Operative Production of Lake Surface Temperature Estimates

Mikko Kervinen, Saku Anttila

Finnish Environment Institute (SYKE)

Data and Information Centre

Geoinformatics and Land Use Division (GEO)

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Contents

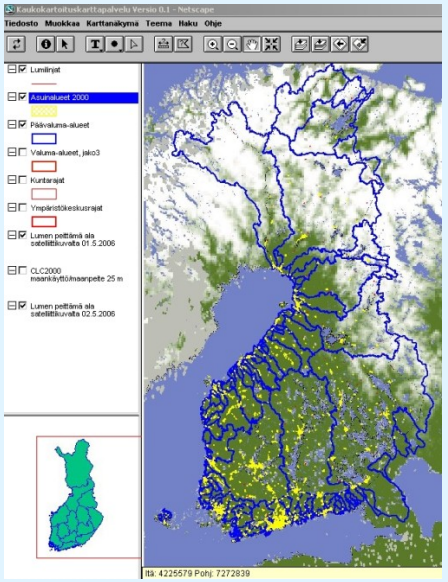
- **Remote sensing at SYKE**
  - **Overview of activities**
  - **Operative products**
- **Products in detail**
  - **Sea & Lake surface temperature**
  - **Snow on lake ice**

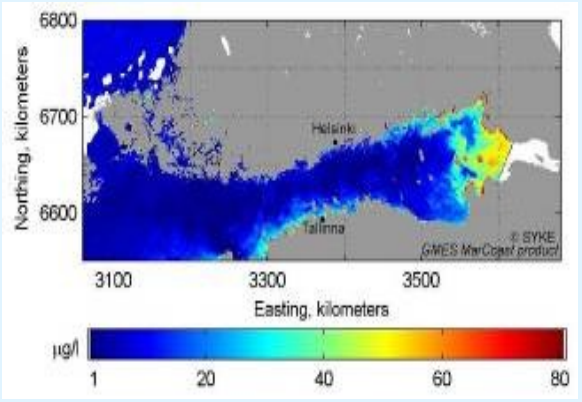
Geoinformatics and Land Use Division (GEO)

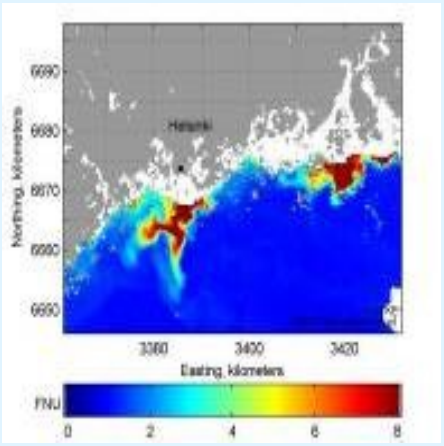
- Within Data and Information Centre
- Research, development, maintenance and support activities
- ~ 30 employees (nearly all with a university degree)
- Services for the whole environmental administration and external users
- Three units:
  - GIS
  - Remote Sensing
  - Land Use Information systems

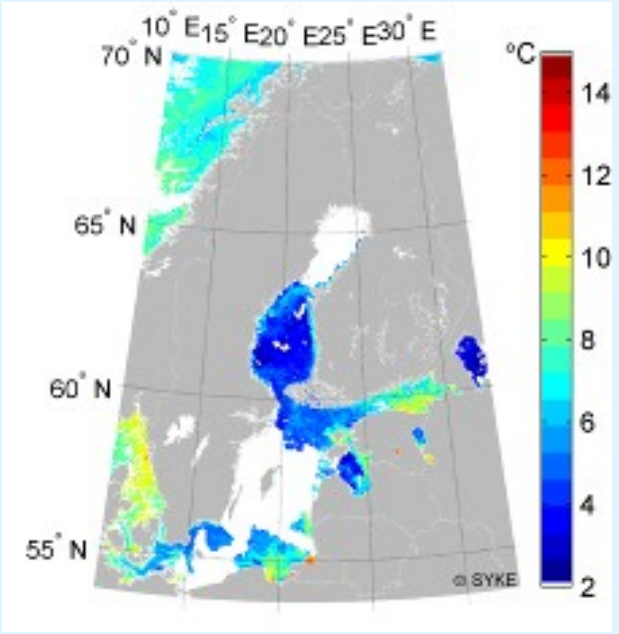
Remote sensing group at SYKE

- 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









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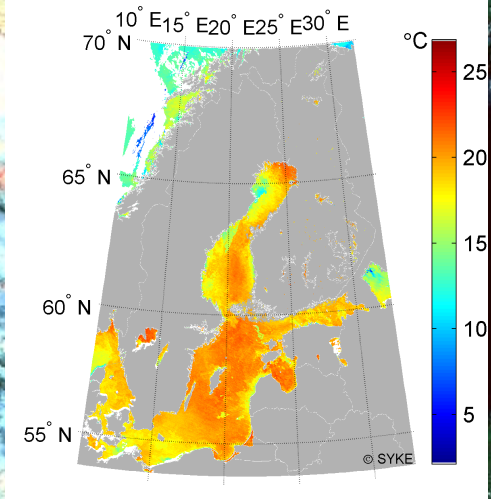
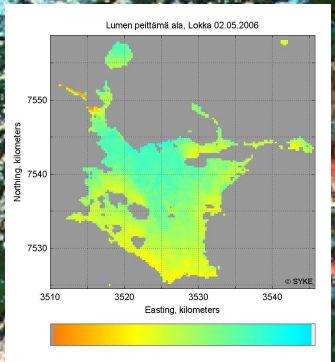
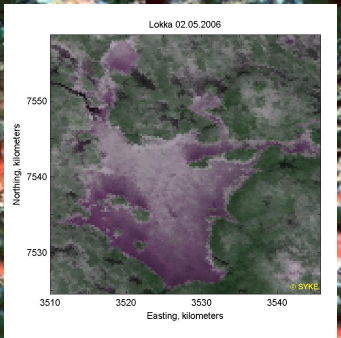
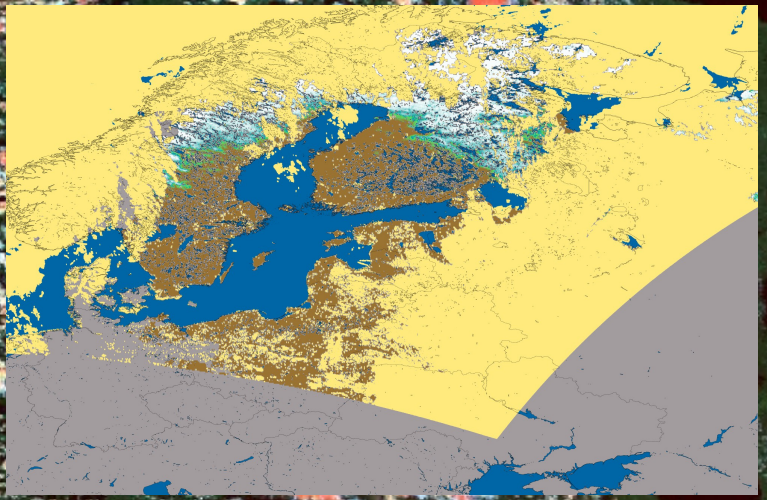
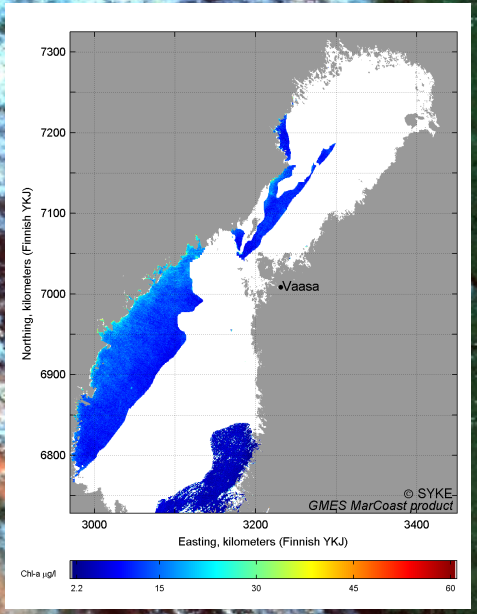
Remote Sensing at SYKE

