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The inconvenient truth about eddy covariance flux partitioning and implications for global carbon cycle estimates

Georg Wohlfahrt[1] and Marta Galvagno[2]

[1] Universität Innsbruck, Austria, [2] ARPA Valle d'Aosta, Italy

Background

- The purpose of flux partitioning algorithms is to disentangle the gross fluxes underlying the net ecosystem production (NEP), that is gross primary productivity (GPP) and ecosystem respiration (ER).
- While nighttime NEP carries a “clear” respiration signal, the estimation of both GPP and ER is complicated by their co-occurrence during daylight conditions.
- GPP and ER thus cannot be measured directly, but must be indirectly inferred by some model.

Background

Measurements $\longrightarrow$ Model $\longrightarrow$ Inferred quantity

NEP

$NEP_n = -ER_n$

$ER_n = f(T) = ER_d$

$NEP_d = GPP + ER_d$

$GPP = NEP_d - ER_d$

Reichstein et al. (2005)

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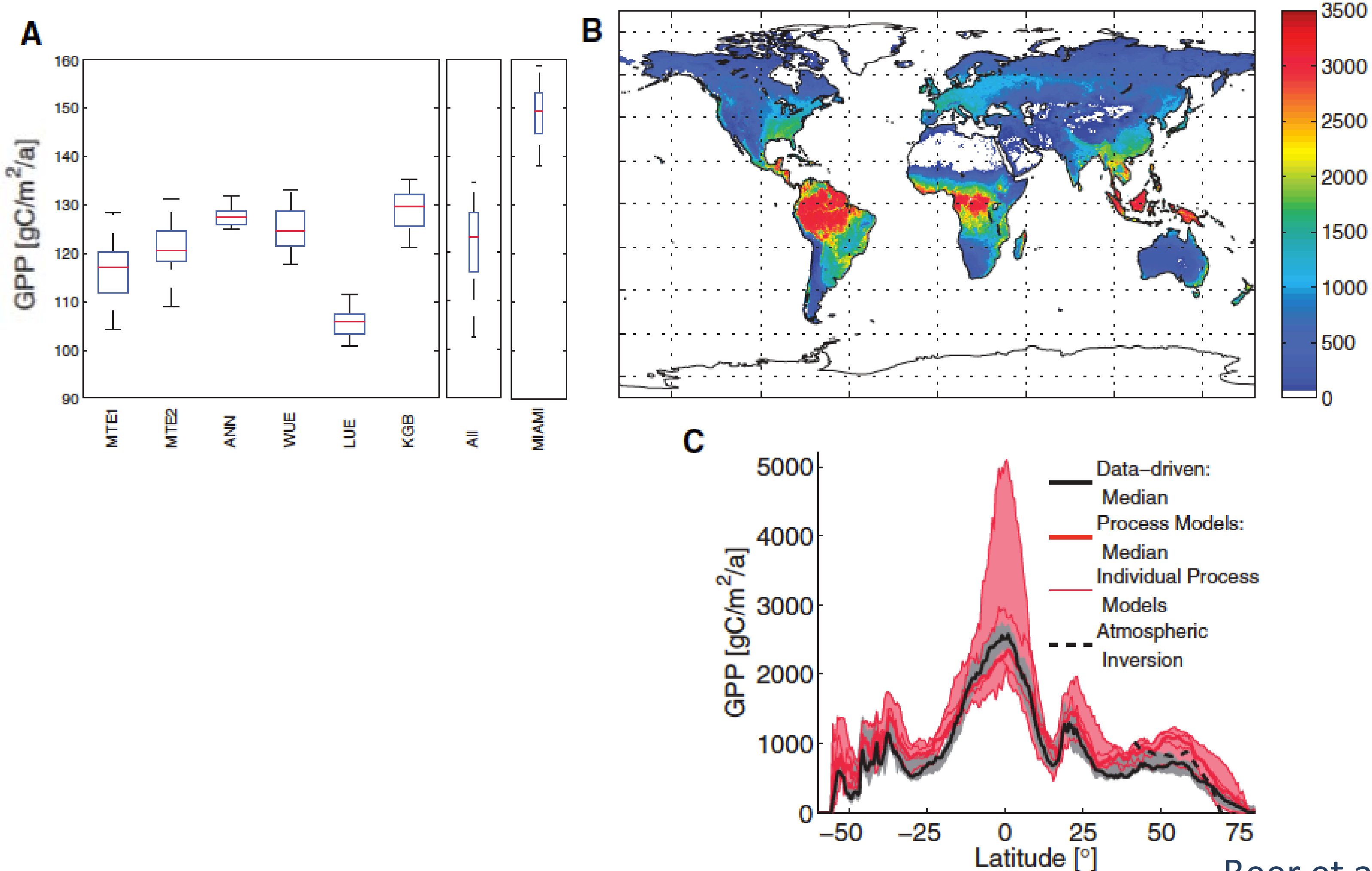
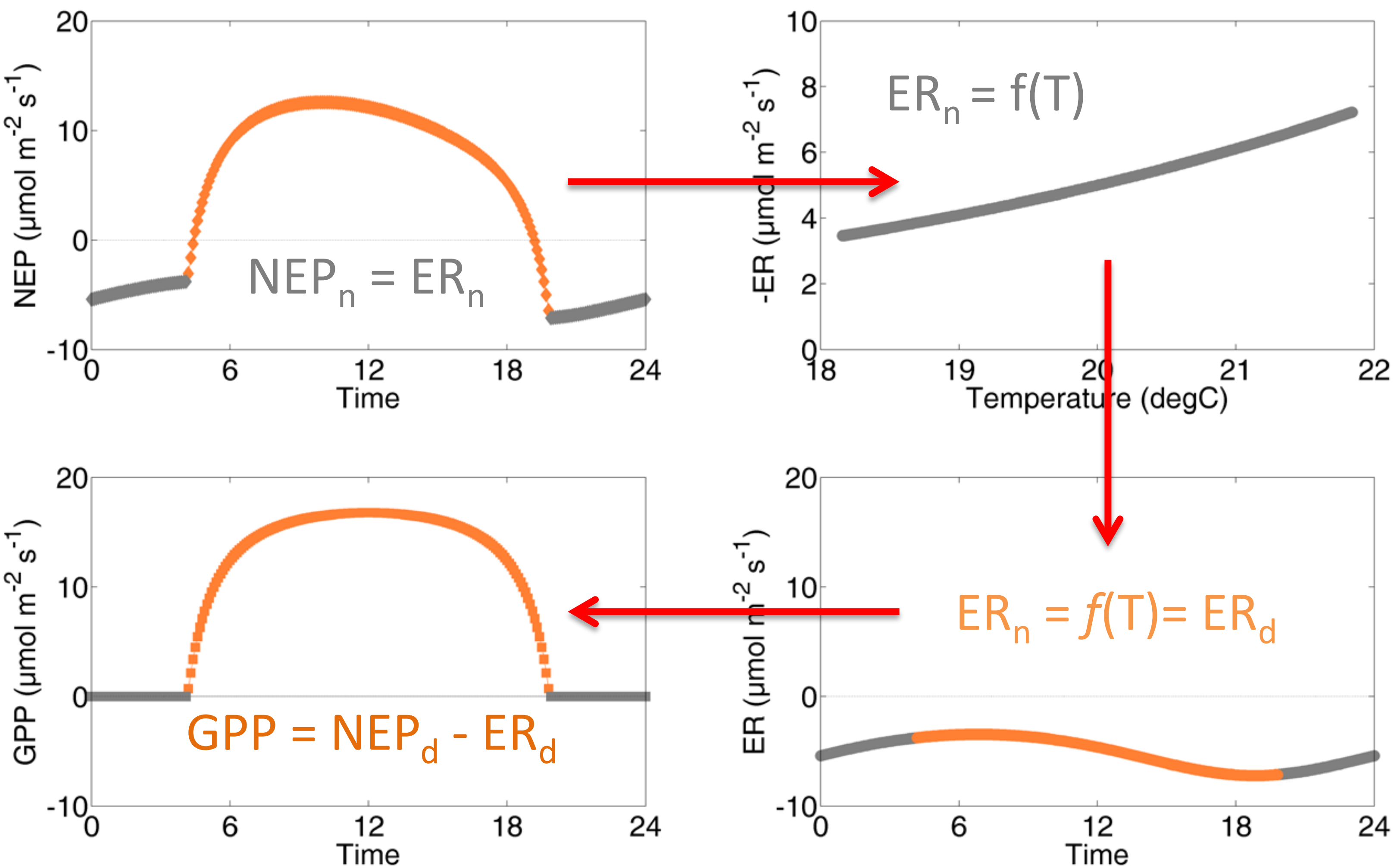
Background



