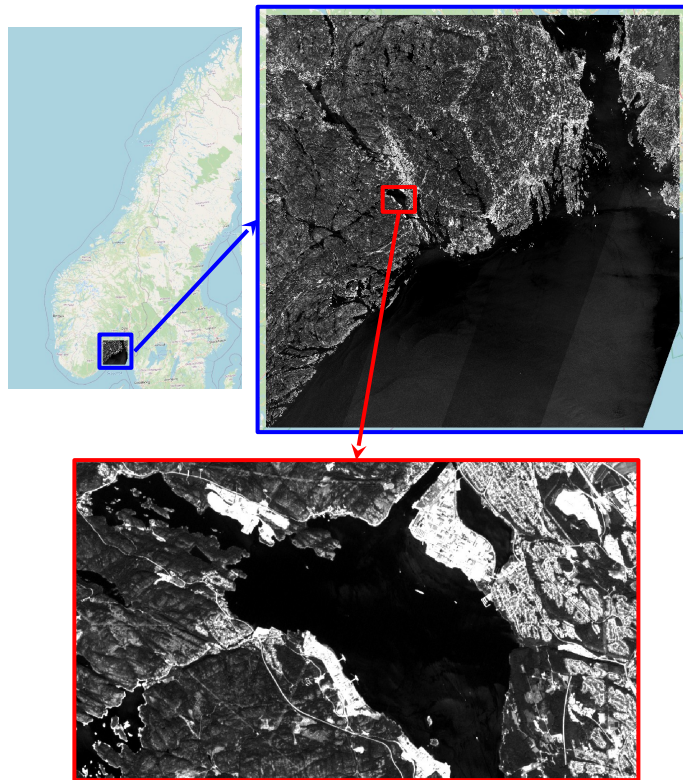


OGC WMS Services



OGC WPS

- Transformation
 - Subsetting
 - Time and space
 - Reprojection
 - Reformatting
 - Output format (NetCDF-CF and GeoTIFF)
- Example: Transform Sentinel-2 Data Cube
 - Extract
 - variables B4, view and zenith angle
 - over predefined AOI
 - for four dates
 - Reproject from WGS84:UTM 32N to Norwegian official datum (EPSG:25833)
- i.e.
 - Moving from 3100 MB of data to download to 35 MB analysis ready

