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Shedding light on daytime flux partitioning

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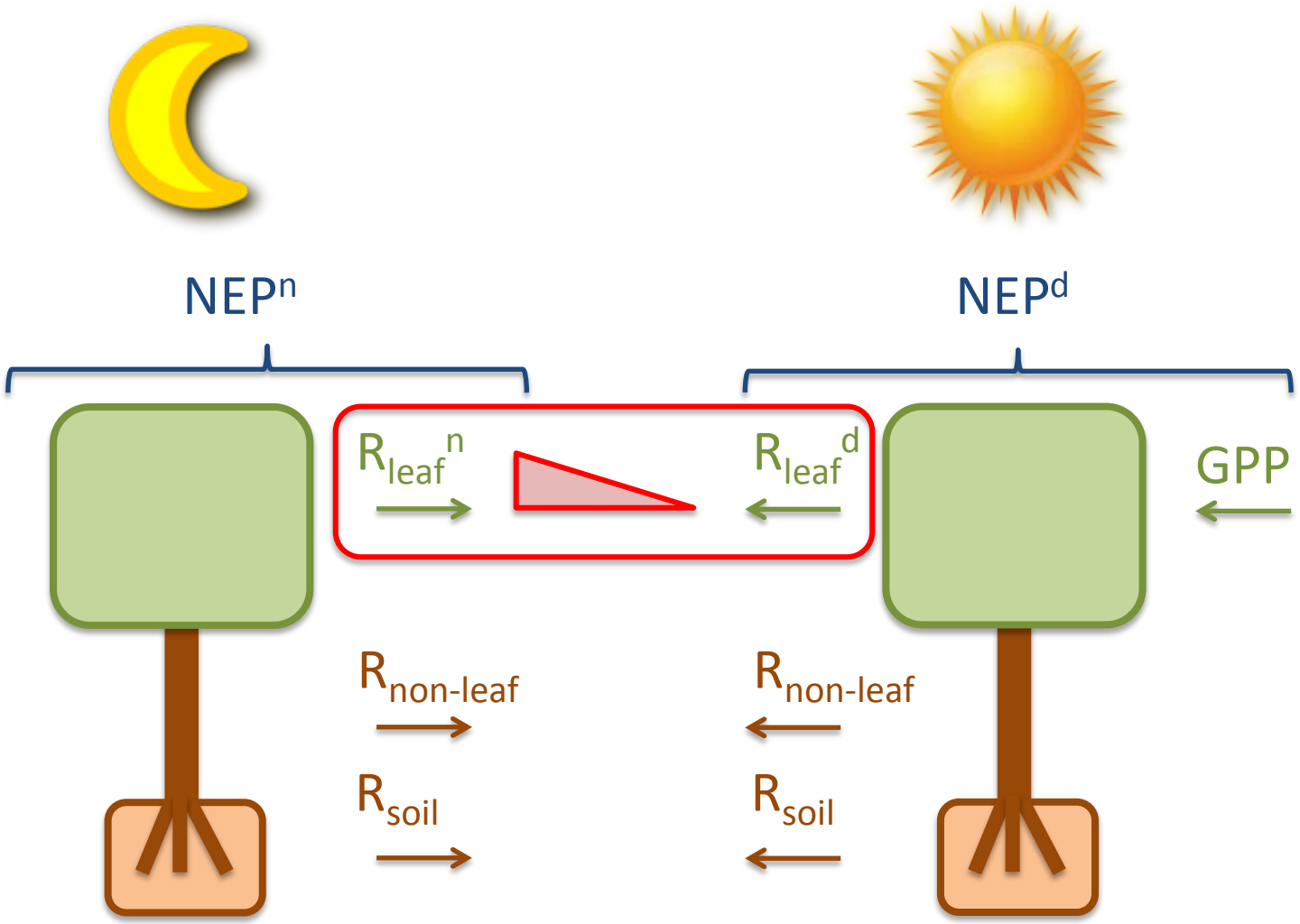
Background

- Gross primary productivity (GPP) and ecosystem respiration (ER) are key ecological concepts widely used to diagnose the global carbon cycle.
- Because GPP and ER co-occur during daylight conditions, and thus obscure each other in the net ecosystem productivity (NEP), they must be inferred by some model, commonly referred to as flux partitioning algorithms.
- GPP and ER are thus simulated quantities and as such affected by the structural uncertainty of the models used to infer them.

