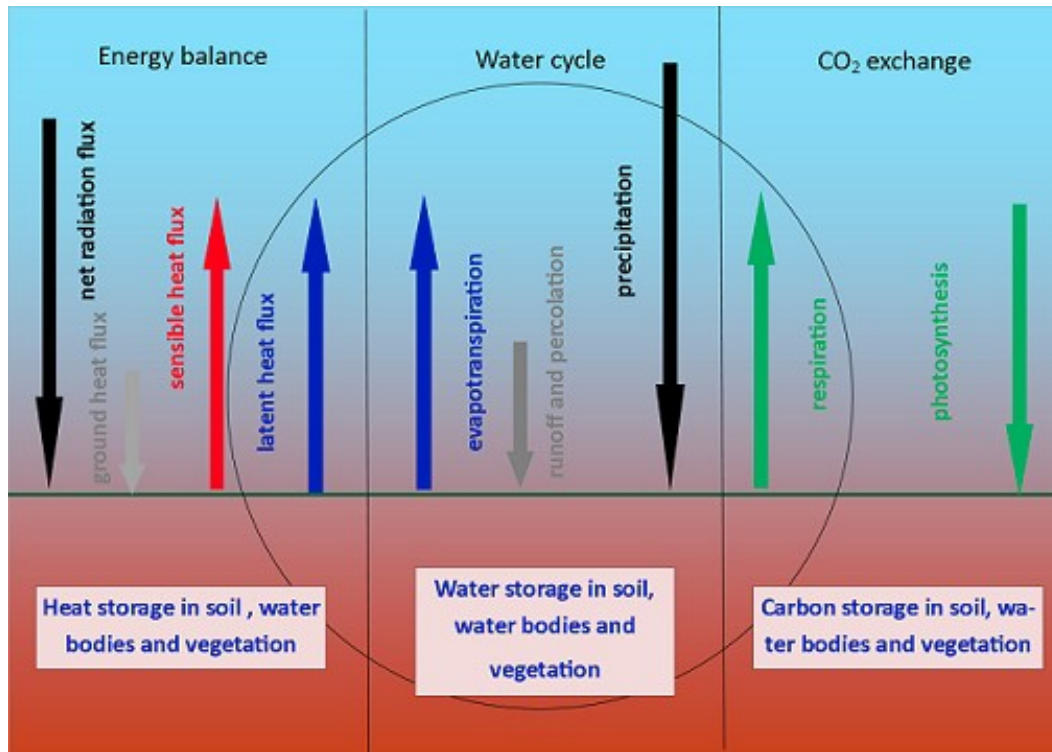# Investigating the use of Copernicus Global Land vegetation products as forcing in land surface modelling

**_J. Miguel Barrios_**, *M.Balzarolo, I. Jannsens, N. Ghilain, A. Arboleda, R. Hamdi, F. Gellens-Meulenberghs*

**RMI**

Royal Meteorological Institute of Belgium

# Hydrometeorology and Land Surface Processes



http://hydroland.meteo.be

Improved ECOsystem PROductivity Modelling by Innovative Algorithms and Remotely Sensed PHEnology Indicators
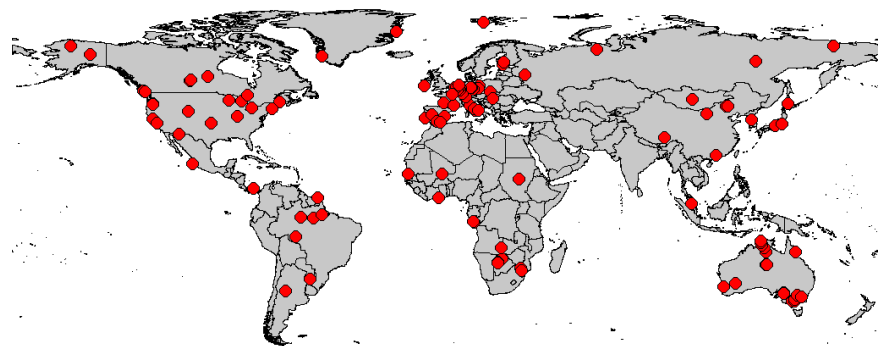**ECOPROPHET**

Evapotranspiration at sub-kilometer spatial resolution

# 1. Improved ECOsystem PROductivity Modeling by Innovative Algorithms and Remotely Sensed PHEnology Indicators
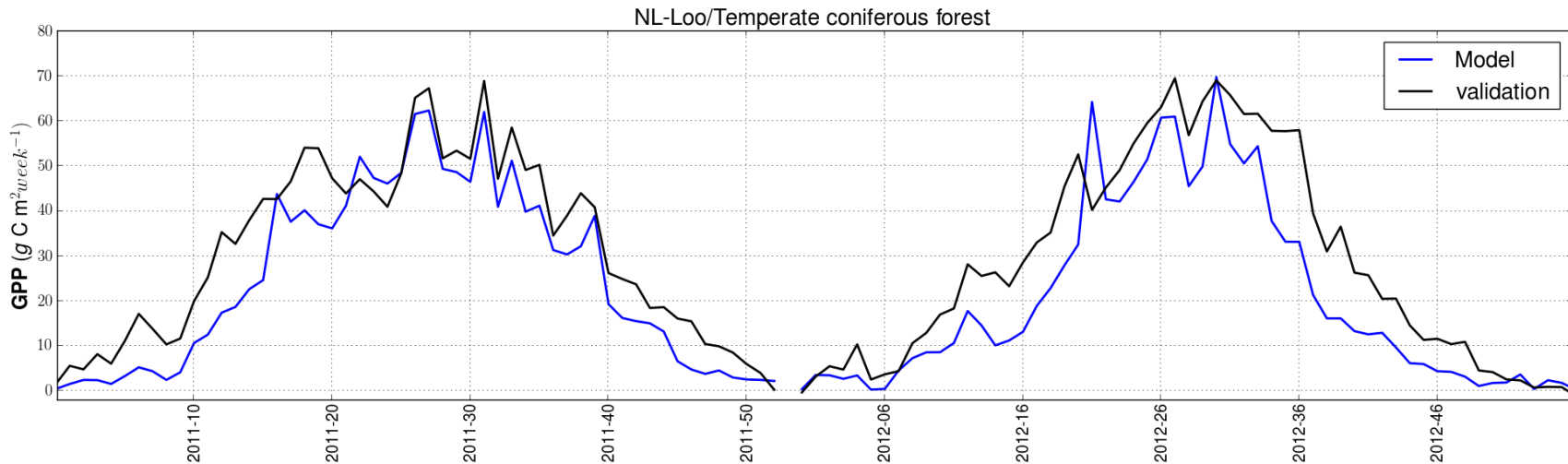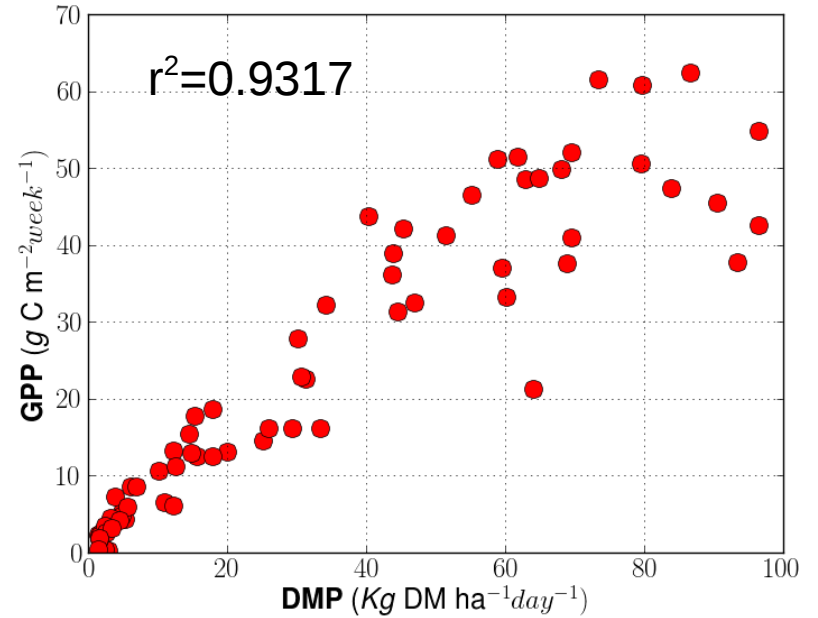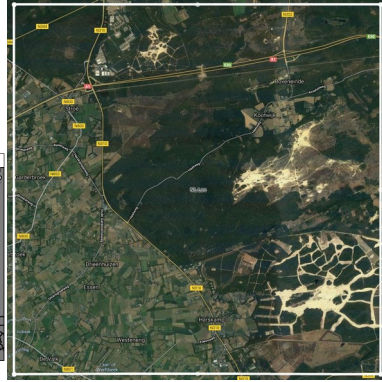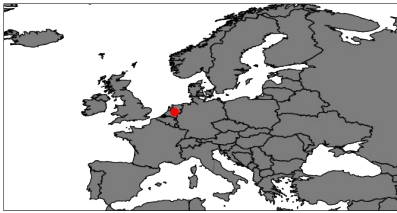# ECOPROPHET project

