

# EU Life+ MONIMET

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## Satellite time series of vegetation phenology and snowmelt in Finland

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FINNISH METEOROLOGICAL INSTITUTE



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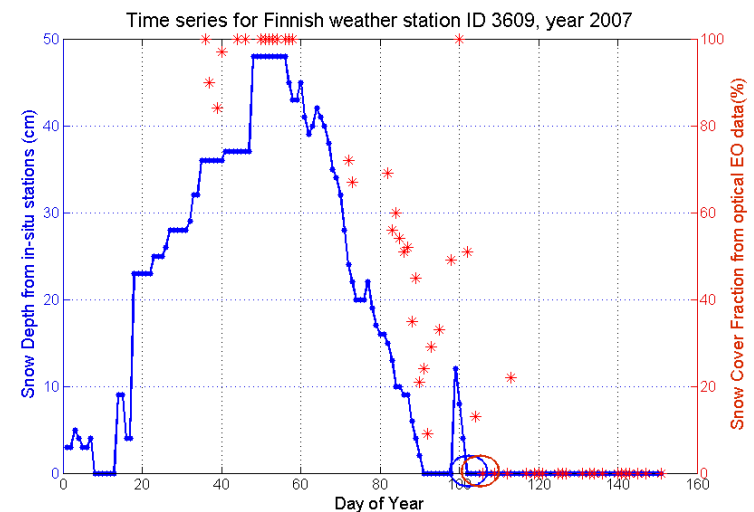
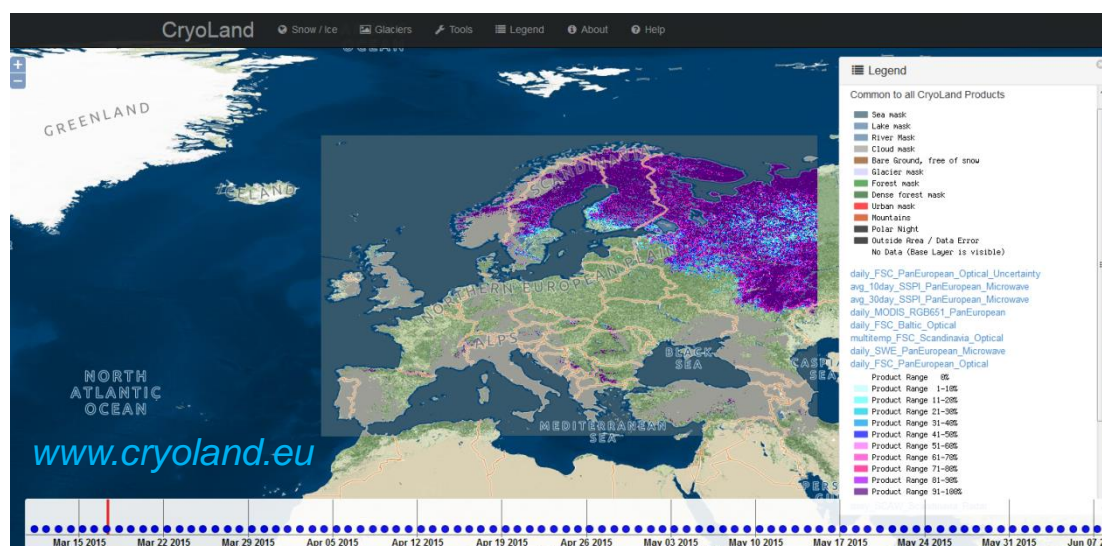
## Objective of remote sensing action in Monimet

