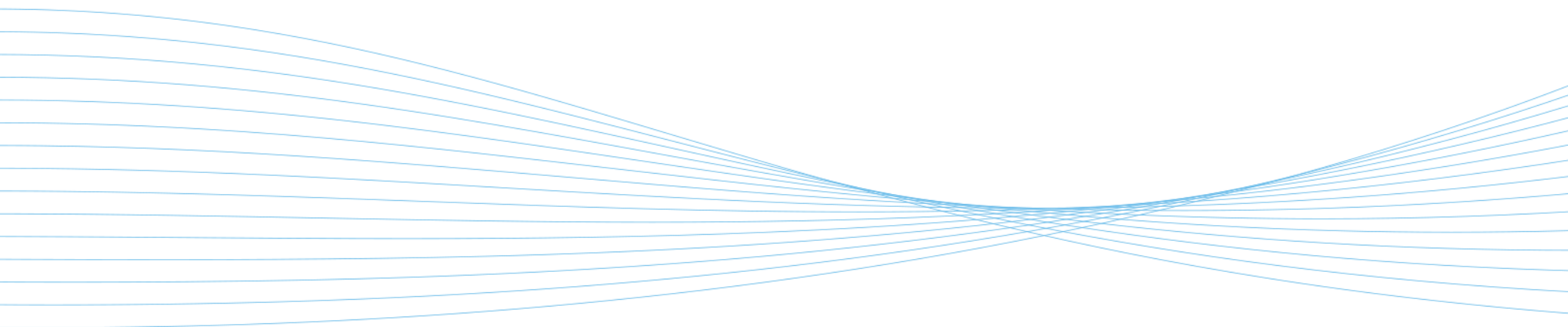




ILMATIETEEN LAITOS
METEOROLOGISKA INSTITUTET
FINNISH METEOROLOGICAL INSTITUTE

FMI Arctic Space Centre

Jyri Heilimo
Finnish Meteorological Institute





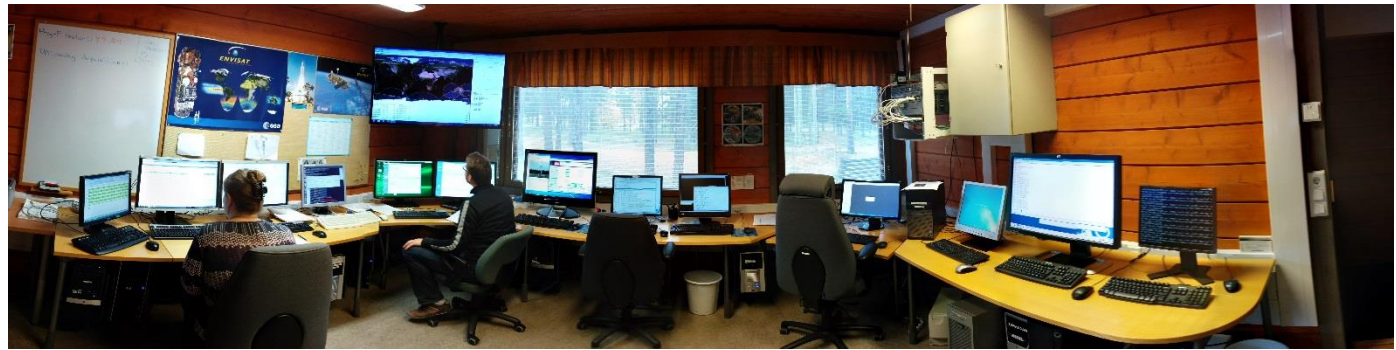
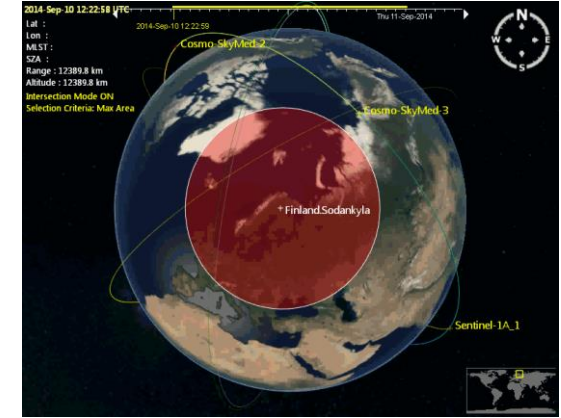
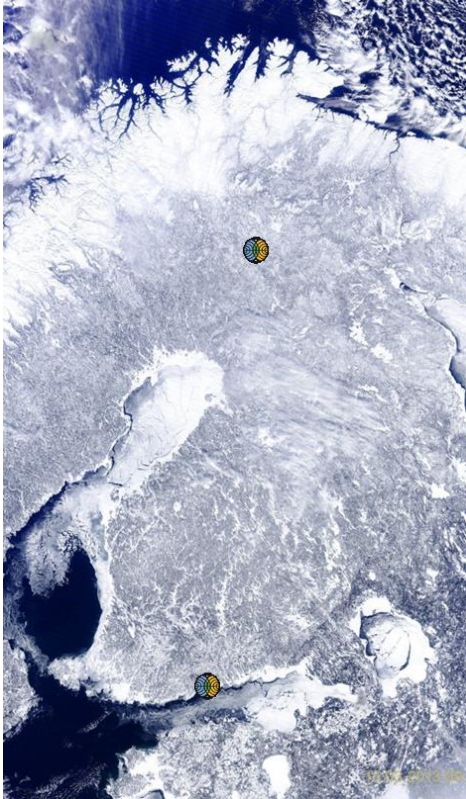
FMI - Arctic Space Center

- Studies of atmospheric phenomena and their interaction with biosphere and cryosphere in high latitudes
 - Hydrology, snow cover, frozen ground and permafrost
 - High atmosphere processes
 - Ionosphere and stratosphere, aurora borealis, stratospheric ozone
- Development of Earth Observation methods
- Development of new operational EO services
- National Satellite Data Centre providing satellite ground segment and data processing services
- ESA Sentinel Collaborative Ground Station
- Maintenance and development of Sodankylä research infrastructure
- Satellite CAL/VAL activities and hosting of satellite reference instruments





