

On the additional information content of hyperspectral remote sensing data for estimating ecosystem carbon dioxide and energy exchange

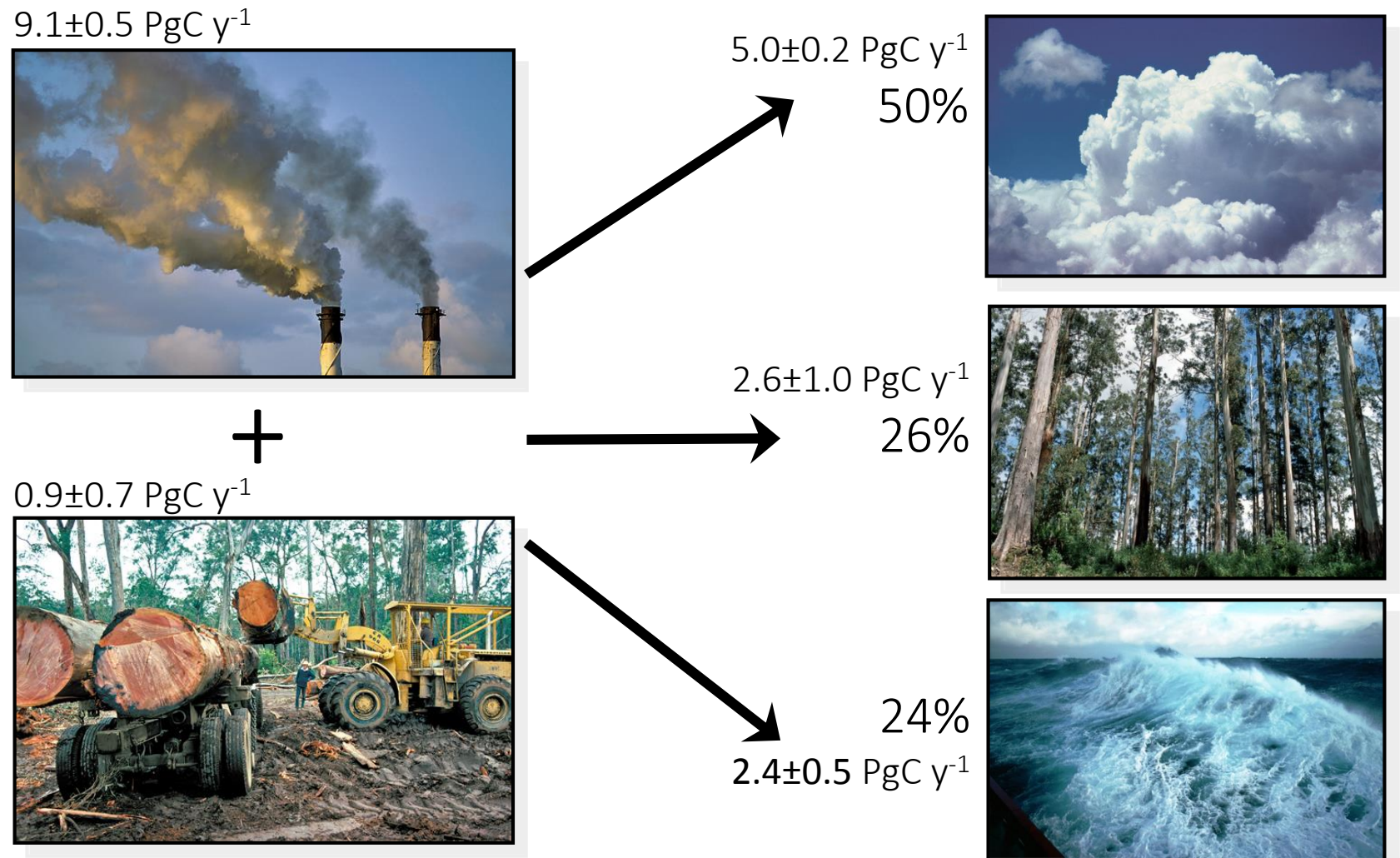
Wohlfahrt G.^{1,2}, **Hammerle A.**¹ & Tomelleri E.²