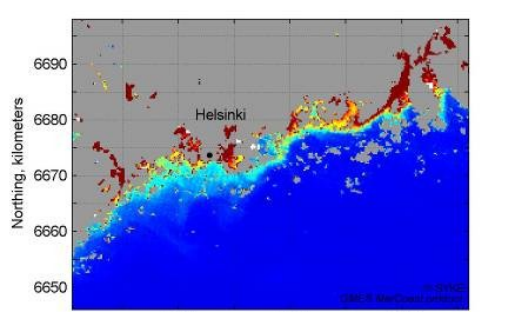






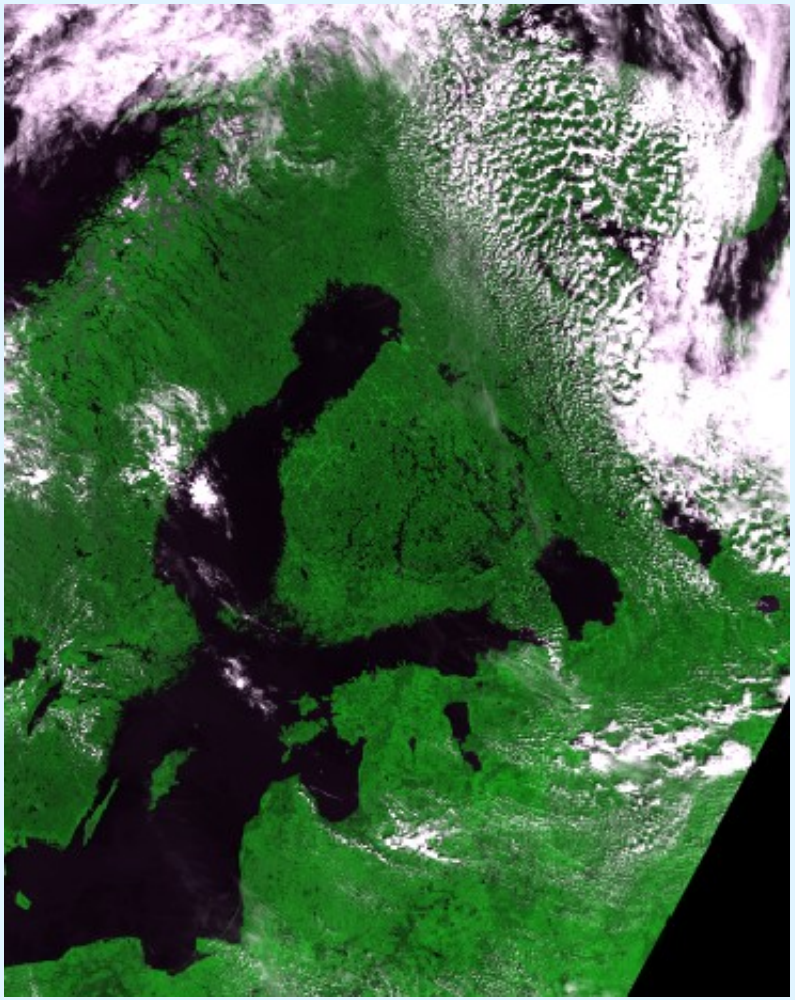






Usage of satellite images

- 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.



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Production line for EO data

EO-data distributer (FMI, ESA)

Automated processing system (SYKE)

FTP-box

Image processing:

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

Archiving

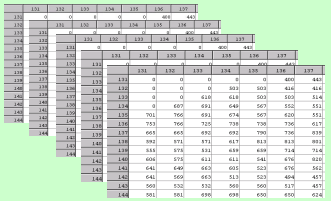
Data in usable form for the localized algorithms

Product calculation & data delivery (SYKE)

Data delivery
- -WWW
- -Map user interface
- -numerical data

End users

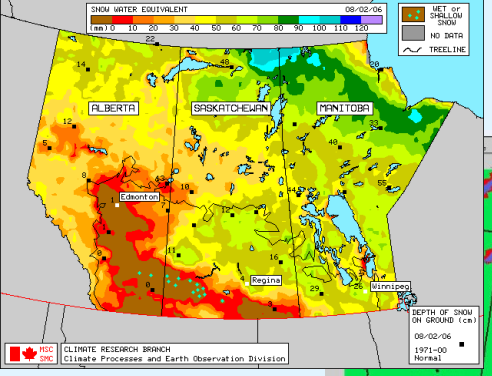
citizens
runoff forecasts
forest industry
climate change research
watershed research
water protection
tourism
hydropower industry