National Satellite Data Center



National satellite data center providing satellite data reception and data processing services to Finnish and international partners

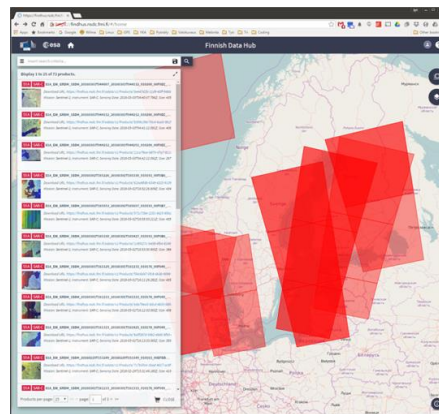
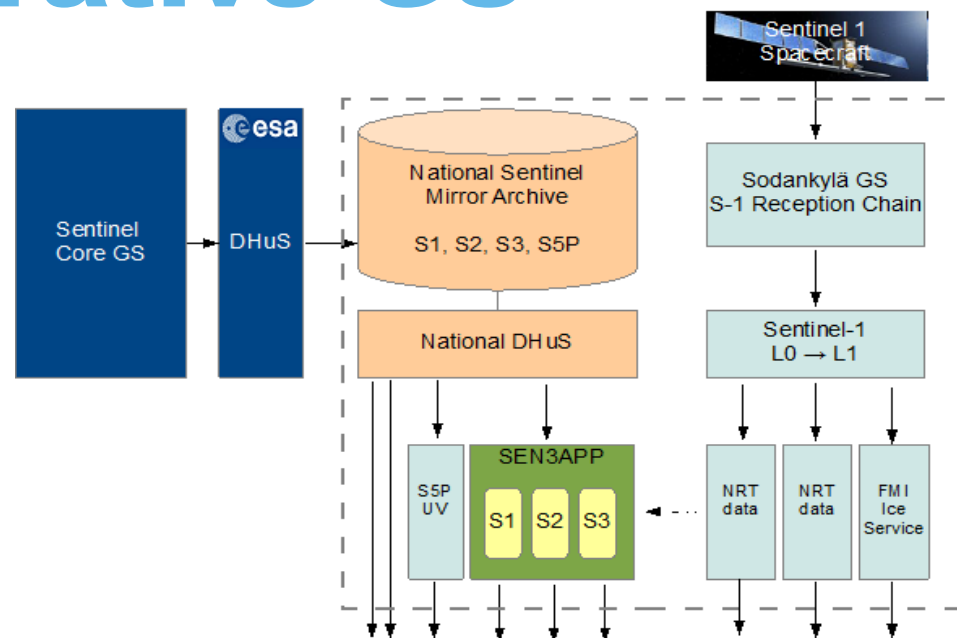
Finnish Collaborative GS

1. Local reception of Sentinel-1 Direct Broadcast

- Focus on NRT and Quasi-Real-Time products
- Special Interests: Baltic Sea Ice monitoring,

2. National Sentinel mirror site

- Provision of Sentinel data to Data users
 - S1, S2, S3, S5P
- Long-term data archive
- Automated data processing lines for specific products
- Bulk processing
- Hosting of processing services (IaaS, PaaS)
- <https://nsdc.fmi.fi>





Satellite data availability from FMI National Satellite Data Centre

Current operational (free access)

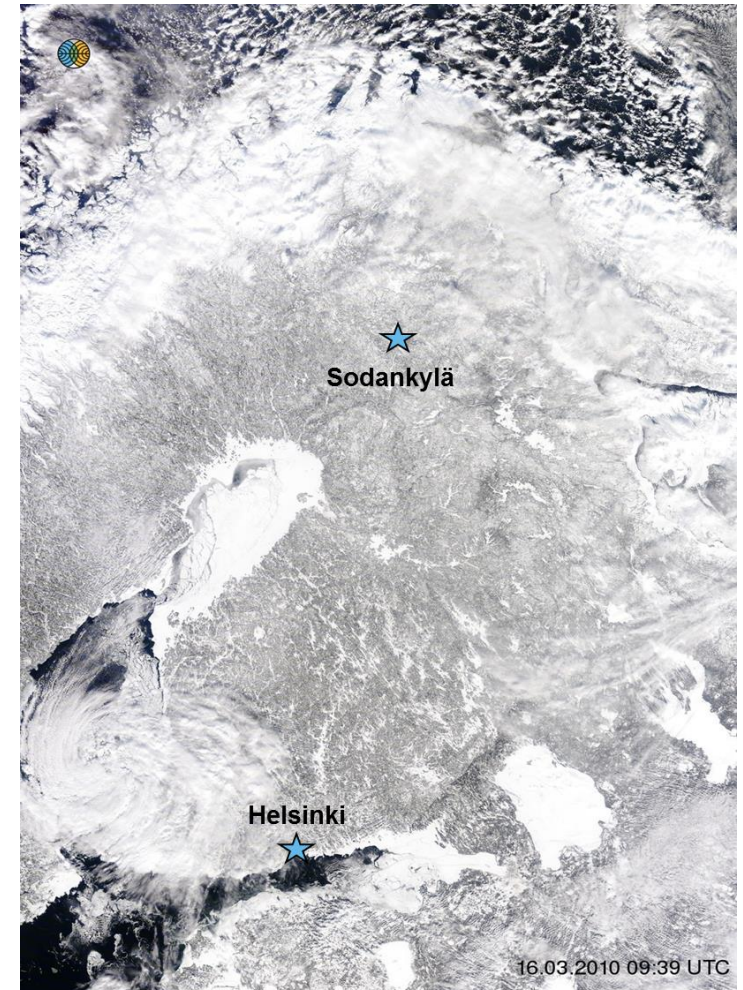
- EOS-Terra/MODIS
- EOS-Aura/ OMI
- Suomi-NPP/VIIRS & OMPS
- Sentinel 1A & 1B
- Sentinel 2A
- Sentinel 3A

Current operational (commercial)

- COSMO-SkyMed (SAR)