Background



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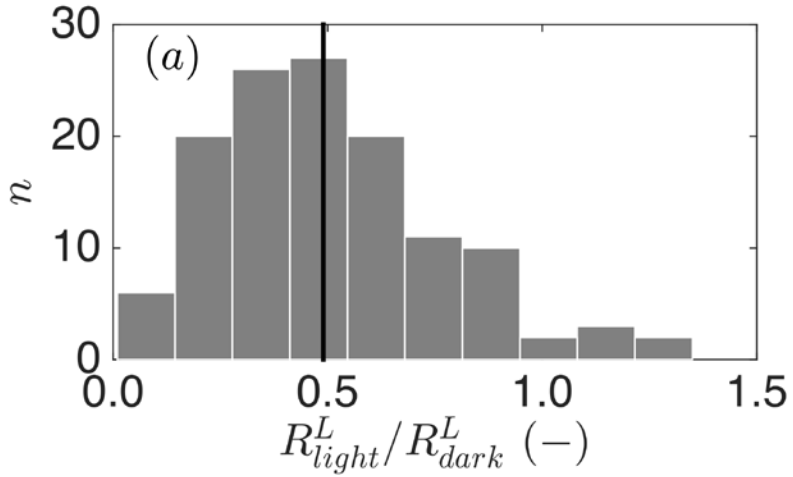
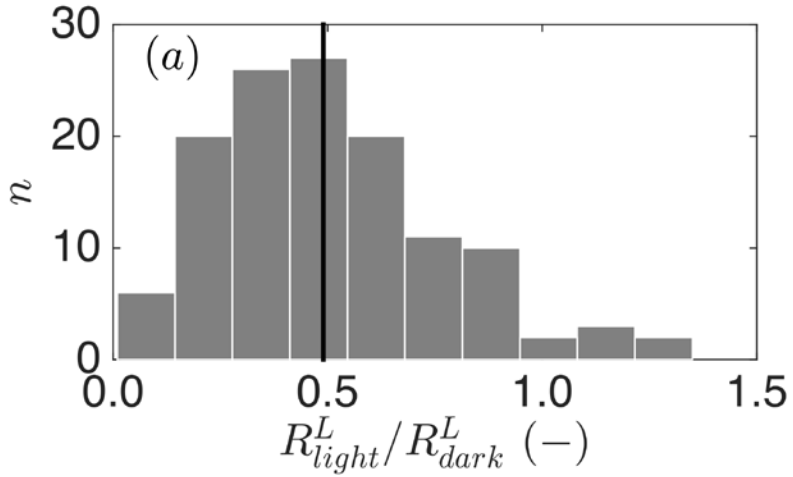
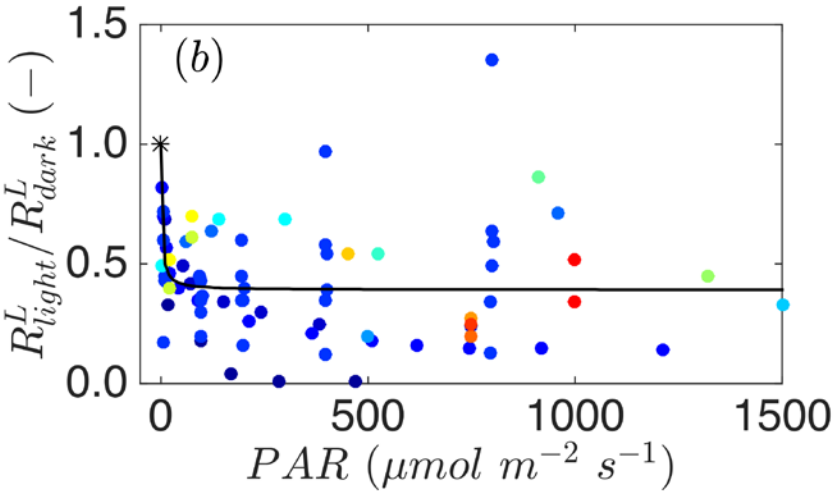