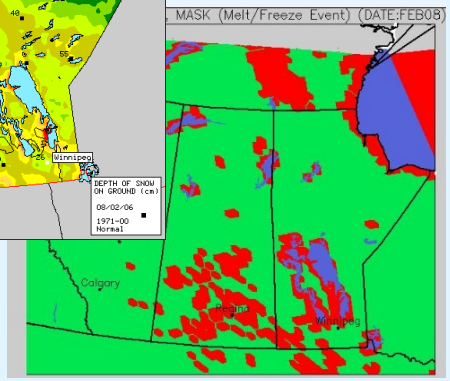


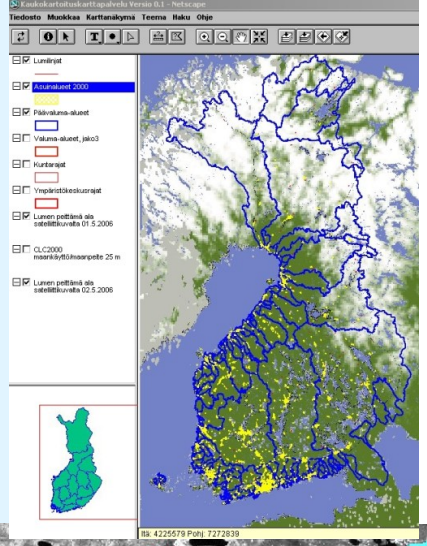
Algorithm & Cloud masks

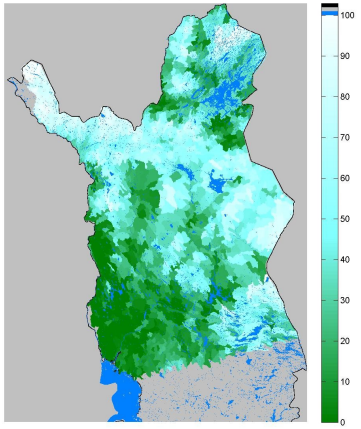
Combination with other data sources

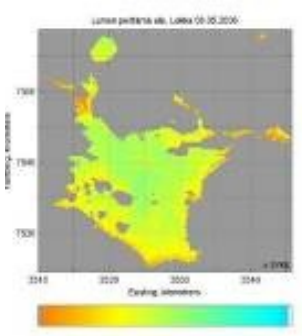
End-product

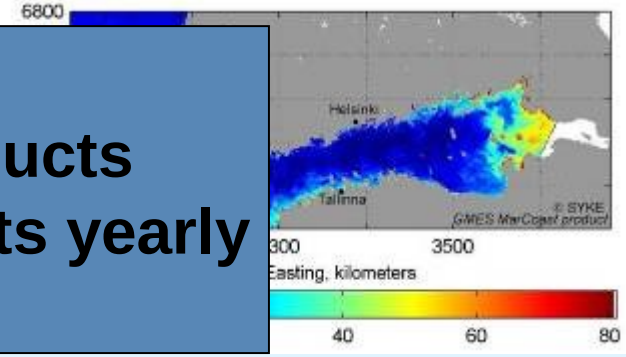




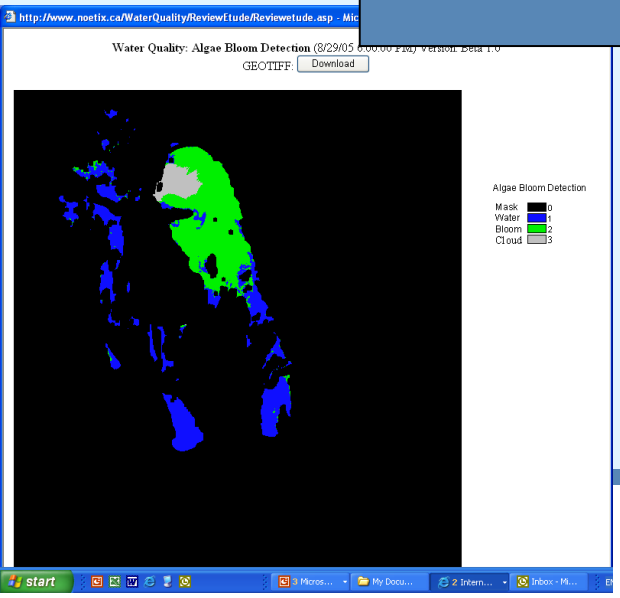


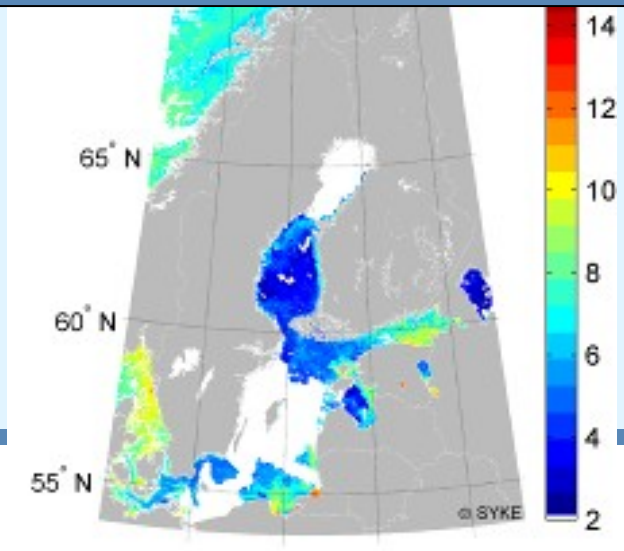


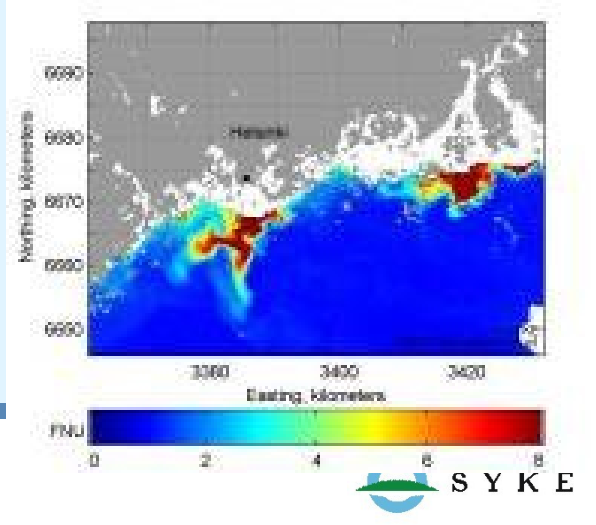




In Finland:
Over 400 Level 1 end products
Several thousand sub-products yearly





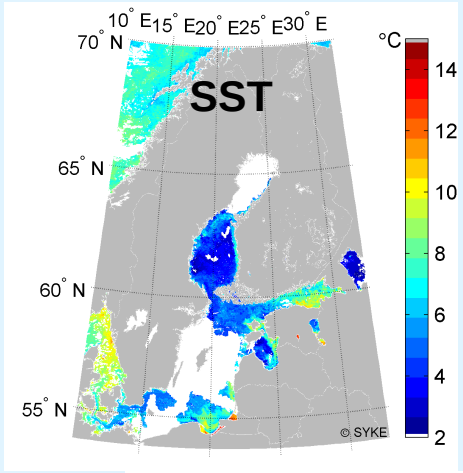


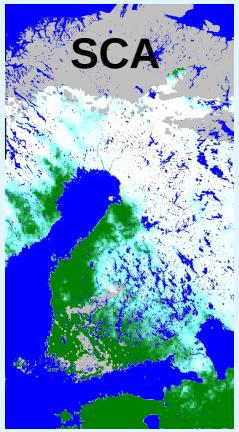
SYKE

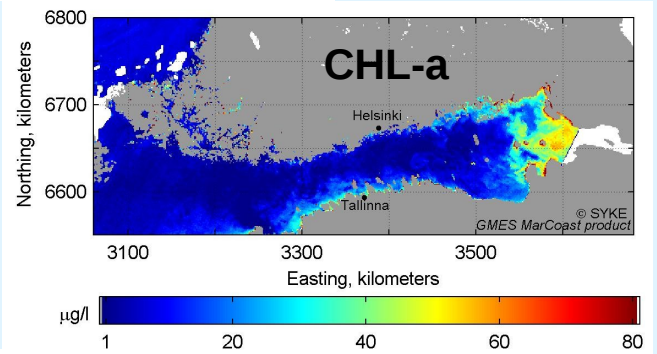
Operative Remote sensing applications

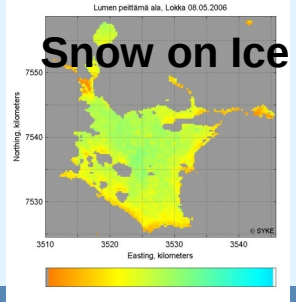
Data processed & published daily by SYKE

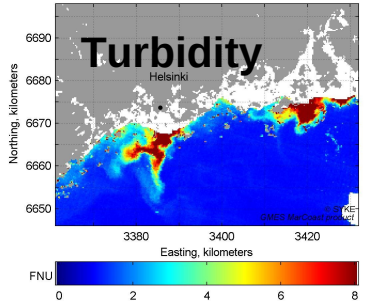
- **Snow Covered area**
  - **Instruments: Modis-Radarsat-Asar**
- **Sea surface temperature**
  - **Instrument: AVHRR**
- **Turbidity**
  - **Instruments: Meris, Modis**
- **Surface Algae**
  - **Instruments: Meris, Modis**
- **Snow covered area on Ice**
  - **Instruments: Modis**
- **Chlorophyll a**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











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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

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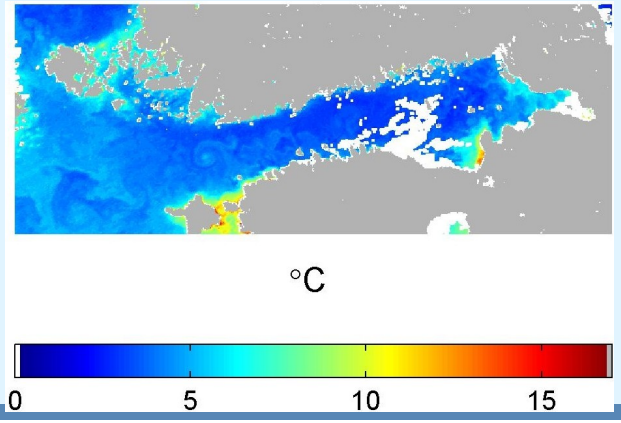
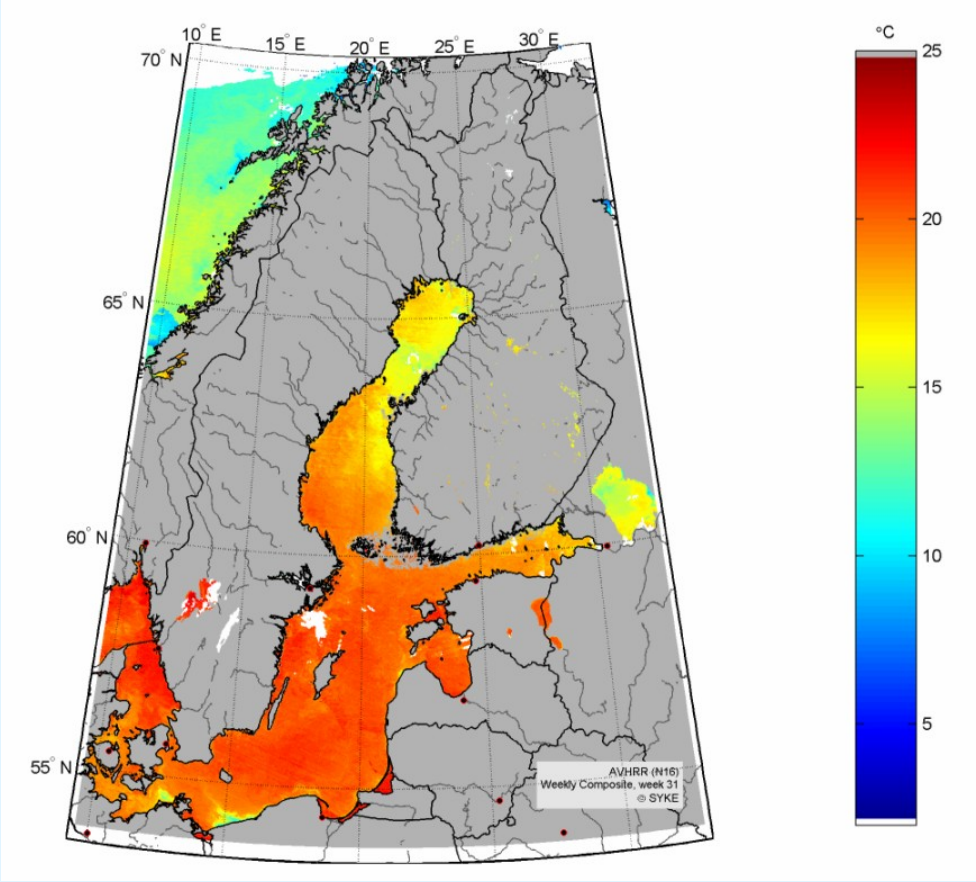
Applications: Sea Surface Temperature (SST)

- Operative since 2002
- Daily Product
- NOAA AVHRR, resolution 1 km, night-time overpasses
- Baltic Sea, Gulf of Bothina, 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





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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

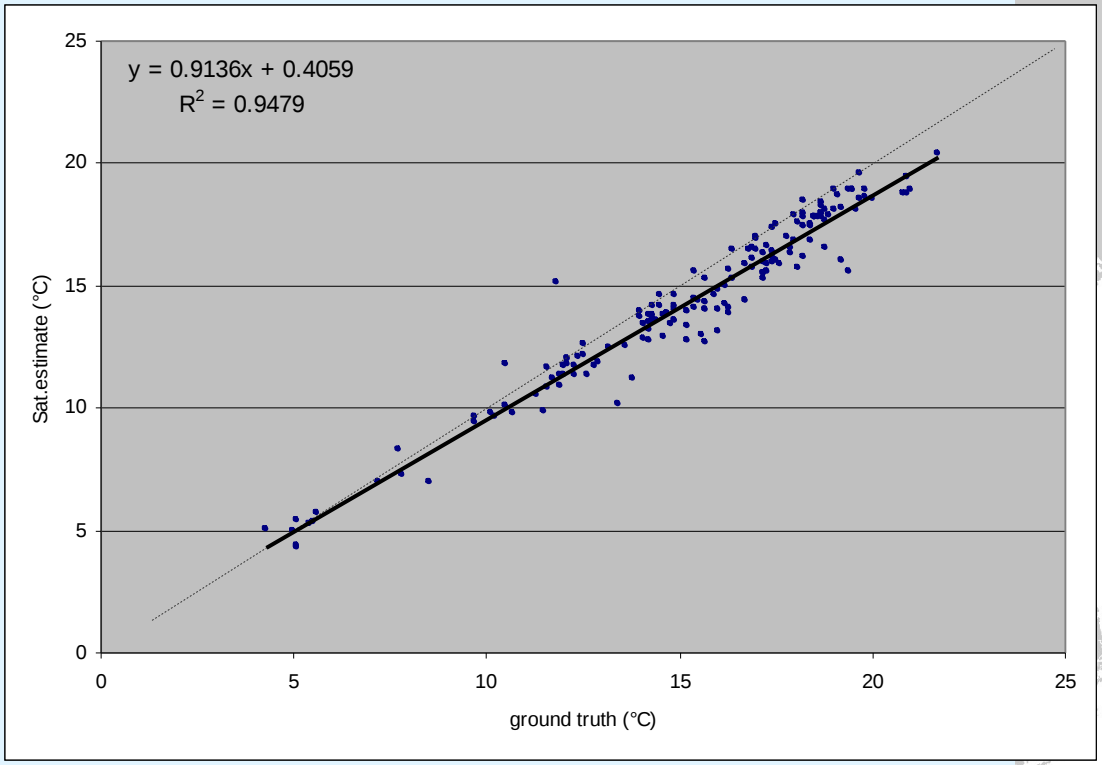
- **Used thermal channels:**
  - **Ch4, 11 µm**
  - **Ch5, 12 µm**
- **Standard coefficients from NASA**

