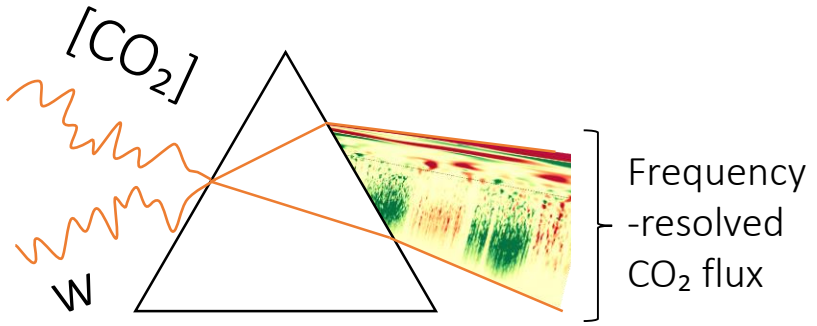
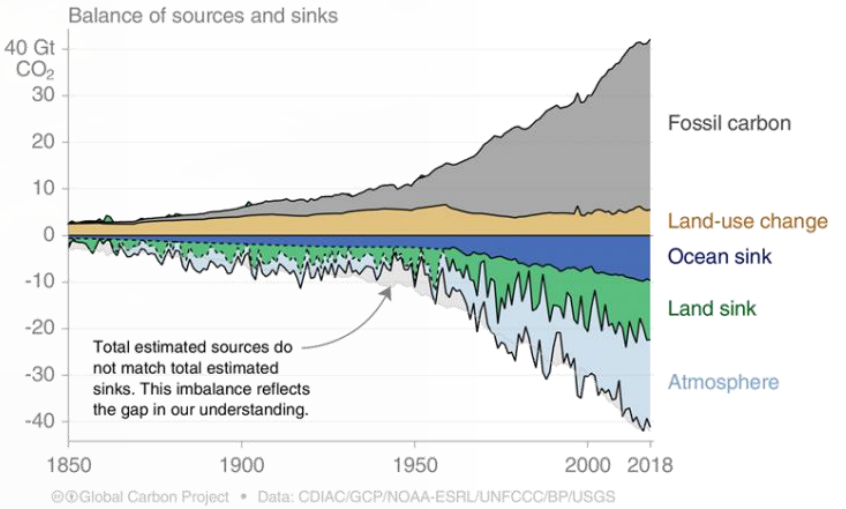
Improvement of CO2 flux quality through wavelet-based Eddy Covariance: a new method for partitioning respiration and photosynthesis

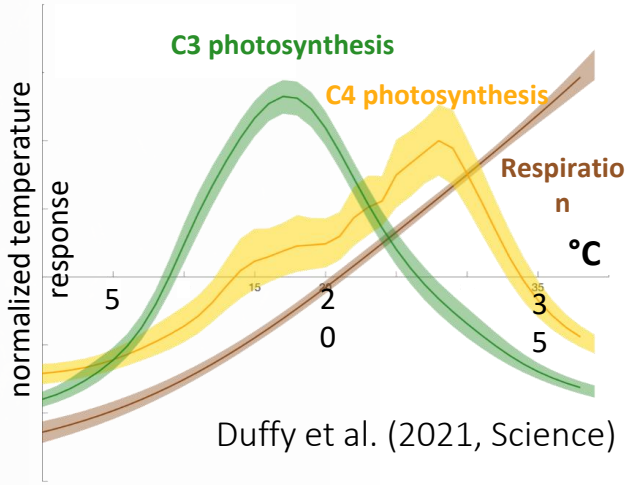


Pedro Coimbra✉, Benjamin Loubet, Olivier Laurent, Matthias Mauder, Bernard Heinesch, Jonathan Bitton, Daniel Berveiller, Nicolas Delpierre, Jérémie Depuydt, Pauline Buysse

pedro-henrique.herig-coimbra@inrae.fr

09-10/11/2023 – Montpellier (France)



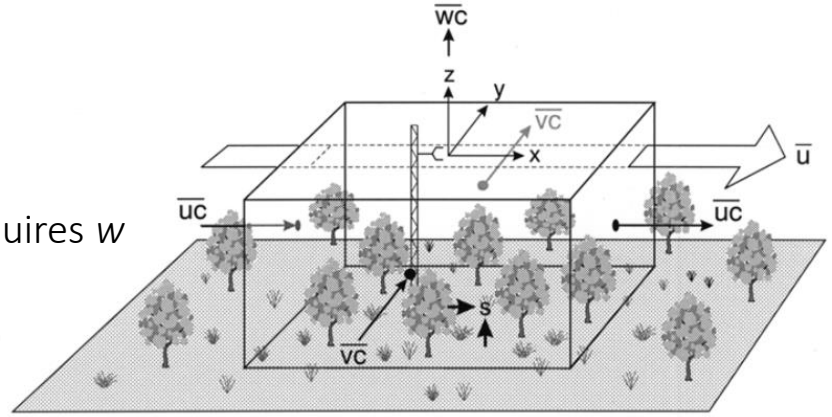


Duffy et al. (2021, Science)