Beer et al. (2010)

Background

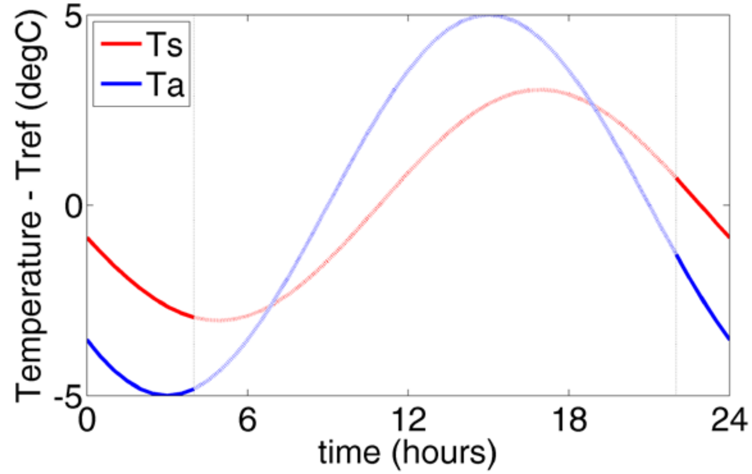

NEP (µmol m-2 s-1)
20
10
0
-10
0
6
12
18
24
Time
NEP$_n$ = ER$_n$
-ER (µmol m-2 s-1)
10
8
6
4
2
0
18
19
20
21
22
Temperature (degC)
ER$_n$ = f(T)
GPP (µmol m-2 s-1)
GPP = NEP$_d$ - ER$_d$
ER (µmol m-2 s-1)
ER$_n$ = f(T)= ER$_d$

