Variations in salt marsh CO_2 fluxes along the US Atlantic coast

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Introduction

Salt marshes are dynamic ecosystems which are located at the boundary between land and sea. Over all, they accumulate sediment and carbon to keep their position relative to sea level, but they are in constant exchange with the adjacent rivers and estuaries. Estimating the net carbon budget accurately is critical to evaluate their role in the coastal carbon budget.

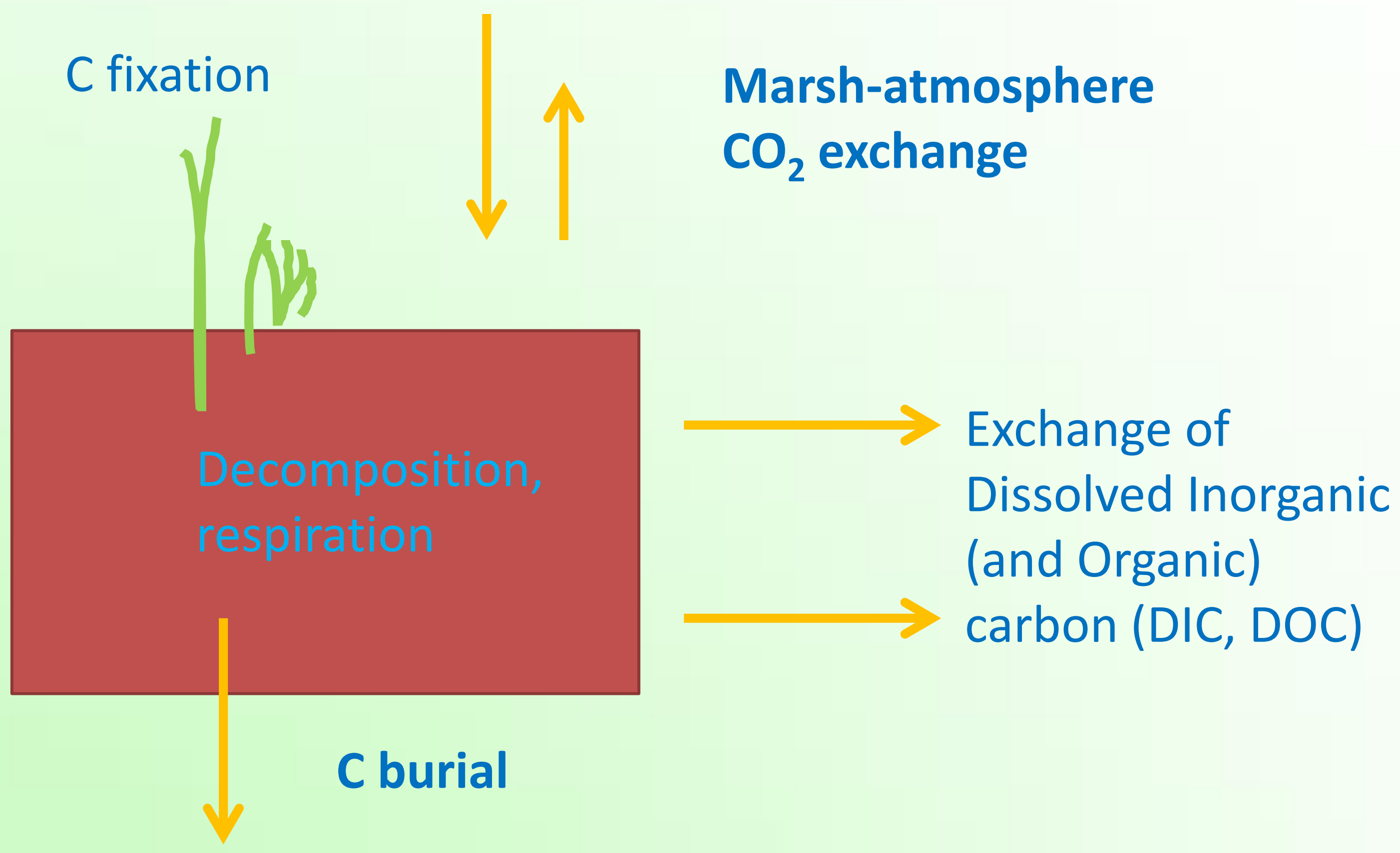


Fig.1 : Scheme of marsh-estuary-atmosphere C exchange

Motivation

We are interested in analyzing and modeling the C exchange between marsh, atmosphere and ocean on the relevant time scales (tidal to annual) and under different environmental conditions (e.g. tidal inundation, seasonality, productivity)

