Landscape heterogeneity around flux measurement stations investigated through Sentinel-2 and PROBA-V satellite imagery

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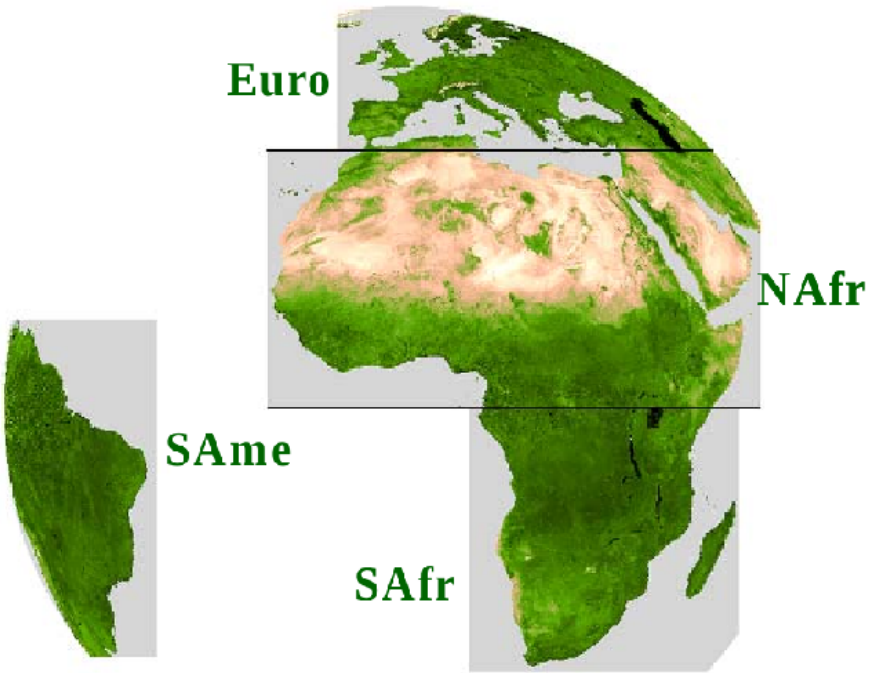
SPIE. REMOTE SENSING

