(Preliminary analysis of) Diurnal cycles in land carbon fluxes and imprint on atmospheric CO_2

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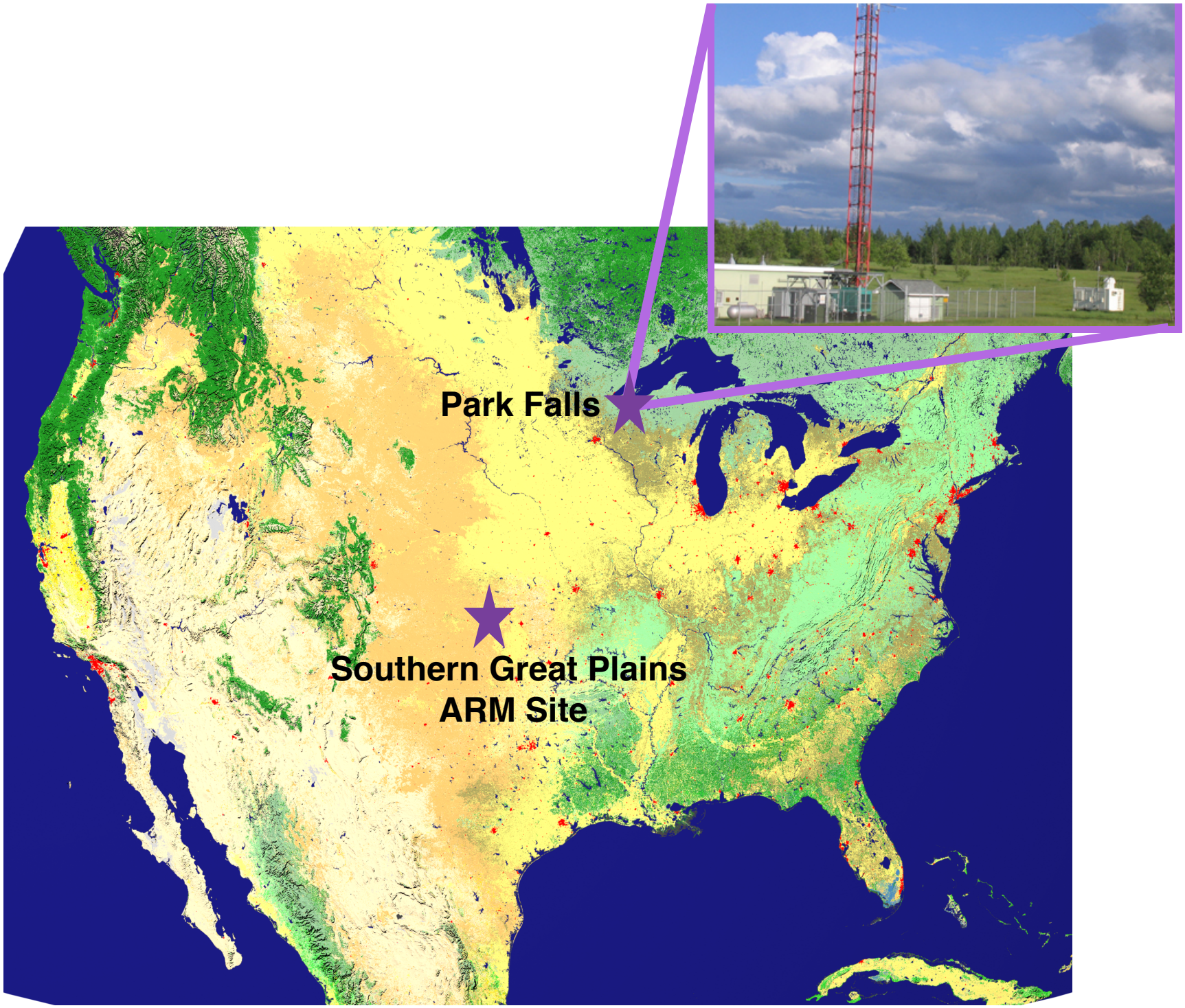
Thank you to: Dave Lawrence, Cecile Hannay, Keith Lindsay, Anthony Torres

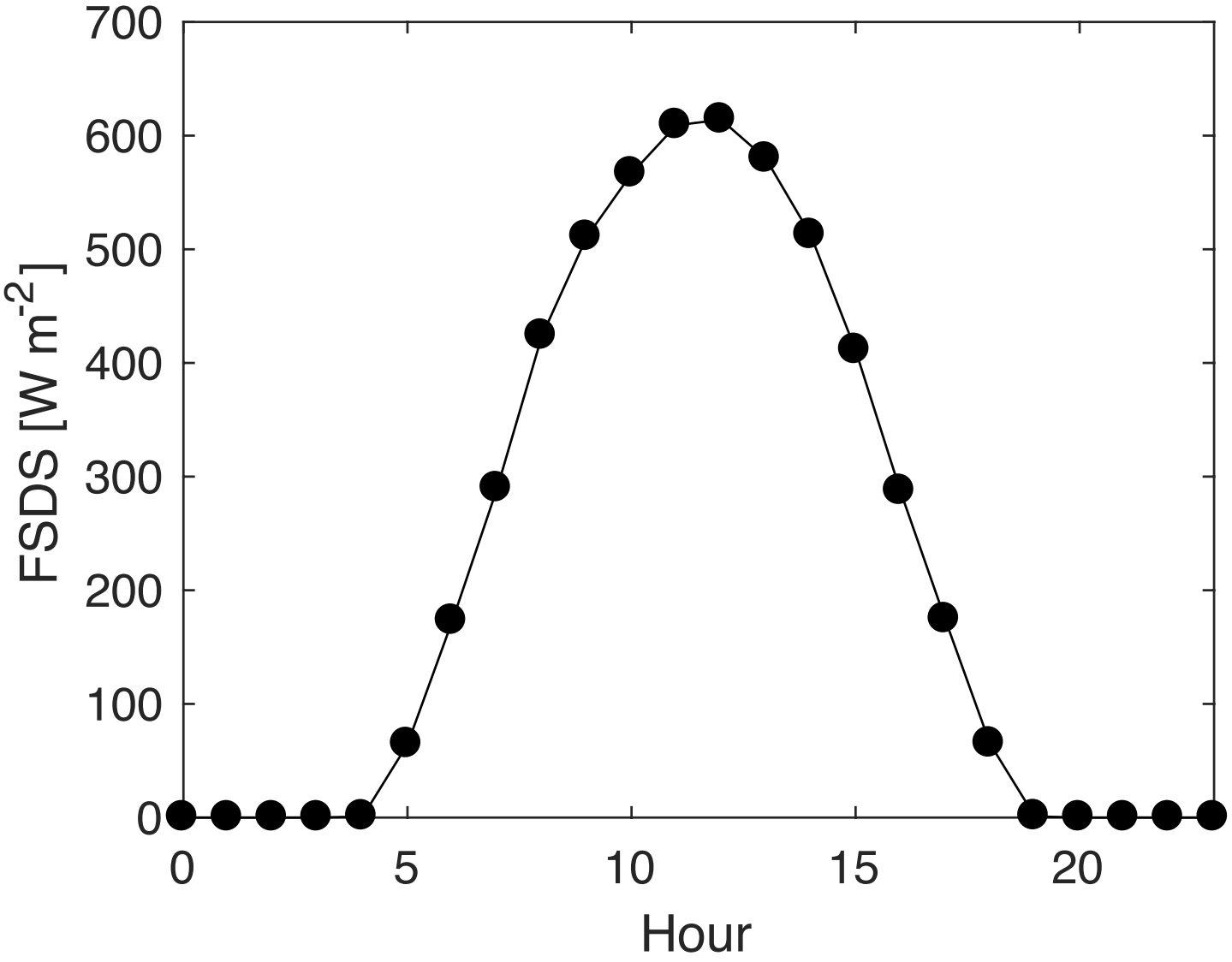
Why evaluate the diurnal cycle?

Seasonal cycle in carbon fluxes is tied to strong seasonal forcings (temperature, radiation)

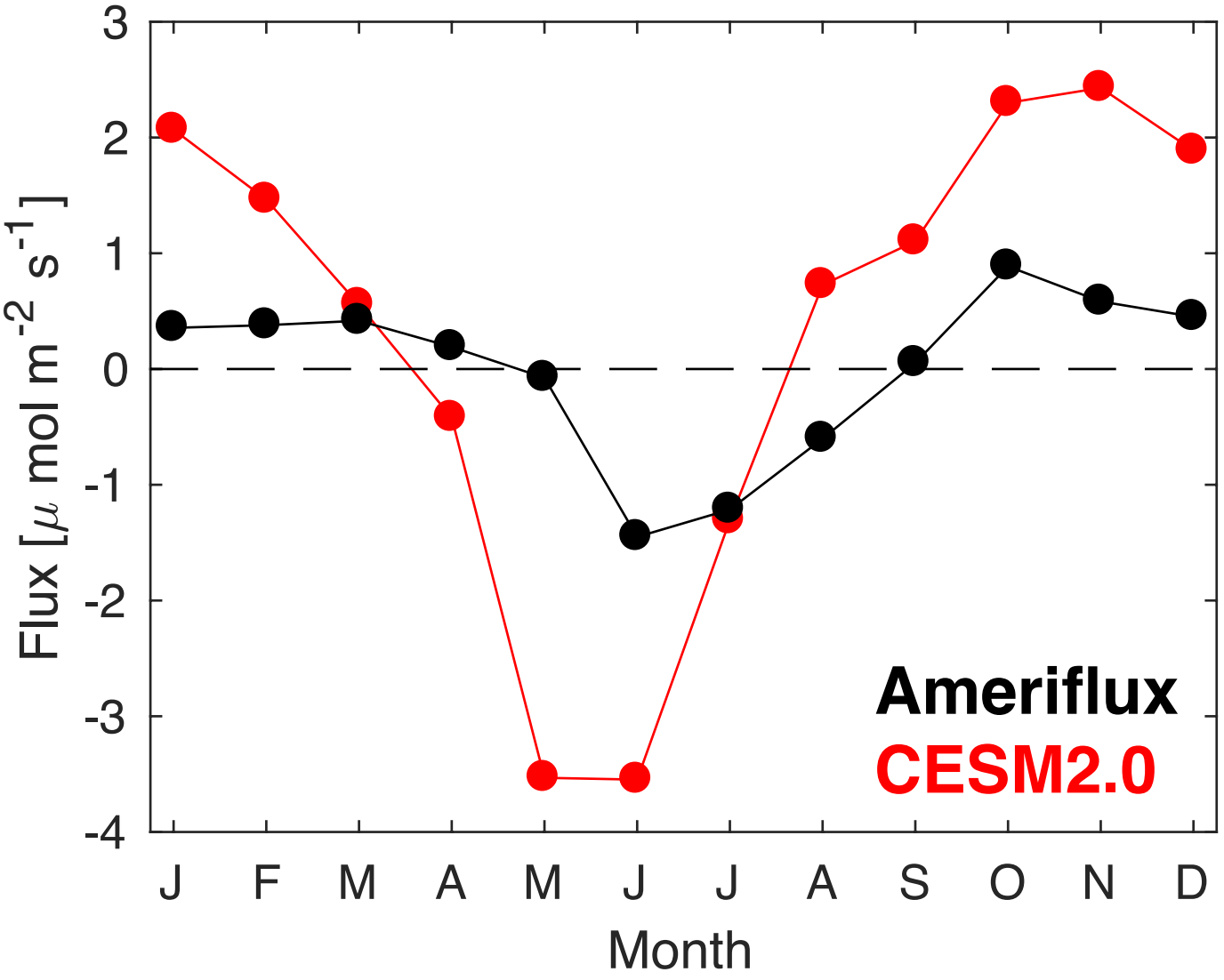
Evaluating fluxes over a range of timescales yields greater confidence that sensitivities and mechanisms are faithfully represented in land models