http://ecoprophet.meteo.be
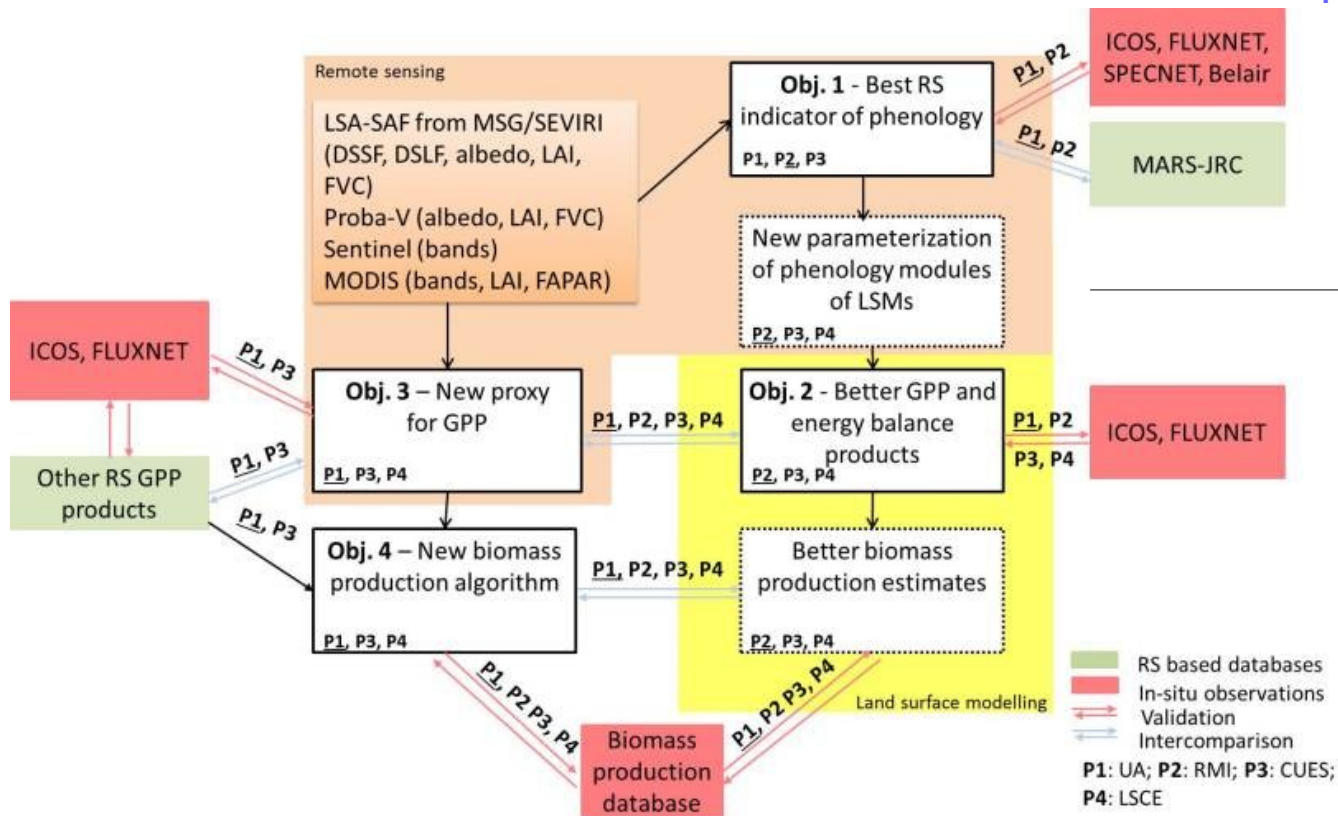


- ISBA
- ORCHIDEE
- RMI model



**Using Sentinel-2 satellite data to predict the ecosystem phenological metrics with new vegetation indices**
**By: Maleki *et al***

A3.15 Land Surface Phenology Poster Session

📅 Thursday, May 16, 2019

🕔 5:20 PM - 7:00 PM

# Loobos (NL-Loo)
# Temperate coniferous forest







$r^2$=0.9317

NL-Loo/Temperate coniferous forest



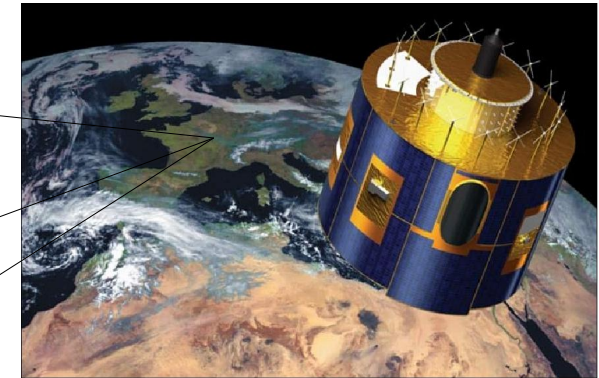| Setting | n | NSE | Bias | $r^2$ | RMSE |
|---|---|---|---|---|---|
| SpotV/ProbaV LAI | 731 | 0.7270 | -1.0826 | 0.9182 | 1.6648 |

4

# 2. Evapotranspiration at sub-kilometer spatial resolution

(based on the algorithm driving the LSA-SAF ET product)



**A** Energy balance at tile level:

$$H = \frac{\rho_a}{r_a} c_p [(T_{sk} - T_a) - g z_a] \qquad LE = \frac{L_v \rho_a}{r_a + r_c} [q_{sat}(T_{sk}) - q_a(T_a)]$$
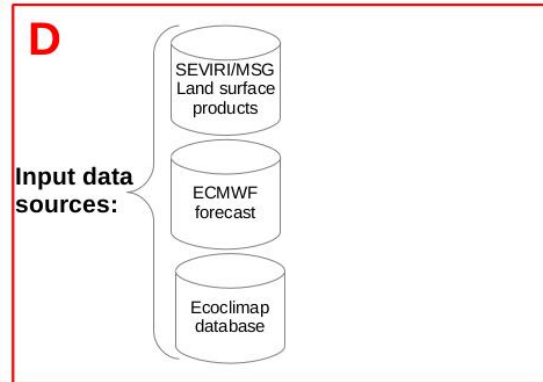
$$R_{net} - H - LE - G = 0$$

$$R_{net} = (1 - \alpha) S\downarrow + \varepsilon(L\downarrow + \sigma LST^4) \qquad G = \beta R_{net}$$
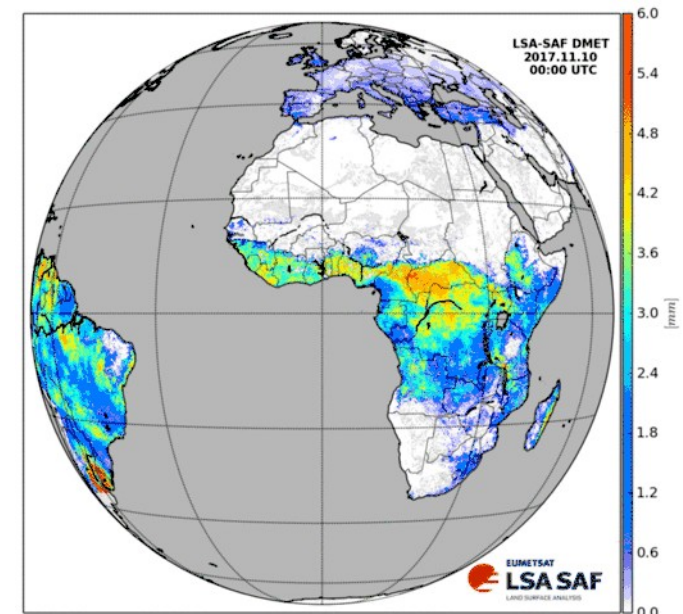
**B** Tiles in a cell

Tile 1    Tile 2    Tile 3    Tile 4

**C** For each cell:

$$LE_p = \sum \varsigma LE_i \longrightarrow \text{Tile level LE aggregated to cell level}$$

$$ET_p = 3600 \frac{LE_p}{L_v} \longrightarrow \text{ET (mm/hour) derived from LE}$$

$$ET_d = \sum ET_p \longrightarrow \text{Daily ET (mm/day)}$$

$$L_v = [2.501 - 0.00234(T_a - 273.15)]10^6$$

**D** Input data sources:
- SEVIRI/MSG Land surface products
- ECMWF forecast
- Ecoclimap database

**EUMETSAT LSA SAF** LAND SURFACE ANALYSIS

**EUMETSAT**

**LSA-SAF coverage**

LSA-SAF DMET 2017.11.10 00:00 UTC

https://landsaf.ipma.pt/

# More on LSA-SAF ET:

**The EUMETSAT LSA SAF ET&SF: An Updated Algorithm to Obtain Near-real Time Evapotranspiration Products Over Europe, Africa, Middle East & South America From EUMETSAT Satellites**
By: Ghilain *et al*

A6.01: RS of Energy Budget Poster Session
📅 Wednesday, May 15, 2019
🕐 5:20 PM - 7:00 PM