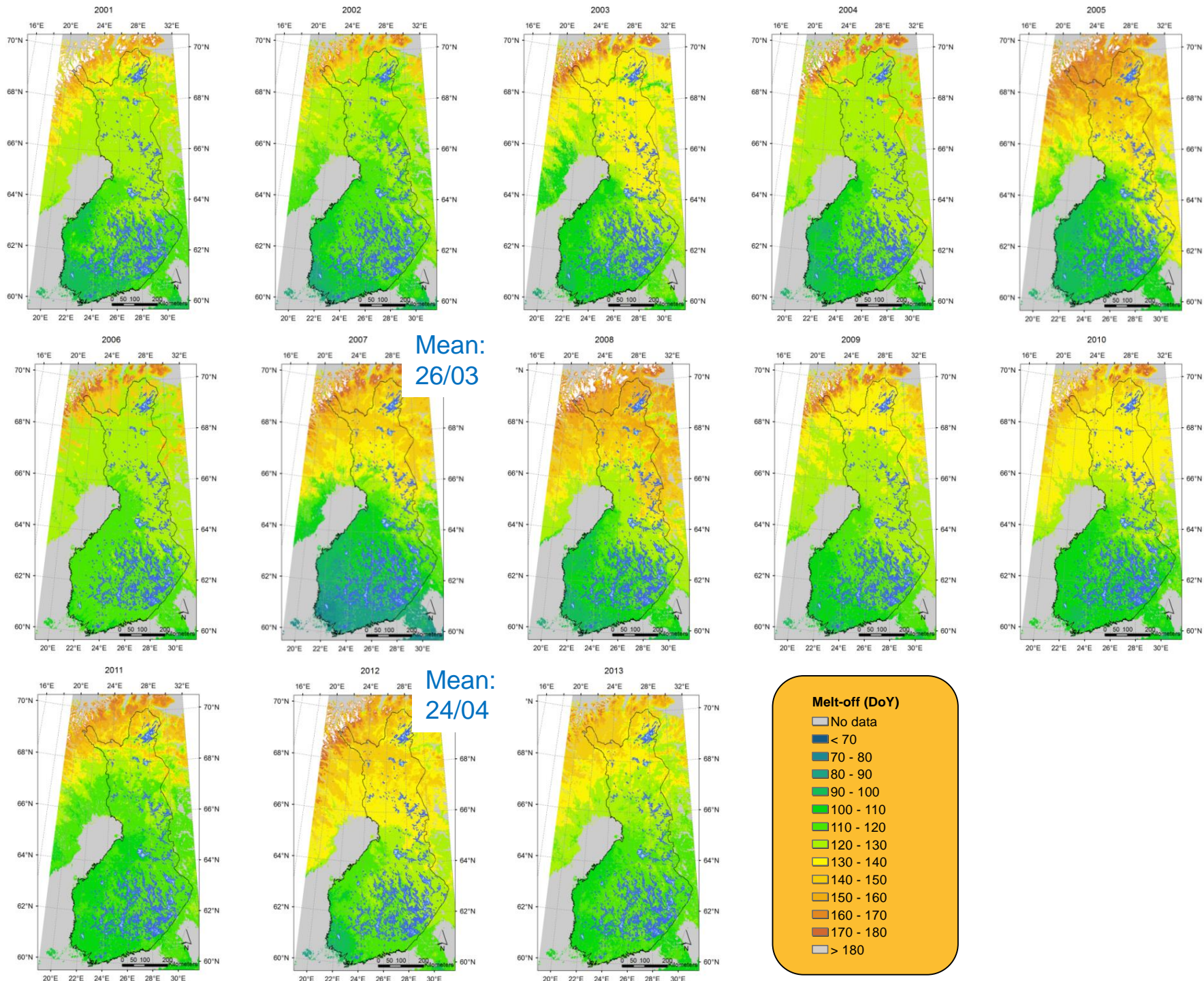
- Provide harmonized data sets on snow cover (snow extent and snow water equivalent), soil freeze and vegetation status from satellite information
  - Model calibration and evaluation
    - Process calibration: phenology and hydrology
    - Comparisons with independent observations
  - Assessment of past changes in climate change indicators
    - Trends in length of the vegetation active season and snow covered period

→ Focus of this presentation: **end of snow melt** and **start of vegetation season**