Park Falls
Southern Great Plains
ARM Site

Diurnal cycle in May solar radiation at Park Falls, Wisconsin



Seasonal cycle of NEE at Park Falls, Wisconsin



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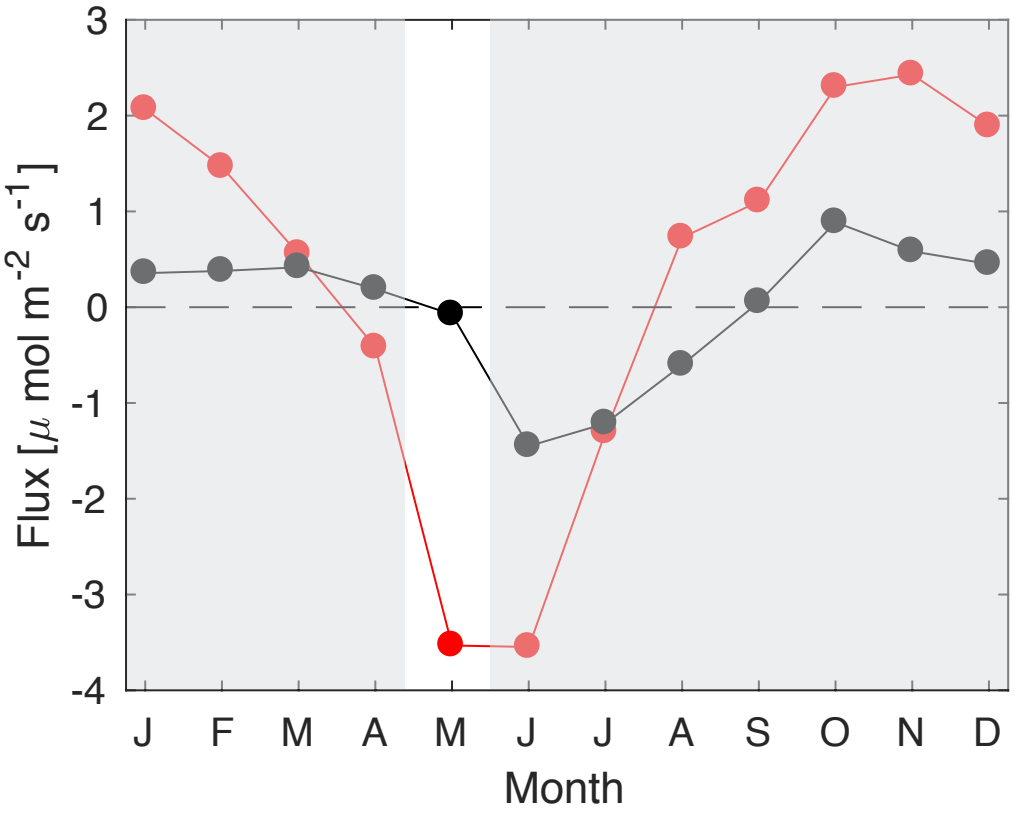
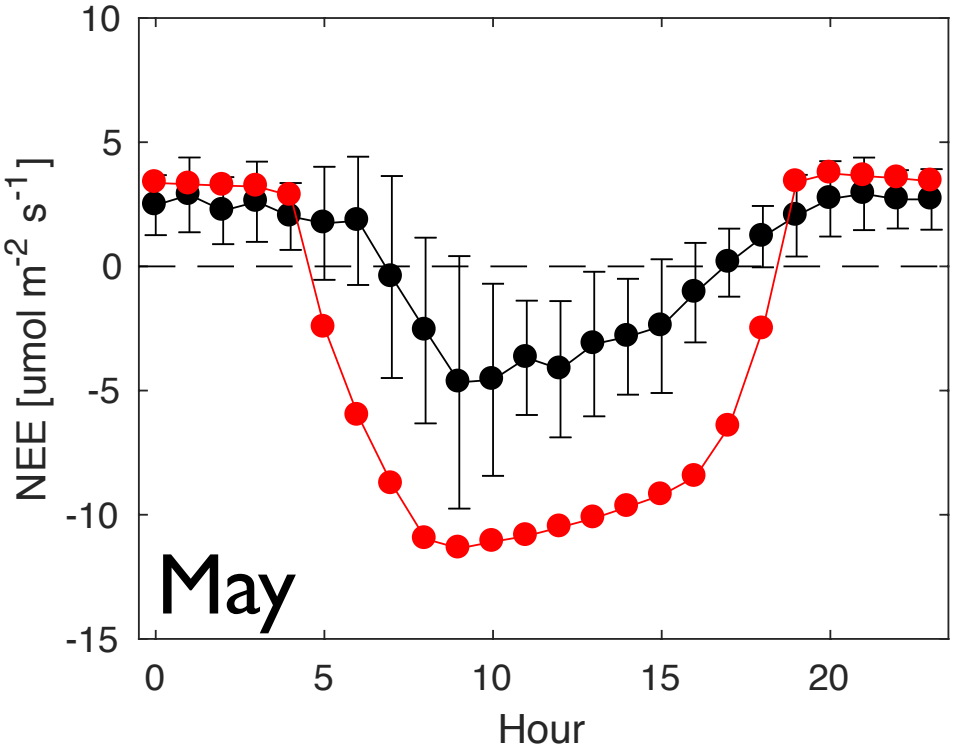


Ameriflux

CESM2.0



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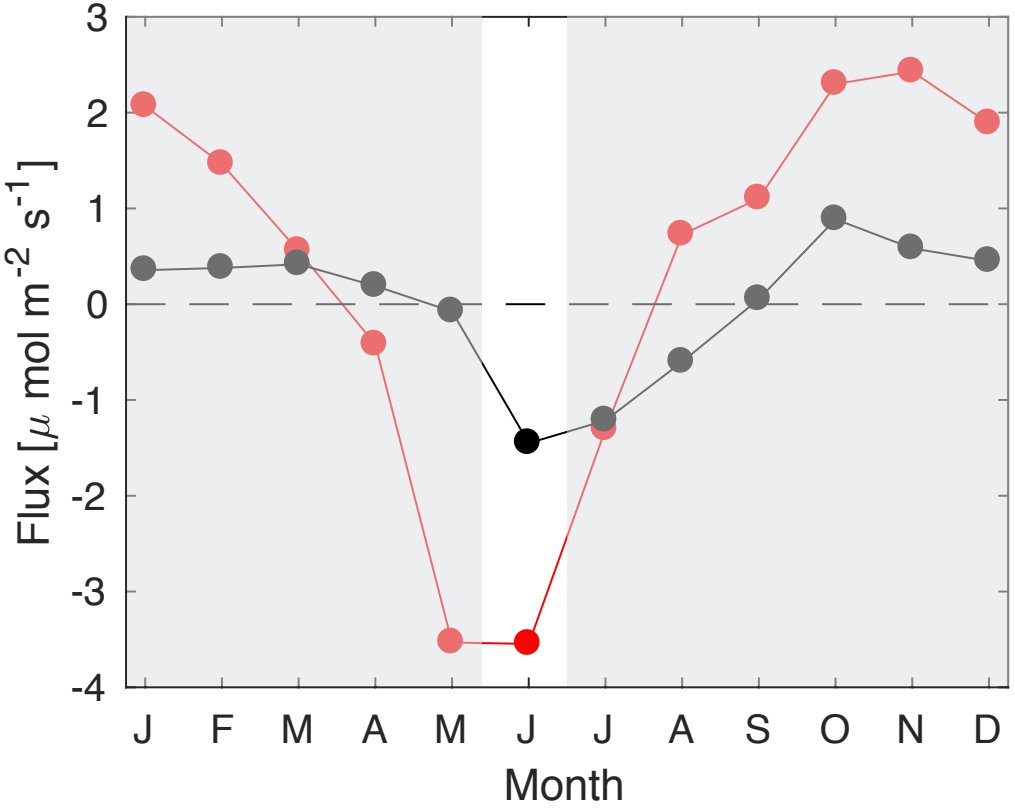

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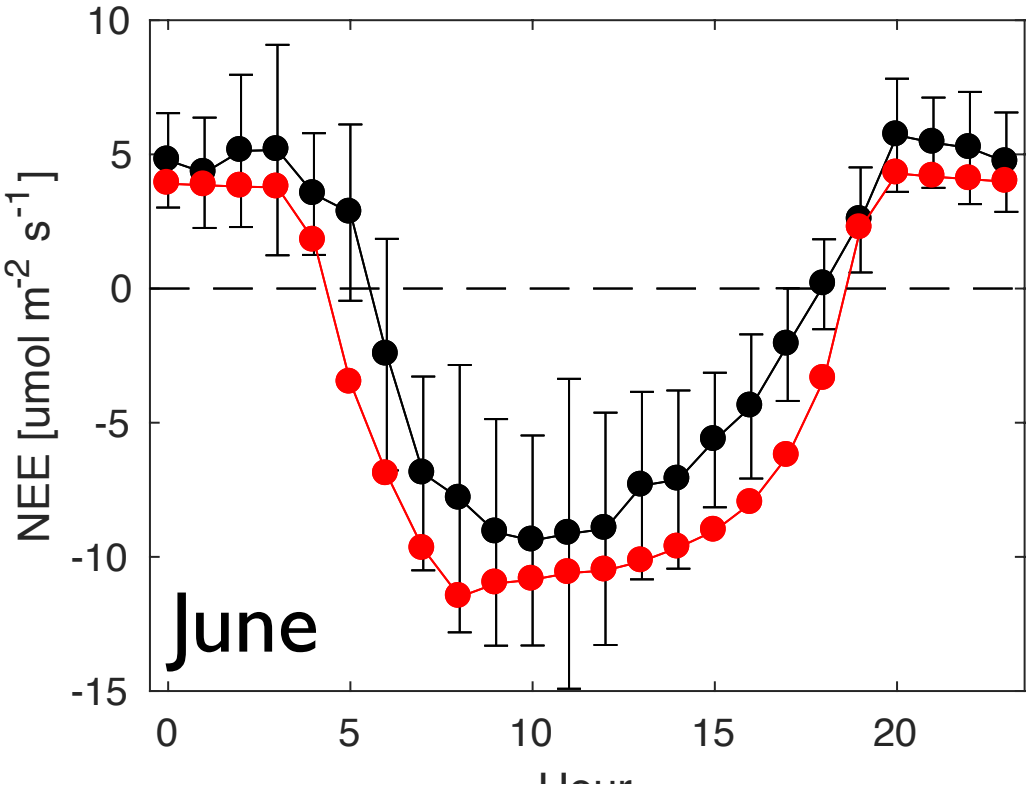

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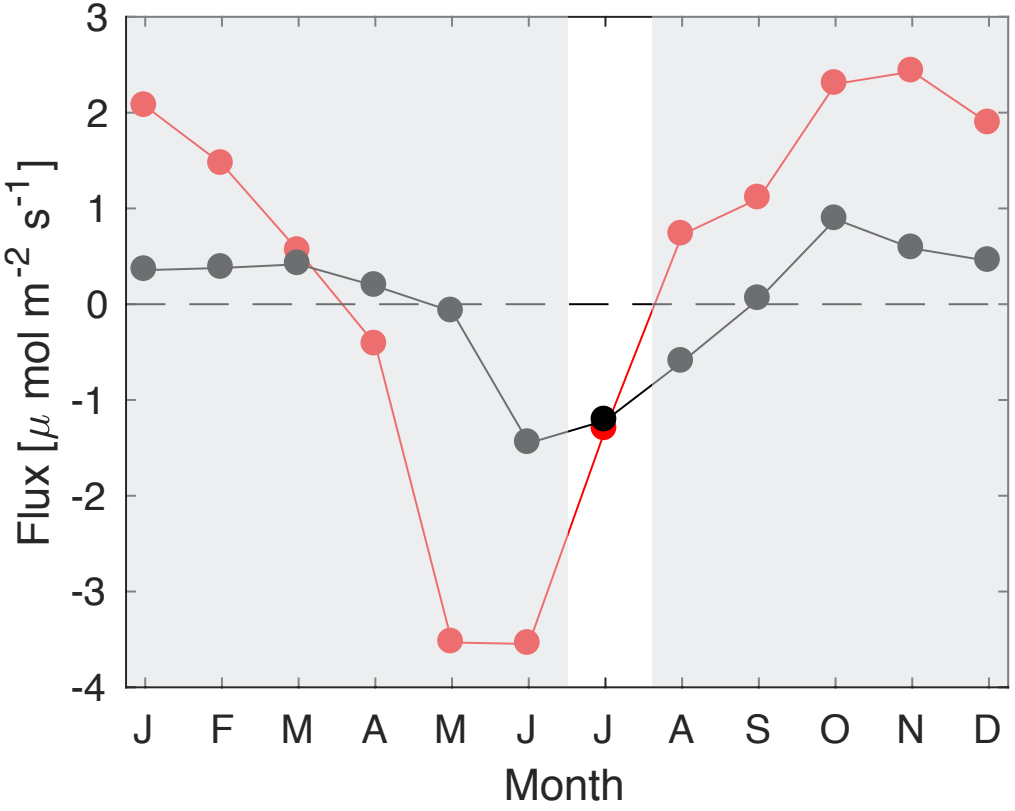

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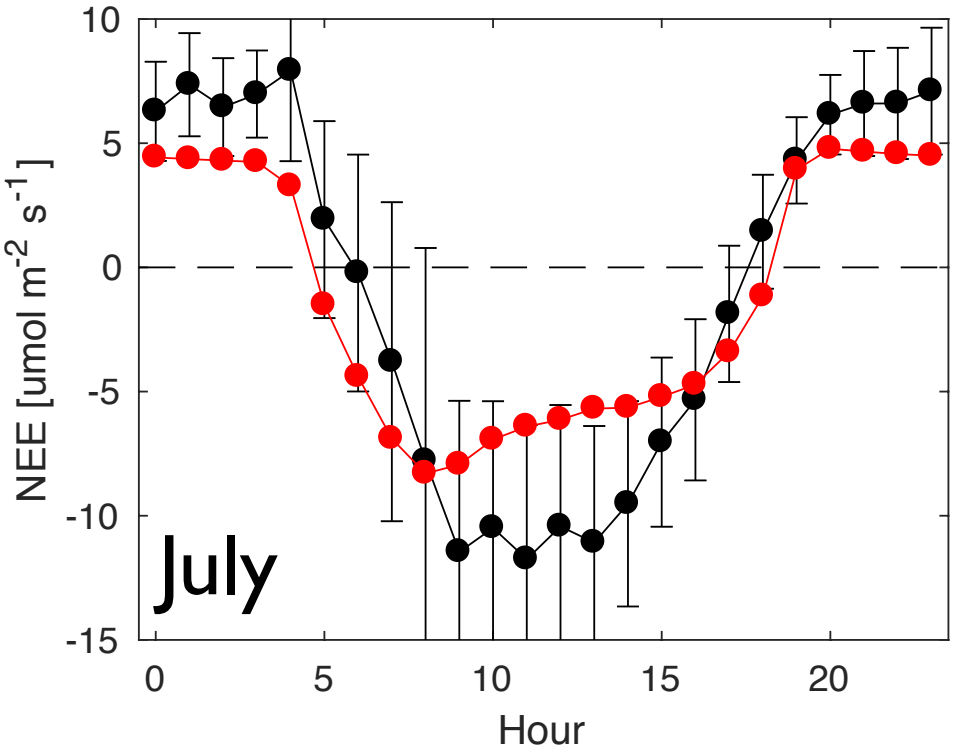

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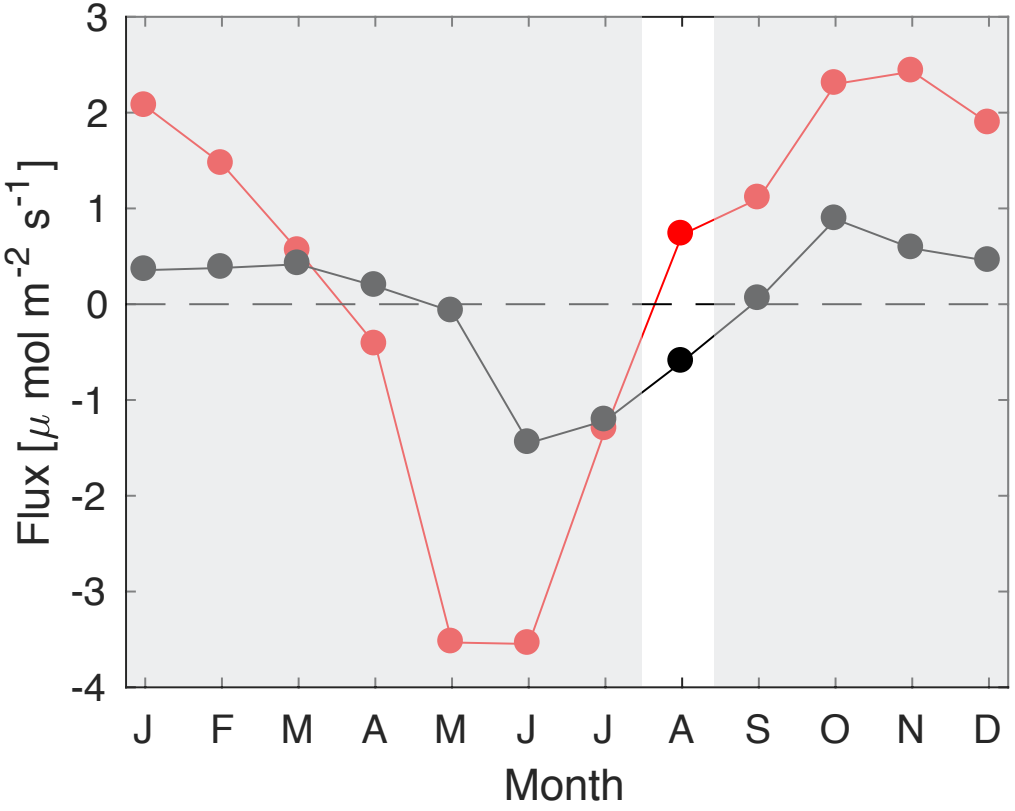