Coimbra et al. (submitted to AFM)

The eddy covariance method (intuitive explanation)

(After corrections) requires w and a concentration c
Net surface flux ($\overline{w'c'}$)



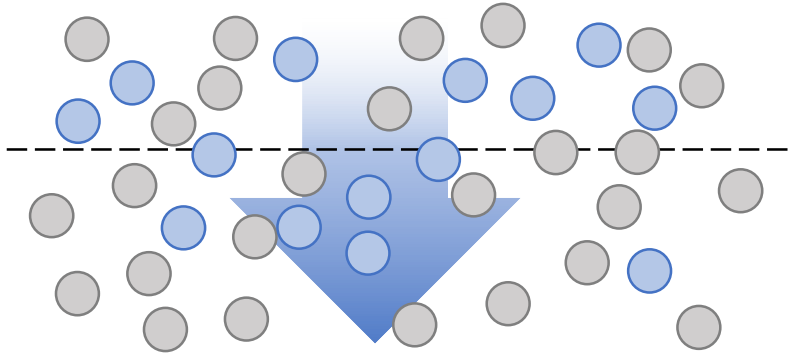
Source: Finnigan et al. (2003)

measuring every many seconds

Lost of high-frequency
Not recommended

How we do it

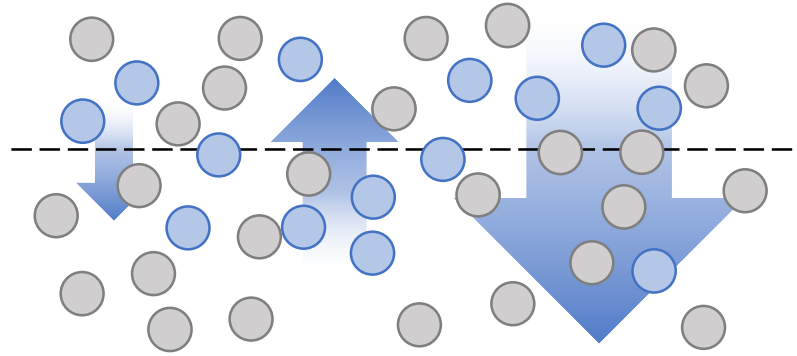
High-frequency measurement (few Hz)



1D flux (time-series)
Requires stationarity
(Co-)spectra possible but calculated apart

