National Aeronautics and Space Administration

Postdoc Research

Linking thermal infrared radiation and solar-induced chlorophyll fluorescence data to water-use-efficiency

Authors: Zoe Amie Pierrat, NASA Postdoctoral Fellow (329G)
Le (Elva) Kuai (329I), Nicholas Parazoo (329G), Abhishek Chatterjee (329G),
AJ Purdy (CSUMB | NASA ARC-CREST), Kerry Cawse-Nicholson (329)

Background

Terrestrial ecosystems play a major role in the global carbon and water cycles. The relationship between ecosystem carbon gain (gross primary production; GPP) and water loss (evapotranspiration; ET), also known as water use efficiency (WUE), is a key variable that can help us better understand the response of ecosystems to changes in climate. Remote sensing of solar-induced chlorophyll fluorescence (SIF; a proxy for GPP) and thermal infrared radiation (TIR; used to derive ET) have potential to constrain the highly dynamic nature of WUE across space and time, but the exact linkages between SIF, TIR, and WUE have not yet been fully evaluated.

Objectives

Figure 1 highlights the science questions and objectives of this work as well as observables used.

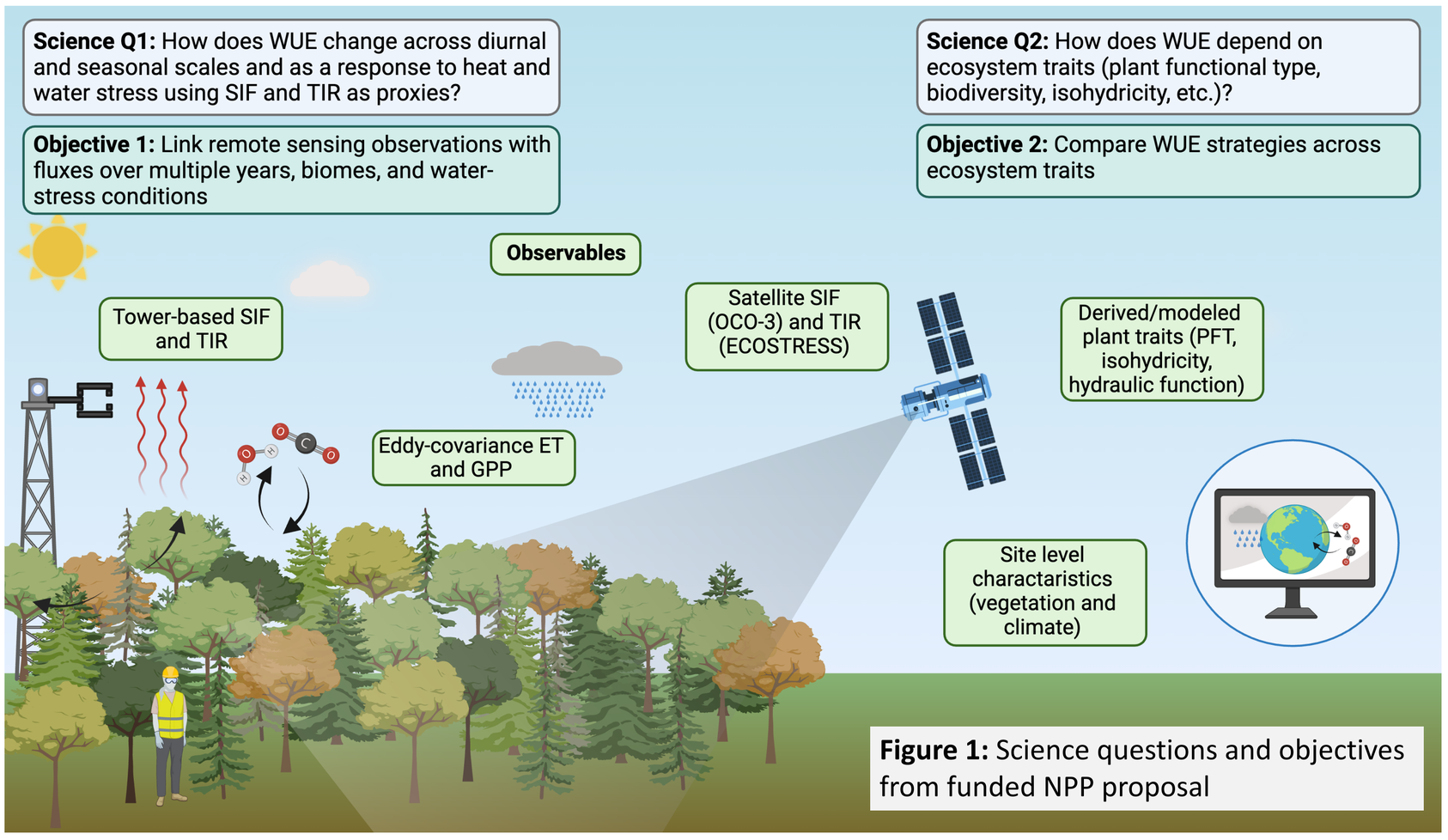

Figure 1: Science questions and objectives from funded NPP proposal

Approach and Results

We use a combination of tower-based SIF and TIR at eddy-covariance sites and overlapping SIF and TIR data from the International Space Station (OCO-3 and ECOSTRESS respectively).