¹ University of Innsbruck, Institute of Ecology

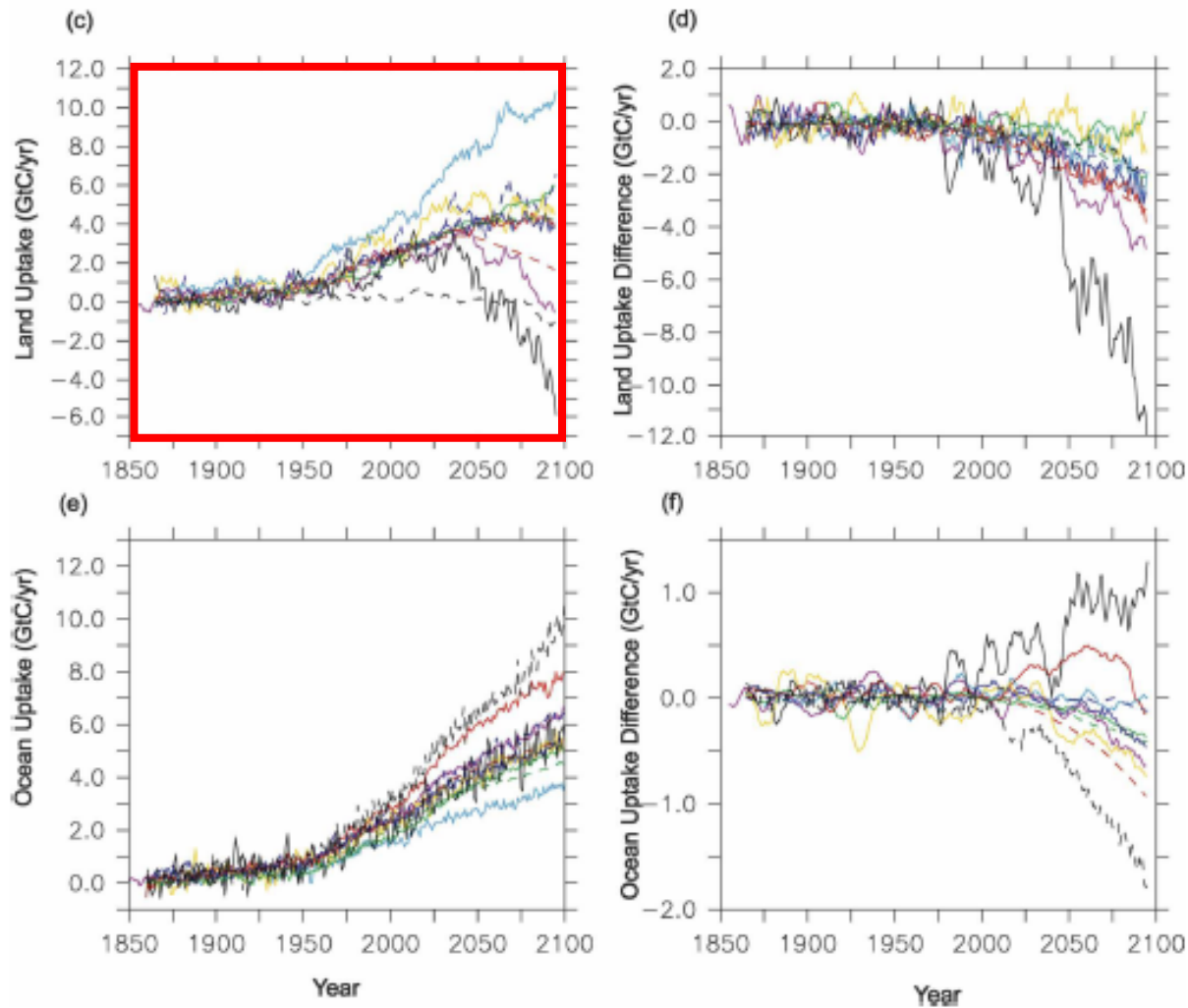
² European Academy Bolzano



Motivation



Motivation



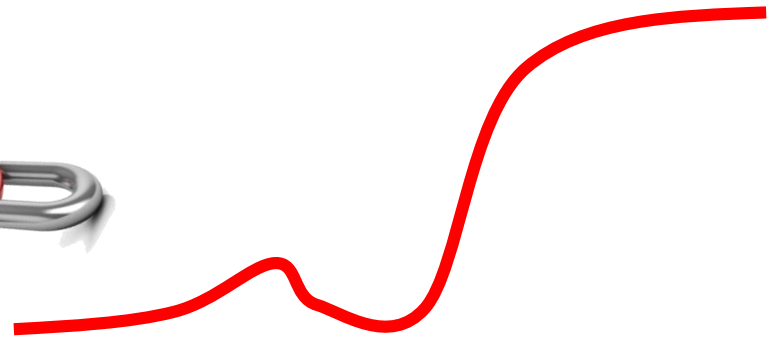
- Key parameters in upscaling: LAI and $A_{\max}$
- Ill-posed problem using NEE data
- Hyperspectral reflectance: info on canopy structure and function

Hypothesis:

- By jointly assimilating hyperspectral VIS and NIR reflectance and eddy covariance CO₂ flux measurements into a combined radiative transfer (RT) and NEE model, model parameters are better constrained.

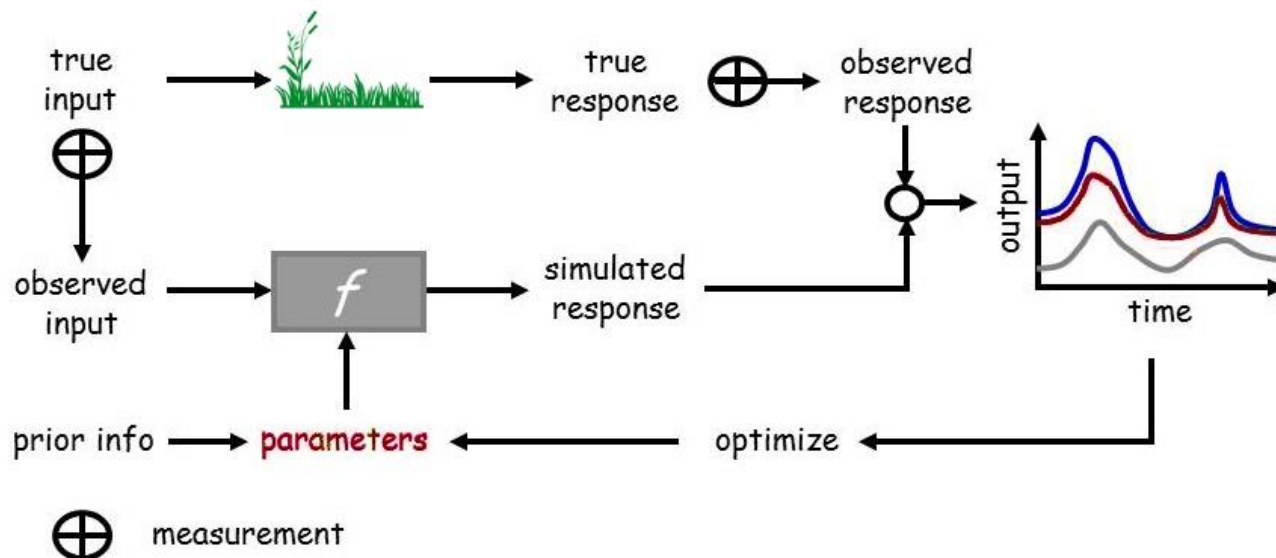
Approach:

- Combined ProSail (Jacquemoud et al. 2009) with a two-leaf big-leaf canopy net photosynthesis model (De Pury & Farquhar 1997).



Approach:

- Use the Bayesian inversion algorithm DREAM (Vrugt et al. 2009) to estimate parameters.



Approach:

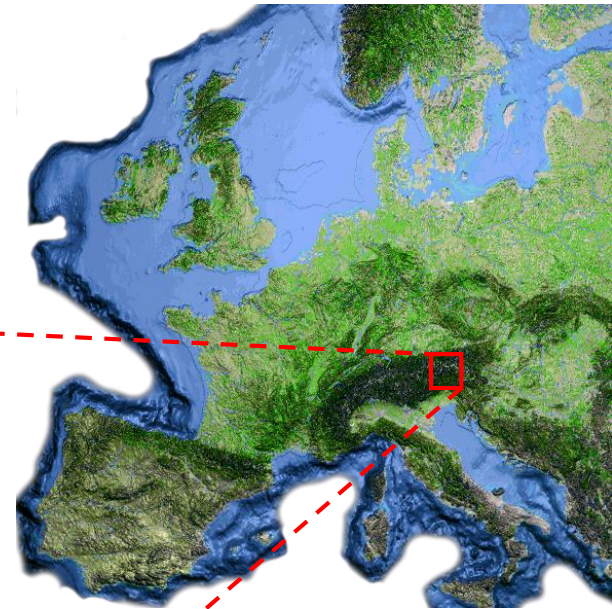
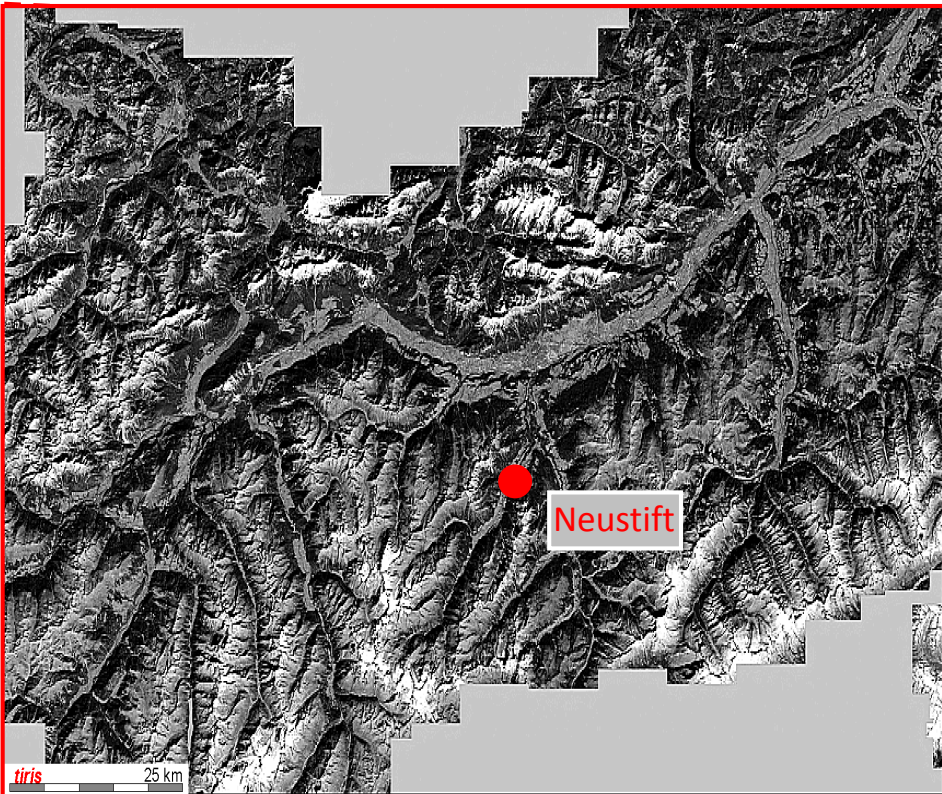
- Three types of inversions:

