

Complex Terrain and Ecological Heterogeneity (TERRECO): Evaluating Ecosystem Services in Mountainous Landscapes

Energy and CO₂ exchange between agro-ecosystems and the atmosphere over a complex terrain in Korea



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Objectives

- Eddy-covariance technique ~ mountainous croplands
 -
- Energy and CO₂ exchange over croplands at Haean
 -
- Input or validation for models

Challenges

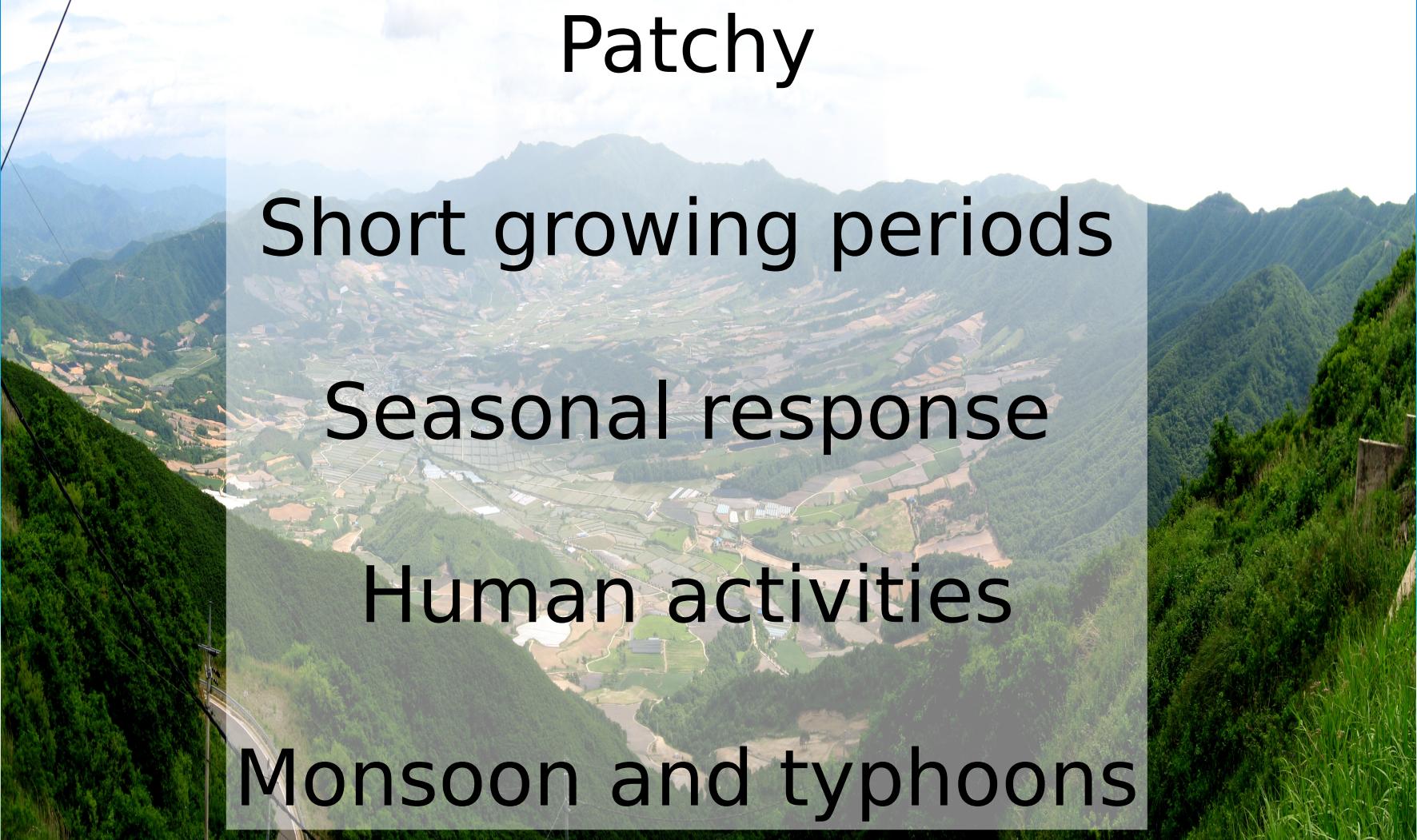
Patchy

Short growing periods

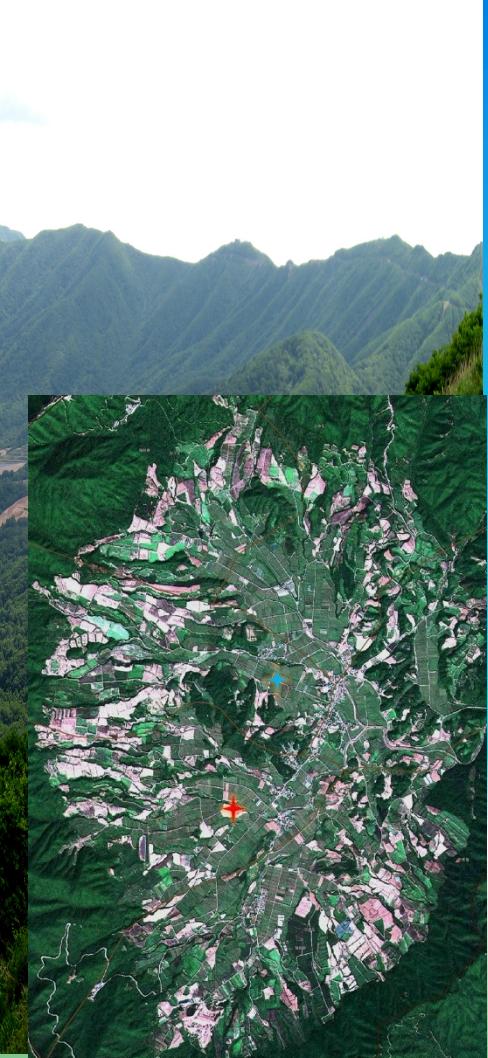
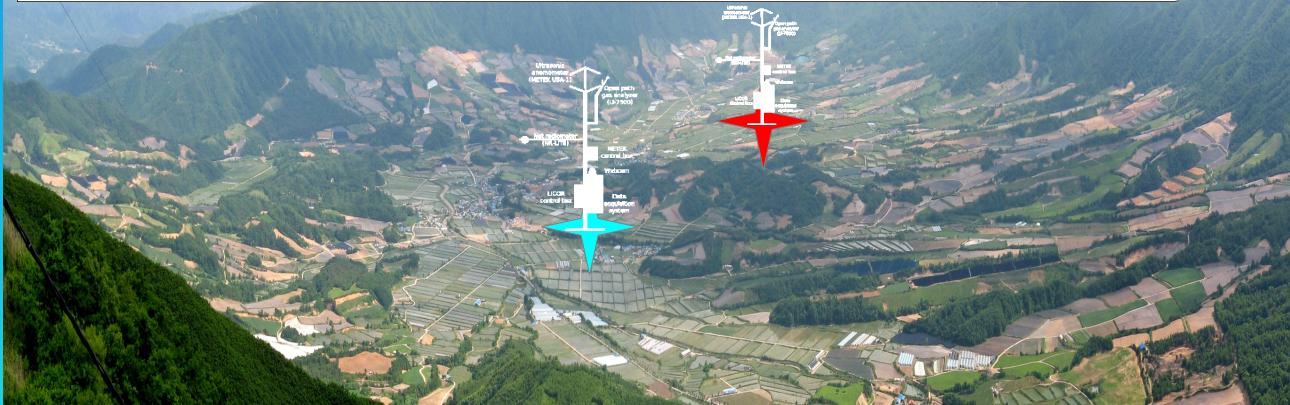
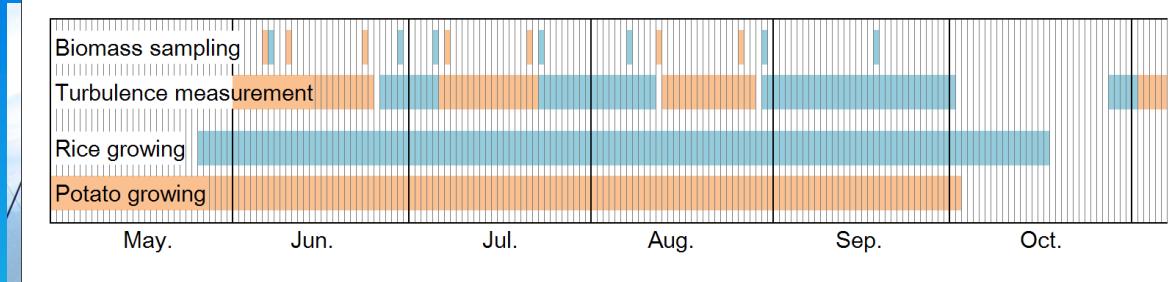
Seasonal response

Human activities

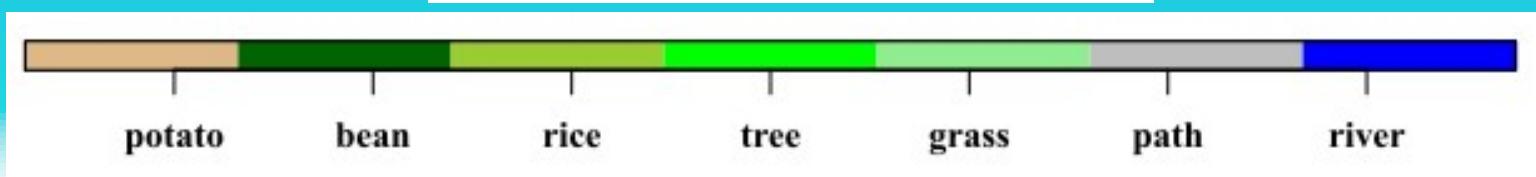
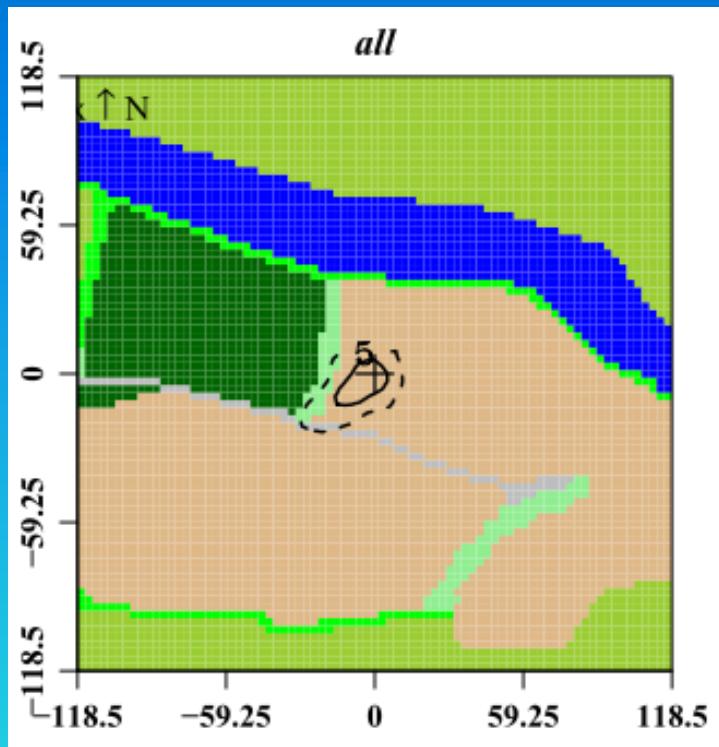
Monsoon and typhoons