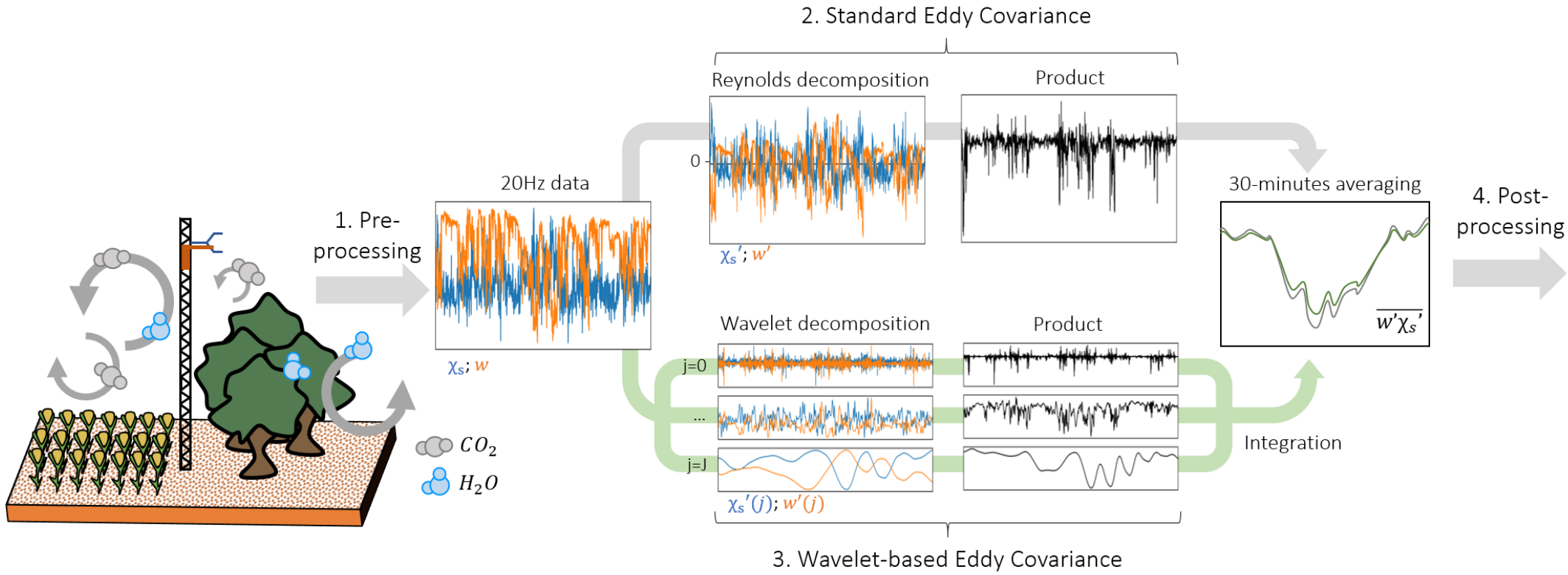
Proposed here

Frequency decomposed measurement

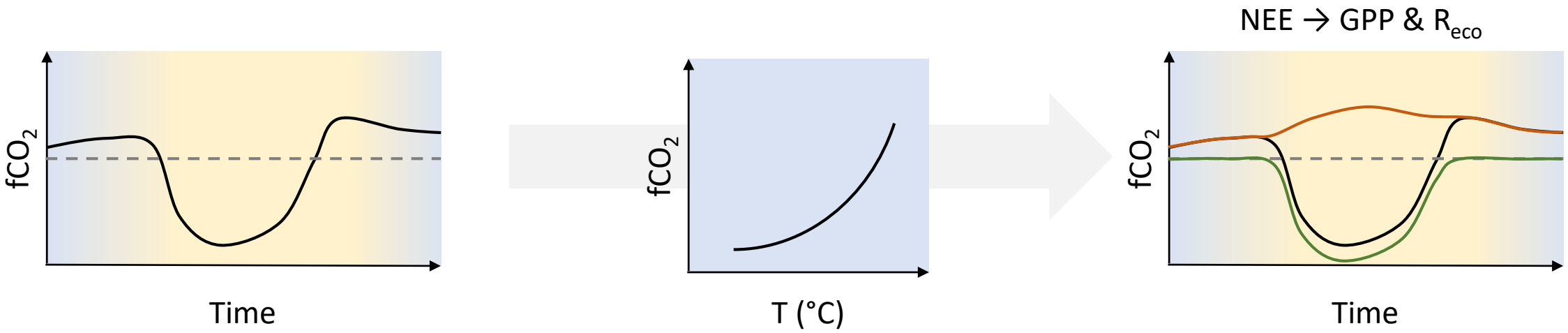


2D flux (time-series)
<u>Does not</u> require stationarity
Split flux in different scales (interpreted as eddy sizes) and possibly processes as well

Comparison: standard and wavelet EC

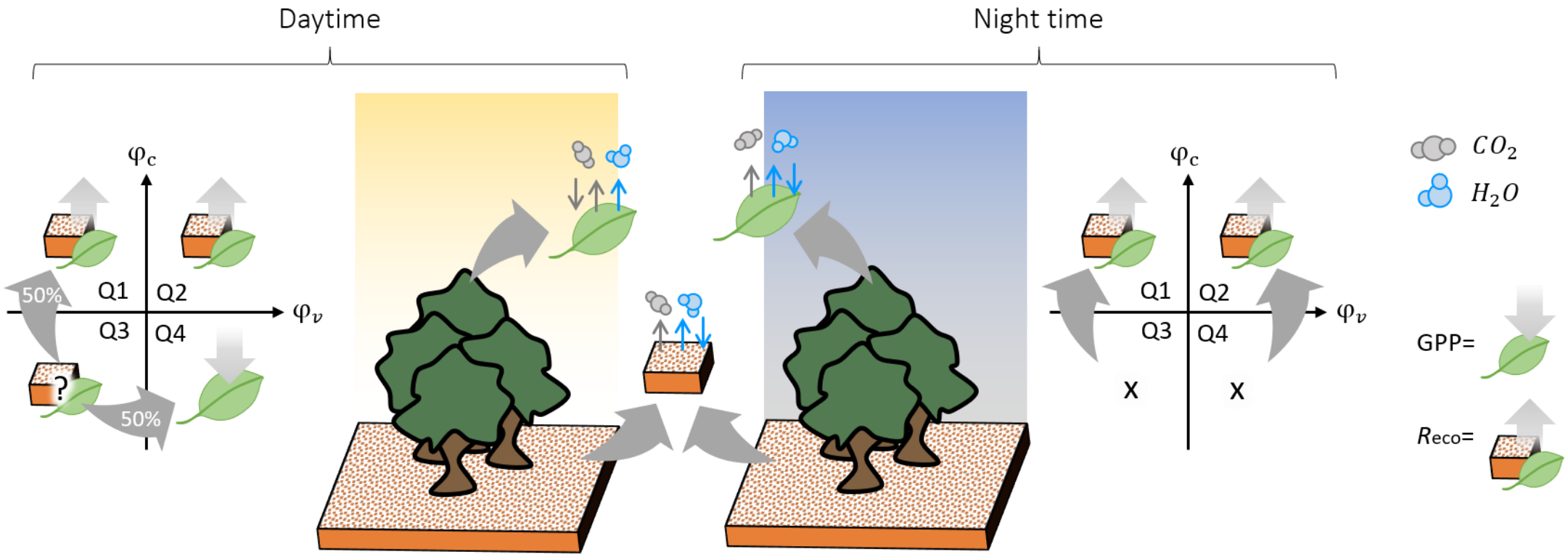


Partitioning methods (night-time)