$$T_s = T_4 + a_1\left(T_4 - T_5\right) + a_0$$

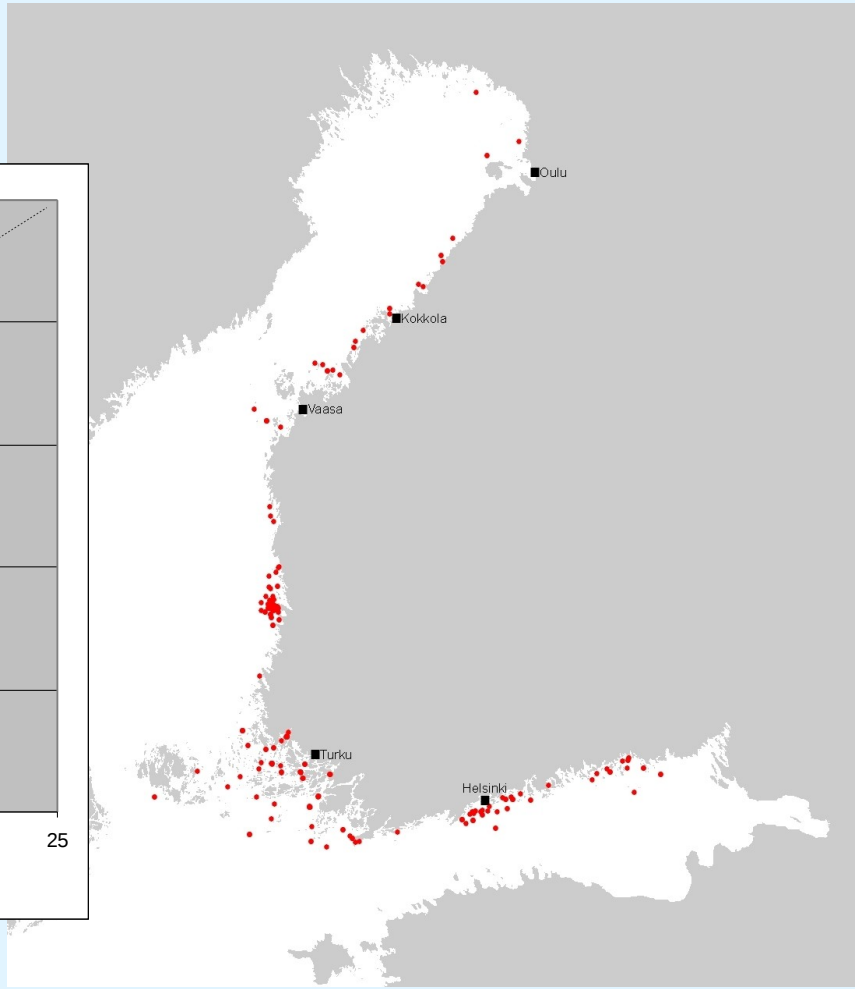
$$MCSST = a_1\left(T_4\right) + a_2\left(T_4 - T_5\right) + a_3\left(T_4 - T_5\right)\left(Secq - 1\right) - a_4$$

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

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!

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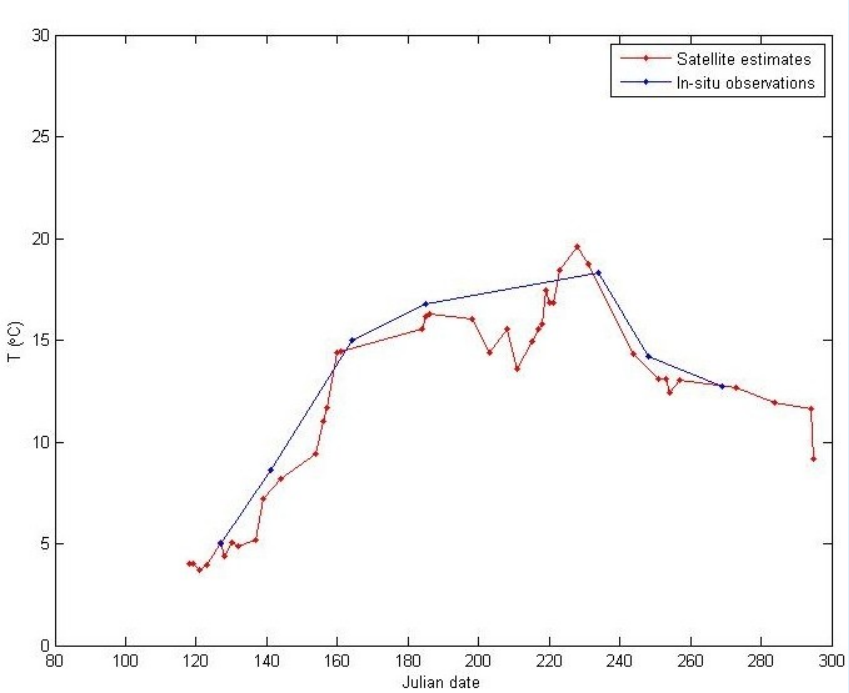
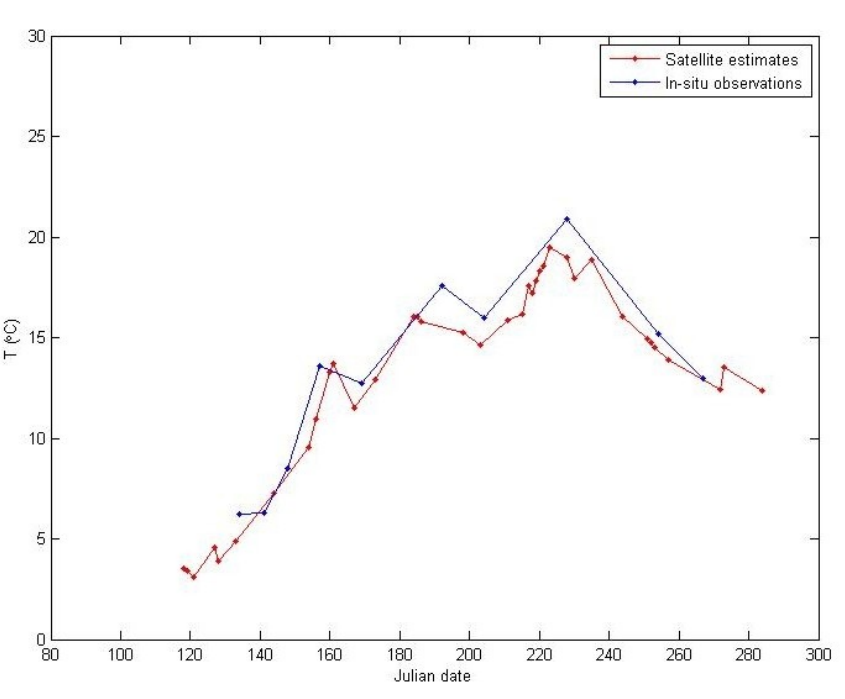
Validation





- **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.