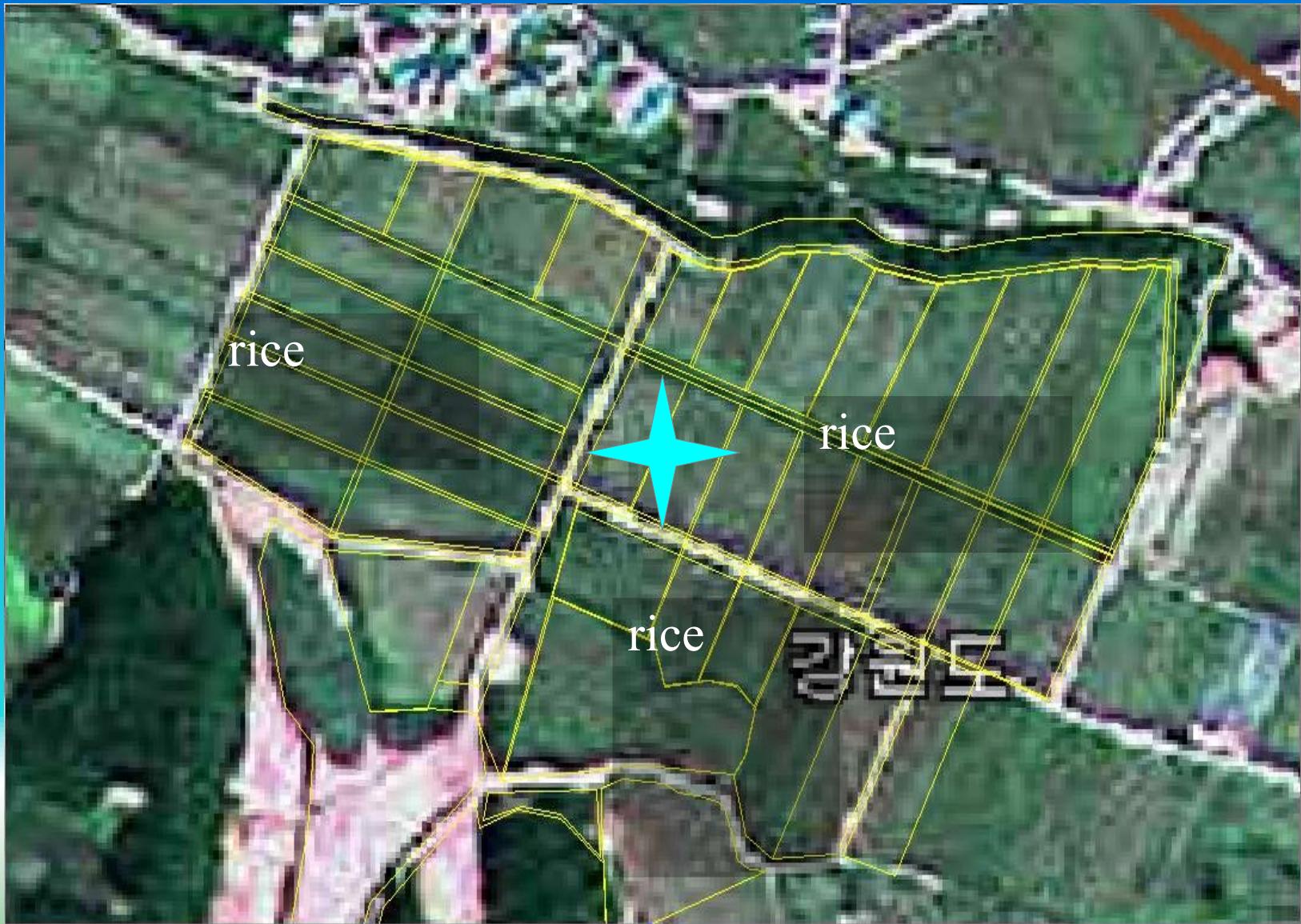
Field campaign 2010

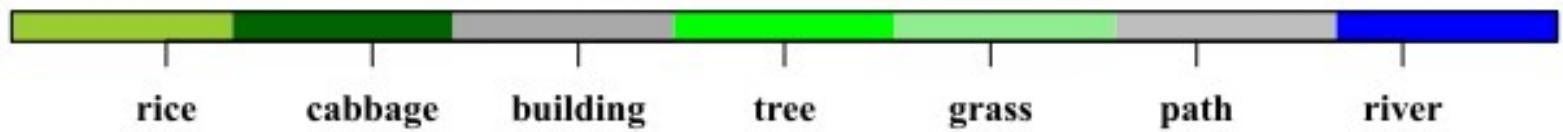
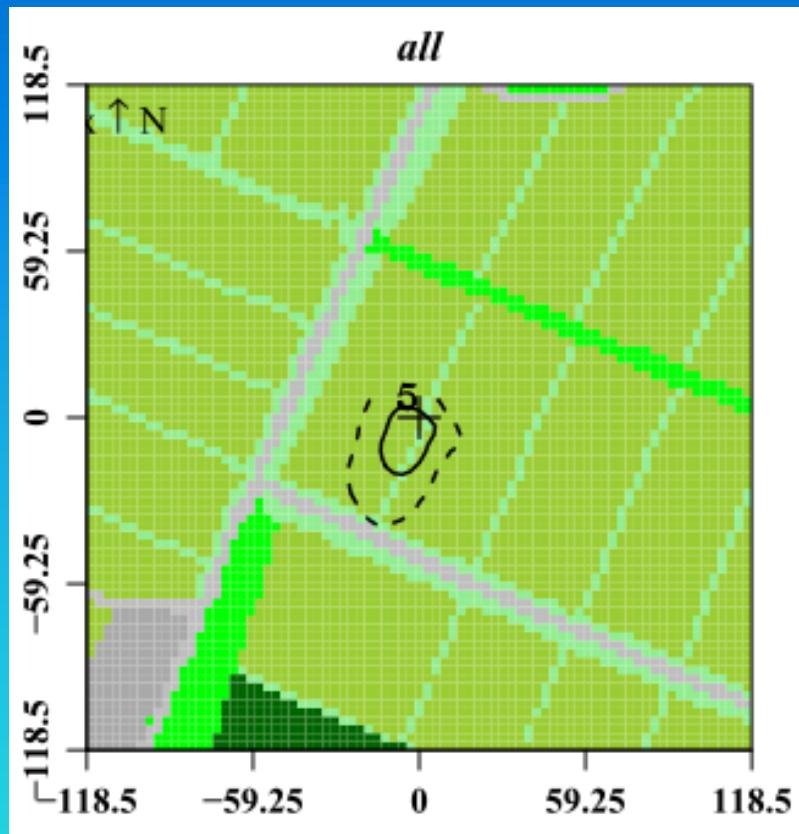






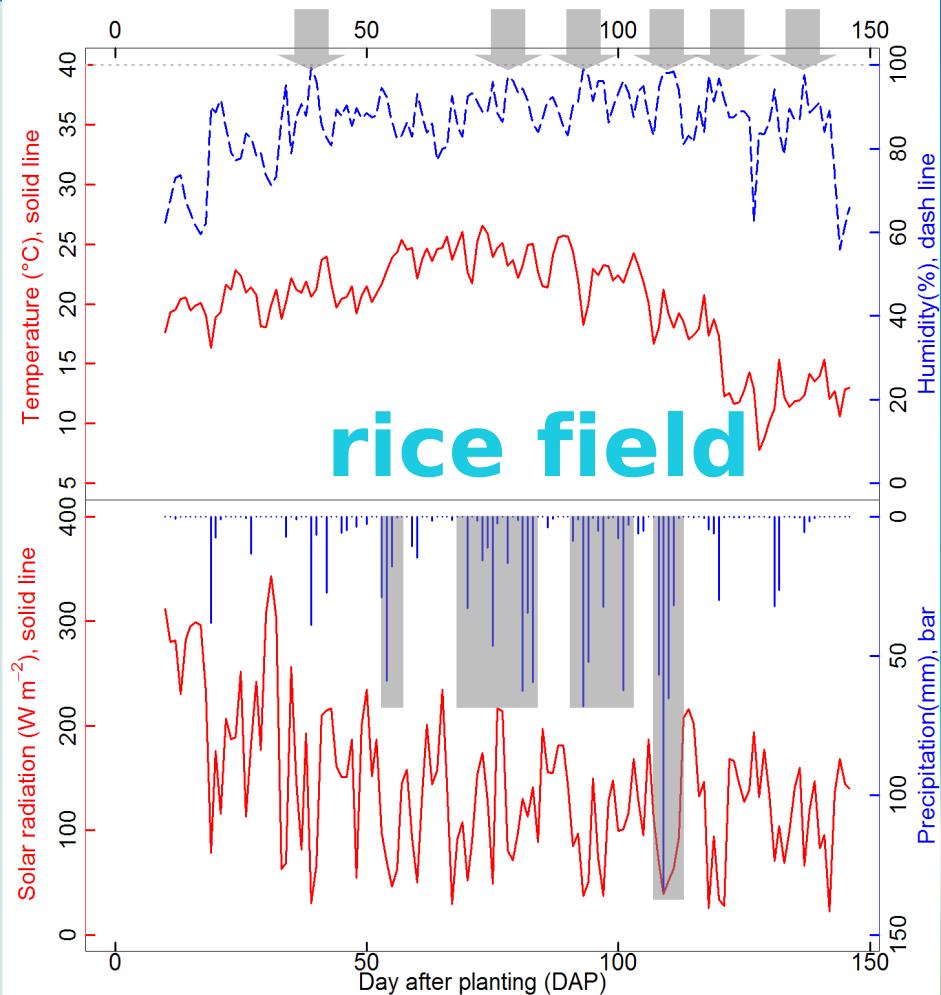
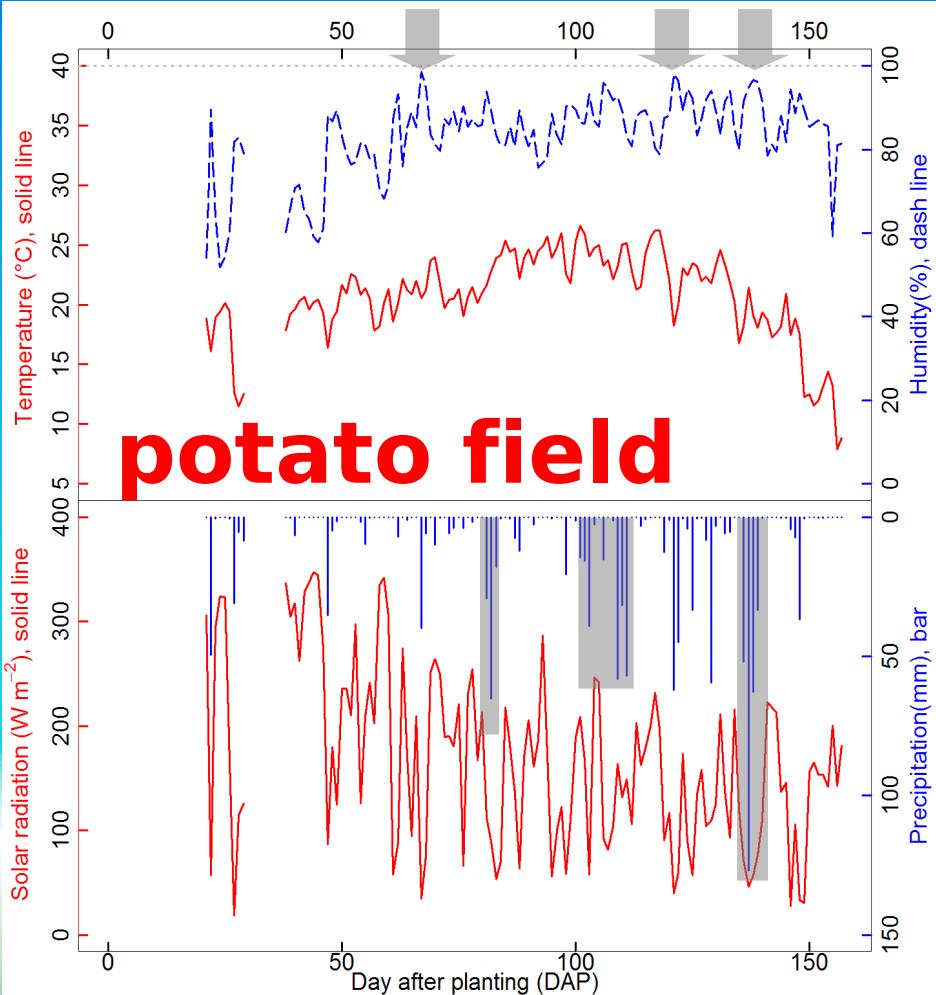
after Göckede et al. (2008)