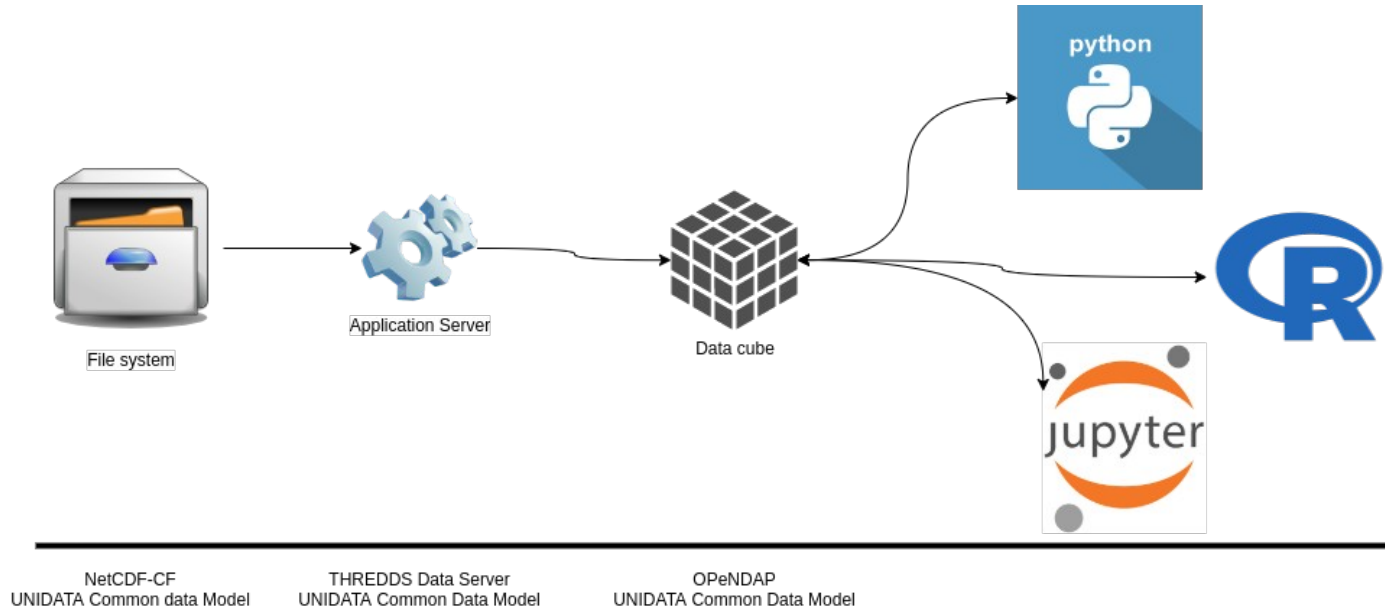


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Data Cube Approach



Data format from SAFE to NetCDF-CF

- Self describing products when adhering to the convention
 - Climate and Forecast Convention (CF)
- Easy to integrate with OPeNDAP streaming of data
 - Same generic data model
 - UNIDATA's Common Data Model
 - Prepared for kinked data and semantic web approaches
 - Server side data reduction
- Easy to integrate in distributed data management
 - And with other types of data
- Allows constructions of “virtual” products/views
 - Data cubes
 - Analysis Ready Data
- Delivering value-added Sentinel products
 - Single product
 - More information in raster resolution
 - Sentinel-1 GRD, Sentinel-2 L1C/L2A (currently)
 - Challenges with some information and the legacy CDM
- Easy to add/develop web services
 - OGC WMS, OGC WPS

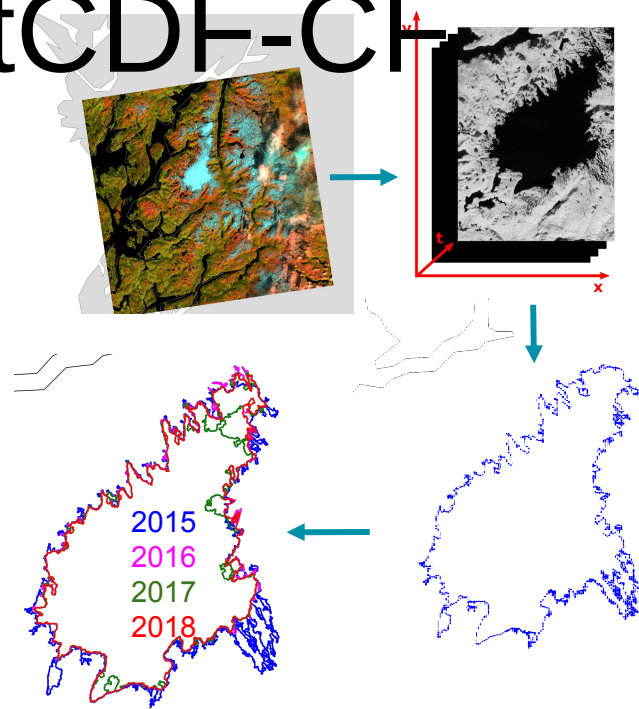


Image slicing on a Sentinel-2 data cube in NetCDF/CF.
Each computation use 0.2 % of the pixels in the product

Working with Sentinel-2 L2A data cube in Python

```
In [1]: import matplotlib.pyplot as plt
import xarray as xa
import numpy as np
%matplotlib inline
```

```
In [2]: # Reading the data

ncin = xa.open_dataset('http://nbstds.met.no/thredds/dodsC/test/S2A-L2A-aggregated')
```

⋮ (filtering operations)

↑
One single product containing 1.5 years of S2
L2A products for tile T32VNP

```
In [18]: # Inspect the scenes that can be used for further analysis
print("All scenes covering T32VNP from 2019-01-01 to 2020-05-15: {}".format(ncin.time.size))
print("All scenes with scene coverage > 40% in subset region: {}".format(len(usable_scenes)))
print("Usable scenes with cloud coverage < 50% in region: {}".format(nb_scenes))
```

All scenes covering T32VNP from 2019-01-01 to 2020-05-15: 70

All scenes with scene coverage > 40% in subset region: 37

Usable scenes with cloud coverage < 50% in region: 26

.. and now perform your analysis (vegetation, snow, new buildings, ...)



