LDRD 6477

Model-Inspired Science Priorities for Evaluating Tropical Ecosystem Response to Climate Change

- Part I: Observations, theoretical process analyses and national and international collaborations

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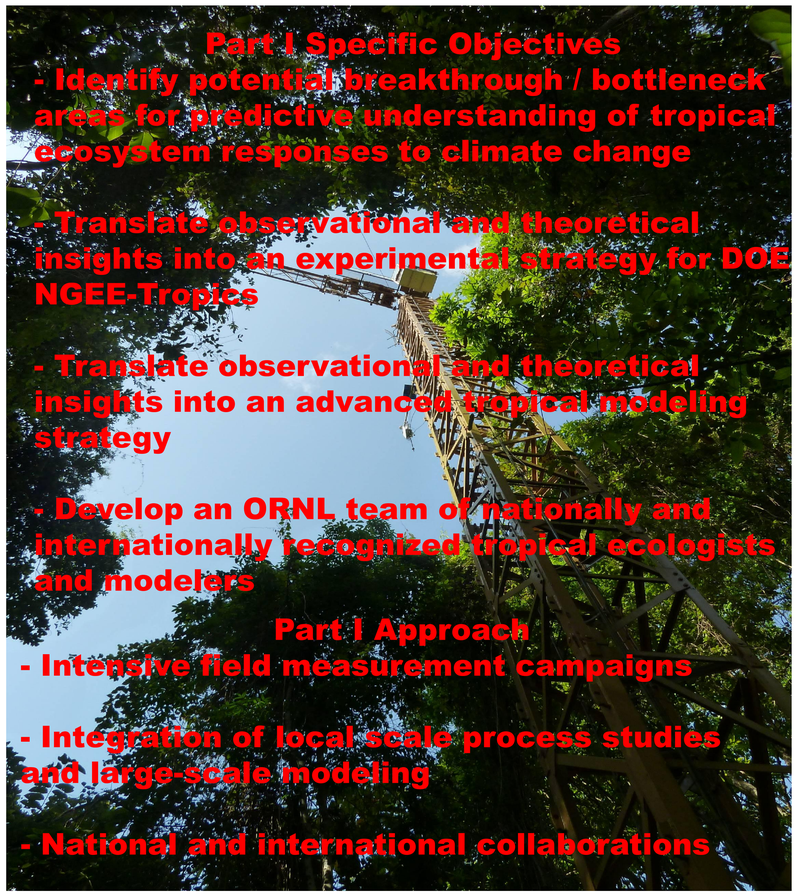
Project Overall Objectives

- Provide model improvements and initial model experiments to define critical science objectives for DOE Next Generation Ecosystem Experiment in the Tropics (NGEE-Tropics)
- Provide guidance for an intensive campaign of structured observations and manipulative experiments
- Position ORNL for a major role in NGEE-Tropics over the next decade



Part I Specific Objectives

- Identify potential breakthrough / bottleneck areas for predictive understanding of tropical ecosystem responses to climate change
- Translate observational and theoretical insights into an experimental strategy for DOE NGEE-Tropics
- Translate observational and theoretical insights into an advanced tropical modeling strategy
- Develop an ORNL team of nationally and internationally recognized tropical ecologists and modelers