n = 127

Background

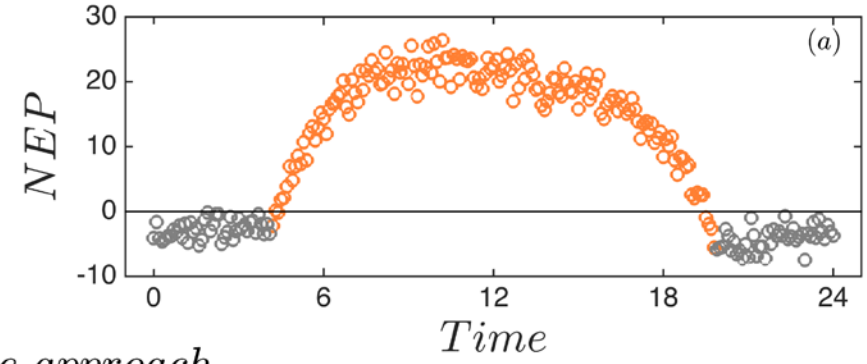




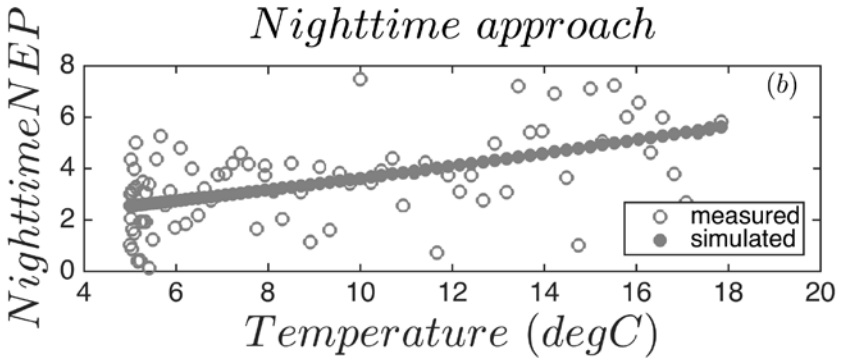
n = 127

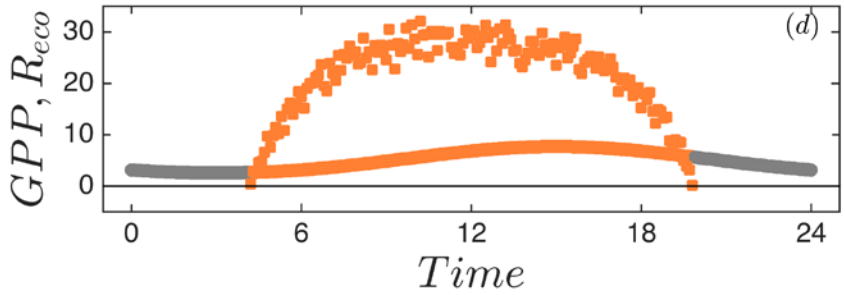
- *L. fragrans* (1)
- *H. arbutifolia* (1)
- *S. oleracea* (2)
- *E. pauciflora* (3)
- *N. tabacum* (4)
- *Poa sp.* (5)
- *V. vinifera* (6)
- *N. tabacum* (7)
- *N. tabacum* (8)
- *T. estivum* (8)
- *H. vulgare* (8)
- *L. fragrans* (9)
- *H. arbutifolia* (9)
- *P. vulgaris* (10)
- *T. estivum* (11)
- *H. annuus* (11)
- *S. cereale* (11)
- *S. cereale* (12)

