

Operative Production of Lake Surface Temperature Estimates

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Finnish Environment Institute (SYKE)

Data and Information Centre

Geoinformatics and Land Use Division (GEO)

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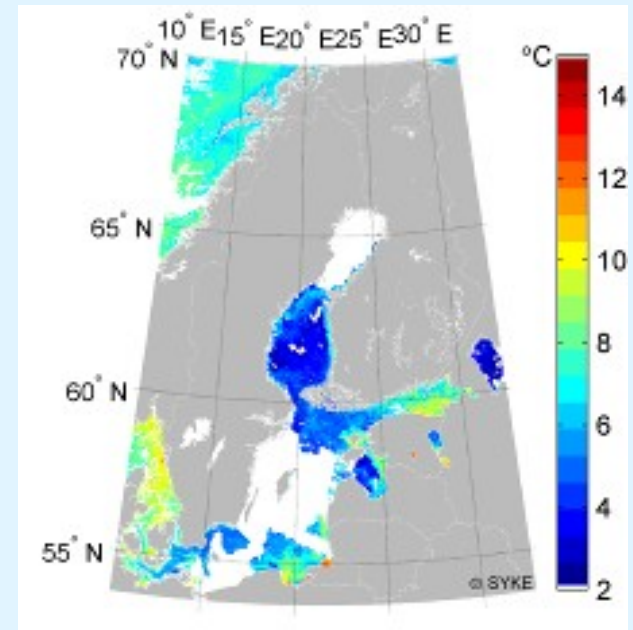
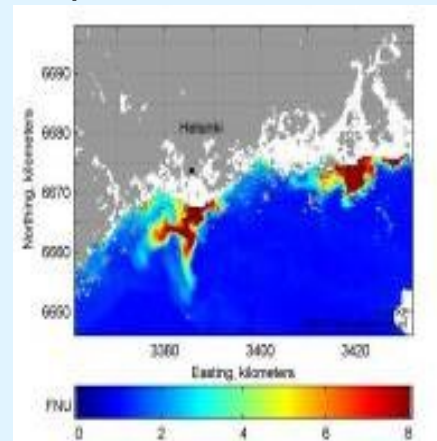
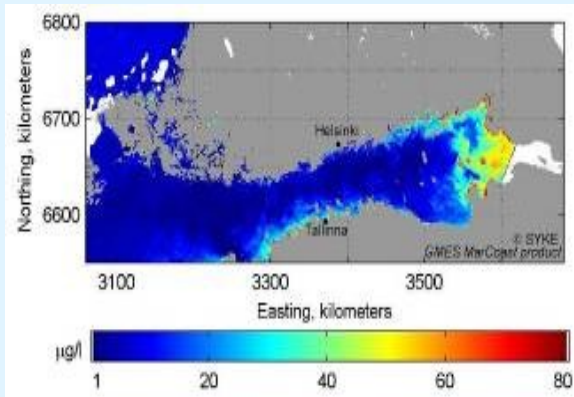
- **Remote sensing at SYKE**
 - Overview of activities
 - Operative products
- **Products in detail**
 - Sea & Lake surface temperature
 - Snow on lake ice

Geoinformatics and Land Use Division (GEO)

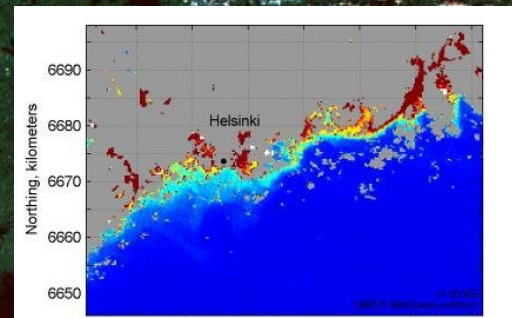
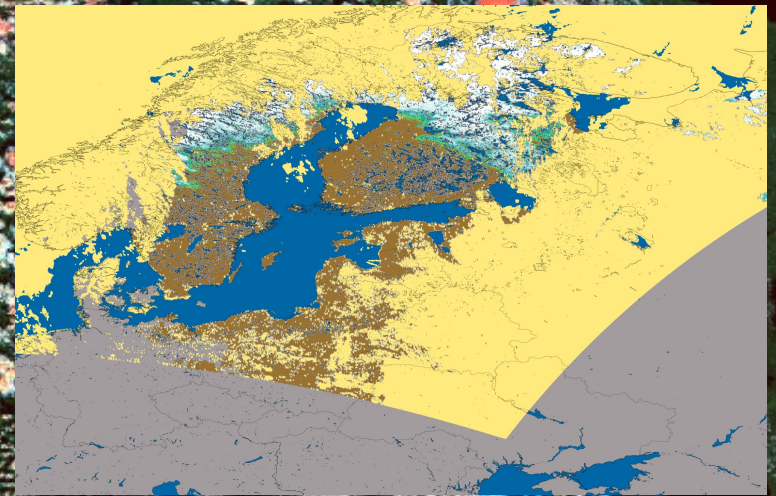
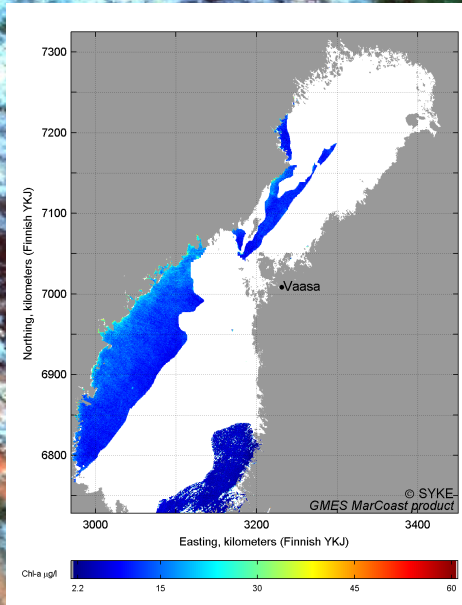
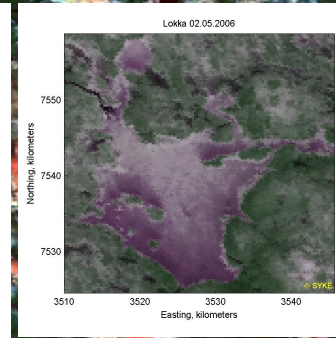
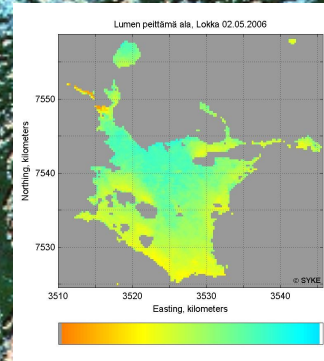
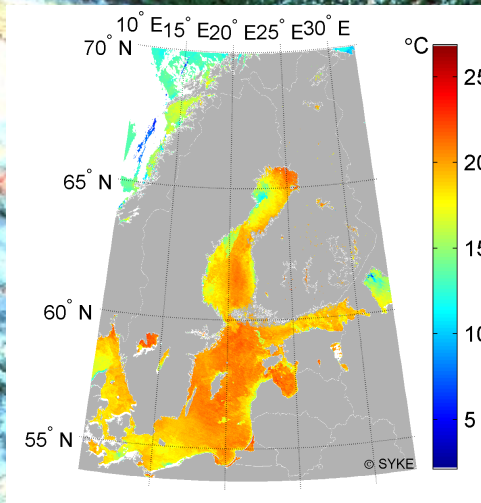
- **Within Data and Information Centre**
- **Research, development, maintenance and support activities**
- **~ 30 employees (nearly all with a university degree)**
- **Services for the whole environmental administration and external users**
- **Three units:**
 - **GIS**
 - **Remote Sensing**
 - **Land Use Information systems**

Remote sensing group at SYKE

- 12 workers
- Research & operative applications
- Data processing systems
- Monitoring
 - Water quality, snow, land cover, vegetation, oil-spill
- End users of products
 - Governmental institutes, hydropower companies, Universities, citizens