Berlin, 11-13 September 2018

LSA-SAF ET products



LSA-SAF coverage

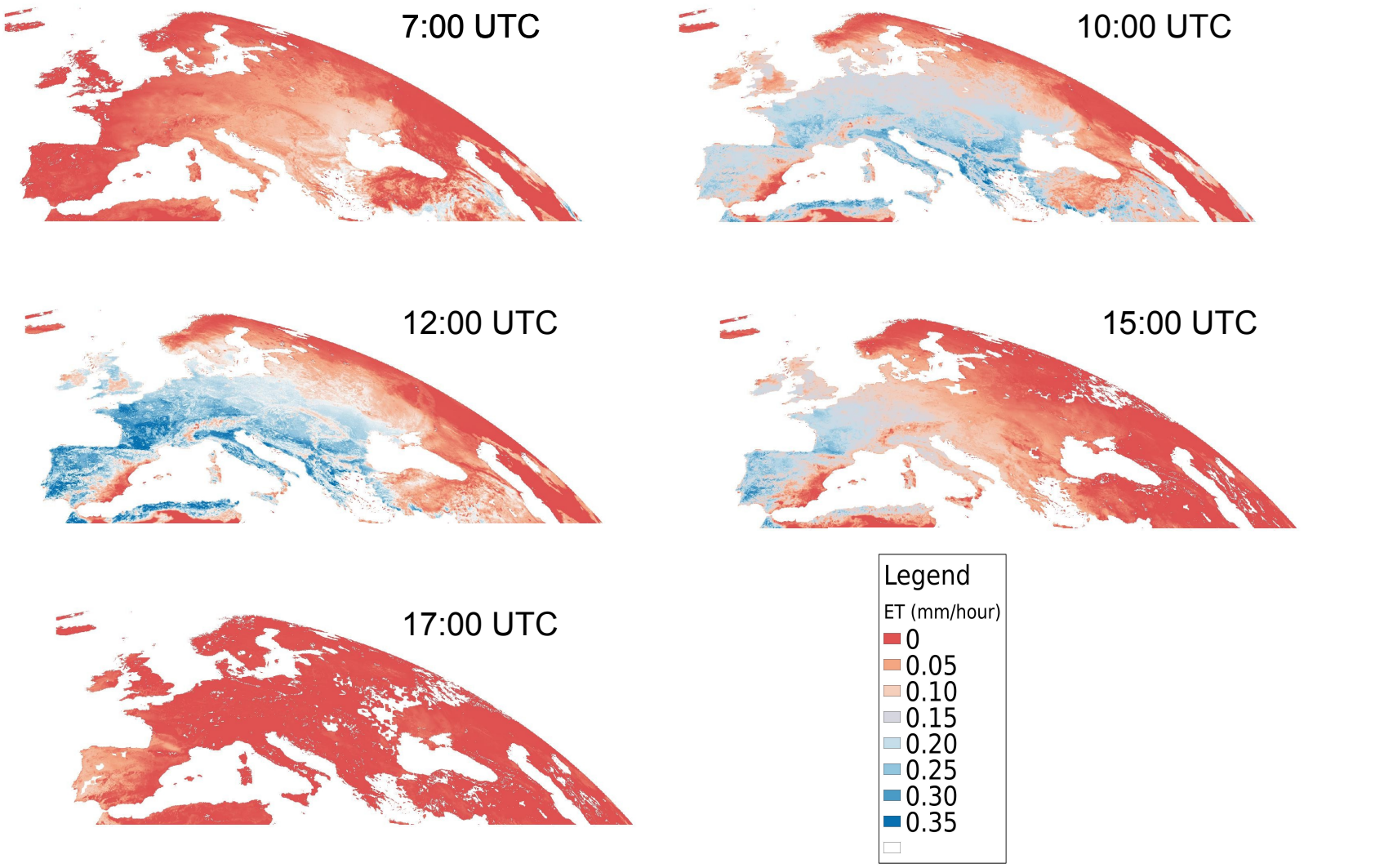
- Half-hourly ET
- Daily ET

For more information and data access:
http://lsa-saf.eumetsat.int/

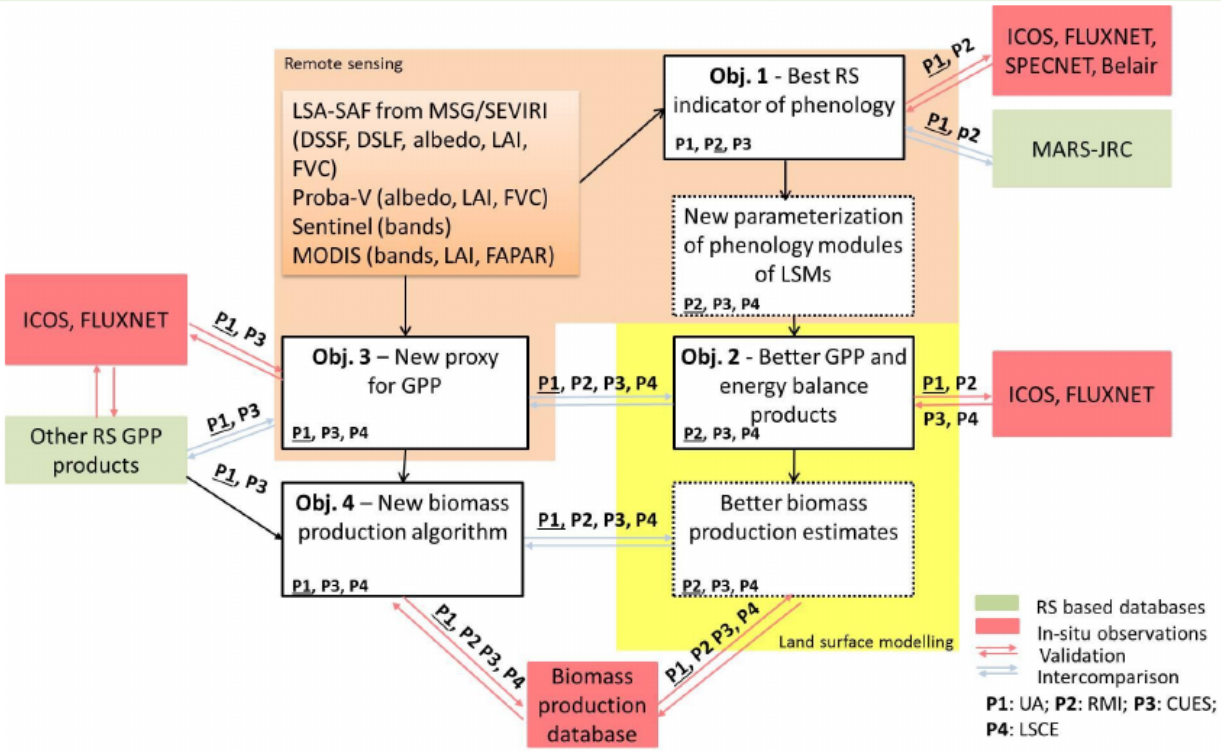
The EUMETSAT Network of Satellite Application Facilities
LSA SAF Land Surface Analysis
EUMETSAT

LSA-SAF ET products (3)

ET Europe March 12, 2014



ECOPROPHET



Obj. 1 - Test new RS products (Sentinel; PROBA-V): focus on "functional phenology indicators".

Obj. 2 - New product from Obj. #1 ➔ reparameterize phenology modules of Land surface models ➔ better estimates of GPP, evapotranspiration, energy balance.

Obj. 3 - New product from Obj. #1 ➔ new GPP product: e.g. GPP = f(new RS product); or GPP = f(new RS product)*PAR; or GPP = f(new RS product)*PAR*ε; or new approaches.

Obj. 4 - Alternative NPP model: NPP = new GPP * NPP/GPP ratio. New GPP from obj. 2 or 3 (or even NDVI-based GPP); NPP/GPP = function (management & site fertility).

Why is it important?

- Important to know what are EC towers measuring
- Affects measurements in general
- Representativeness
- Energy balance closure

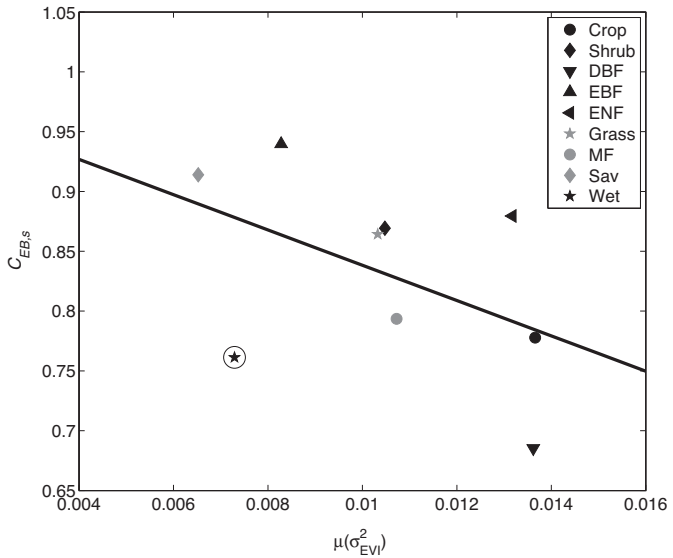


Fig. 7. Energy balance closure for FLUXNET eddy covariance research sites ($C_{EB,s}$) as a function of the variance of the MODIS enhanced vegetation index (EVI) for the 20×20 km region surrounding each eddy covariance tower and averaged per ecosystem type. The solid line is the best-fit relationship after removing wetland ecosystem types and is defined as $C_{EB,s} = -14.76\mu(\sigma^2_{EVI}) + 0.99$. Excluding wetland

(Stoy *et al*, Agriculture and Forest Meteorology (2013))

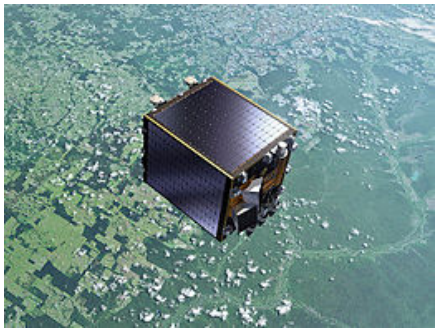
Assessing heterogeneity

Studied variable: NDVI
Main assumptions:

- NDVI: relevant determinant of fluxes
- Homogeneous areas exhibit lower NDVI variability
- Heterogeneous areas exhibit low spatial autocorrelation

Proba-V and S2: opportunity

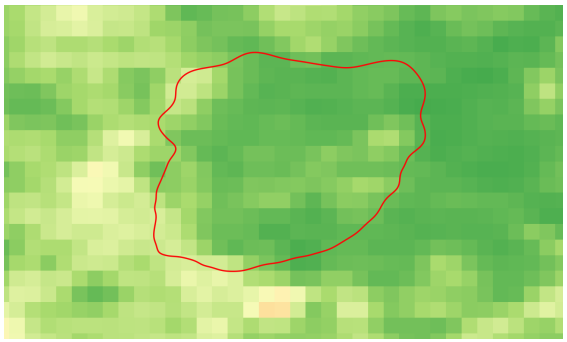
Proba-V



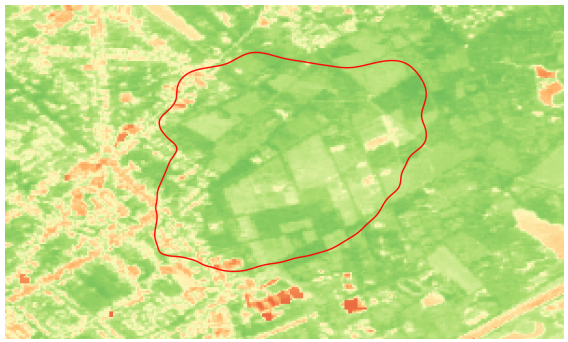
Spatial resolution: 100 m
Frequency: 5 days