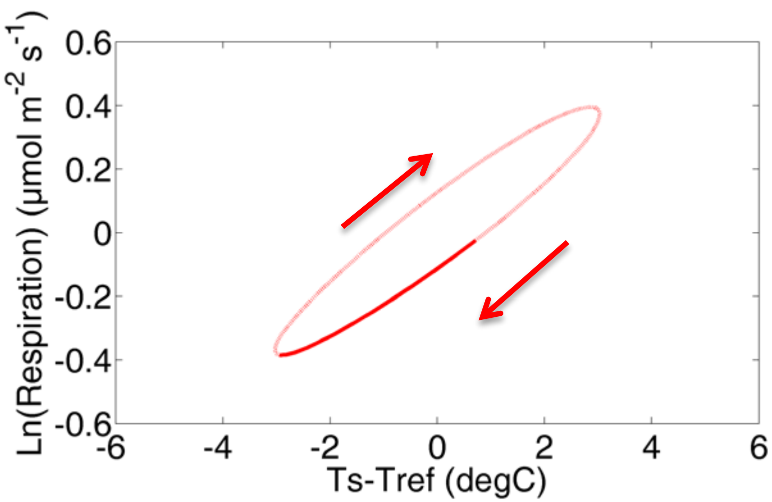
Flux partitioning revisited

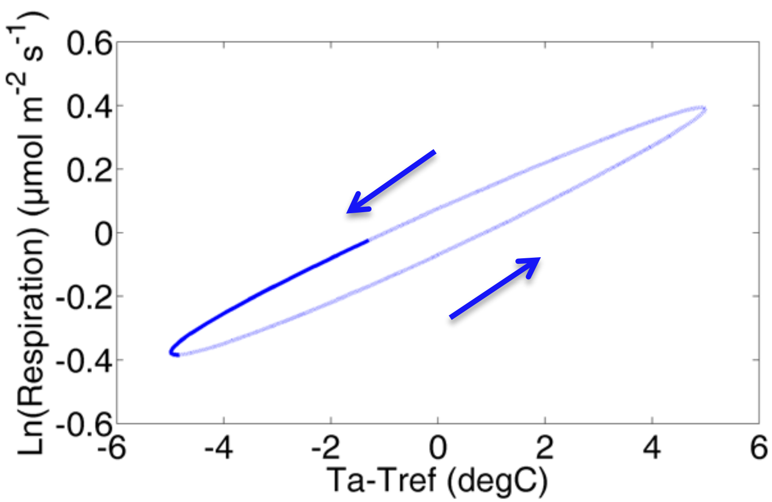
$R_{eco} = R_s + R_{ag}$

$R_s = f(T_s)$

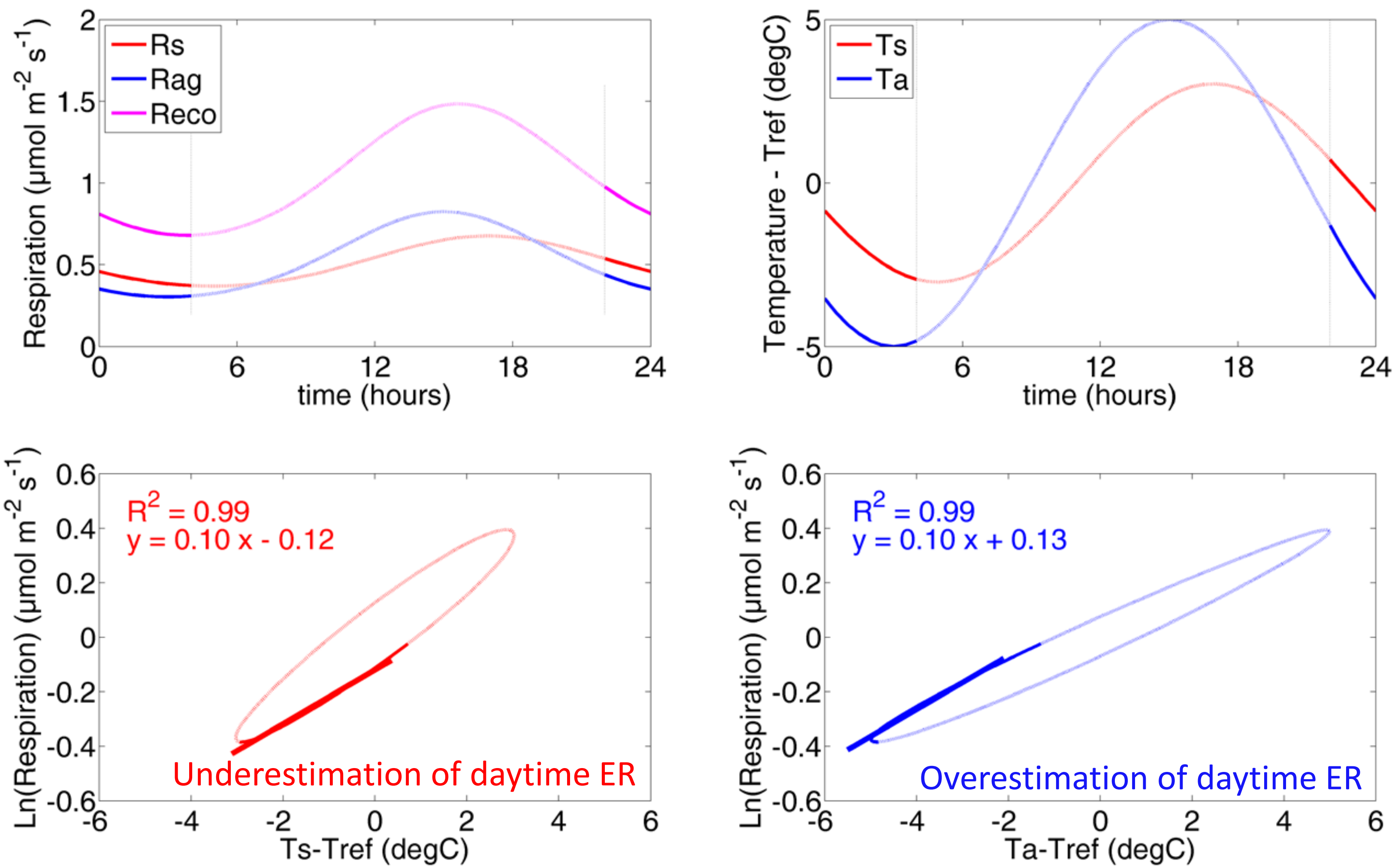
$R_{ag} = f(T_a)$