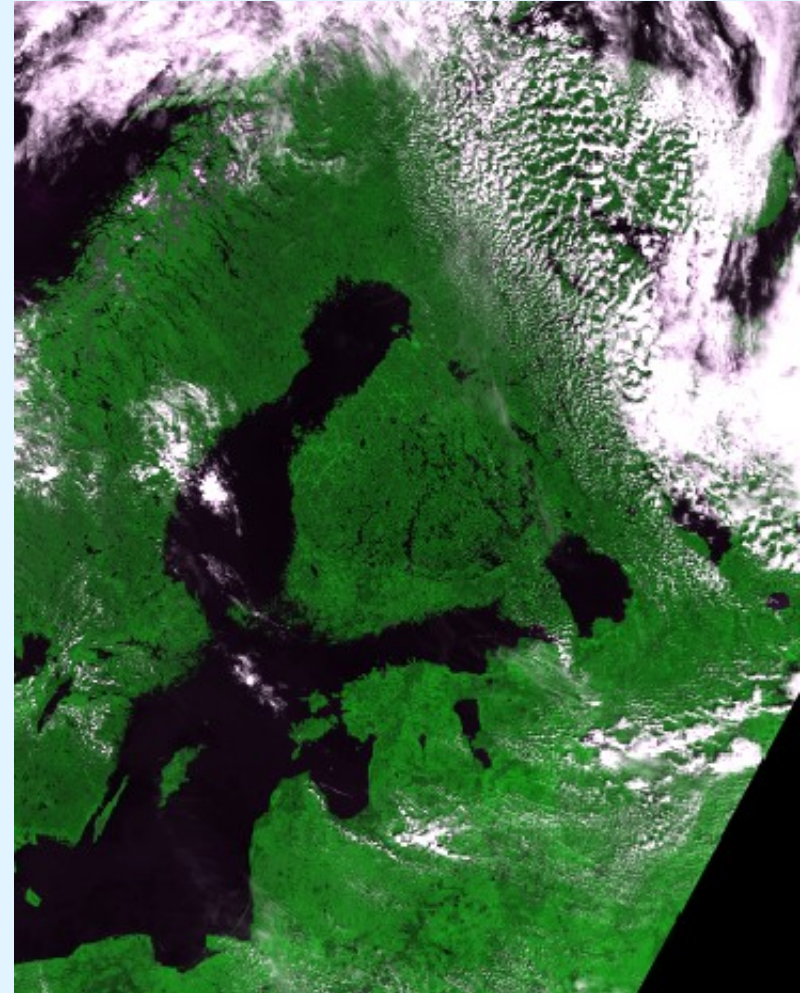


Remote Sensing at SYKE



Usage of satellite images

- Near real time (NRT) services
 - Winter and spring :
 - Snow monitoring, snow on ice
 - Spring and summer :
 - Water quality and temperature
 - Algae blooms
 - Seasonal vegetation monitoring
 - Oil spill detection
- Long term services
 - Land cover
- Satellite data used
 - Modis/Terra, Envisat/Meris, NOAA AVHRR, Landsat ETM, Radarsat, etc.



Production line for EO data

EO-data distributor (FMI, ESA)

Automated processing system (SYKE)

FTP-box

Image processing:

2. Unpacking
3. Radiometric calibration and atmospheric correction
4. Geometric correction

Archiving

Data in usable form for the localized algorithms

Product calculation & data delivery (SYKE)

Data delivery

- WWW
- Map user interface
- numerical data

End users

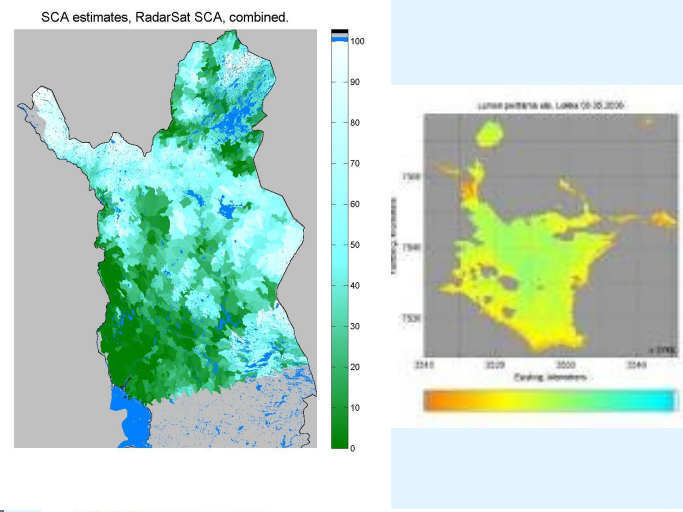
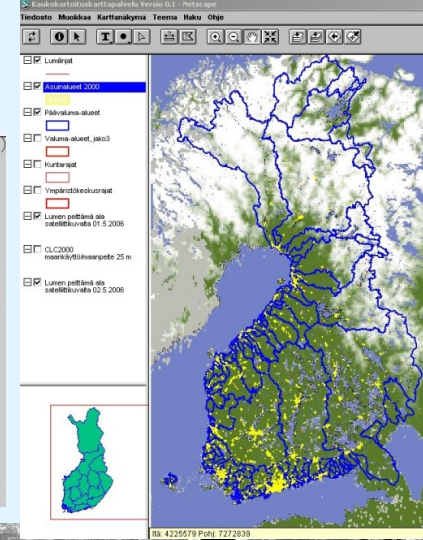
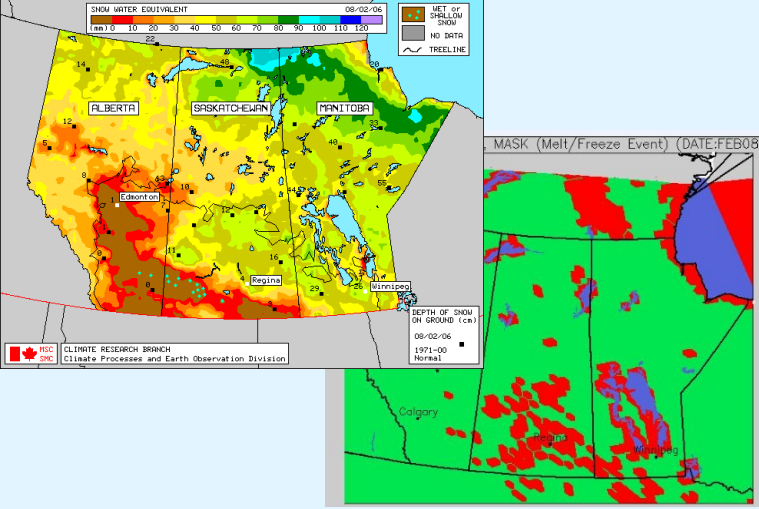
citizens runoff forecasts forest industry
 climate change research watershed research
 water protection tourism
 hydropower industry

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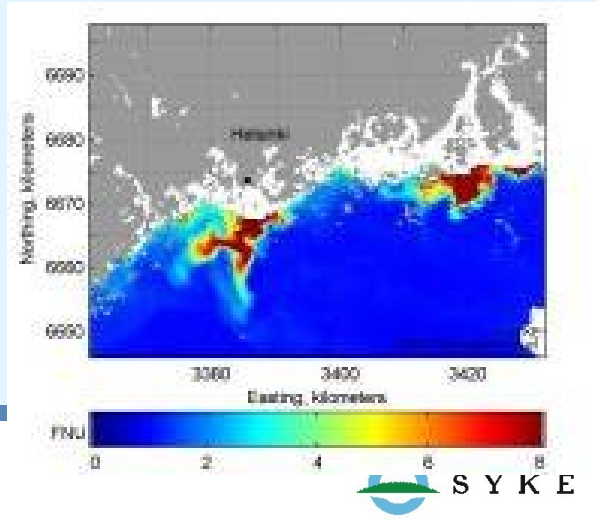
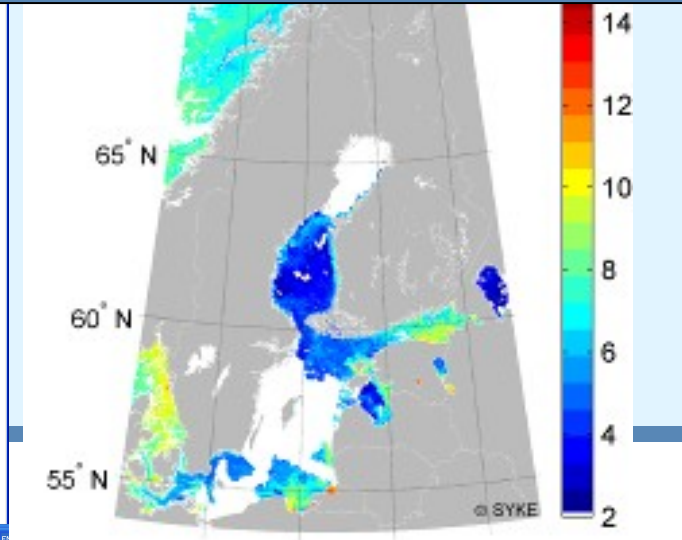
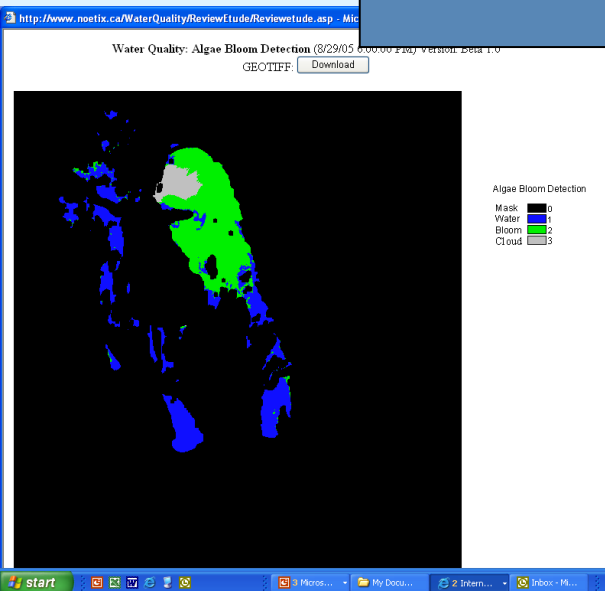
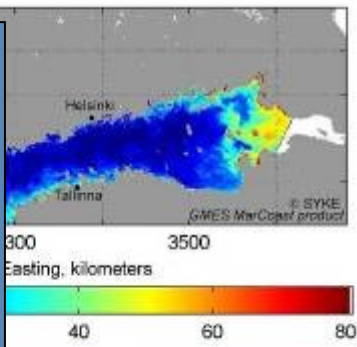
End-product