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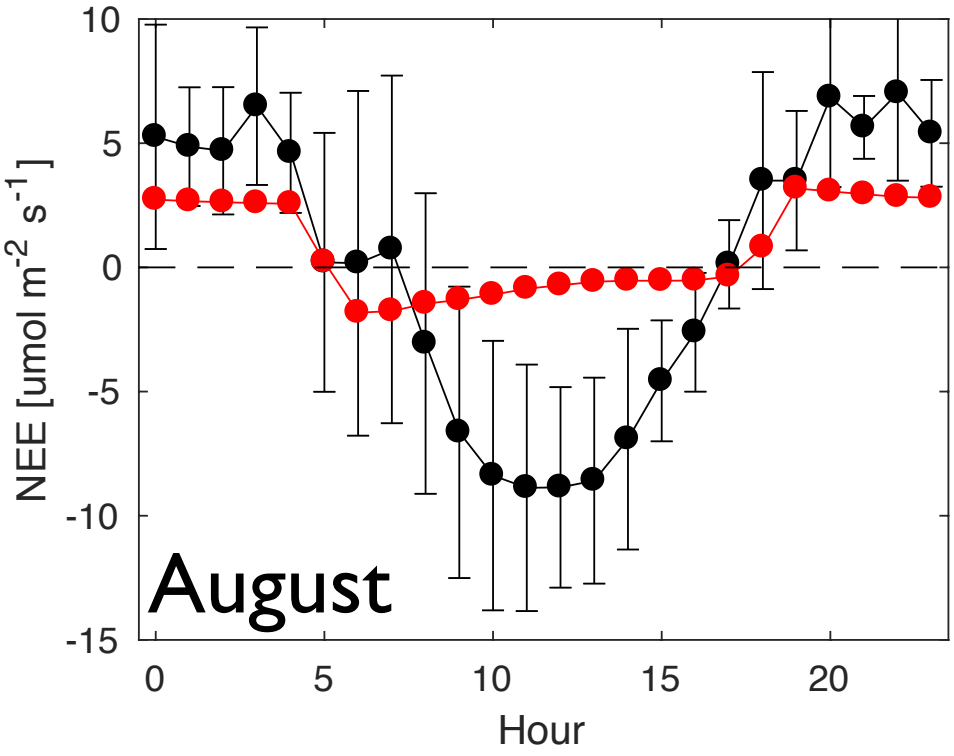

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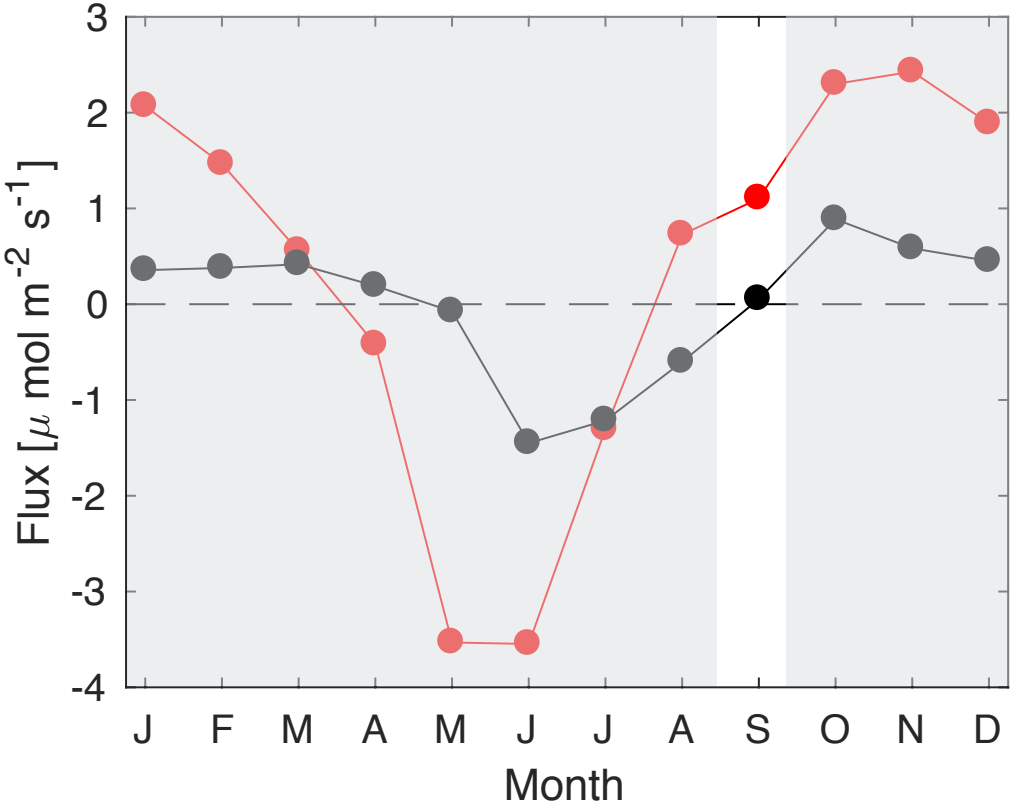

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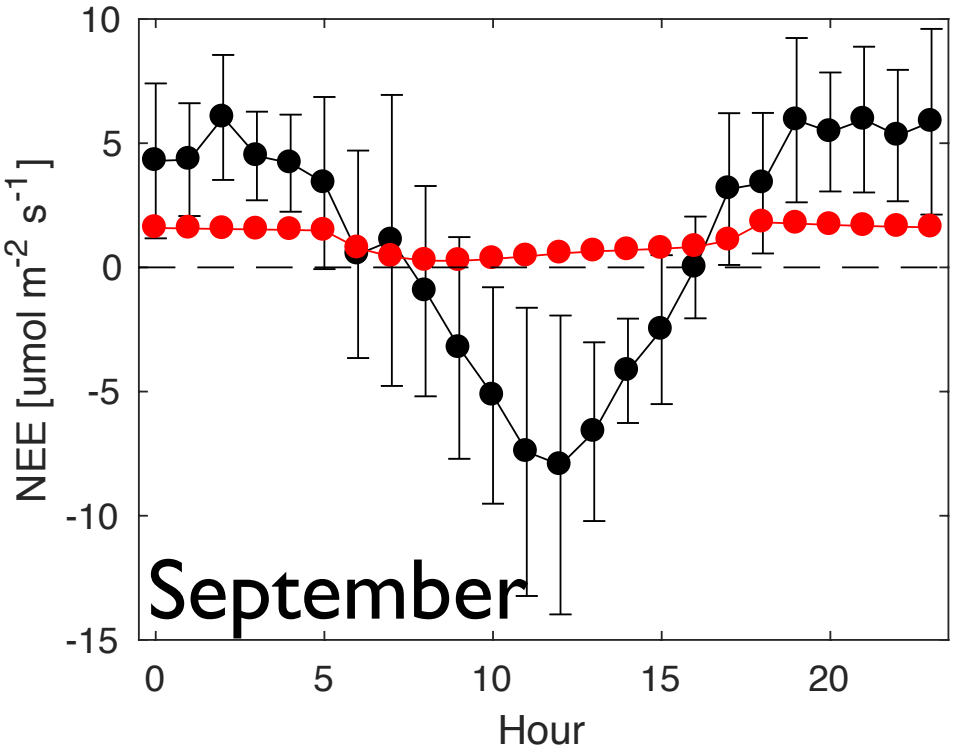

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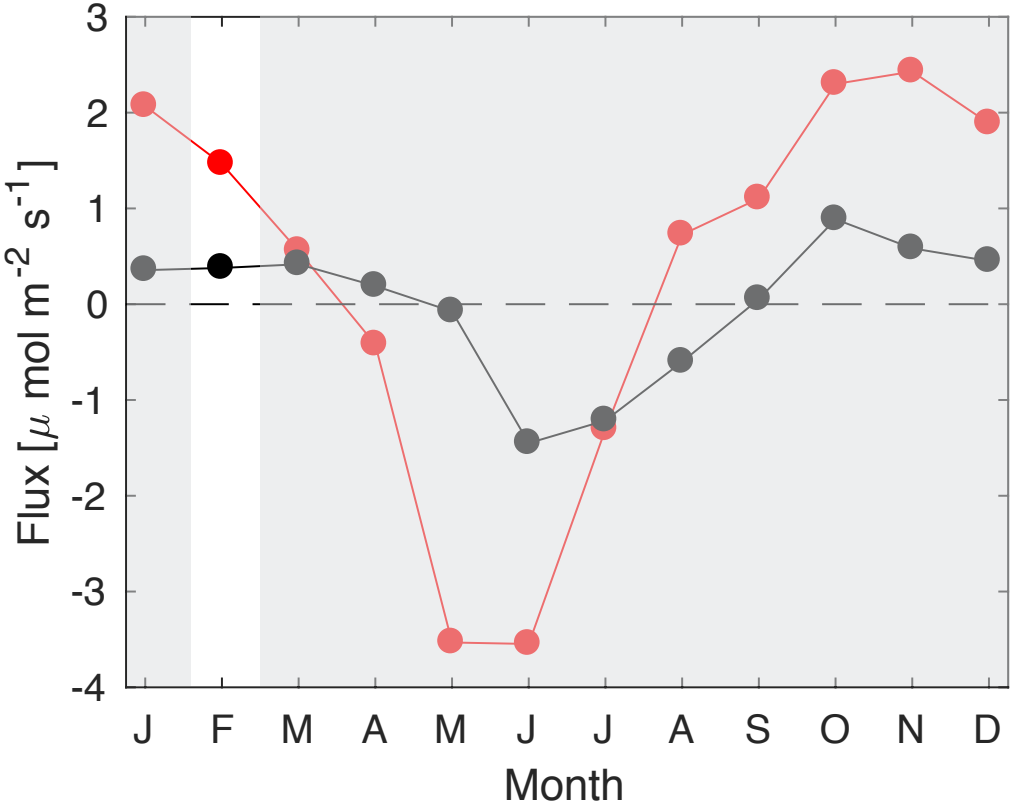

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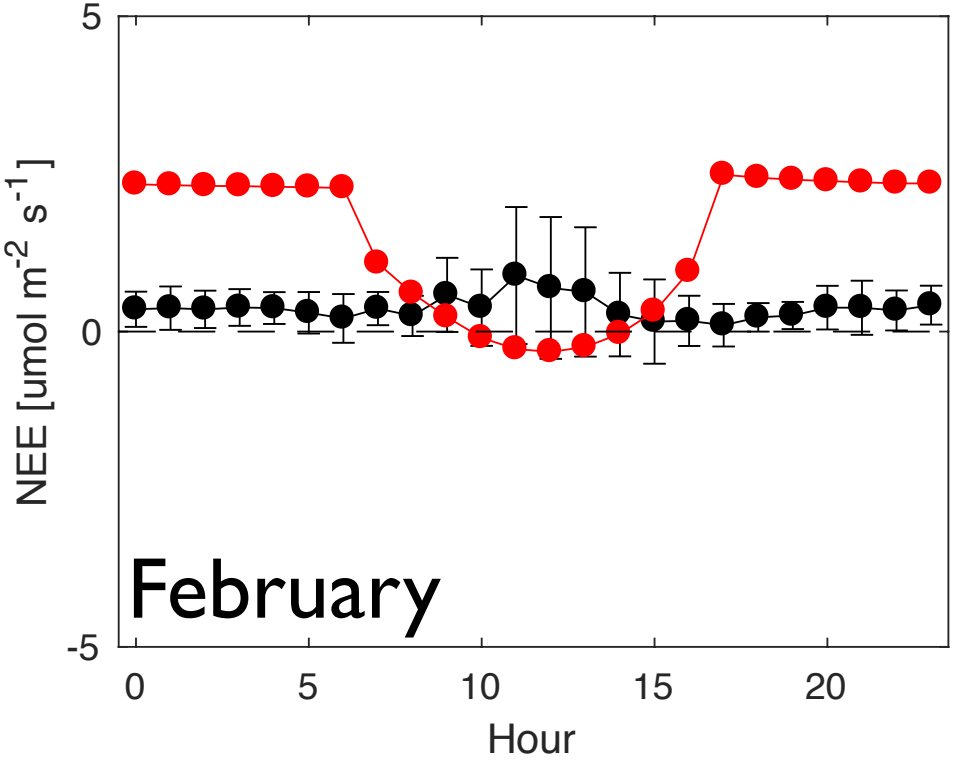