Test/Pre-operational/planned

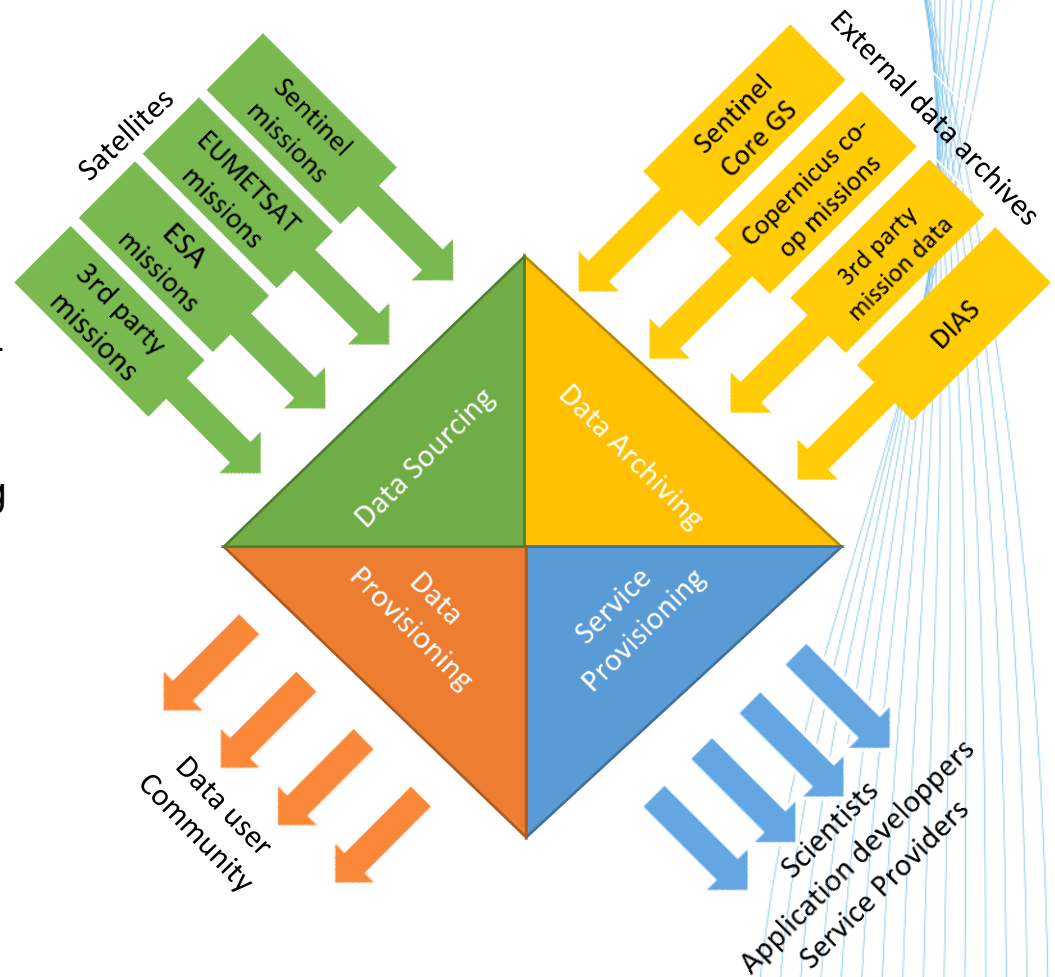
- Sentinel 5P
- FY-3B/C/D
- HY-2
- JPSS & EPS-SG
- + others





Satellite data services

- Safe long-term archive of scientific data
 - Ceph storage offers well scalable storage
 - Current capacity ~800TiB
- Sentinel data in Collaborative Ground Segment
 - S3 Cloud for efficient and fast data access
 - ~500TiB reserved for Sentinels data (3-4 years)
- Virtualization environment for operational product processing and hosted processing
 - Red Hat Virtualization 4.0
 - Splitted to two separated server rooms
 - Total CPU cores: **224**
 - Total memory: **2 TB**
- Calvalus – Processing Cluster
 - System for efficient Remote sensing data **storage and processing**
 - Based on open source Big Data solution (Apache Hadoop)
 - **25** quad core computing nodes, 620TB HDD





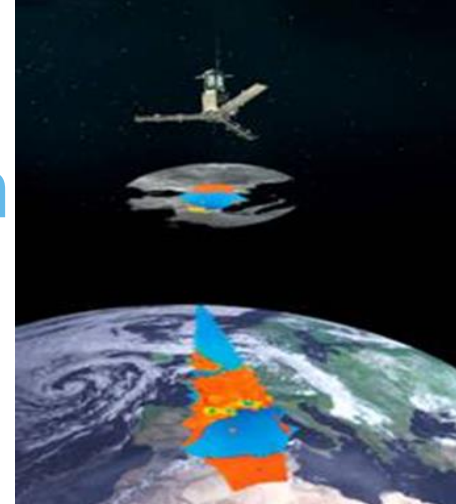
Satellite instrument Calibration and product validation at Arctic Space Centre





Major Reference and calibration instruments for EO satellites

- **Sodankylä FTIR** (Fourier Transform Infrared Spectrometer)
 - Validation and calibration of JAXA GOSAT and NASA OCO-2 carbon monitoring satellites
 - Column amounts of CO₂, CH₄ and N₂O
- **ESA Elbara-II for SMOS satellite CAL-VAL**
 - L-band (1.4 GHz) microwave radiometer
 - Continuous SMOS reference measurement
 - Ground moisture/frost algorithm development
 - Also reference for NASA SMAP mission