Combination with other data sources

Algorithm & Cloud masks



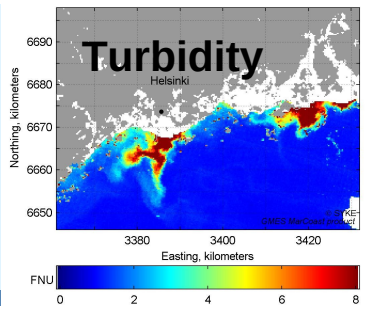
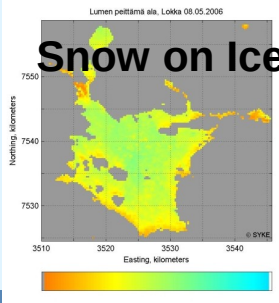
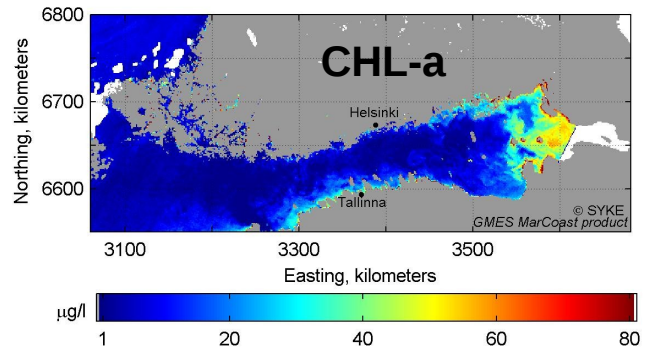
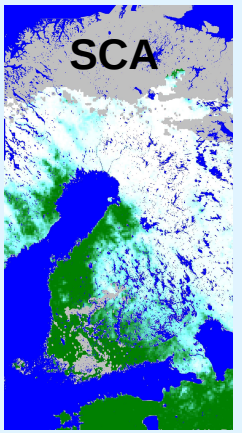
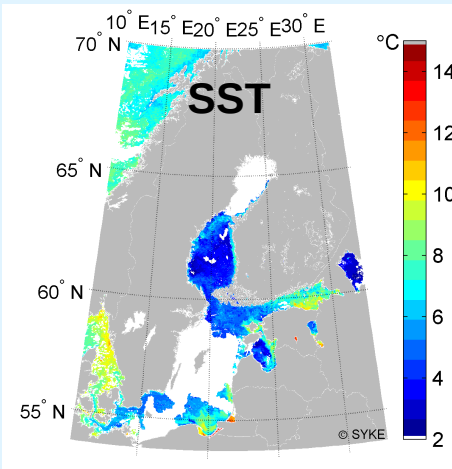
**In Finland:
Over 400 Level 1 end products
Several thousand sub-products yearly**



Operative Remote sensing applications

Data processed & published daily by SYKE

- **Snow Covered area**
 - Instruments: Modis-Radarsat-Asar
- **Sea surface temperature**
 - Instrument: AVHRR
- **Turbidity**
 - Instruments: Meris, Modis
- **Surface Algae**
 - Instruments: Meris, Modis
- **Snow covered area on Ice**
 - Instruments: Modis
- **Chlorophyll a**
 - Instruments: Meris

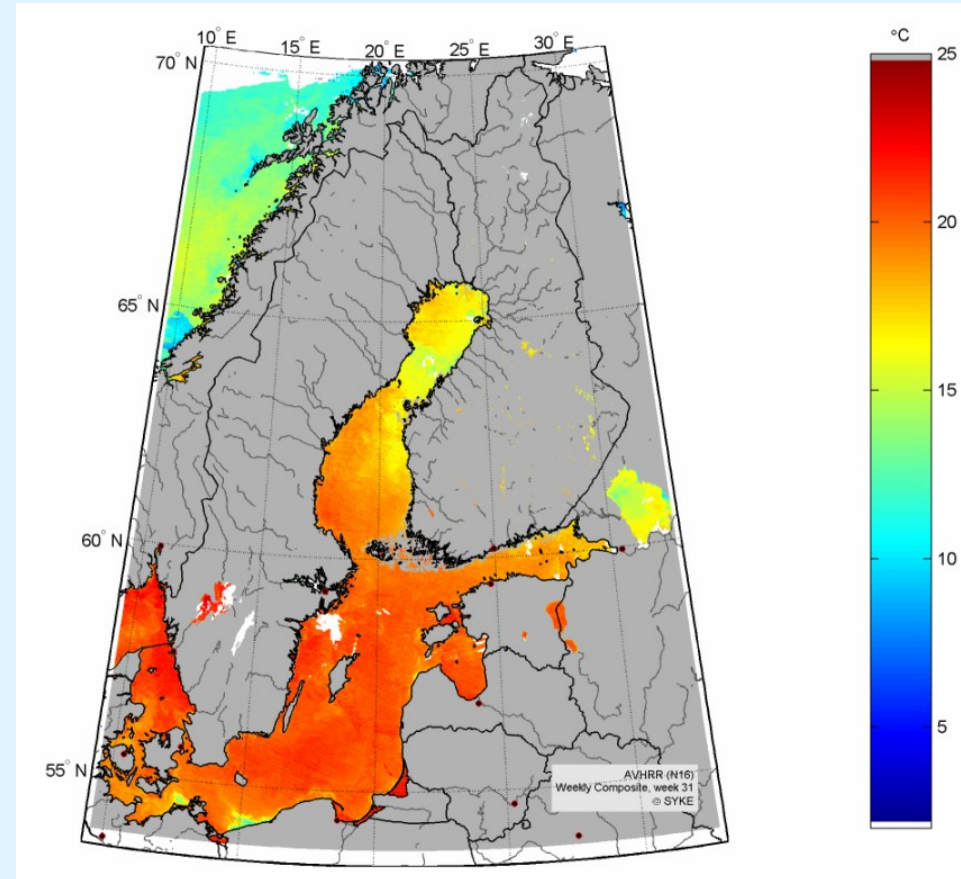
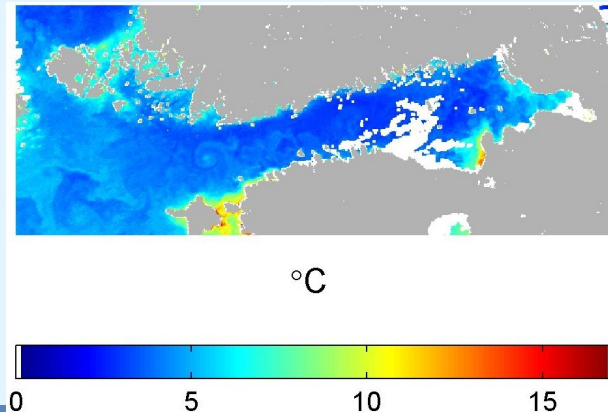


Operative Products 2008

Products 2008	Instrument	Resolution	Daily map	Composite map (weekly)	Summary data after production period	Production period
SST & Lake surface temperature	NOAA AVHRR	1000 m	X	X		May-October
Surface floating algae blooms	ENVISAT Meris	300 m	X	X	X	July-August
Chlorophyll	ENVISAT Meris	300 m		X	X	May-September
Turbidity	ENVISAT Meris	300 m		X		May-September
Snow covered area	Modis Terra, Radarsat	5000 m	X			February - May
Snow on Lake ice	Modis Terra	250 m	X			March - May

Applications: Sea Surface Temperature (SST)

- Operative since 2002
- Daily Product
- NOAA AVHRR, resolution 1 km, night-time overpasses
- Baltic Sea, Gulf of Bothnia, Gulf of Finland and 12 Finnish lakes in more detail
- From April to October
- Split-window coefficients
- Processing is automatic
- Results are published in WWW daily



Characteristics of SYKE's SST Product

- **Customized cloud detection algorithm**
- **Focus on fast delivery**
- **Current users are interested mainly on detection of the upwelling phenomena and spatial differences of the surface temperature**
 - **Absolute scale is not that important**