**EUMETSAT LSA-SAF evapotranspiration products: potential applications**
By: Arboleda *et al*

A3.05: NRT Forest Monitoring Poster Session
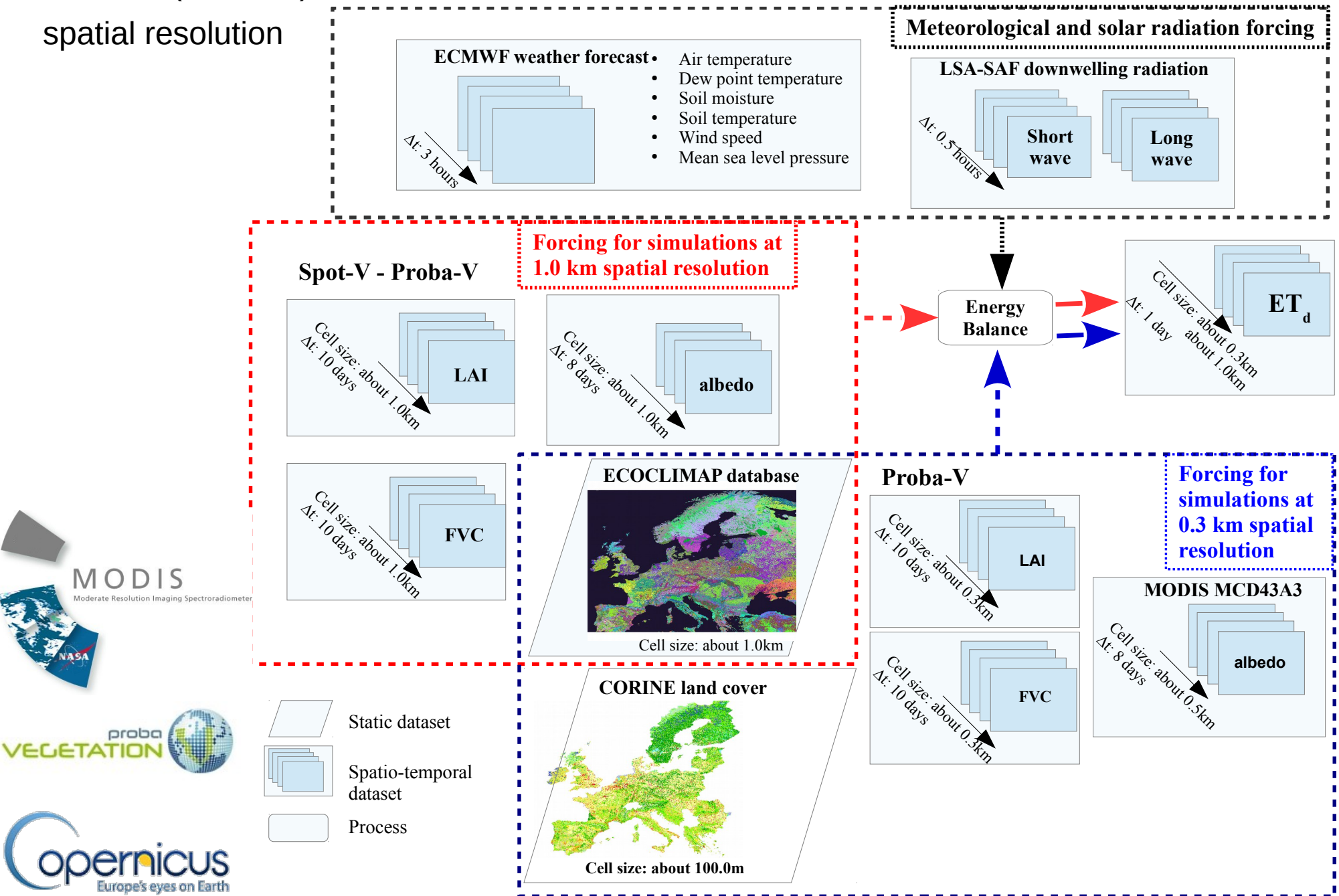📅 Thursday, May 16, 2019
🕐 5:20 PM - 7:00 PM

**Some study sites**



Hautes Fagnes

Zarnekow

Anklam

Biebrza

Schechenfilz Nord

Spreewald

7
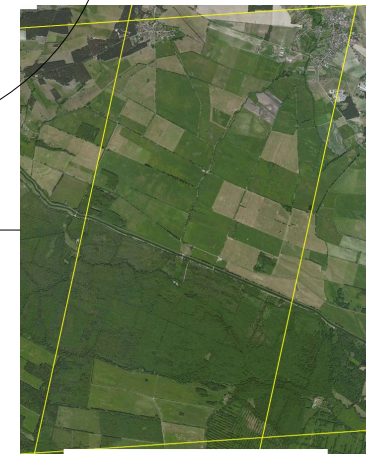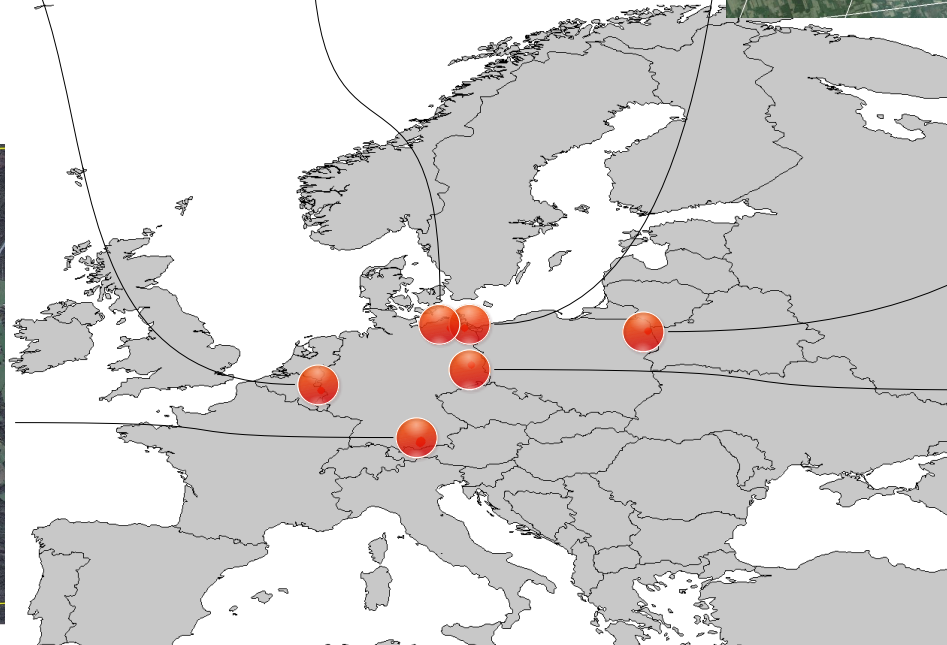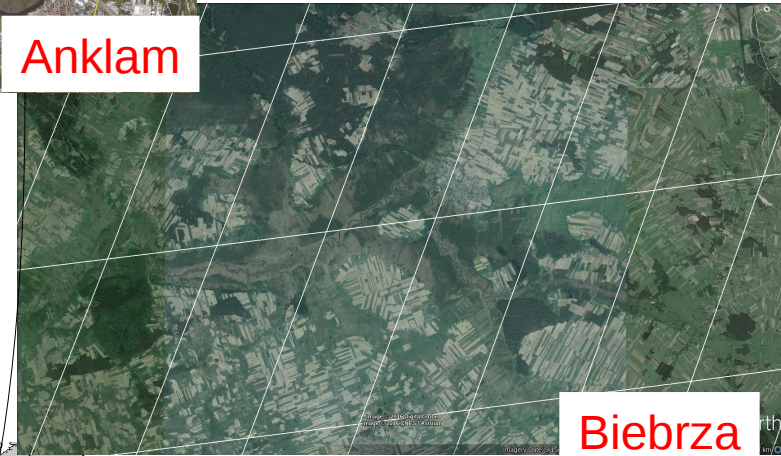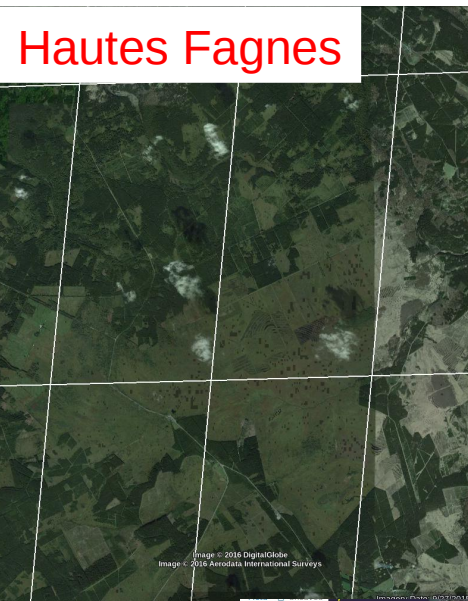
Towards ET estimates at
- 1 km (SPOT-V/Proba-V)
- 300 m (Proba-V)