Sodankylä FTIR station





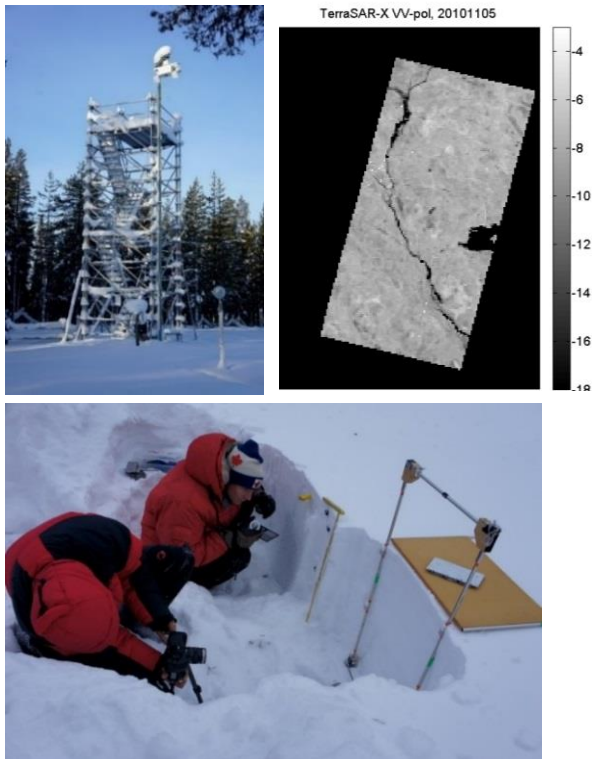
How can FMI-ARC support NewSpace activities in Finland?

1. Payload data downlink in X-band
2. Satellite TM/TC with S-band up-/downlink
3. Satellite data distribution in Finland
4. Cloud processing of EO products
5. Joint development of new services

FMI – ARCTIC RESEARCH DEVELOPING REMOTE SENSING CAPABILITIES

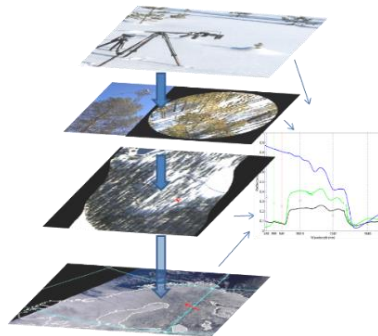
EXPERIMENTS

Campaign datasets, ...

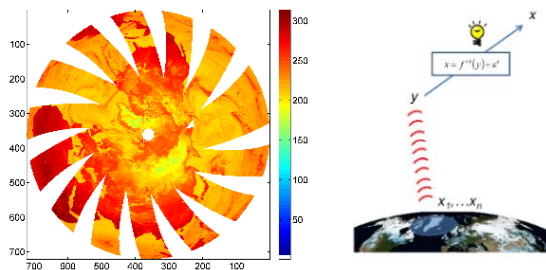


PHYSICS

...model development...

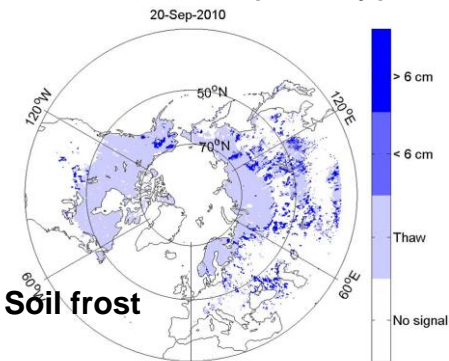


...for better understanding of satellite observations

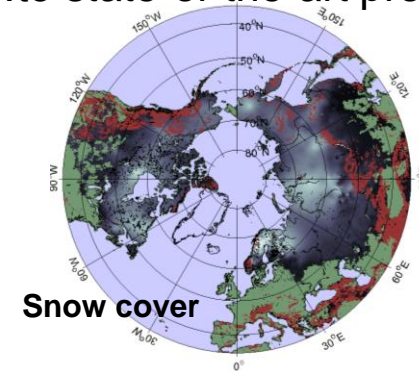


APPLICATIONS

From innovative prototypes...

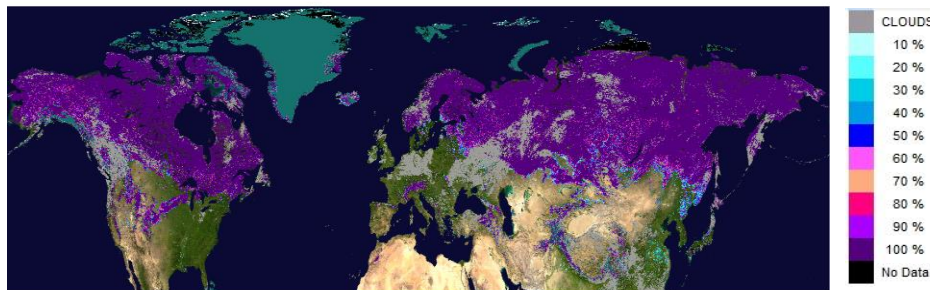


...to state-of-the-art products

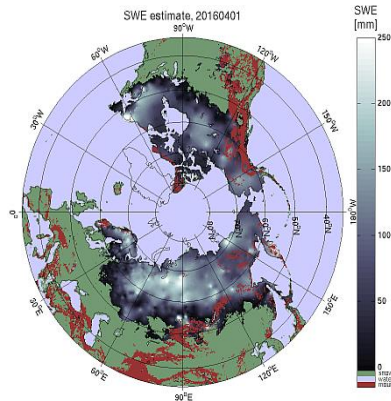


Copernicus Global Land Service Cryosphere products

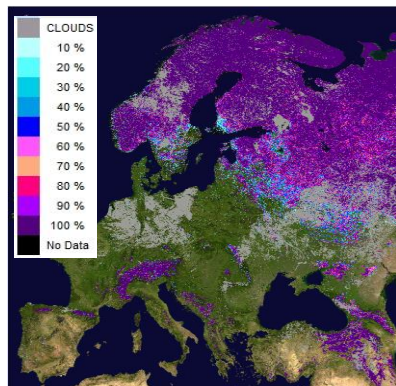
Snow Extent, Snow Water Equivalent, Lake Ice Extent (by FMI, ENVEO, SYKE)



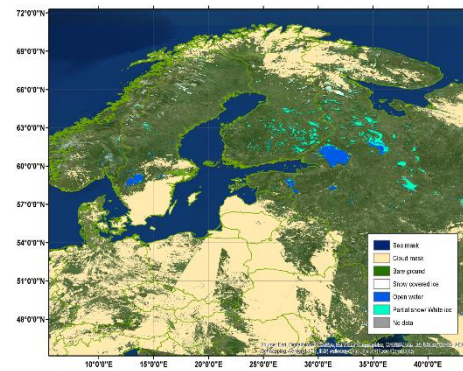
Northern-Hemisphere Snow Extent (SE)