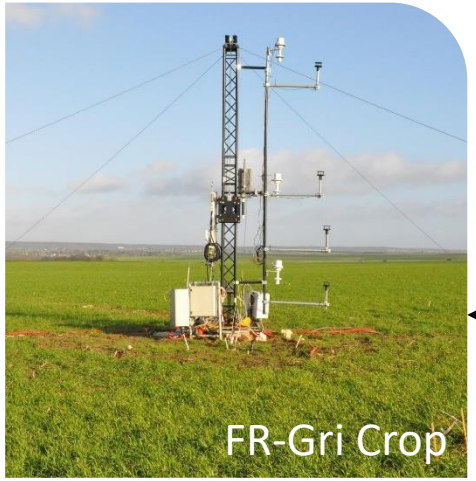


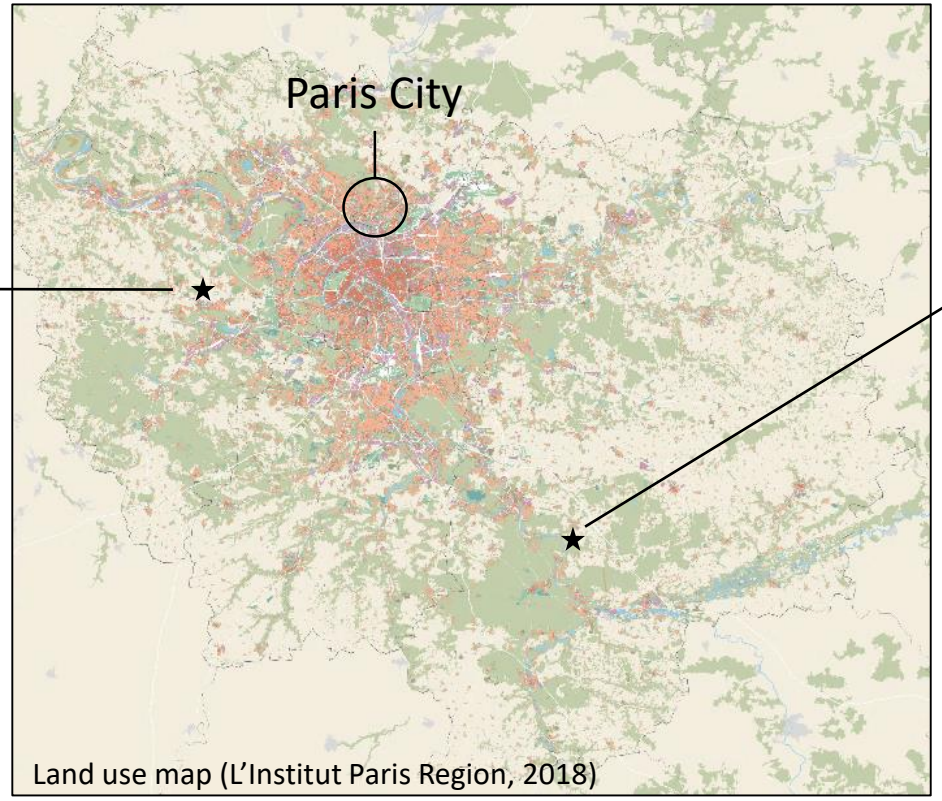
- Model-based
- Wind direction not considered (heterogeneity)