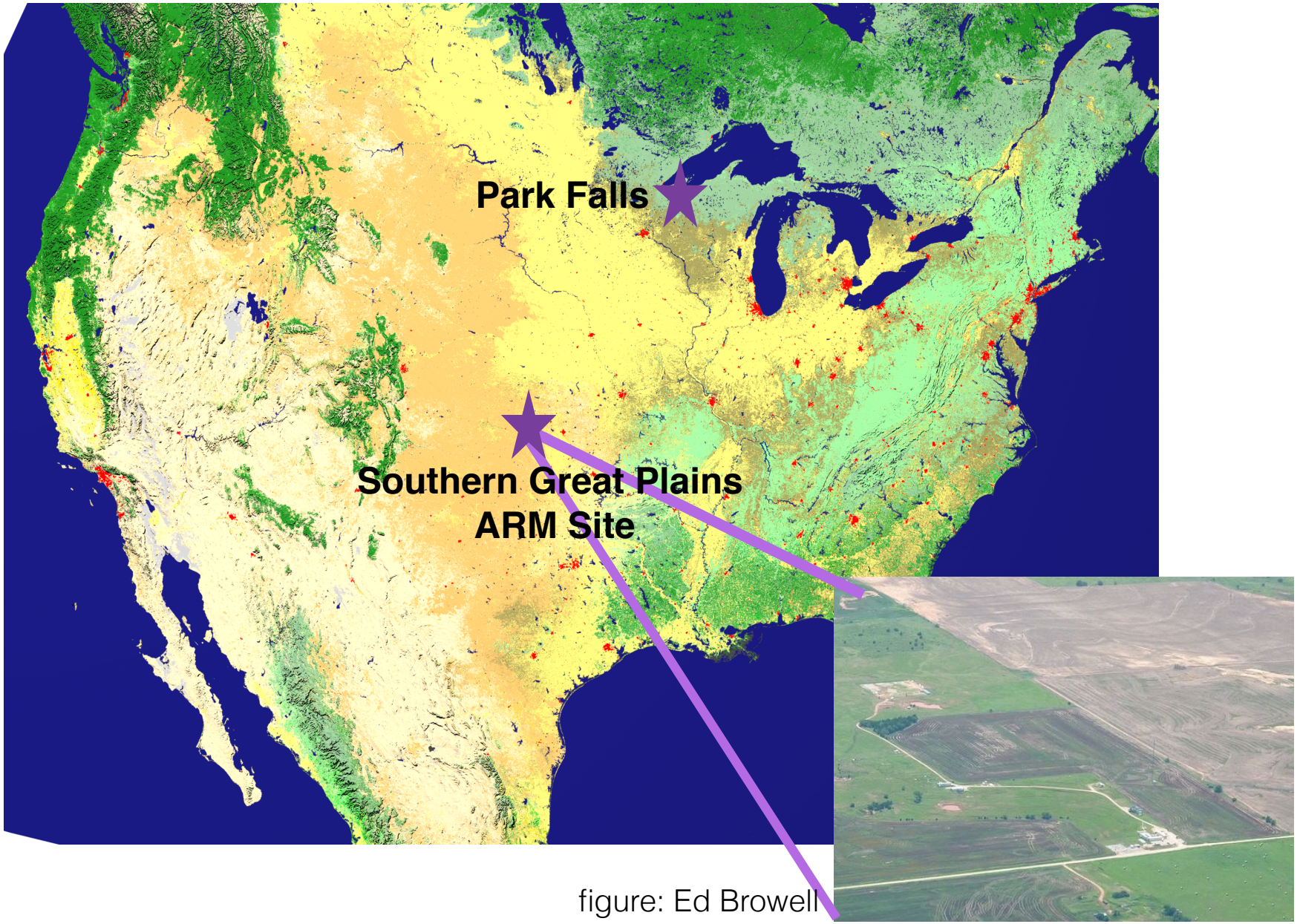
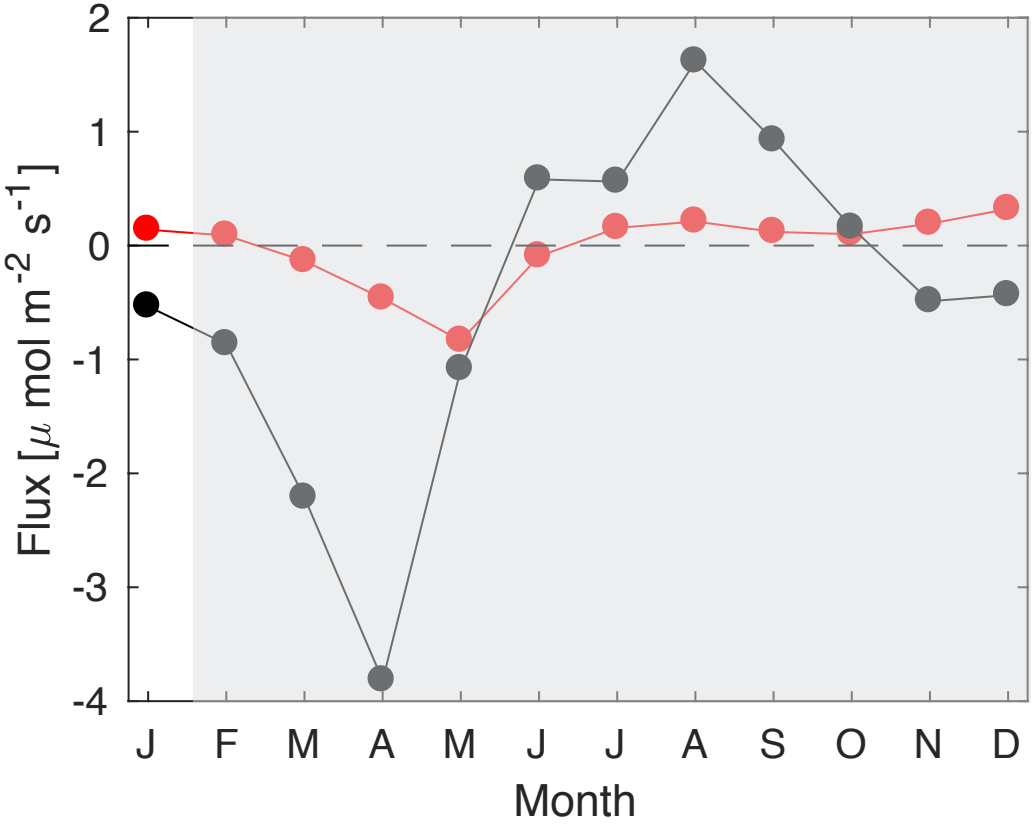
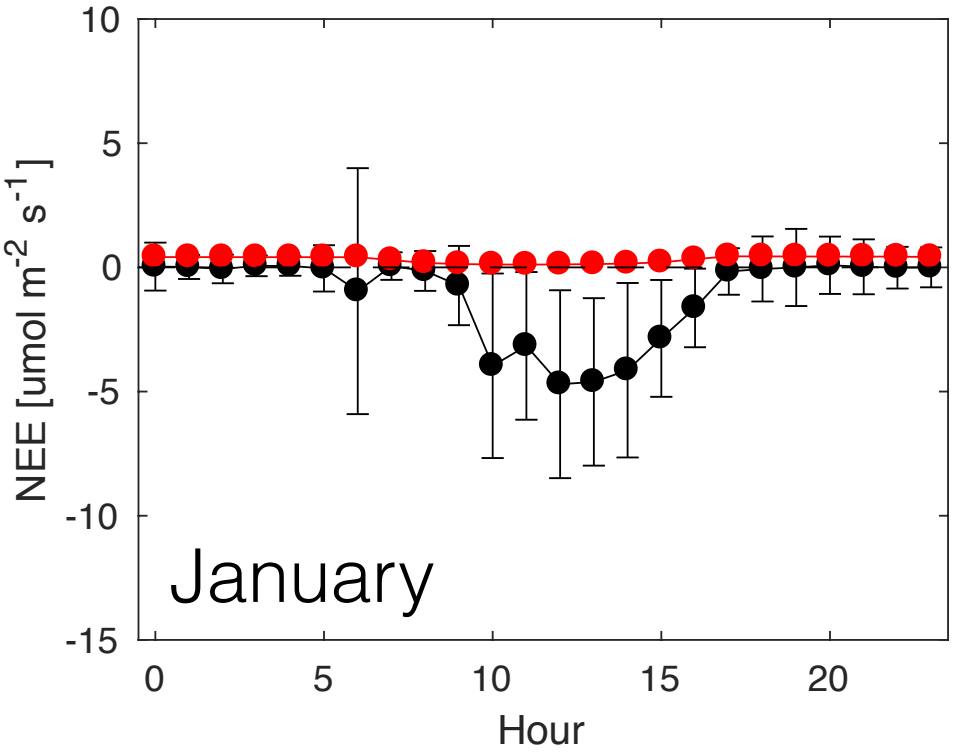


figure: Ed Browell

NEE at Southern Great Plains





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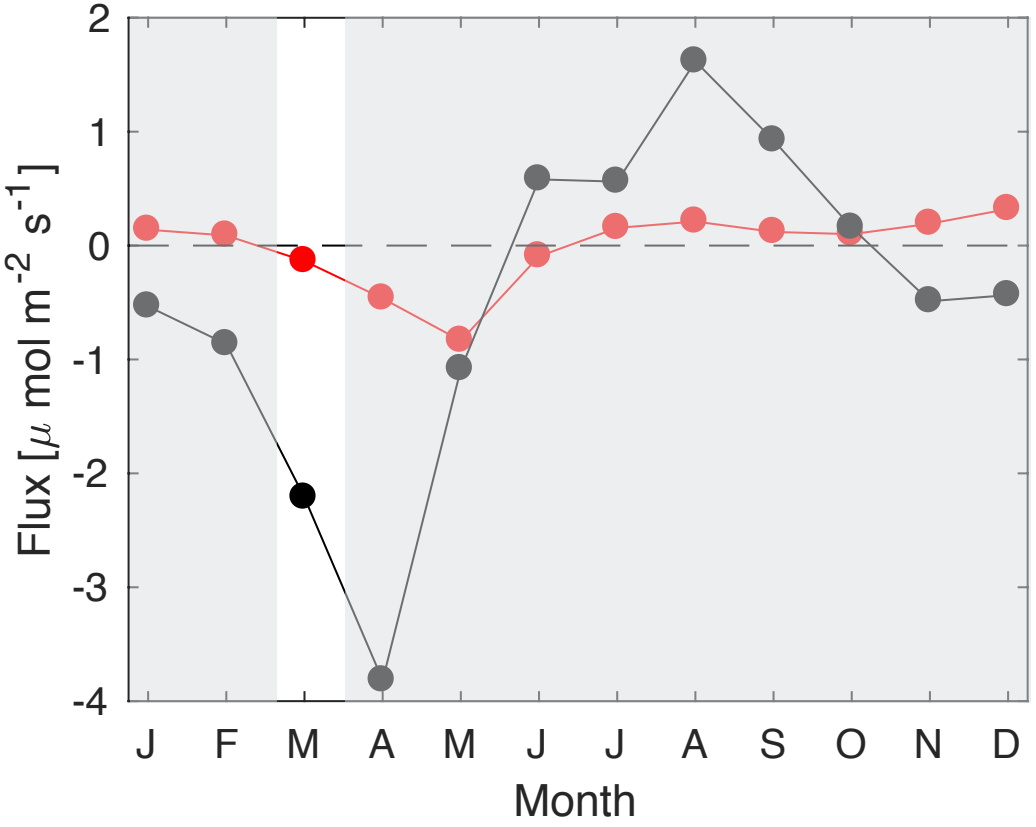

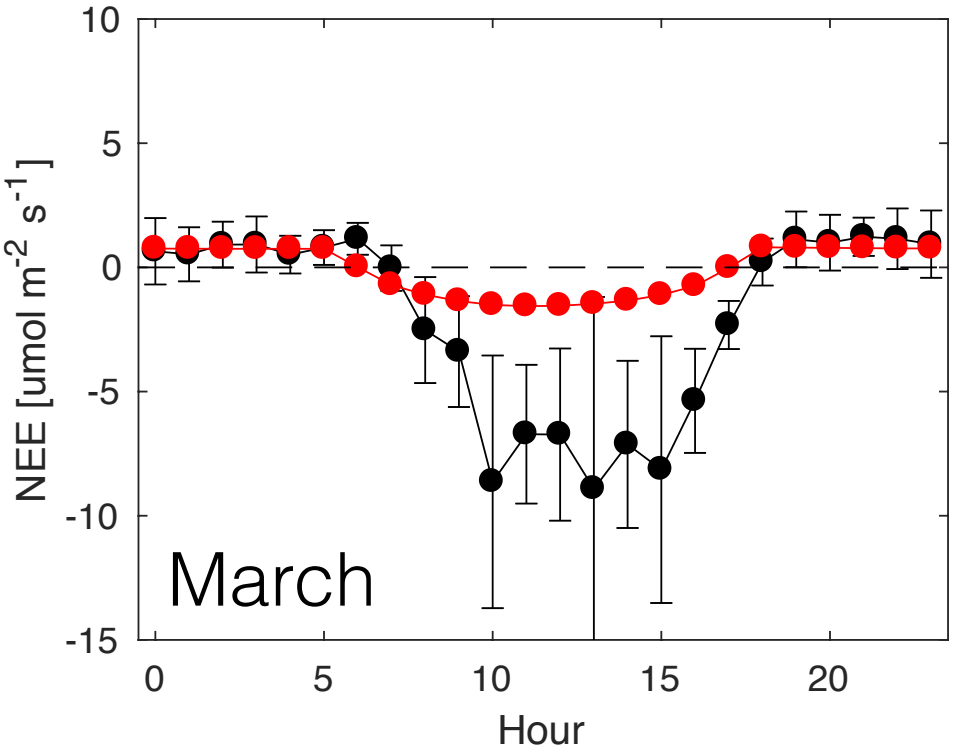

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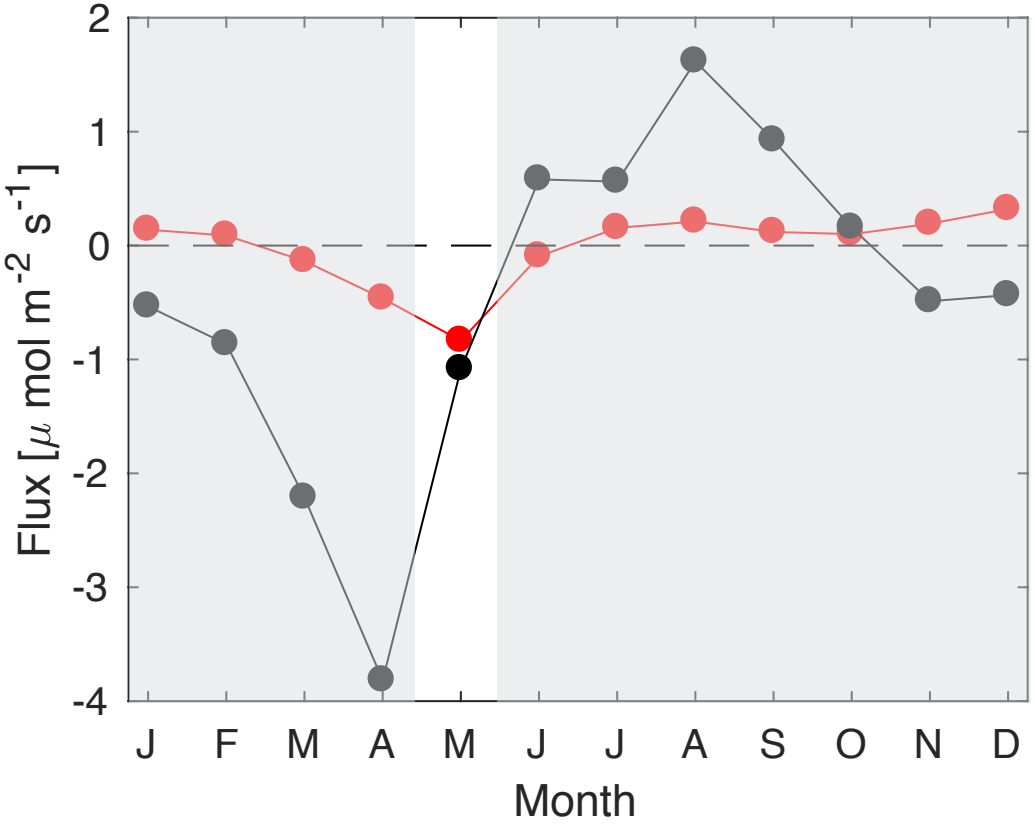

