Copernicus, the Sentinels and the Norwegian Ground Segment of Satellitedata

TerraNor remote sensing user meeting 06.02.2020

Norsk Romsenter
Norwegian Space Agency

Solveig Havstad Winsvold
Norsk Romsenter
solveig.havstad.winsvold@spaceagency.no

What is Copernicus?

- European Union´s Earth Observation program

- Purpose:
  - Better resource management
  - Better climate and environmental surveillance
  - Enhance civilian security

- Norway is participating

- Free and open data policy

- User driven program

- One of the worlds biggest data distributors

- 7 operational satellites

- Since 2014 Norway has gotten 113 million euros in new contracts!

The Norwegian Space Agency has the national responsibility for Copernicus

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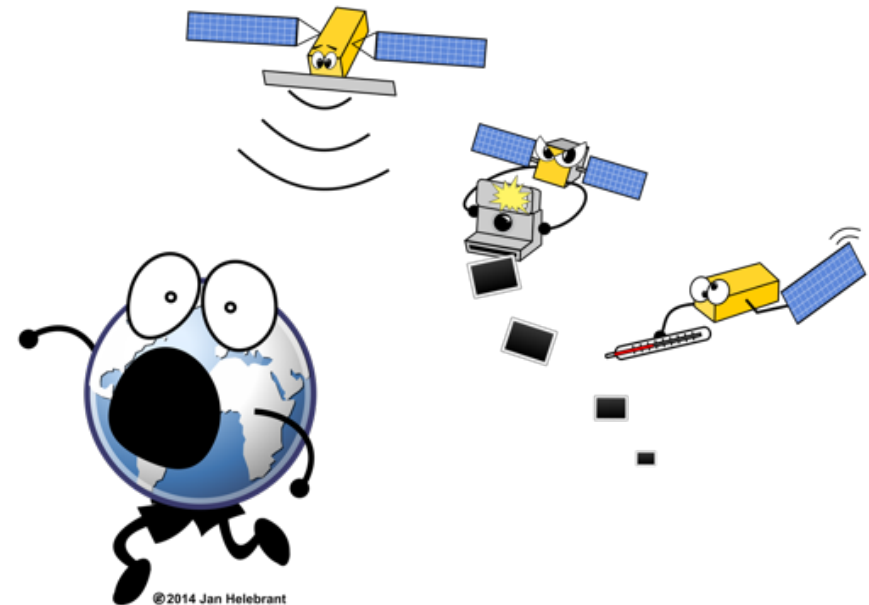
Copernicus – three components

- Space component
  - Sentinel satellites
  - Ground segment infrastructure
  - Data infrastructure

- Copernicus services
  - Land
  - Marine environment
  - Atmosphere
  - Emergency management
  - Climate change
  - Security

- In-situ component
  - Marine environment
  - Land
  - Atmosphere and air quality
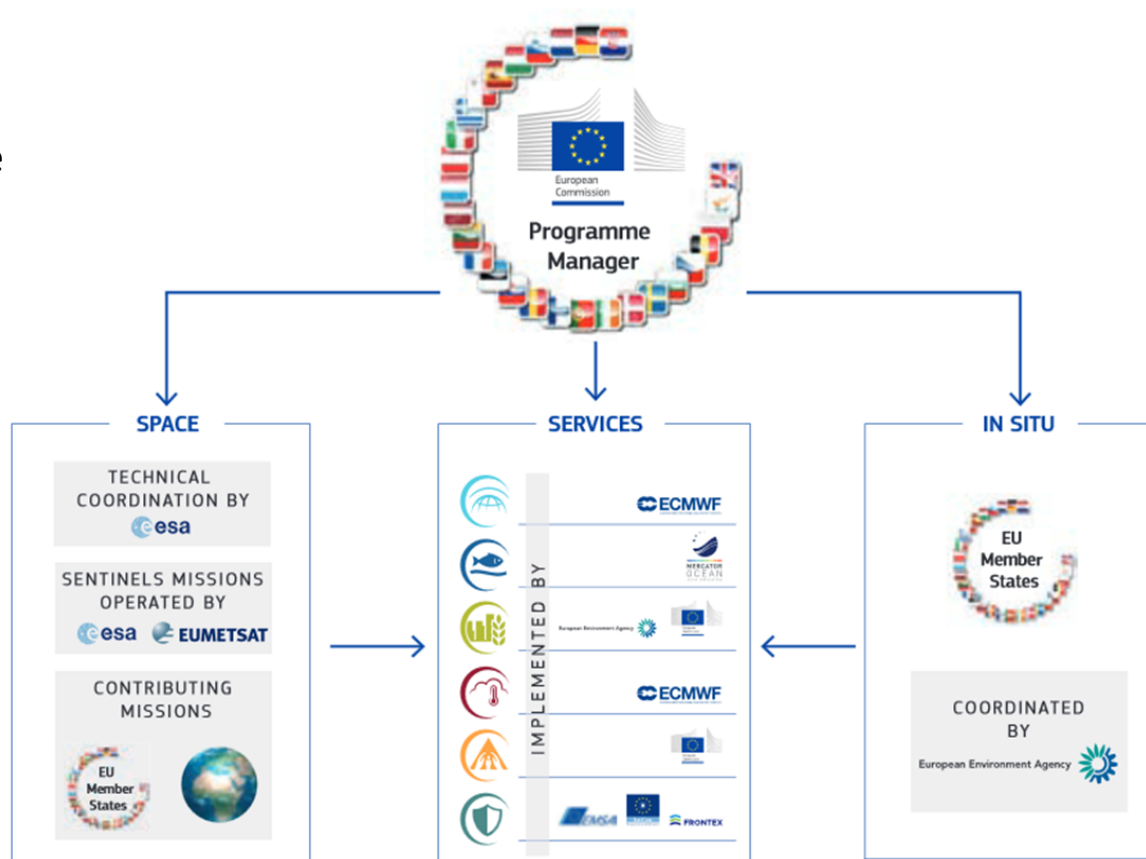
Copernicus programme - Sentinels