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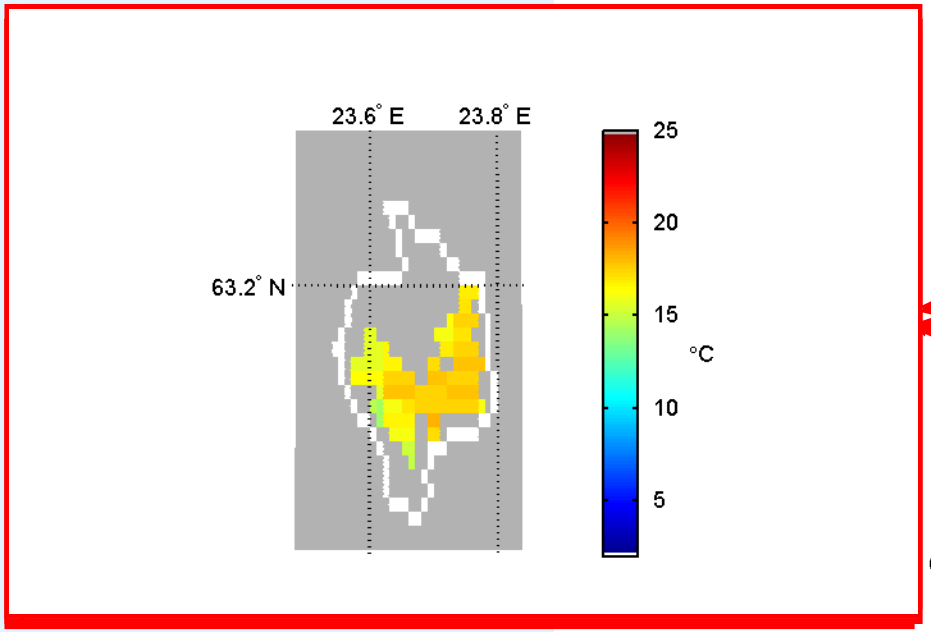
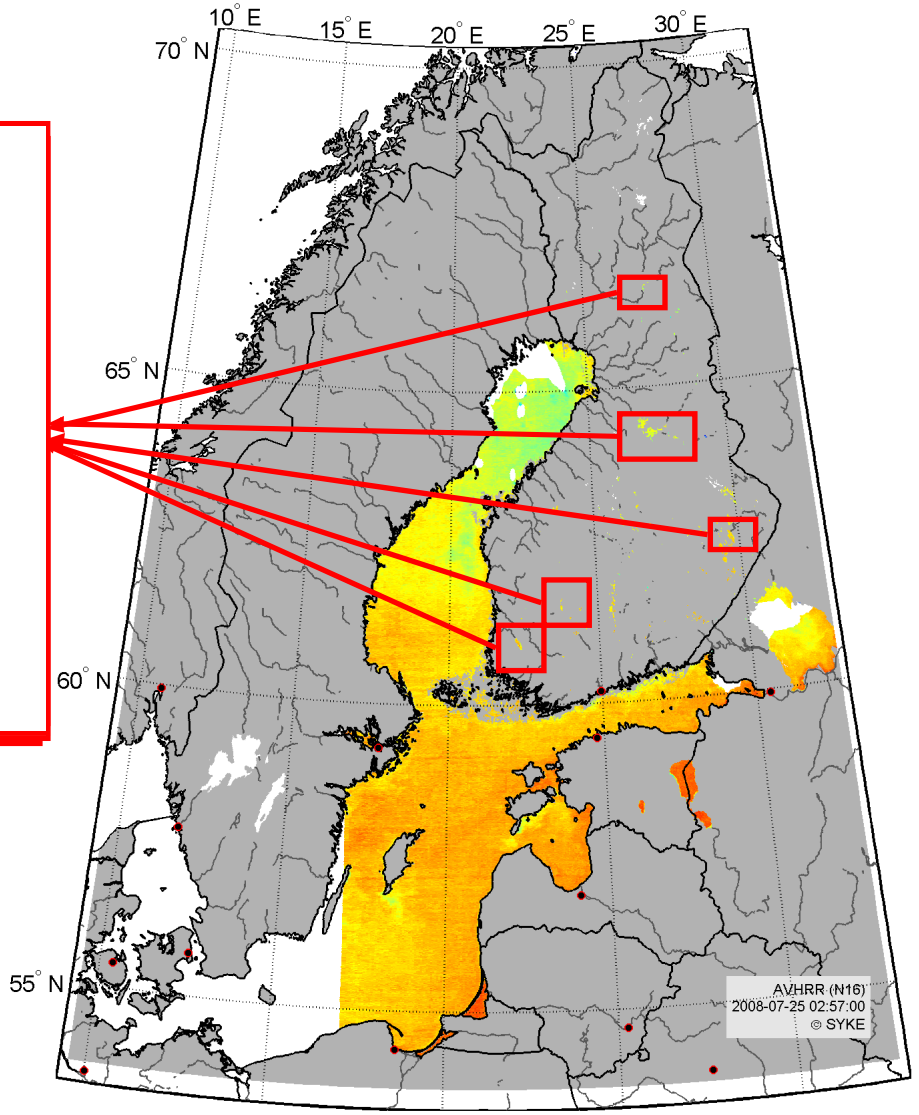
Lake Surface Temperatures





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

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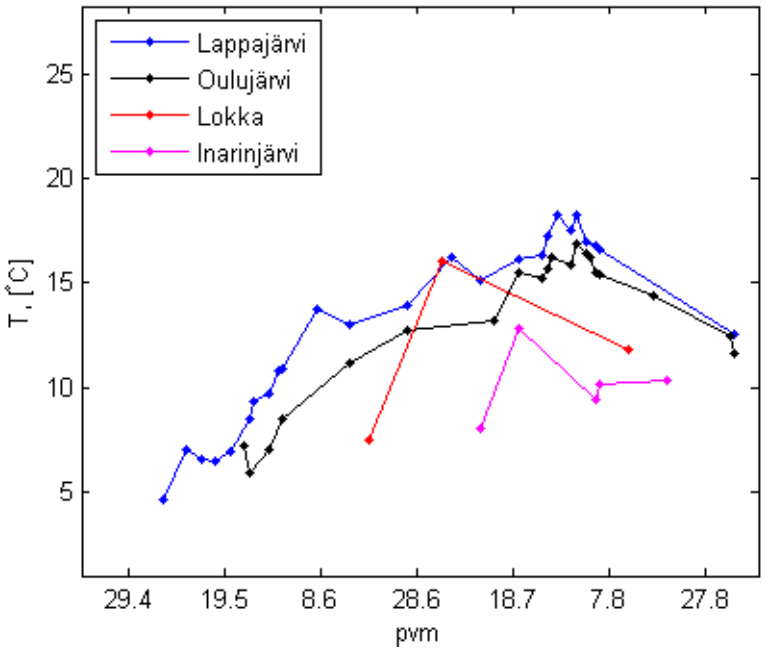
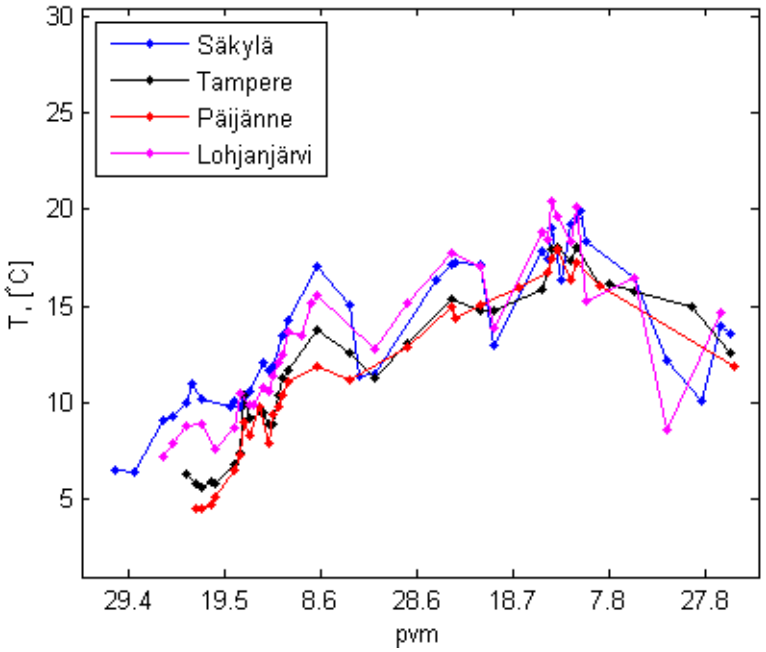
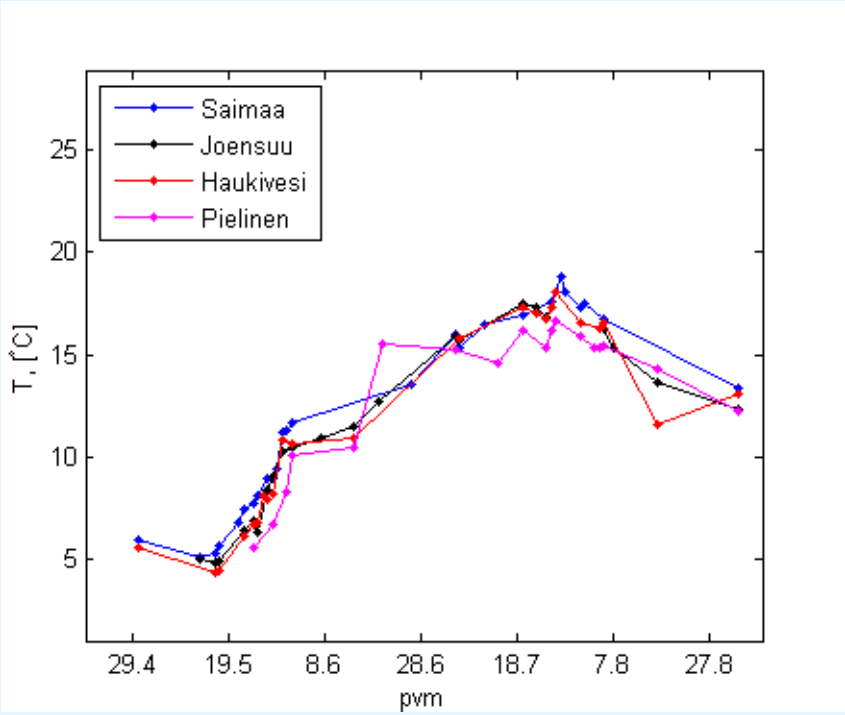
Time series





Clouds are a big problem!



