Title: Survey Derived Gas Exchange Data Identify Diurnal Patterns in Leaf Level Water Use Efficiency and Improve Model Representation of Stomatal Function in Tropical Forests

Kenneth J. Davidson[1,2*], Julien Lamour[1], Alistair Rogers[1], Kim S. Ely[1], Qianyu Li[1], Nate G. McDowell[3,4], Alexandria L. Pivovaroff[5], Brett T. Wolfe[6,7], S. Joseph Wright[7], Alfonso Zambrano[7], and Shawn P. Serbin[1]

[1]Department of Environmental and Climate Sciences, Brookhaven National Laboratory, Upton, NY, USA
[2]Department of Ecology and Evolution, Stony Brook University, Stony Brook, NY, USA
[3]Atmospheric Sciences and Global Change Division, Pacific Northwest National Lab, Richland, WA, USA
[4]School of Biological Sciences, Washington State University, Pullman, WA, USA
[5]Biology Division, Glendale Community College, Glendale, CA, USA
[6]School of Renewable Natural Resources, Louisiana State University, Batton Rouge, LA, USA
[7]Smithsonian Tropical Research Institute, Apartado, 0843–03092, Balboa, Panama

Contact: (kdavidson@bnl.gov)
Project Lead Principal Investigator (PI): Jeffrey Chambers, Berkeley Lab
BER Program: ESS
Project: NGEE Tropics (led by Berkeley Lab)
Project Website: https://ngee-tropics.lbl.gov

Project Abstract:
A primary source of uncertainty in Earth system model (ESM) projections of terrestrial carbon and water cycling is the relationship between CO_2 assimilation (A) and water loss via stomatal conductance (g_s). A common framework for modeling this relationship relates A to g_s over environmental conditions (temperature, CO_2, irradiance, and humidity) and is governed by two terms, the stomatal slope (g_1) and intercept (g_0). Given their importance in determining the relationship between forest productivity and climate, an accurate and mechanistic understanding of the g_1 and g_0 parameters is crucial. In this study, we assess possible physiological and mechanistic controls on the estimation of g_1 and g_0 using both diurnal gas exchange surveys and leaf level response curves for six tropical broadleaf evergreen tree species across a full range of leaf phenological stages. We found that g_1 estimated from curves was on average 50% less than g_1 estimated from survey data. We also show that while g_0 varied significantly between leaves of different phenological stages, this effect was generally not observed for g_1. While some species groups exhibited variable g_0 or g_1 with phenological stage, among species groups there was no consistent pattern of change in g_0 or g_1 with phenological stage. We also identified a diurnal trend associated with g_1 and g_0 that significantly improved model projections of diurnal trends in g_s. These results suggest that to improve the accuracy of modeled g_s in tropical forests, we should investigate the mechanism responsible for variation among species and across diurnal patterns.