Sentinel-2

Spatial resolution: 20 m
Frequency: 5 days (Equator, 2 satellites)



NDVI (Proba-V) - 2016-06-06



NDVI (S2) - 2016-06-07

Real color view

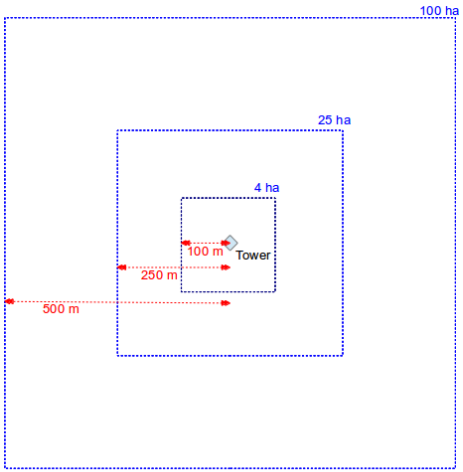
(PROBA-V Mission Explotation Platform: https://proba-v-mep.esa.int)

Objective

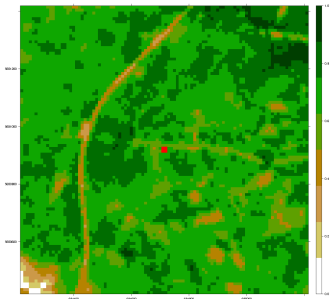
General

- to investigate the heterogeneity of the landscape at different points in time and over different spatial extents around EC measurement sites on the basis of multidate NDVI derived from Proba-V and S2 observations
- The overall purpose: to better characterize EC sites used in val/cal models

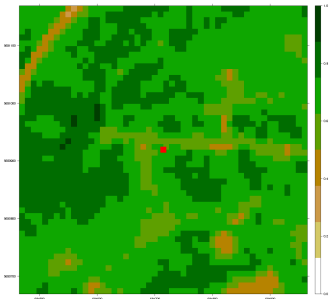
Spatial extent of analysis



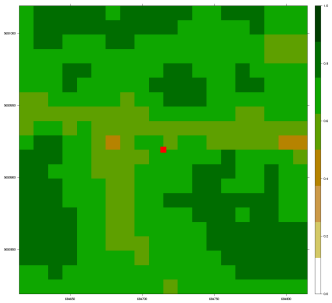
a



b (100 ha)



c (25 ha)



d (4 ha)

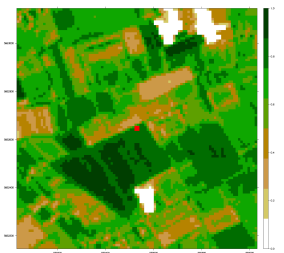
Methods

- Central tendency and dispersion statistics
- Mean Spatial Heterogeneity Index (SHI):

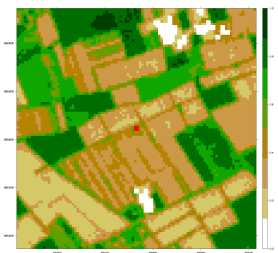
$$SHI_{ij} = \sum_{a=-1}^{1} \sum_{b=-1}^{1} |NDVI(i,j) - NDVI(i+a, j+b)| \quad (1)$$

$$MeanSHI = \frac{1}{m.n} \sum_{i=1}^{m-1} \sum_{j=1}^{n-1} SHI_{ij} \quad (2)$$

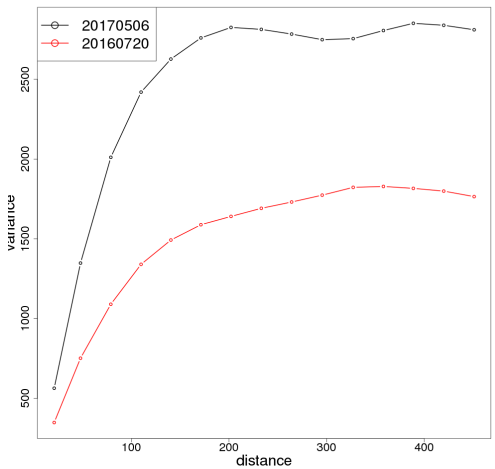
- fitting semi-variogram



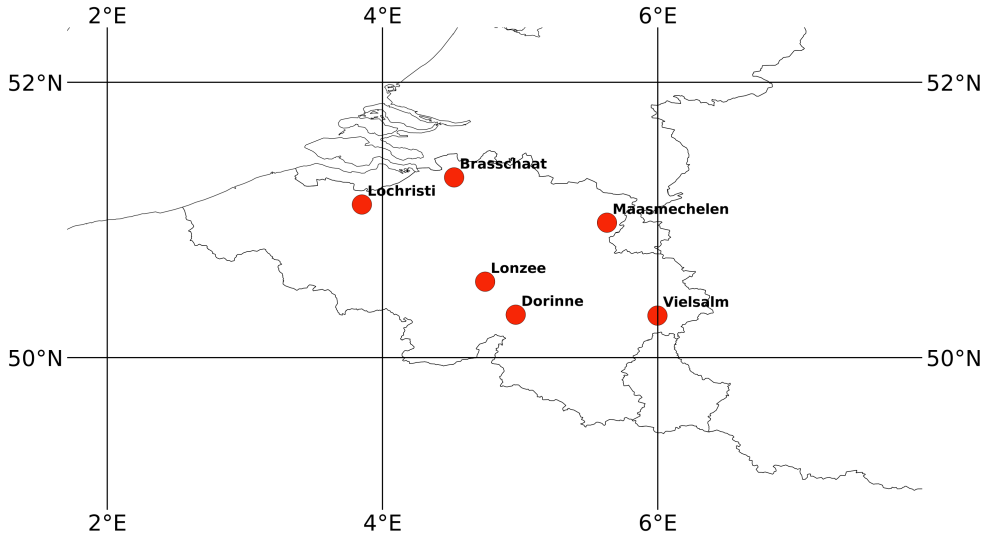
2016-07-20



2017-05-06



Study sites



ICOS National Network Belgium

Study sites (2)