spatial resolution

Anklam
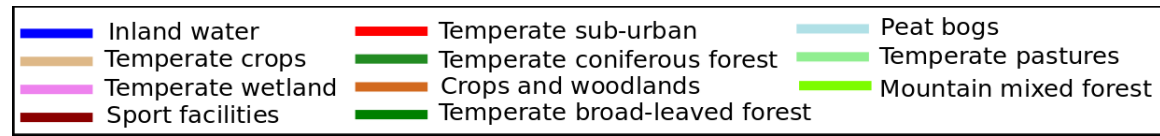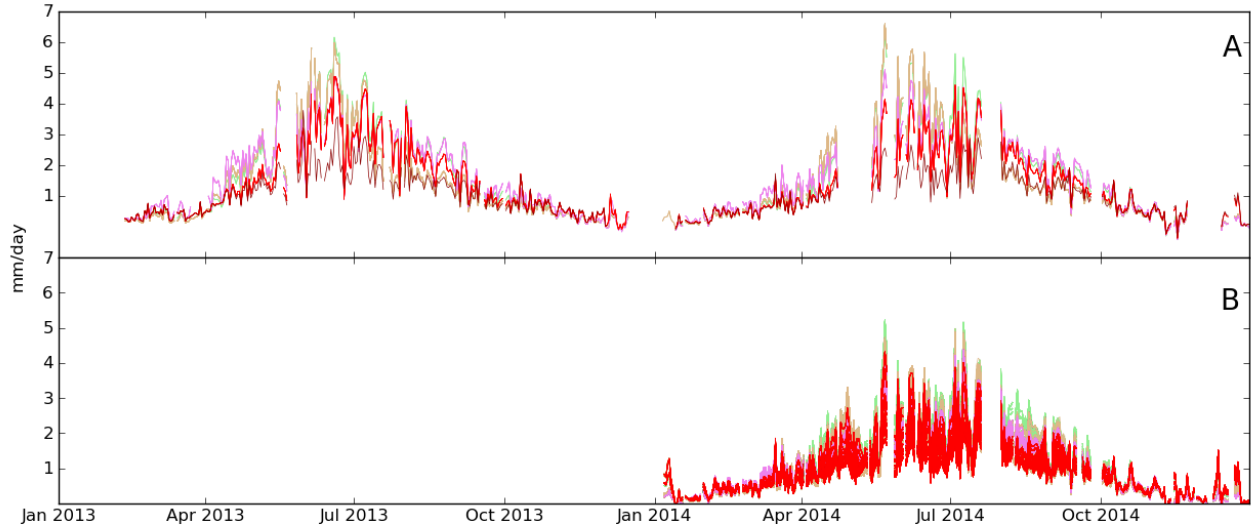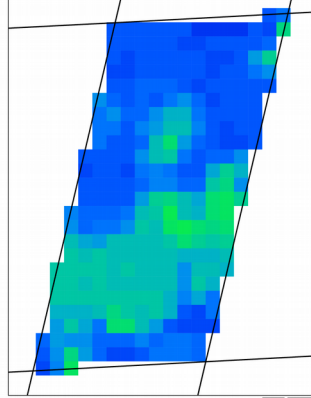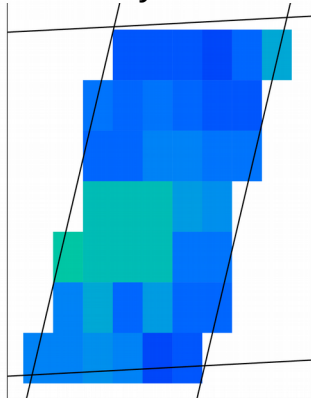
doy: 135

doy: 258

ET (mm/day)

0    1    2    3    4    5    6

Zarnekow

doy: 135

doy: 258

ET
(mm/day)

0   1   2   3   4   5   6+

EC tower
LSA-SAF ET

EC tower
1 km grid

EC tower
0.3 km grid

mm/day

Jan 2013    Apr 2013    Jul 2013    Oct 2013    Jan 2014    Apr 2014    Jul 2014    Oct 2014
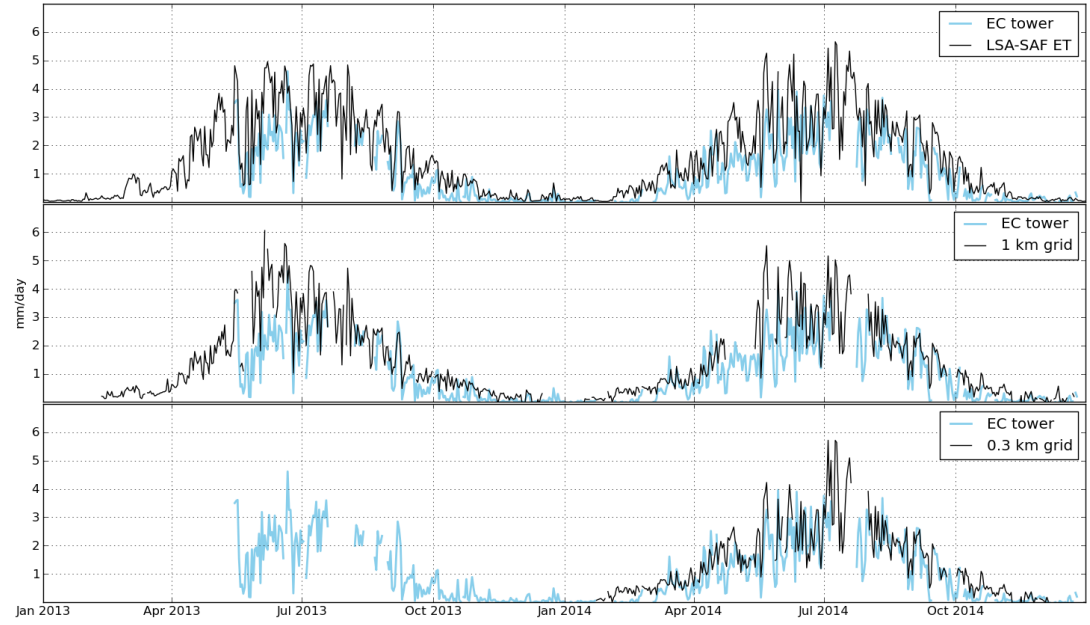
A