New direct partitioning method



Material: ICOS Ecosystem

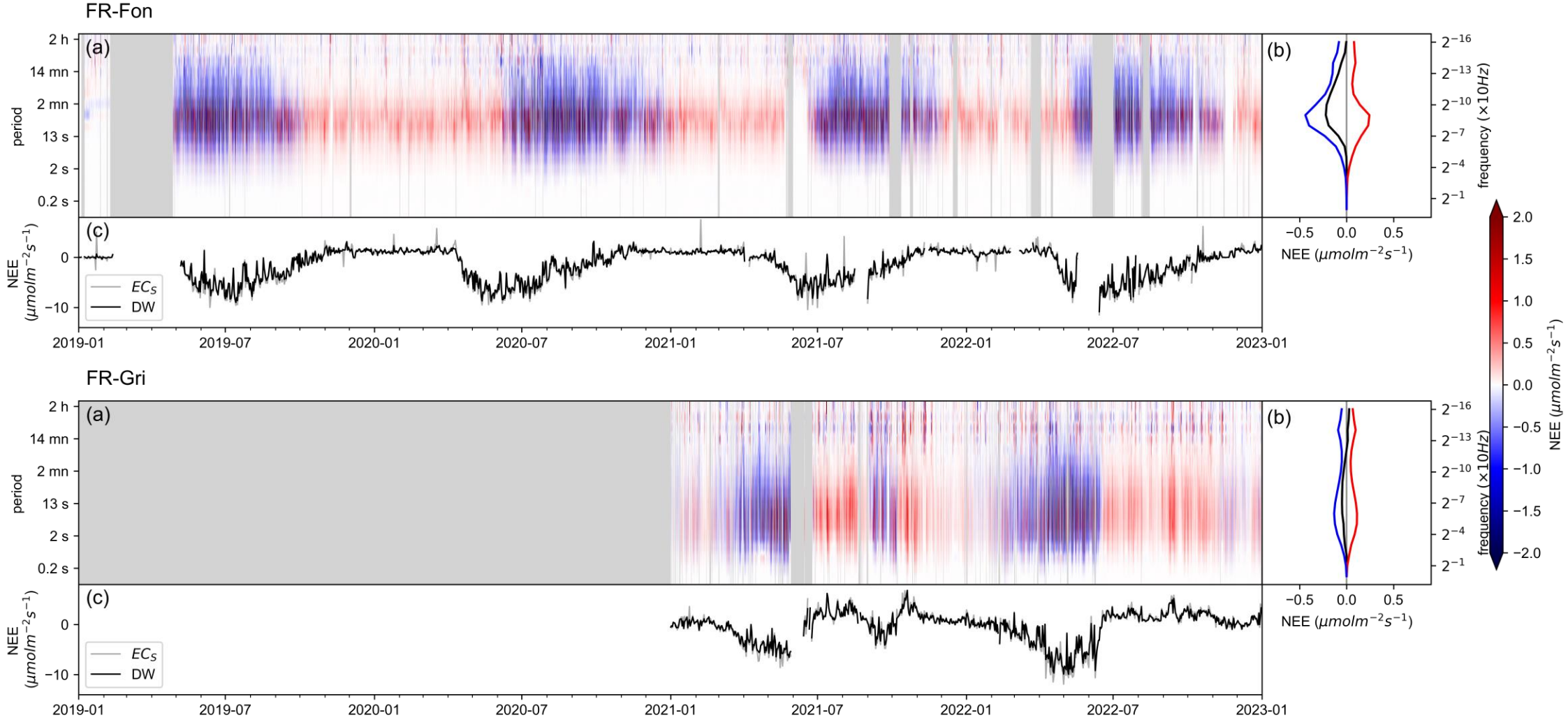




Tower

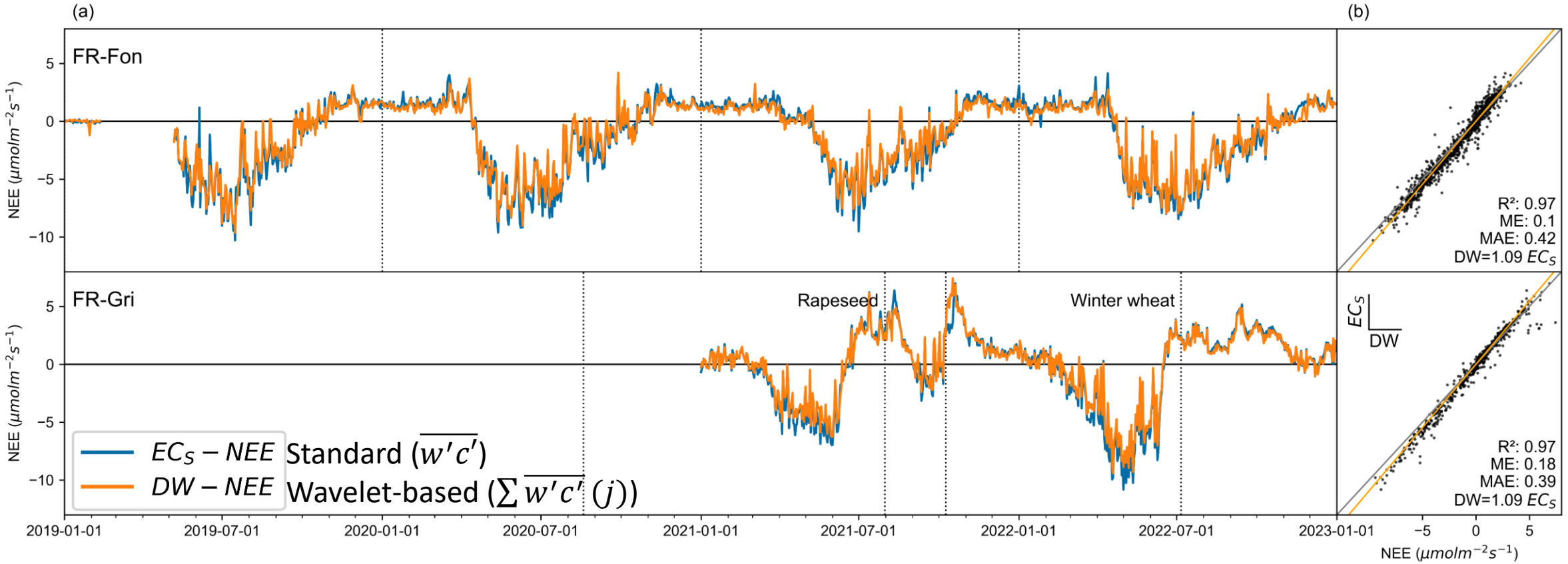
Target area

Raw data



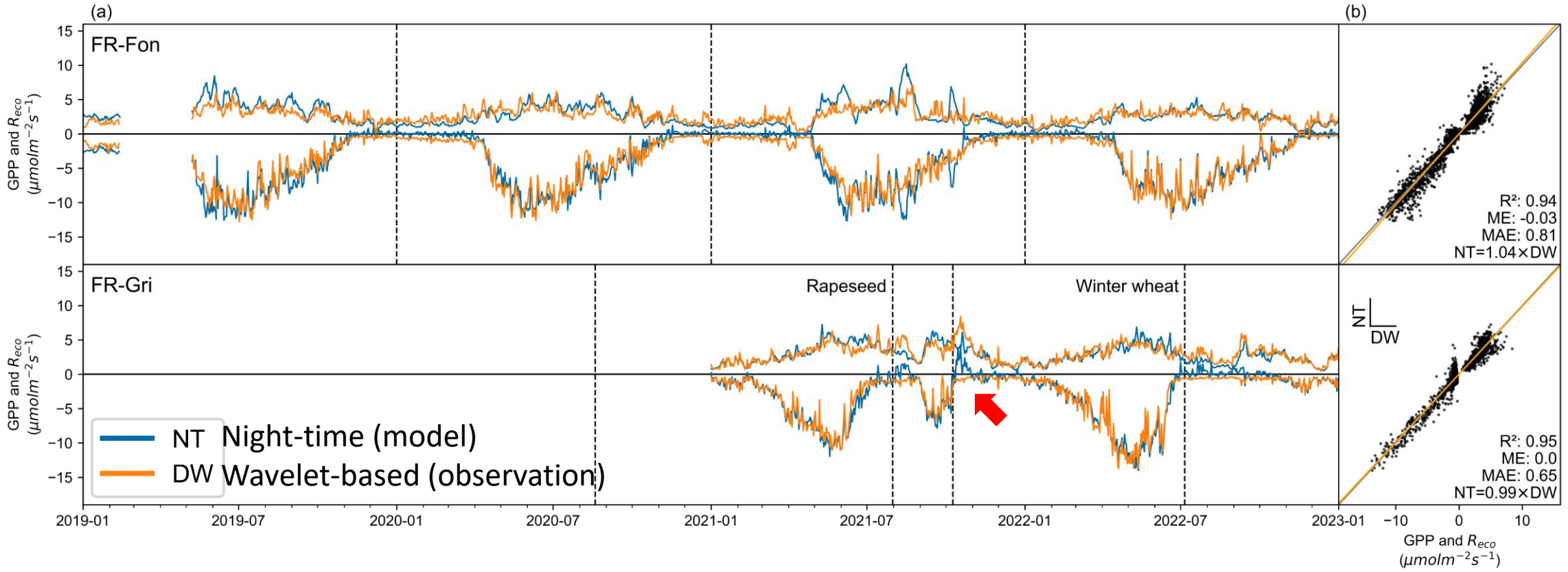
(a) cospectra; (b) mean cospectra; (c) integrated cospectra (black) and standard EC (gray)