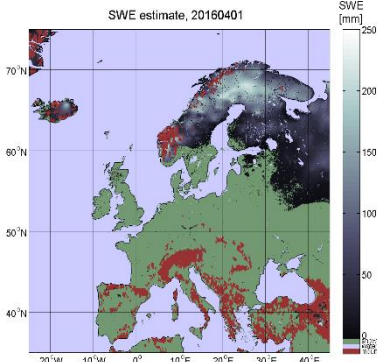
Northern Hemisphere SWE



Pan-European Snow Extent (SE)



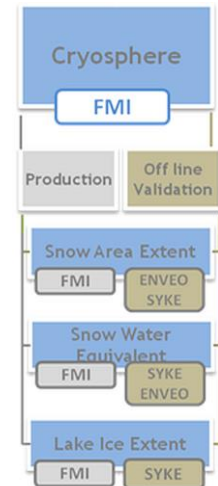
Lake Ice Extent (LIE) for Baltic Sea area



Pan-European SWE

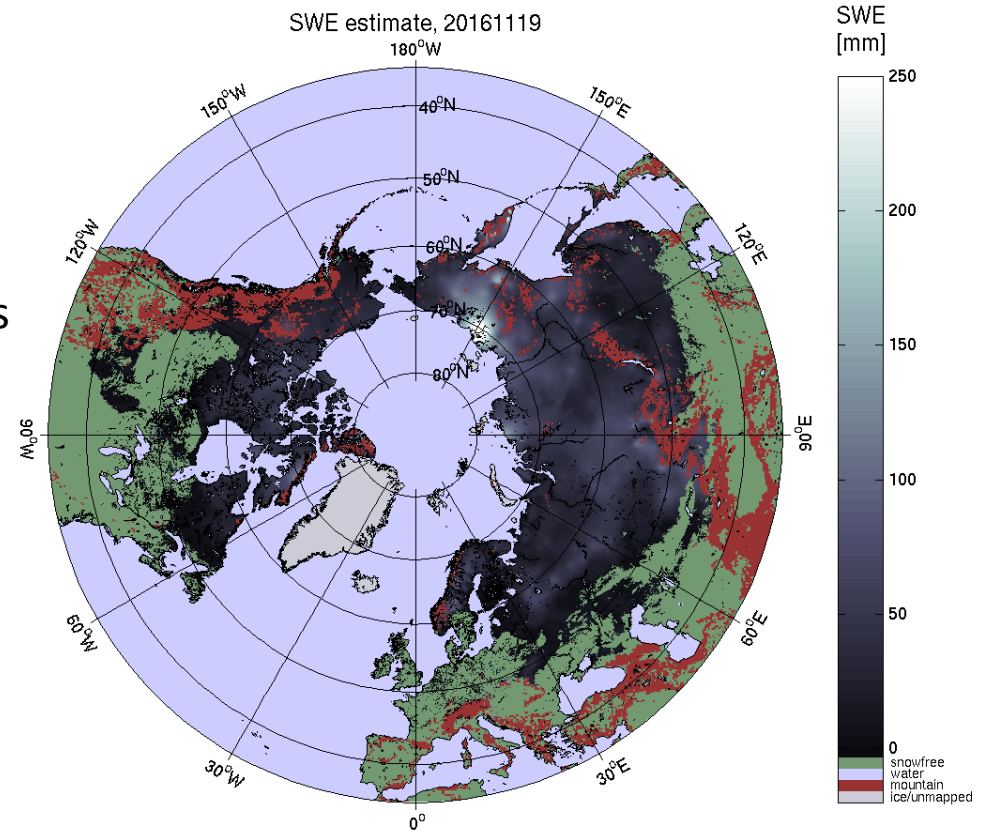
Finnish Meteorological Institute (FMI), ENVEO and Finnish Environment Institute (SYKE) are producing daily near-real time products on snow cover and lake ice for Pan-European domain and Northern Hemisphere. The products have a long-standing legacy from ESA GlobSnow and EC Cryoland projects.

The cryosphere products have been developed in close collaboration between FMI, ENVEO and SYKE and will be produced jointly at the FMI production centre.



NH Snow Water Equivalent (SWE)

- Northern Hemispheric SWE
- Daily product, 5km spatial resolution
- COMBINES:
 - Passive microwave radiometer data
 - ground-based synoptic snow observations
 - Sentinel-3 SLSTR data
 - Using Variational data-assimilation
- Daily data + 35-years historical time-series
- Extensive development legacy from ESA GlobSnow & EC CryoLand projects



Takala, M., Luojus, K., Pulliainen, J., Derksen, C., Lemmetyinen, J., Kärnä, J.-P., Koskinen, J., Bojkov, B., “Estimating northern hemisphere snow water equivalent for climate research through assimilation of spaceborne radiometer data and ground-based measurements”, *Remote Sensing of Environment*, Vol. 115, Issue 12, 15 December 2011, doi: [10.1016/j.rse.2011.08.014](https://doi.org/10.1016/j.rse.2011.08.014)