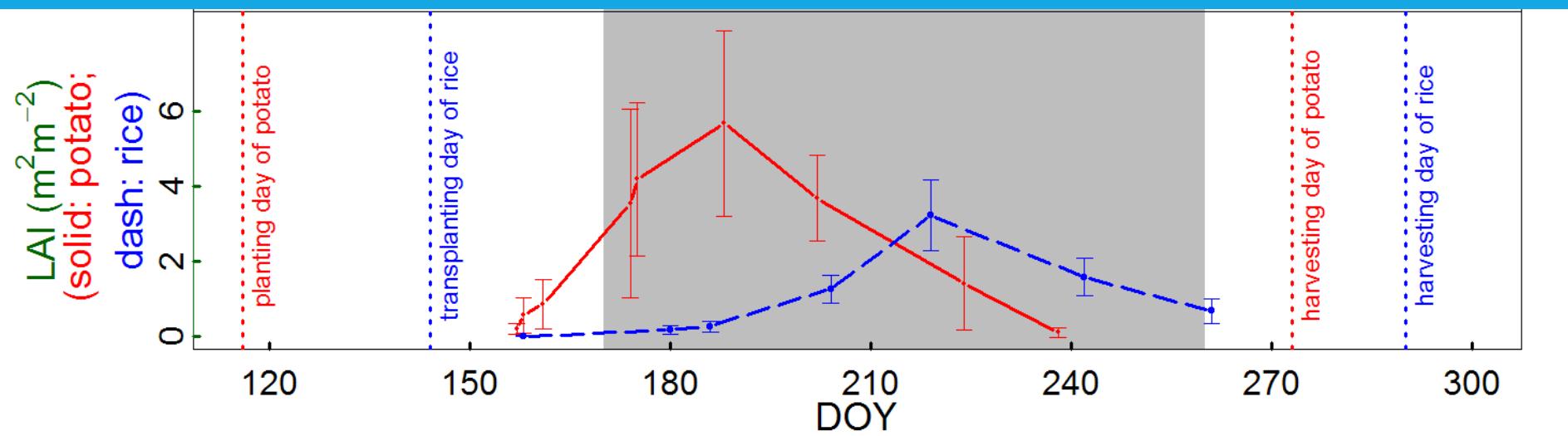


after Göckede et al. (2008)

Monsoon & typhoons



Fast-growing

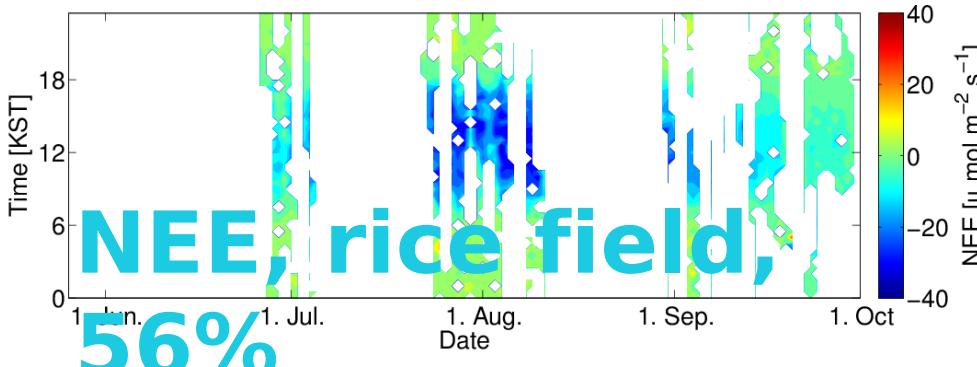
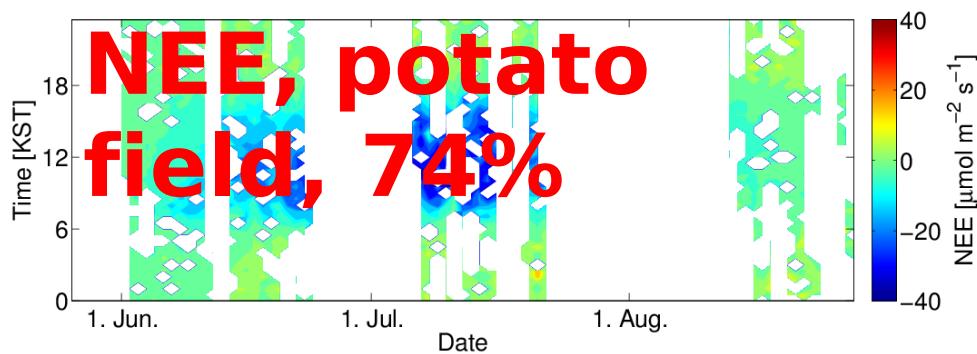


New Multi-Step-Error-Filter

1. All pre-data-processing software already addressed incorrect values will be inherited.
2. Reasonable physical consistency limits for each parameter
3. A quality classification to eliminate certain quality classes
4. (optional) A Status-or-Threshold-Value (STV) filter to mark certain periods
 - information from a Present Weather Detector (to detect rain or snow periods),
 - a wind speed/direction classification,
 - a footprint information (e.g. percentage of the target area), or
 - a diagnostic value like the combined AGC-value of the LI-7500
5. A statistical outlier check
 - quantile check
 - standard deviation filter
6. (optional) Detected single or double outliers can be directly gap-filled using a short window linear interpolation.

Gaps in data-set

Data acquisition after overall quality control
(Foken et al., 2004) and outlier check



Gap-filling methods

- Mean Diurnal Variation
- Look-Up Table
- Non-linear regression
- Other methods, e.g. artificial neural networks

Aubinet et al. 2000
Falge et al., 2001
Moffat et al. 2007

Driving factors of NEE

$$\beta^* = \begin{cases} \beta_0^* e^{-k(VPD-VPD_0)} & , VPD > VPD_0 \\ \beta_0^* & , VPD \leq VPD_0 \end{cases}$$

Lasslop et al., 2010

5

Q: dry and irrigated farmland?

Vapor pressure deficit (VPD)

other

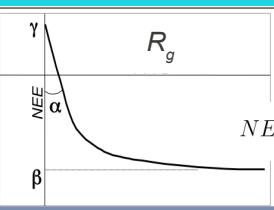
NEE

Seasonal

3

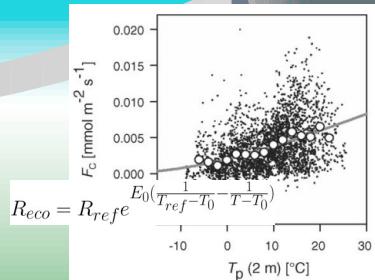
- Time windows
Q: 16 days, 8 days, 4 days, 2 days?
- When no observation available

4

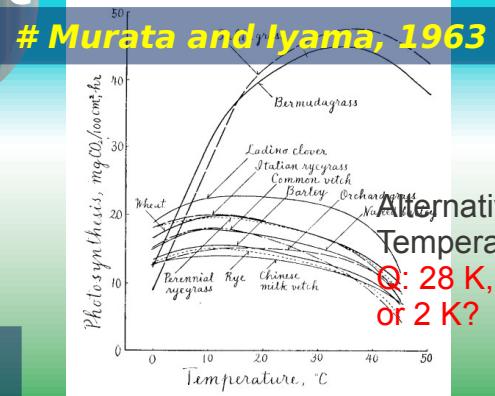


Michaelis and Menten, 1913
Falge et al., 2001

$$1 \quad GPP = \frac{\alpha R_g \beta}{\alpha R_g + \beta}$$



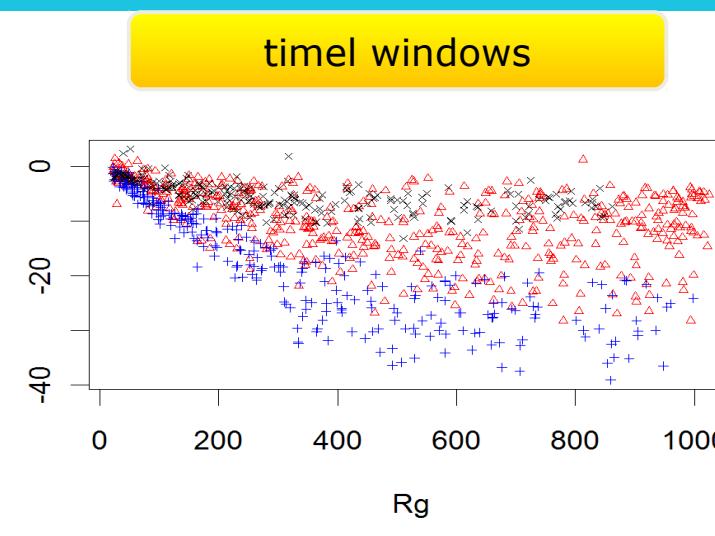
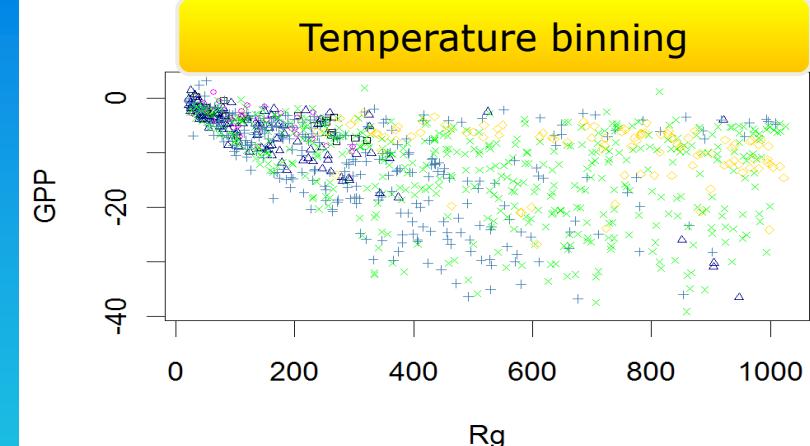
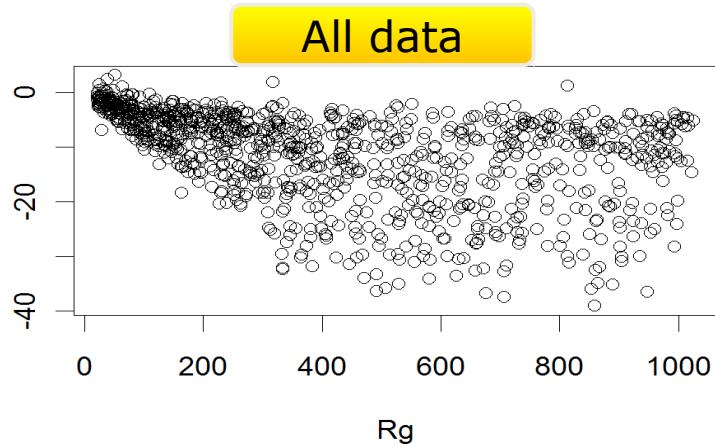
Lloyd and Taylor, 1994
Ruppert et al., 2006