Background



$all\ flux\ units : \mu mol\ m^{-2}\ s^{-1}$



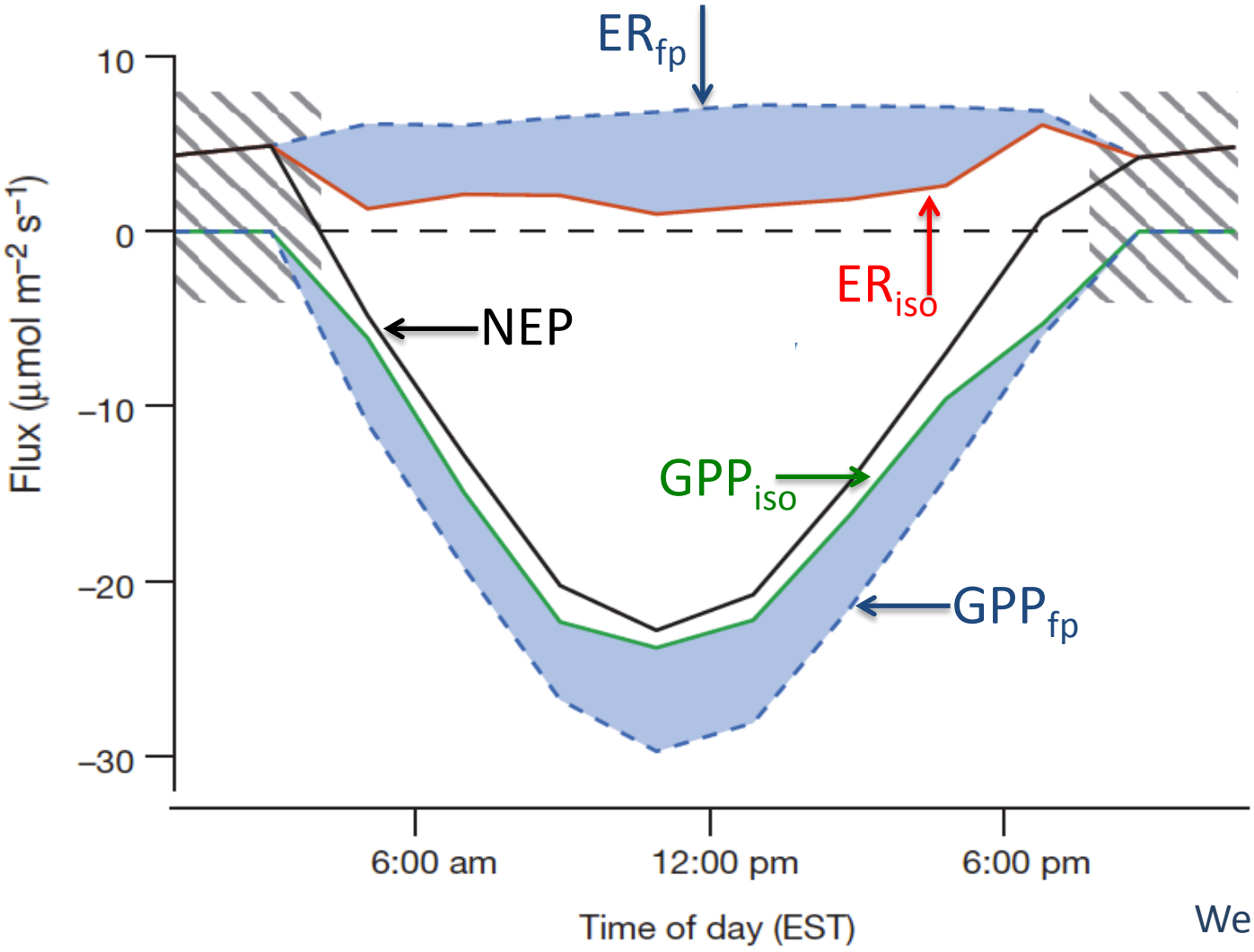


$ER_n = f(T) \mid NEP_n$

$ER_d = f(T)$

$GPP = NEP_d - ER_d$

Background



Wehr et al. (2016)

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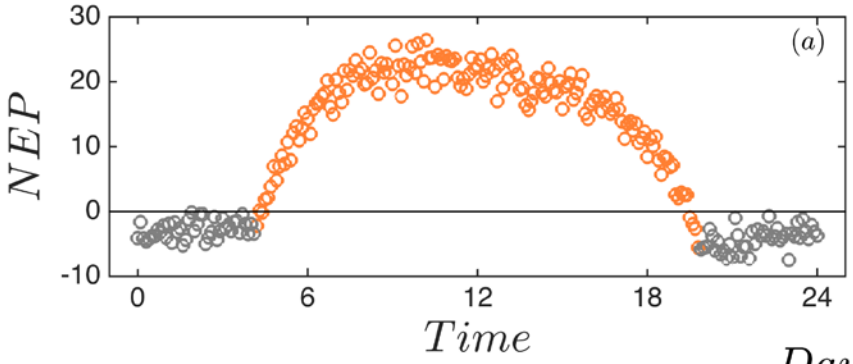
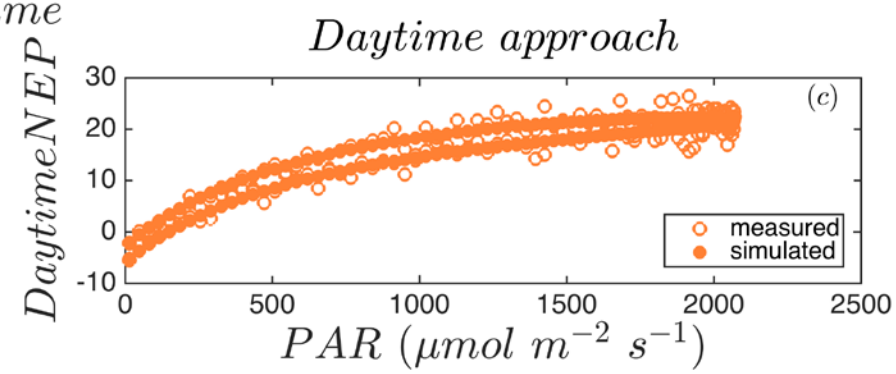
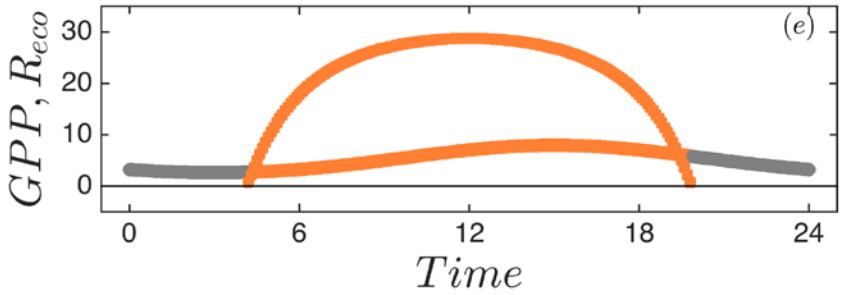
Background



$all\ flux\ units: \mu mol\ m^{-2}\ s^{-1}$

- GPP = *f*(PAR) | NEP_d
- ER_d = *f*(T) | NEP_d, (NEP_n)
- ER_n = *f*(T)