NOAA/AVHRR-16 Split-Window

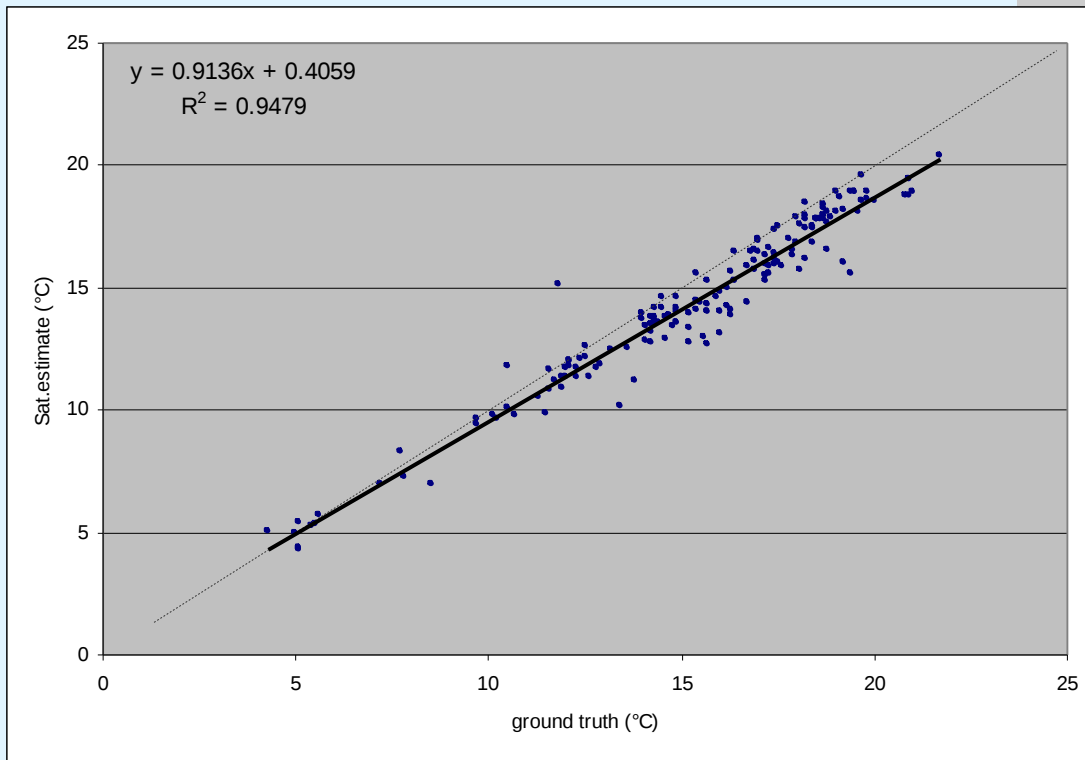
- **Used thermal channels:**
 - **Ch4, 11 μm**
 - **Ch5, 12 μm**
- **Standard coefficients from NASA**

$$T_s = T_4 + a_1(T_4 - T_5) + a_0$$

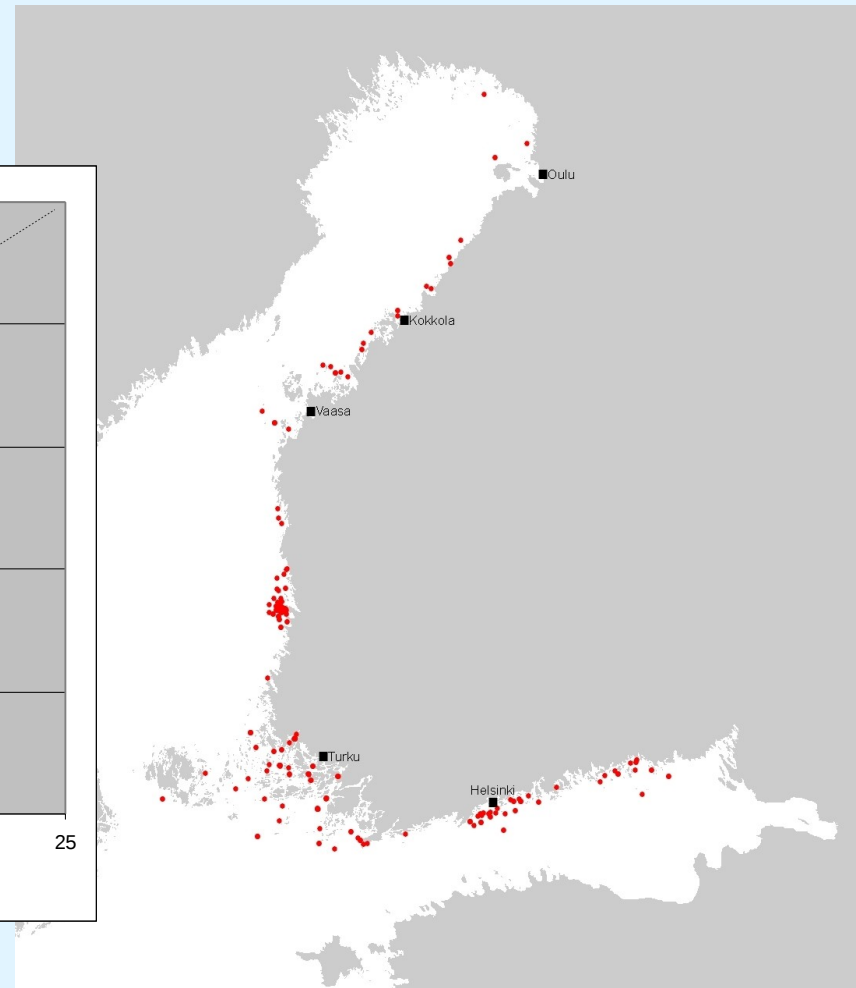
$$MCSST = a_1(T_4) + a_2(T_4 - T_5) + a_3(T_4 - T_5)(Secq - 1) - a_4$$

$$NLSST = b_1(T_4) + b_2(T_4 - T_5) * MCSST + b_3(T_4 - T_5)(Secq - 1) - b_4$$

Validation

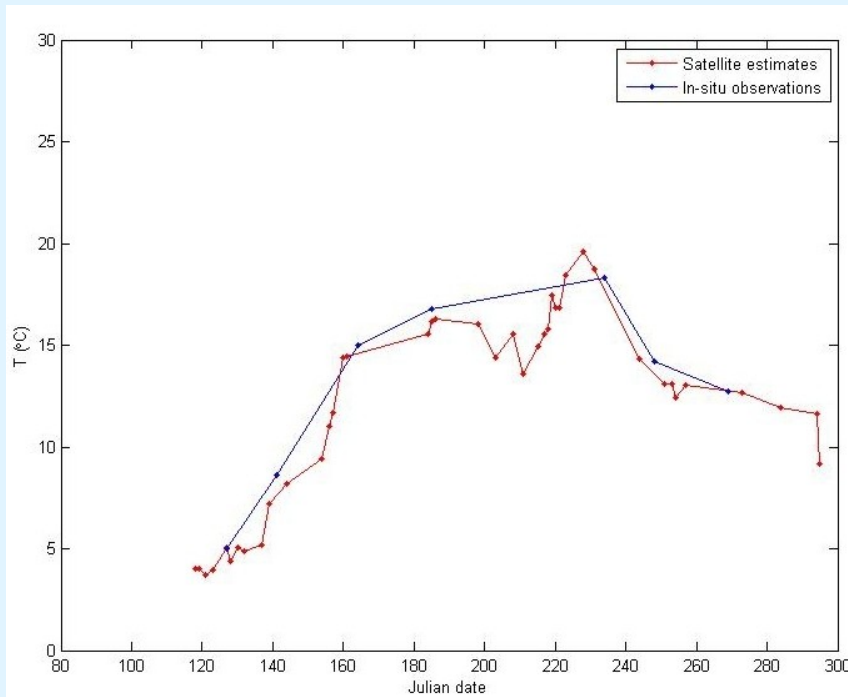


Regression plot for SST: estimate values compared against the in-situ observations during period May-October 2007. In-situ measurements are done during the day, resulting in higher values than the corresponding satellite estimates calculated from images taken during night time.

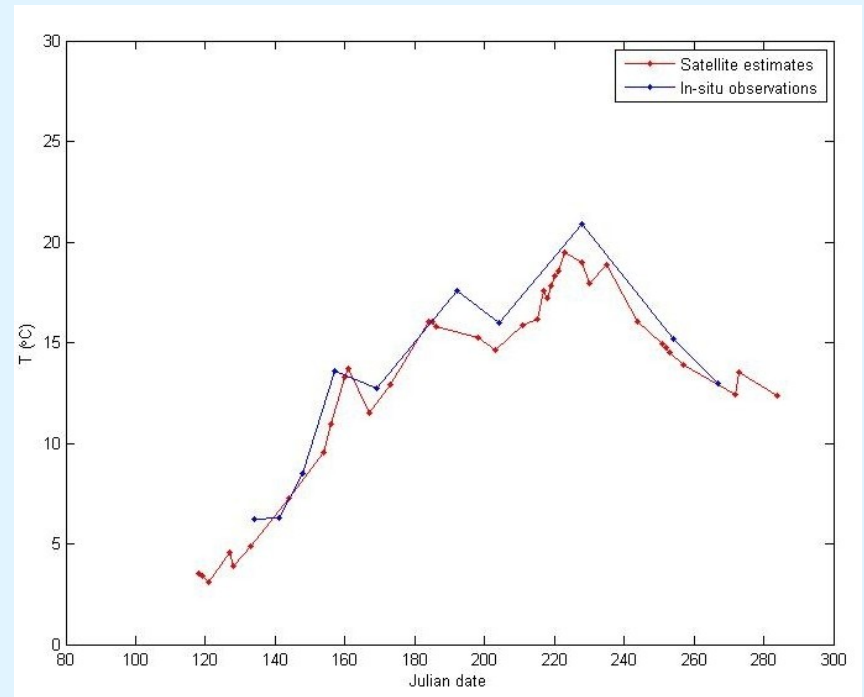


Difference between the skin temperature and the water temperature directly below the surface is approximated to be 0.2 degrees. In-situ observations in 1 m depth!

