Comparison of daytime and nighttime data based estimates of GPP and Reco

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INTRO

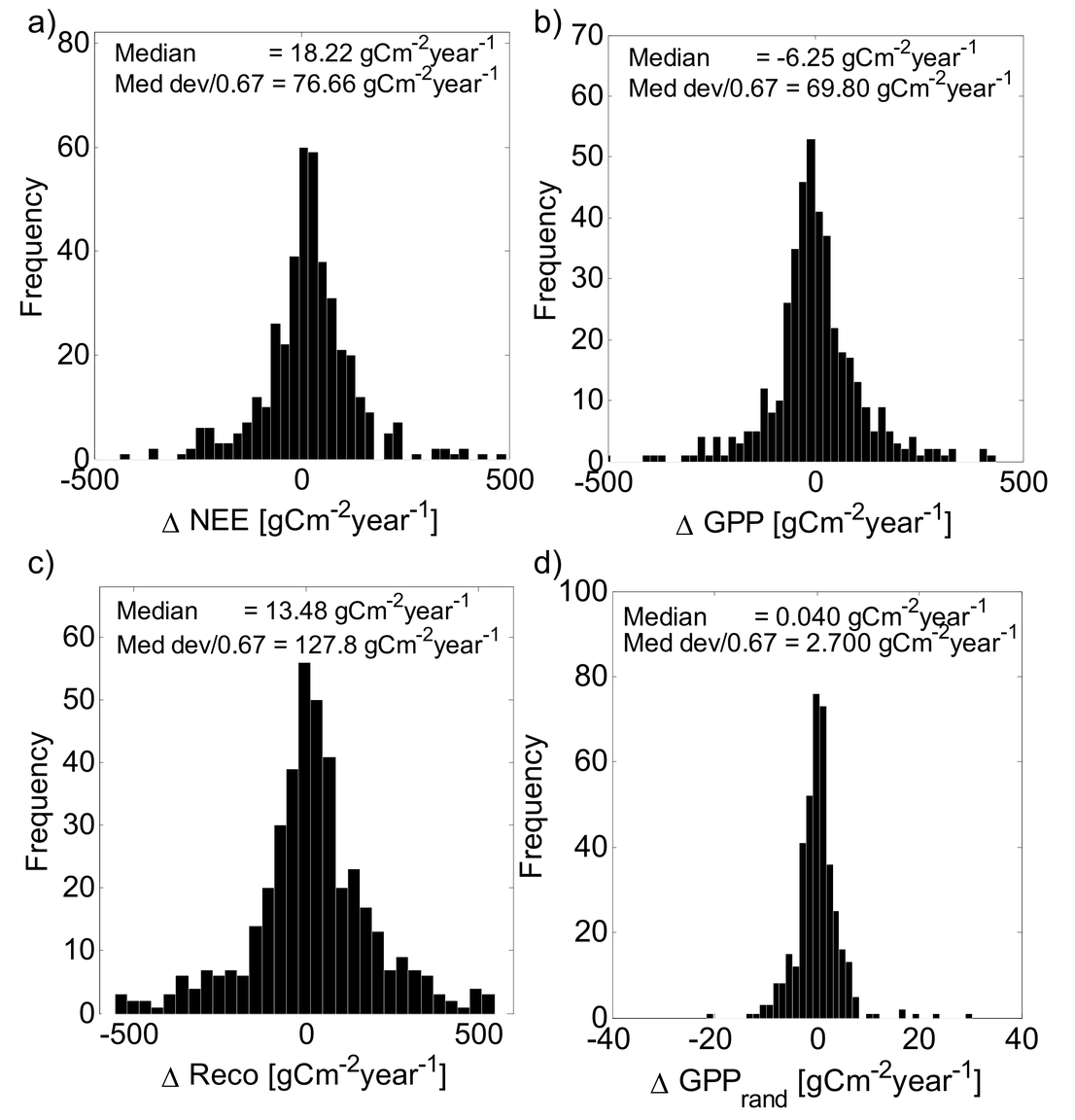
Eddy covariance systems measure the ecosystem exchange (NEE) of carbon which is the sum of two main processes, respiration (Reco) and gross primary production (GPP). To understand the dynamics and underlying processes of NEE it is essential to split the measurements into these two components. Such flux partitioning algorithms are usually based on problematic and possibly biased nighttime measurements. In this study we compare estimates of GPP and Reco based on nighttime data with estimates based on daytime data. The deviations between these two estimates indicate the uncertainty arising from inconsistent data.

