**Title**: Key Parameters under Varying Phosphorus Supply in the Nutrient-enabled ELM-FATES

Xinyuan Wei[1*], Daniel Ricciuto[1], Xiaojuan Yang[1], Anthony Walker[1], Ryan Knox[2], Charles Koven[2], Rosie Fisher[3,4]
[1]Environmental Sciences Division, Oak Ridge National Laboratory, Oak Ridge, TN, USA
[2]Climate and Ecosystem Sciences Division, Lawrence Berkeley National Lab, Berkeley, CA, USA
[3]CICERO Centre for International Climate and Environmental Research, Oslo, Norway
[4]Evolution et Diversité Biologique, CNRS, Université Toulouse Paul Sabatier, Toulouse, France

**Contact**: weix@ornl.gov
**Project Lead Principal Investigator (PI):** Jeffrey Chambers, Berkeley Lab
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**Project Abstract**:
Demographically structured vegetation models have a large number of input parameters, which complicates model development and calibration. Quantifying the impact of each parameter on model outputs and identifying key influential parameters are necessary to understand model behavior at various spatial-temporal scales. In this study, we conducted a comprehensive sensitivity analysis to diagnose influential parameters in the Energy Exascale Earth System Model (E3SM), land model (ELM) coupled to the nutrient-enabled Functionally Assembled Terrestrial Ecosystem Simulator (ELM-FATES). We used the Luquillo Experimental Forest site in Puerto Rico as a testbed to quantify the global sensitivities of model outputs (including carbon fluxes and above-ground biomass) to 43 model parameters. Since the phosphorus is generally limited in tropical forest ecosystems, we examined impacts of less phosphorus supply on the ELM-FATES parameter sensitivity. We designed two scenarios. In scenario 1, we used the climate data during the time period of 1995-2014 and high phosphorus supply to drive the model. In scenario 2, we used lower phosphorus supply together with the same climate data. We identified key parameters by using 1,000 model simulations of each scenario together with the Sobol' sensitivity indices from chaos. Overall, specific leaf area at the top of canopy and leaf N:C ratio were found to be the two most important parameters for simulated carbon stocks and fluxes. When phosphorus supply was low, the leaf C:P ratio became a more influential parameter for the above-ground biomass and gross primary production.