Research Sites: PIE and GCE LTER

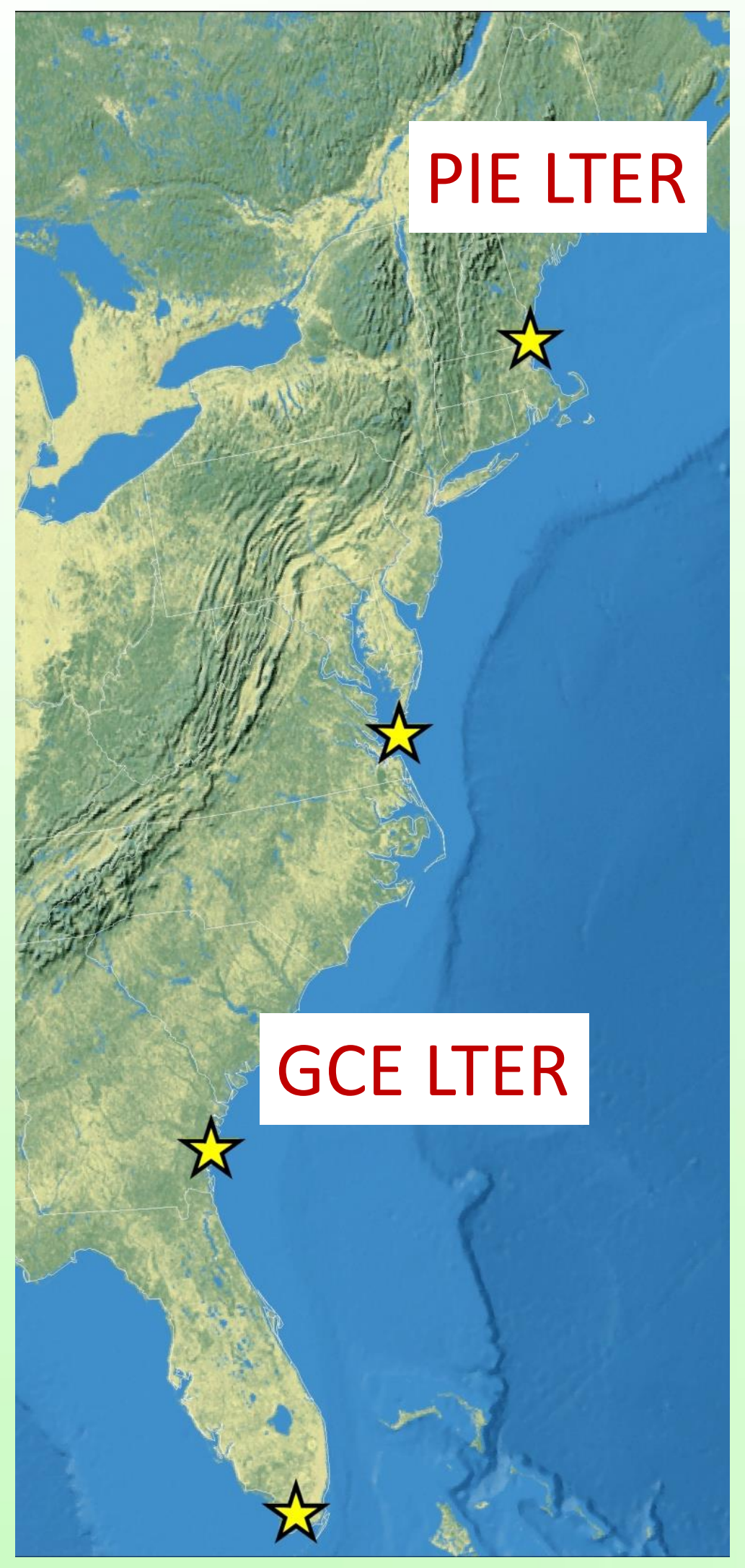