B

mm/day

Jan 2013    Apr 2013    Jul 2013    Oct 2013    Jan 2014    Apr 2014    Jul 2014    Oct 2014
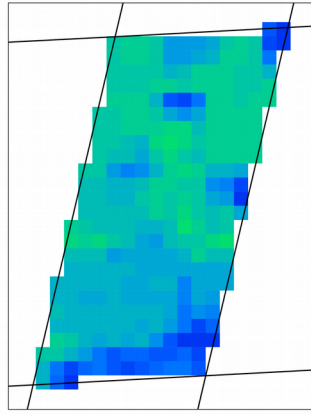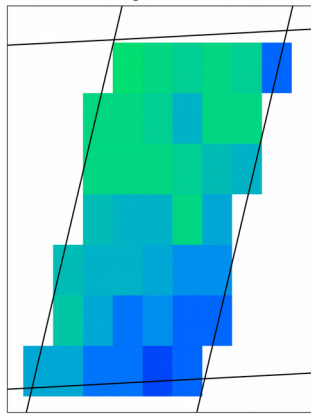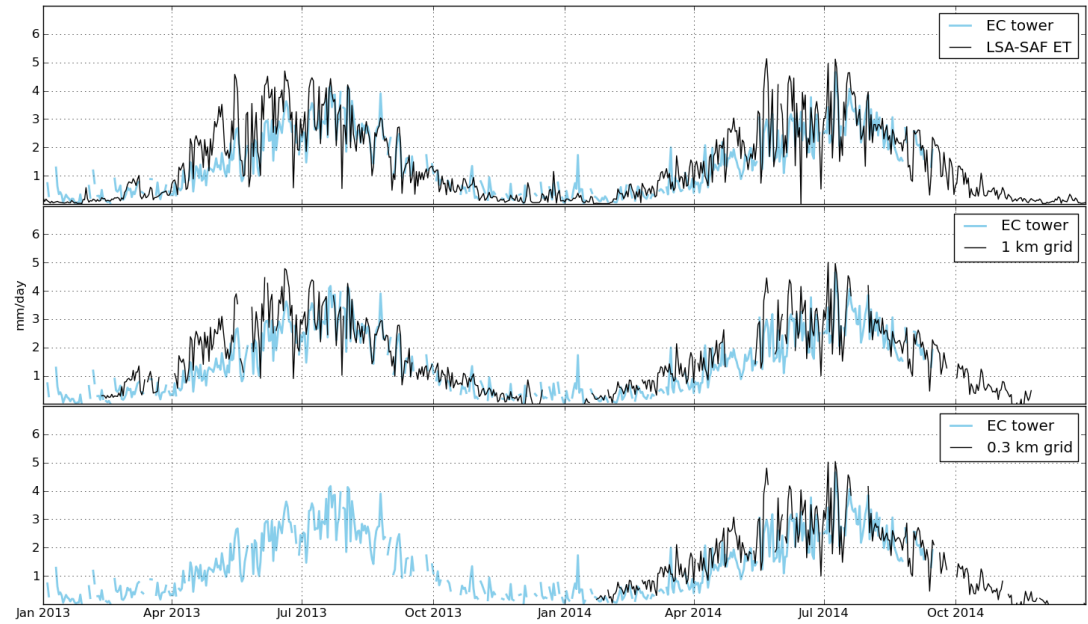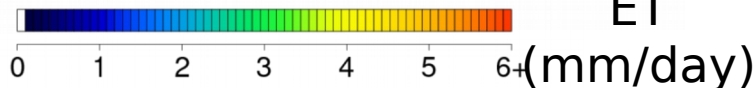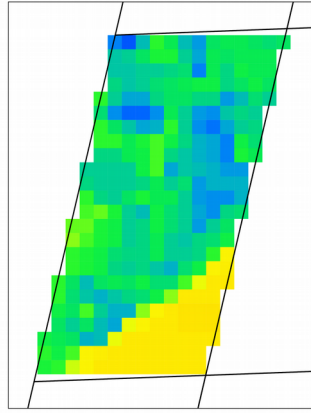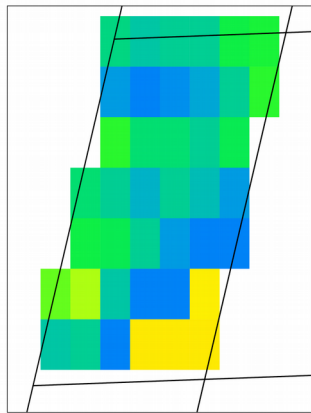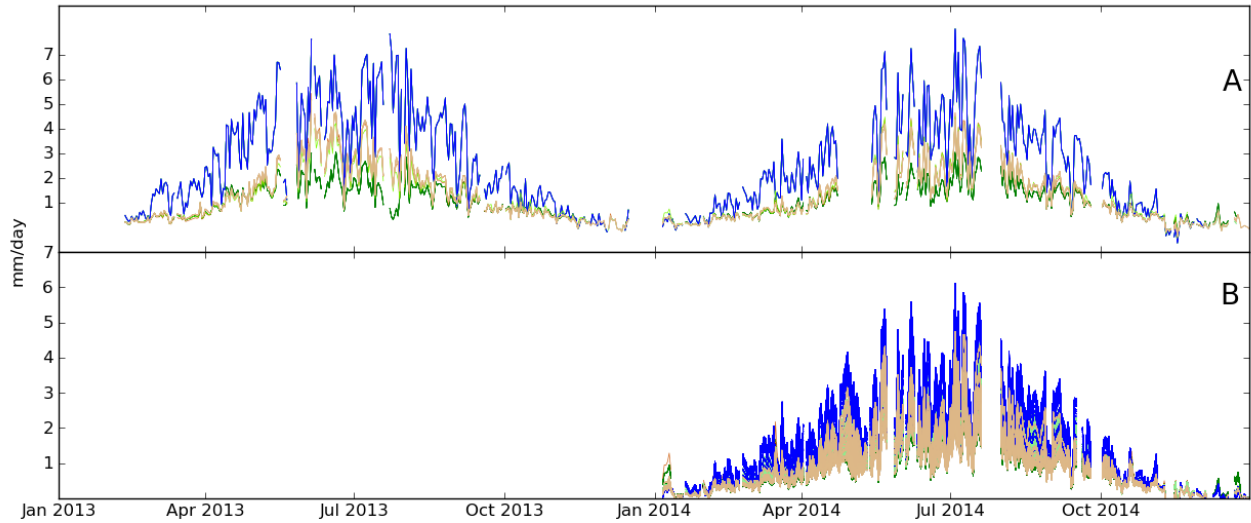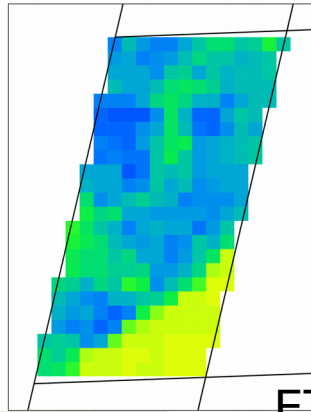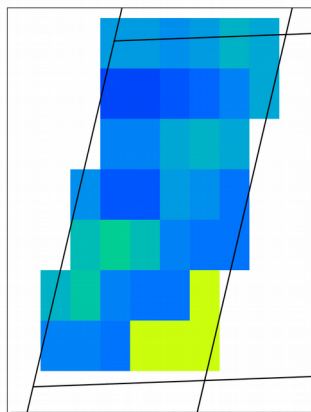
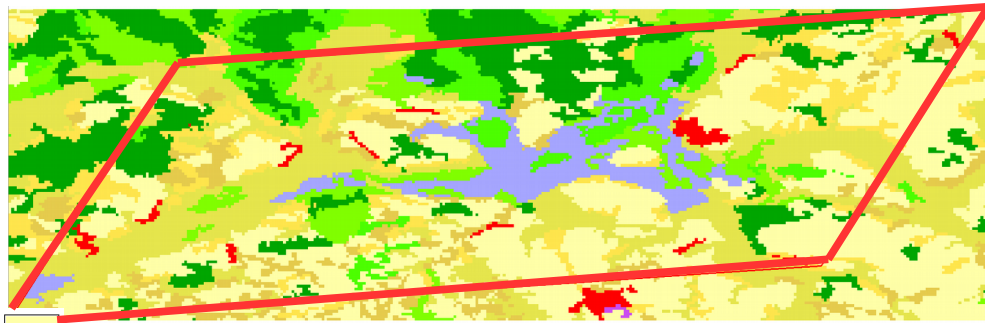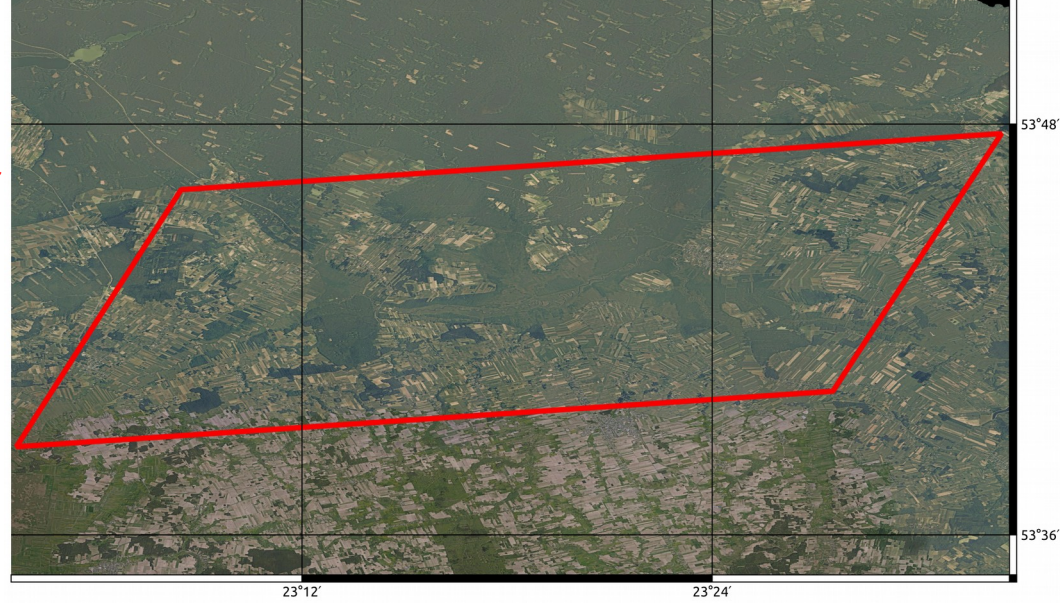Inland water                  Temperate sub-urban              Peat bogs
Temperate crops              Temperate coniferous forest      Temperate pastures
Temperate wetland            Crops and woodlands              Mountain mixed forest
Sport facilities             Temperate broad-leaved forest
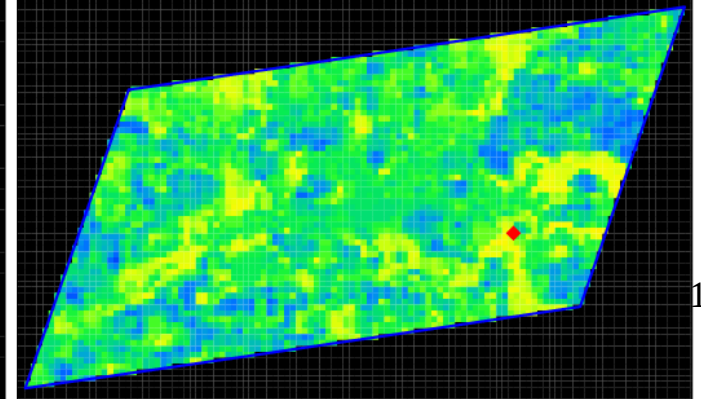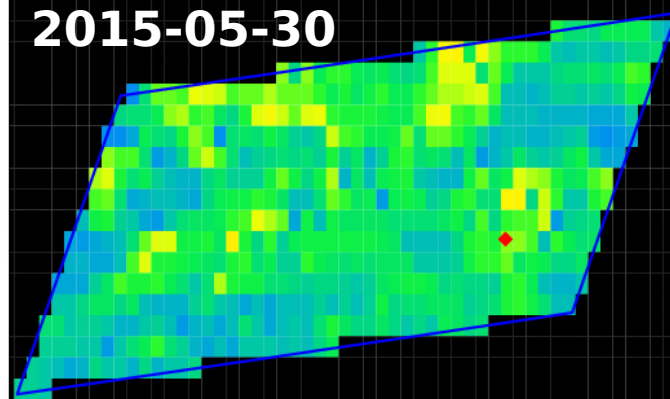
10