## End of snow melt

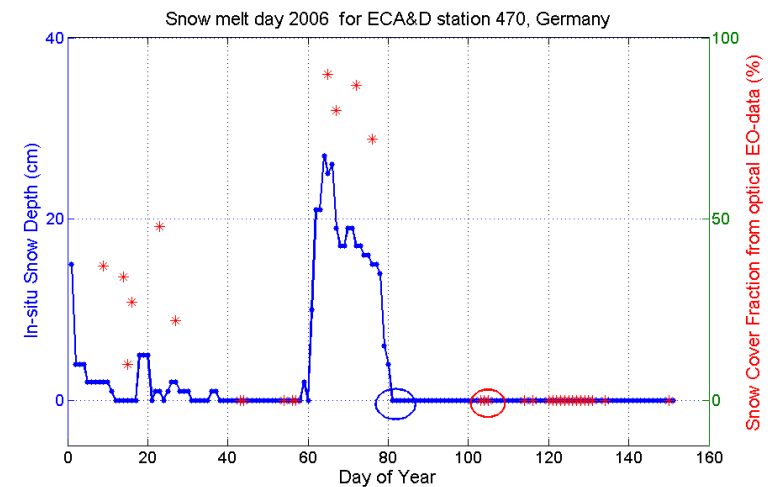
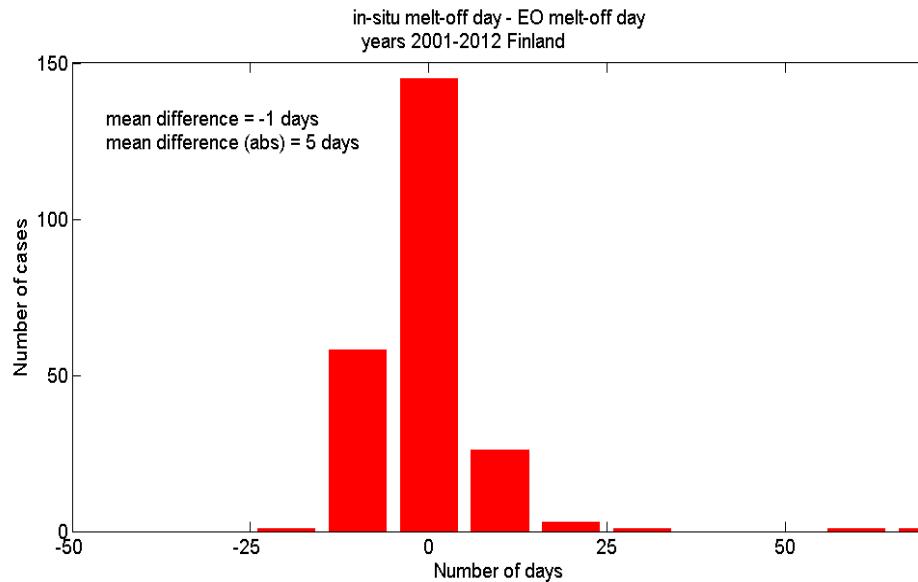
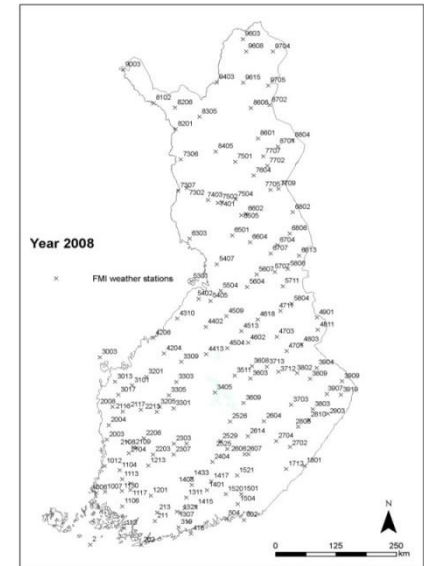
- Determined from daily CryoLand pan-European Fractional Snow Cover (FSC) product at 0.005° grid resolution for the period from 2001 to 2014
- FSC product is based on SCAMod-algorithm (Metsämäki et al. 2005) applied to MODIS (Moderate Resolution Imaging Spectrometer) reflectance data
- End of snow melt (day of year) detected from FSC time series when FSC=0 after last snow covered period