METHODS

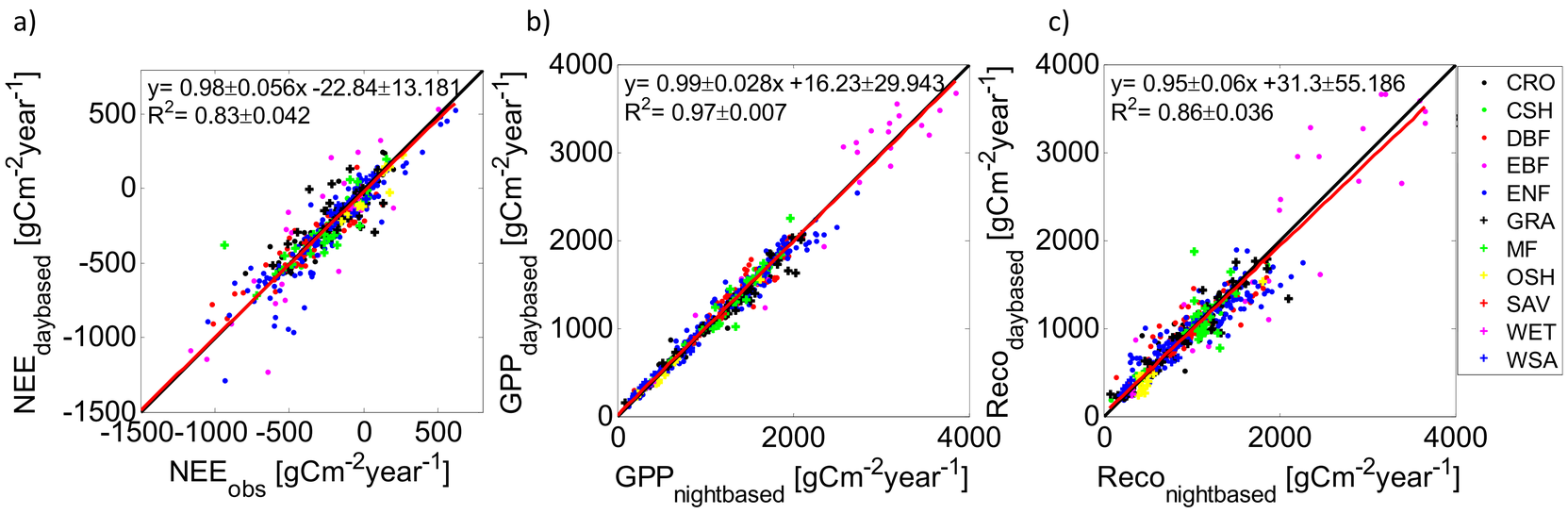
In this study we compare the nighttime data based estimates of Reichstein et al (2005) with a daytime data based estimate for 419 siteyears of the FLUXNET database. The daytime data based on a hyperbolic light response curve, extended by a temperature dependency of respiration (Lloyd and Taylor model) and a water vapour pressure deficit (VPD) limitation of Photosynthesis.

$$NEE = -\frac{\alpha \cdot \beta(VPD) \cdot Rg}{\alpha \cdot Rg + \beta(VPD)} + \gamma(T)$$