# Upper Biebrza
## (>35000 ha)
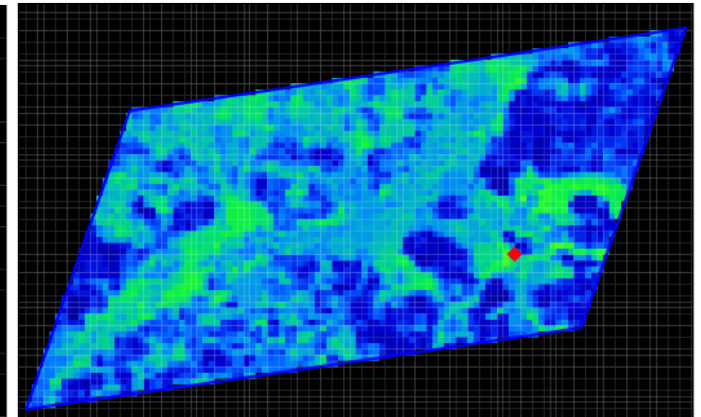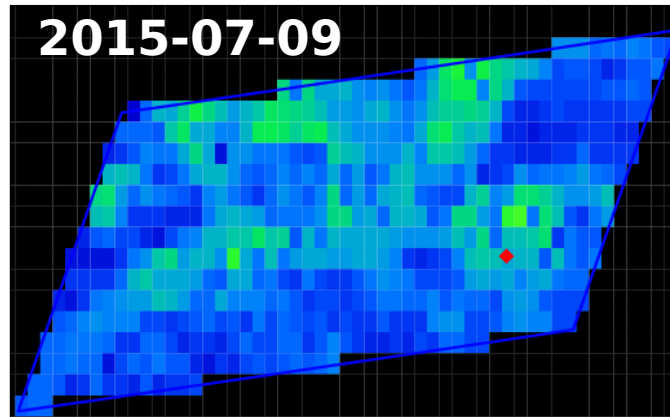


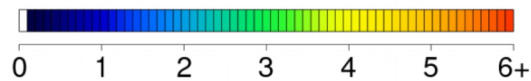**Non-irrigated arable**

**Pastures**

**Agriculture**

**BLF**

**Coniferous forest**

**Inland marshes**

## Over SpotV/ProbaV grid (1 Km)

## Over ProbaV grid (300 m)

**2015-07-09**

**2015-05-30**

ET (mm/day)

0  1  2  3  4  5  6+

11

**Upper Biebrza**

At EC tower location

Temperate wetlands

Temperate broad-leaved forest

Temperate crops

Temperate coniferous forest

Temperate pastures

12
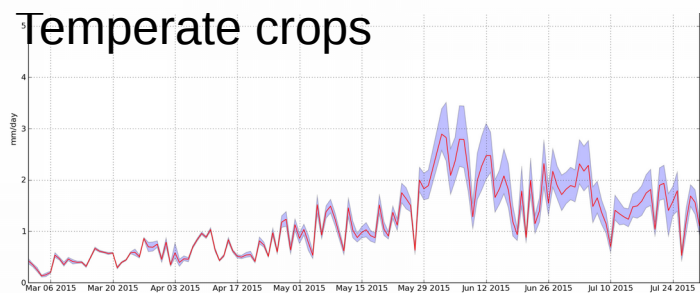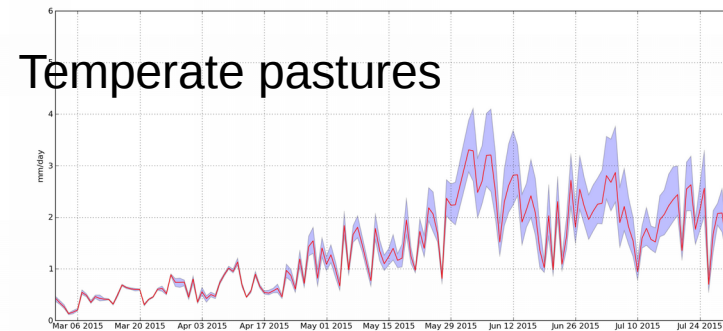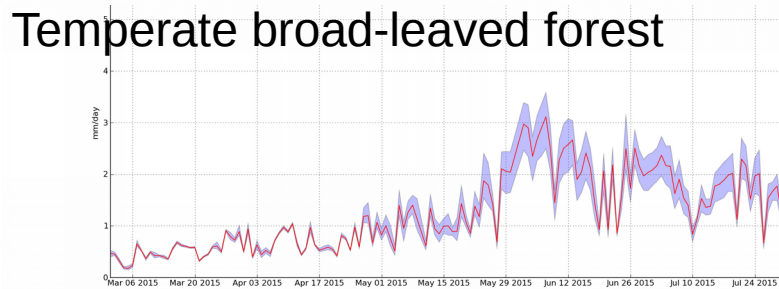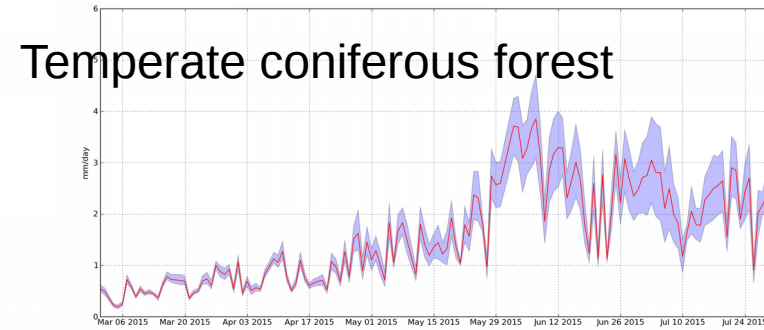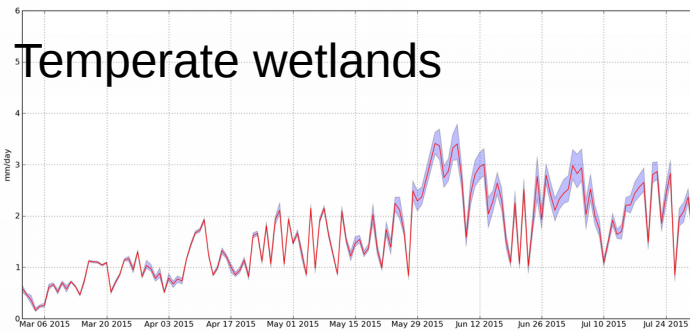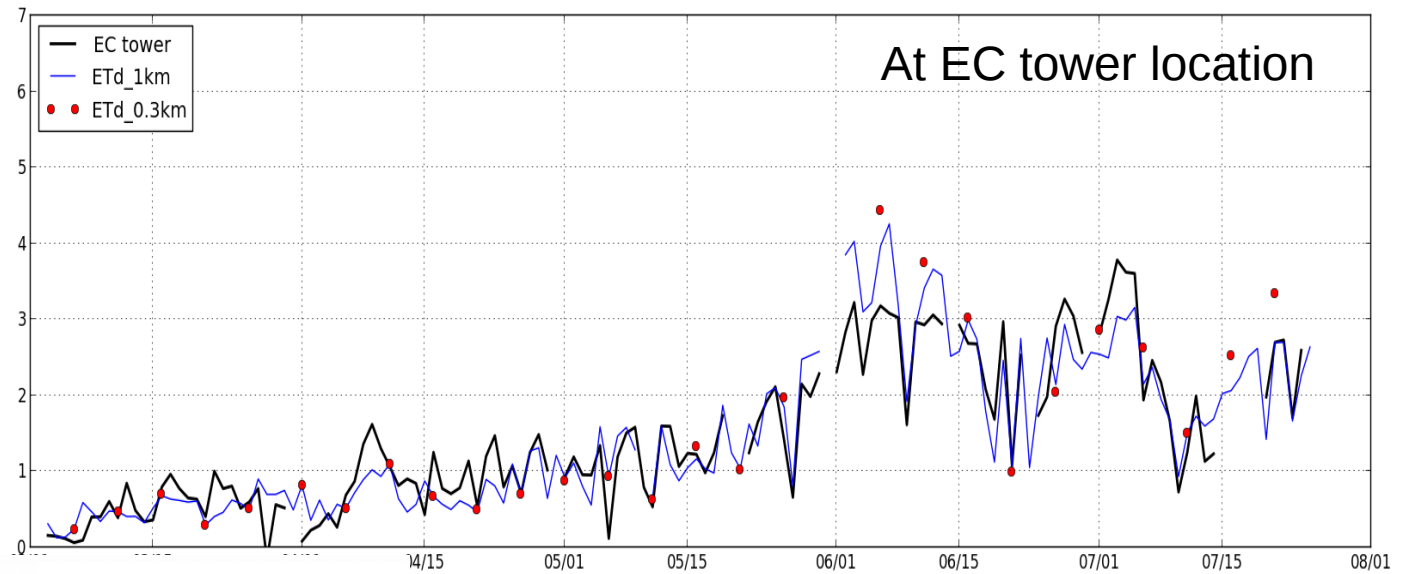
| Site | Grid-model | RMSE | Bias | $R^2$ | NSI | $n$ |
|---|---|---|---|---|---|---|
| Anklam | 1.0 km cell | 0.5814 | −0.0430 | 0.9006 | 0.8101 ✅ | 411 |
|  | 0.3 km cell | 0.5768 | −0.0176 | 0.8964 | 0.8023 | 191 |
|  | LSA-SAF ET | 0.6480 | −0.1635 | 0.8945 | 0.7790 | 526 |
| Spreewald | 1.0 km cell | 0.7245 | −0.3063 | 0.8047 | 0.5293 | 426 |
|  | 0.3 km cell | 0.6805 | −0.1927 | 0.8085 | 0.6104 | 254 |
|  | LSA-SAF ET | 0.5575 | 0.2709 | 0.9191 | 0.7216 | 599 |
| Schechenfilz Nord | 1.0 km cell | 0.5634 | 0.1276 | 0.9138 | 0.8147 ✅ | 369 |
|  | 0.3 km cell | 0.5805 | −0.1509 | 0.9246 | 0.8293 | 247 |
|  | LSA-SAF ET | 0.7984 | −0.0156 | 0.8015 | 0.6233 | 598 |
| Zarnekow | 1.0 km cell | 0.6763 | 0.2174 | 0.8925 | 0.7490 | 417 |
|  | 0.3 km cell | 0.5757 | 0.1400 | 0.8969 | 0.7900 ✅ | 245 |
|  | LSA-SAF ET | 0.6467 | 0.2783 | 0.9093 | 0.7630 | 505 |