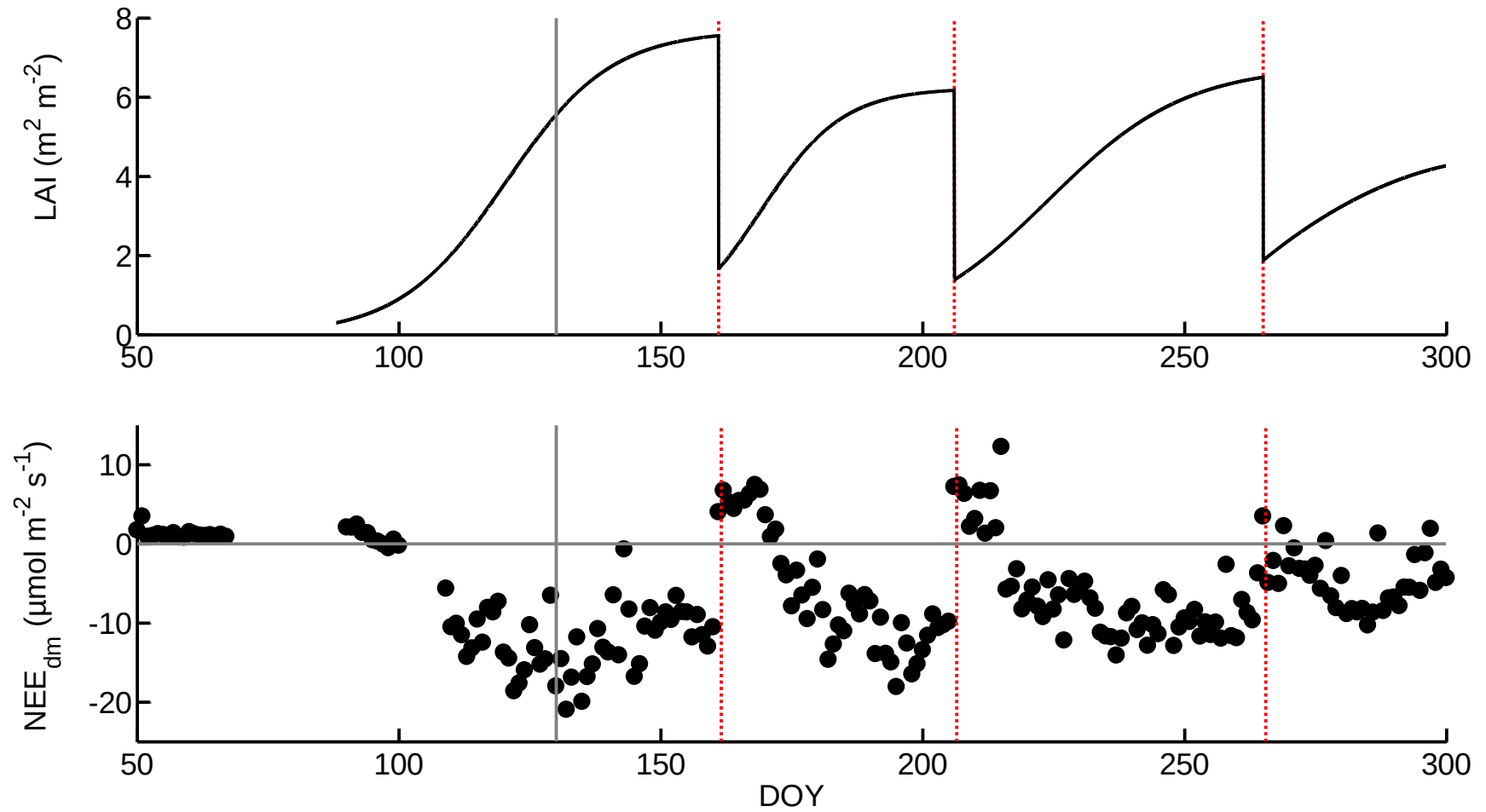
(i) big-leaf only,

(ii) ProSail only,

(iii) big-leaf-ProSail

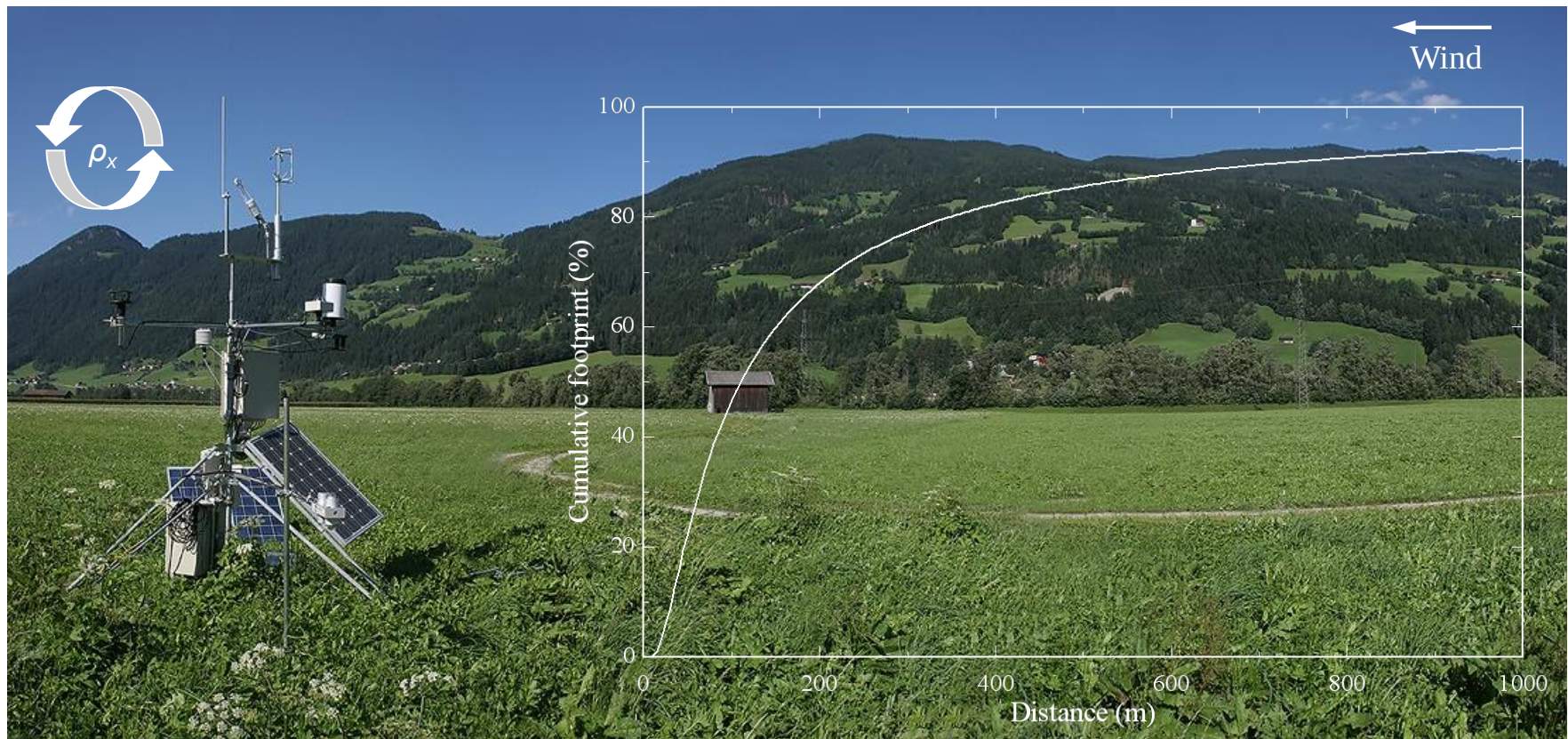