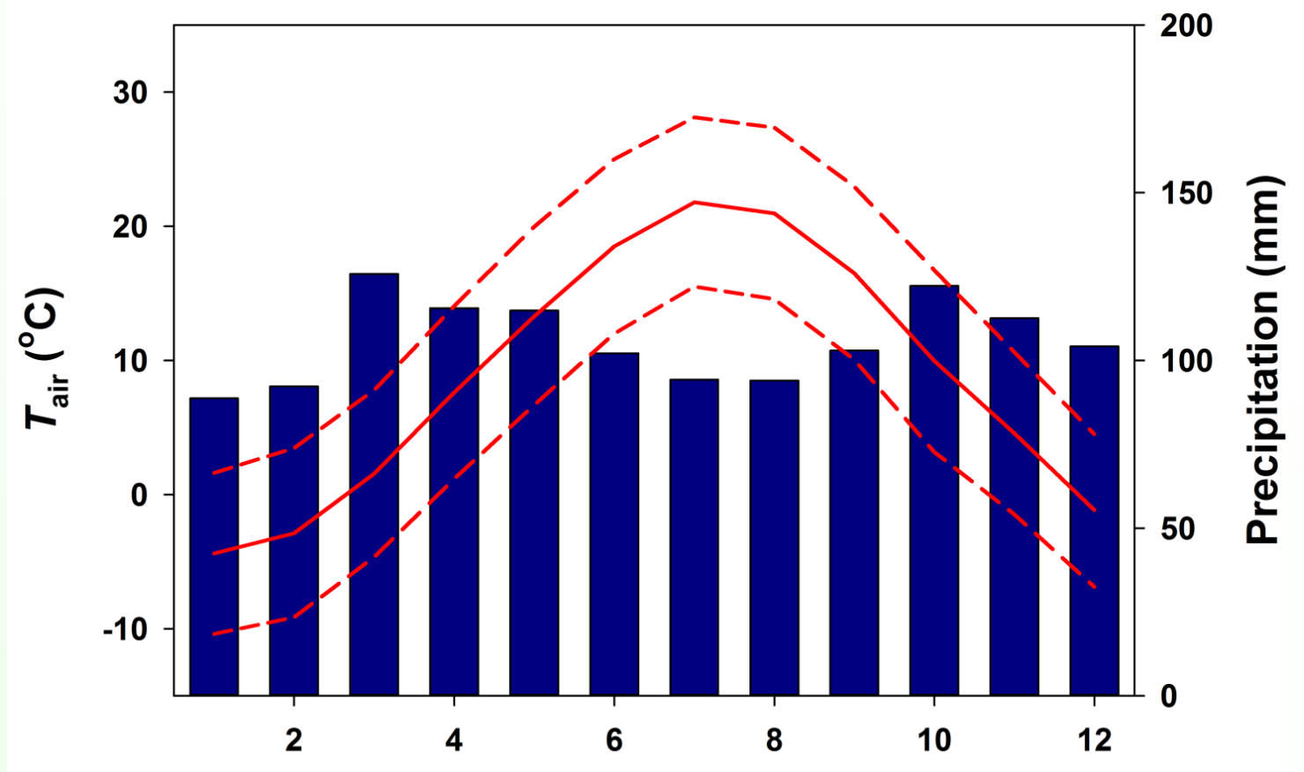
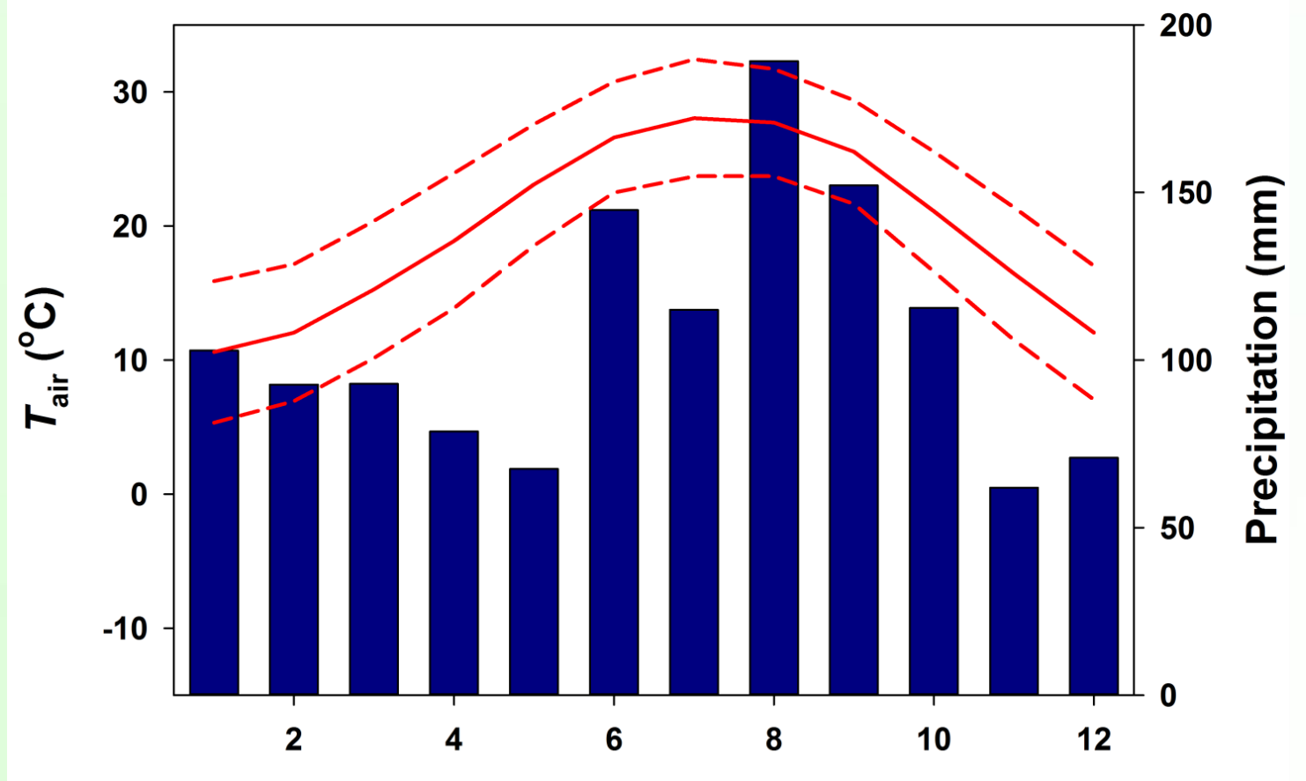