# At Biebrza:

| Model | RMSE | Bias | r2 | NSI | n |
|---|---|---|---|---|---|
| 1 km cell | 0.4949 | 0.0629 | 0.8722 | 0.7438 | 275 |
| LSA-SAF ET | 0.8426 | 0.6615 | 0.8672 | 0.2057 ✅ | 289 |





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Biebrwza(pixel:366)-Temperate wetlands

bias : 4.7119
r2   : 0.9473
slope: 1.1288
rmse: 6.234
n: 5287.0

Tsk

MODIS LST

Biebrwza(pixel:366)-Temperate pastures

bias : 3.8433
r2   : 0.9347
slope: 1.0668
rmse: 5.7974
n: 4780.0

MODIS LST

Biebrwza(pixel:366)-Temperate crops

bias : 4.1614
r2   : 0.9326
slope: 1.111
rmse: 6.2154
n: 11143.0

Tsk

MODIS LST

Biebrwza(pixel:366)-Temperate complex cultivation pattern

bias : 3.8124
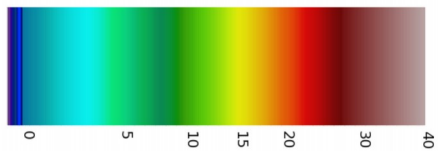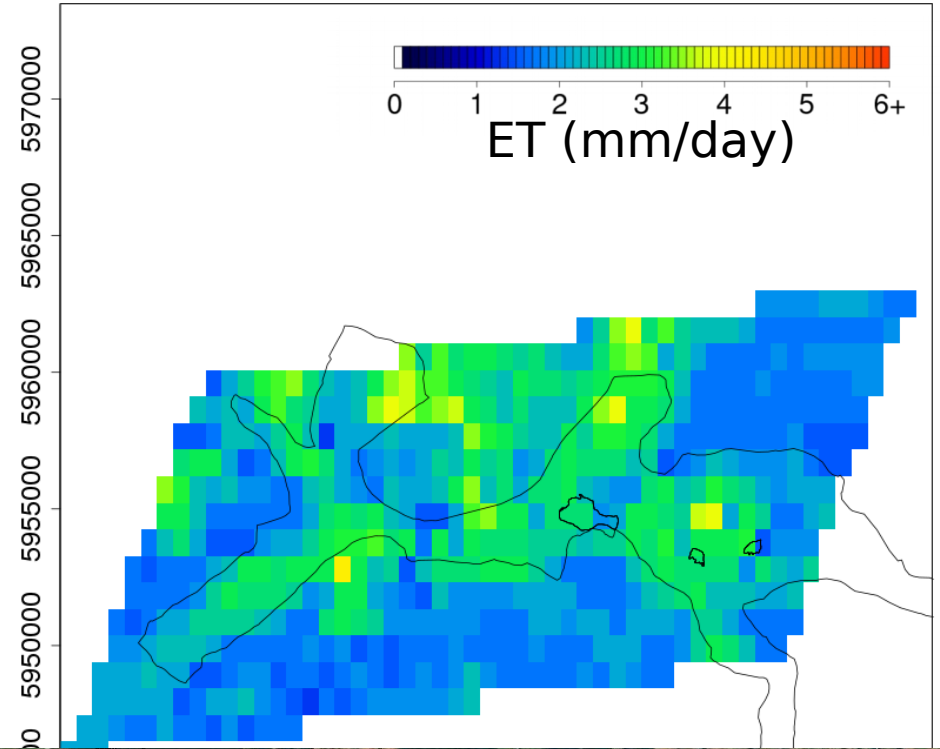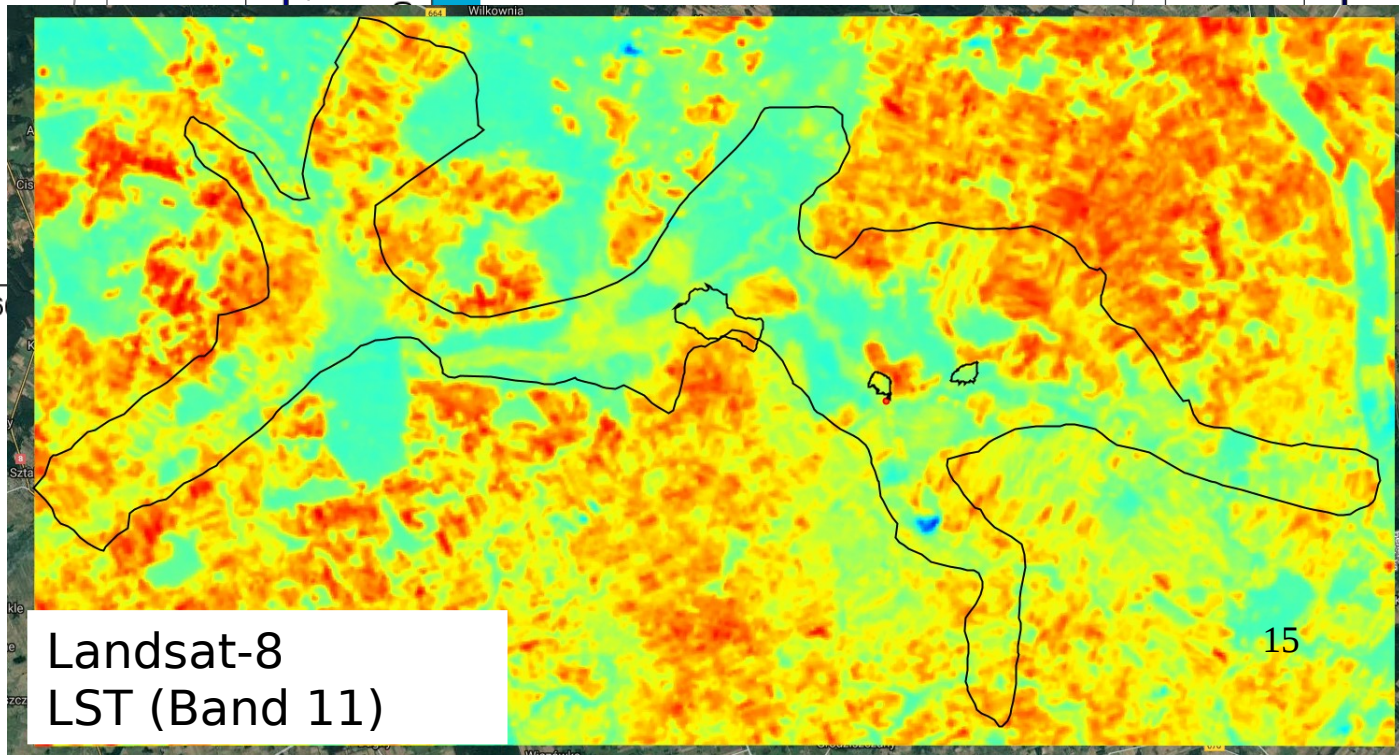r2   : 0.9326
slope: 1.1132
rmse: 5.9422
n: 1082.0

Tsk

MODIS LST

14

## MODIS LST-(20160605)

## Daily ET-(20160605)

ET (mm/day)

LST
(°C)