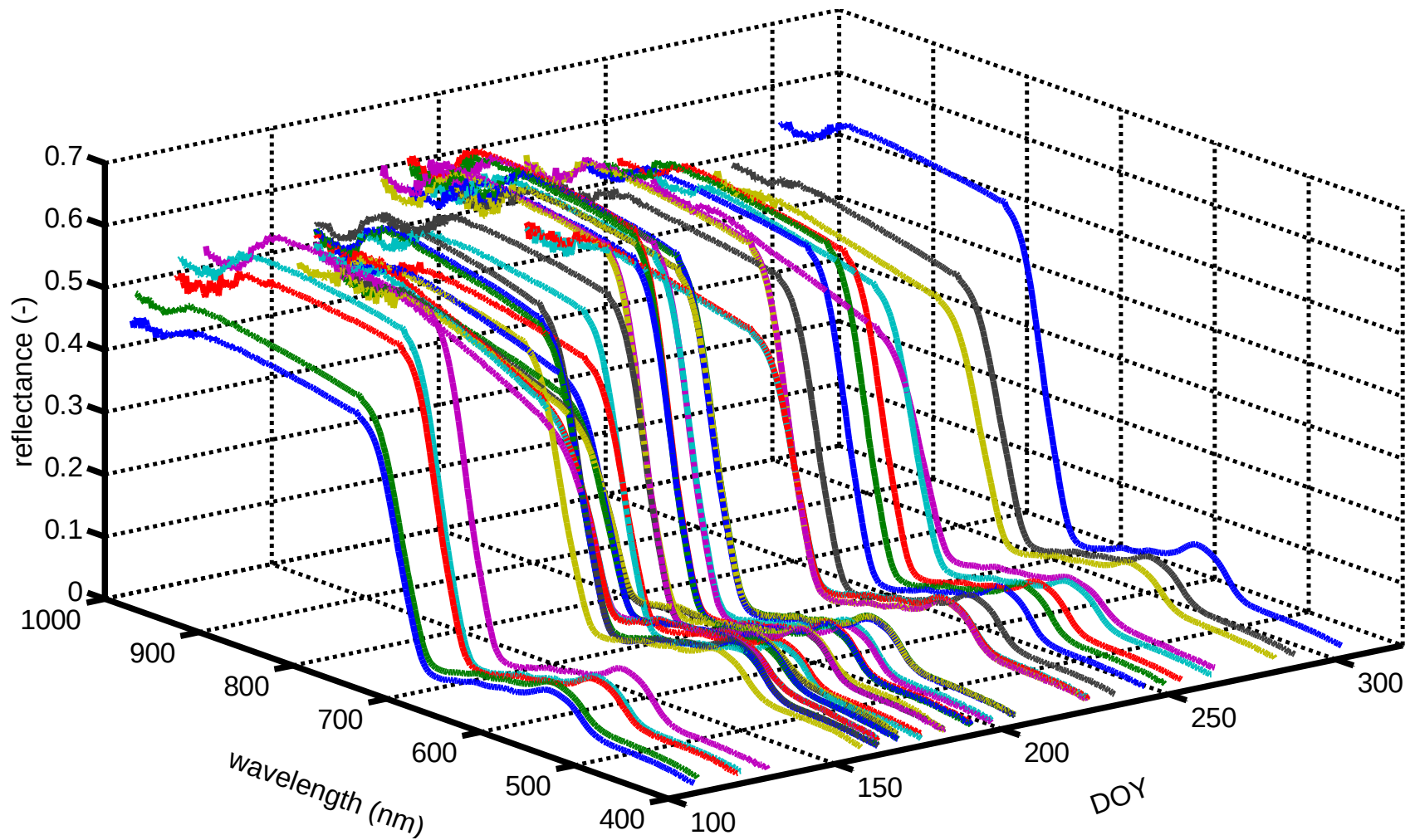




2006

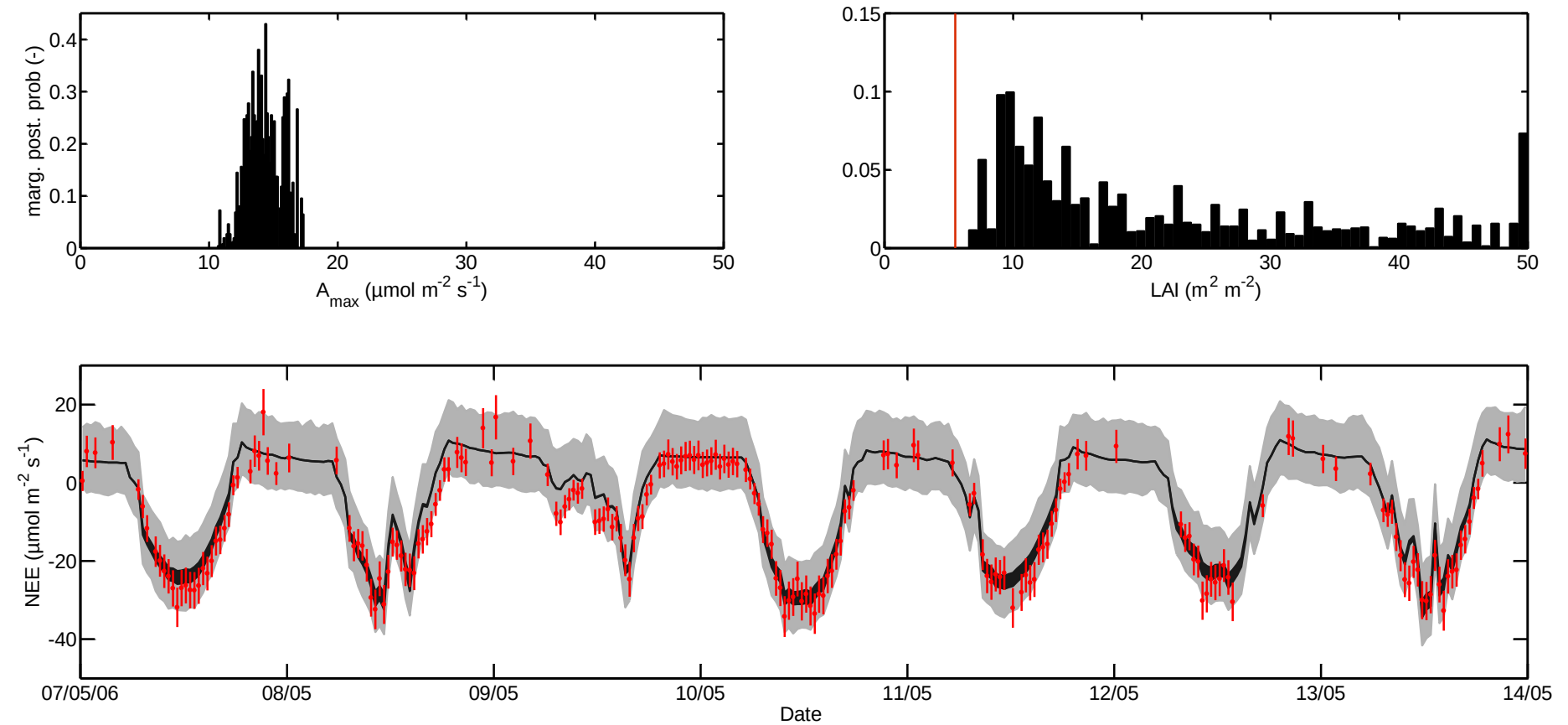
$$F_x = \overline{w' r'_x}$$