Validation

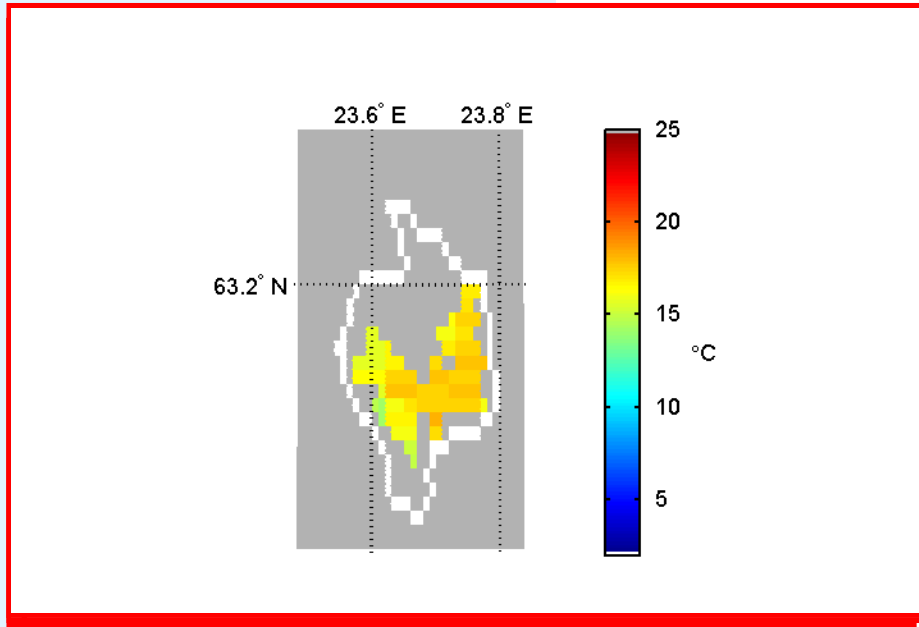


- The in-situ and satellite estimated SST values at the monitoring station of Porvoo (UUS-15) in summer 2007

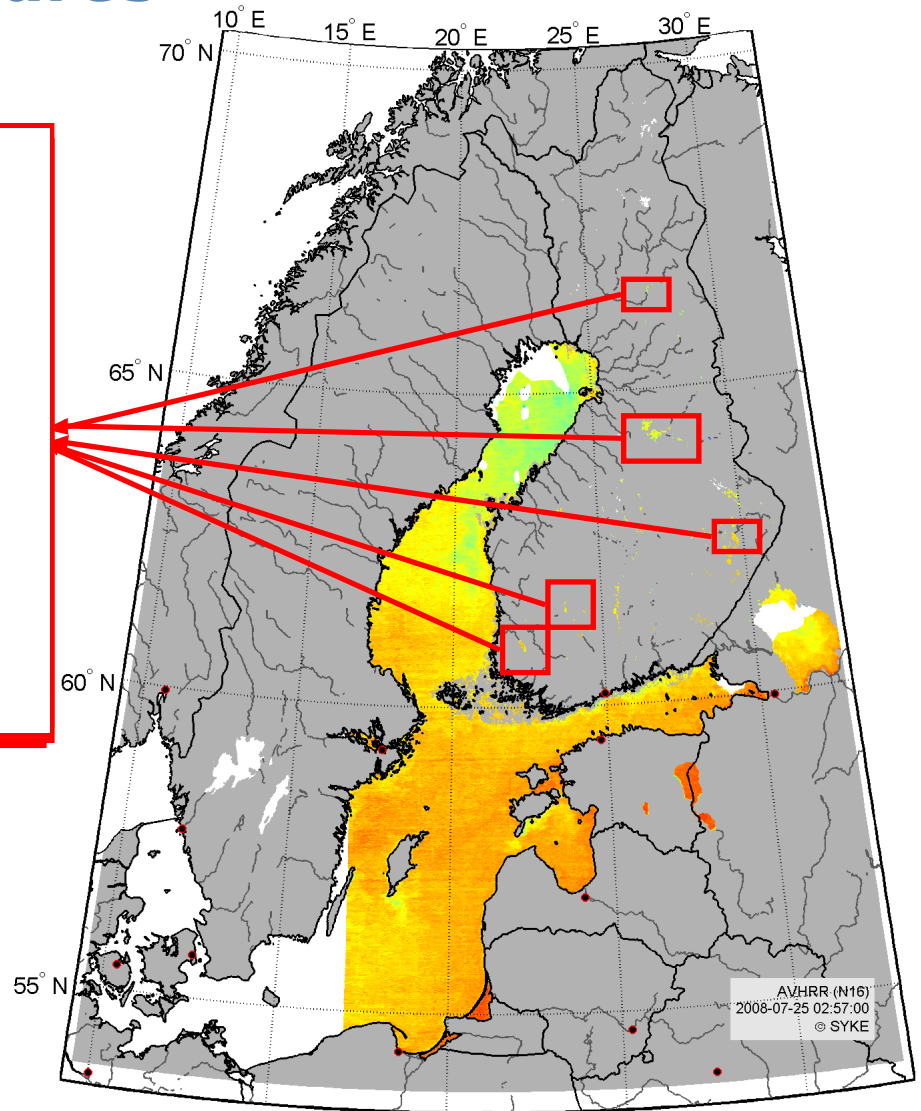


- The in-situ and satellite estimated SST values at the monitoring station of Haapasaari (Kyvy-11) in summer 2007.

Lake Surface Temperatures

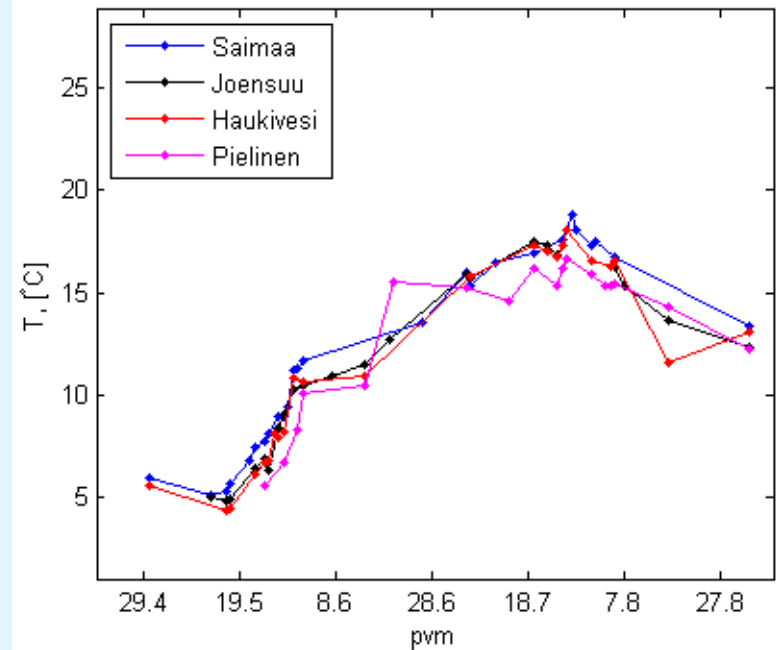
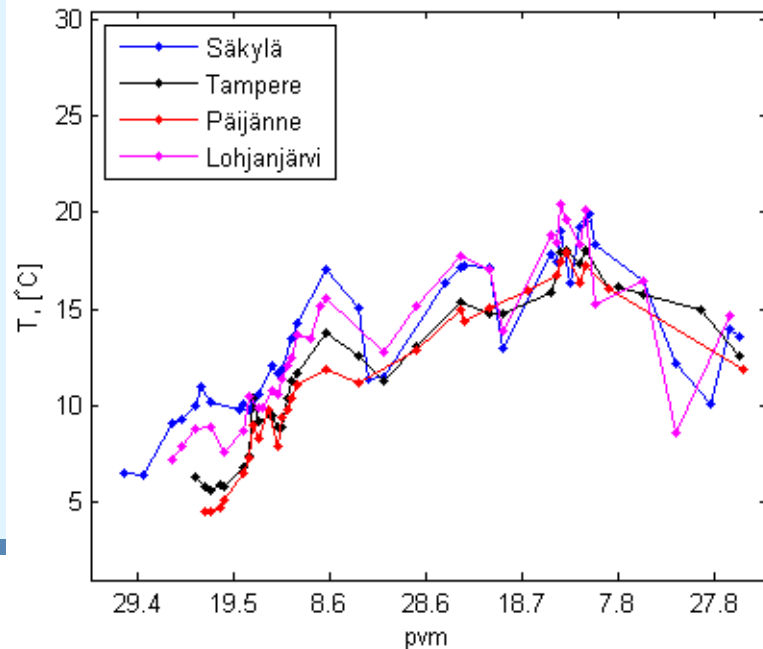
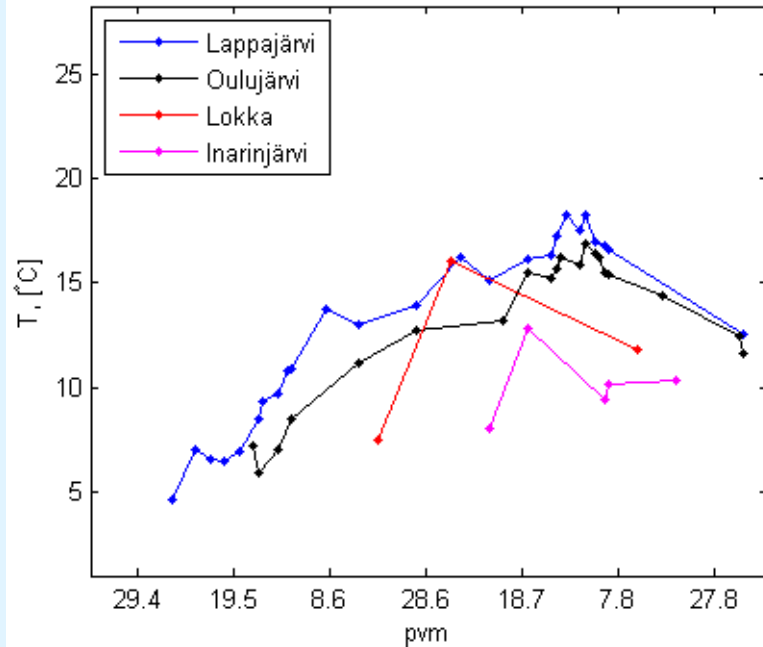