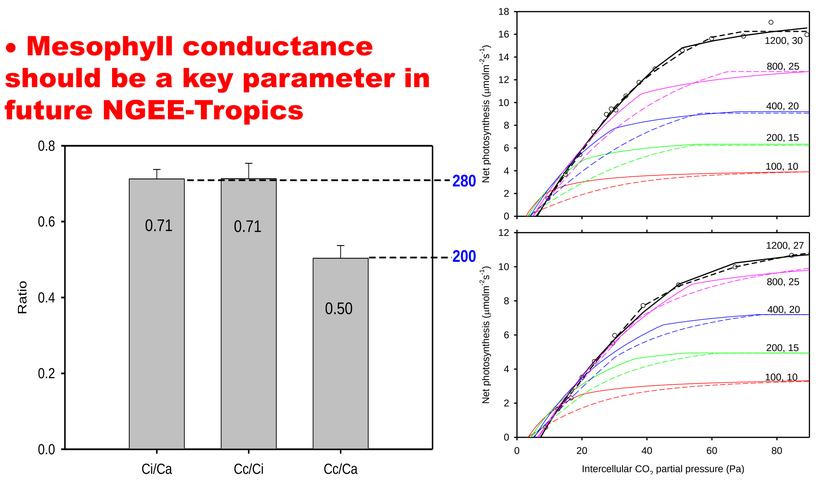
Part I Approach

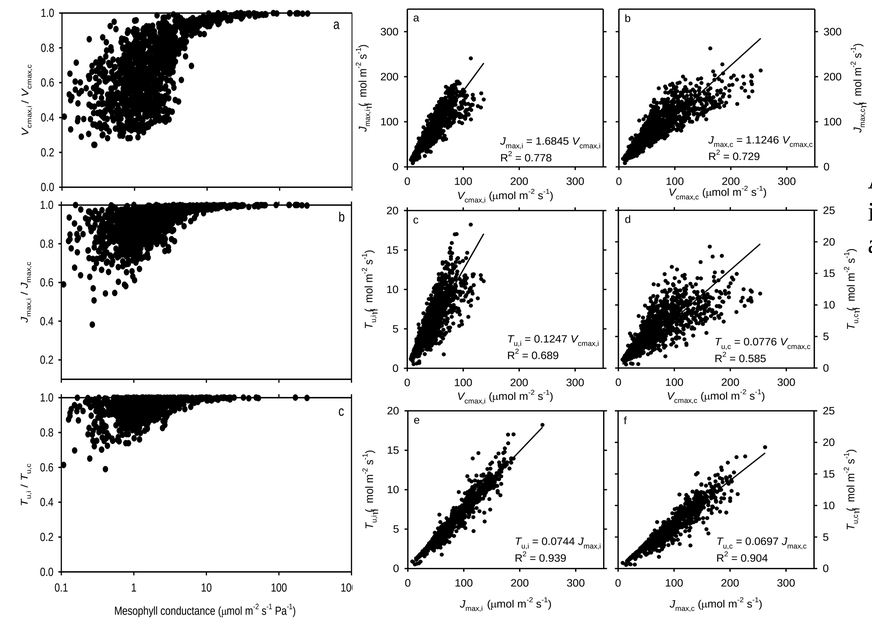
- Intensive field measurement campaigns
- Integration of local scale process studies and large-scale modeling
- National and international collaborations

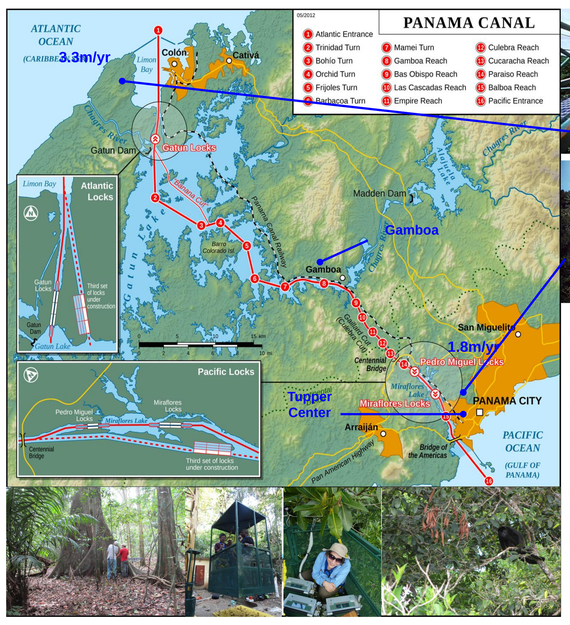
What have we achieved scientifically?

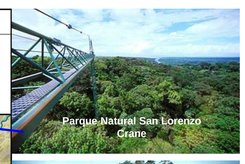
(See the second poster for achievements in Part II of the Project)

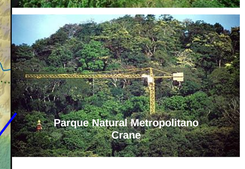
- Carboxylation in the tropics is currently operating at a CO_2 partial pressure much smaller than previously thought
- Tropical photosynthesis may have more sustained response to increasing atmospheric CO_2 concentrations than previously thought
- Mesophyll conductance should be a key parameter in future NGEE-Tropics