Gap-filled data keeps the overall great agreement between methods



Proposed method (**orange**) has **17-29 %** less gap-filling

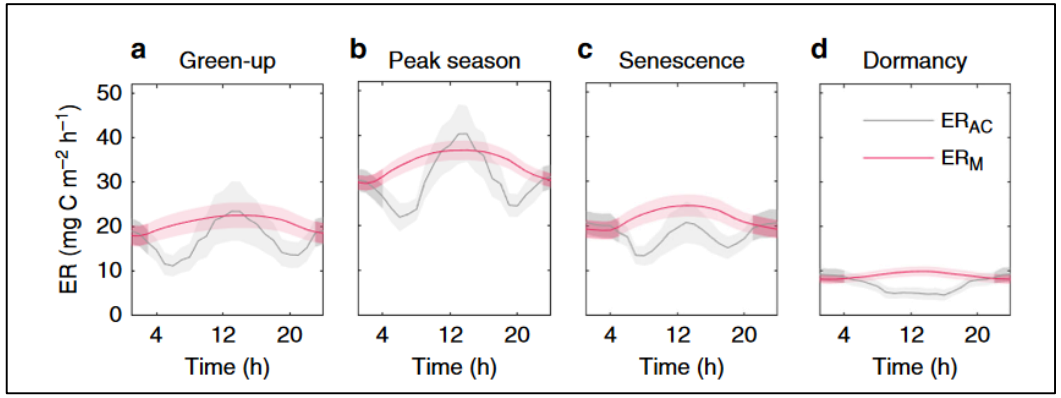
New direct partitioning overall agrees with night-time method (standard)