- Estimates for 12 biggest lakes in Finland
- Manual inspection of cloud masks

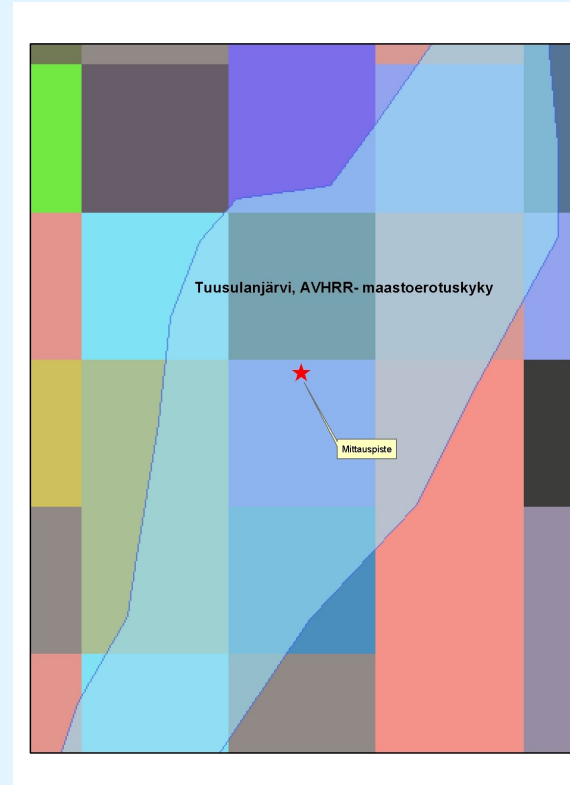
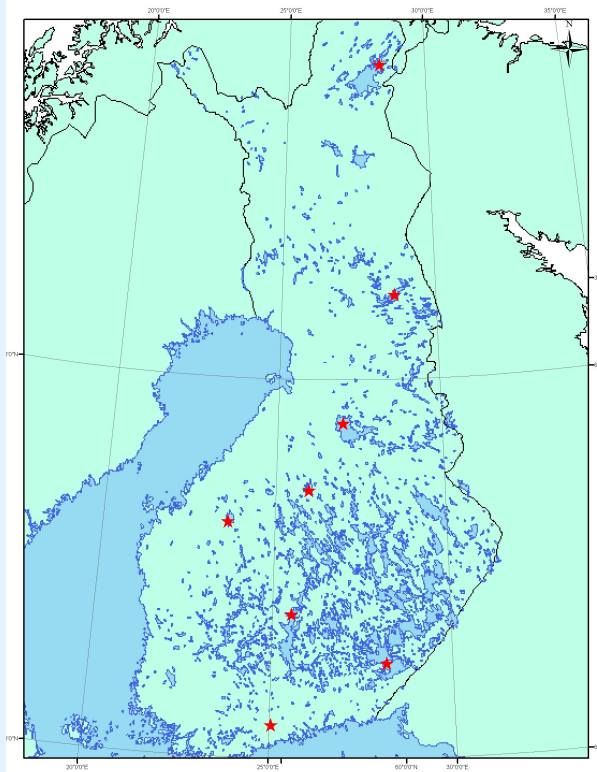


Time series

Clouds are a big problem!

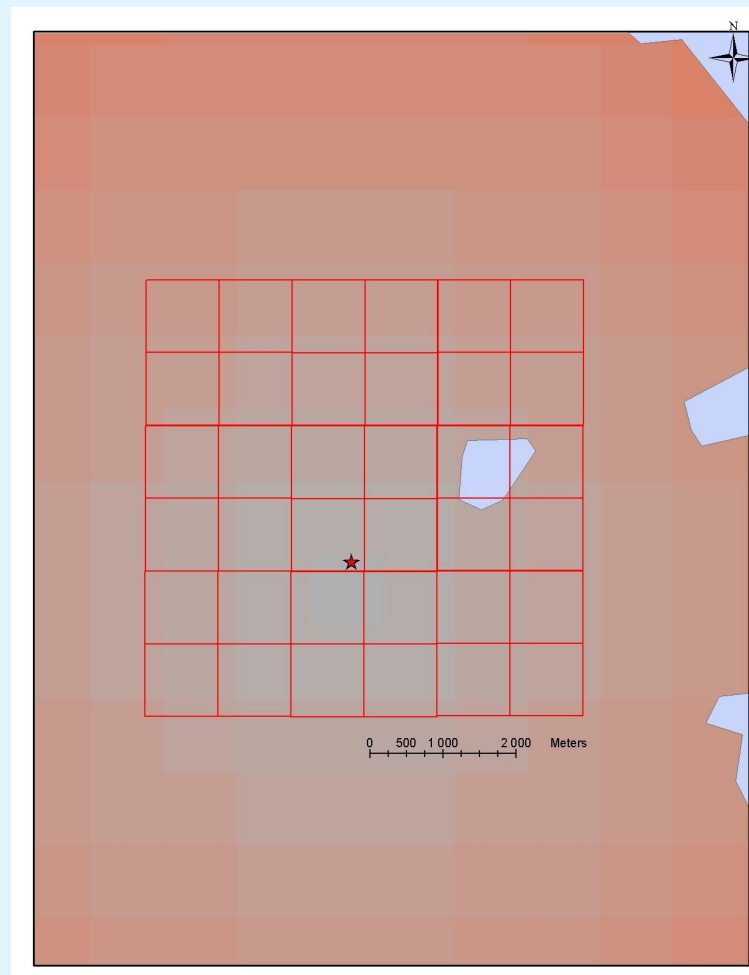
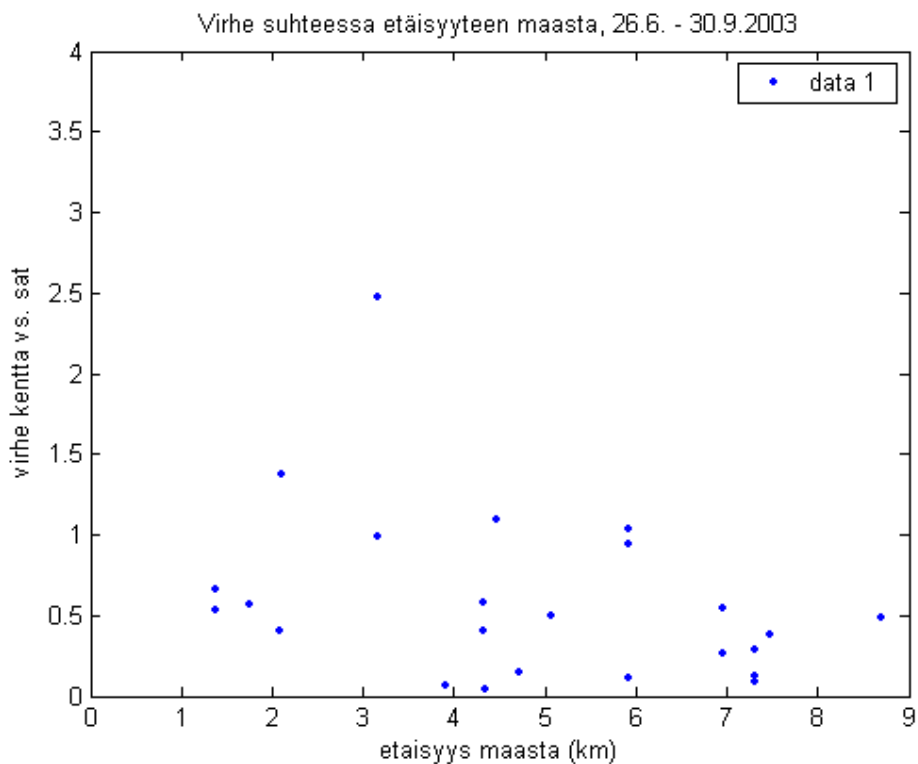