Research question

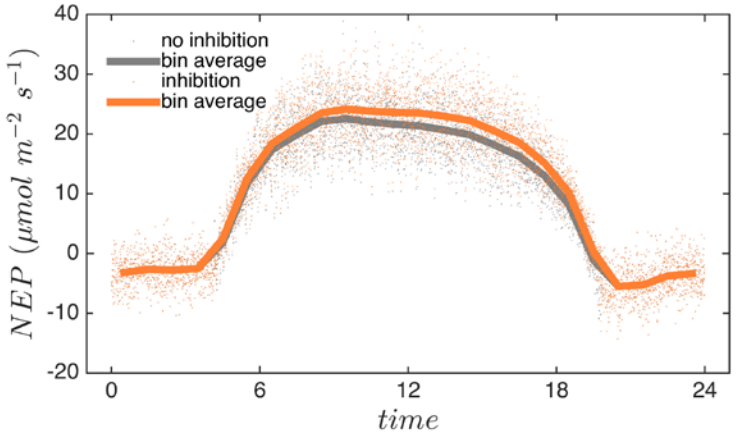
- Nighttime NEP does not carry any information on the reduction of leaf mitochondrial respiration during day and thus the nighttime approach is overestimating daytime ER and GPP (Wohlfahrt et al., 2005; Wohlfahrt & Gu, 2015).
- **This prompts the question whether the daytime approach, which (almost) exclusively relies on daytime NEP data, is able to correctly estimate daytime ER and GPP.**

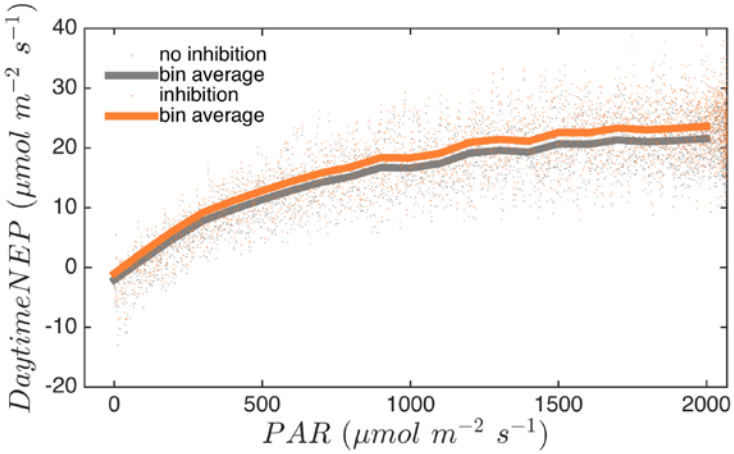
Research approach

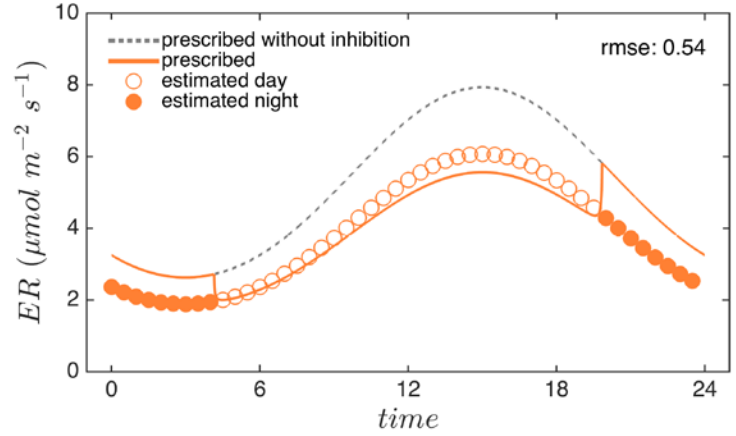
Tier 1

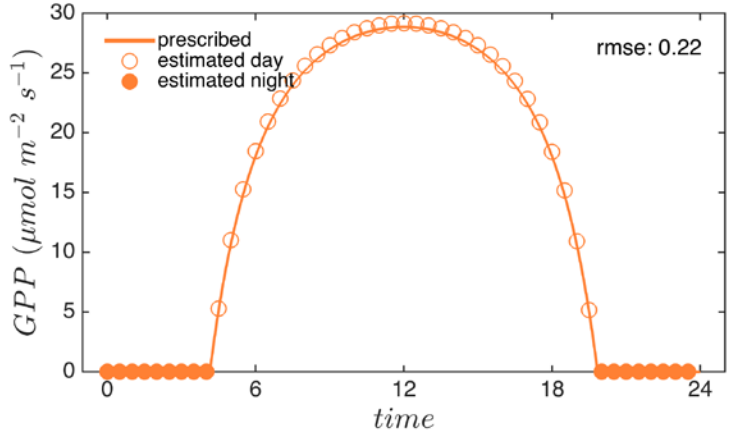
- ☐ Simulate light and temperature diurnal course.
- ☐ Simulate GPP and ER using daytime flux partitioning algorithm.
- ☐ Specify leaf respiration/ER ratio and apply inhibition to leaf respiration fraction.
- ☐ Convolve with realistic noise.
- ☐ Apply daytime flux partitioning approach.