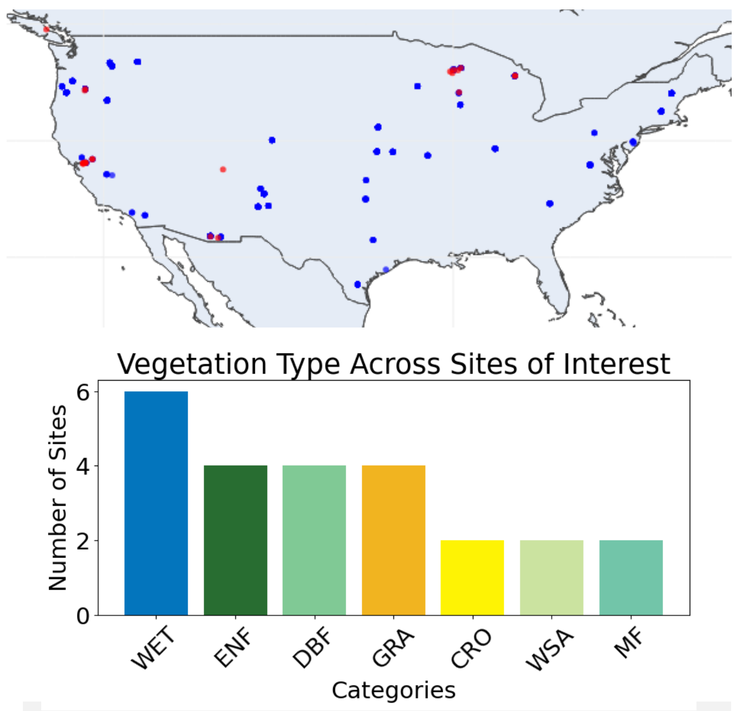

Figure 2: Site locations with overlapping OCO-3 and ECOSTRESS data (blue) and quality site-level validation data from AmeriFlux (red)

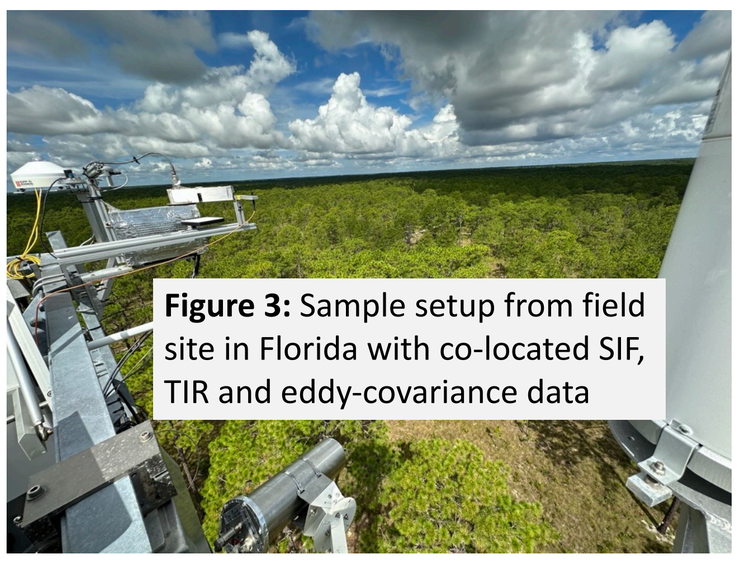

Figure 3: Sample setup from field site in Florida with co-located SIF, TIR and eddy-covariance data