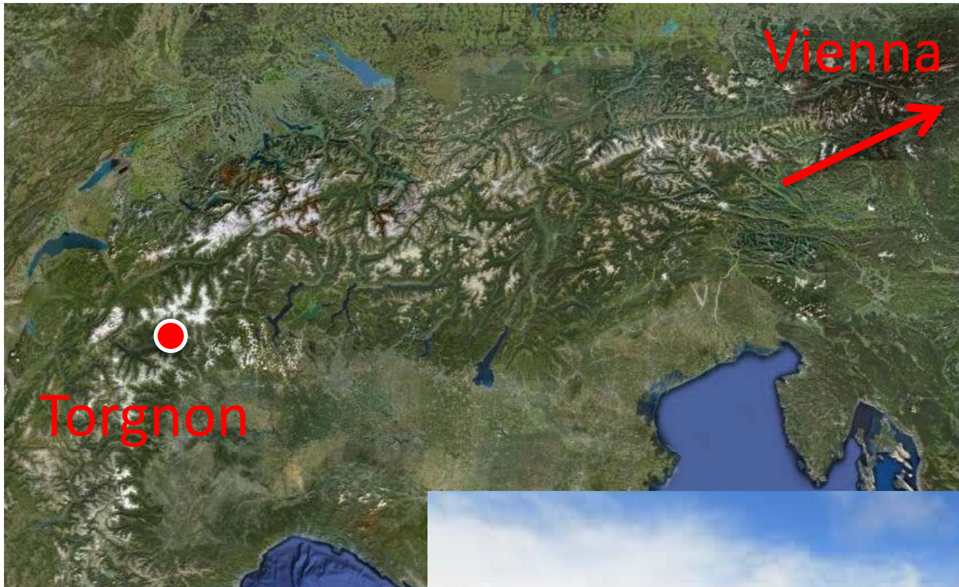




Flux partitioning revisited



Flux partitioning revisited



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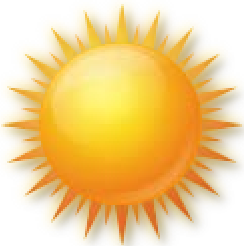
Flux partitioning revisited



