Poster #93

Ecophysiological Controls on Amazonian Precipitation Seasonality and Variability

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In this project, we aim to address how plant physiological processes, as assessed by fluorescence measurements and other observations, influence climate variability and precipitation over Amazonian rainforests, with a particular focus on the physiological control on deep convection triggering along a geographical water stress gradient. To achieve this goal, we have performed in situ observations, satellite and in situ data analysis, and the analysis of climate model results.

In situ measurements were developed along an atmospheric and soil water stress gradient, over three different sites in Amazon basin (Manaus site (K34), Rebio Jaru site (RBJ), Bananal site (BAN)). To understand the overall soil-plant-atmosphere system regarding water and carbon fluxes, we measured the seasonal variation of water transfer between soil and an atmosphere, mediated by plants, and the plant response to a seasonal or extreme water stress. We have developed and successfully installed a spectrometer that can measure fluorescence from both Fraunhofer lines in an optically transparent band of the atmosphere (745 – 759 nm) and the telluric O2A band (760 – 770 nm) in Manaus. Analysis of initial data demonstrates the advantage of Fraunhofer line SIF analysis: due to the atmosphere transparency in this band, the results are more robust in the face of changeable cloud cover than is the O2A band analysis. We expect to continue collecting data for several seasons to investigate how inter- and intra-annual changes in SIF correlate with other changes in plant ecophysiology.

Using novel remote-sensing based solar-induced fluorescence observations and a multivariate Granger causality technique, we showed that biosphere-atmosphere feedbacks are globally widespread and regionally strong, explaining up to 30% of precipitation and surface radiation variance. We show that Earth system models underestimate these precipitation and radiation feedbacks because they underestimate biosphere photosynthetic and water sensitivity. We also used the solar-induced fluorescence (SIF) measurements from two satellites that have different local overpass time (GOME2 – Global Ozone Monitoring Experiment-2: 09:30 am; GOSAT – Greenhouse gases Observing SATellite: 1:30 pm) to understand the broad spatial pattern of photosynthesis decline on a daily scale across the entire Amazon Basin. Our results suggest that there is mild mid-day depression of photosynthesis on the north, while the mid-day depression becomes significant on the south. We suggest that satellite SIF can reveal spatial and temporal patterns of vegetation water stress across Amazon.

We have compared CMIP5 model results of vertical moisture profiles in the Amazon with observations and found that are too dry at low levels, especially during the dry season. We are also evaluating the carbon uptake of CLM4.5, aiming to improve the CLM performance in simulating future land carbon uptake.