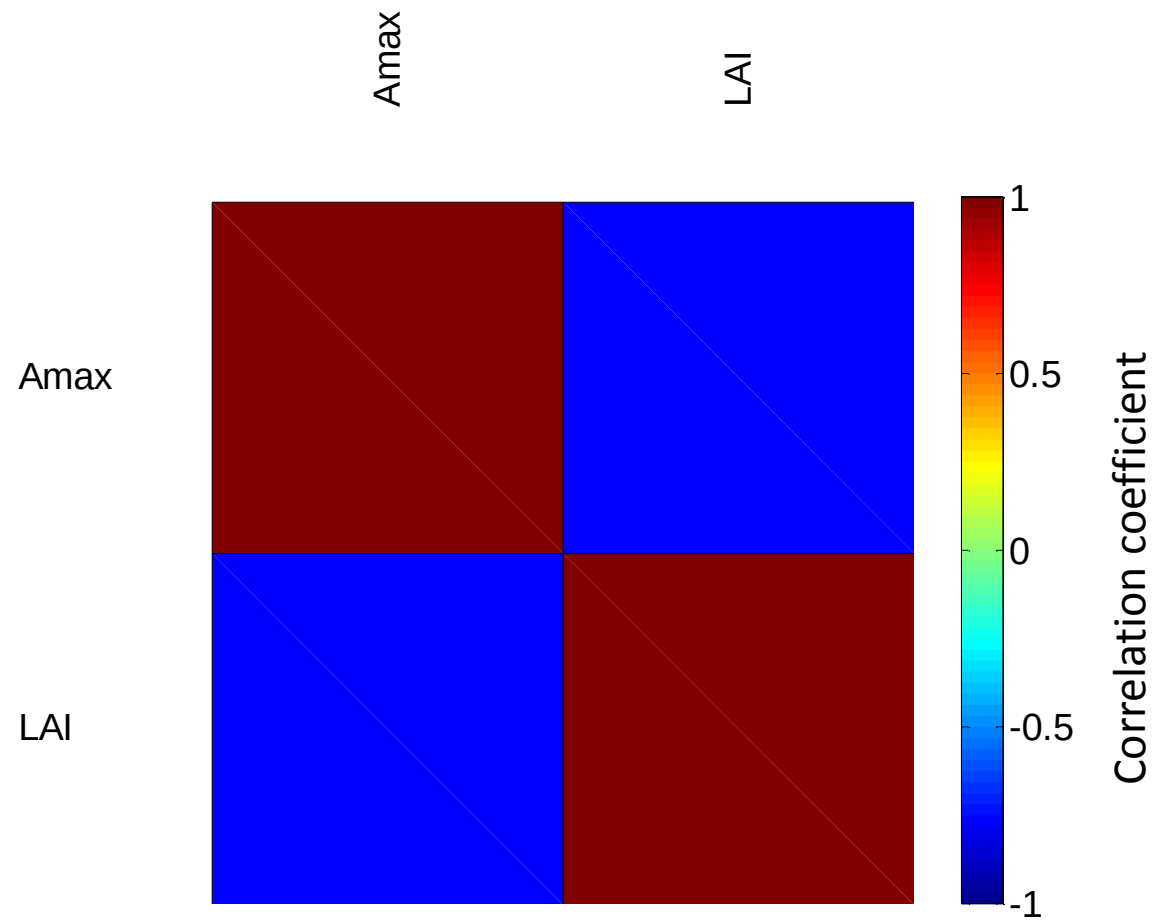


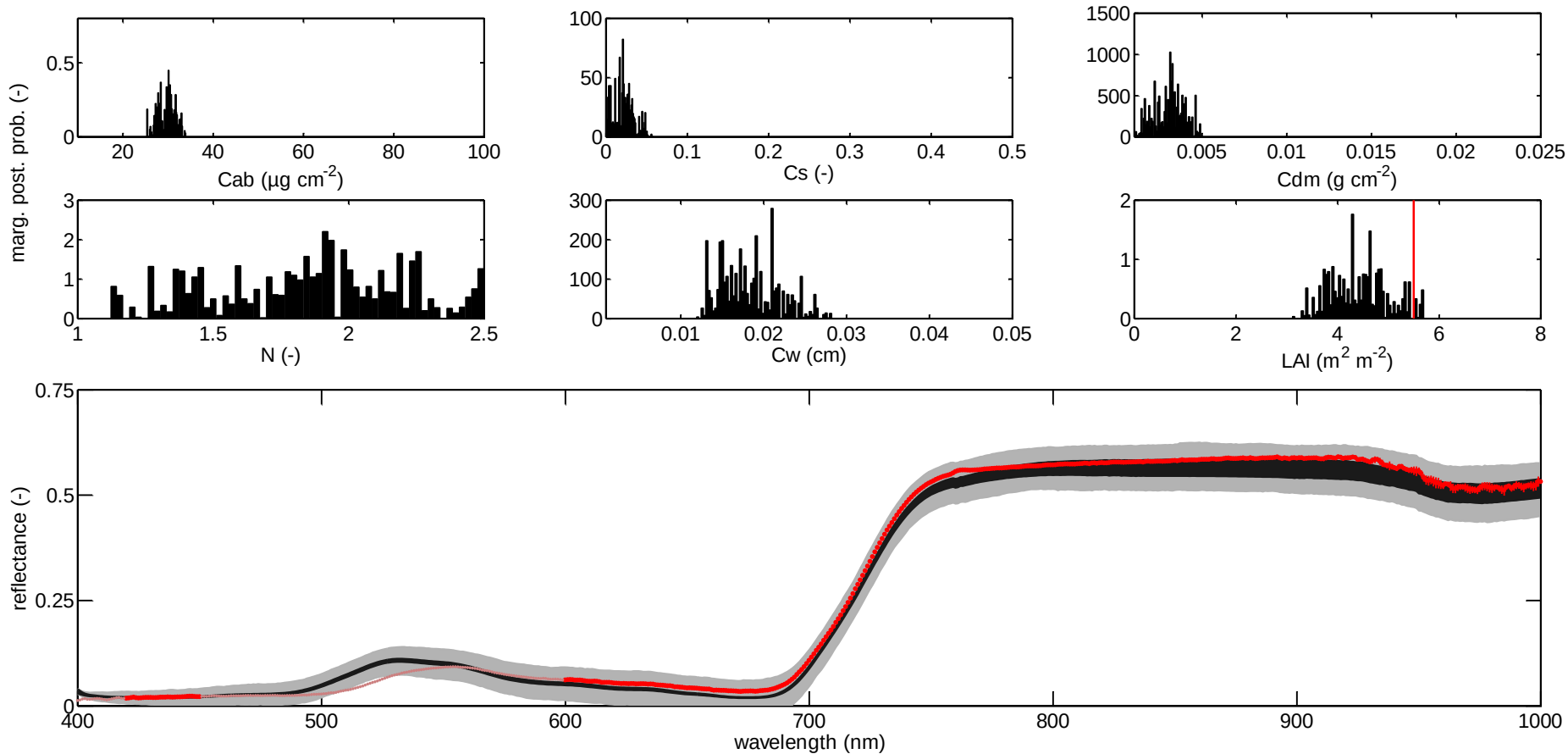
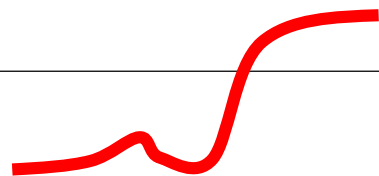