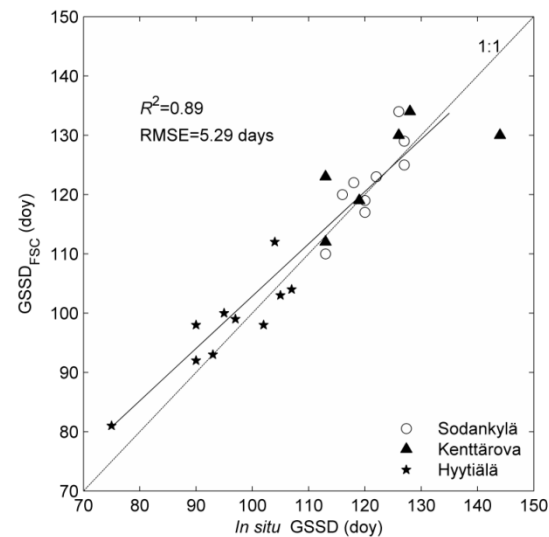
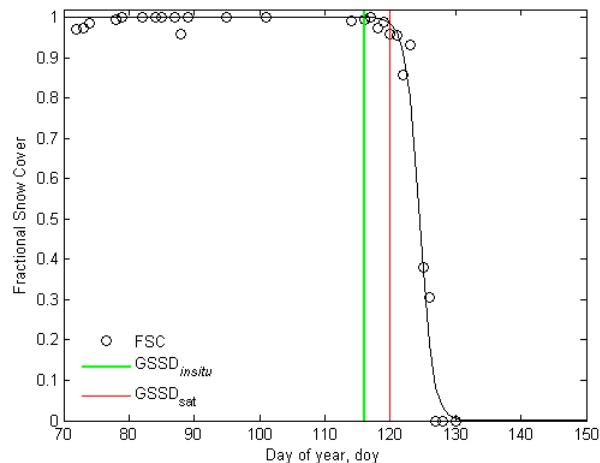
## End of snow melt

- Comparison of satellite-based melt-off day against in situ observation of snow depth from Finnish weather stations
- Gaps in the FSC time series due to cloud cover affect detection capability



## Start of season in coniferous forest

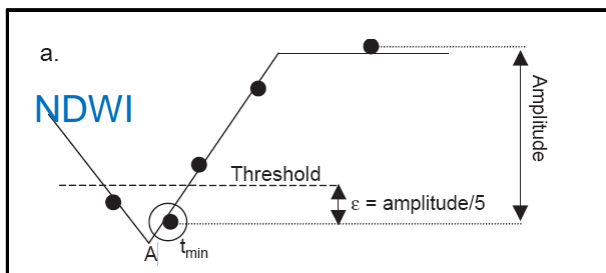
- Time when Fractional Snow Cover decreases at the beginning of snow melt can be used as proxy for the start of season (start of photosynthetic activity)
- Determined from daily time series of FSC based on MODIS satellite observations at 0.005° grid size processed by SYKE



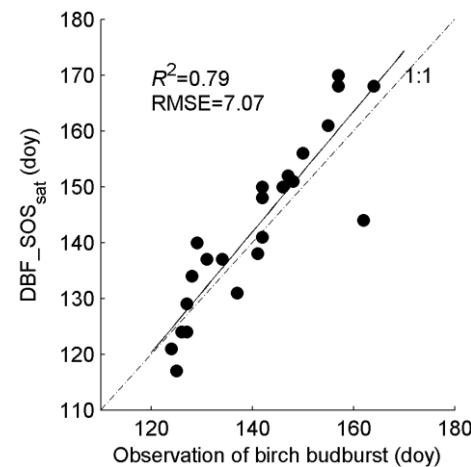
Böttcher et al. 2014. *Remote Sensing of Environment* 140: 625-638.