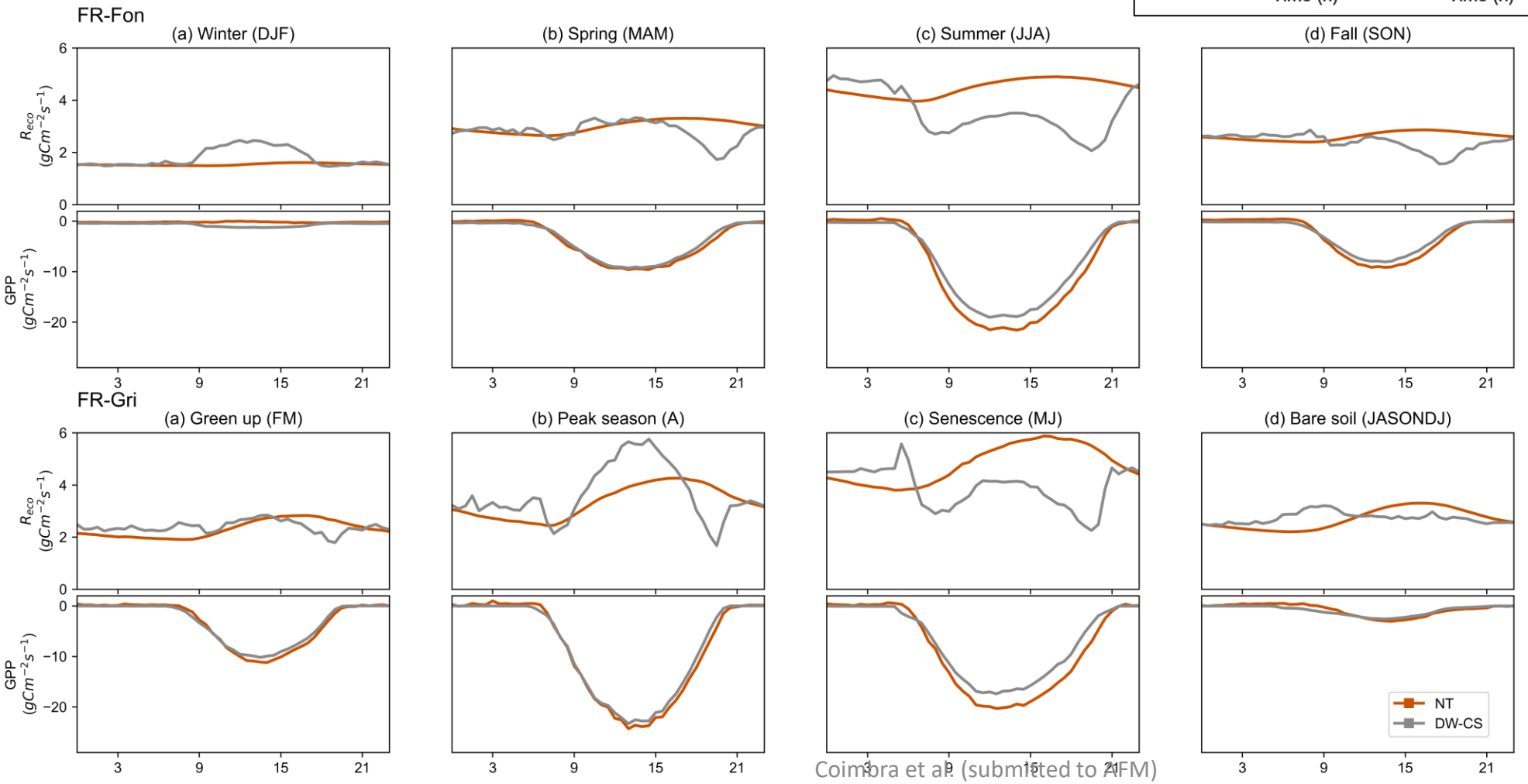


Proposed method avoids common mistakes

GPP and R_{eco} diel patterns

Järveoja et al. 2020. Nature Commun.