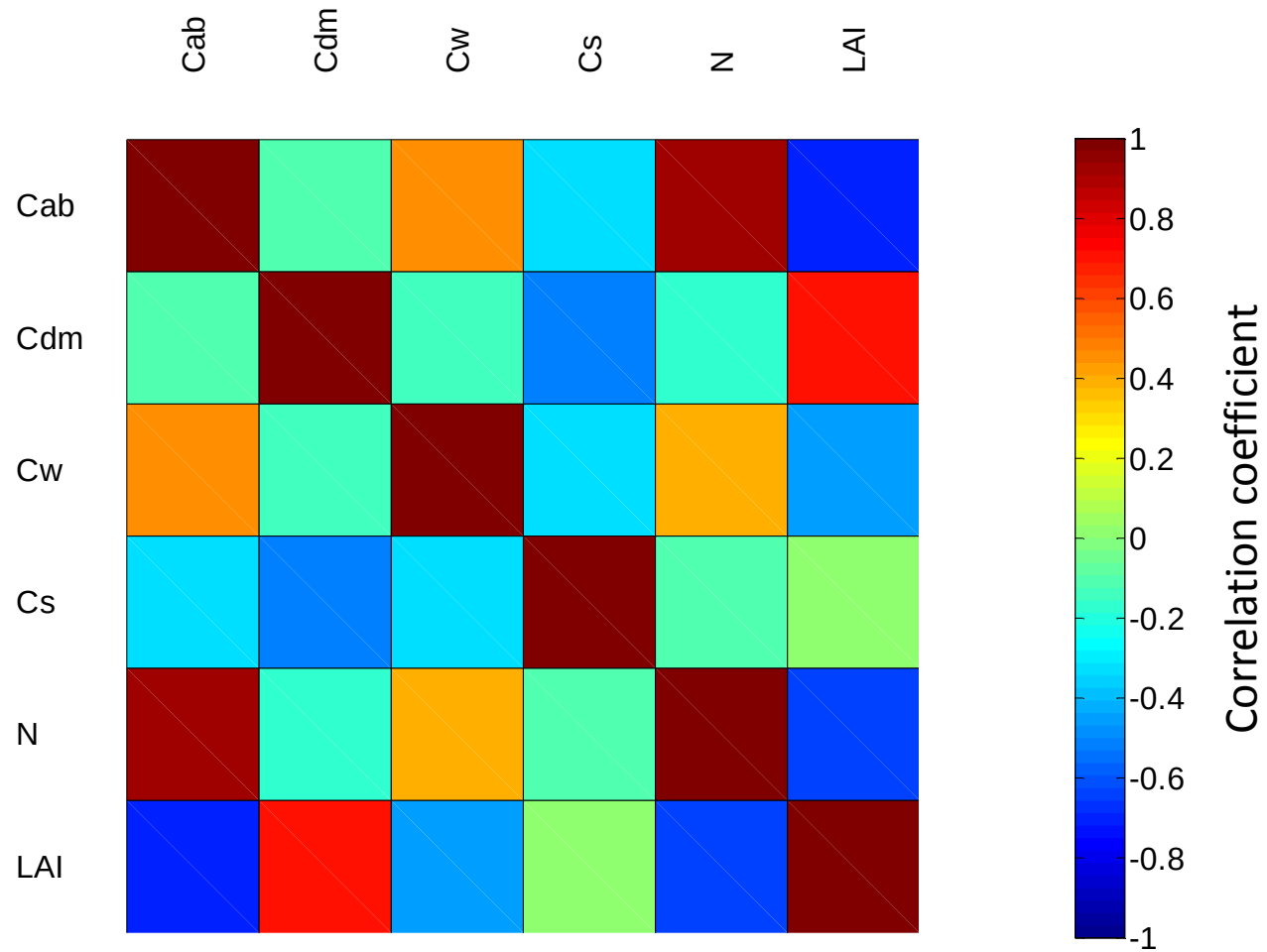
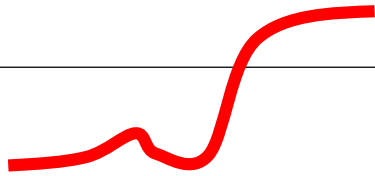


Big-leaf only

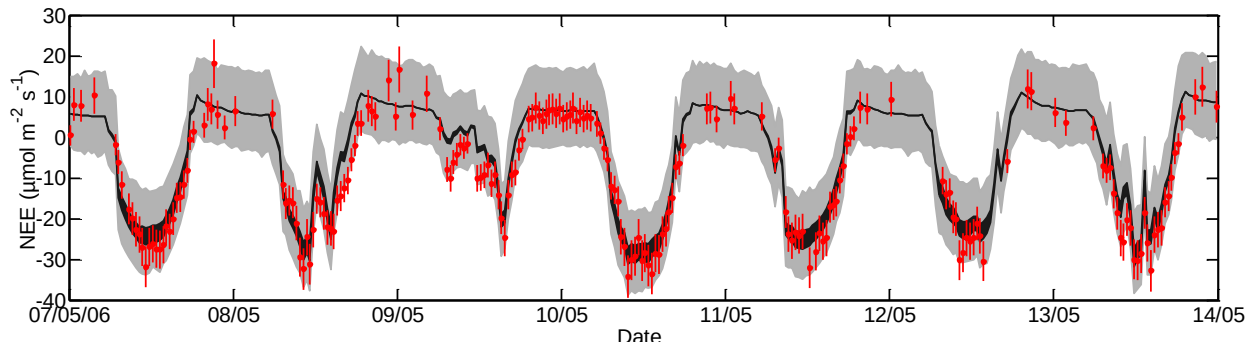
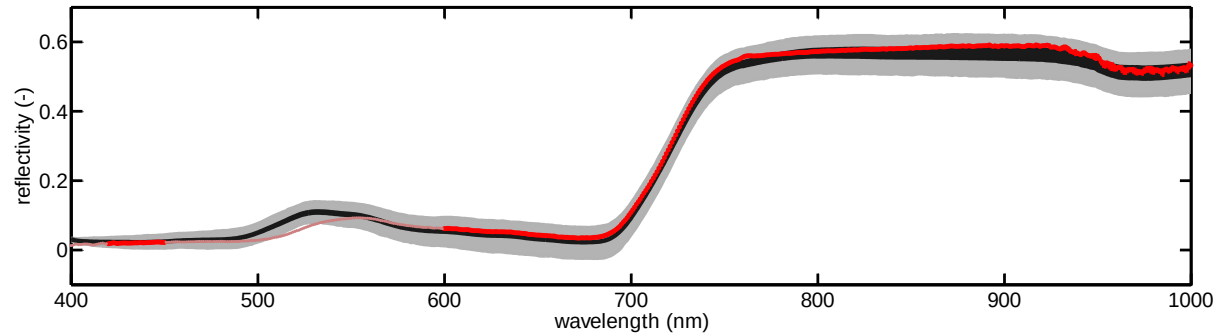
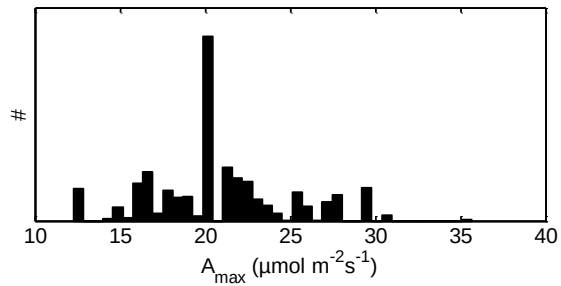
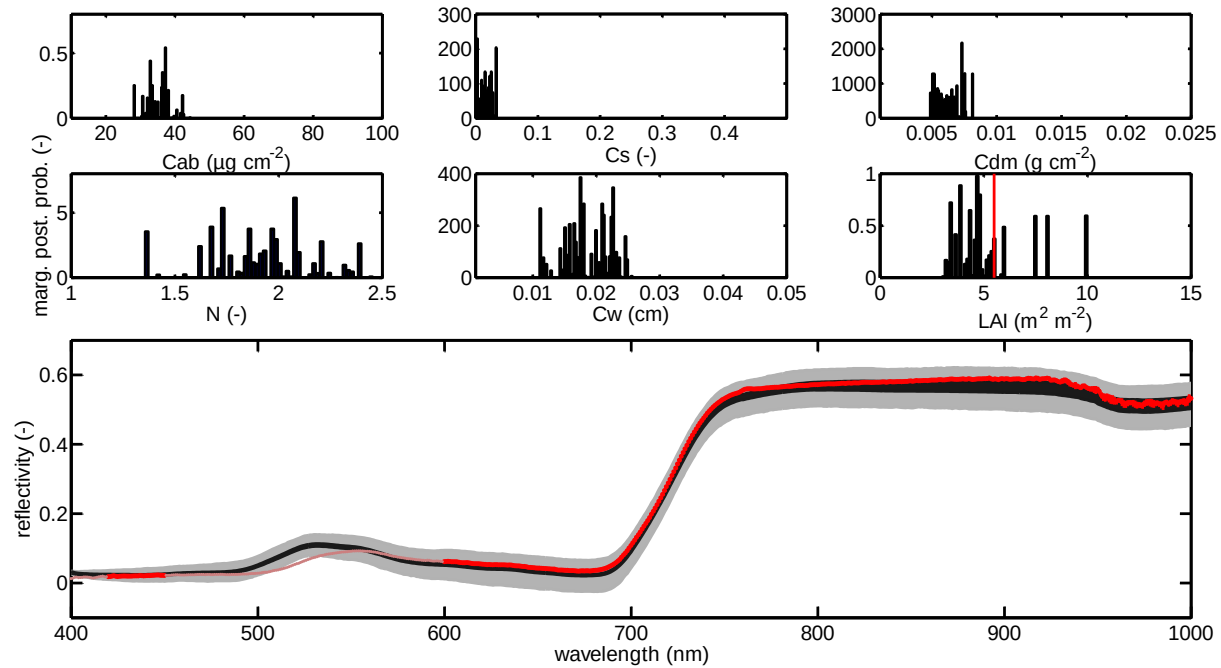




