Poster# 79

Improving Plant Functional Types in Earth System Models: Pan-Tropical Analysis of Tree Survival across Environmental Gradients

Daniel J. Johnson[1], Jessica Needhamr[2], Chonggang Xu[1], Stuart Davies[2], Jeffery Chambers[3], Sean McMahon[2], and Nate McDowell[1]

1 Los Alamos National Laboratory
2 Smithsonian Institution
3 Lawrence Berkley National Laboratory

Contact: Daniel Johnson [djohnson@lanl.gov]

Terrestrial carbon cycling is a function of the growth and survival of trees. Current model representations of tree growth and survival at a global scale rely on coarse plant functional traits that are parameterized very generally. In view of the large biodiversity in the tropical forests, it is important that we account for the functional diversity in order to better predict tropical forest responses to future climate changes. Several next generation Earth System Models are moving towards a size-structured, trait-based approach to modelling vegetation globally, but the challenge of which and how many traits are necessary to capture forest complexity while retaining computationally efficient models remains critical. Additionally, the challenge of collecting sufficient trait data to describe the vast species richness of tropical forests is enormous and typically we do not have species level traits available. We propose a more fundamental approach to these problems by characterizing forests by their patterns of size-dependent survival. We expect our approach to distill real-world dynamics into a reasonable number of functional types for efficient modeling.

Using 14 large-area tropical forest plots that span geographic, edaphic and climatic gradients, we model tree survival as a function of tree size for almost two thousand species. We found four categories of size-dependent survival functions emerge. This indicates fundamental survival strategies at play across diverse forests providing reasonable constraint to the range of plant functional types. We mapped common plant traits onto these survival strategies and found little evidence for between site variation in wood density, seed mass and leaf mass per area. We related the relative biomass of our survival strategies to long term environmental variables and found that mean annual temperature and cumulative water deficit were strong predictors suggesting predictability of shifts in community composition with changing climate. We compare size-structured survival in DOEs FATES model with our observational results and offer potential improvements in how mortality is represented in this dynamic global vegetation model to greatly reduce uncertainty about carbon cycling.