Results tier 1







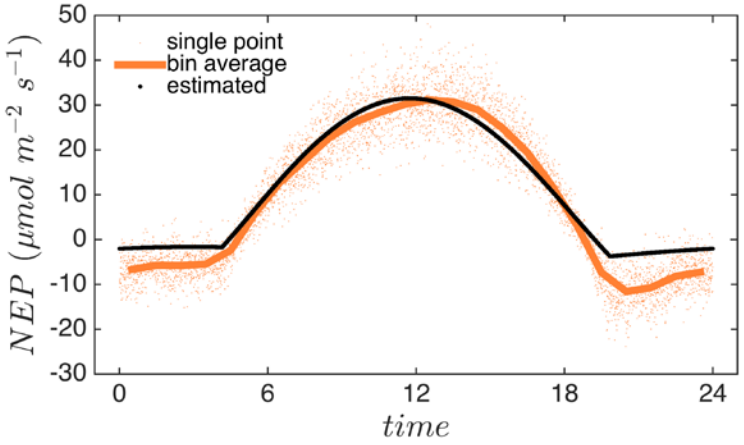


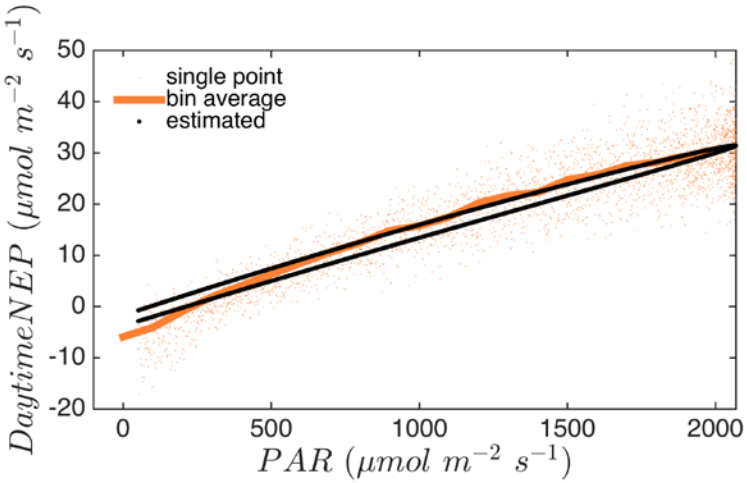
Research approach

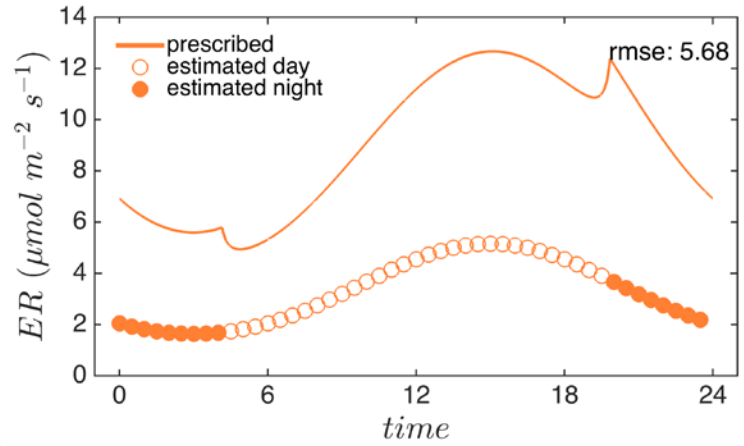
Tier 2

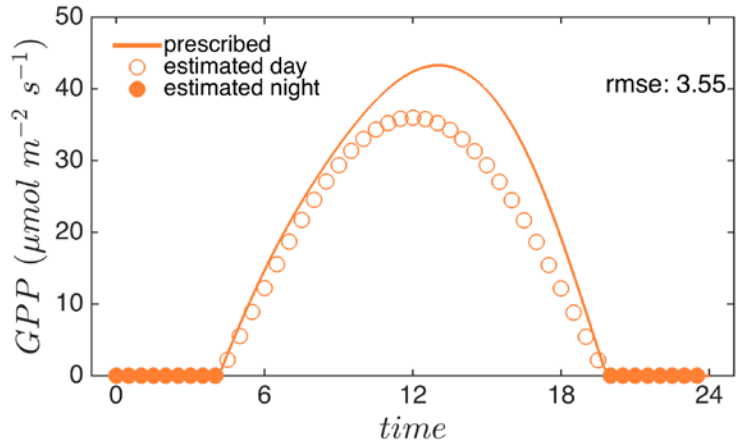
- ☐ Simulate light and temperature diurnal course.
- ☐ Simulate GPP and ER using two-leaf big-leaf model based on Farquhar et al. photosynthesis model.
- ☐ Convolve with realistic noise.
- ☐ Apply daytime flux partitioning approach.