Free and open data

Higher spatial and temporal resolution than earlier

OCEAN TOPOGRPHY
Radar altimeter

«RADAR VISION» (SAR)
- S1A – April 2014
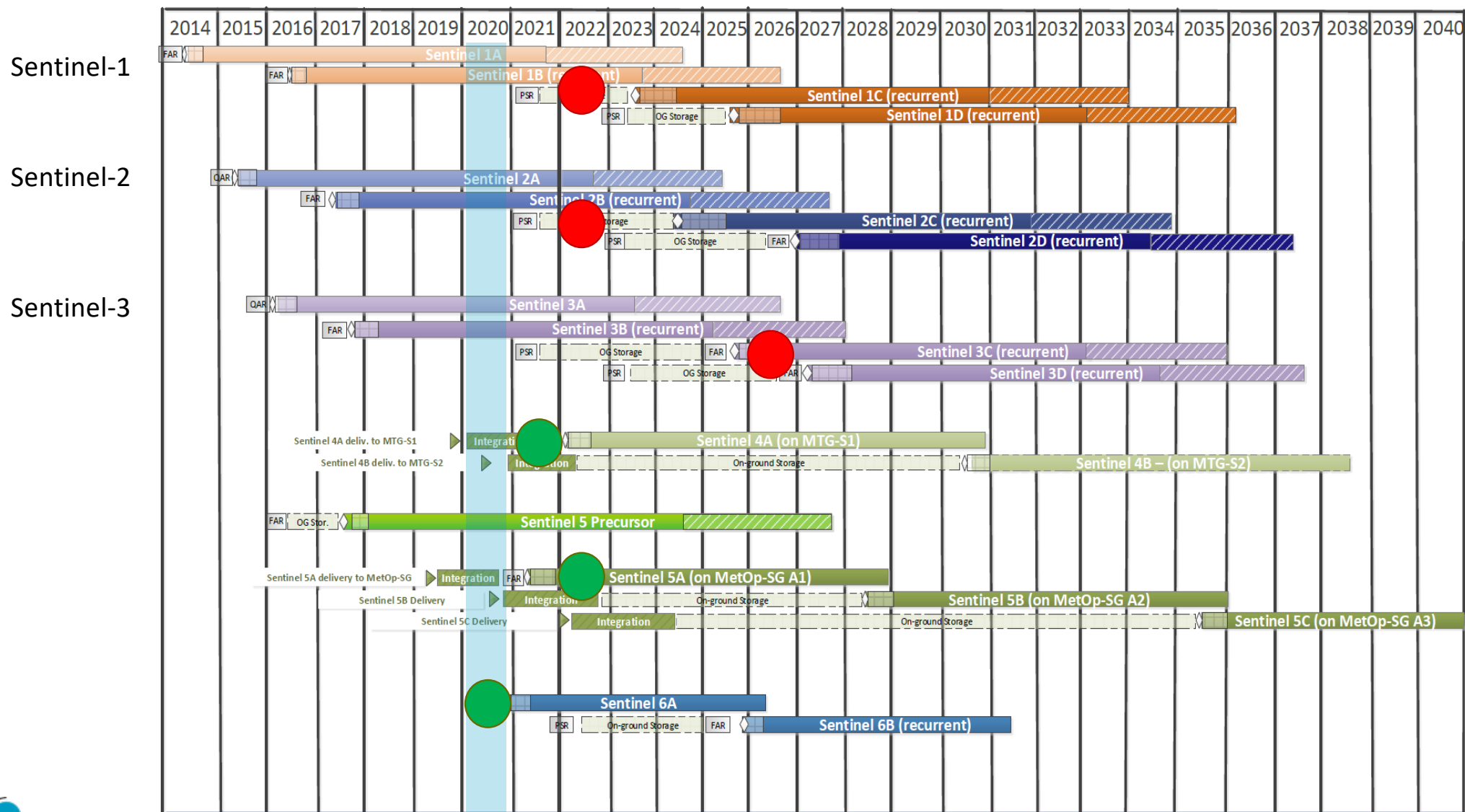- S1B – April 2016

«COLOR VISION» (optical 10-20m)
- S2A – June 2015
- S2B – March 2017

GLOBAL AIR MEASUREMENTS (Atmospheric chemistry)
- S5p – October 2017

sentinel-6

sentinel-1

sentinel-2

sentinel-5

sentinel-5p

sentinel-3

sentinel-4

«THE BIGGER PICTURE» (optical 300 m ++)
- S3A – February 2016
- S3B - April 2018

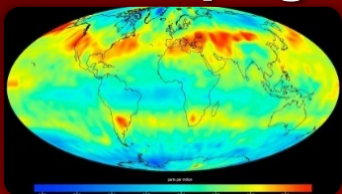EUROPEAN AIR MEASUREMENTS
Atmospheric measurements
(Geostationary)

esa

Sentinel-1
Sentinel-2
Sentinel-3

| 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 | 2038 | 2039 | 2040 |

FAR — Sentinel 1A
FAR — Sentinel 1B (recurrent)
PSR — Sentinel 1C (recurrent)
PSR — OG Storage — Sentinel 1D (recurrent)

QAR — Sentinel 2A
FAR — Sentinel 2B (recurrent)
PSR — Storage — Sentinel 2C (recurrent)
PSR — OG Storage — FAR — Sentinel 2D (recurrent)