Accuracy of the estimation on lakes

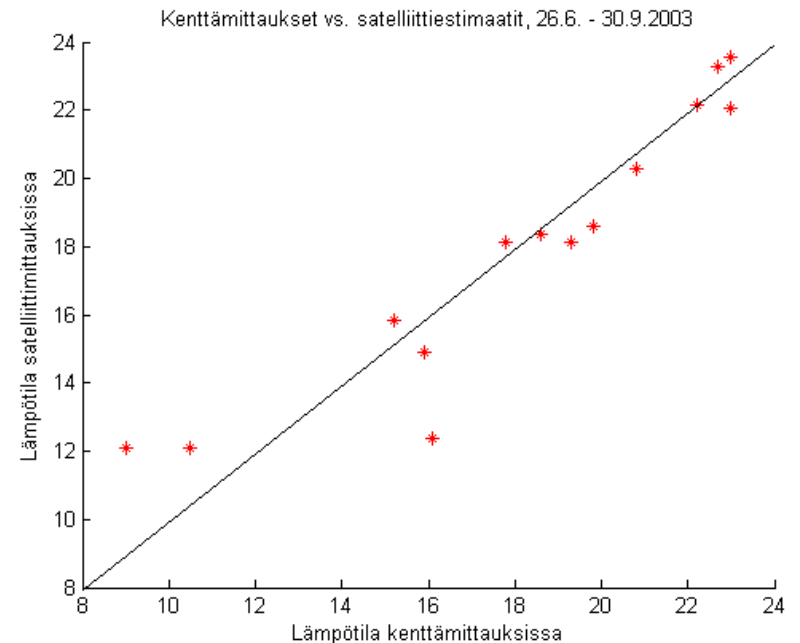
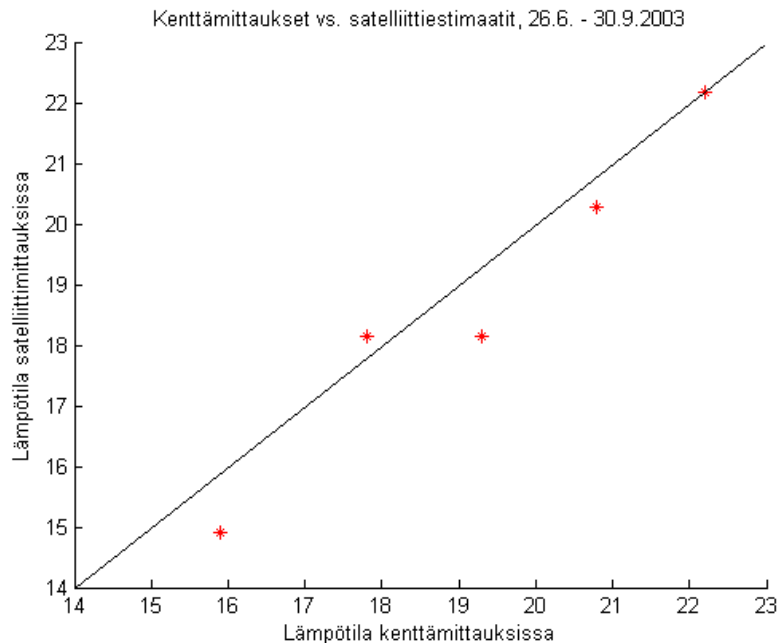


Problems: Resolution vs. object size, adjacency effects

Accuracy vs distance from shoreline



Accuracy of the estimates on lakes (Field measurement vs satellite)

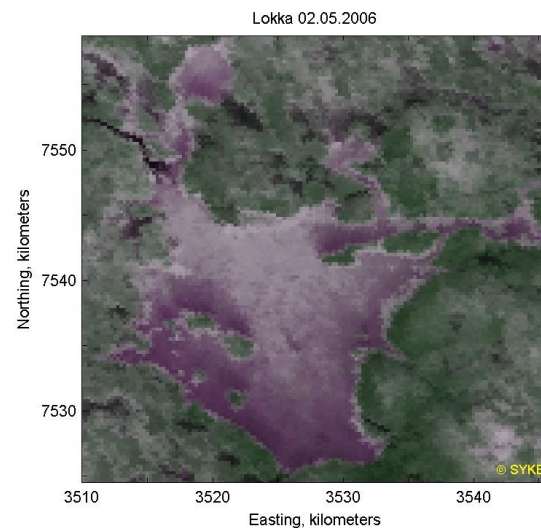
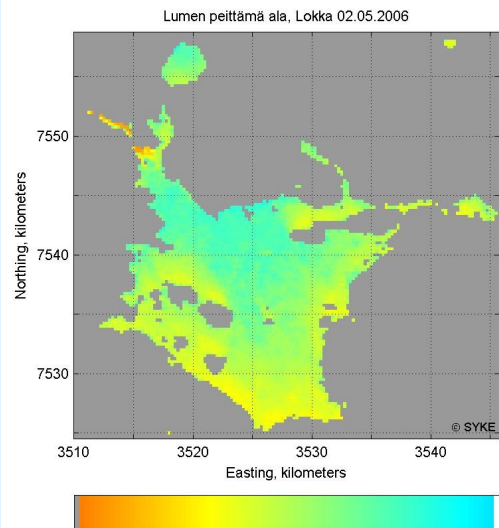


- $n = 5$
- stderr 0.6123
- stdev = 0.4654

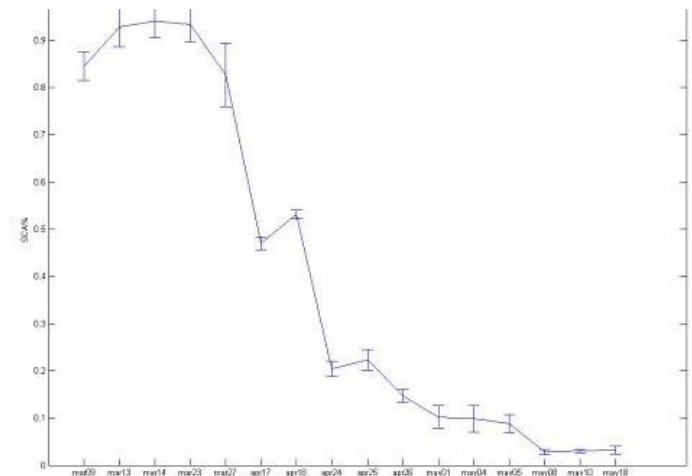
- Linear interpolation of satellite observations in time-scale
- $n = 15$
- stderr 1.1493
- stdev = 1.0307

Applications: Snow coverage on lake ice

- Indicates ice brake off timing in spring
- Estimated for 9 lakes around Finland
- Modis/Terra, 250 m resolution
- Based on SYKEs SCA algorithm (without transmissivity)