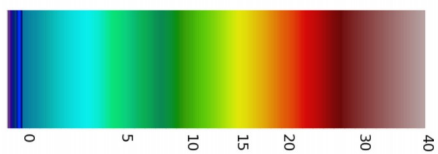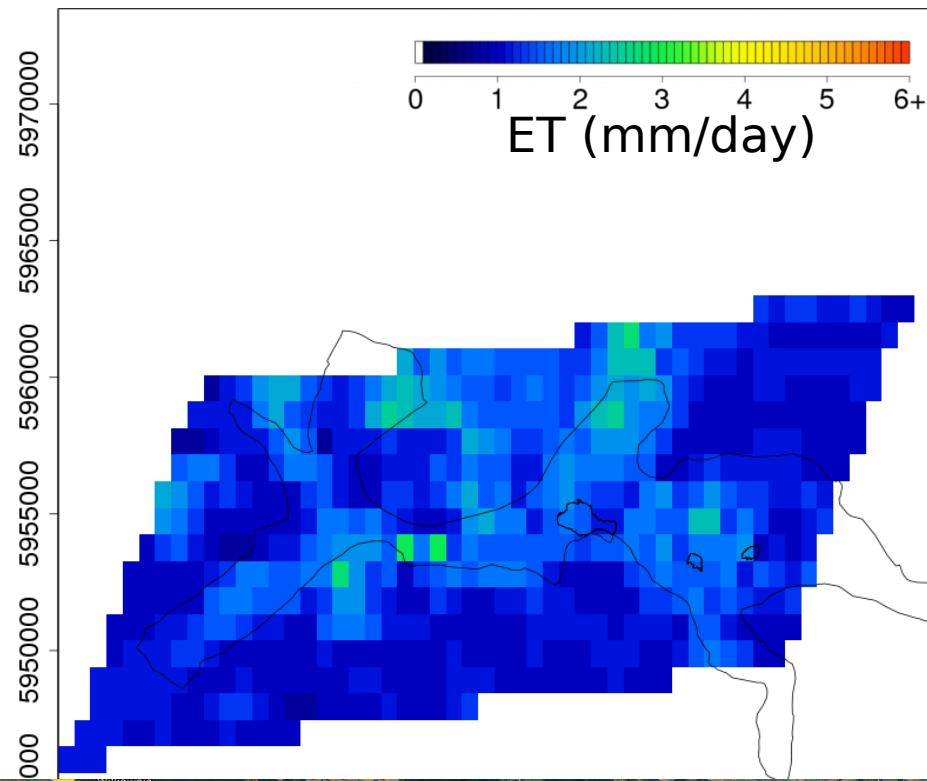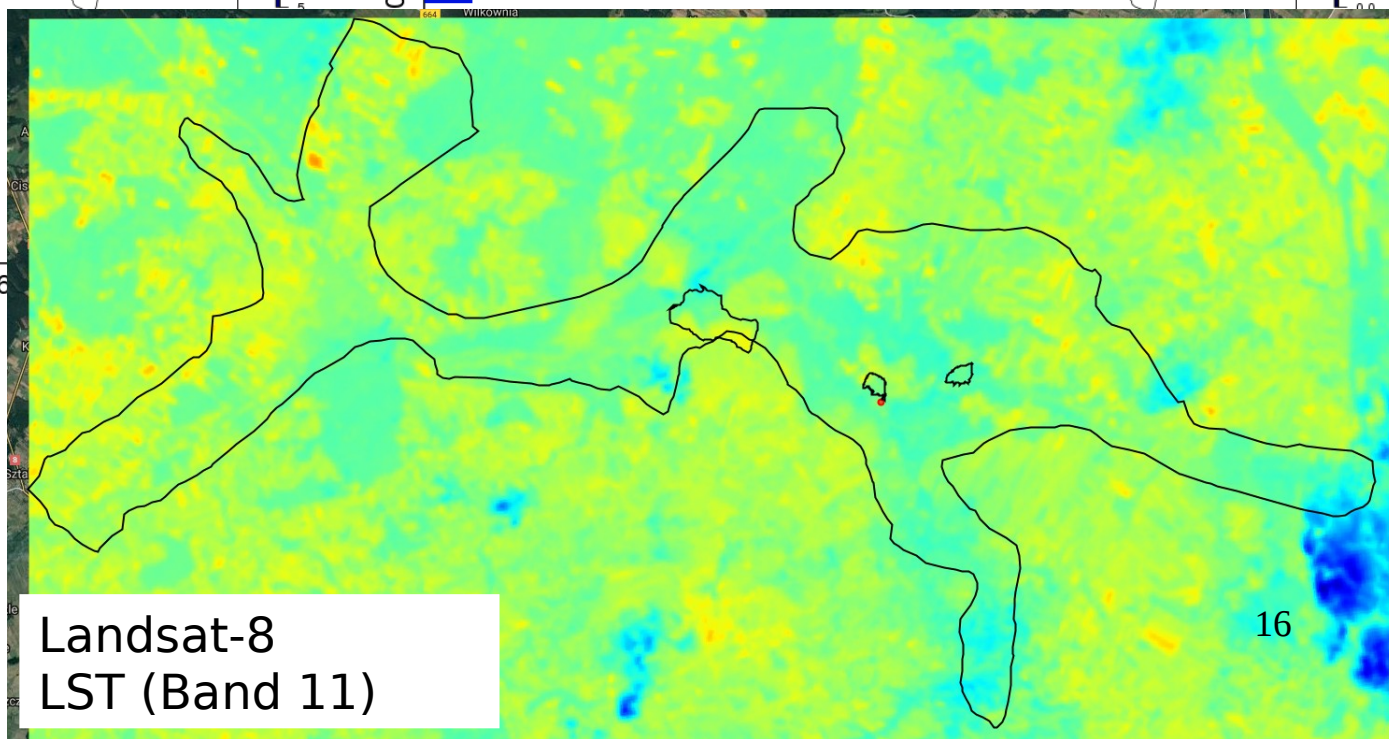Landsat-8
LST (Band 11)

15

## MODIS LST-(20160808)



## Daily ET-(20160808)

ET (mm/day)

LST
(°C)

Landsat-8
LST (Band 11)

16
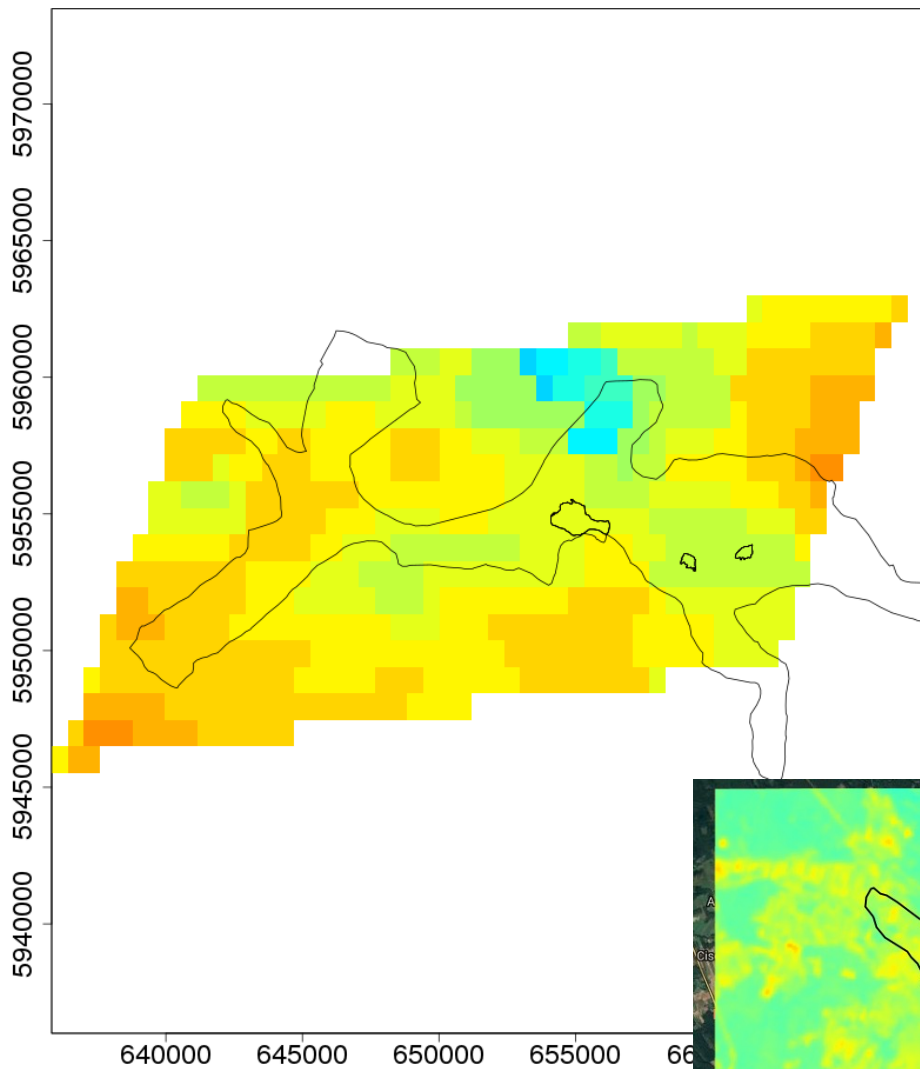
# Conclusions

○ The Copernicus GL vegetation products: a promissing resource to be included in the forcing of lland surface models.
On going work: In depth exploration

○ Spot-V/Proba-V vegetation products and MODIS albedo can be combined with high-temporal resolution forcing to generate sub-kilometre estimates of daily ET
On going work: analysis with S3. In particular the incorporation of the thermal channel

○ In most of the cases statistical scores of estimated 0.3 km resolution ET outperform ET estimates at geostationary satellite spatial resolution

○ Consistency in estimates over Proba-V grids 0.3 km and 1 km =
•Possibility to couple Spot-V archive and construct long ET time series (from 1998)
•Possibility to couple with S3 observations ?

# Thank you

**Acknowledgements:**


belspo

ECOPROPHET consortium



**Contact:**

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**http://ecoprophet.meteo.be**