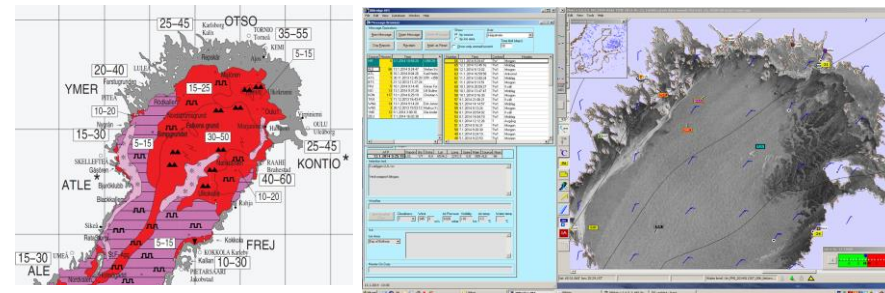
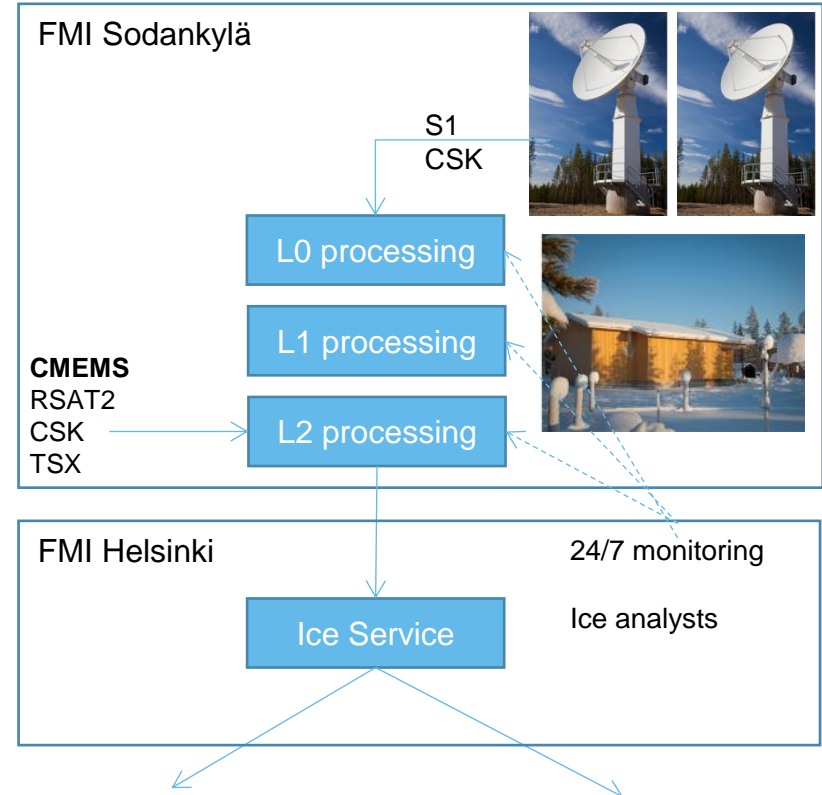


Baltic Sea Ice Monitoring

- Commercial and environmental needs
 - Finland is essentially an island
 - ~90% of Finland's import and export via sea routes
 - Gulf of Finland is one of the most busiest marine routes for oil transport
- Operative Service
 - Availability target 99.9%
 - Quasi-real-time / NRT needs
 - Daily products
- Customer:
 - Finnish Transport Agency
 - Finnish, Swedish, Estonian Ice breakers
- Operations:
 - Fully automated processing lines at Sodankylä
 - Operators and ice analysts in 2 shift
 - 24/7 monitoring of the processing lines

Data need:

- Sentinel-1 EW HH+HV pass-through
- Radarsat 2, Cosmo-Skymed, TerraSAR-X
- AOI: Baltic Sea
- Time: Nov – May



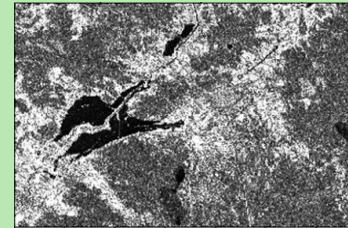


Flood detection and monitoring

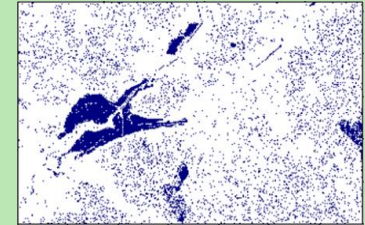
- Annual flooding of rivers in Bothnia
 - Spring floods due snow melt
 - Autumn floods due heavy rain
- Operational service for regional authorities
 - Flood covered area, Flood depth
 - Forest floods

Data needs

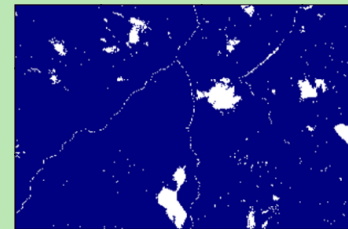
- SAR data: Cosmo-SkyMed and Sentinel-1
- Polarisation: HH + HV
- Time: Apr-May
- Timeliness: NRT ~3hrs
- Aol: Finland