QAR — Sentinel 3A
FAR — Sentinel 3B (recurrent)
PSR — OG Storage — FAR — Sentinel 3C (recurrent)
PSR — OG Storage — FAR — Sentinel 3D (recurrent)

Sentinel 4A deliv. to MTG-S1 — Integration — Sentinel 4A (on MTG-S1)
Sentinel 4B deliv. to MTG-S2 — Integration — On-ground Storage — Sentinel 4B – (on MTG-S2)

FAR — OG Stor. — Sentinel 5 Precursor

Sentinel 5A delivery to MetOp-SG — Integration — FAR — Sentinel 5A (on MetOp-SG A1)
Sentinel 5B Delivery — Integration — On-ground Storage — Sentinel 5B (on MetOp-SG A2)
Sentinel 5C Delivery — Integration — On-ground Storage — Sentinel 5C (on MetOp-SG A3)

Sentinel 6A
PSR — On-ground Storage — FAR — Sentinel 6B (recurrent)

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Legend: Qualification Acceptance Review (QAR) Flight Acceptance Review (FAR) or PreStorage Review (PSR)   On-ground (OG) Storage   ◇ Tentative launch date   In-orbit Commissioning   3 years Extended lifetime

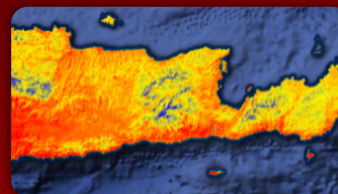Copernicus 4.0 – New Monitoring Missions (6 HPCM)

esa

Anthropogenic CO$_2$ Monitoring
Causes of Climate Change

Land Surface Temp. Mission
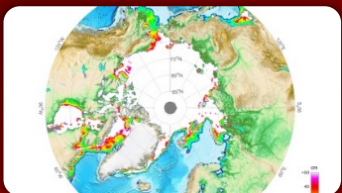Agriculture & Water Productivity

CRISTAL – Polar Ice & Snow
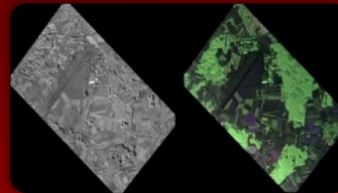Effects of Climate Change