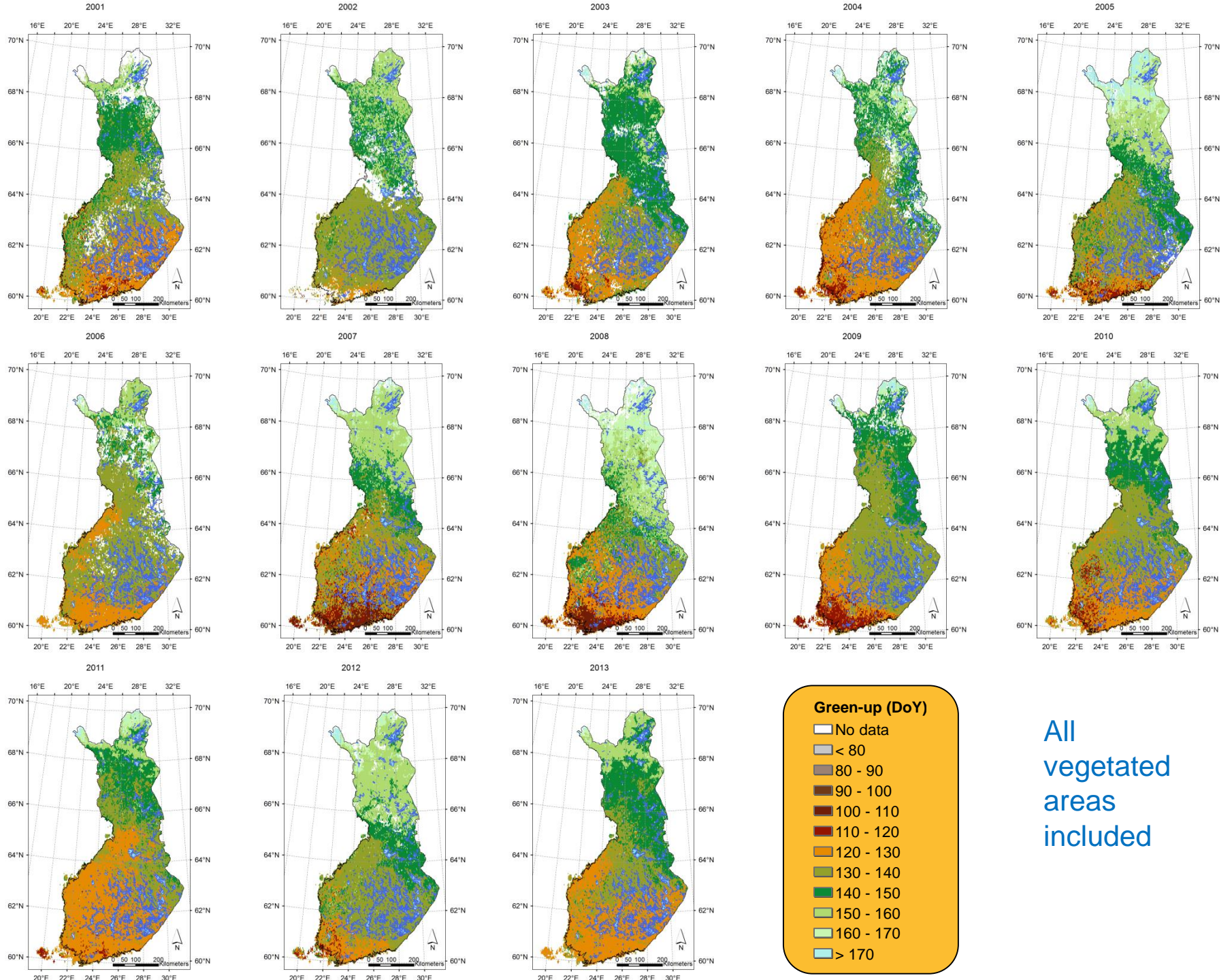
## Start of season in deciduous vegetation

- Daily time series of Normalized Difference Water Index (NDWI) calculated from MODIS at 0.005° grid size for the period from 2001 to 2013 by SYKE
- NDWI allows to distinguish between snow melt and greening-up
- Start of season (green-up) determined according to method by Delbart et al. (2005)