“dark” R_{eco}

Flux partitioning revisited

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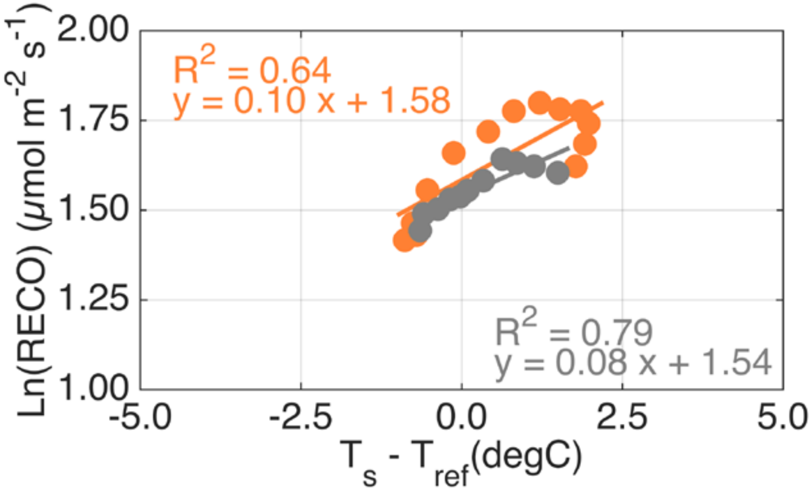