Fig.2 : Map showing locations of coastal LTER sites along US Atlantic coast. PIE and GCE are highlighted, other sites include VCE and FCE (Everglades).



PIE LTER

- Inundated only during spring tides (elevation 1.35m NAVD88))
- Mean tidal range: 2.5m
- *S. patens, S. alterniflora*



GCE LTER

- Regularly inundated (elevation 0.77m NAVD88))
- Mean tidal range: 2.3m
- *S. alterniflora*

Eddy covariance measurements

- Turbulent vertical fluxes of CO_2
- *Net* Ecosystem Exchange (NEE)
- Temporal resolution: 30min
- 'ecosystem scale' measurements

Fig.3 : Measurement set up (Campbell Sci. EC200 closed path system) at PIE during a spring tide (z=4.16m at low tide)

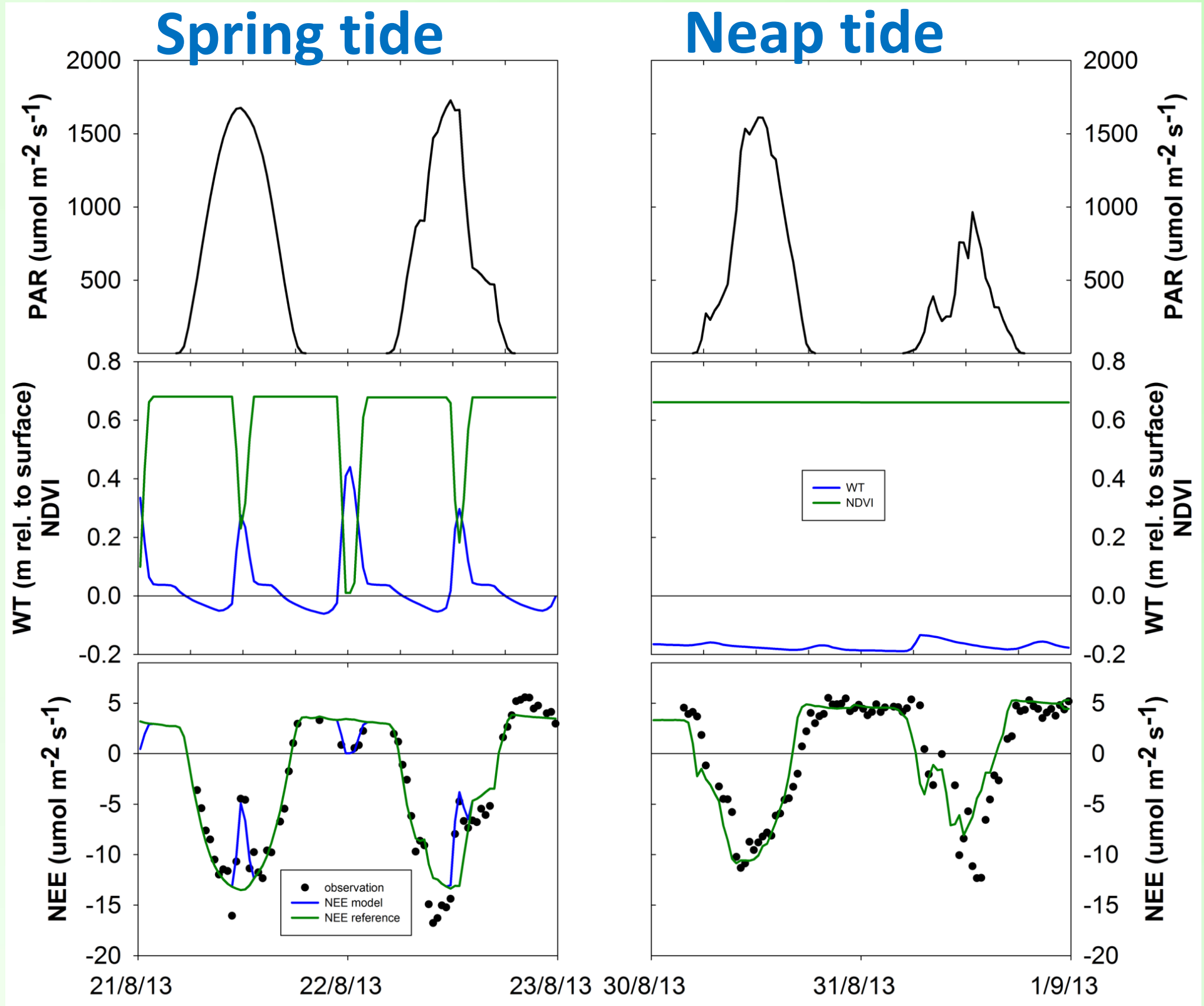


Fig.4 : During spring tides, standing water on the marsh platform suppresses CO_2 fluxes, which is not observed during neap tides. A modified PLIRTLE model can be used to model NEE and estimate the flux reduction during tidal inundation (Forbrich & Giblin 2015).

Carbon storage: NEE measurements vs. Burial rates

- We use burial rates as a reference for the net ecosystem carbon budget for the marsh
- Mass accumulation (and accretion) rates at PIE are about twice as high than they are at GCE. Soil C densities at PIE are higher, resulting in a burial rate that is much higher than at GCE.