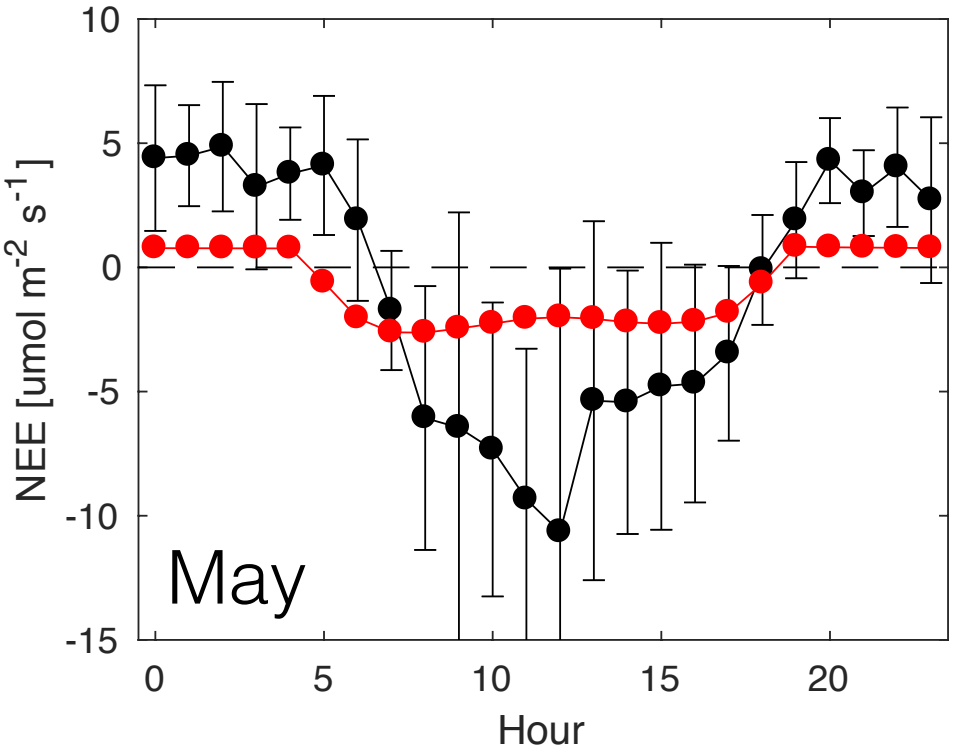

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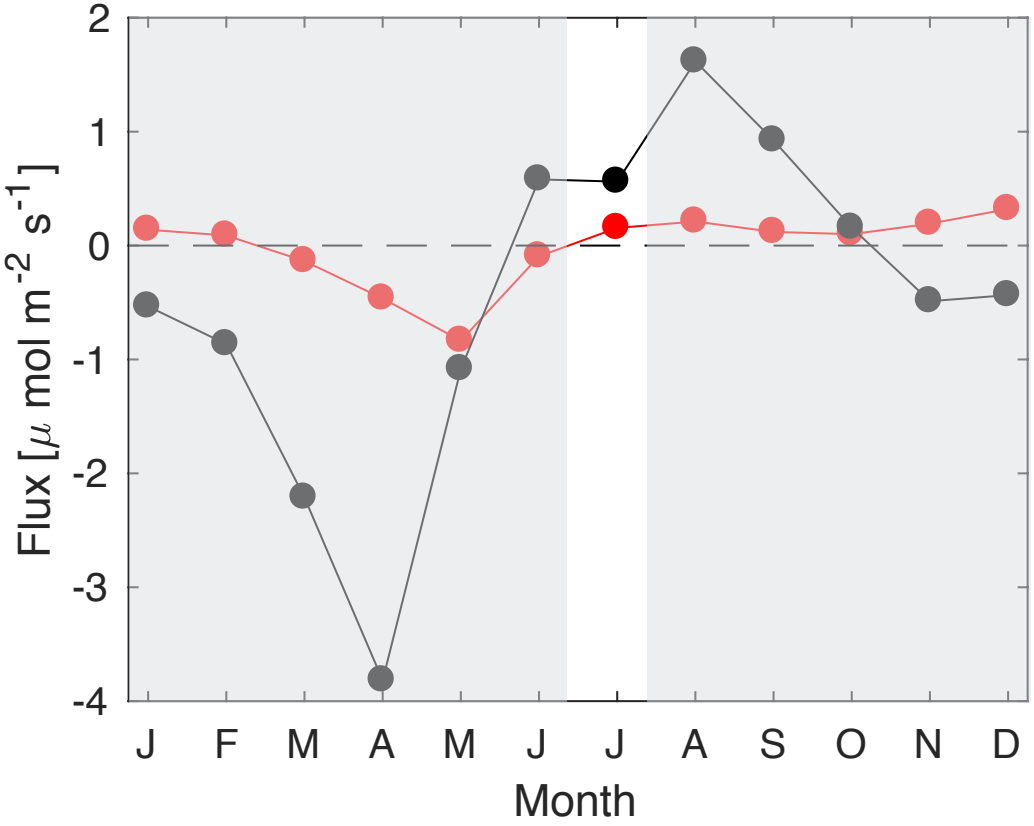

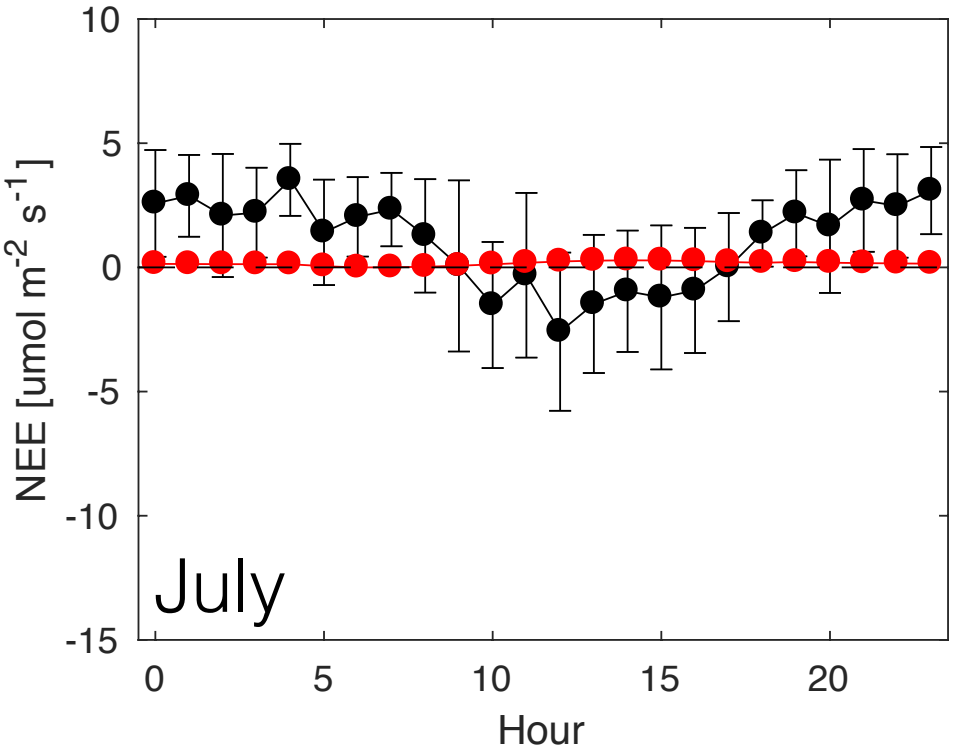

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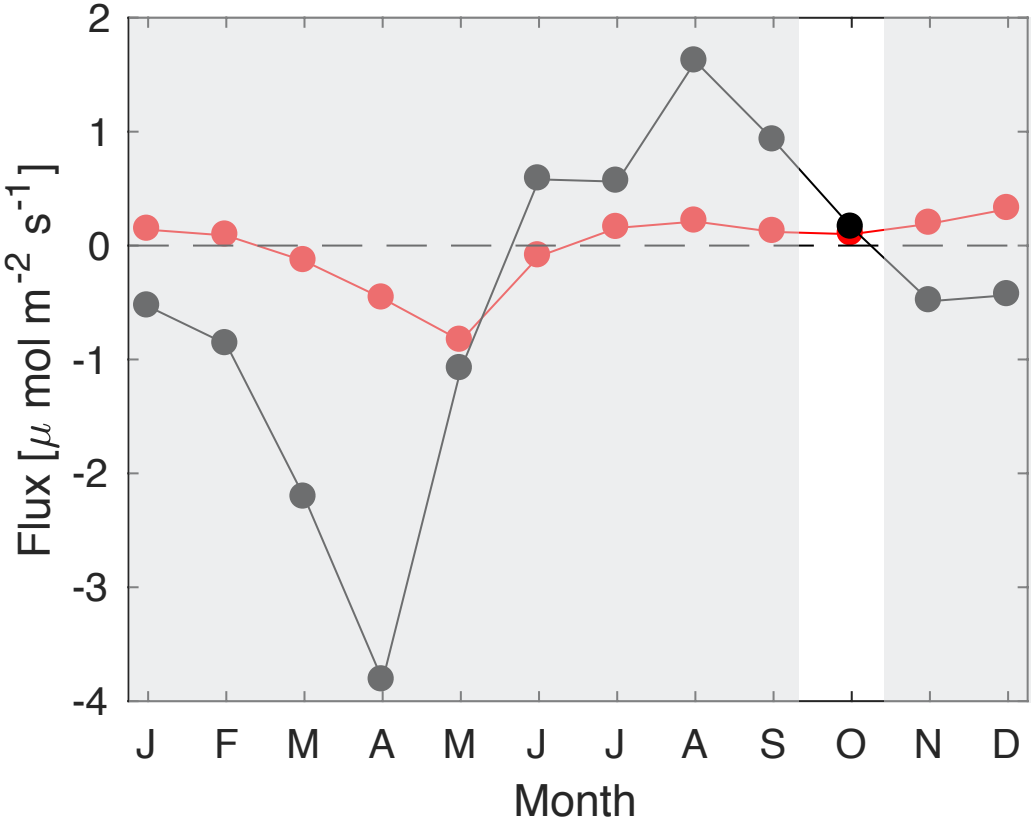
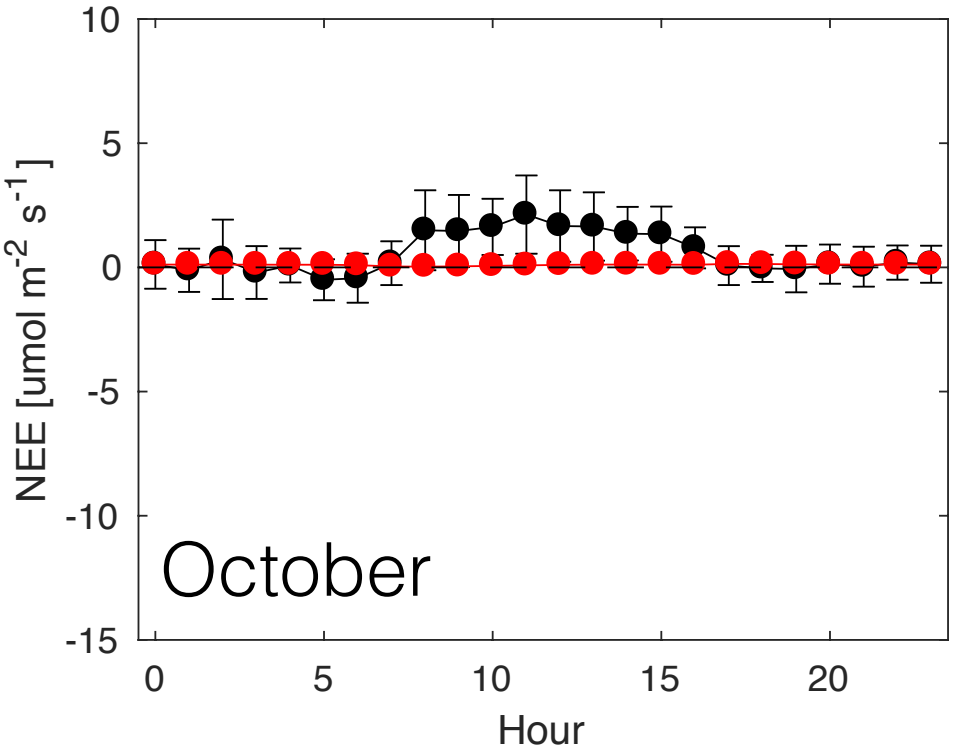




Evaluating CESM against flux towers may not be representative due to heterogeneity