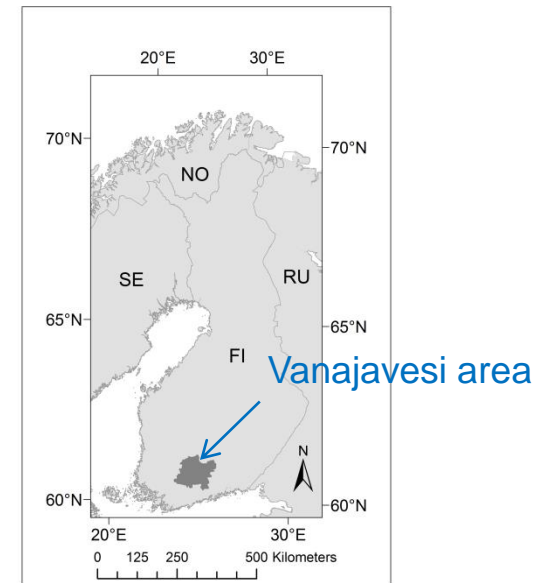
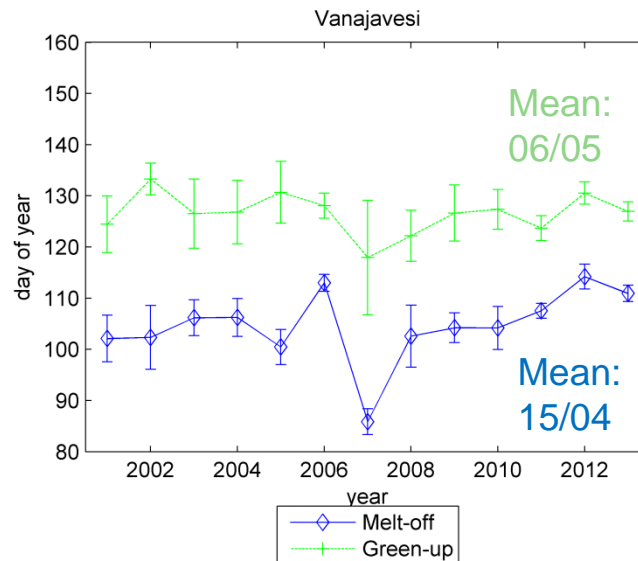
Source: Delbart et al. 2005. *Remote Sensing of Environment* 97: 26-38.





## Time series for the Vanajavesi area

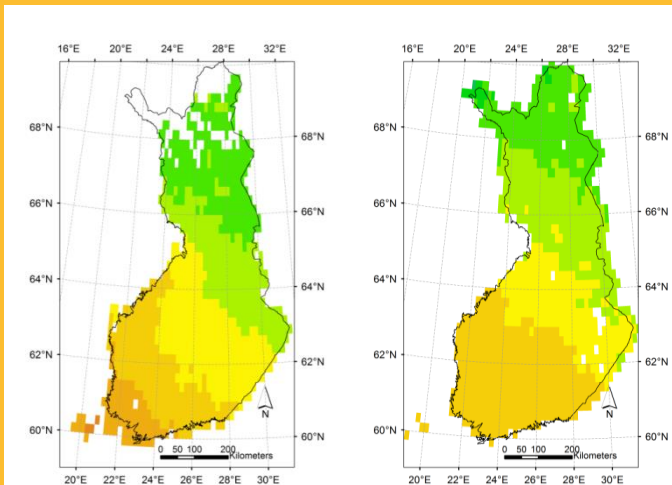
- Mean yearly melt-off and green-up calculated for the area
- No significant trends observed for the period from 2001-2013
- Early melt (26/03) detected in year 2007; coincides with observations of warmer spring temperatures



## Evaluation of model performance

- Comparison of satellite-derived start of season maps with estimates of the JSBACH (Jena Scheme for Biosphere-Atmosphere Coupling in Hamburg) biosphere model for the period from 2003-2010
- Satellite and JSBACH model estimates resampled to the same grid