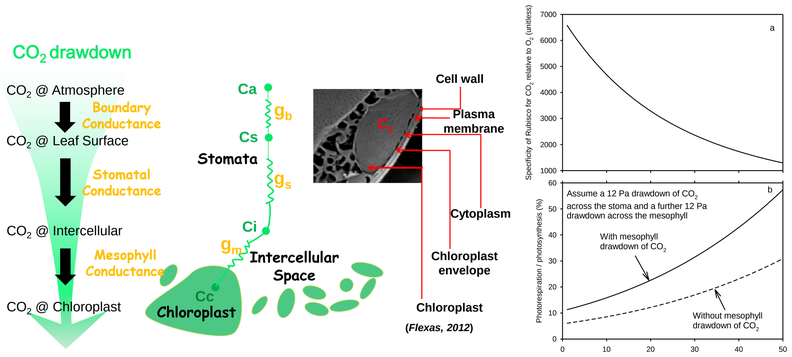




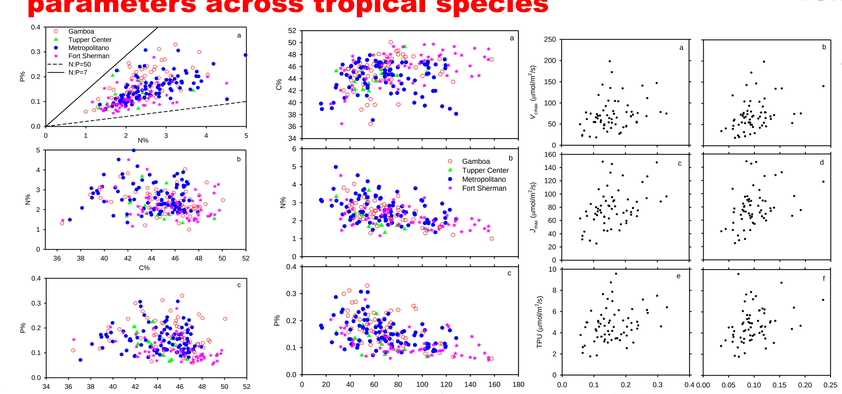


- Leaf gas exchange measurements with canopy cranes
- Leaf CNP measurements
- Leaf mesophyll conductance estimation
- Measurements made along a strong precipitation gradient
- High species diversity
- Unknown plant biology

Mesophyll conductance and its importance in the tropics

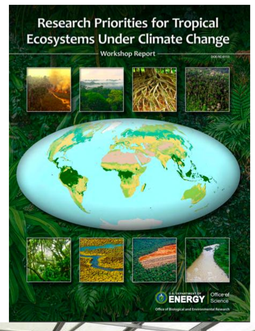


- CNP ratios vary widely across tropical species
- %P is the best predictor for photosynthetic parameters across tropical species



What have we achieved for strategically positioning ORNL for the NGEE-Tropics?

- DOE workshop on "Research Priorities for Tropical Ecosystems Under Climate Change", with ORNL leadership, identified critical issues for investigation through experiments and modeling
- We have established partnerships with colleagues in Puerto Rico, Panama, and Brazil to advance experimental approaches to climatic warming and elevated CO2, guided by our modeling insights
- Development of collaborative agreement with research staff of the Smithsonian Tropical Research Institute (STRI)



Dr. Klaus Winter, senior STRI researcher and a leading tropical plant physiologist, helps with ORNL photosynthesis campaign in Gamboa, Panama

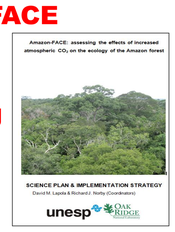
- Interactions with participants in a USFS experiment investigating responses of a forest in Puerto Rico to warming, including pre-experiment modeling of warming response, possible use of ORNL technology for soil warming and coordination of P cycling measurement and modeling

Ariel Lugo, chief of US Forest Service in Puerto Rico, shows potential site for a warming experiment

Sasha Reed, USGS co-leader of warming experiment, learns about ORNL warming technology

Amazon FACE experiment

- Workshop at Inter American Development Bank considered alternative experimental designs for elevated CO_2 experiment
- Consensus was for a free-air CO_2 experiment (FACE) experiment in primary forest
- Visit to ZF2 site north of Manaus, Brazil, identified research plots for FACE experiment
- Science plan was written and funding sources have been identified



Amazon-FACE science plan reflects importance of

- Mesophyll conductance and improved modeling of photosynthesis
- P cycling and soil measurements
- Data-model interaction based on ORNL leadership in FACE synthesis

Two papers have been already accepted by a leading international journal

Sun Y. et al (2013) Asymmetrical effects of medophyll conductance on fundamental photosynthetic parameters and their relationships estimated from leaf gas exchange measurements. Plant Cell and Environment (accepted)

Gu, L. and Y. Sun (2013) Artifactual response of mesophyll conductance to CO2 and irradiance estimated with the variable J and online isotope discrimination methods. Plant Cell and Environment (accepted)