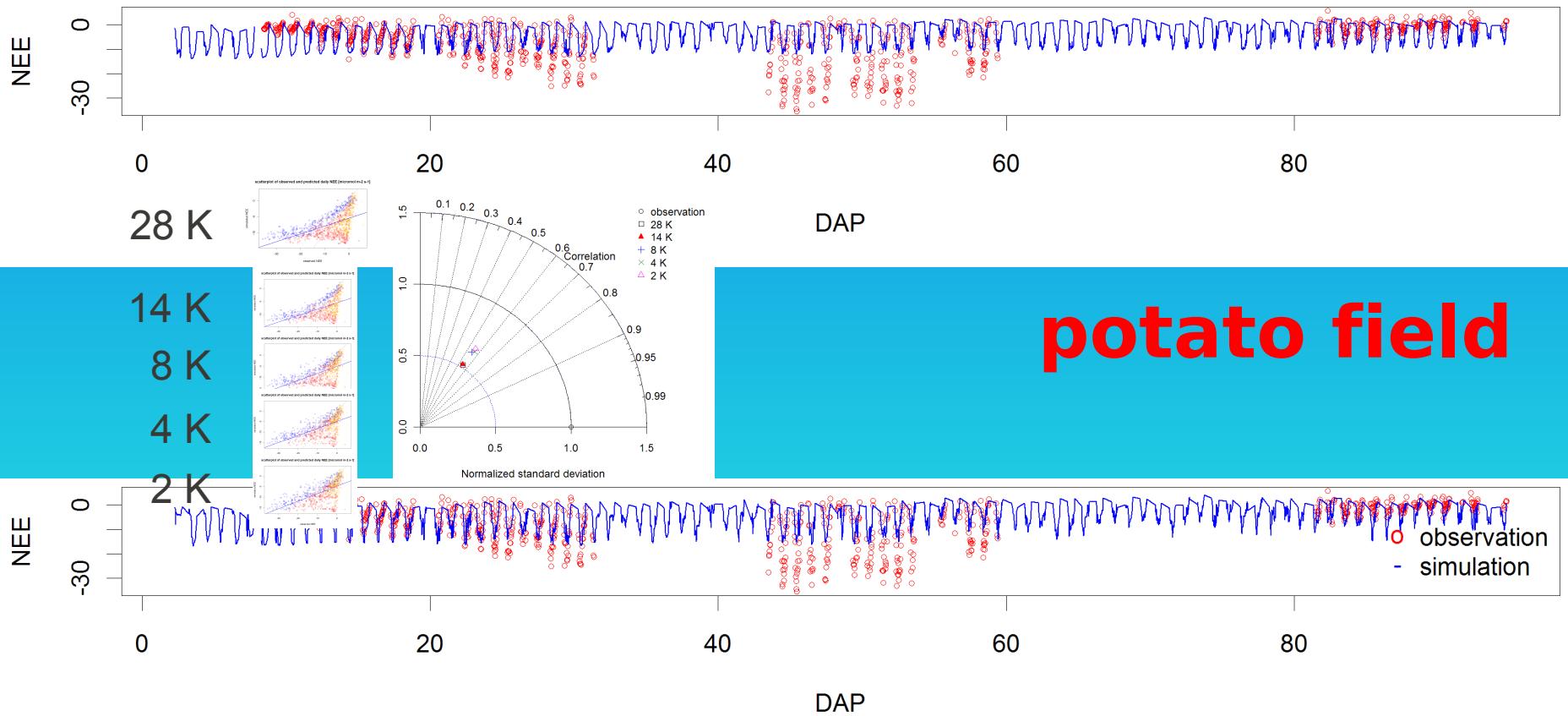
Alternative:
Temperature binning
Q: 28 K, 14 K, 8 K, 4 K
or 2 K?