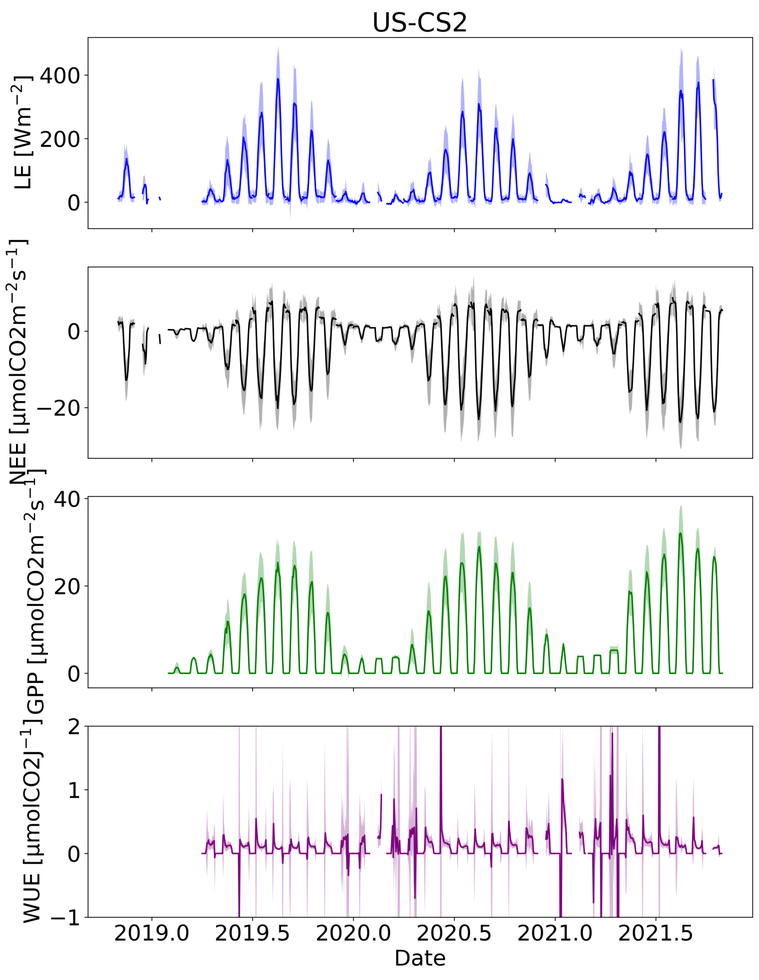

Figure 4: Sample monthly diurnal profiles of eddy-covariance data from AmeriFlux

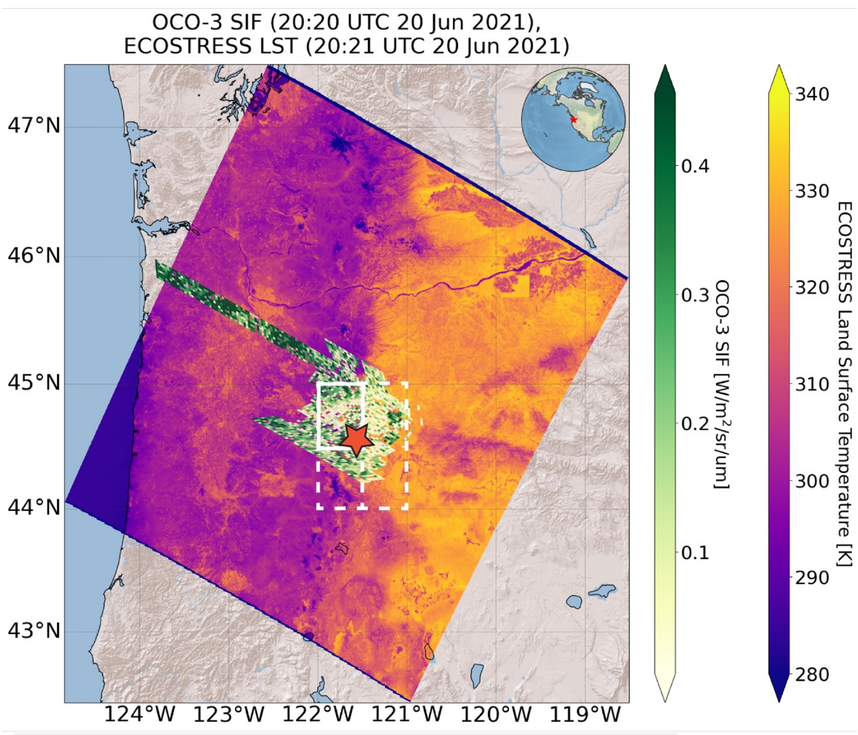

Figure 5: Sample overlapping ECOSTRESS and OCO-3 data from site of interest

Future Work

Our current work has identified key sites of interest and compiled existing datasets. The future of this work will be analyzing the representativeness of remote sensing proxies for ecologic processes and evaluating water-use-efficiency across space and time.

Significance of Results/Benefits to NASA/JPL

This work highlights the potential of combining co-located instrumentation for new scientific discoveries. We make use of synergistic datasets and help to advance our understanding of carbon and water fluxes. Finally, we plan to release overlapping data to the broader scientific community for future research on WUE.

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Jet Propulsion Laboratory
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Publications and Acknowledgements:

1. Pierrat et al., *Combining proximal-remote sensing with fluxes for an improved understanding of ecosystem carbon, water, and energy cycling.* In prep.
2. Pierrat et al., *Seasonal and diurnal patterns in water-use-efficiency from Solar-Induced Fluorescence and Thermal Infrared Radiation.* In prep.
3. Pierrat et al., *Water-use-efficiency as a function of ecosystem traits (plant functional type, biodiversity, isohydricity, etc.).* In prep.

Author Contact Information:

(603) 275-2500 zoe.a.pierrat@jpl.nasa.gov