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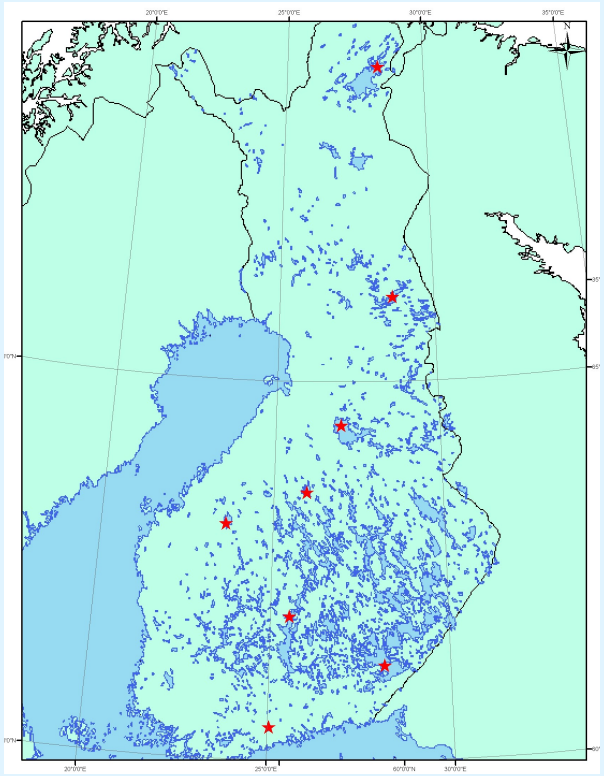
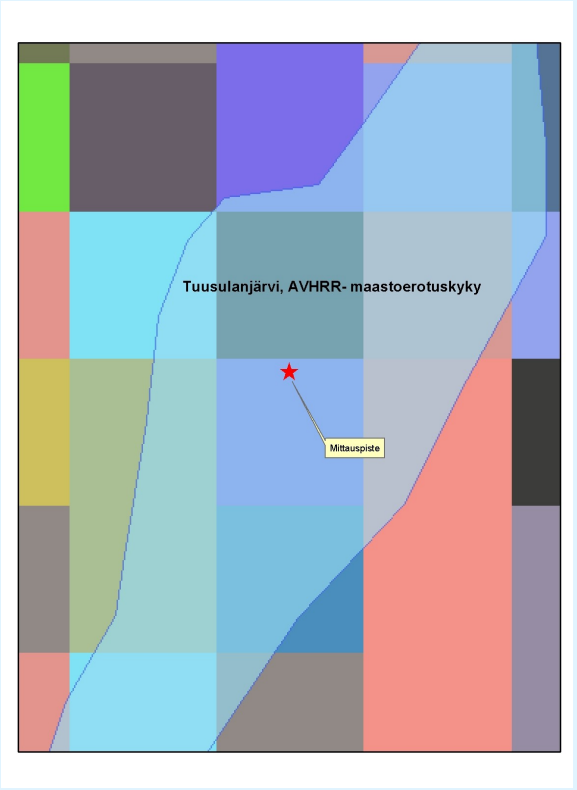
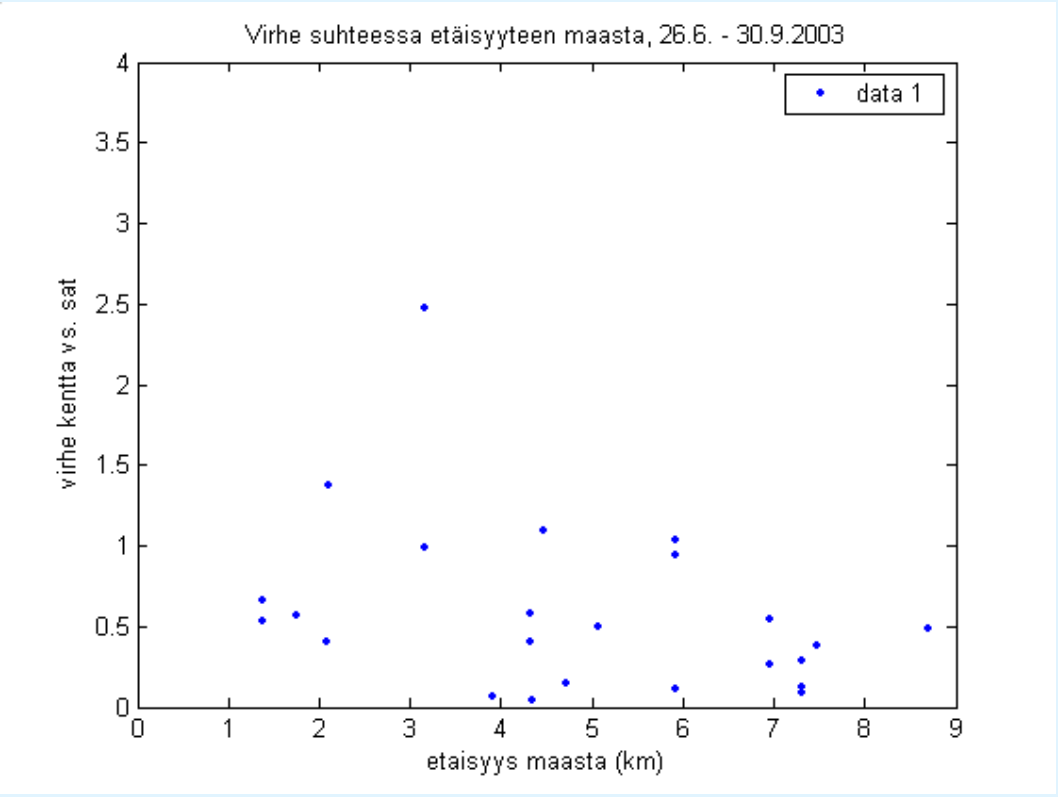
Accuracy of the estimation on lakes

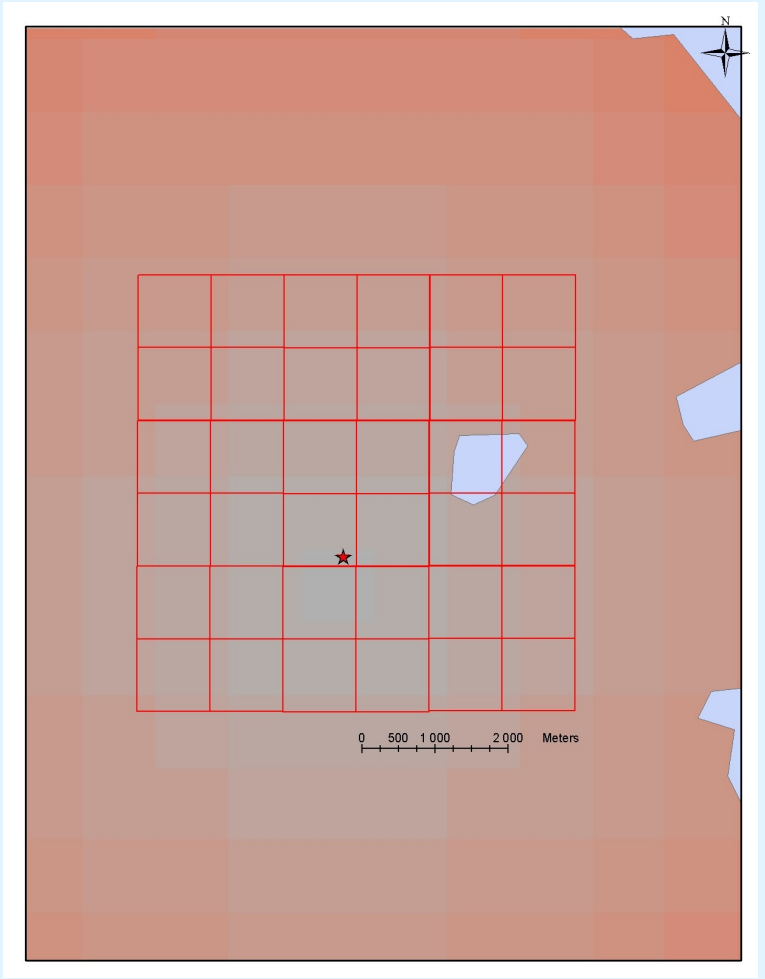




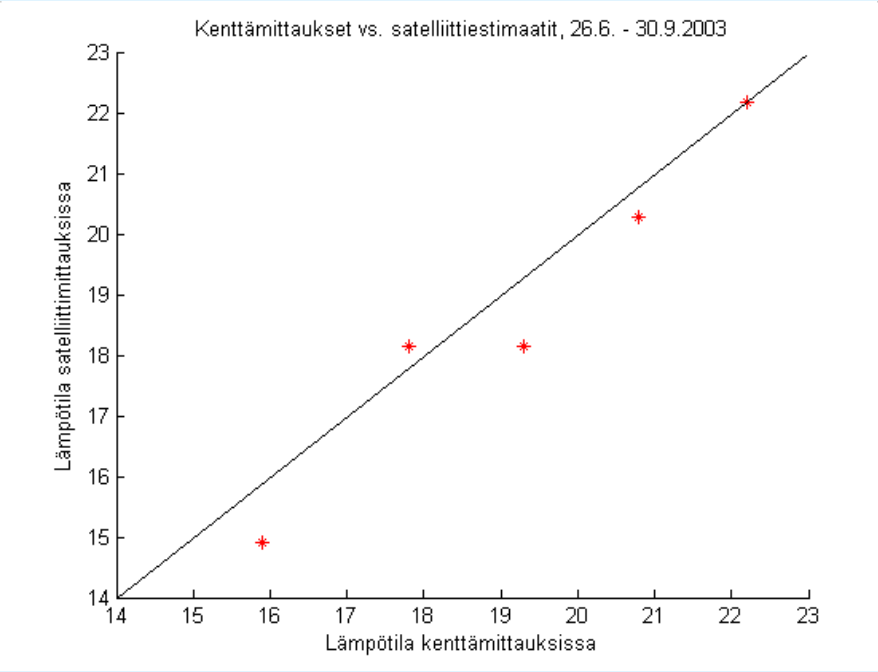
Problems: Resolution vs. object size, adjacency effects