2

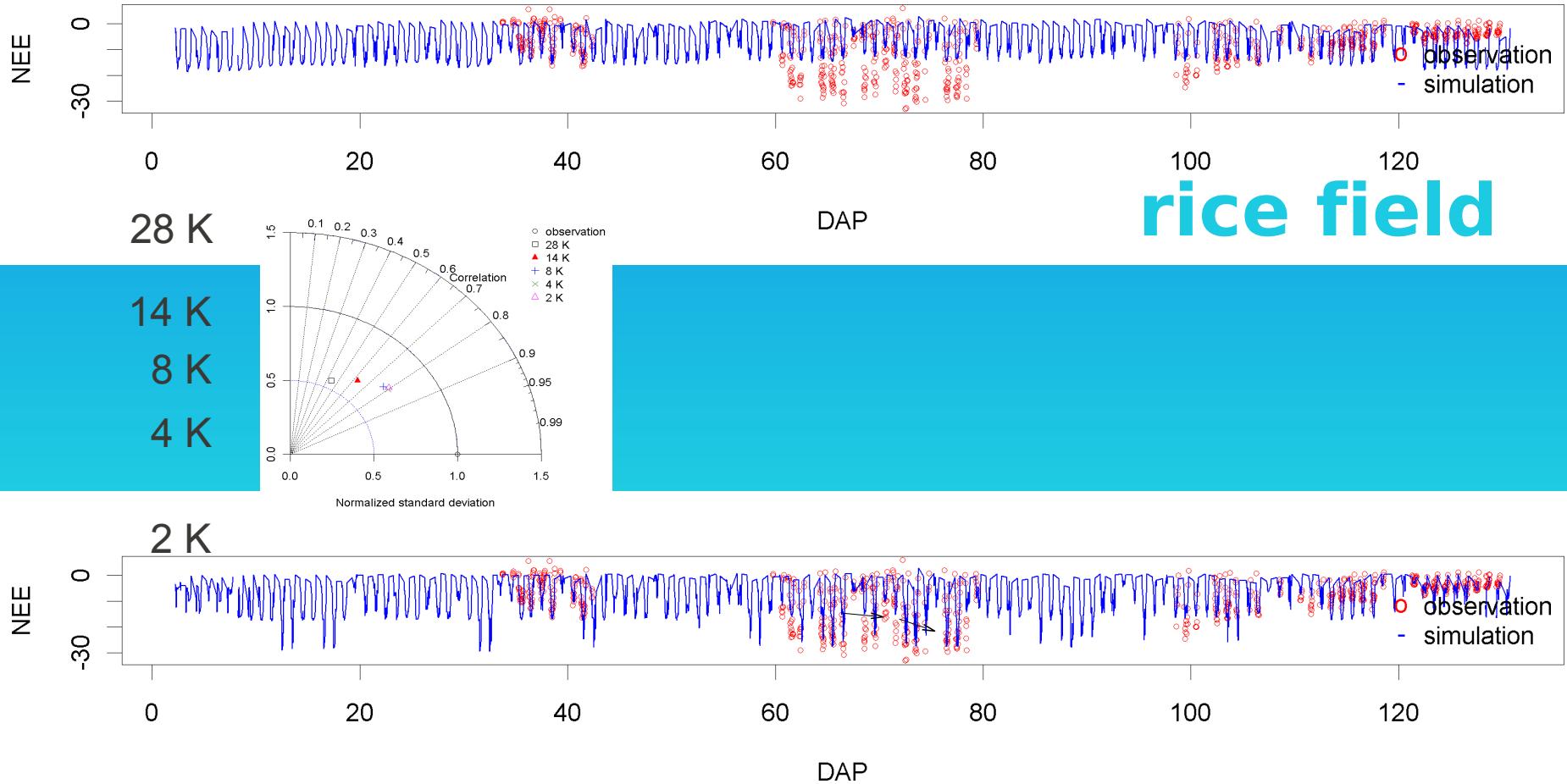
Data grouping



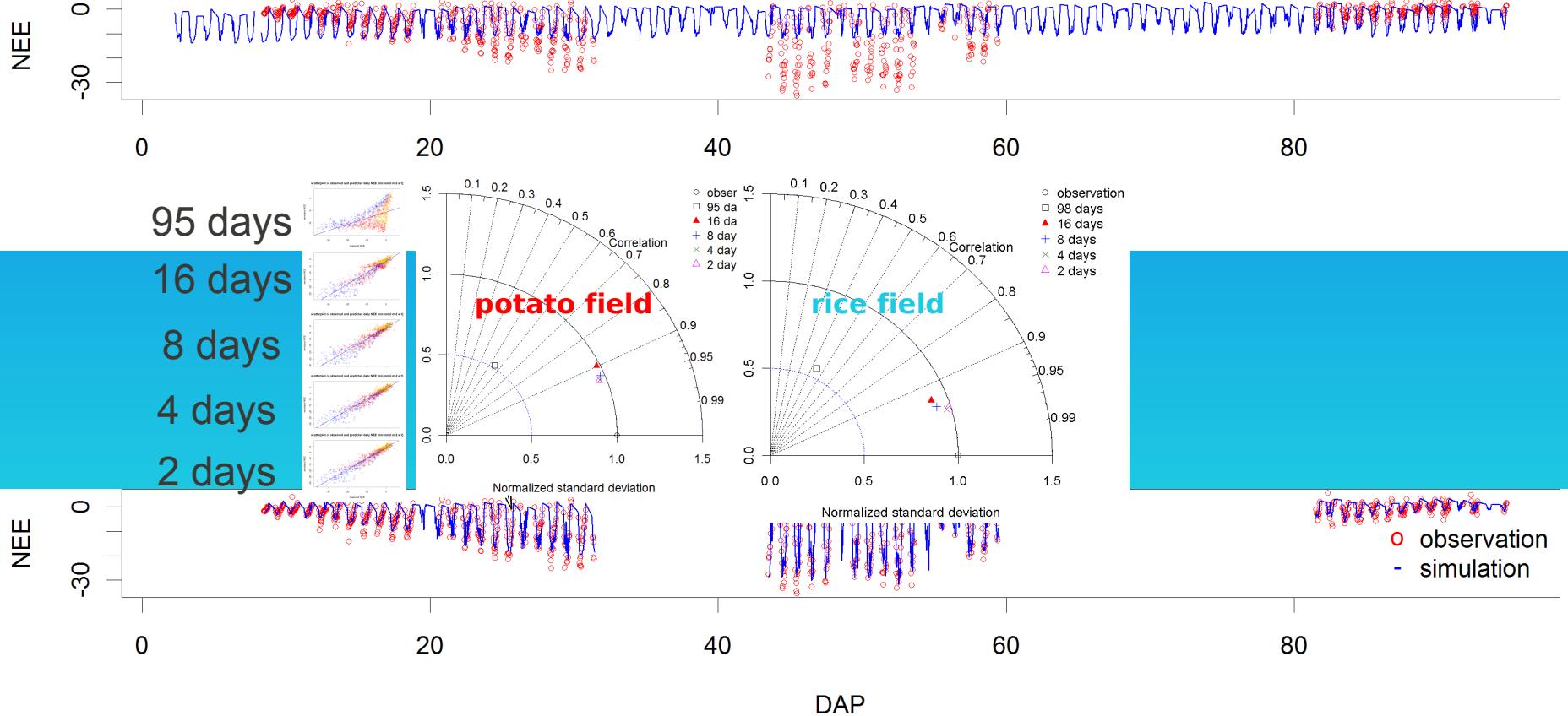
Temperature binning



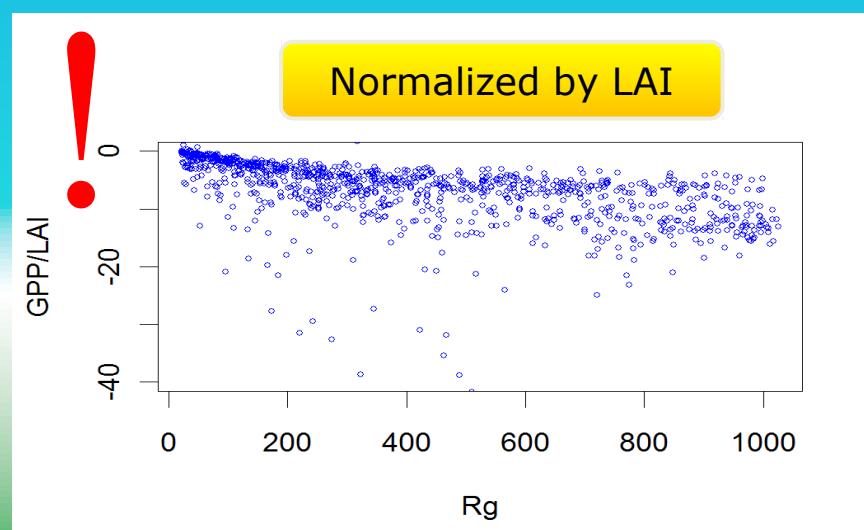
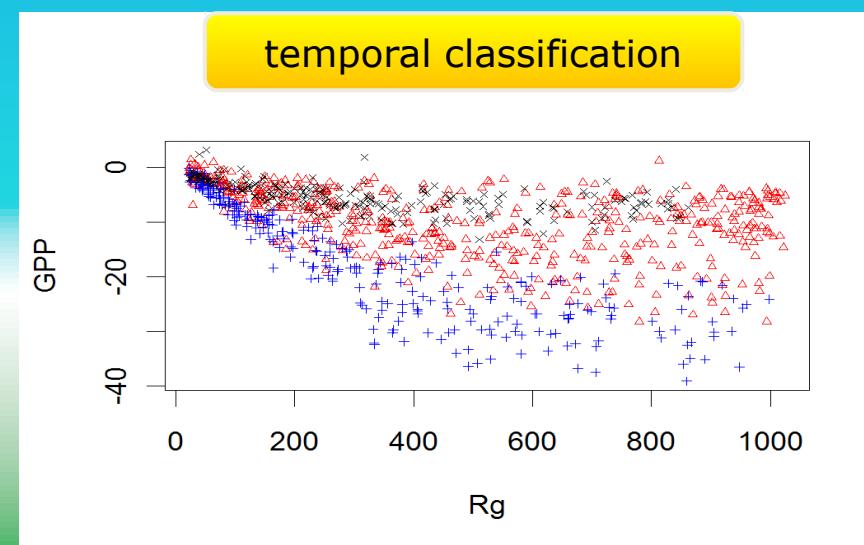
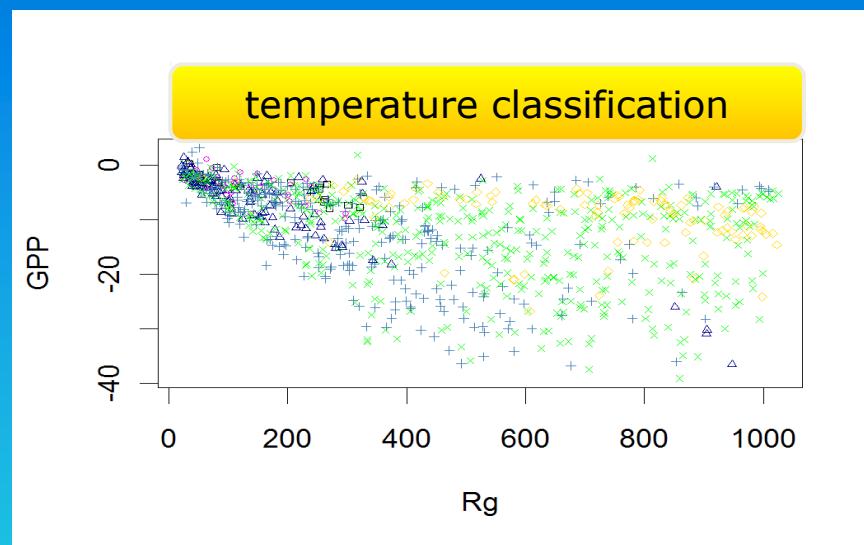
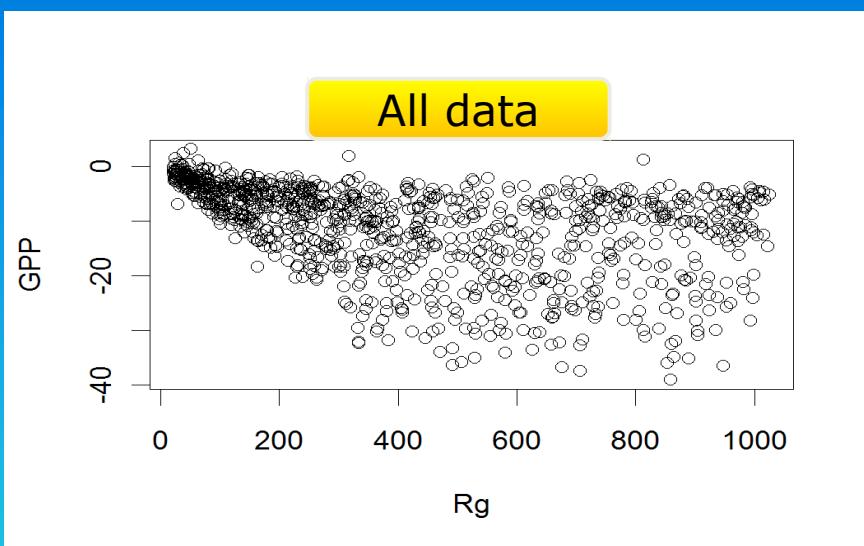
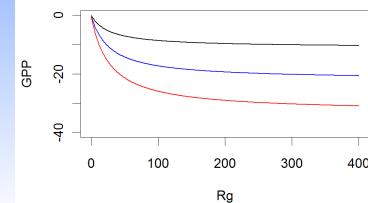
Temperature binning



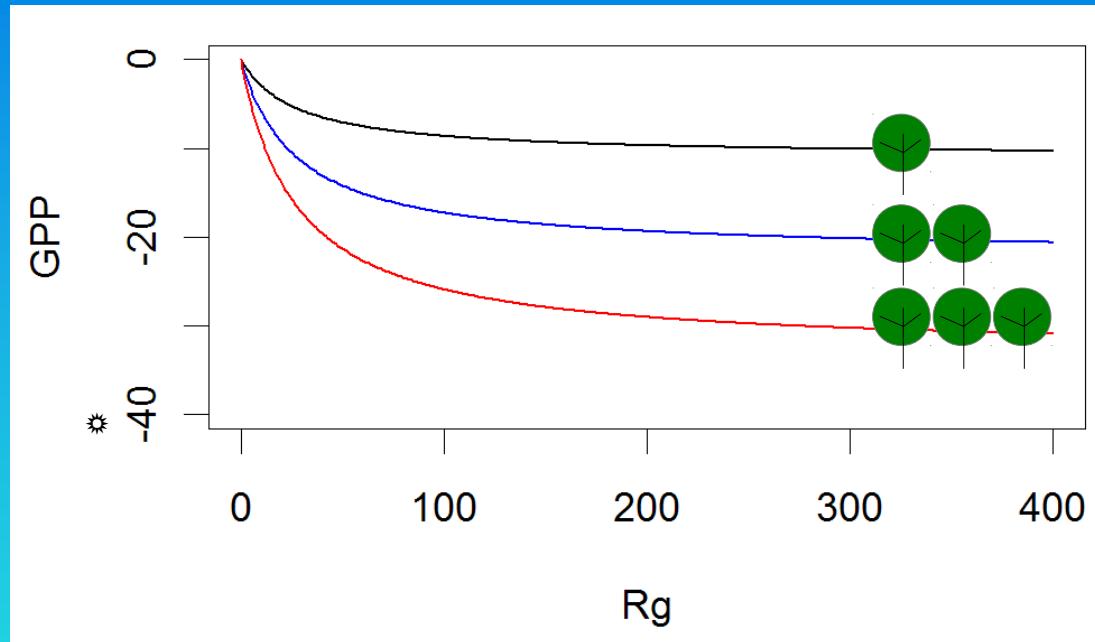
Time windows



Data classification



LAI factor



$$GPP = \frac{\alpha R_g \beta}{\alpha R_g + \beta}$$



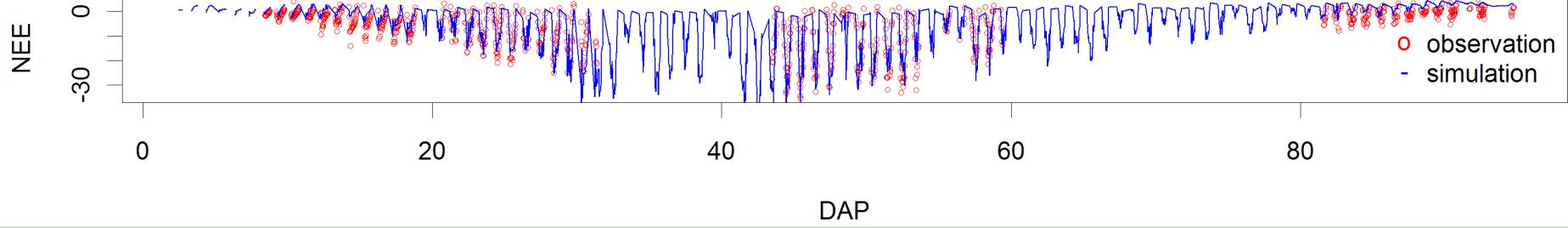
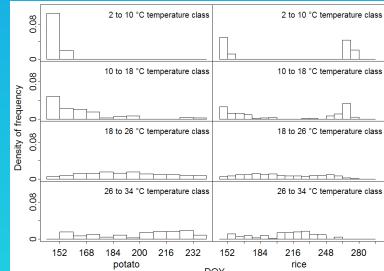
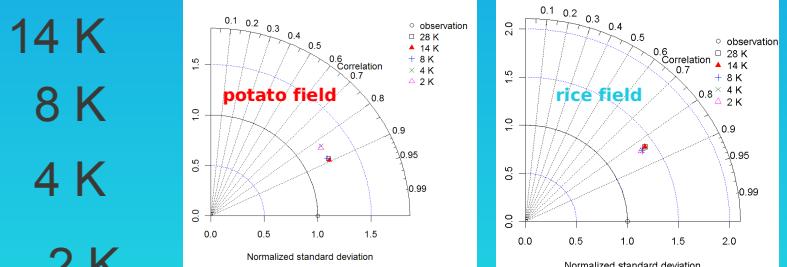
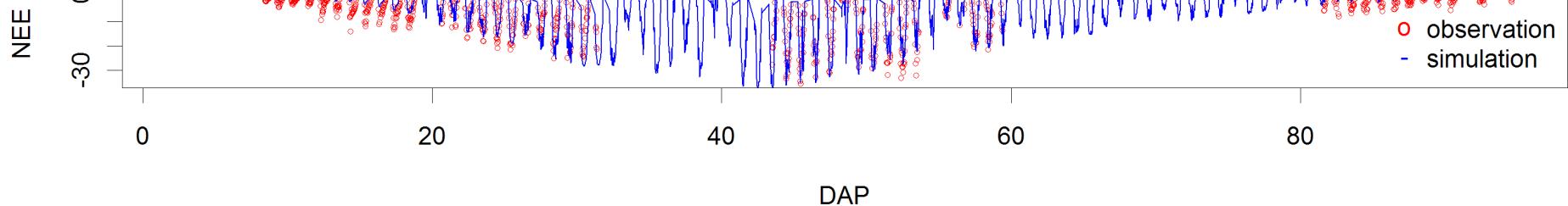
$$\frac{GPP}{LAI} = \frac{\frac{\alpha}{LAI} R_g \frac{\beta}{LAI}}{\frac{\alpha}{LAI} R_g + \frac{\beta}{LAI}}$$

