National Aeronautics and Space Administration

Developing Multi-Instrument Approaches to Observing Terrestrial Ecosystems and the Carbon Cycle

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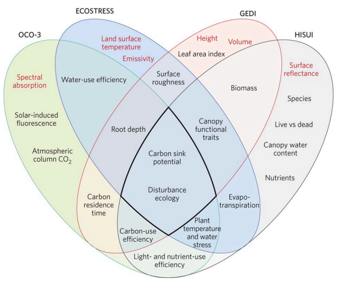
Program: Strategic Initiative

Project Objective:

The objective of our R&TD activity was to develop the JPL scientific and technical capabilities needed to take better advantage of multi-instrument synergistic datasets for observing terrestrial ecosystems and the carbon cycle from space during the unprecedent co-flight of ECOSTRESS, GEDI, OCO-3, DESIS, HISUI, and EMIT aboard the International Space Station during the ~2018-2022 timeframe.



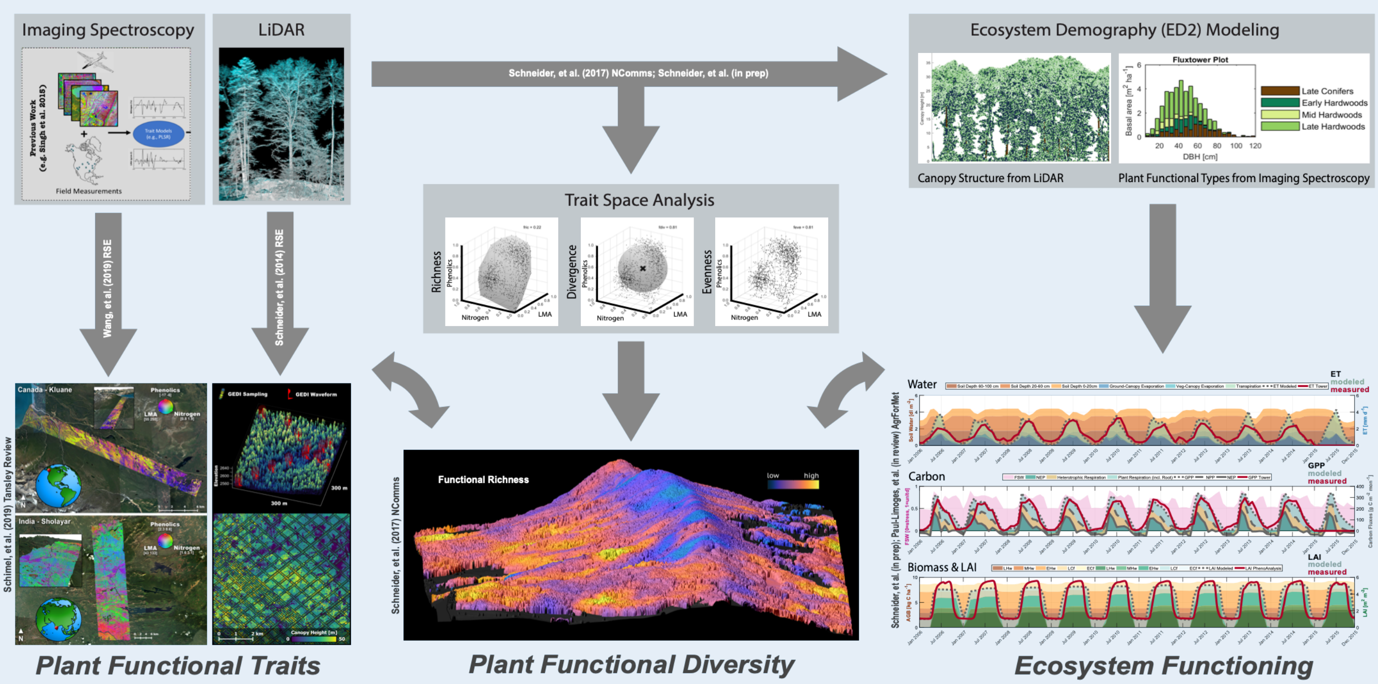
A pretzel diagram of observations (red text) from each instrument (coloured shapes) and the synergistic physical parameters that can be derived (black text) when observations are taken at synchronous and complementary spatial and temporal resolutions.

Benefits to NASA and JPL (or significance of results):

The goal of preparing JPL scientifically and technically to take advantage of the unprecedented simultaneous co-flight of multiple ecosystem-focused instruments on the International Space Station has large been achieved. We have developed new approaches for using new and upcoming instruments on the ISS. The SRTD team is now participating through NASA US Participating Investigator program on the HISUI and DESIS science teams. With several papers in review and others in preparation, we have well-positioned the Lab to compete in upcoming ROSES calls for the GEDI and EMIT science teams as well as an expected late FY19/early FY20 multi-instrument synergy ROSES call. This project has also provided key inputs to the SBG mission architecture study.

FY18/19 Results:

Combining Remote Sensing and Ecosystem Modeling to Link Traits to Diversity and Functioning



Imaging spectroscopy is a passive remote sensing technique to measure **spectral signatures of plants** in the visible, near infrared and short-wave infrared spectrum of radiation, continuously over large spatial scales. The spectral signatures can be linked to a range of **leaf biochemical** and **biophysical traits** describing the health, stress, productivity, and defense strategies of indiviudal plants to whole ecosystems. These plant functional traits build the basis for mapping plant functional diversity. Three **aspects of diversity** can be quantified by analyzing the distribution of traits of a specific area in the functional trait space: **functional richness** (total niche extent), **functional divergence** (niche differentiation), and **functional evenness** (regularity). To test the hypothesis that more diverse ecosystems are more productive and stable over longer time scales, we integrate the remotely sensed information on **canopy structure** and the distribution of **plant functional types** into the dynamic **ecosystem demography model ED2**. First results show that simulations of **water and carbon fluxes** as well as **biomass** are comparable to ground measurements, and can be improved by integrating remotely sensed inputs. Therefore, it will enable to run the model on a variety of sites to study the **effects of functional diversity, canopy structure and physiology on ecosystem functioning**.

Publications:

Schimel, D., Schneider, F., JPL Carbon and Ecosystem Participants, Bloom, A., Bowman, K., Cawse-Nicholson, K., ... & Liu, J. (2019). Flux towers in the sky: global ecology from space. New Phytologist.

Stavros, E. N., Schimel, D., Pavlick, R., Serbin, S., Swann, A., Duncanson, L., ... & Schweiger, A. (2017). ISS observations offer insights into plant function. Nat. ecol. evol, 1, 0194.

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