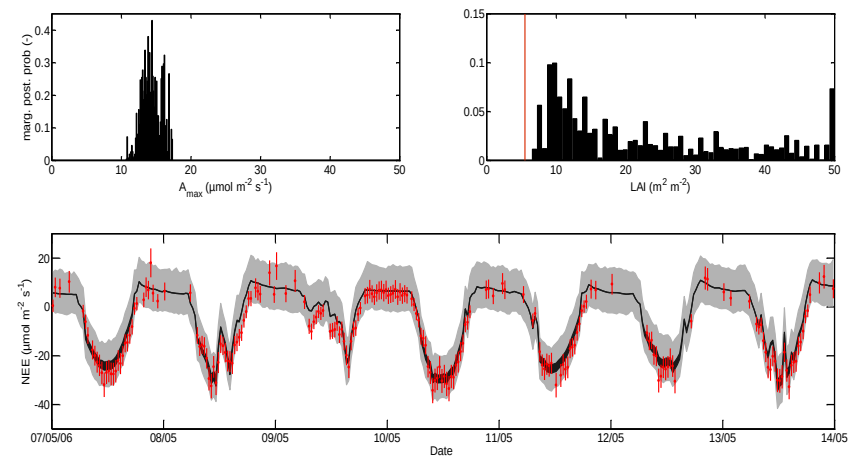
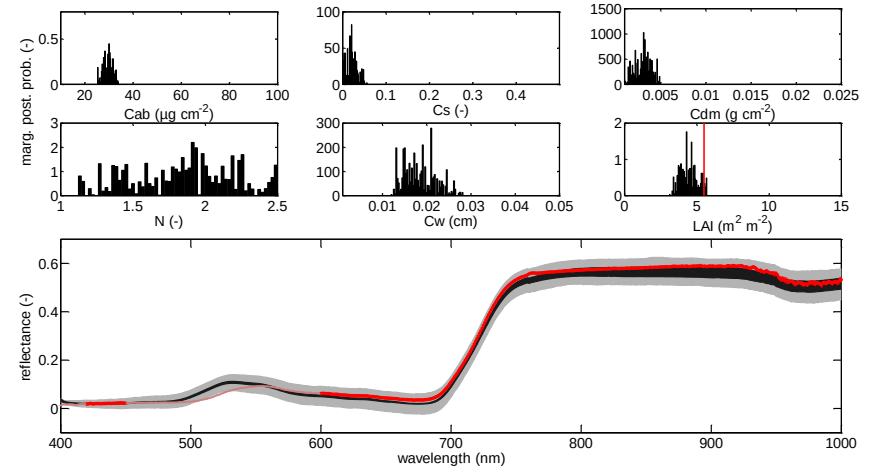
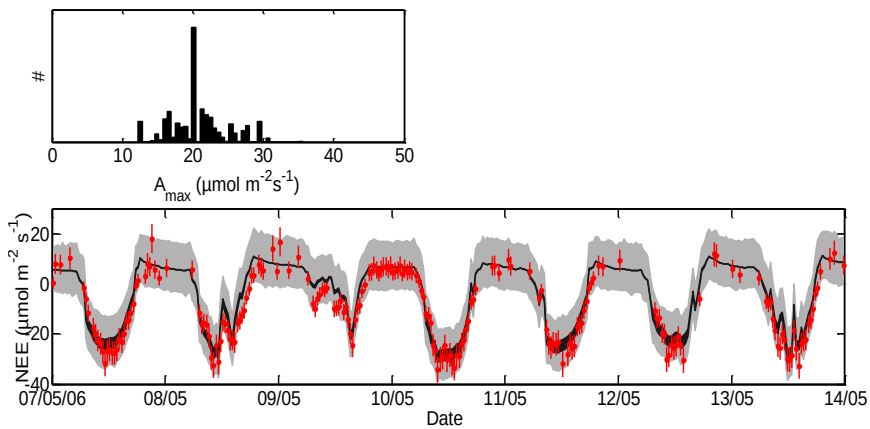
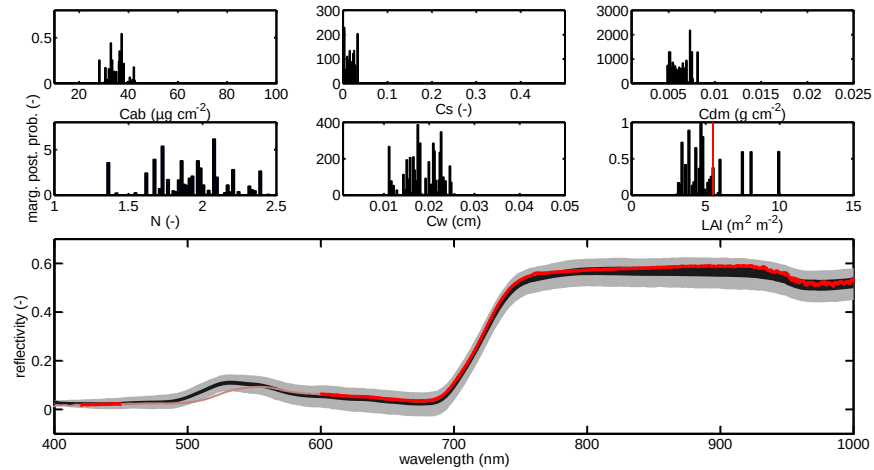