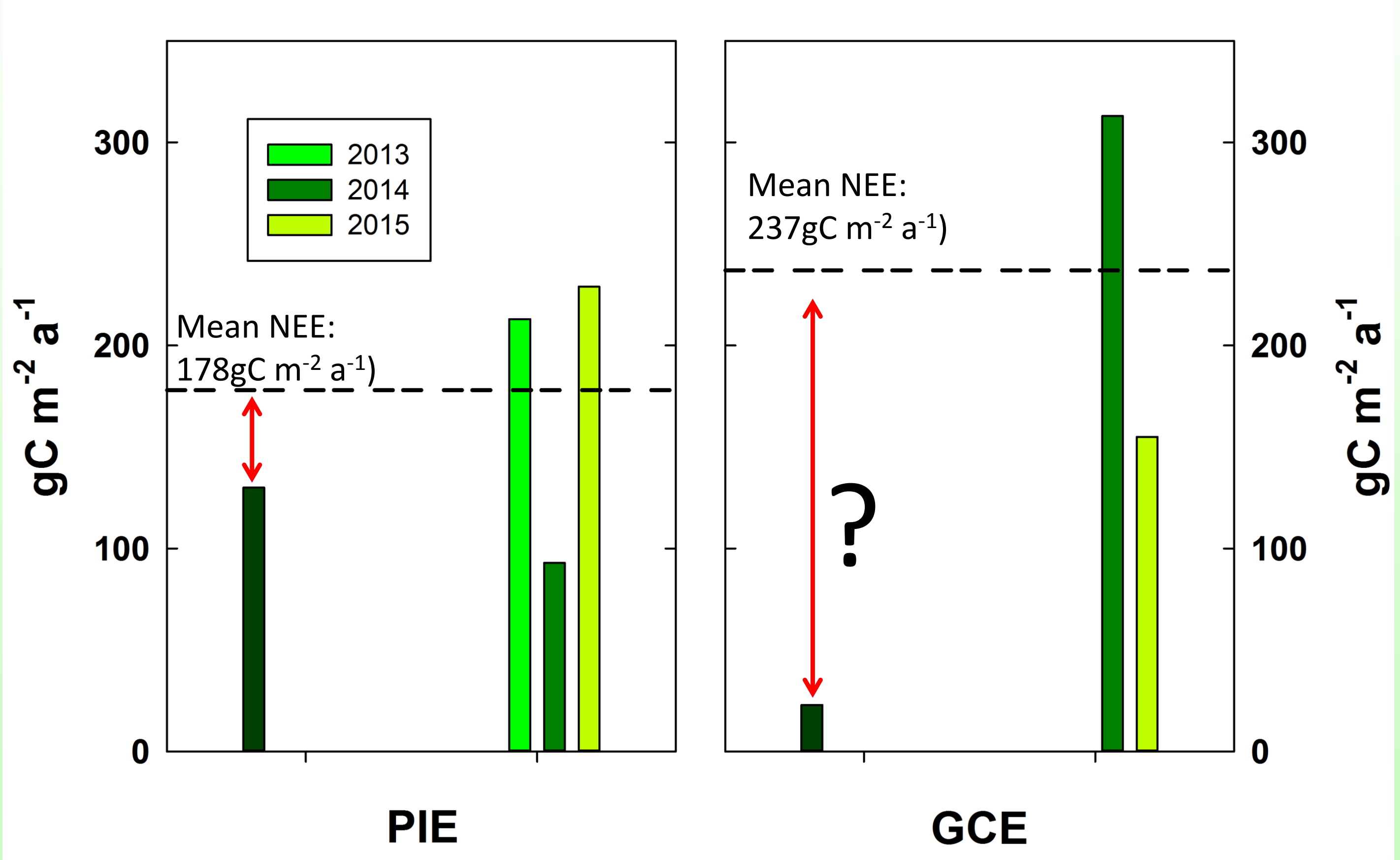


Fig.5 : Available estimates for annual NEE compared to estimates of burial rates (for GCE: from Craft 2010). The dashed line indicates mean NEE which is larger than the burial rates at both sites. This can be due to the different time scales the measurements encompass but indicates a potential for lateral C loss, especially at GCE.

Summary

- Despite difference in growing season length, GPP is similar between sites
- Large difference in burial rates between sites – a possible indication for a larger loss of carbon via tidal exchange in southern marshes than at PIE.