$$GPP' = GPP / LAI$$
$$\alpha' = \alpha / LAI$$
$$\beta' = \beta / LAI$$

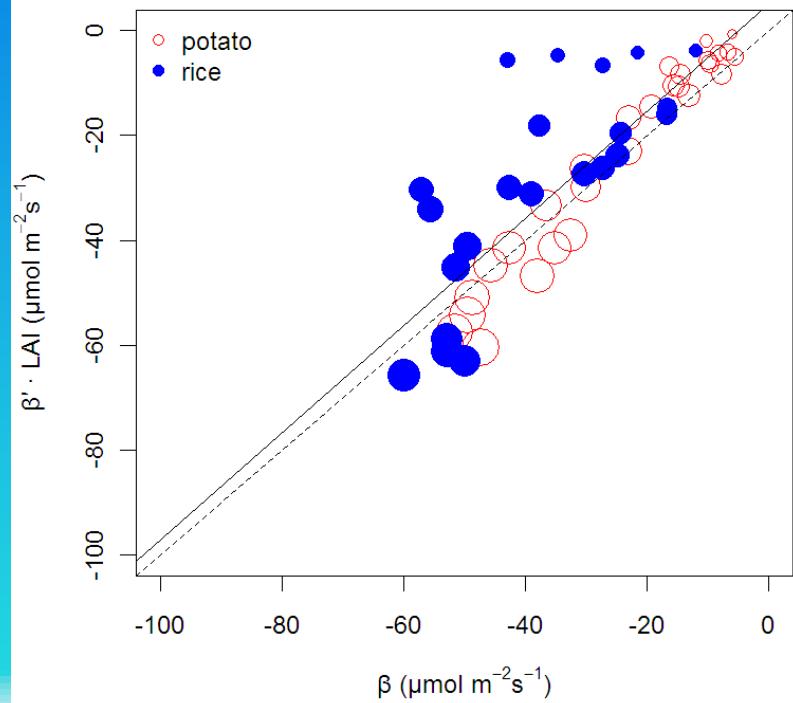
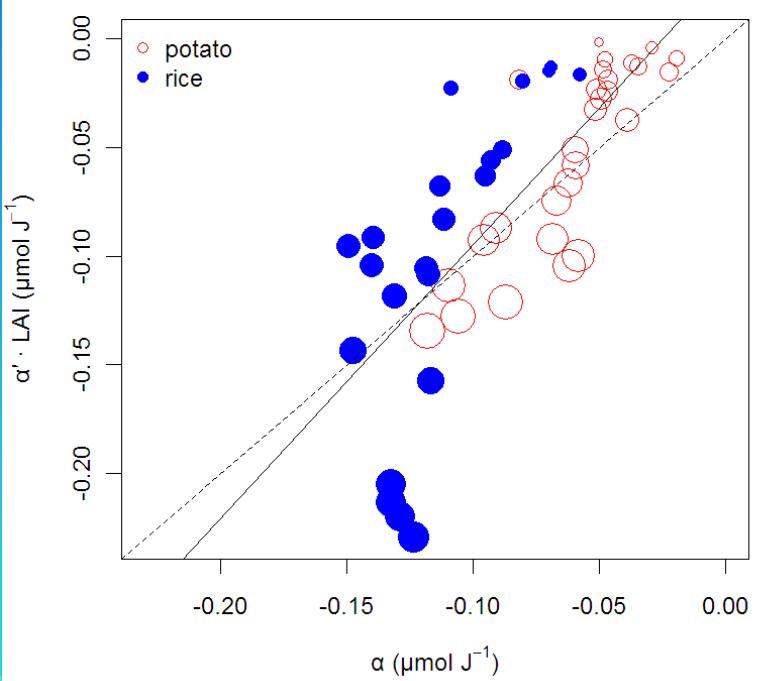


$$GPP' = \frac{\alpha' R_g \beta'}{\alpha' R_g + \beta'}$$

LAI factor



LAI factor VS time windows



$$GPP' = \frac{\alpha' R_g \beta'}{\alpha' R_g + \beta'}$$

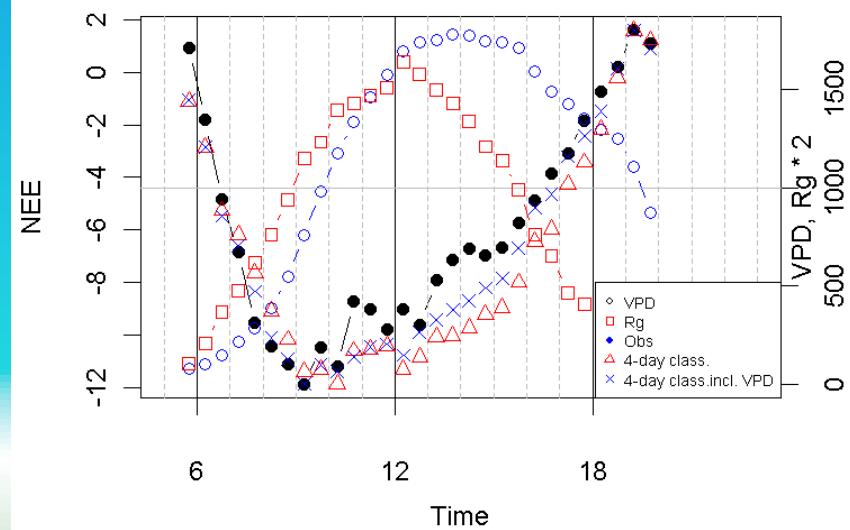
$$\alpha' = \alpha / LAI$$

$$\beta' = \beta / LAI$$

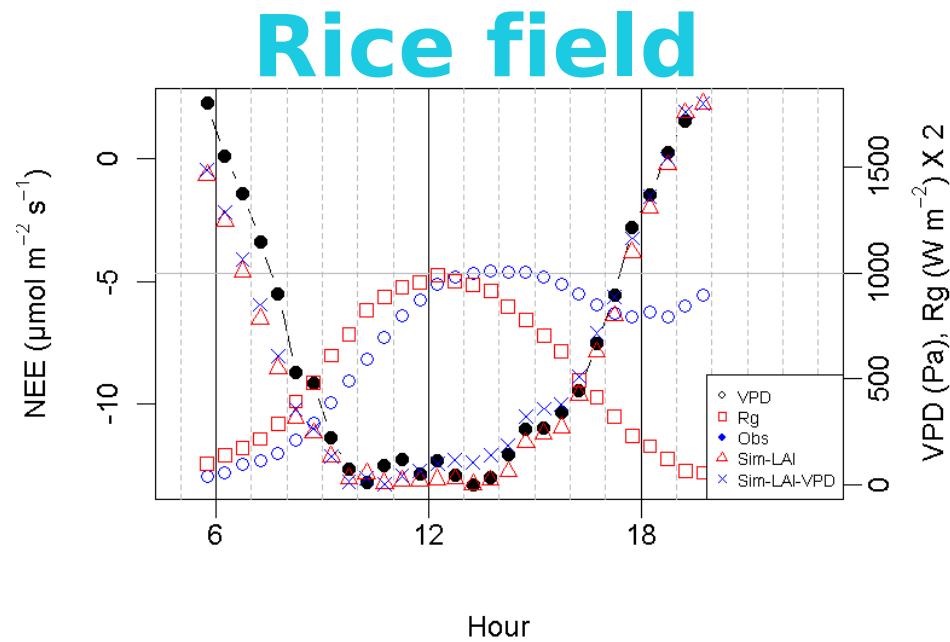
- 😊 sufficient data
for regression
- 😊 large gaps
- 😢 sampling
- 😢 interpolation
- 😢 foliar clumping