CHIME – Hyperspectral Mission
Food Security, Soil, Biodiversity

CIMR – Microwave Radiometer
Sea: Surface Temp. & Ice Concentration

L-band SAR Mission
Vegetation & Ground Motion & Moisture
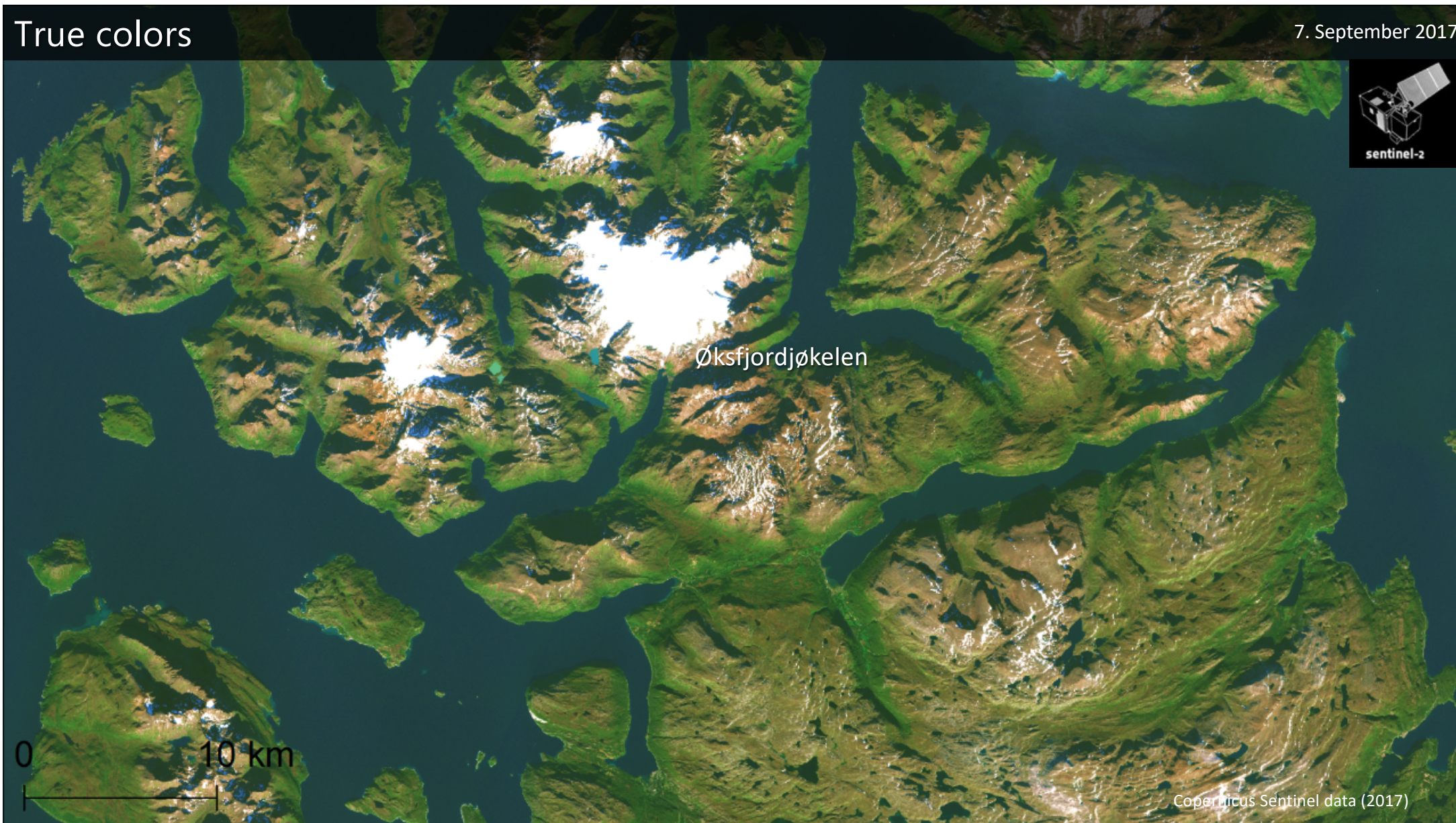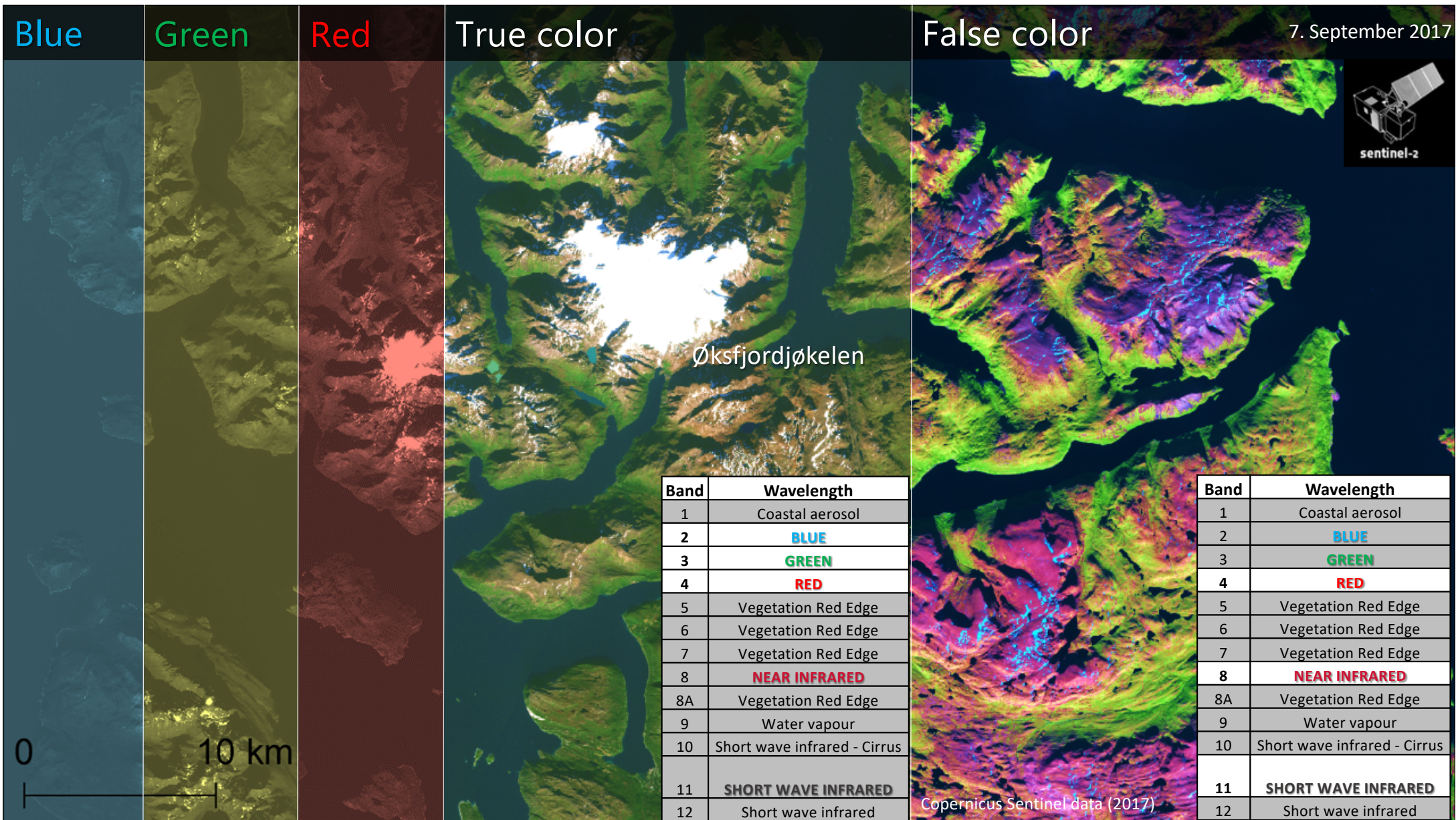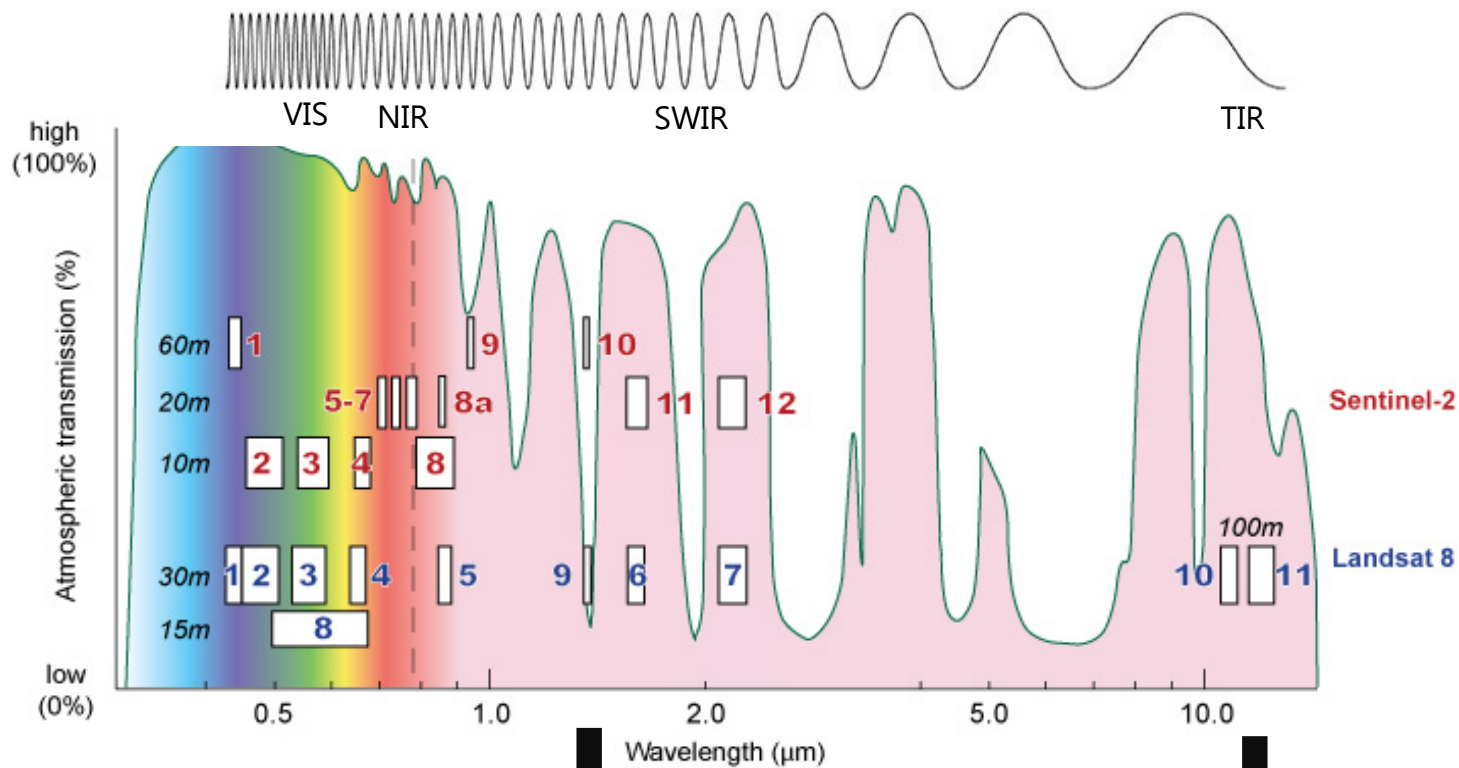
European Space Agency