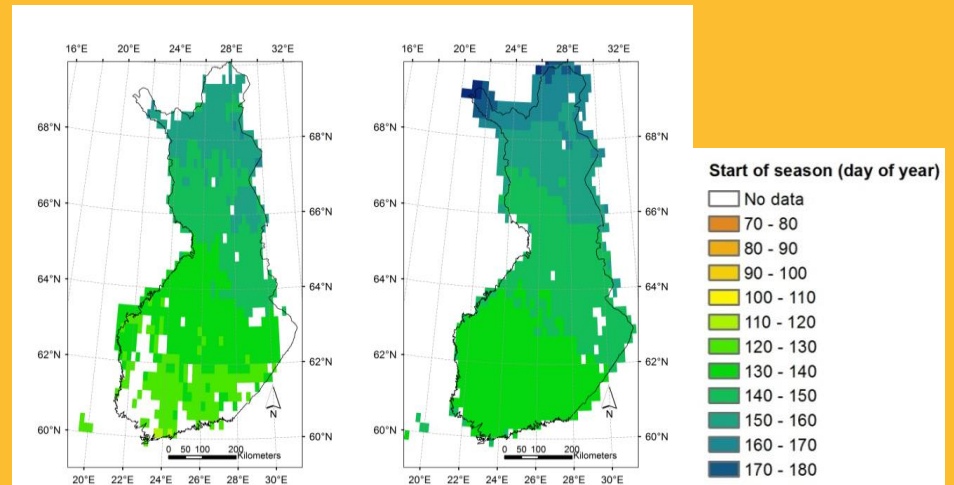
Mean start of season coniferous forest



Satellite

JSBACH model

Mean start of season deciduous forest



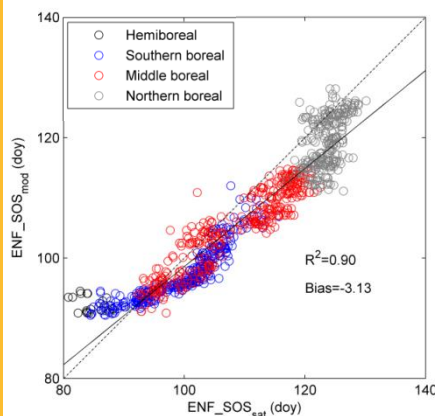
Satellite

JSBACH model

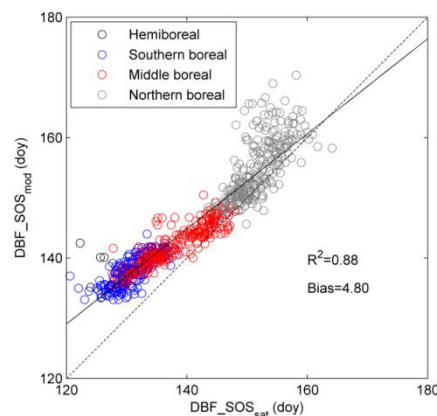
## Evaluation of model performance

- Good spatial correspondence between the two data sources
- Small early bias for start of season in coniferous forest and late bias for deciduous forest