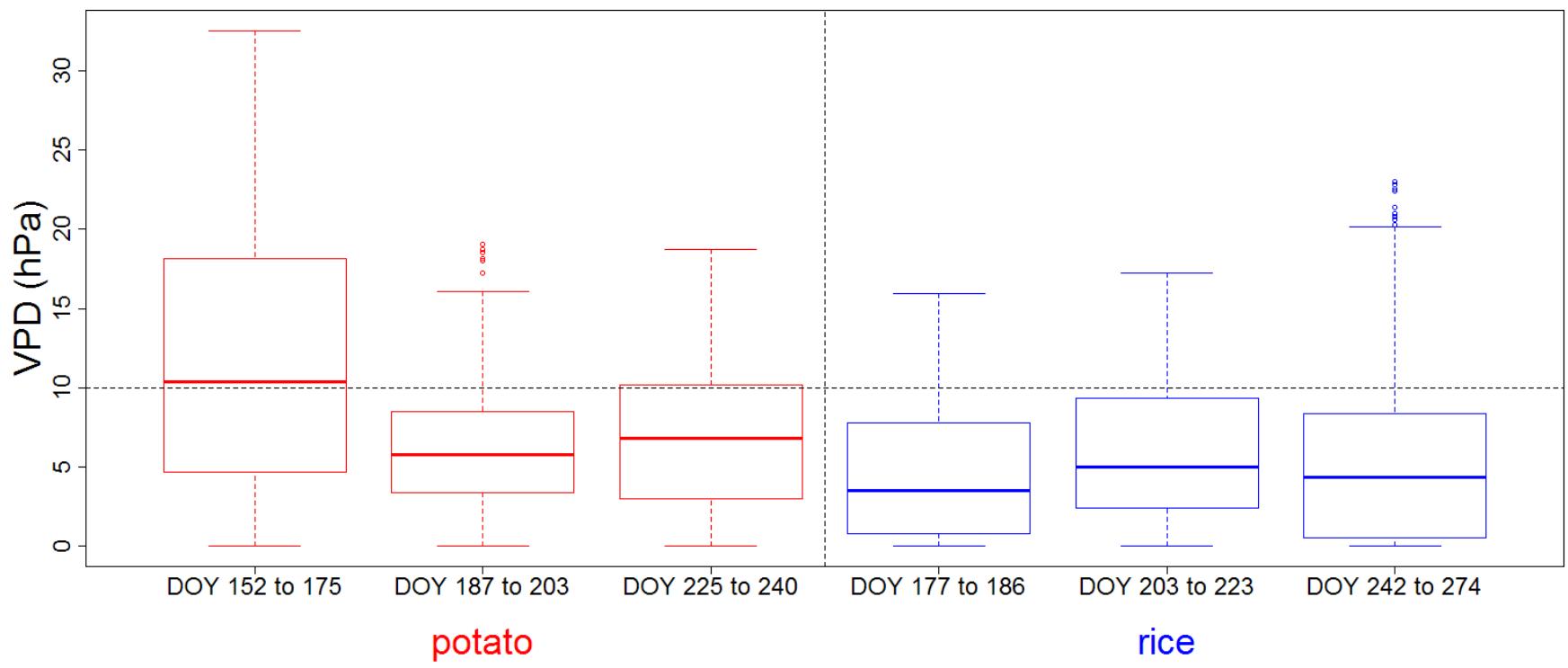
Mean diurnal cycle

Potato field



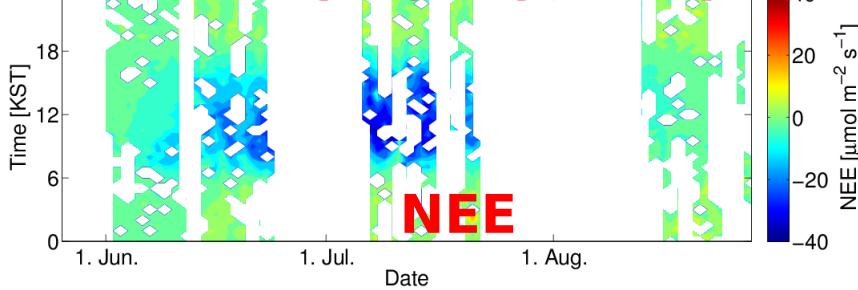
Rice field



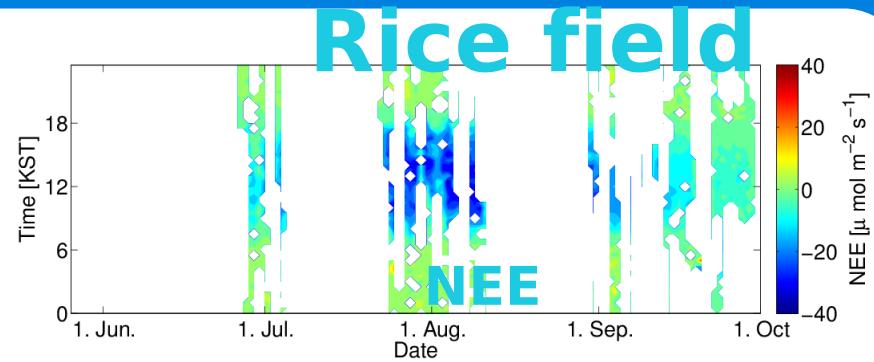


Fluxes: observed

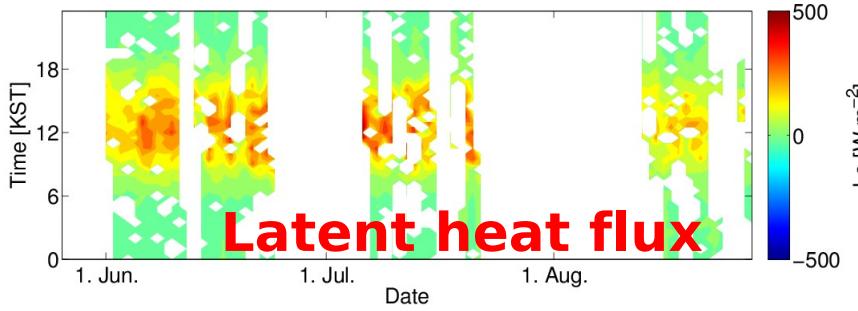
Potato field



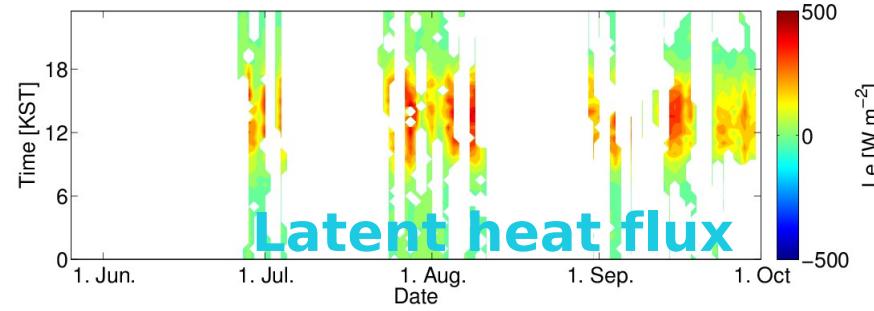
Rice field



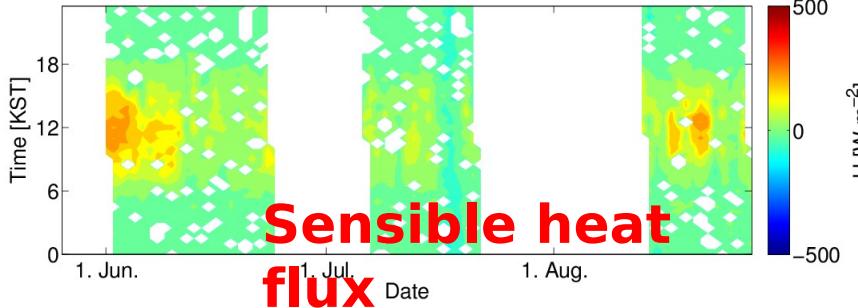
Latent heat flux



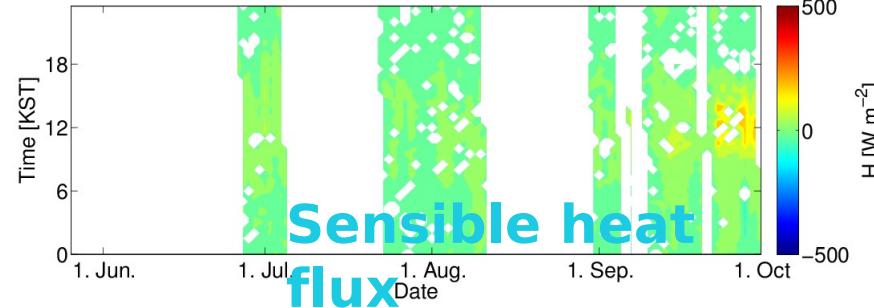
Latent heat flux



Sensible heat flux

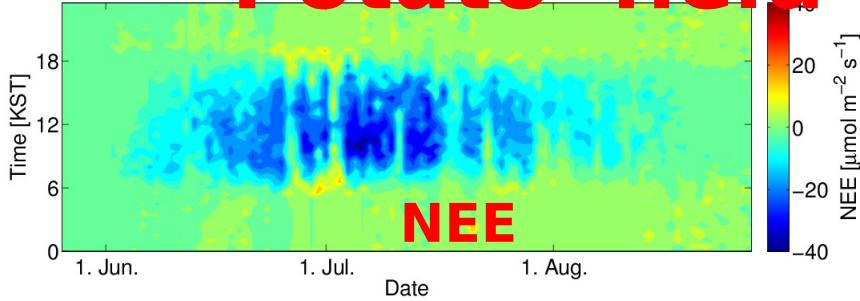


Sensible heat flux

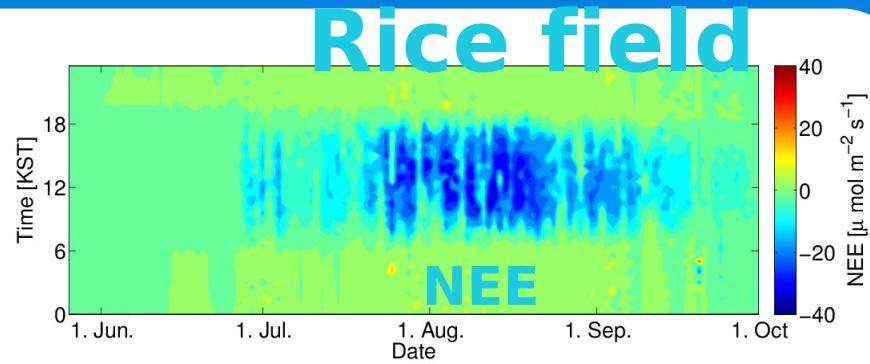


Fluxes: gap-filled

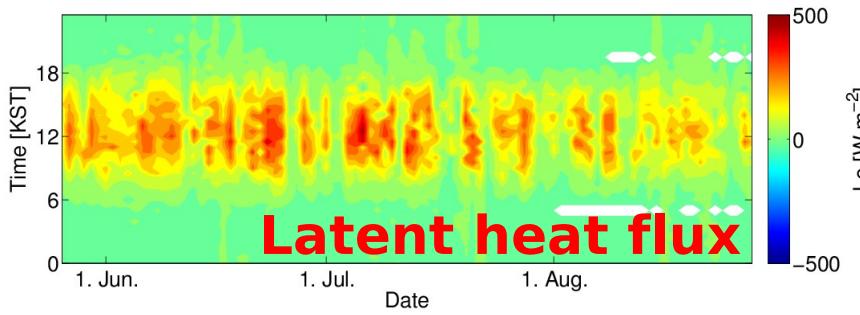
Potato field



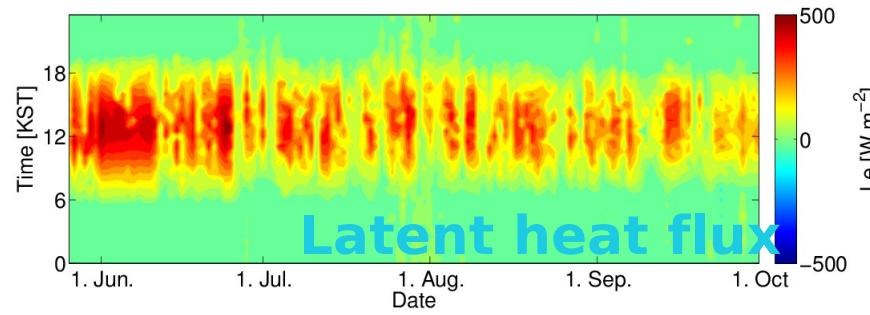
Rice field



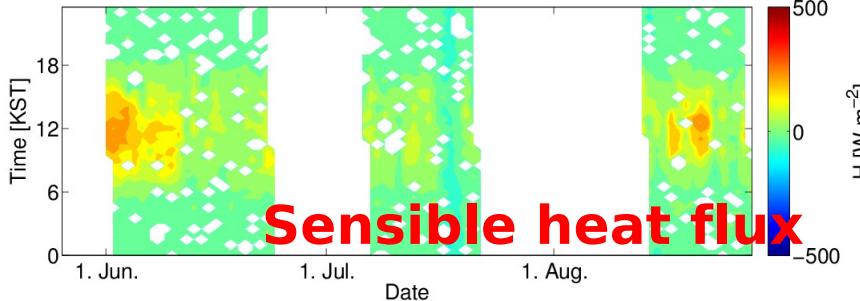
Latent heat flux



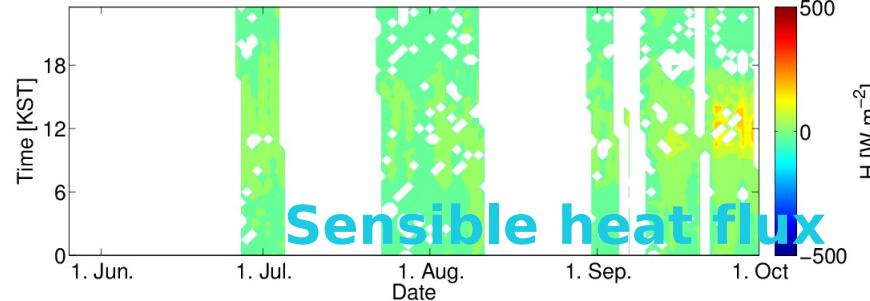
Latent heat flux

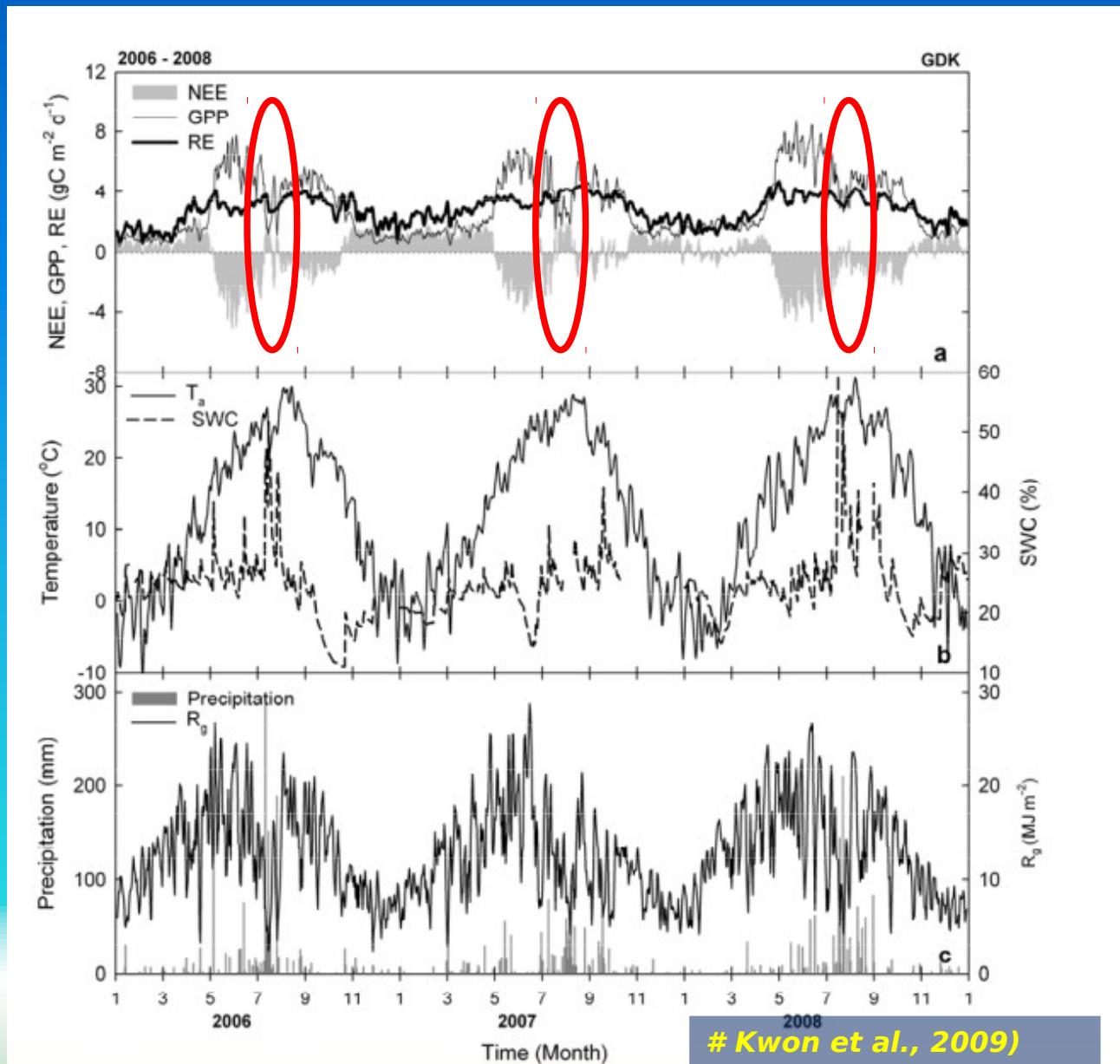


Sensible heat flux

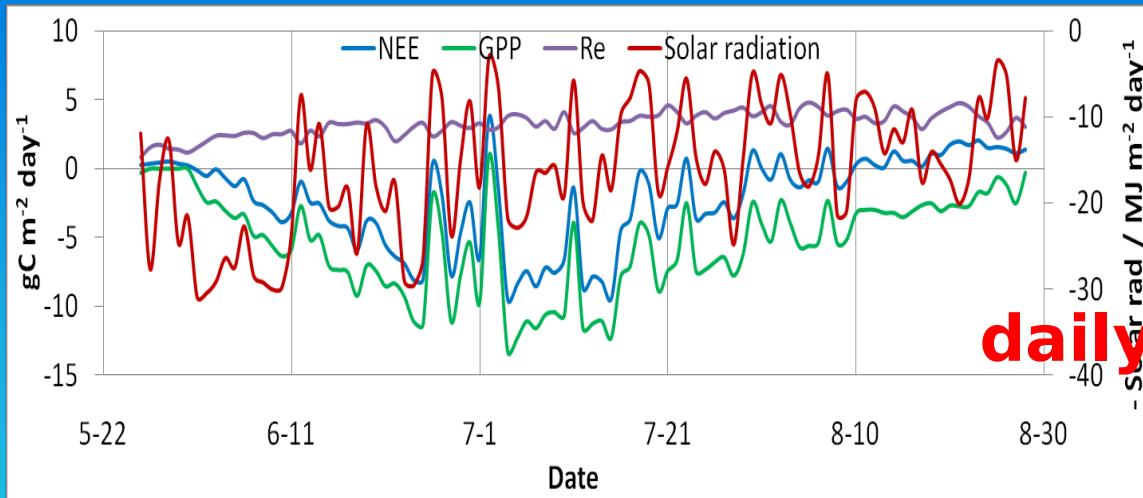