True colors

7. September 2017

sentinel-2

Øksfjordjøkelen

0   10 km

Copernicus Sentinel data (2017)

Blue   Green   Red   True color   False color   7. September 2017

sentinel-2

Øksfjordjøkelen

Copernicus Sentinel data (2017)

0   10 km

Band	Wavelength
1	Coastal aerosol
2	BLUE
3	GREEN
4	RED
5	Vegetation Red Edge
6	Vegetation Red Edge
7	Vegetation Red Edge
8	NEAR INFRARED
8A	Vegetation Red Edge
9	Water vapour
10	Short wave infrared - Cirrus
11	SHORT WAVE INFRARED
12	Short wave infrared

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12	Short wave infrared

Sentinel-2 satellite bands

Kääb, 2005

Band	Wavelength	Res.(m)
1	Coastal aerosol	60
2	BLUE	10
3	GREEN	10
4	RED	10
5	Vegetation Red Edge	20
6	Vegetation Red Edge	20
7	Vegetation Red Edge	20
8	NEAR INFRARED	10
8A	Vegetation Red Edge	20
9	Water vapour	60
10	Short wave infrared - Cirrus	60
11	Short wave infrared	20
12	Short wave infrared	20

Cloud pixels are usually colder than clear-sky pixels
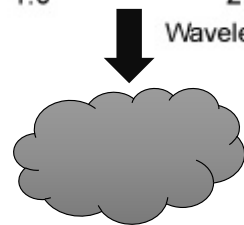
Cirrus band
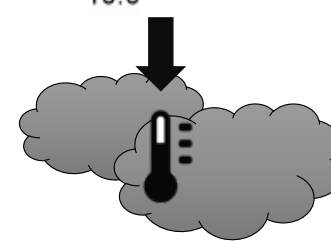
Brightness temperature

Access to Copernicus-data

Open access hub

ESA

satellittdata.no

National ground segment for satellite data

DIAS:
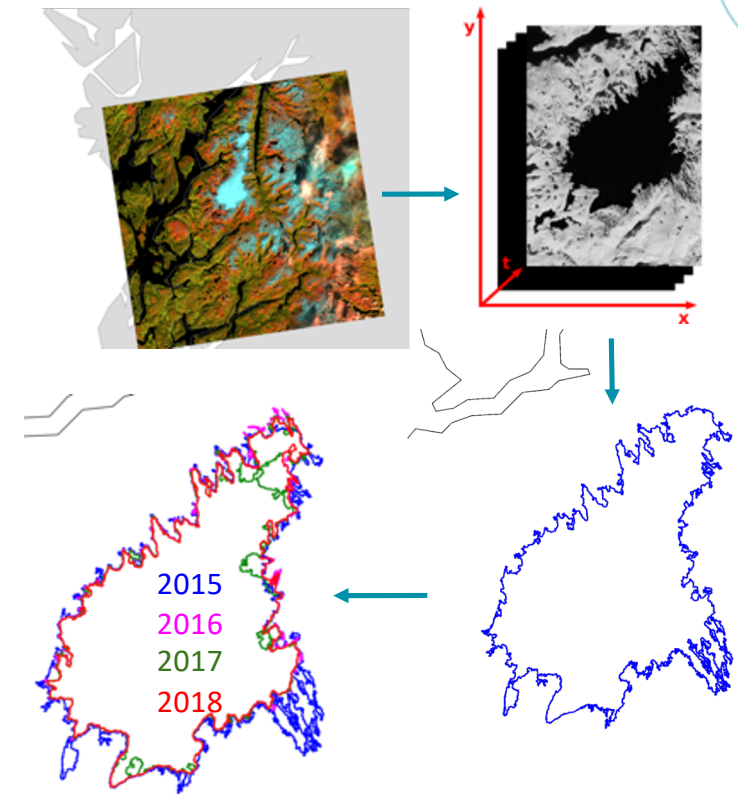Data and information access services