Temperature response of NEE

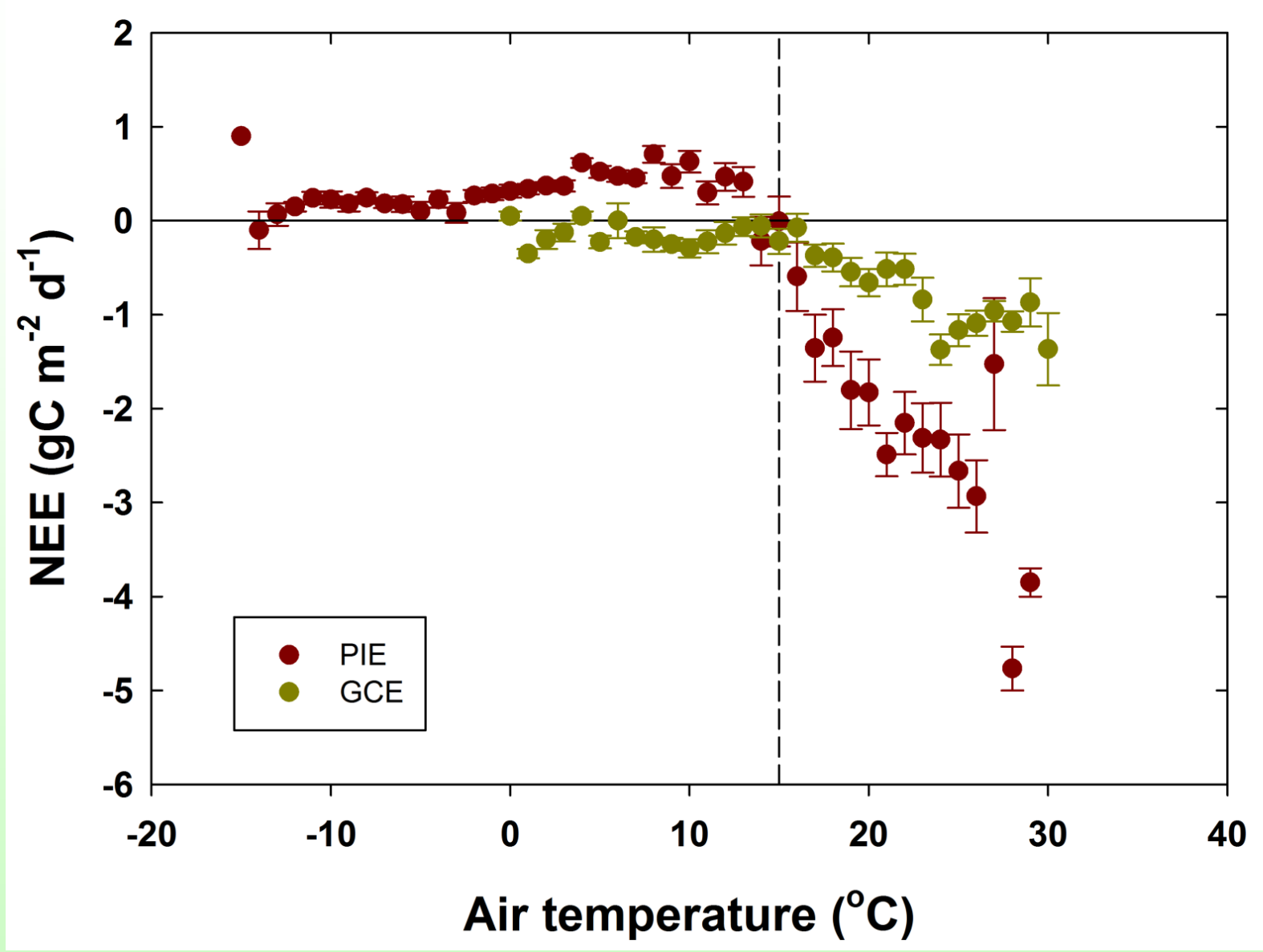


Fig. 9: Response curve of NEE with temperature at PIE and GCE. Average NEE was calculated for 1° temperature classes for the available years at both sites. The transition temperature from C source to sink seems identical between sites at 15°C.