Brasschaat

Lochristi

Lonzee

Maasmechelen

Dorinne

Vielsalm

Results

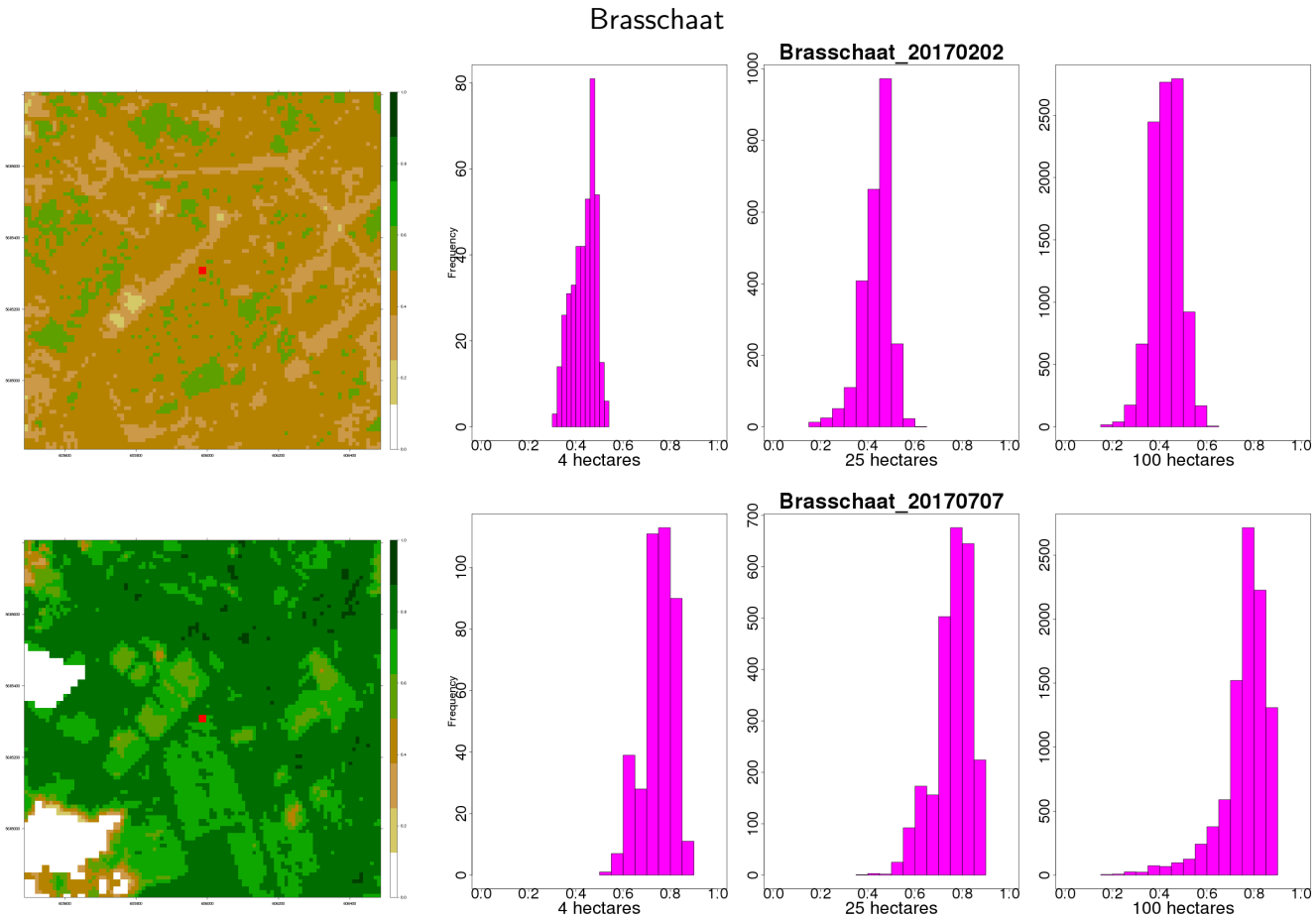


Figure: Histograms for winter and summer NDVI images at Brasschaat and Lonzee

Results

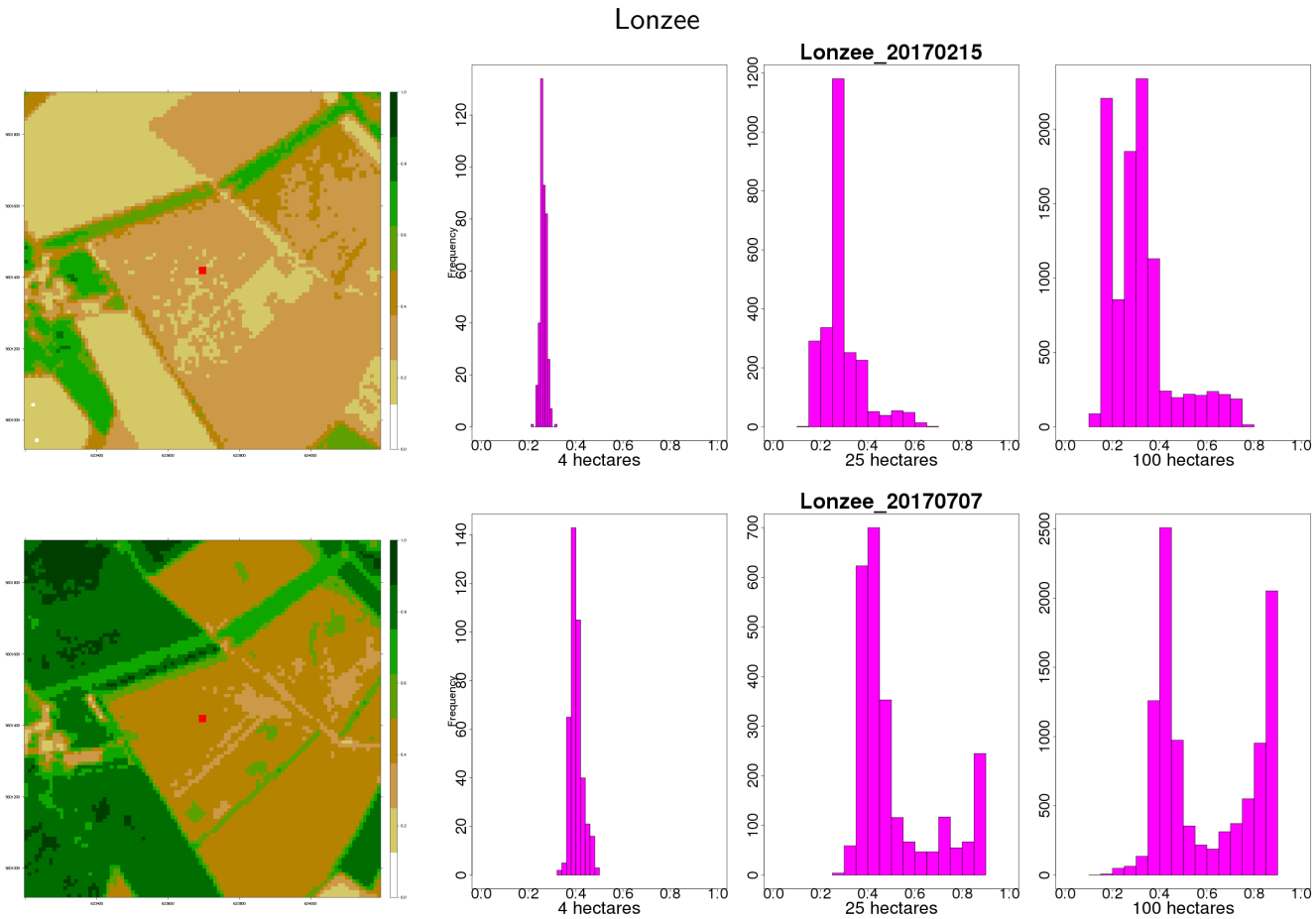
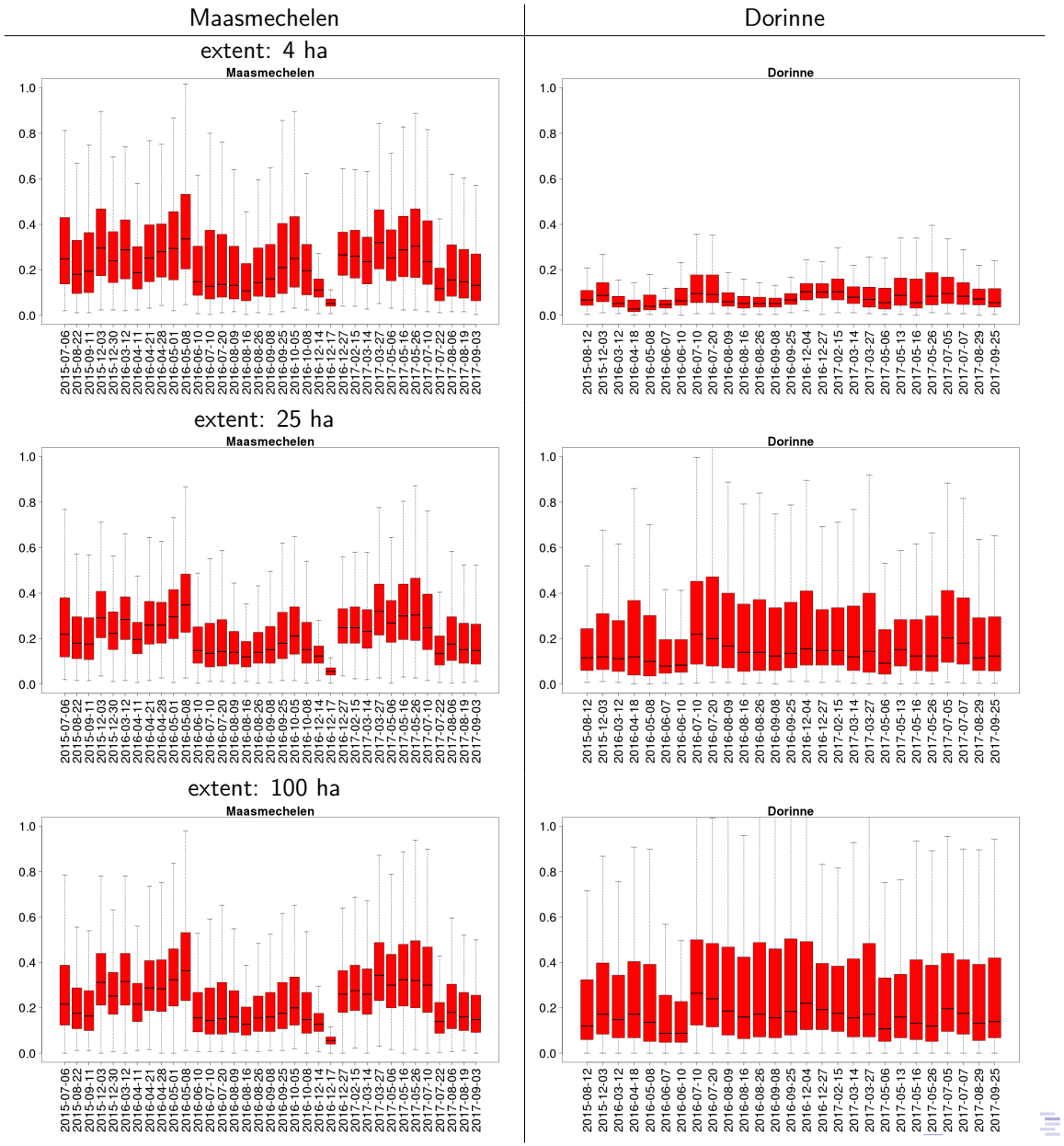


Figure: Histograms for winter and summer NDVI images at Brasschaat and Lonzee