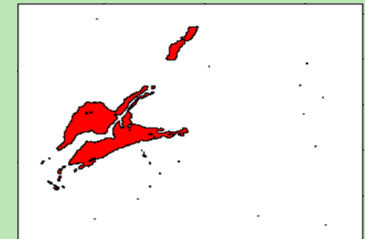
Terrain corrected SAR image



Water detection

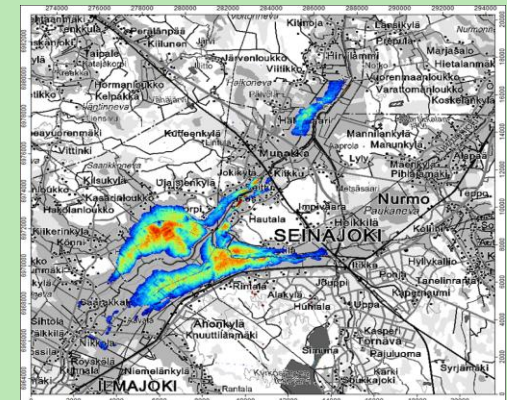


Removal of natural waters
and bogs



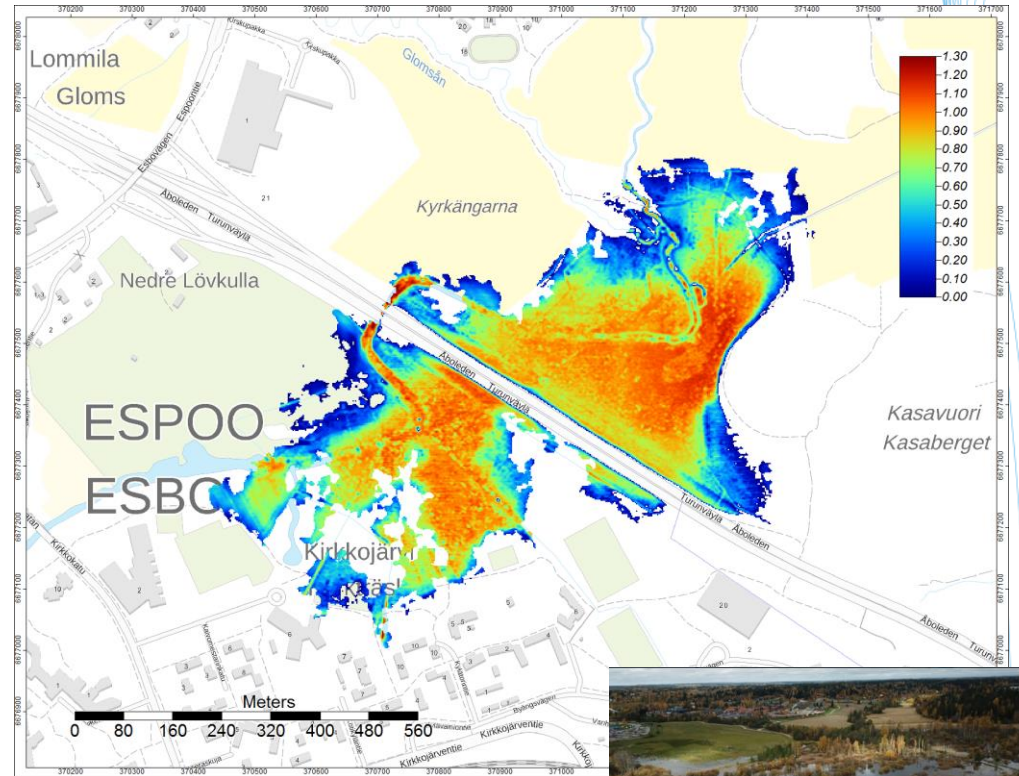
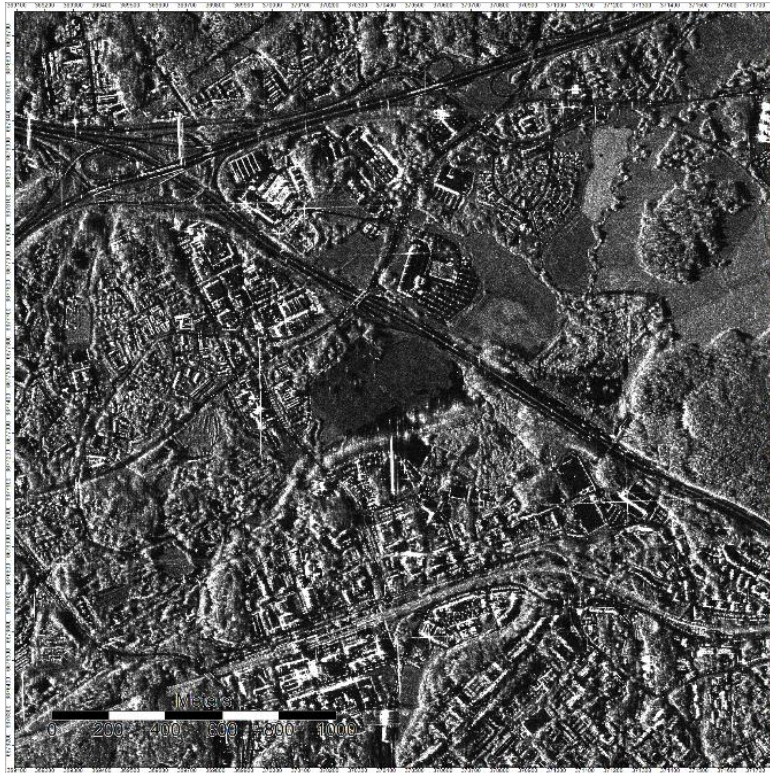
Filtered flood areas

Flood extent and depth
maps





Autumn flooding at Espoo 2017





Outotec Sustainability report 2017: Emission reductions verified by satellite data

Talous

Afrikassa aukeavat miljardimarkkinat puhtaalle teknologialle – suomalaisen Outotecin tehdas teki namibialaisen pikkukaupungin ilmasta helpompaa hengittää

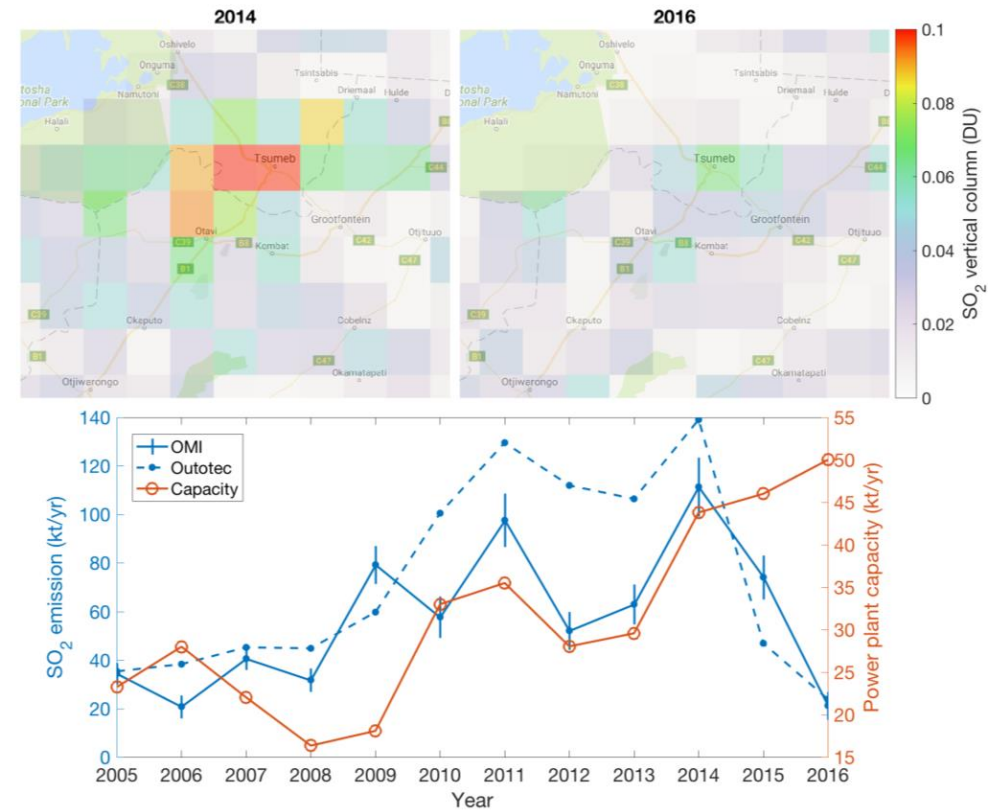
Maailmanpankin arvon mukaan Saharan eteläpuolinen Afrika investoi lähivuosina yli 800 miljardia puhtaaseen teknologiaan. Suomalaisilakin yrityksillä on mahdollisuus saada siivu bisneksestä.