Copernicus

satellittdata.no

- Simplify access to Sentinel data for national users
- Ensure support for national services
- Preserve data for Norwegian AOI
- Near real time (e.g. Sentinel-1 data)
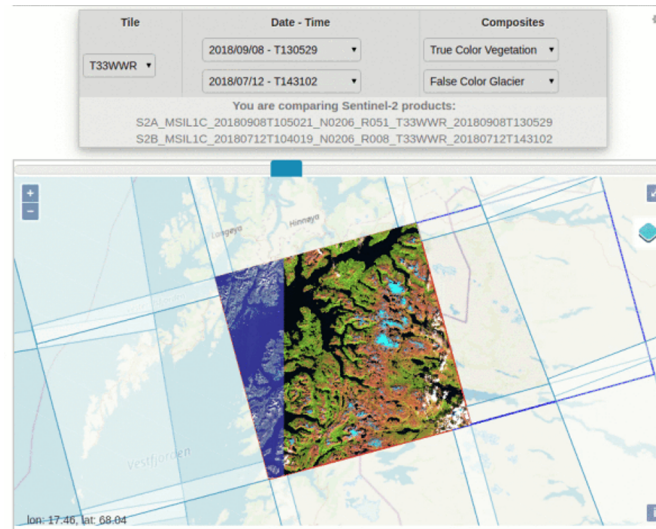- Provide open data linking EO with other types of data (e.g. model, in-situ etc.)

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Norwegian
Meteorological
Institute
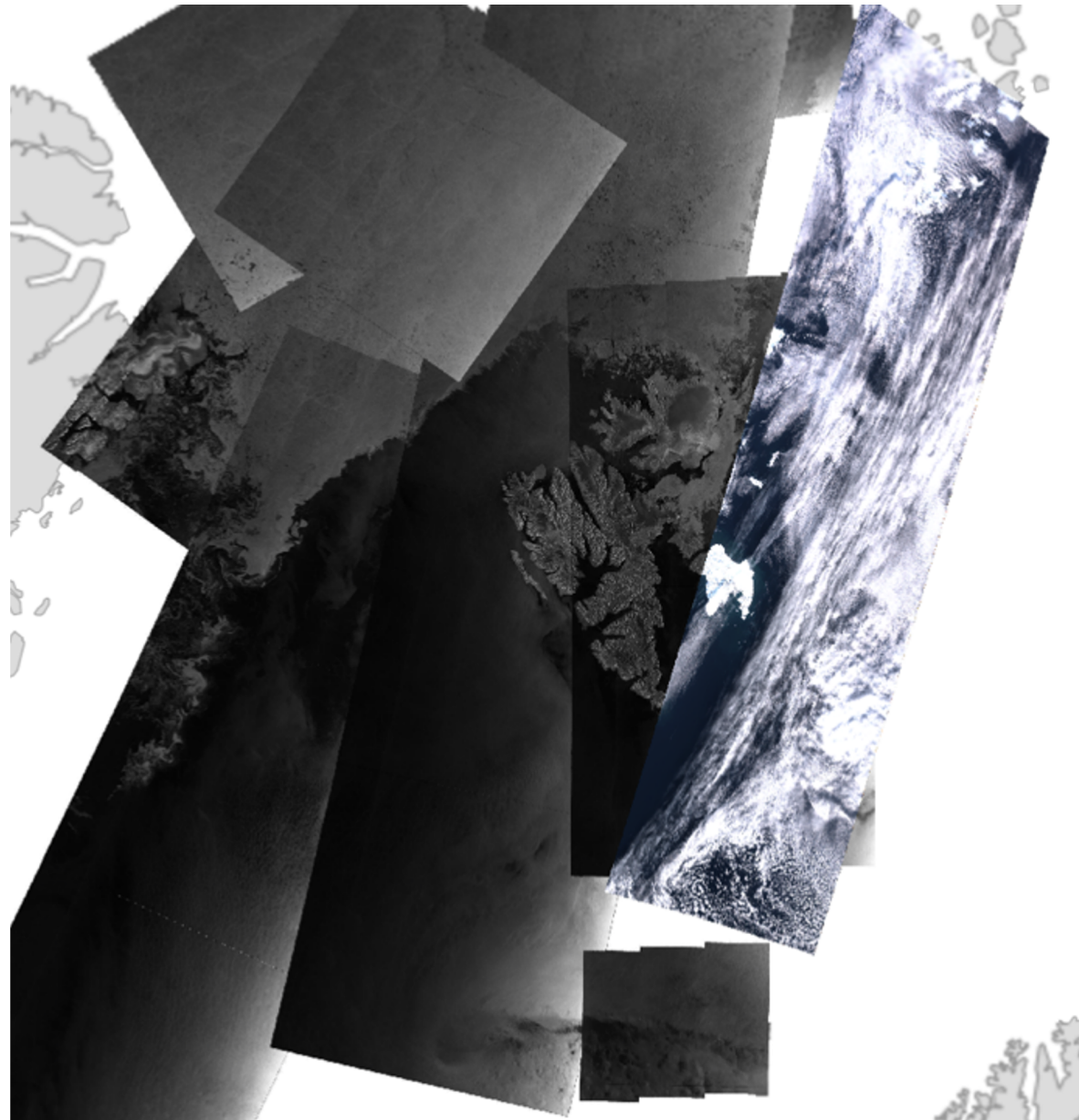
Data format - from SAFE to NetCDF-4/CF