Results (SHI)


Maasmechelen
Dorinne
extent: 4 ha
extent: 25 ha
extent: 100 ha
Maasmechelen
Dorinne

Results

Maasmechelen

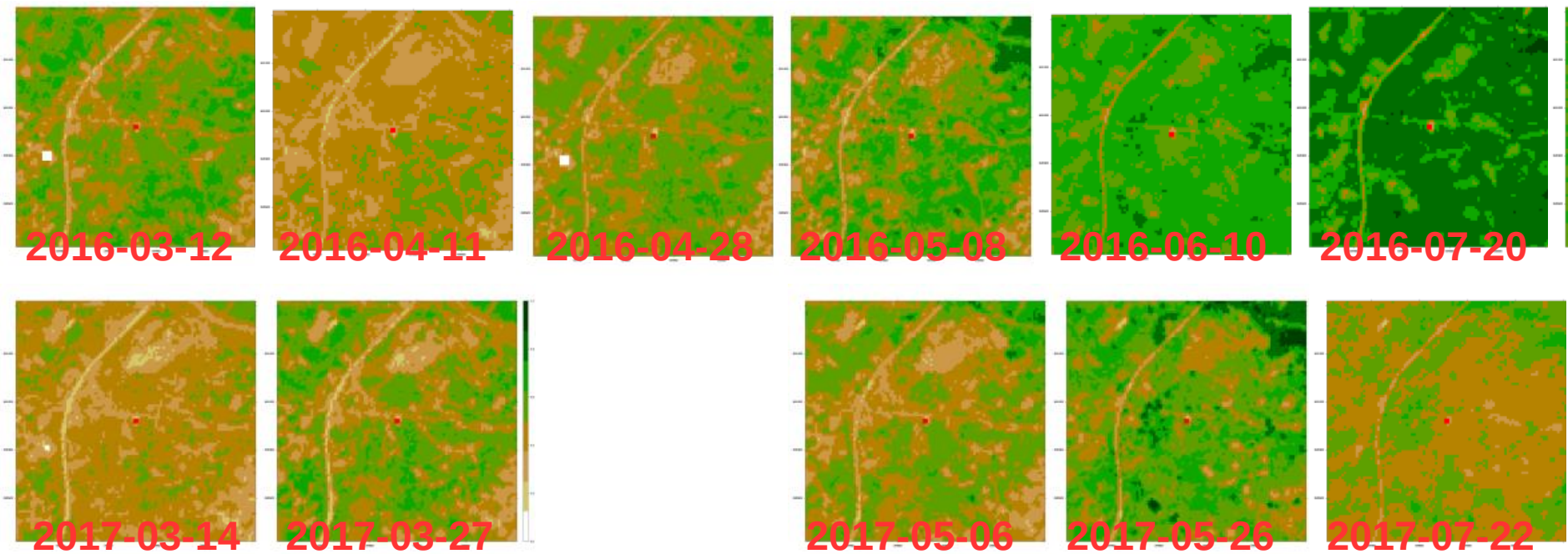


Figure: NDVI images for different dates in 2016 and 2017 across an area of 100 hectares around the Maasmechelen EC measurement site