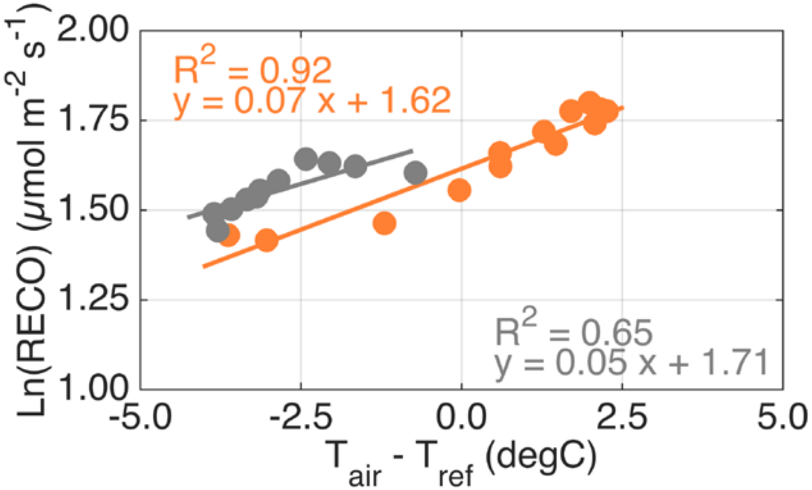
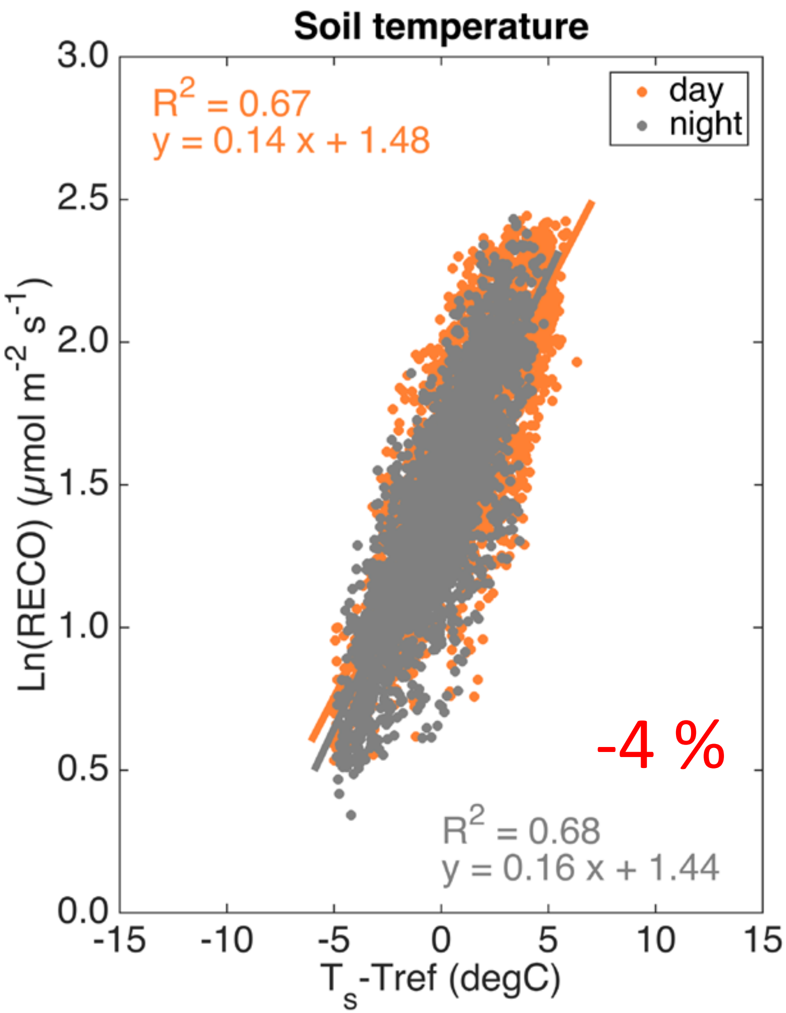
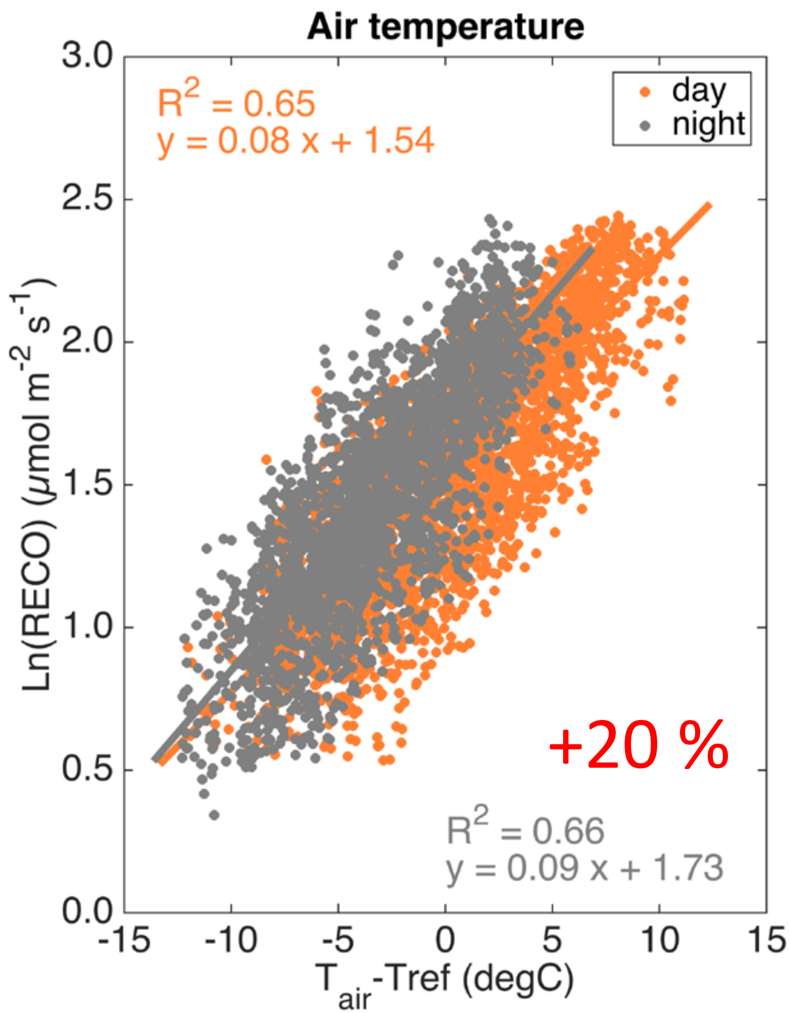