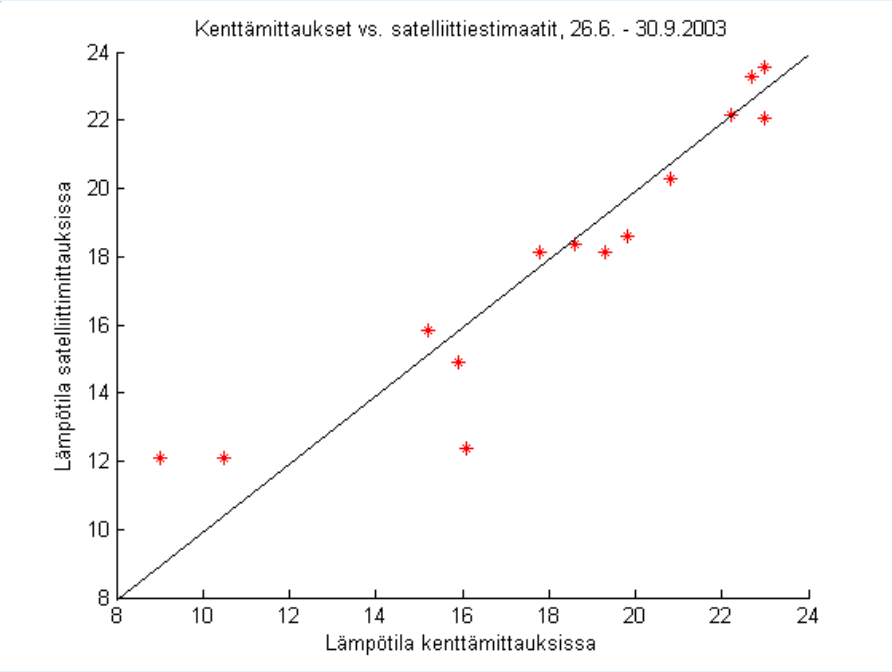
Accuracy vs distance from shoreline





Accuracy of the estimates on lakes (Field mesurement 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

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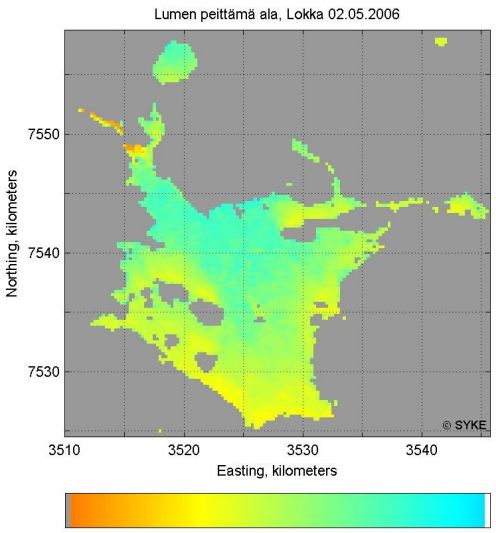
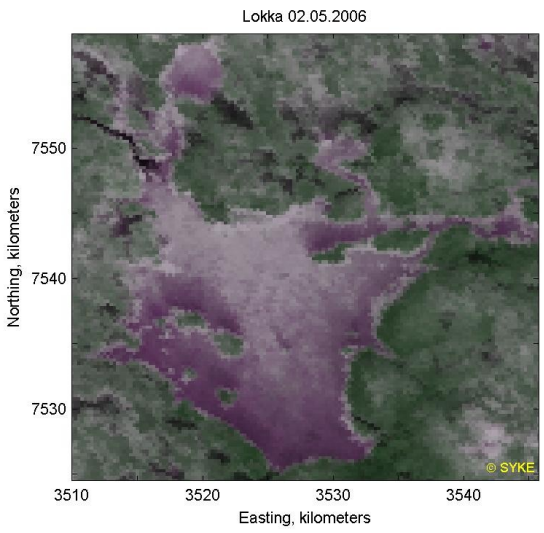
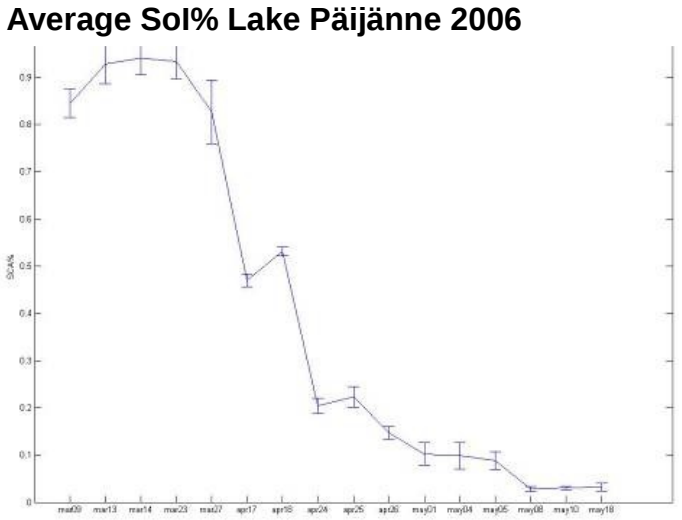
Applications: Snow coverage on lake ice

- 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)