- Self describing products when following a metadata convention (CF)
- Supports streaming of data through OPeNDAP
- Enables aggregation of virtual products
- Delivering value-added Sentinel products:
  - For example for Sentinel-2: all raster bands in 10x10m resolution
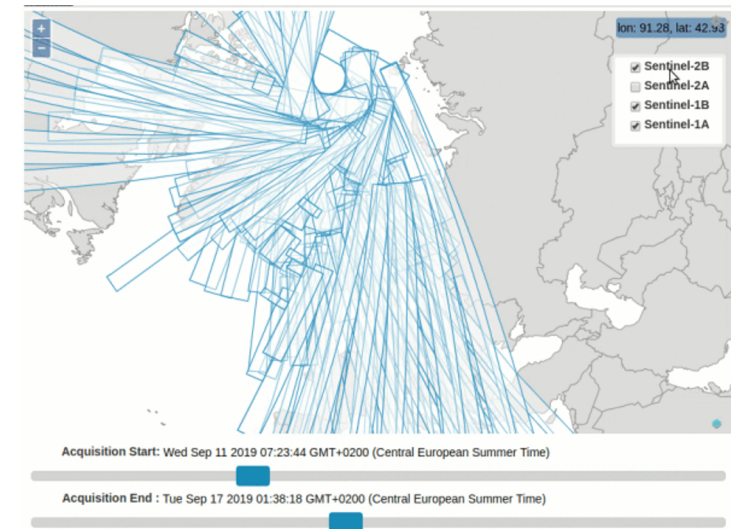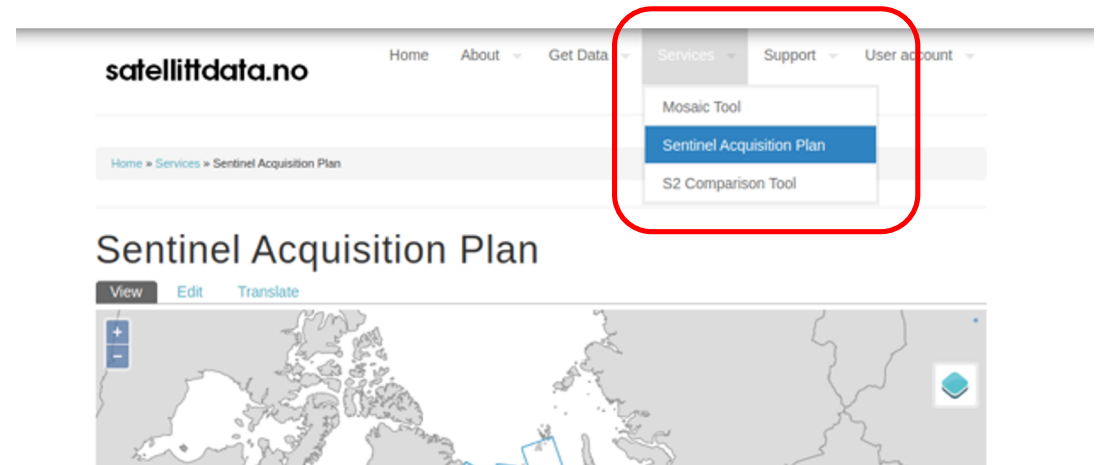- Makes it easy to add/develop services
  - OGC WMS, OGC WPS

2015
2016
2017
2018

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OP*e*NDAP

```
print(str("OPeNDAP: Supported in " +
          "multiple programming " +
          "languages."))
```

Interactive mosaic tool

Sentinel-2 comparison tool

Sentinel Acquisition plan

Current Services

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# Transformation

OGC WPS

- Subsetting – Area of interest
- Reprojection
- Reformatting – GeoTiff, NetCDF

Example Sentinel-2:

- GeoTIFF incl. red, green, blue, NIR, SWIR bands over predefined AOI
- All in 10 m resolution (can be defined)
- Reproject from UTM 32N (Tile VNM) to ETRS89 / UTM zone 33N

