Construction of a FATES Testbed at Barro Colorado Island, Panama

Problem: FATES is a complex model; need to simultaneously benchmark fluxes (of water, C, energy, individuals) and (structured) states

• Need site with multiple types of data, e.g. inventory, flux tower, etc, and design benchmarks for assessing model skill
• Also want to match the scale and ecosystem specificities of a given site, so use site-level meteorological drivers and distributions of plant traits.
• Want to design testbed workflow that can be extended to other sites, easily modified to consider new model versions (FATES-Hydro and associated observations) or model complexities (single-PFT -> multiple competing PFTs)
Outline of workflow

1. Parameterize model
   a) Identify joint distribution of a set of plant traits based on observed values
   b) Add other (non-observed) traits to consider their effect on model predictions
   c) Randomly sample full joint trait distribution and use to define perturbed parameter ensemble

2. Run Model

3. Analyze output
   a) Benchmark model
   b) Assess parametric control
Defining trait distributions

• Observed traits available: Vcmax, SLA, Leaf N/area, leaf lifespan, wood density, mortality rate of trees > 10cm (which we here use as background mortality rate)

• Non-observed traits varied here: crown allometry (coefficient and exponent), leaf:fine root biomass, leaf biomass: DBH allometry, sapwood area : Leaf area allometry, stomatal slope
Observed trait distributions
Full set of traits as defined into ensemble
Sanity check: Most (86% of) ensemble members have some sort of surviving forest
Leaf Area Index

FATES ensemble predictions

Site-level observations

Detto et al., (2018)
GPP seasonal cycles
ET and SH seasonal Cycles

Seasonal cycle of LH

Seasonal cycle of SH
Stem size distributions

Tree Size Distributions

Observations
FATES ensemble members

Tree number density (n/ha/cm)

Tree Diameter (cm)
Fluxes (of trees too)

Growth

Death
LIDAR and canopy height structure
Parametric control of GPP
Parametric control of leaf area index
Parametric control of canopy area index
Conclusions / Next Steps

• Testbed approach for combined benchmarking and identifying parametric control is very useful.
• FATES can produce reasonable predictions as compared to suite of observations, expect further convergence with some further iterations of trait choice, values, and model structural changes.
• All of this in 1-PFT system, need to extend to 2- and multi-PFT systems.
• Need to extend to FATES-hydro with hydraulic traits benchmarks.