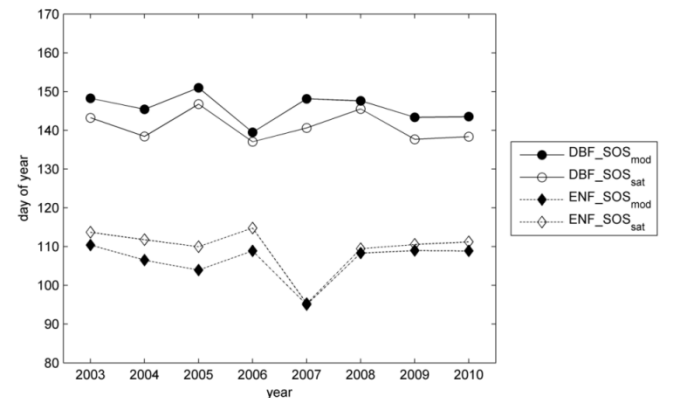
### Coniferous forest



### Deciduous forest



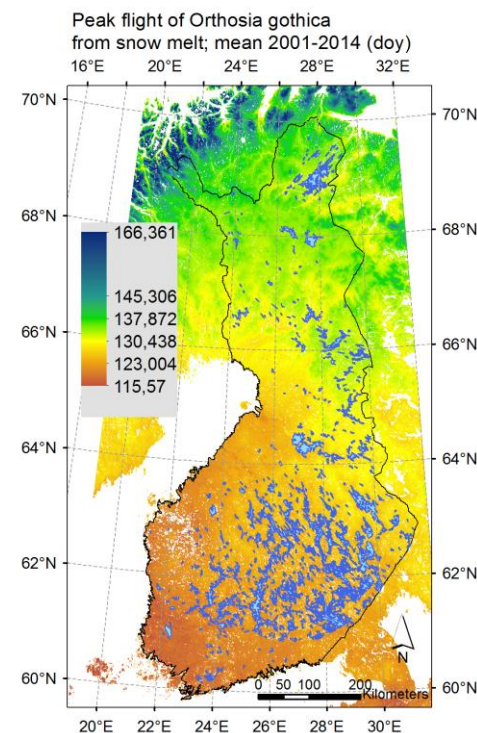
### Inter-annual variation in Finland



## Moth Phenology Indicator

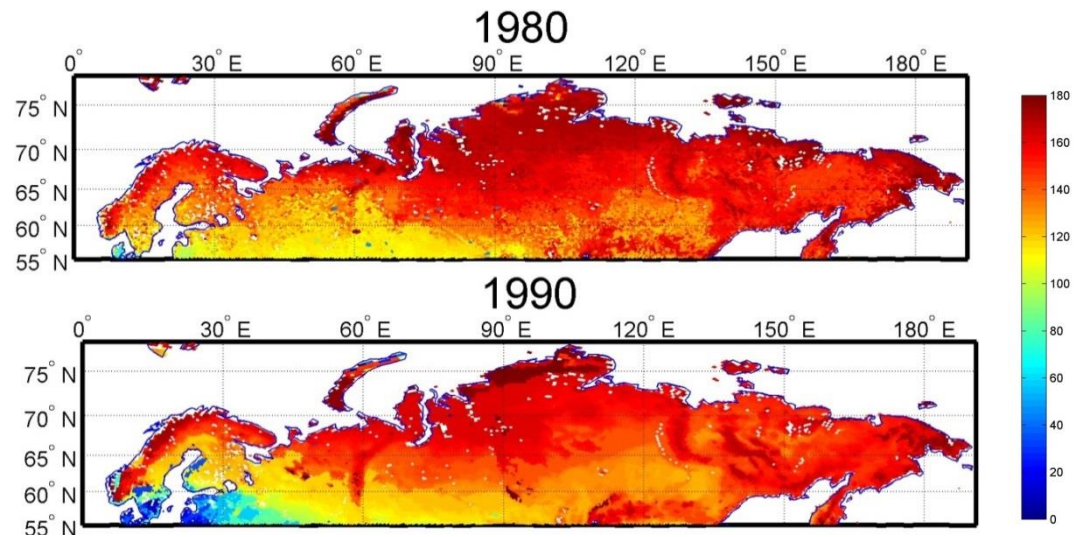
Juha Pöyry (SYKE)

- Indicator on moth phenology based on statistical models combining climate and satellite information
- Results for one focal species (*Orthosia gothica*) with peak flight in spring:
  - Predictive power in the randomly selected test set (30% of data) using linear mixed effect models
    - Latitude:  $r^2 = 0.50$
    - Snow melt date:  $r^2 = 0.62$**
    - Thermal sum:  $r^2 = 0.61$ 
      - Base  $t = 3^\circ \text{C}$
    - Greening date:  $r^2 = 0.57$**
    - All four variables:  $r^2 = 0.75$
  - Spatial predictions based on model including snow melt date for Finland



## Summary and outlook

- Daily time series of NDWI and FSC and derived end of snow melt and start of vegetation season available for the period 2001 to 2013 for Finland
- Time series will be completed for 2014 and 2015 during spring next year
- End of snow melt time series could be complemented with microwave radiometer observation provided by FMI (starting in 1980)



*Takala et al. 2009. IEEE transaction on Geosciences and Remote Sensing. 47:2996-3007.*

## Summary and outlook

Other remote sensing products that Monimet provides:

- Normalized Difference Vegetation Index time series from MODIS (2001-) (SYKE)
- Soil freeze product at 25 km resolution (2010-) (FMI, Kimmo Rautiainen)
- Reduced Simple Ratio and Leaf Area Index time series from MODIS under development (SYKE and FMI, Terhikki Manninen)

**Thank you!**

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