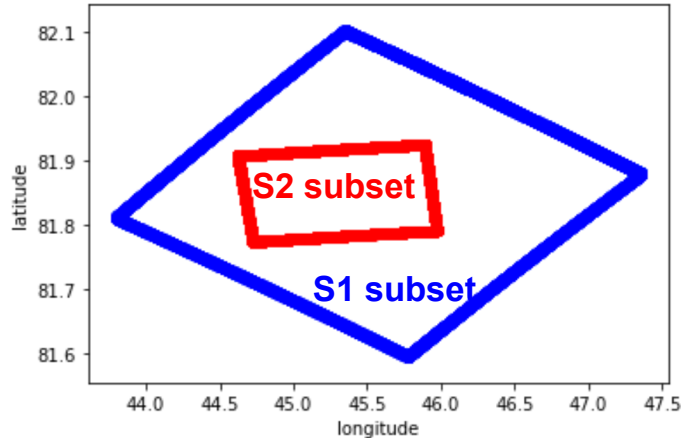
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Data fusion example 1

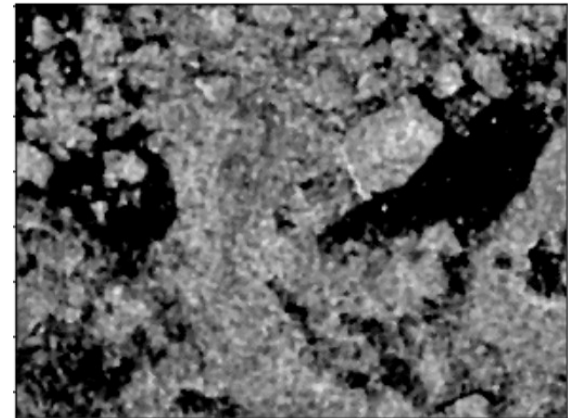
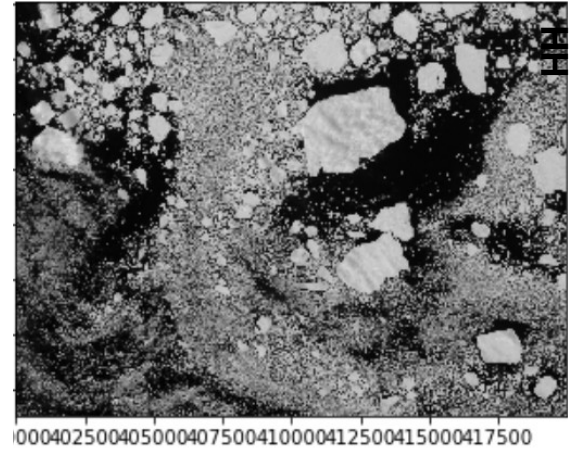
Objective: Align and compare sea ice concentration from S1 and S2 data



Reproject, resample and extract same AOI.