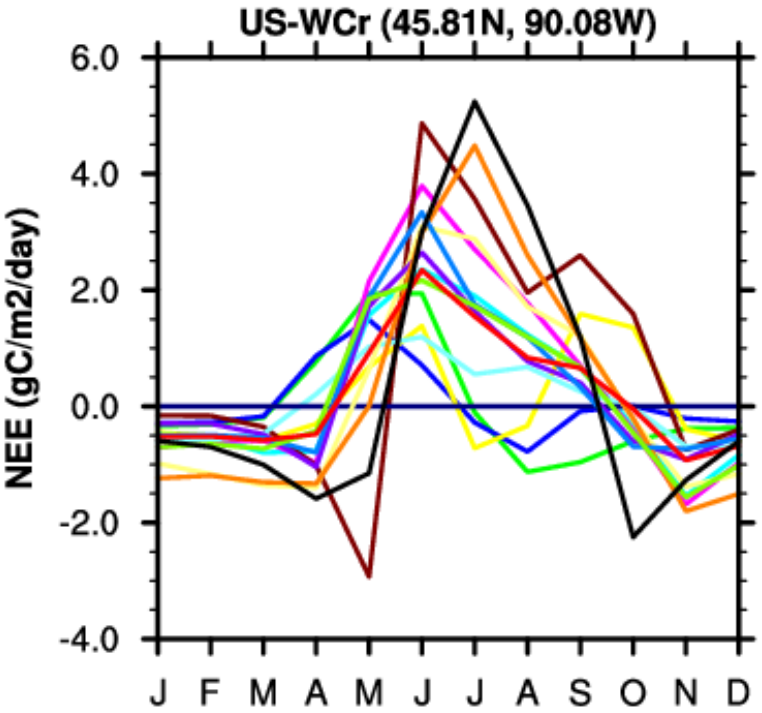
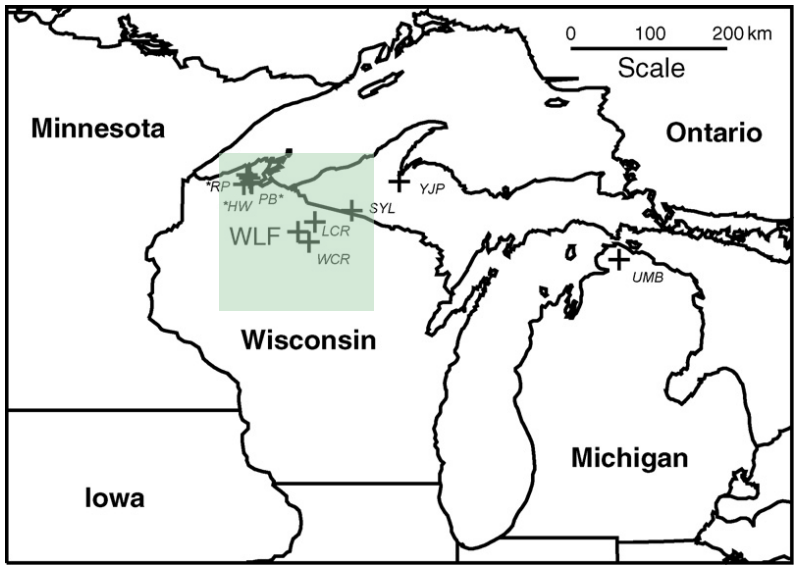
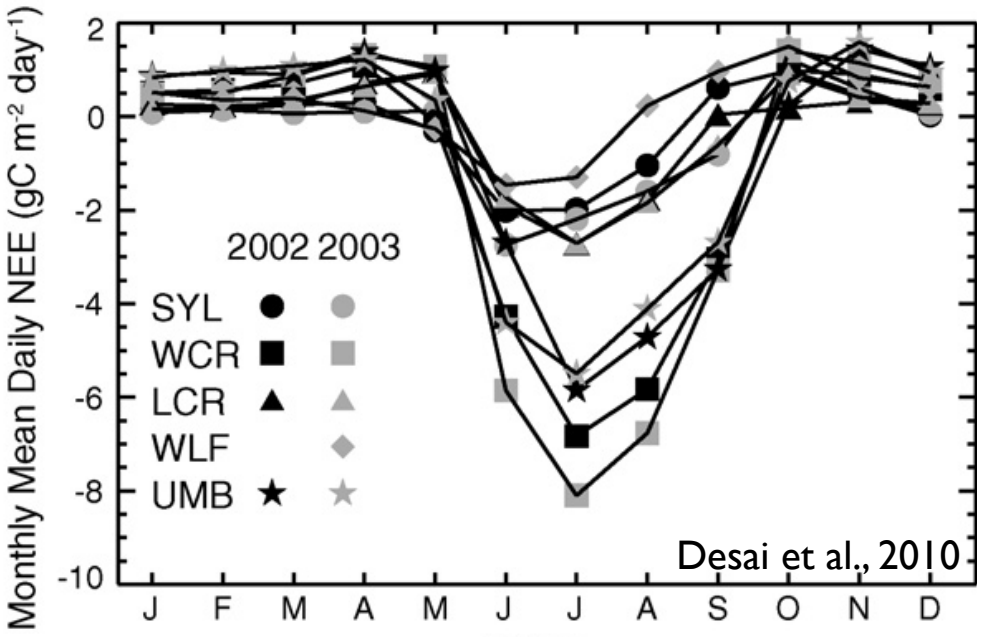
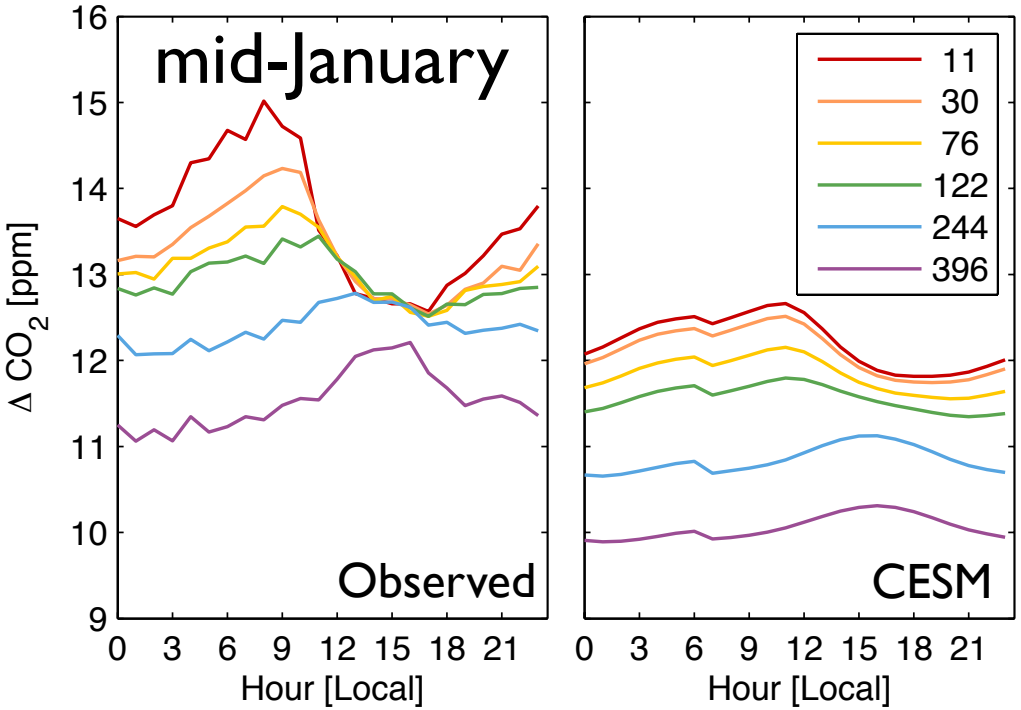


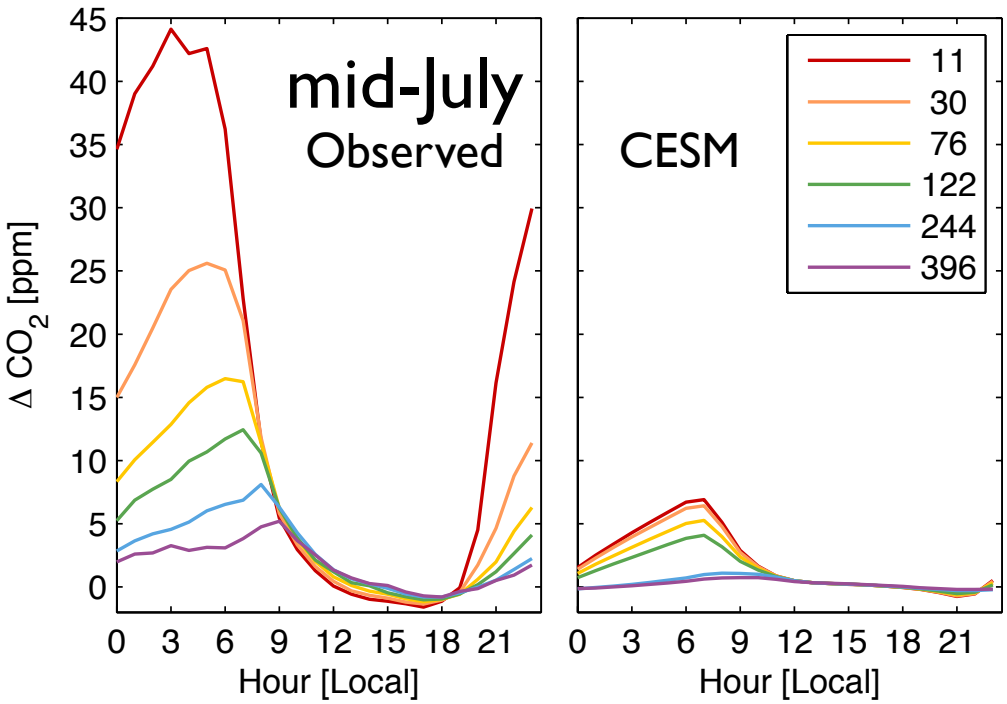
Figure: Mingquan Mu





Diurnal Rectifier at Park Falls, Wisconsin

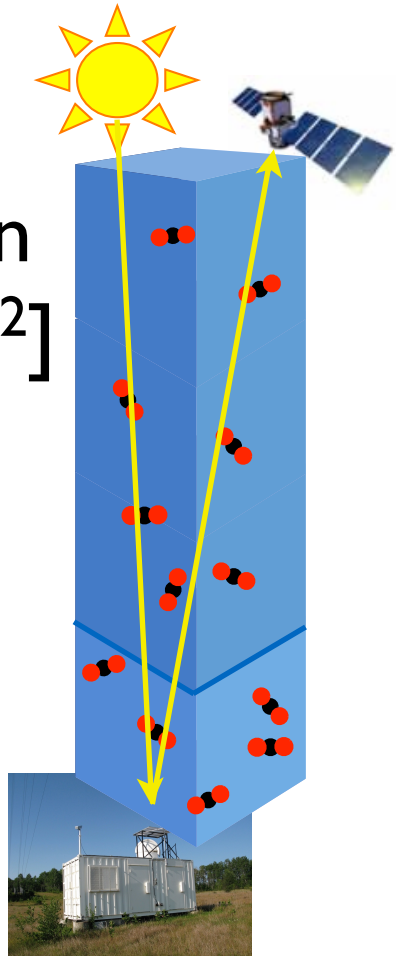




(CO_2 reported relative to South Pole)

The vertically integrated mixing ratio, X_{CO2}

Column
[mol m^{-2}]

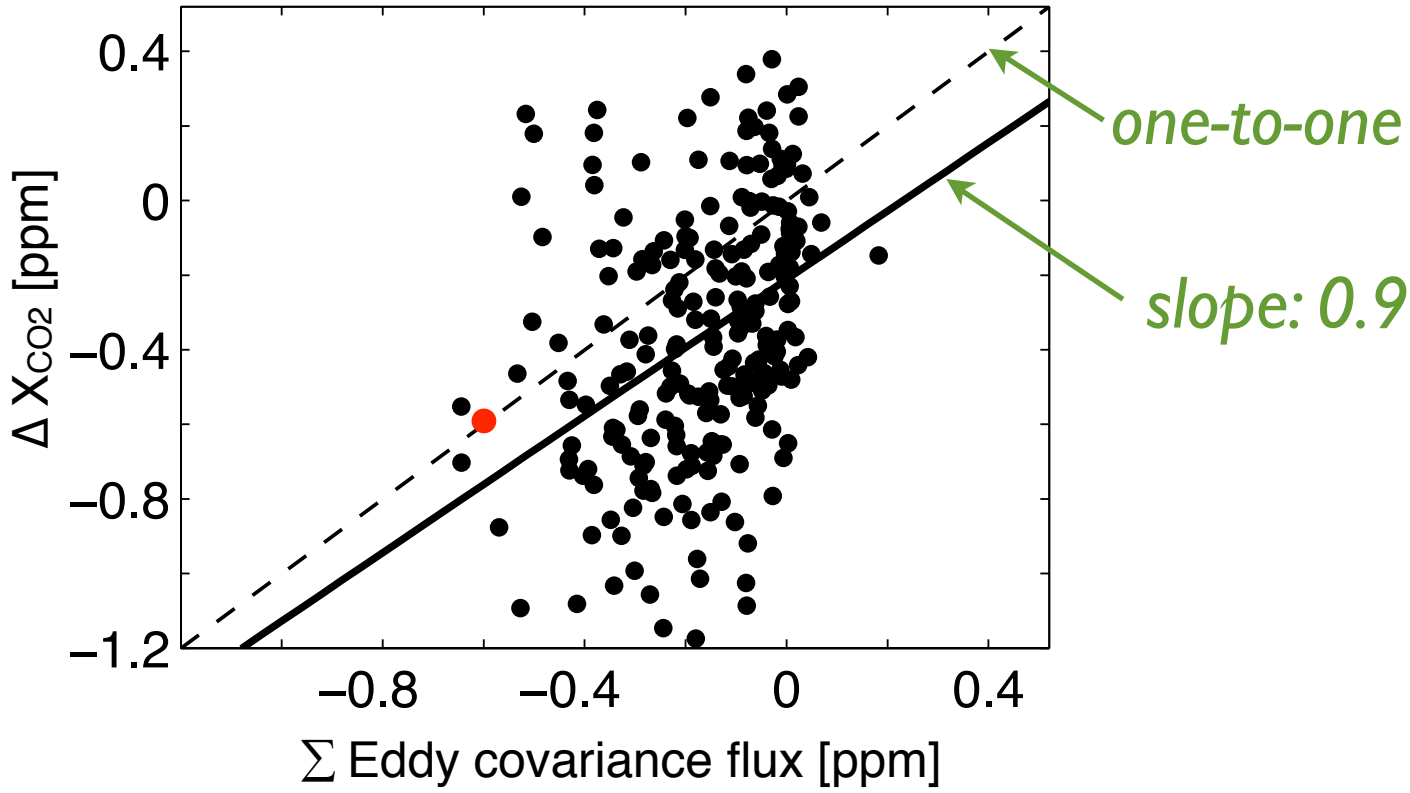


$$X_{CO2} = [O_2] \frac{\text{Column } CO_2}{\text{Column } O_2}$$

Variations in X_{CO2} are directly related to mass fluxes.