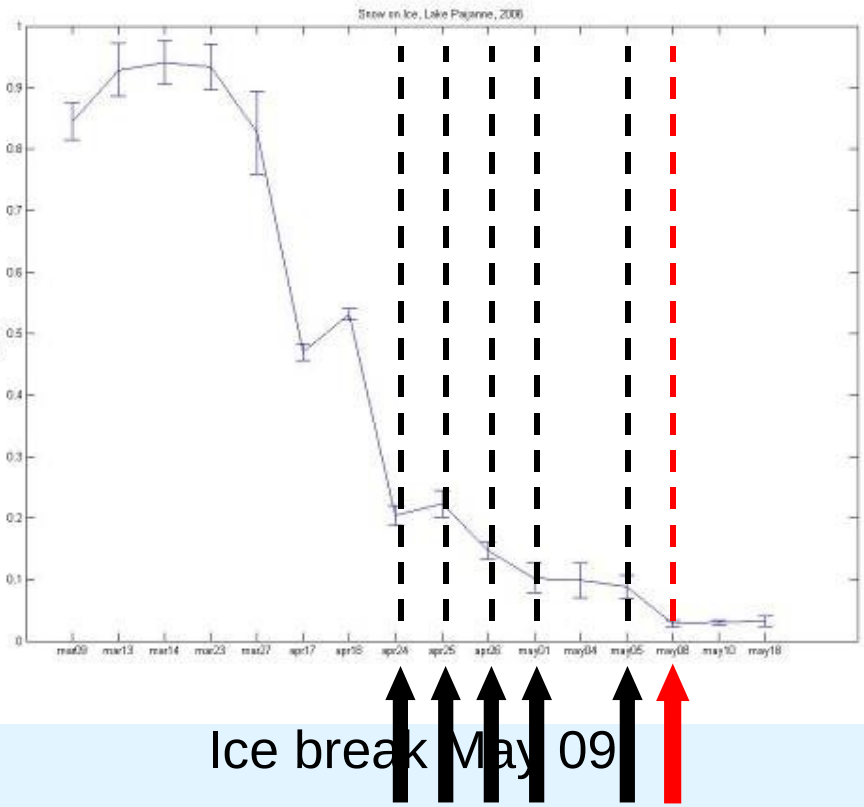




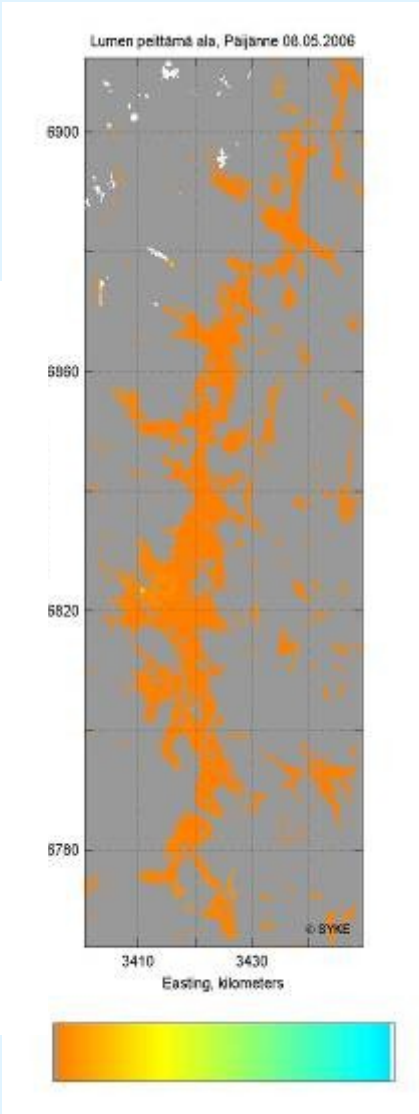
Example

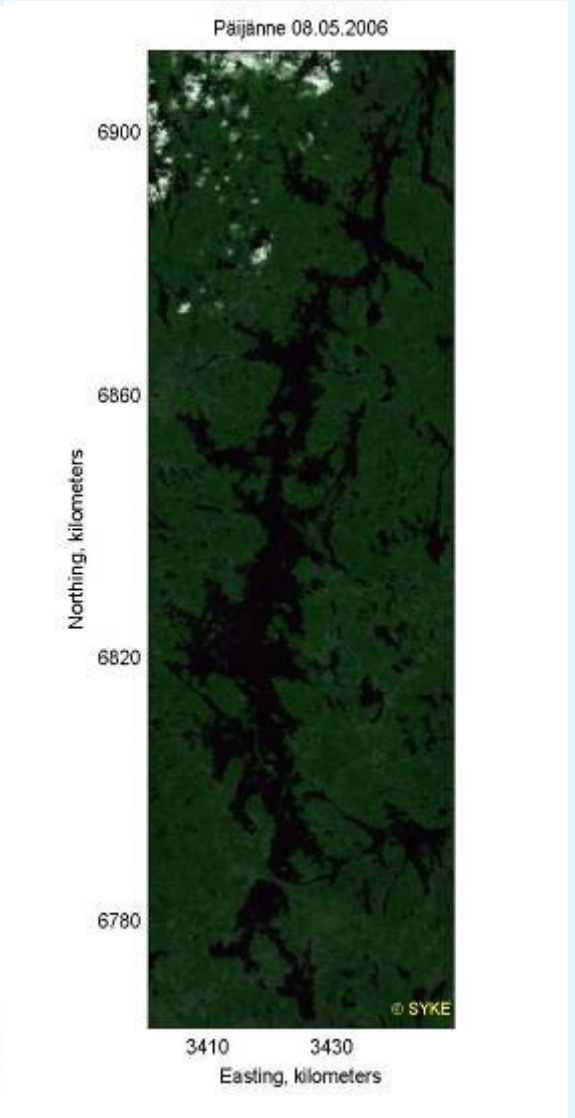
Average Snow on Ice,

Lake Päijänne 2006



Ice break May 09





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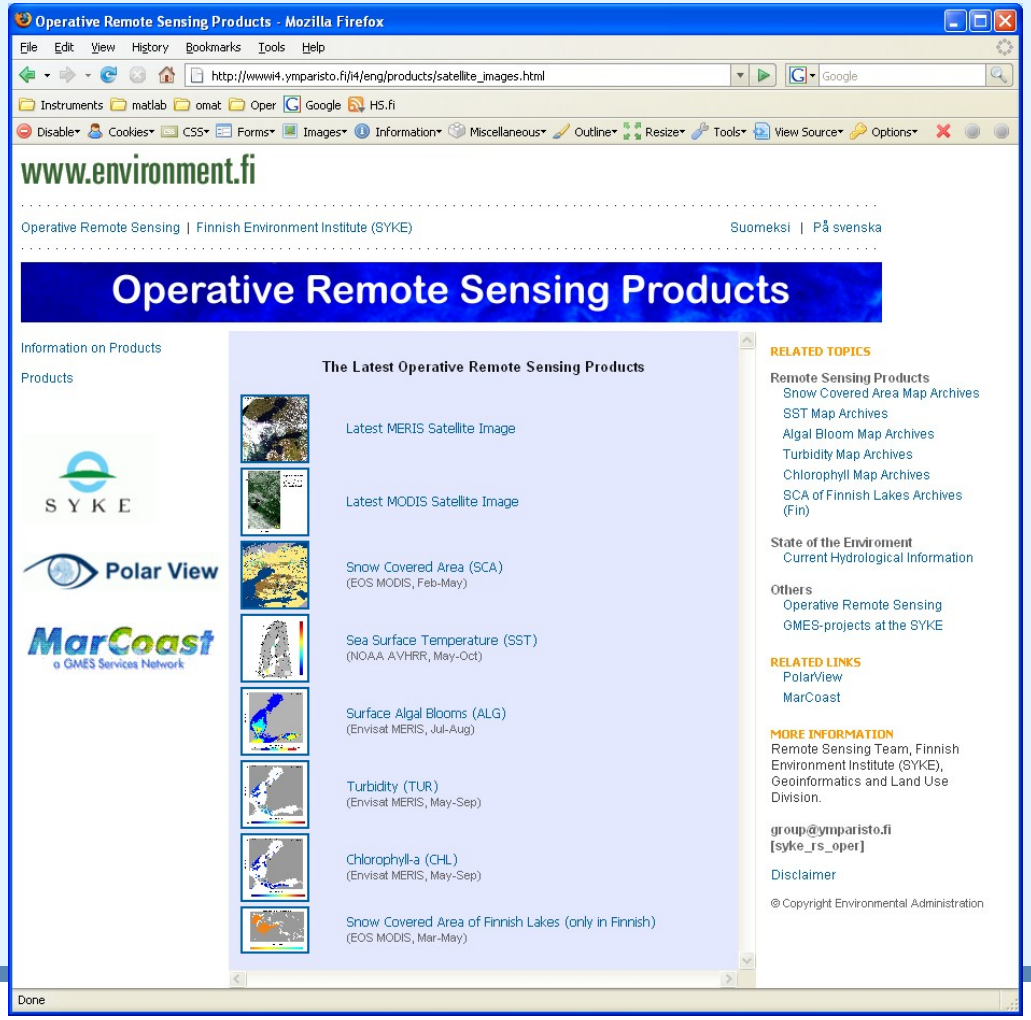
For more info

www.environment.fi/syke/remotesensing



- **Questions, comments ?**

syke_rs_oper@environment.fi

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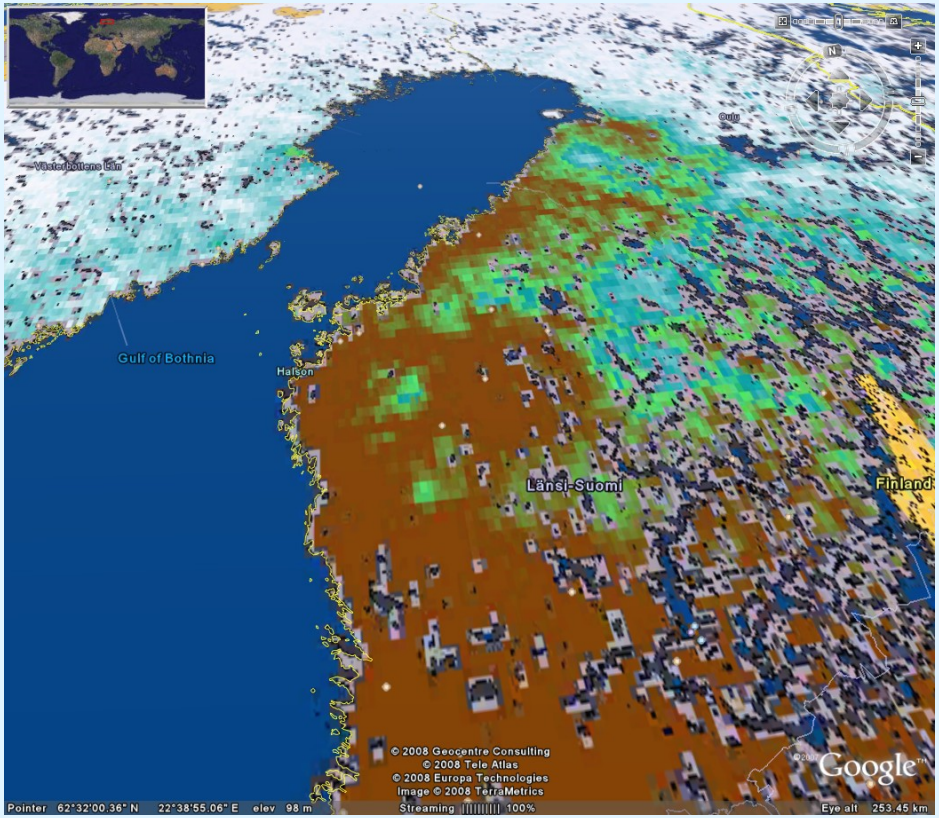
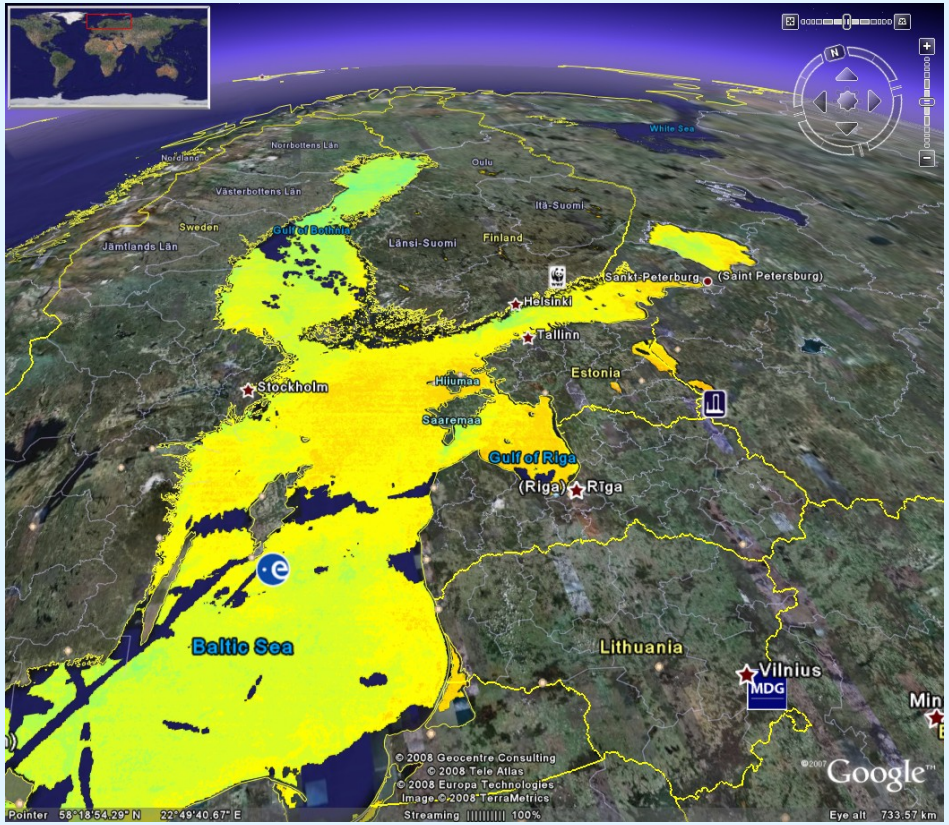
Thank You!



Snow covered area (SCA)



Sea Surface Temperature (SST)

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