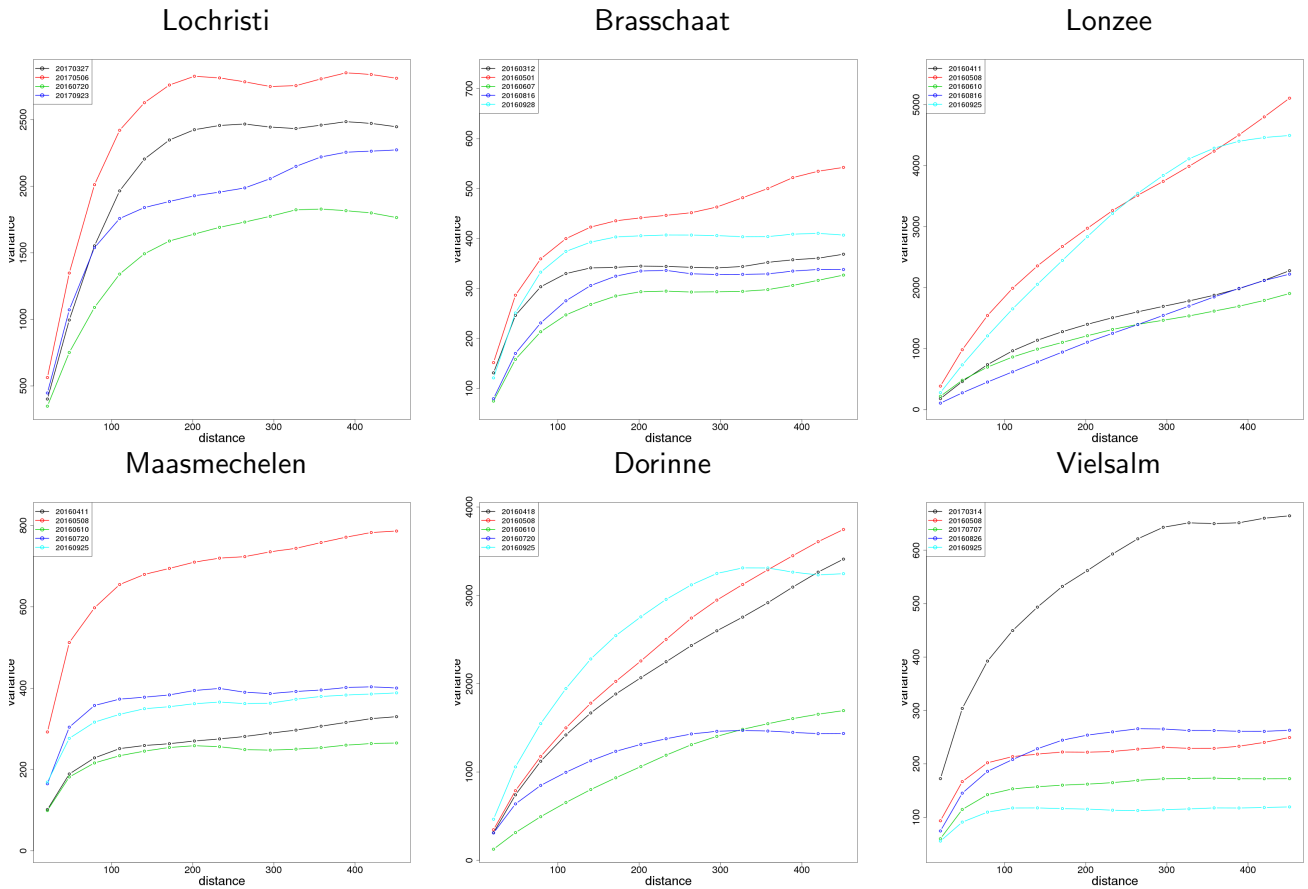
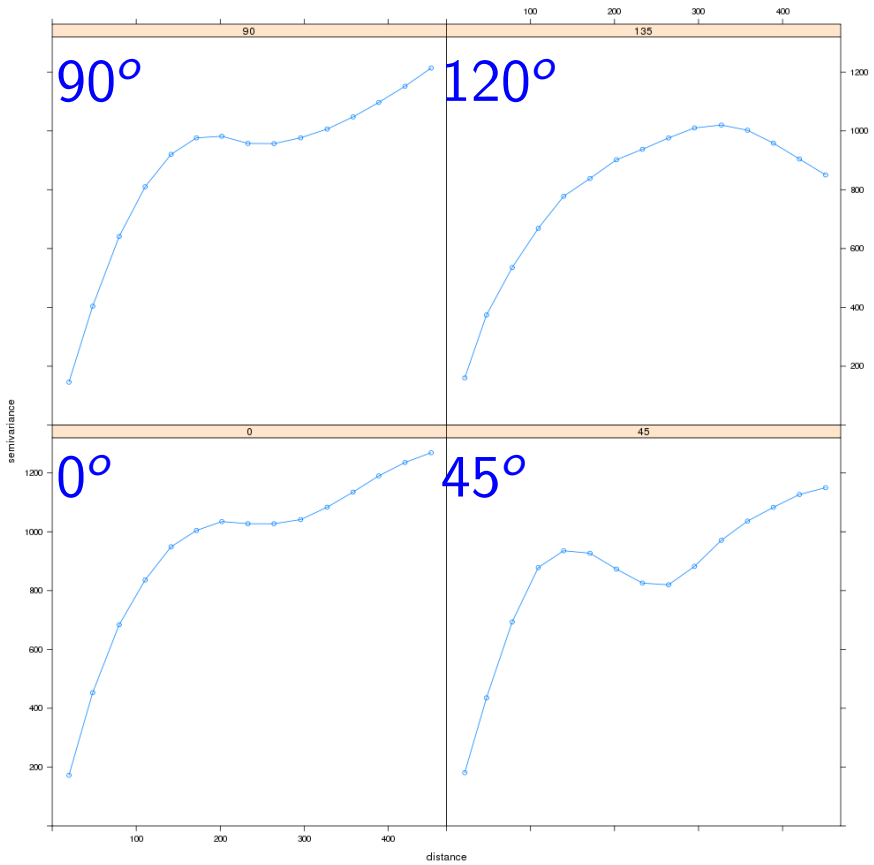