Sensible heat flux

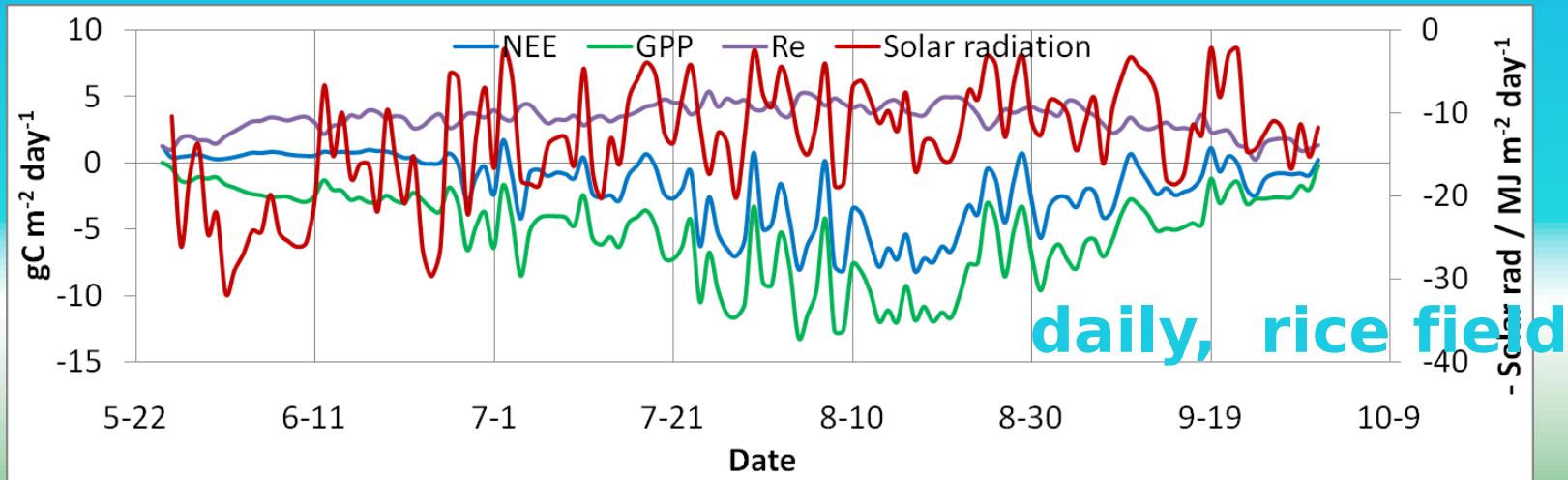




Daily mean



daily, potato field



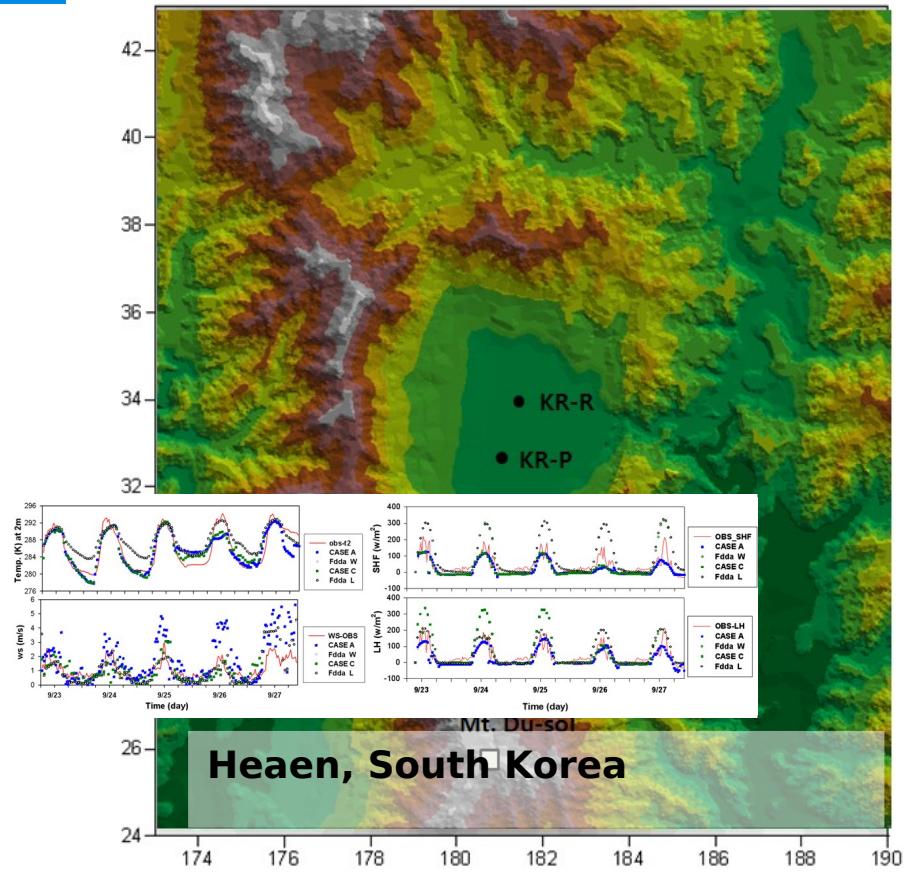
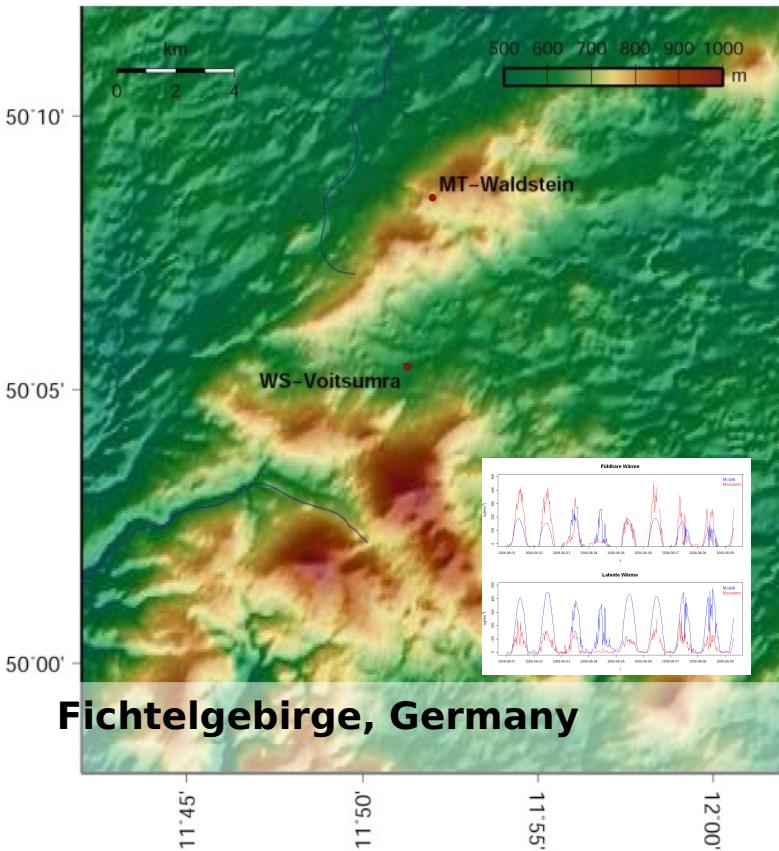
daily, rice field

Diffuse rad. VS direct rad.

- diffuse radiation
 - more efficiently used by plants
 - rarely reaches saturation levels
 - increases with an increase in radiation level
 - influences on plant growth is modified by other environmental factors [e.g., water vapor pressure deficit (VPD), air temperature] during certain times of the day.

Gu et al., 2002
Xing et al., 2007

Comparison of WRF model with observations



A scenic rural landscape featuring a dirt road leading towards distant mountains. To the left is a large, lush green field. To the right, there's dense greenery and a bicycle leaning against a fence. The sky is filled with scattered white and grey clouds.

Thank you for your attention.