Flux partitioning revisited





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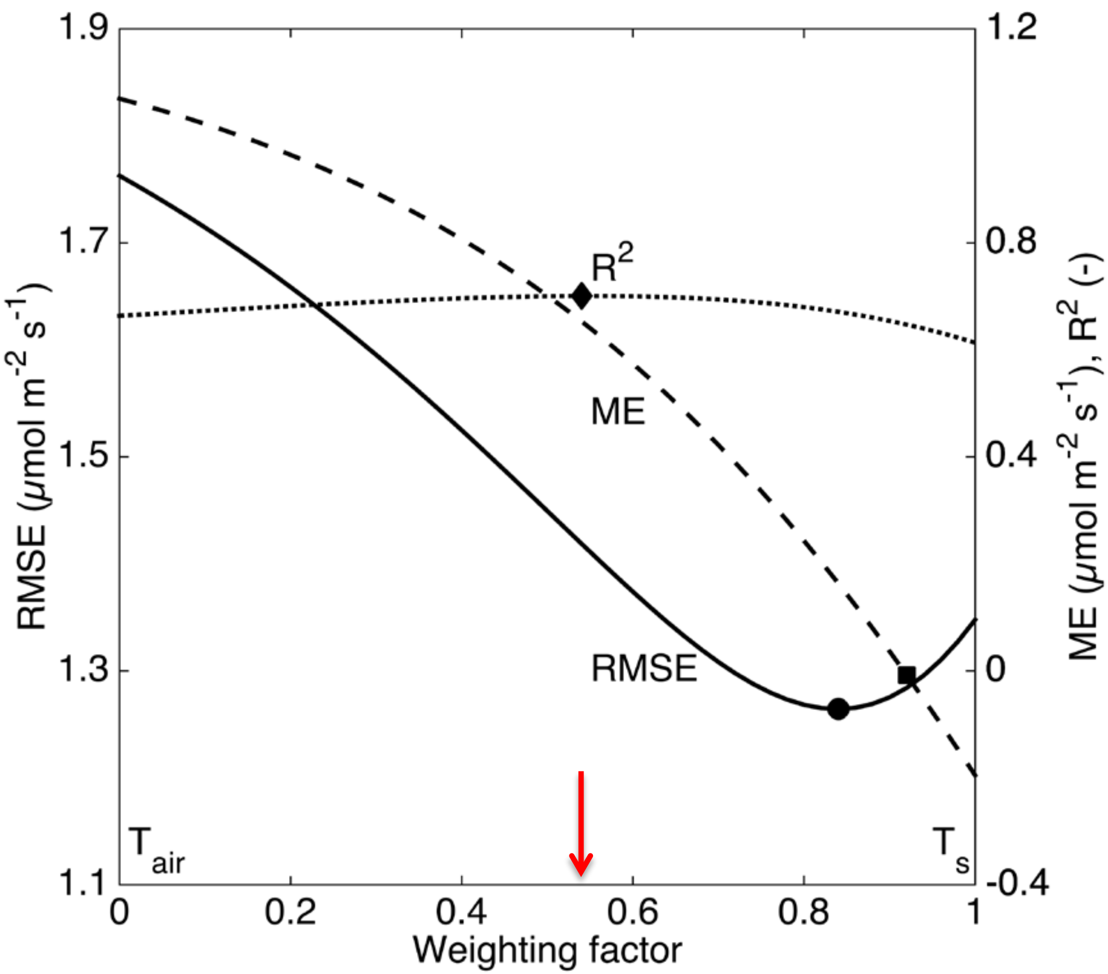
Flux partitioning revisited



Flux partitioning revisited

	R^2	MEF	RMSE	ME
T_{air}	0.66	0.31	1.76	1.07
T_{soil}	0.61	0.60	1.35	-0.20
$T_{weighted}$	0.70	0.55	1.42	0.65
Averaged output	0.70	0.64	1.27	-0.44
Unmixing	0.70	0.69	1.18	0.16

Conclusions

- Flux partitioning using either air or soil temperature results in biased estimates of daytime (dark) ER.
- The magnitude of bias is difficult to predict due to the interaction of several biophysical factors. It is definitely site-specific!
- It is thus critical to report the uncertainty of partitioned quantities and ultimately to move towards multi-model GPP and ER products, similar to current practice in climate science.
- “Unmixing” of above- and below-ground respiration components worked reasonably well for chamber data – can it be applied to noisy, u_*-filtered and gap-infected nighttime EC data?

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Georg Wohlfahrt

Institute of Ecology
University of Innsbruck

georg.wohlfahrt@uibk.ac.at

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