Coimbra et al. (submitted to AFM)

Keynotes

- Wavelet-based Eddy Covariance yields significantly fewer gaps than standard method
- Reduced gaps led to small difference on carbon budget but improved partitioning (*not shown here*)
- New wavelet-based direct CO2 partitioning method finds bimodal respiration pattern
- No-extra measurements are required allowing reprocessing of old data
- Promising method for broader applications, other gases, landscapes and site setups

Perspectives

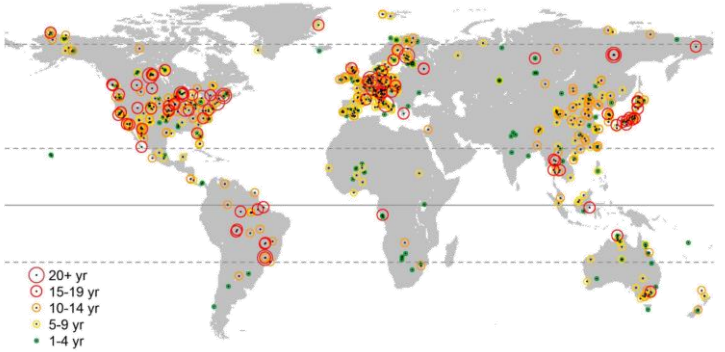
We need the minimal:

w,

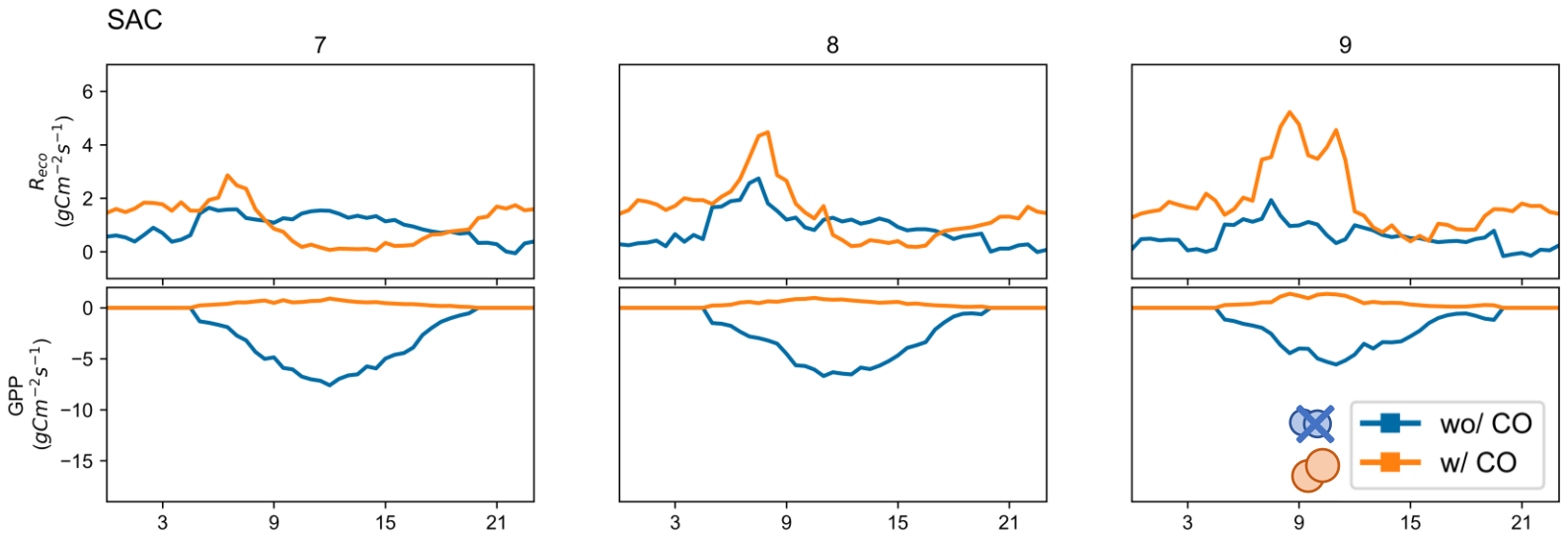
gas of interest (CO_2),

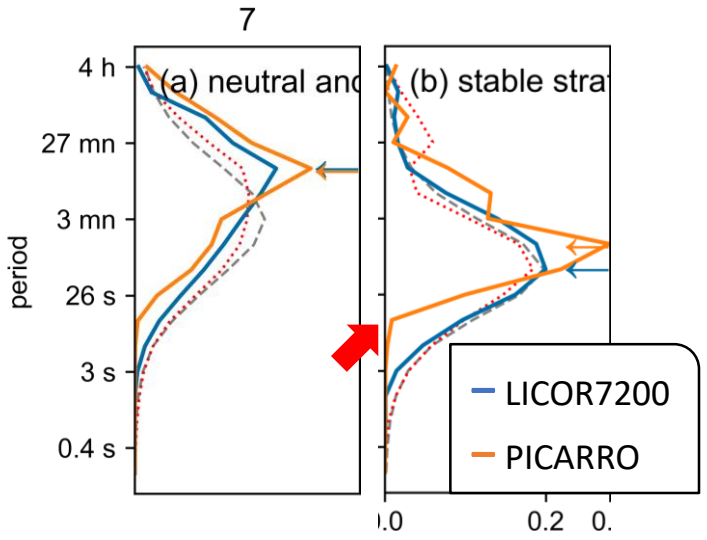
gas to condition (H_2O)

Does the result holds using all ICOS ETC sites ? (collab ICOS ETC)



w'CO2' cospectra seems ok





Merci

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