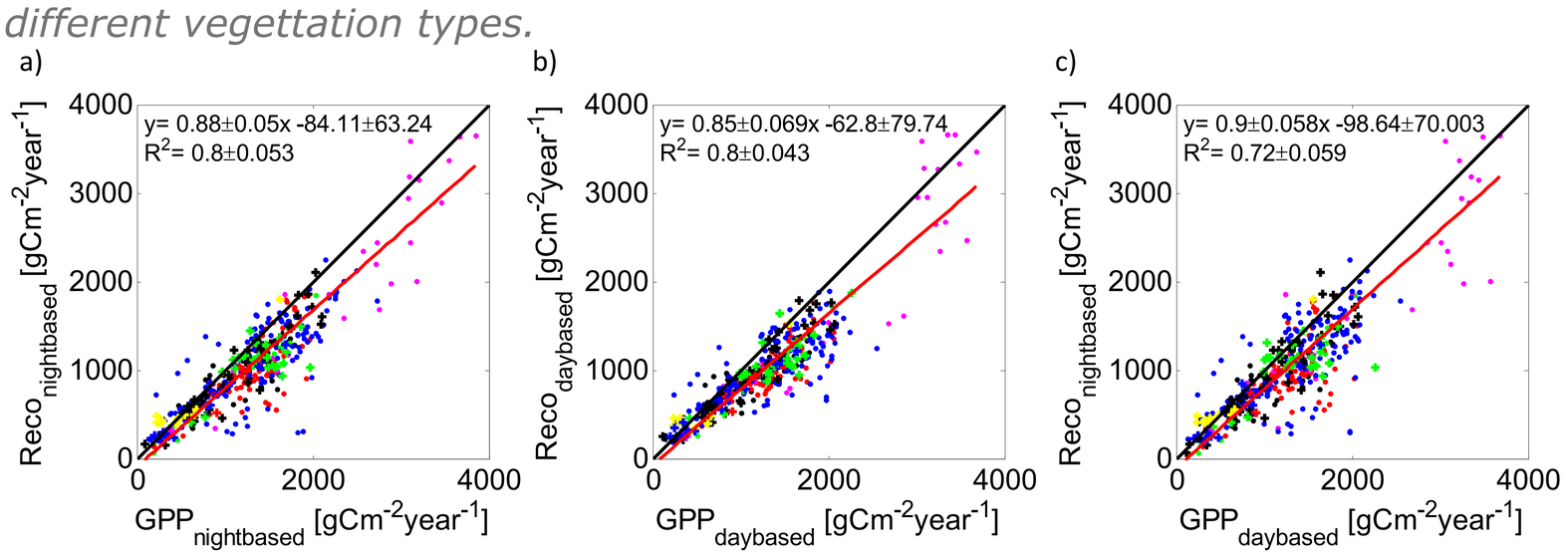
α: canopy light utilization efficiency
β: GPP (Gross primary production) at light saturation, limited by VPD
γ: Lloyd & Taylor model, Respiration
Rg: global radiation
The model is fit to a 4 days moving window of low turbulence filtered Eddy Covariance data. Only the temperature sensitivity of the Lloyd and Taylor model is estimated with nighttime data, the flux magnitude is determined by daytime data.



[^ FIG 1] *Histograms of the difference between annual observations and the daytime data based estimate of NEE (a), annual nighttime data based estimate and daytime data based estimate for b) GPP, c) Reco. D) Histogram of the expected difference caused by the random error for GPP.*



[Fig 2 ^] *Scatter plots of a) annual sums of gapfilled observations (x-axis) and daytime data based (y-axis) estimates of NEE, annual sums of nighttime data based (x-axis) and daytime data based (y-axis) estimates of b) GPP and c) Reco for different vegettation types.*



[Fig 3 ^] *Scatter plot of the annual sums a) of the nighttime data based estimate of Reco and GPP, b) of the daytime data based estimate of Reco and GPP, c) of the daytime data based GPP and the nighttime data based Reco,legend see figure 2.*

RESULTS

The comparison of the two estimates shows, that **using mainly daytime measurements for the fluxpartitioning does not introduce a systematic bias.** The median of the differences between the estimates is close to zero (Fig1). The median is only significantly different from 0 for NEE. The parameters of the regression line in the scatterplots are not significantly different from the 1:1 line (FIG2). The uncertainty of Reco is higher than for GPP.
The statistical uncertainty is much lower than the deviations of the two estimates (Fig1), this illustrates that **systematic errors need to be considered when propagating uncertainties**.
The **global patterns derived from the FLUXNET dataset, as for instance the correlation between Reco and GPP, are robust and reliable** using both methods although for some sites nighttime based estimates are expected to be biased (FIG3).

Acknowledgements

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REFS

Reichstein M et al. (2005) On the separation of net ecosystem exchange into assimilation and ecosystem respiration: review and improved algorithm. Global Change Biology, 11, 1–16.