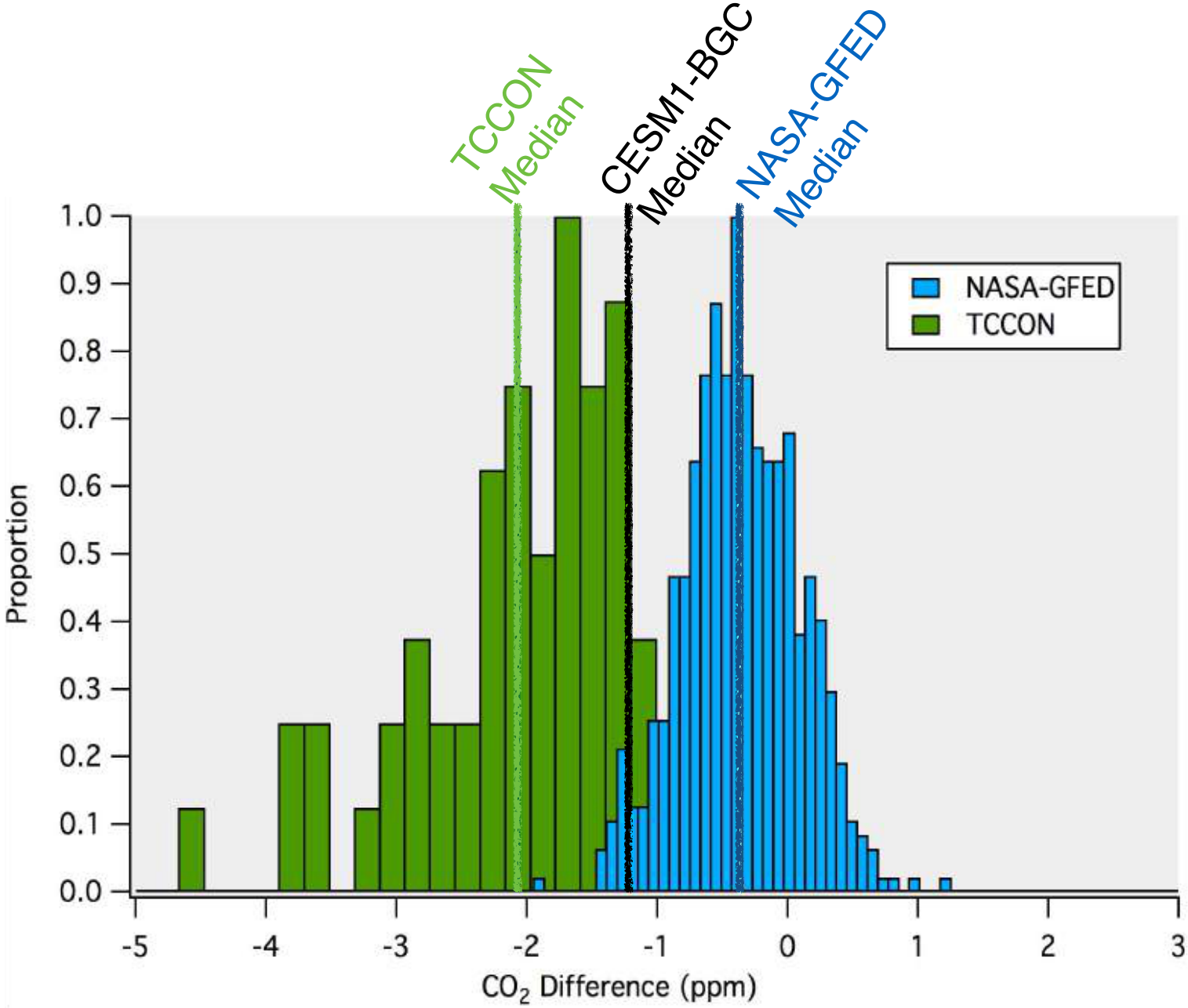
Crisp et al., 2005; Washenfelder et al., 2006;
Keppel-Aleks et al., 2012

Synoptic activity complicates column drawdown and local flux at Park Falls



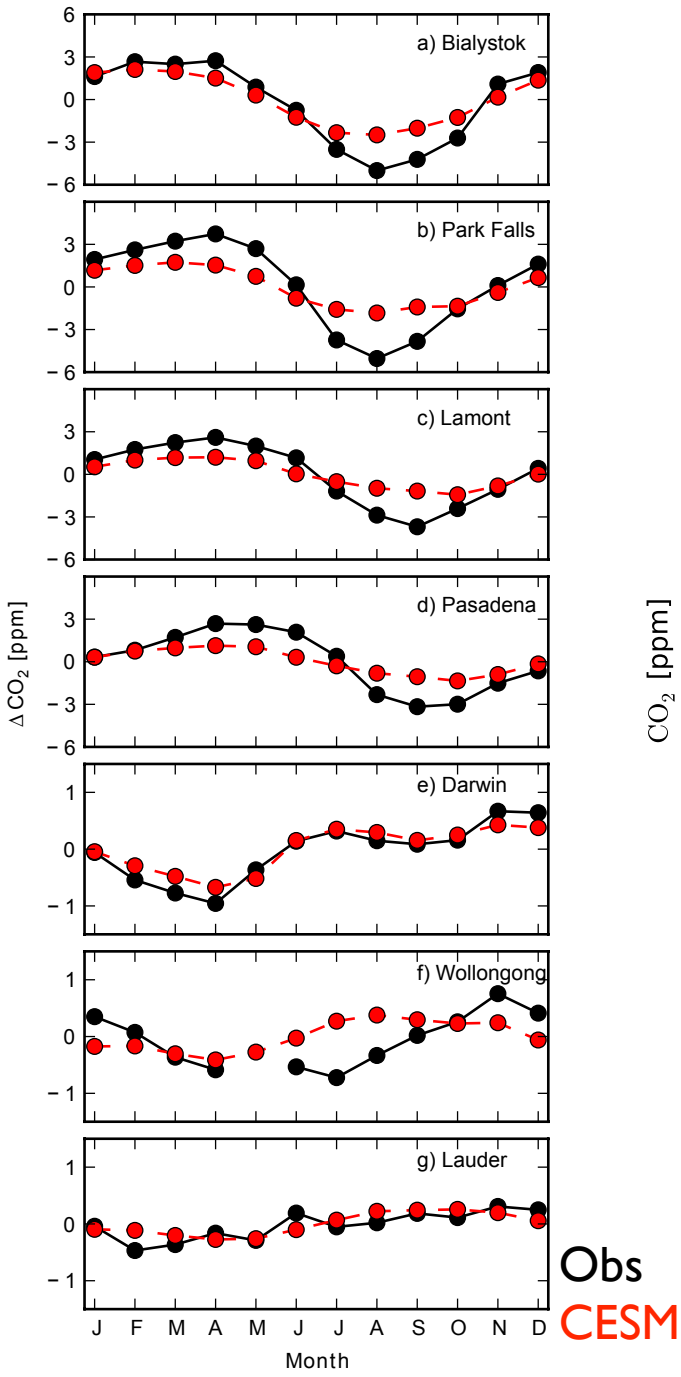
Keppel-Aleks et al., 2012

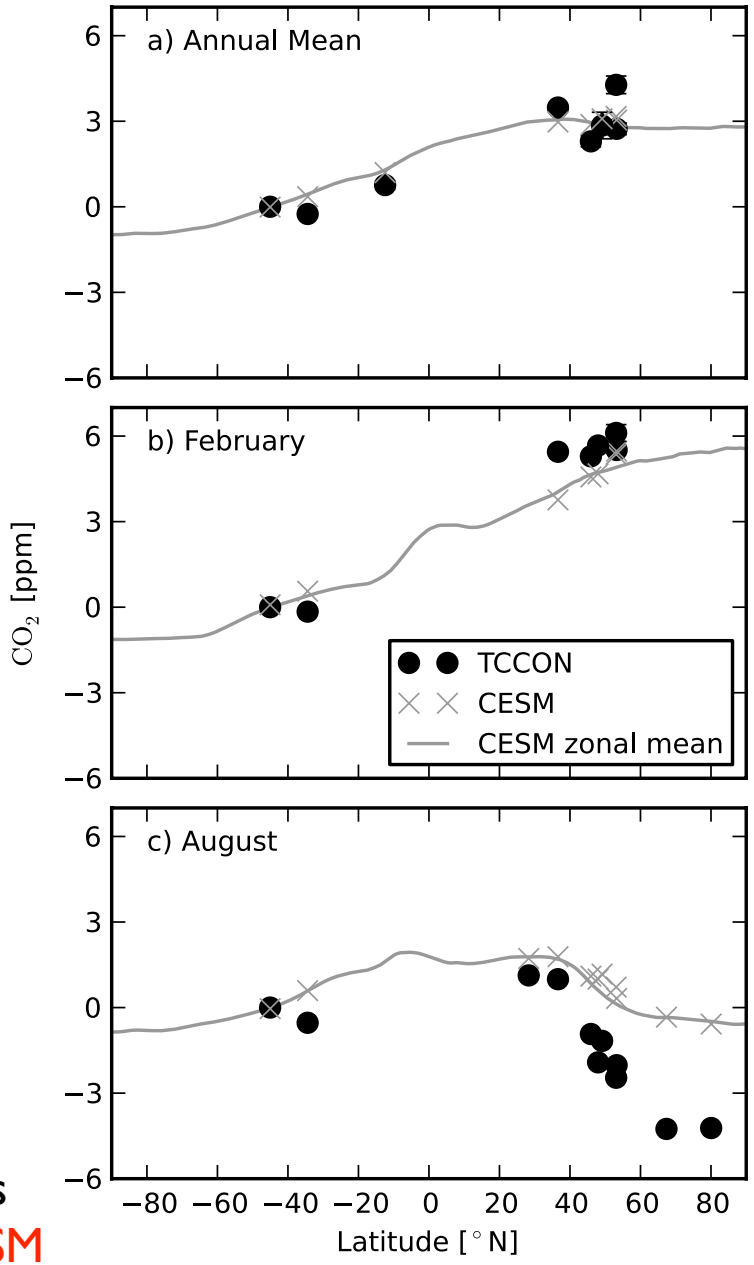
CESM1 performed favorably relative to empirical terrestrial ecosystem models for diurnal drawdown at Manaus



TCCON: Dubey
NASA-GFED: Kawa

Seasonal variations in column CO_2

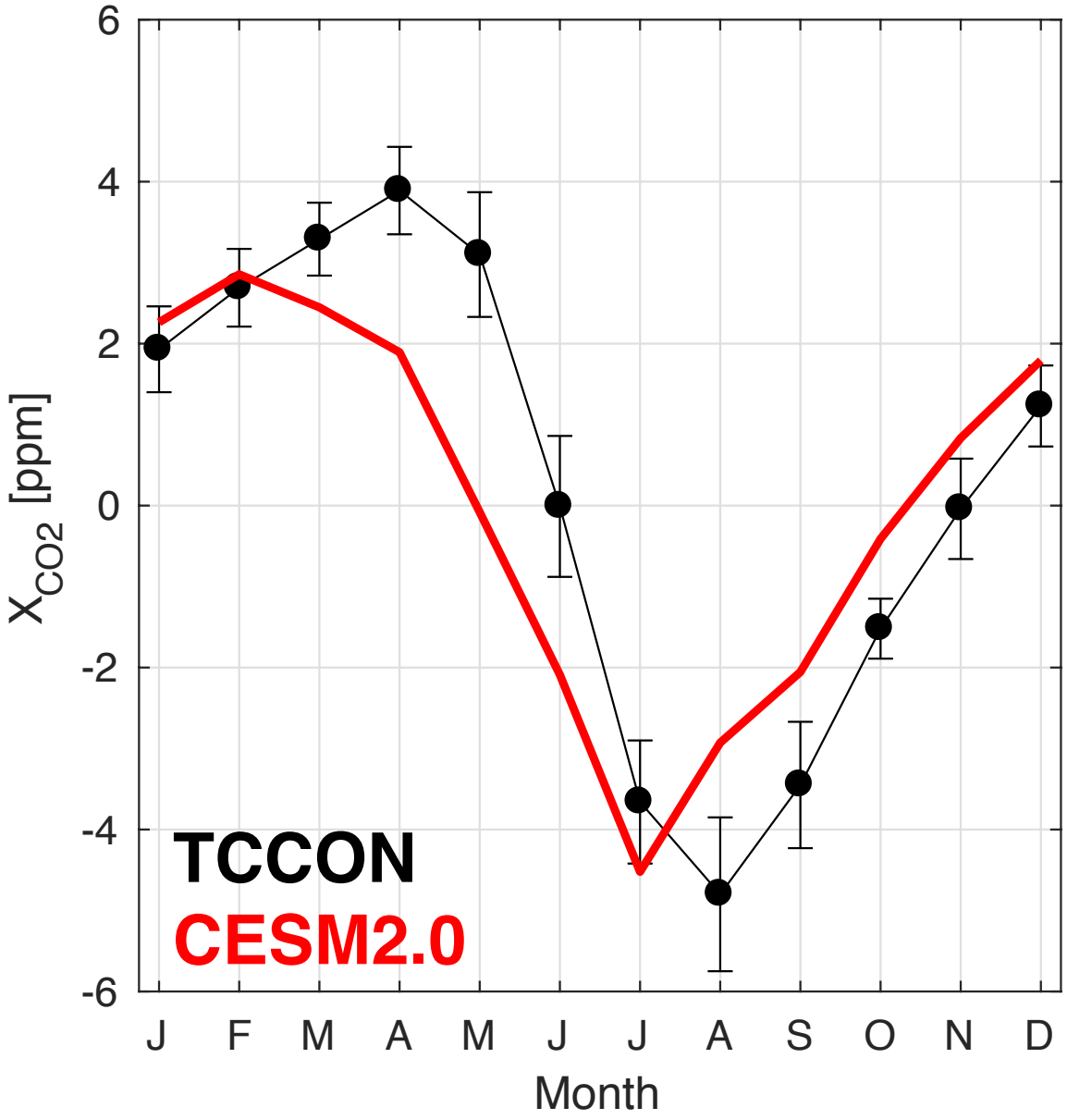




Total column CO_2 suggests that CESM northern hemisphere NEP is small during the growing season by 50%.