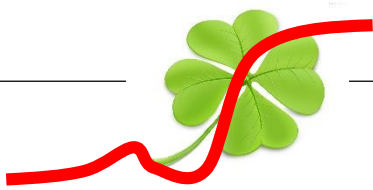


Big-leaf & ProSail

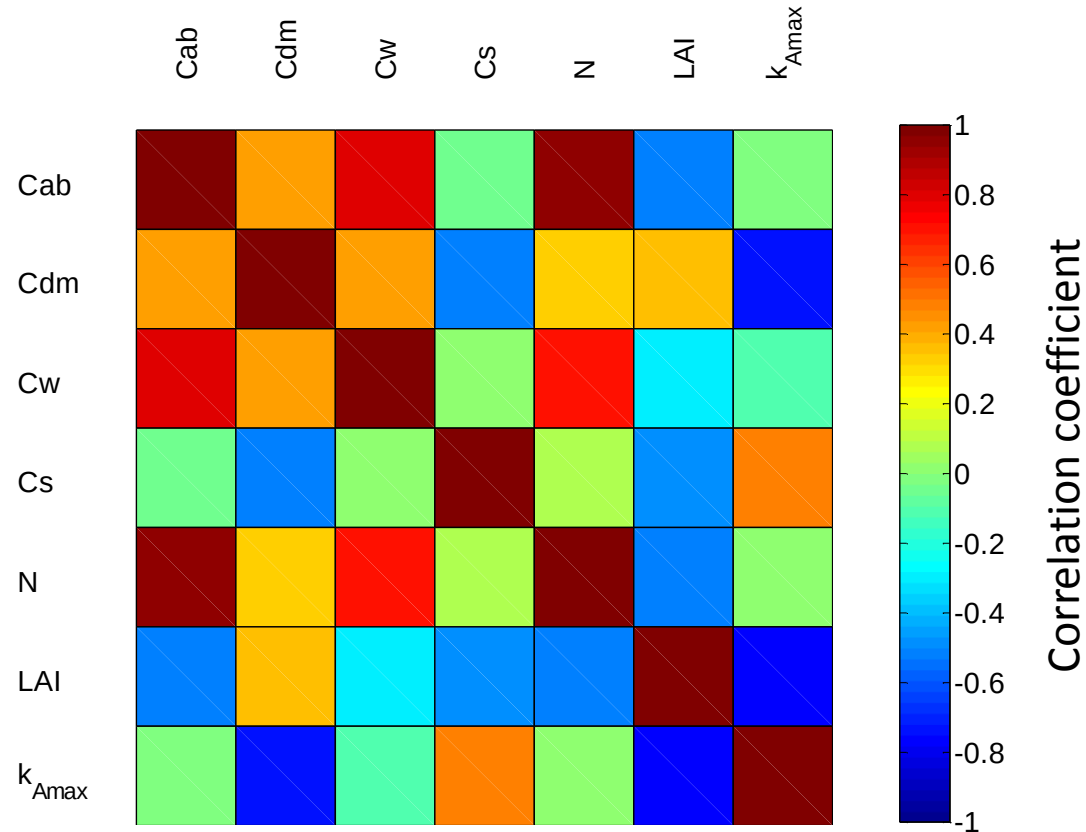


Big-leaf & ProSail

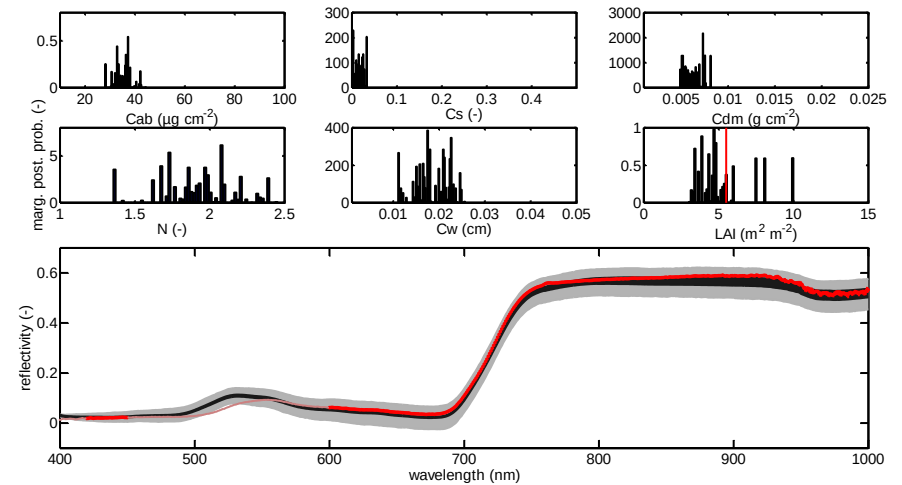
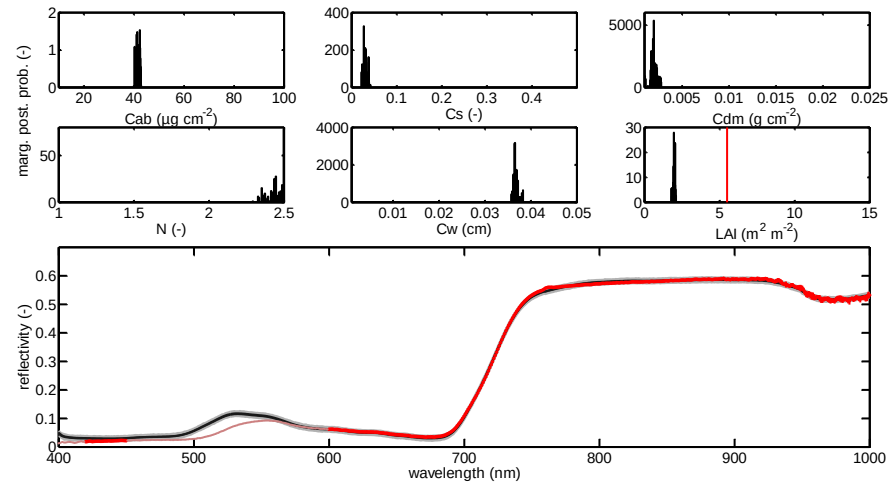
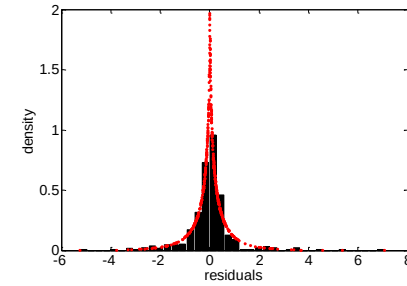
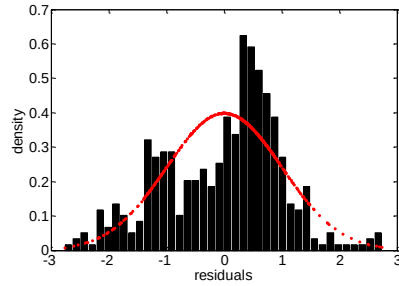




Big-leaf & ProSail



Residual handling



Independent of the approach used, measured data are predicted accurately



Big-leaf only:

Good representation of NEE data ($\text{MAE} = 3.32 \mu\text{mol m}^{-2} \text{s}^{-1}$), but parameter estimates are badly constrained, highly correlated and reach unrealistic values.



ProSail only:

Again good representation of measured reflectance spectra ($\text{MAE} = 0.013$), with reasonably constrained parameters in a realistic range.



Combined BigLeaf – ProSail

The combined model is able to describe both data streams very well (MAE = $3.46 \mu\text{mol m}^{-2} \text{s}^{-1}$ and 0.013)

Posterior parameter ranges became narrower

Parameter correlations were reduced.

Statistics

Correct residual handling essential for realistic parameter estimates.

A full-page background image showing rain falling onto a grassy field. The rain is captured as numerous vertical streaks, and the grass at the bottom is illuminated, creating a bokeh effect of light circles.

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