Different Seasonal Dynamics of Plant growth

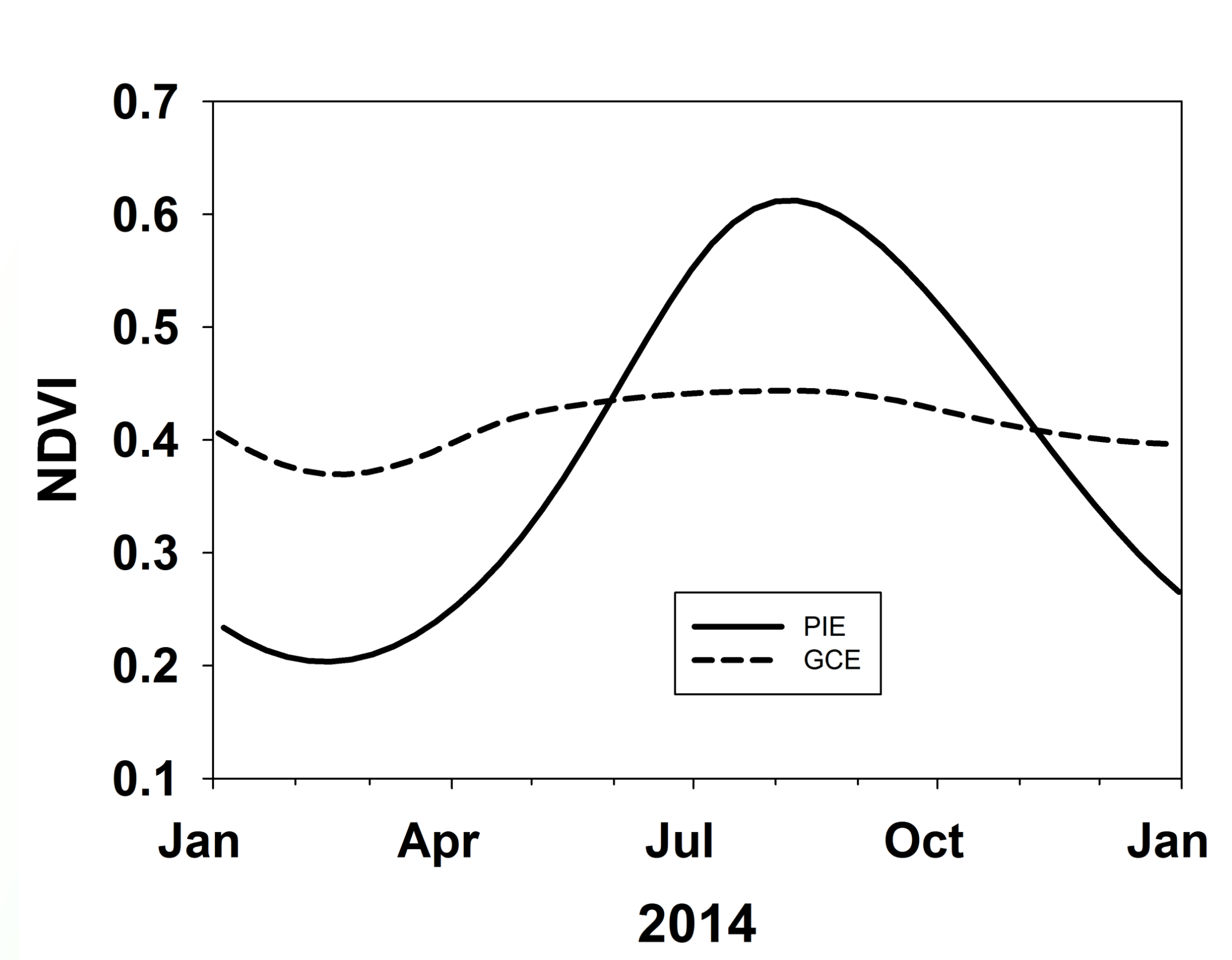
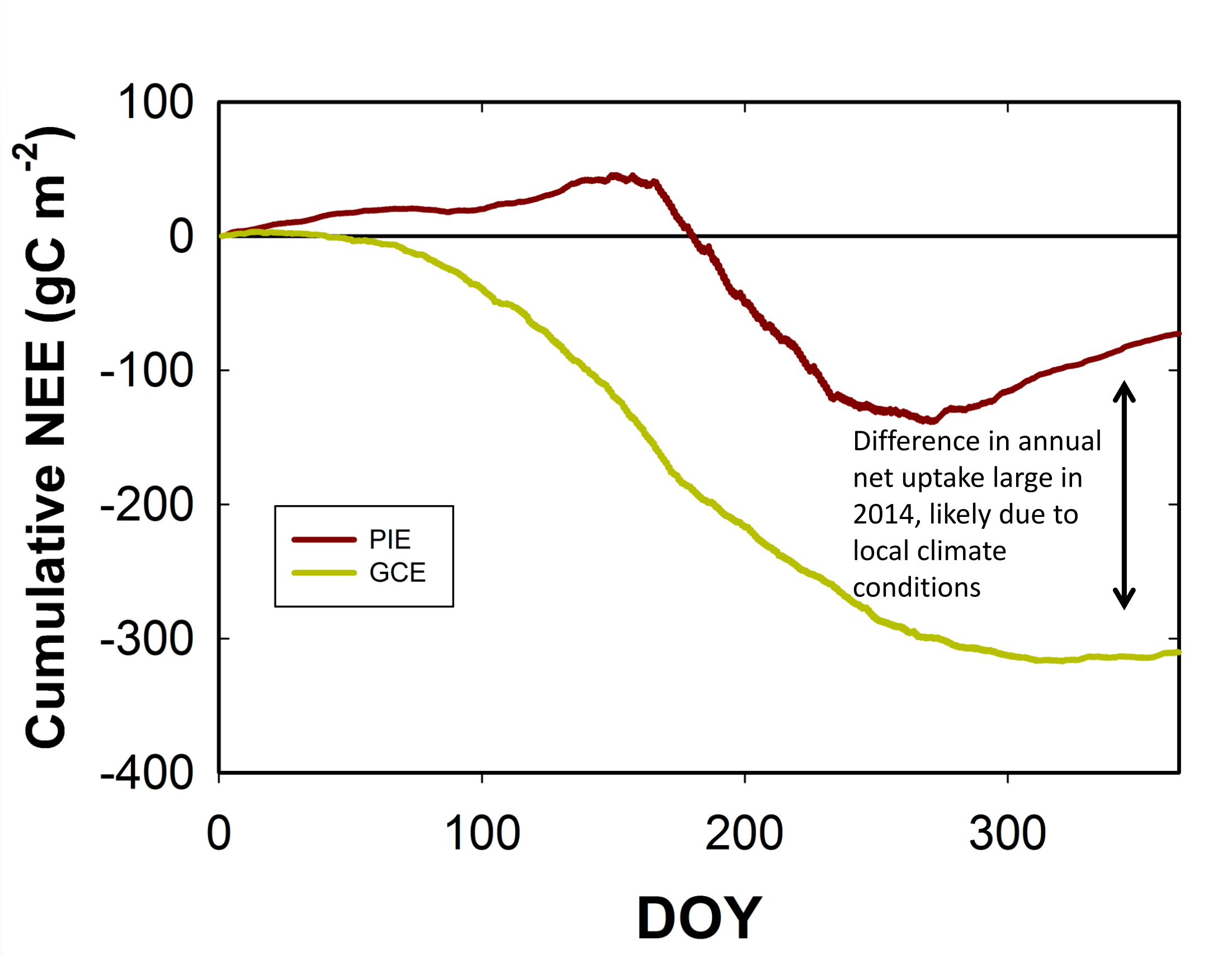


Fig. 6: Smoothed MODIS NDVI time series (250m resolution) for the tower pixel at PIE and GCE for 2014 (O'Connell et al., submitted). For PIE, NDVI shows a clear seasonal peak, while at GCE little variation is detectable during the year.