Results tier 2







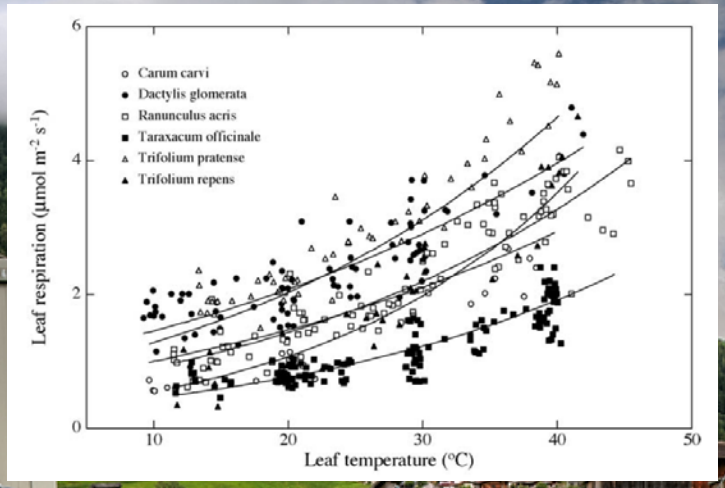


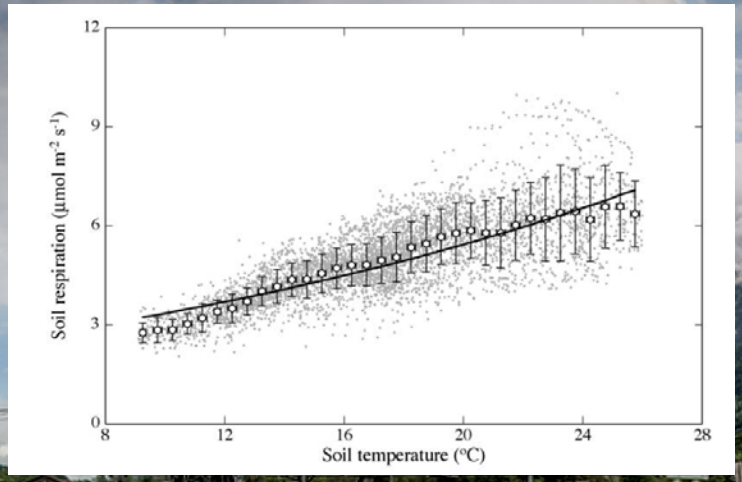
Research approach

Tier 3

- ☐ Estimate daytime ER and GPP based on the approach of Wohlfahrt et al. 2005) using measured data from the FLUXNET site Neustift (AT-Neu), where detailed records of soil and leaf respiration, as well as LAI dynamics are available.
- ☐ Apply daytime flux partitioning approach to measured NEP.

Research approach





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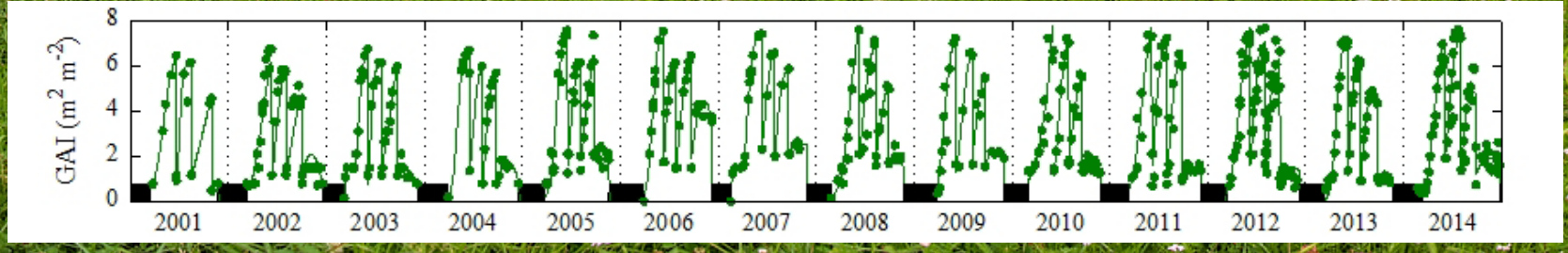
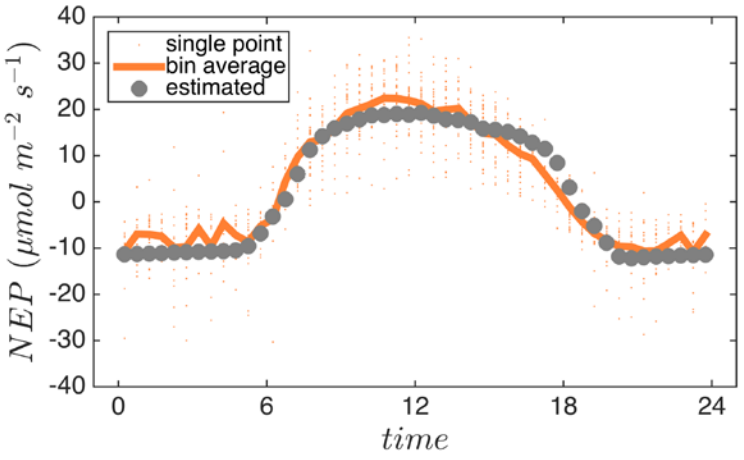
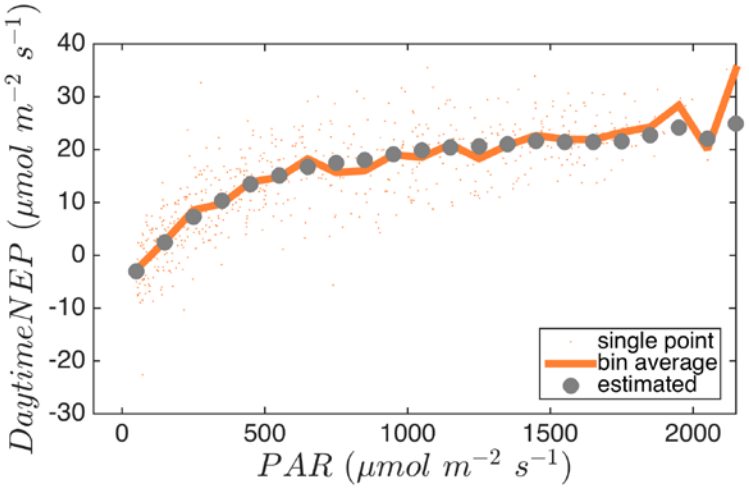
Estimation of daytime ecosystem respiration to determine gross primary production of a mountain meadow