Result

211 MB vs 771MB file ready to use for analysis in favoured projection

Visualisation   Oslo

Sentinel-2B 16. Januar 2020

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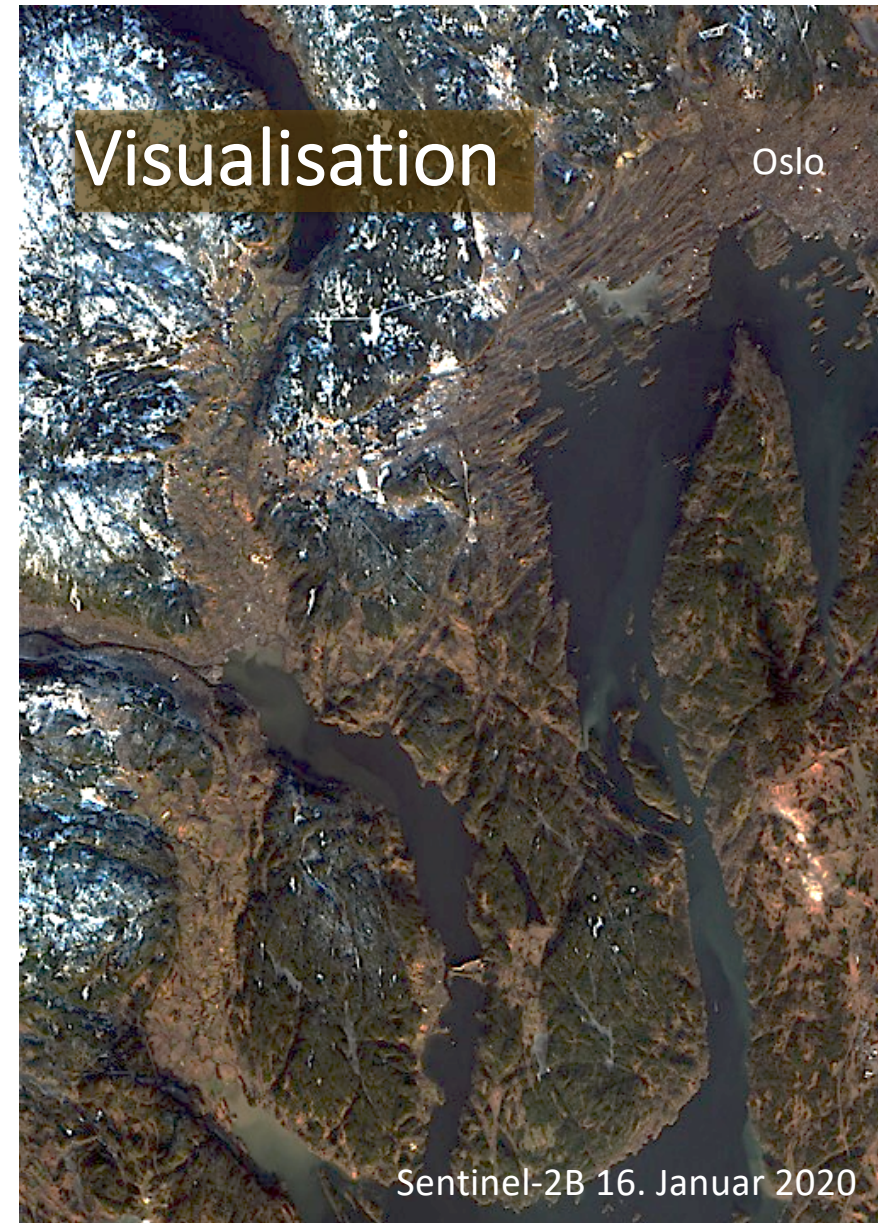
New on satellittdata.no

- Information to users:
  - Difference between ColHub.met.no vs. Open access hub
    - 15 concurrent downloads on ColHub.met.no
  - DTERRENGDATA
  - Relevant Copernicus sites

- User support
  - Videos (in Norwegian)
  - Python scripts
    - How to read products with OPeNDAP
    - How to plot Sentinel-data
    - etc.

- New data:
  - Sentinel-2B aquisitions with low sun angle
  - L2A – available in ColHub (not DTERRENGDATA)
  - Test product: Sentinel-2 Level2A time aggregated products in NetCDF
  - Sentinel-2B DTERRENGDATA over Svalbard

- Future:
  - Sentinel-1 orthorectified products
  - Sentinel-3 in NetCDF/CF
  - Improvement of the graphical interface
  - Map user needs (e.g. Hosted computing) – national system vs. existing infrastructure
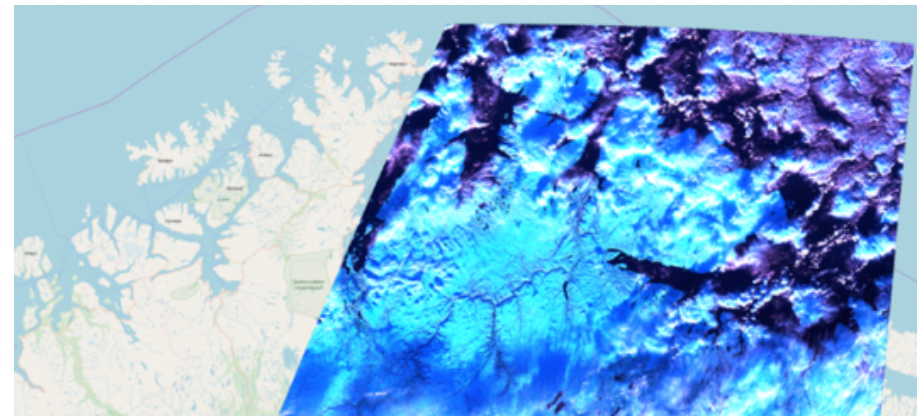
Sentinel-2B covering Finnmark, 26th October 2019

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Geometric performance of Sentinel-2

Norway has since 2015 pushed towards a better quality DEM used for orthorectification of Sentinel-2 imagery.

Sentinel-2 orthorectified with Norwegian DEMs
- satellittdata.no
    - Denoted with the suffix *DTERRENGDATA*

Goal: Sufficient geometric performance on Sentinel-2 in Norway, Sweden and Finland.
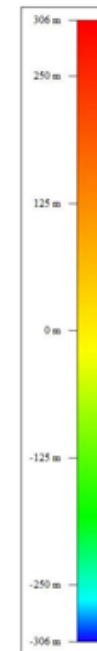
New Copernicus DEM
- Ongoing work - New release in May
- NOSA and the Norwegian mapping authority cooperate with ESA on improving this DEM
- Orthorectification of Sentinel-2 data using the Copernicus DEM is forseen for Q4 2020

Difference between Norwegian mapping authority DEM and PlanetDEM90 (Currently used DEM)

Thank you!

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