Fall 2020 ESMD PI Meeting Abstract

Title: **ELM-FATES progress updates:** Impacts of modeling global vegetation demography and dynamic plant competition

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Better representation of global vegetation through plant demography and mechanistic plant competition in Earth System Models (ESMs) is at the forefront of modeling more realistic interactions between biologically driven feedbacks with future climate change and impacts to biogeochemical and water cycles. To advance this research we have integrated fine-scale demographic processes into E3SM’s Land Model (ELM) via the Functionally-Assembled Terrestrial Ecosystem Simulator (FATES). In order to represent ecosystem response from competing vegetation dynamics FATES was used to simulate the growth, reproduction, and mortality of individual trees varying in size- and age-structure, multi-layered canopies, and across many plant functional traits. This enabled ELM to model the fine-scale environmental heterogeneity associated with disturbance and recovery processes.

We produce ELM-FATES global simulations to investigate dynamic plant functional type (PFT) distributions and turnover processes, now with the absence of ‘bioclimatic envelopes’. Initial global simulations successfully include eight interacting and competing PFTs. Global maps of net primary productivity, leaf area index, and total vegetation biomass by ELM-FATES matched patterns and values compared to several big-leaf models and MODIS estimates. Through model testing and evaluation, we found complex sensitivities due to the many interacting, co-varying plant traits. To improve accuracy and efficiency of model parameterization and calibration against global observations, we used machine learning techniques to generate surrogate models which predicted ELM-FATES responses over many combinations of input parameters, enabling better model benchmarking. Next, we assessed the effects when varying the representation of model vegetation features on carbon storage, net ecosystem exchange, and evapotranspiration. This entailed conducting global simulations with and without FATES, and with and without dynamic plant hydraulics to understand the implications of ecosystem demography on terrestrial carbon storage.