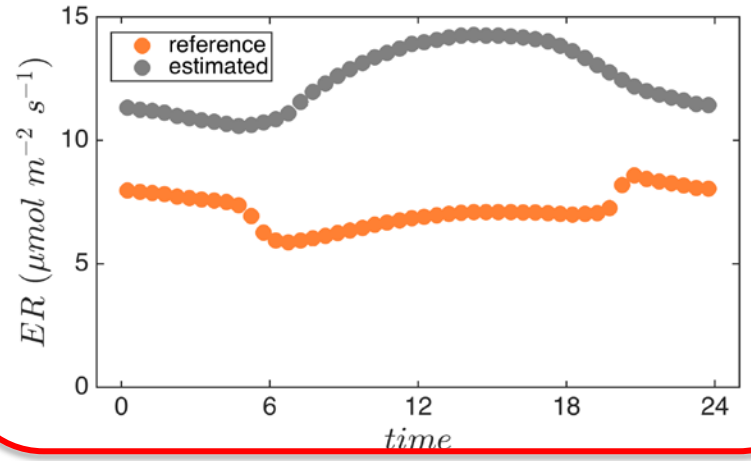
Georg Wohlfahrt *, Michael Bahn, Alois Haslwanter, Christian Newesely, Alexander Cernusca

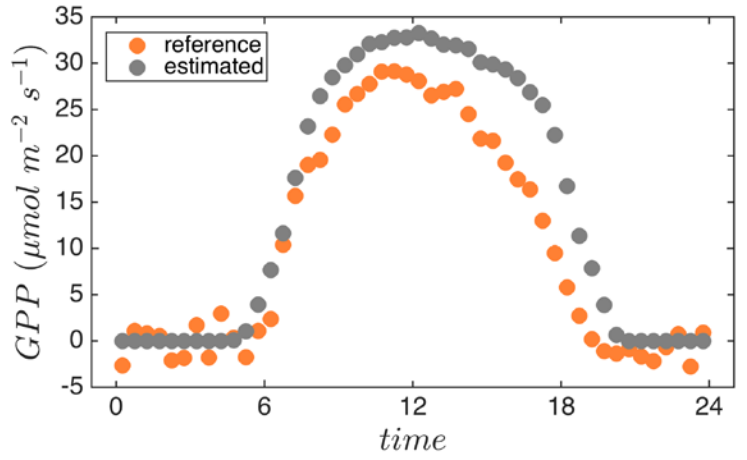


Results tier 3









Conclusions

- Under “laboratory conditions”, yes, otherwise results are clearly, well, ambiguous.
- A key issue appears to be the shape of the true light and temperature response of GPP and ER as compared to the response represented by the model.
- In any case, ER estimated based on the daytime flux partitioning approach must be expected to underestimate nighttime ER.
- A key issue for constraining daytime ER, and thus GPP, in the context of CO_2 flux partitioning, is our ability to disentangle leaf and non-leaf, in particular soil, respiration.

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