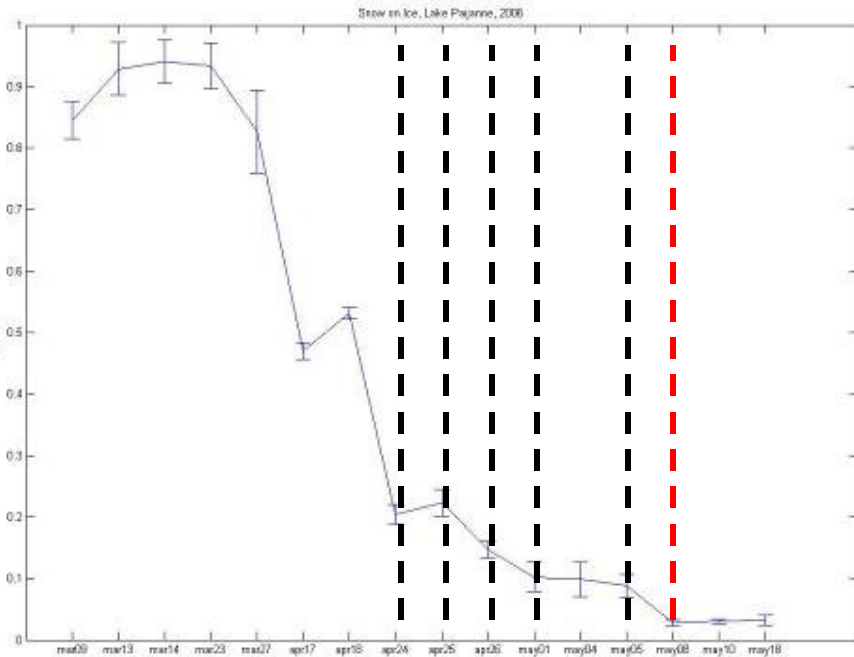


Average Sol% Lake Päijänne 2006

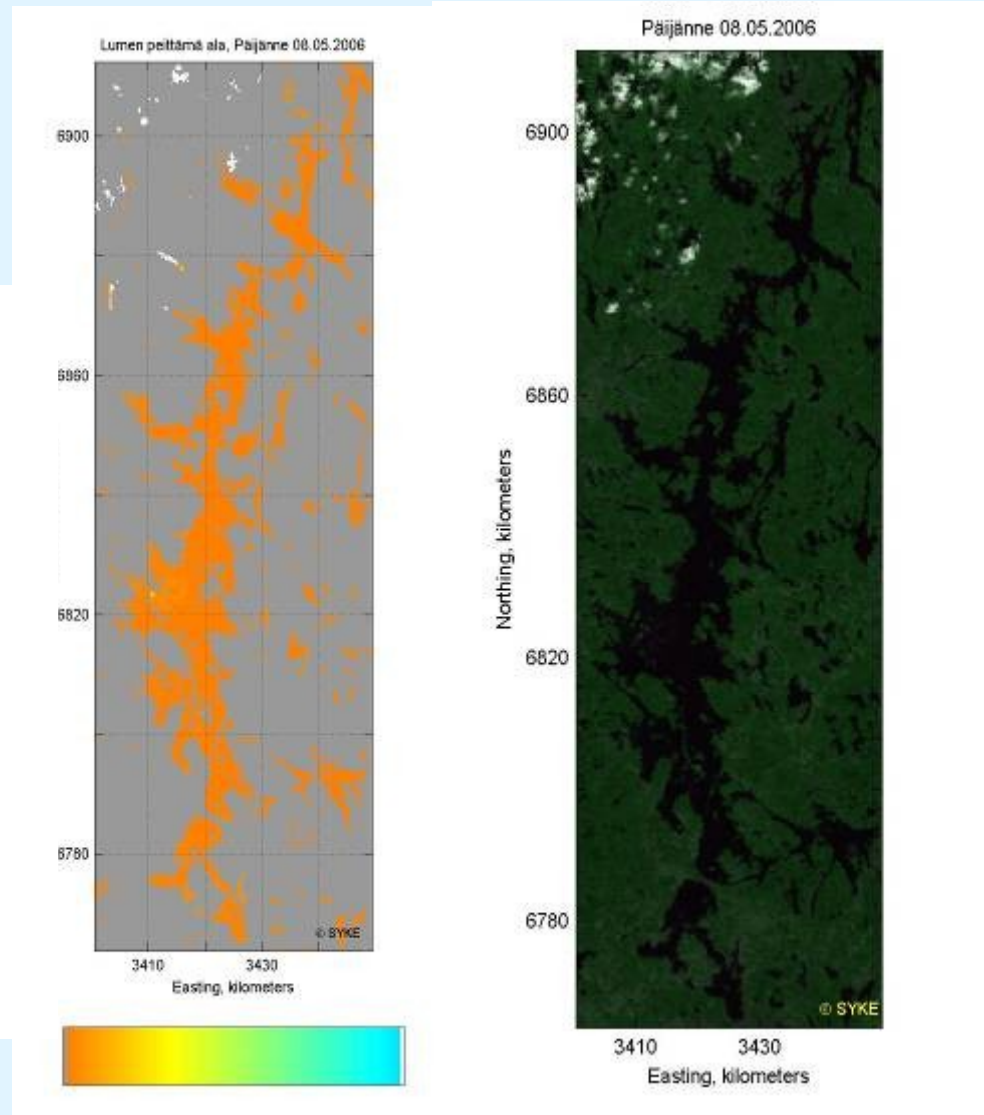


Example

Average Snow on Ice, Lake Päijänne 2006



Ice break May 09



For more info

www.environment.fi/syke/remotesensing

The screenshot shows a Mozilla Firefox browser window displaying the website http://www4.ymparisto.fi/f4/eng/products/satellite_images.html. The page title is "Operative Remote Sensing Products - Mozilla Firefox". The website content includes:

- Header: www.environment.fi, Operative Remote Sensing | Finnish Environment Institute (SYKE), Suomeksi | På svenska
- Section: **Operative Remote Sensing Products**
- Left sidebar: Information on Products, Products, SYKE logo, Polar View logo, MarCoast logo (a GEMS Services Network).
- Main content: **The Latest Operative Remote Sensing Products**
 - Latest MERIS Satellite Image
 - Latest MODIS Satellite Image
 - Snow Covered Area (SCA) (EOS MODIS, Feb-May)
 - Sea Surface Temperature (SST) (NOAA AVHRR, May-Oct)
 - Surface Algal Blooms (ALG) (Envisat MERIS, Jul-Aug)
 - Turbidity (TUR) (Envisat MERIS, May-Sep)
 - Chlorophyll-a (CHL) (Envisat MERIS, May-Sep)
 - Snow Covered Area of Finnish Lakes (only in Finnish) (EOS MODIS, Mar-May)
- Right sidebar: **RELATED TOPICS**
 - Remote Sensing Products
 - Snow Covered Area Map Archives
 - SST Map Archives
 - Algal Bloom Map Archives
 - Turbidity Map Archives
 - Chlorophyll Map Archives
 - SCA of Finnish Lakes Archives (Fin)
 - State of the Environment
 - Current Hydrological Information
 - Others
 - Operative Remote Sensing
 - GMES-projects at the SYKE**RELATED LINKS**
 - PolarView
 - MarCoast**MORE INFORMATION**

Remote Sensing Team, Finnish Environment Institute (SYKE), Geoinformatics and Land Use Division.

group@ymparisto.fi
[\[syke_rs_oper\]](mailto:syke_rs_oper)

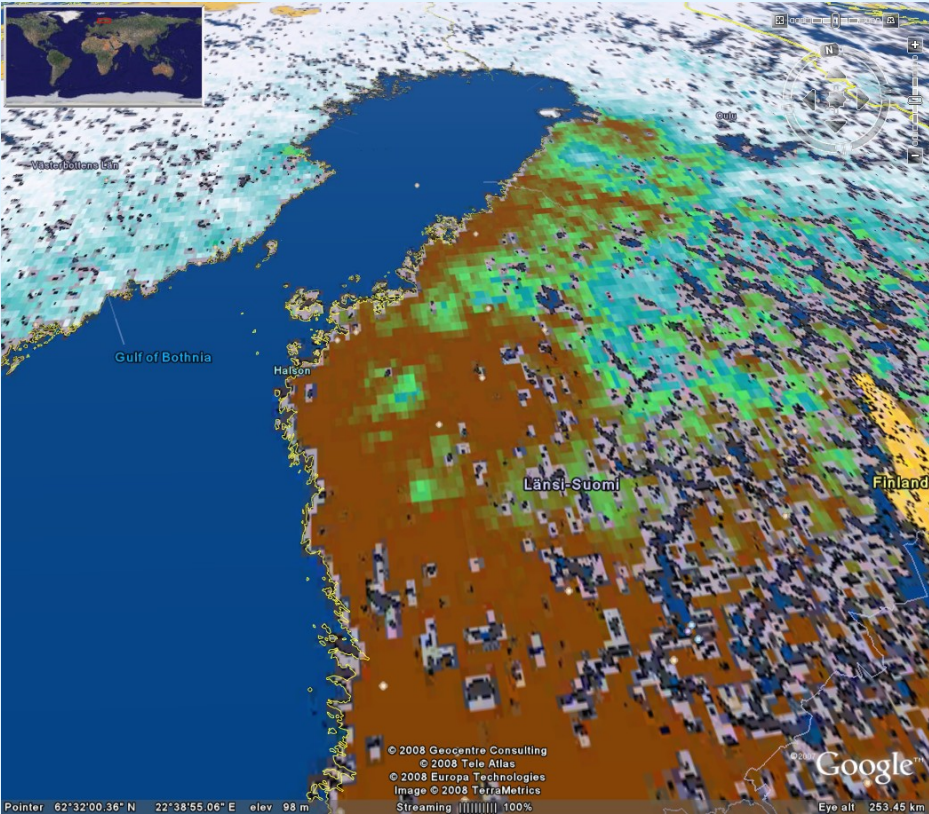
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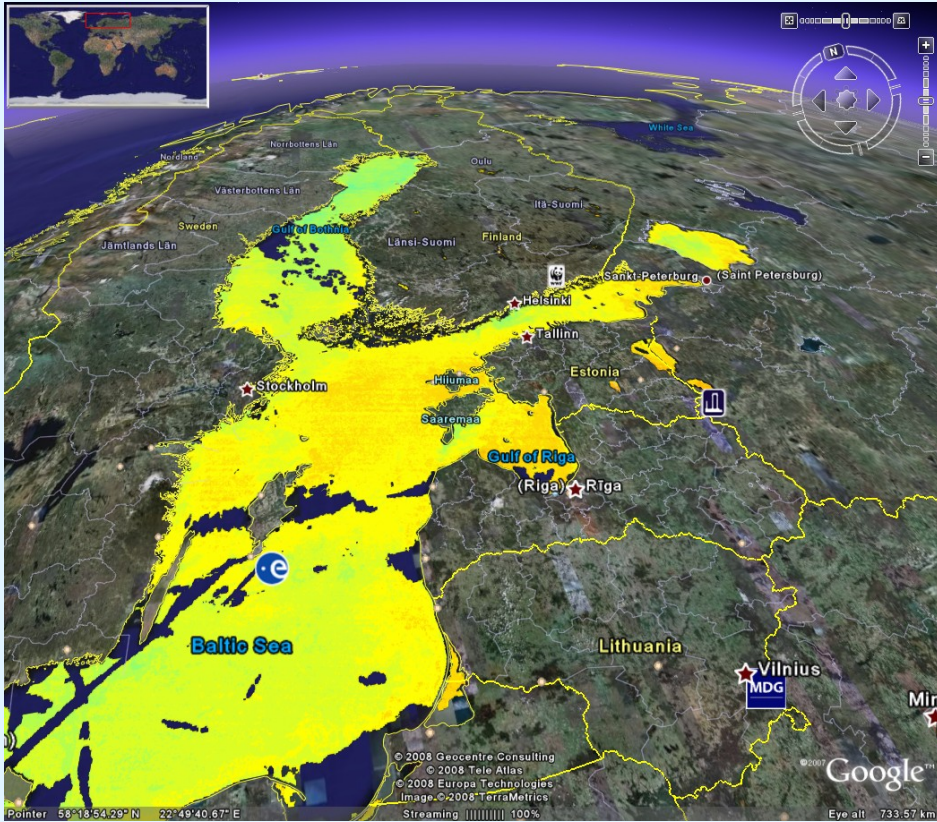
■ Questions, comments ?

syke_rs_oper@environment.fi

Thank You!



Snow covered area (SCA)



Sea Surface Temperature (SST)