Title: A Novel Halophyte-Capable Plant Hydraulics Model for Mangrove Forest Function

Ashley M. Matheny[1*], Maria Ulatowski[1], Annalisa Molini[2], Matteo Detto[3], Chonggang Xu[4], Tim Shanahan[1]

[1]University of Texas at Austin, Austin, TX;
[2]Tulane University, New Orleans, LA;
[3]Princeton University, Princeton, NJ;
[4]Los Alamos National Lab, Los Alamos, NM;
Contact: (ashley.matheny@jsg.utexas.edu)

Project Lead Principal Investigator (PI): Ashley M. Matheny

BER Program: ESS

Project: Exploring halophyte hydrodynamics and the role of vegetation traits on ecosystem response to disturbance at the terrestrial-aquatic interface (University Project)

Project Website: http://www.jsg.utexas.edu/matheny/halophyte-hydrodynamics/

Project Abstract: Mangroves grow along coastlines and intertidal zones, and are therefore very rarely limited by water availability. However, during the dry season, these ecosystems behave more similarly to semi-arid ecosystems than like well-watered forests. Mangroves likewise provide a critical carbon sink sequestering carbon at a rate disproportionate to ecosystem extents. Modeling the water and carbon dynamics of mangrove forests is a critical task for developing robust models of coastal climate processes, particularly in the face of sea-level rise and disruptions to local hydroclimates and therefore freshwater inputs.

Here, we present the development of a salt-exclusion water uptake module for the FETCH2 advanced vegetation hydrodynamics model that is capable of mechanistically simulating root osmoregulation by halophytes. FETCH2 approximates water flow through xylem as flow through non-saturated porous media and accounts for dynamic changes to conductance and capacitance of plant tissues caused by changes in water content. The FETCH2-osmo model bases vegetation water potentials on total matric, gravitational, and osmotic potentials at each height increment. Parameter sets within FETCH2 are based on measurable hydraulic properties. Studies have shown that many such traits can be highly plastic and vary spatiotemporally. Here, we use the findings of an on-going greenhouse-based study of mangrove hydraulic traits and their variability to parameterize our halophyte-capable version of FETCH2. These plant traits are complemented by environmental forcing observations from 4 field study sites are positioned to promote analysis of mangrove forest function across both humidity and salinity gradients which are predicted to change in response to disturbances such as sea level rise, precipitation variability, inundation frequency, and increased atmospheric CO_2. Within the greenhouse, we are able to test for species and population-level differences in adaptation and acclimation of different hydraulic traits to fluctuating humidity and salinity environments. This project supports mangrove monitoring in four sites across the globe: from humid (Panama) to arid (Abu Dhabi) and at the northern (Texas) and southern (Victoria, Australia) growth limits. Ultimately, the new FETCH2-osmo model with will integrate into the DOE's functionally assembled terrestrial simulator (FATES) within E3SM.