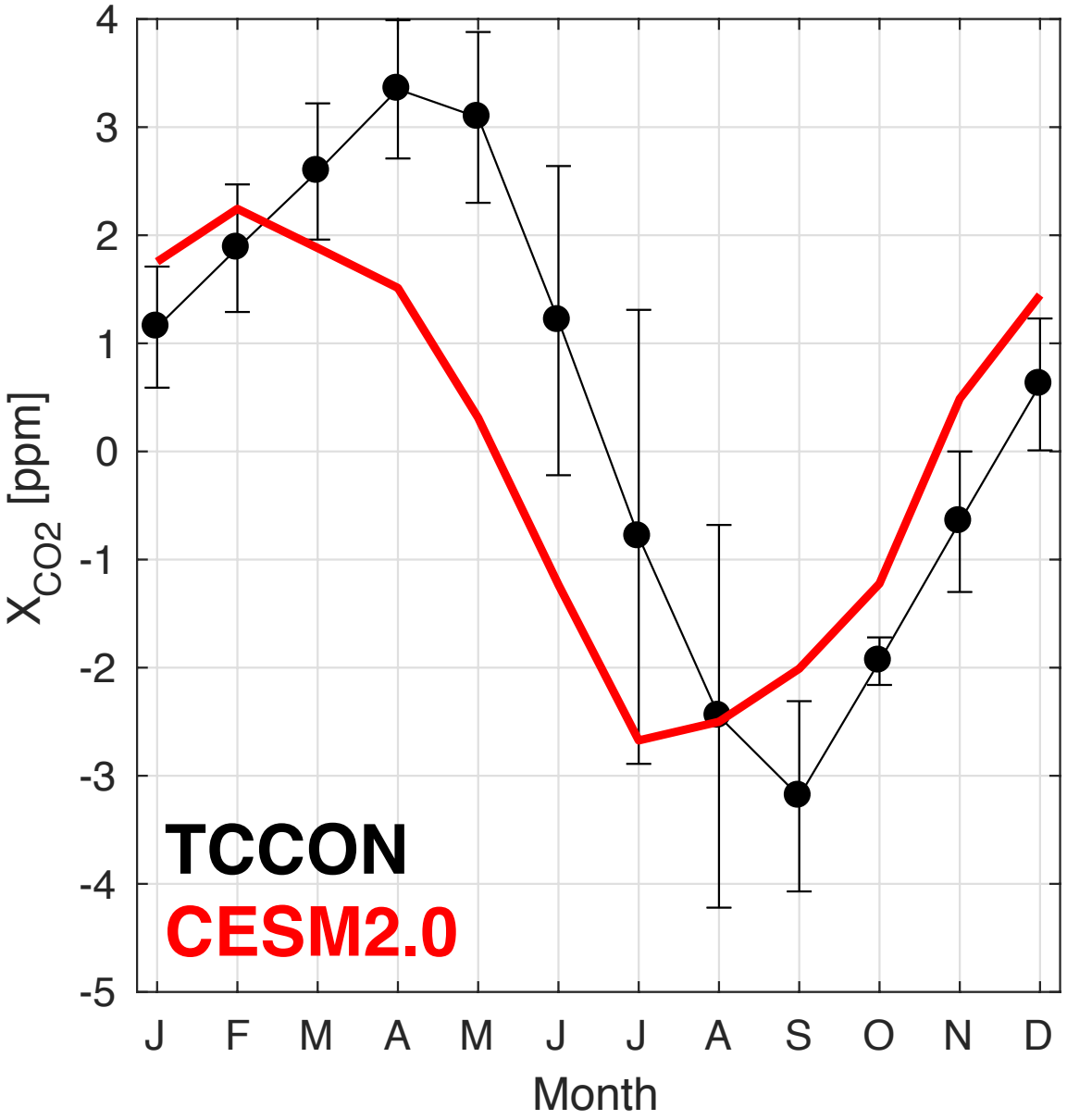
Keppel-Aleks et al., *2013*

Column mean annual cycle at Park Falls, Wisconsin



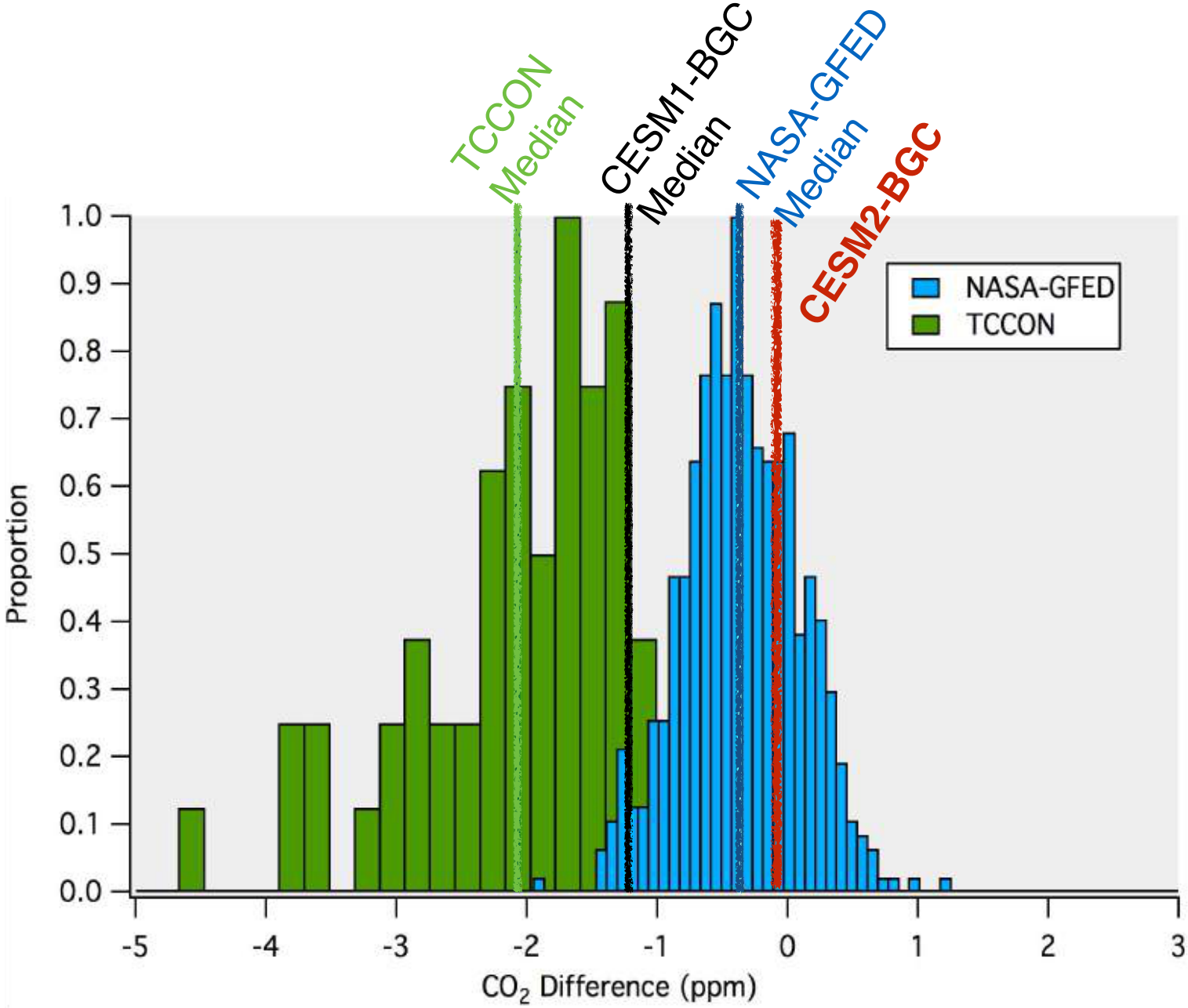
TCCON 8.7 ppm
CESM 2.0 7.3 ppm
CESM1.0 3.7 ppm

Mean annual cycle at Southern Great Plains



TCCON 6.5 ppm
CESM 2.0 4.9 ppm
CESM1.0 2.5 ppm

CESM1 performed favorably relative to empirical terrestrial ecosystem models for diurnal drawdown at Manaus



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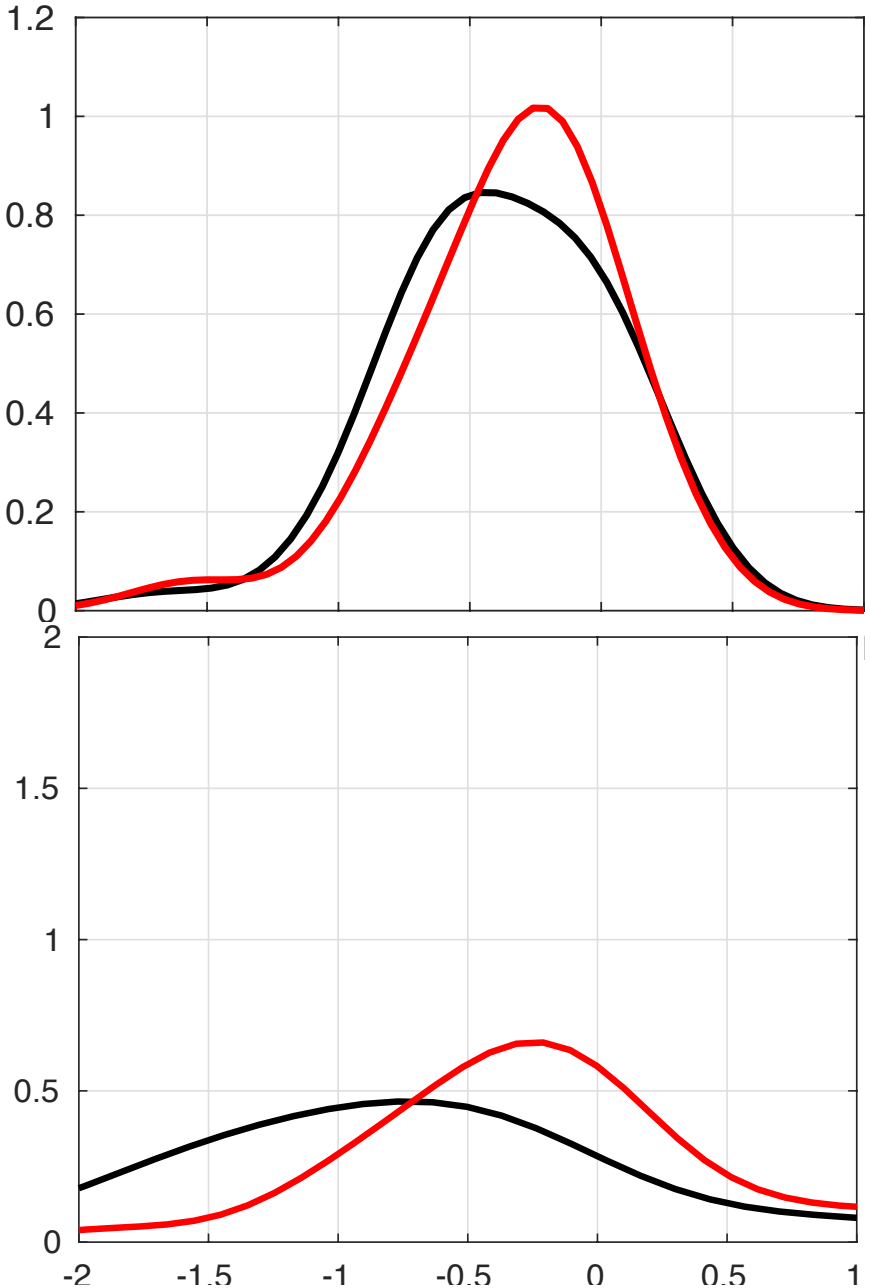
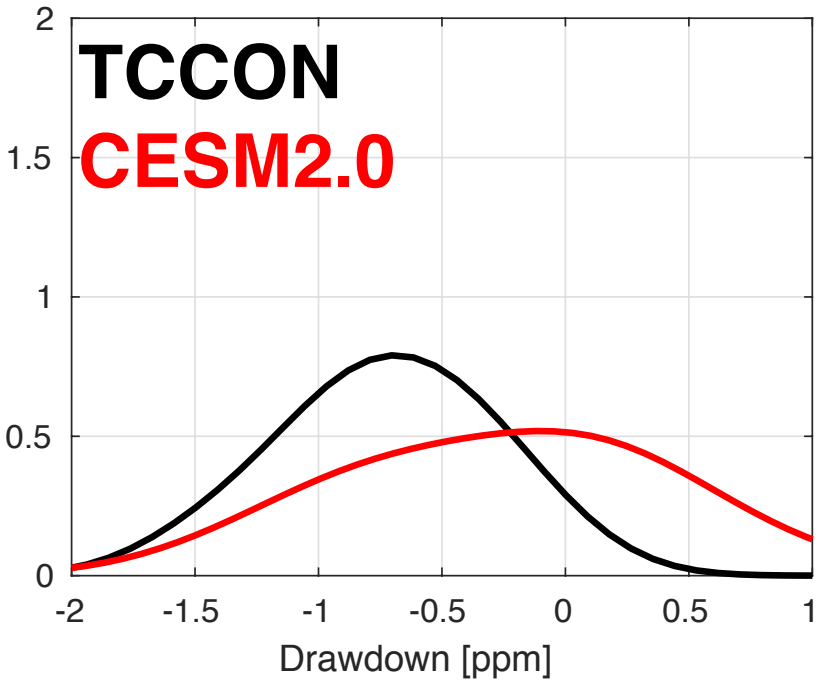
Diurnal column drawdown at Park Falls, Wisconsin





Diurnal variations are underestimated, but interpretation requires understanding of spatial gradients and links to Ameriflux results

Mean annual cycle in CO_2 is underestimated by 15-25% in CESM2, in contrast to >60^ in CESM1

Comparisons at
—smaller spatial scales (annual cycle of NEE)
—shorter time scale (diurnal fluxes & CO_2)
provide opportunities to understand the skill of the mechanisms in CLM

Postdoctoral Positions at University of Michigan

NASA-funded project to understand the role of soil moisture in controlling carbon and energy fluxes

- CLM5
- SMAP (Soil Moisture Active Passive) satellite
- SIF (solar-induced fluorescence) from satellites

NASA-funded project to understand the amplification of the CO_2 mean annual cycle

- CESM
- CO_2 from flasks, aircraft, TCCON
- GEOS-Chem atmospheric transport model

Please contact: gkeppela@umich.edu