… and corresponding CO_2 fluxes



Difference in annual net uptake large in 2014, likely due to local climate conditions

Fig.7 :Cumulative CO_2 exchange during 2014 at both sites show different seasonal dynamics: PIE marshes act as C source during the non-growing season but are effective sinks during the short growing season. GCE marshes act as a sink of CO_2 during most of the year.

… but similar GPP and Respiration

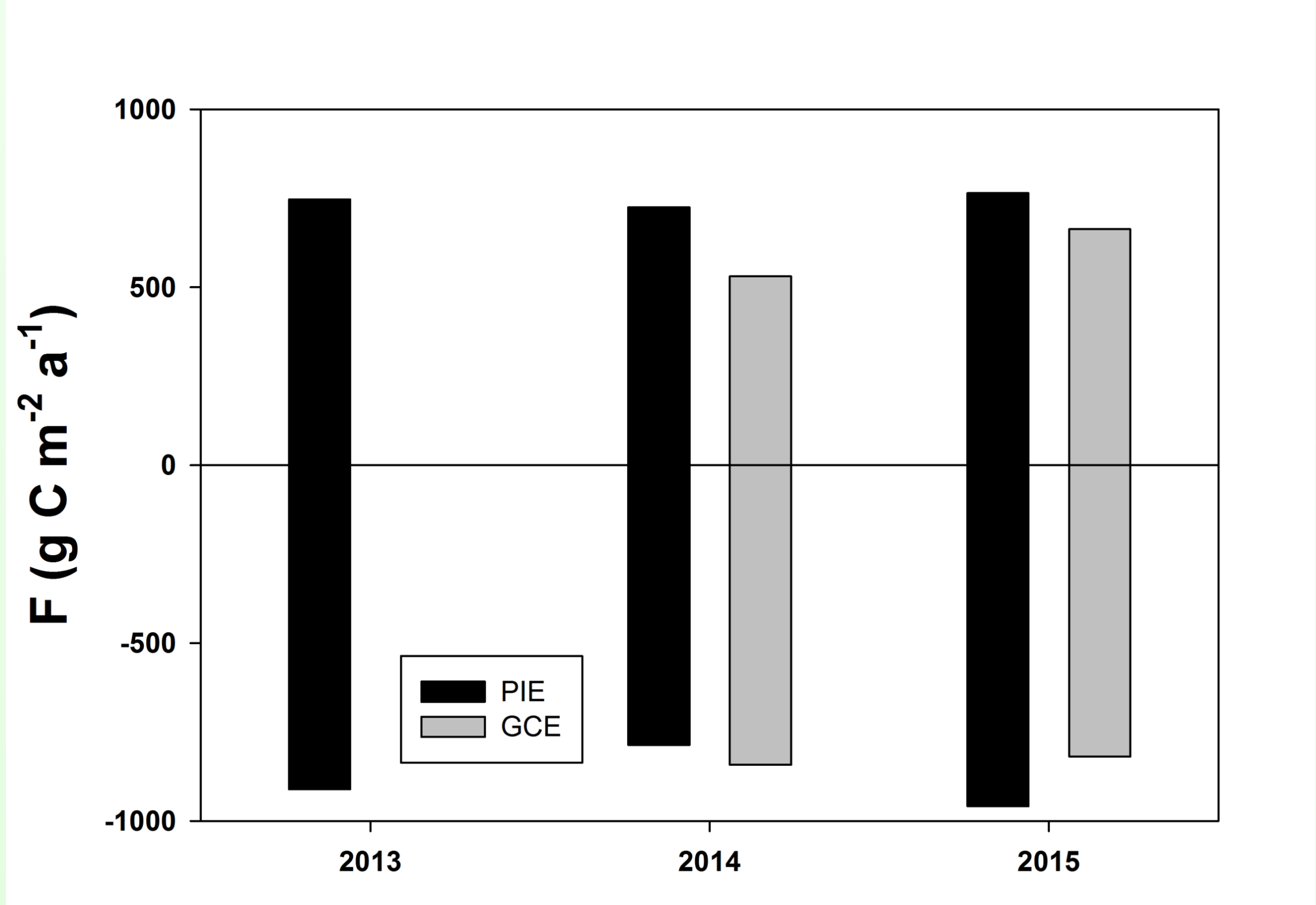


Fig.8: Component fluxes (Gross Primary Production and Ecosystem Respiration) for the available years at both sites. *DESPITE* differences in seasonality, GPP and R are in a similar magnitude.