Figure: variograms for different sites over the NDVI images of the study sites

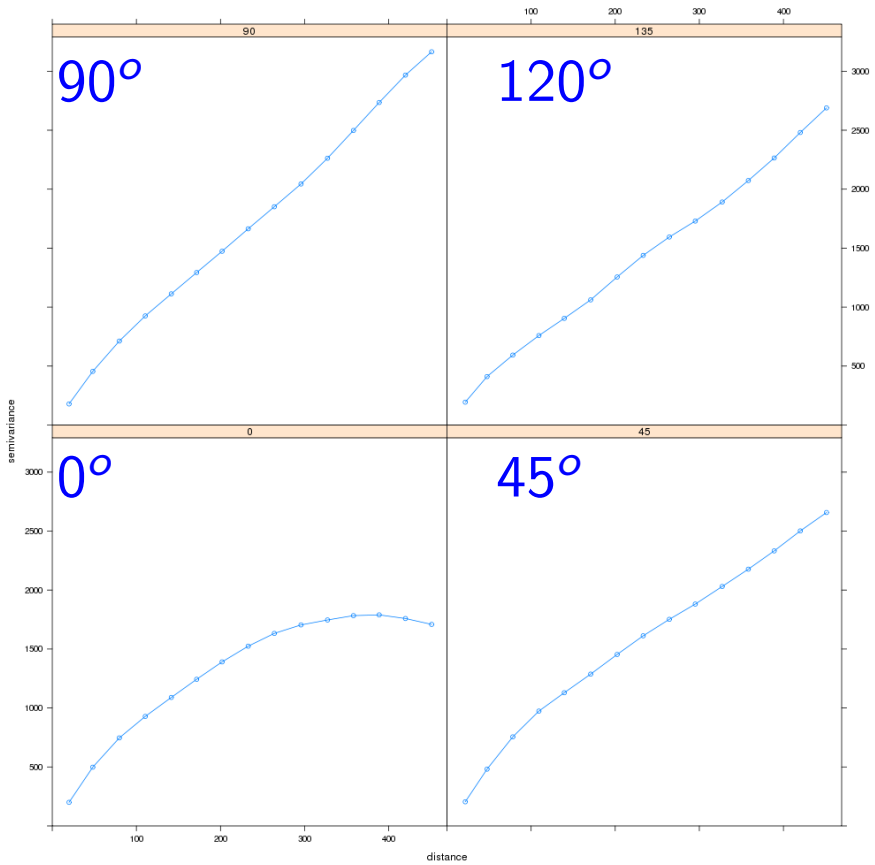
Directional variograms

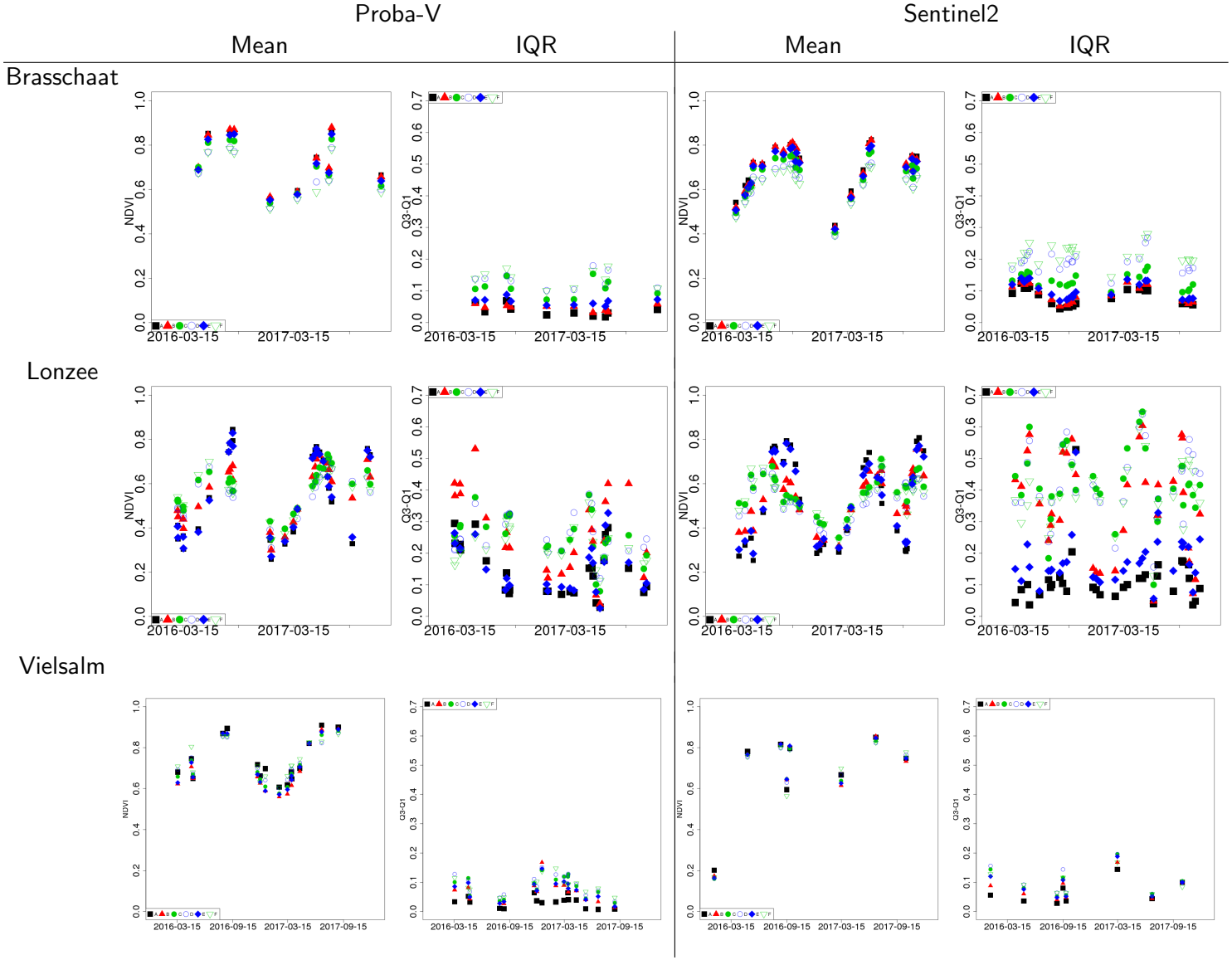
Lonzee

2017-02-15



2017-07-07





A=25 ha; B=100 ha; C=400 ha; D=1600 ha; E=Footprint climatology; F=MSG

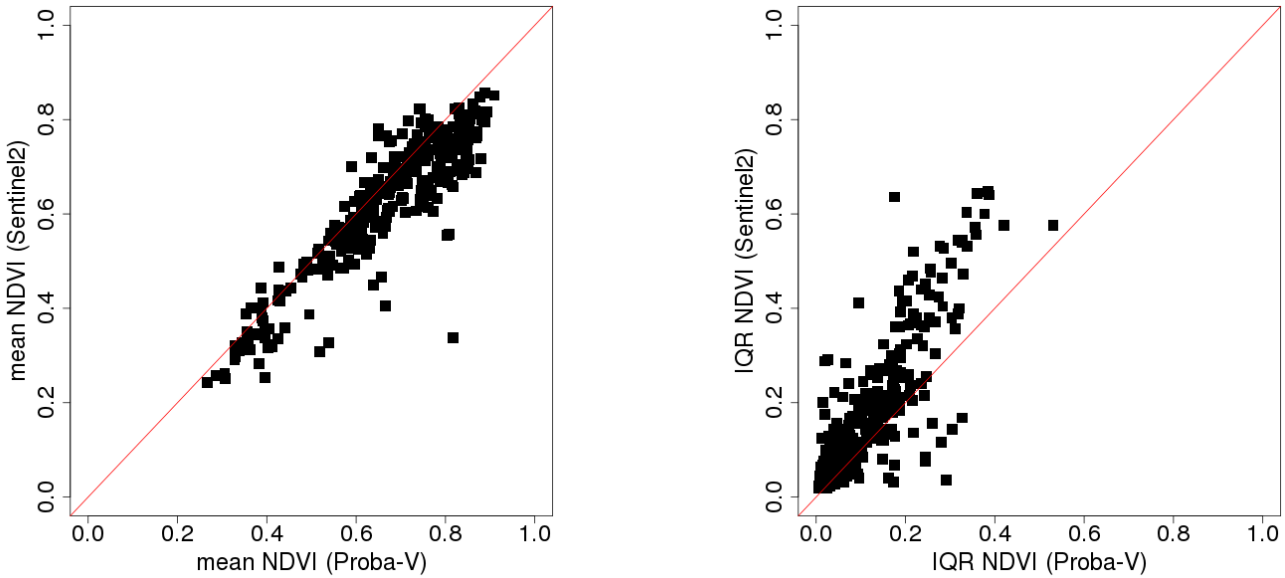
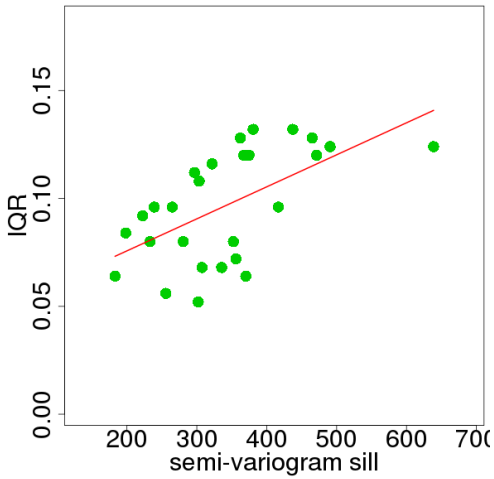
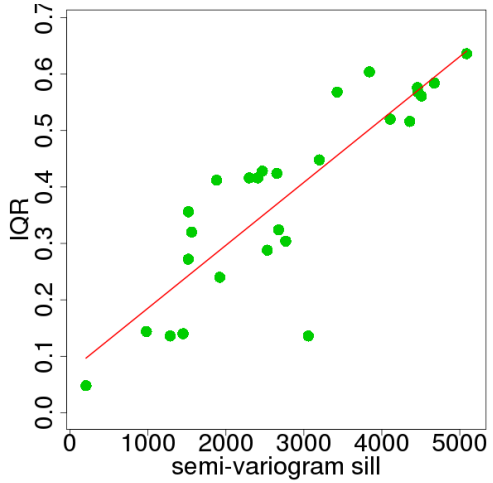


Figure: Scatterplot of NDVI mean and Interquartile Range (IQR) as derived from Proba-V and Sentinel2

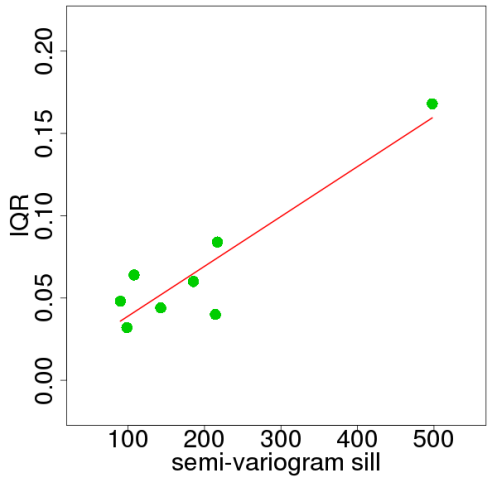
Semi-variogram Sill versus IQR



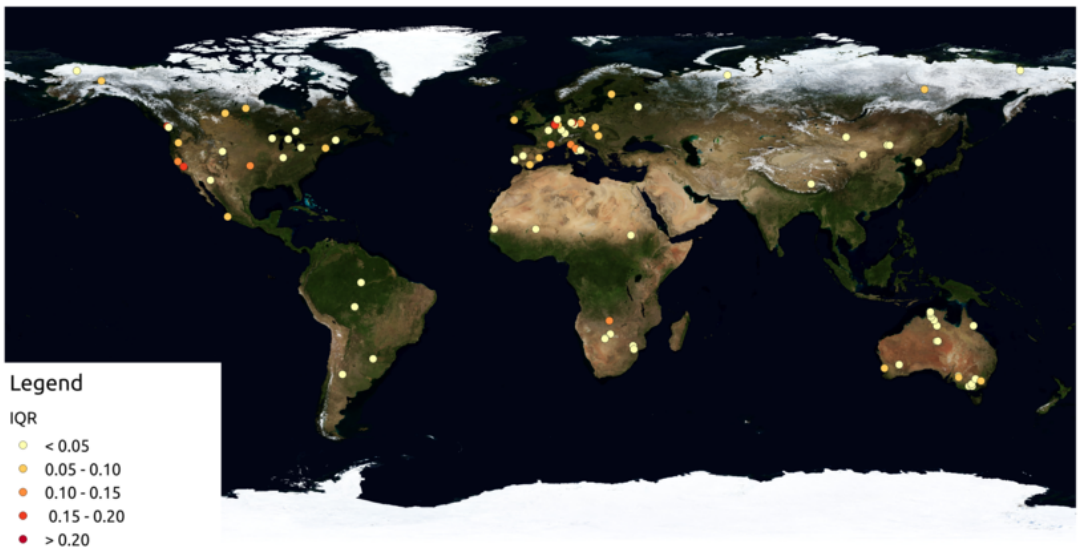
Brasschaat



Lonzee



Vielsalm



EC sites classification based on Mean NDVI IQR derived from Proba-V NDVI (100 m resolution)

Conclusions

- S2 and Proba-V NDVI: valuable resource to investigate spatial heterogeneity in the vicinity of flux measurement stations
- S2 and Proba-V can be used synergetically at global or continental scale
- First order statistics: insigth on NDVI variability across a certain area. No spatial structure.
- SHI: overview of time varying heterogeneity assessed when comparing adjacent neighbours only
- Semi-variograms: a more versatile tool. Different lag-distances and orientations can be considered
- Different approaches complement each other

The next step:

- Investigate the impact of NDVI spatio-temporal variability in measured/modelled fluxes

Acknowledgements

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http://ecoprophet.meteo.be

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