Outotecin toimittama kaasunpuhdistusjärjestelmä ja rikkihappotehdas käsittelee kuparisulaton poistokaasut rikkihappoksi Tsumebin pikkukaupungissa Namibiassa. (KUVA: TIJU KAITALO)

Luetuimmat

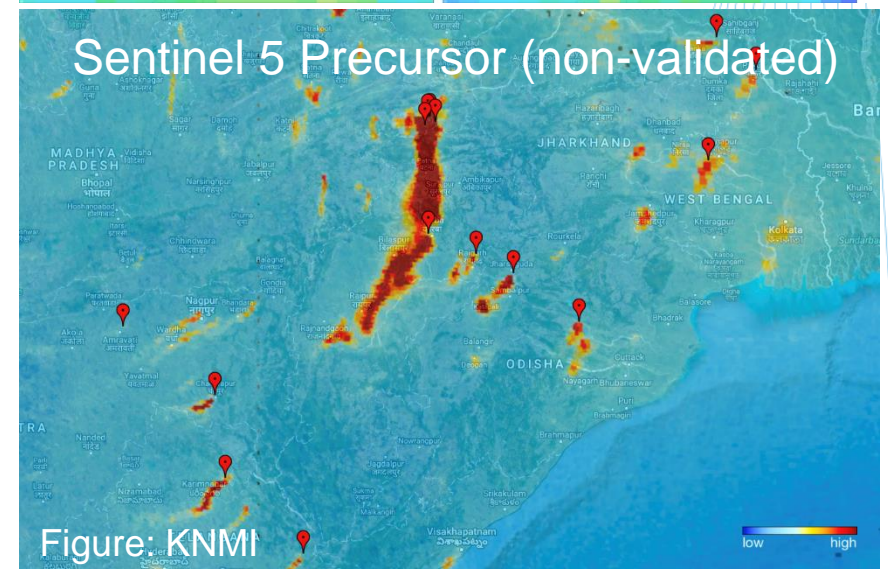
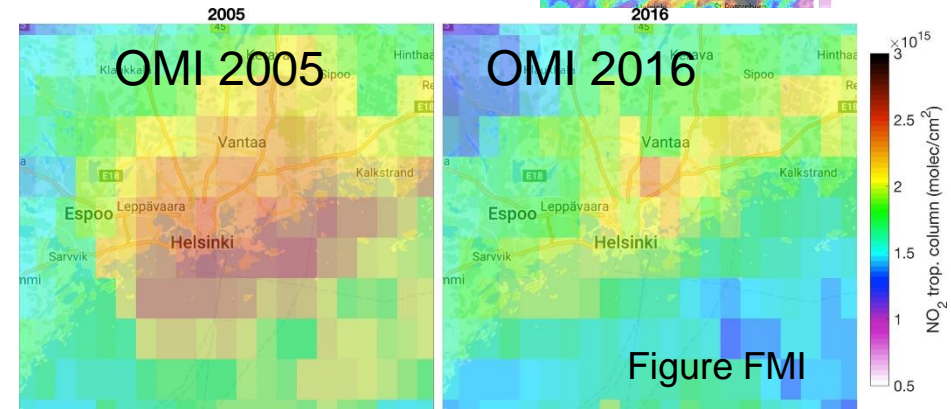
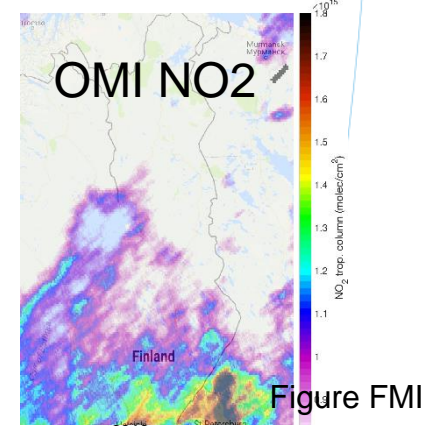
JUURI NYT	PÄIVÄ	VIIKKO
1.	Suositus pyöräilykypärästä saattaa pian poistua laista – Kypärää turhakkeena pitävä brittikirurgi Henry Marsh kävi koeajamassa Helsingin kaupunkipyörän	
2.	Valtava kyberhyökkäys pysähtyi puolivahingossa – 22-vuotias analytikko rekisteröi 10 dollarilla verkko-osoitteen, joka oli ohjelman "tappokytin"	
3.	Torsti tietää: Miksi Suomessa on koettu nälkävuosia, vaikka järvet ovat täynnä kalaa?	
4.	Väitös: Oikeudenkäynnistä ei saa tulla yläluokan nautinto – hävityn jutun kuluista selviämiseksi voi jopa joutua myymään asuntonsa	
5.	Näin äitiys alkaa – HS:n kuvaaja seurasi uuden lapsiperheen ensimmäistä viikkoa	
6.	Sveitsiltä erikoinen pyyntö Suomelle: yksi Hawk-hävittäjä	





Support for CleanTech

- Dutch-Finnish OMI demonstrated satellite based monitoring of regional air quality. 13 years of data allows monitoring changes.
- Detecting individual sources shown by Sentinel 5 Precursor / TROPOMI with smaller pixels and better signal-to-noise ratio.
- Potentially useful for supporting CleanTech industry e.g. to independently verify sustainable solutions.



Contact info:

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Finland

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Email: jyri.heilimo@fmi.fi