Compute sea ice concentration



Jupyter Notebook:

<https://nbviewer.jupyter.org/gist/hevgyr/3ee3c0a927a3ef202e4b797dfe2b6fd9>

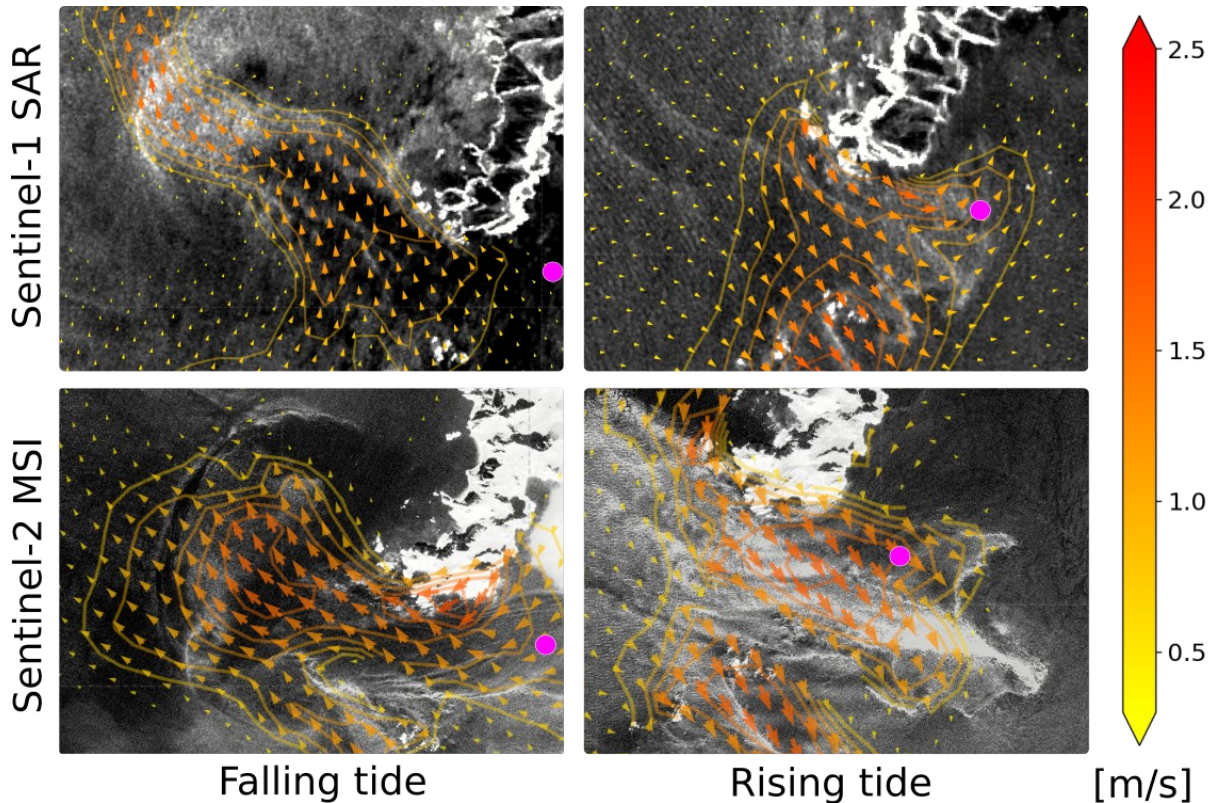
```
print("Sentinel-1 sea ice concentration: {}".format(1-np.sum(s1_ice_sheets)/(s1_ice_sheets.size)))
print("Sentinel-2 sea ice concentration: {}".format(1-np.sum(s2_ice_sheets)/s2_ice_sheets.size))

print("Product time difference: {} hours".format((ncin_s2['time'][0]-ncin_s1['time'][0])/(60*60)))
```

Sentinel-1 sea ice concentration: 0.8205586666666667
Sentinel-2 sea ice concentration: 0.5890176666666667
Product time difference: 7.217777777777778 hours

Data fusion example 2

Objective: Compare the sea surface signature of a strong tidal current with high resolution ocean model current output.



Satellite and ocean model representation of the Lofoten Maelstrom. The magenta dot indicates the position of a bottom-mounted ADCP. The time difference between satellite acquisition and model time is within 30 minutes for all the cases.



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Future perspectives

- Improving web services
 - For metadata and data
- Improving data access
- Improving integration of DHUS and national software
- Improving integration with other EO-data
- Evaluating integration of services within NBS
- Evaluating linkages to European services
- Evaluating hosted processing