BGC Feedbacks SFA
Tropical Research Agenda

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Biogeochemistry Feedbacks Scientific Focus Area

- Develop new hypothesis-driven approaches for evaluating ESM processes and using observations at site, regional, and global scales
- Investigate degree to which contemporary observation may reduce uncertainties, using emergent constraints
- Create community open source benchmarking software systems
- Evaluation performance of biogeochemical processes and feedbacks in models
Model-Data-Experiment Integration

Advanced computational methods

Data synthesis, scaling, and integration

Field measurements and manipulative experiments

Process research, site characterization, and experimental design

Identification of key knowledge gaps

Data assimilation

Model simulations, evaluation, analysis, and benchmarking

Model development employing modular design

COMMUNITY DATA, MODELS, AND ANALYSIS CAPABILITIES

Watershed Research
Ameriflux
CMIP6
ESS Data Center
ARM Data Archive

SPRUCE
Akuna
Agni
FACE
NGEEs
PCMDI
ESGF

PLOTTRAN
Amanzi-ATS
ParFlow
CrunchFlow
GCAM
ACME
ILAMB
CASCADE
UQ
CIDM
PMP

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Advanced computational methods
Tropical Research Objectives

- To study land–atmosphere interactions and how climate variability and change influence ecosystem responses
- To study terrestrial, marine, and atmospheric responses and feedbacks of El Niño Southern Oscillation (ENSO) and extreme events
- To support model–data integration and develop metrics for benchmarking land and ocean responses and feedbacks
- To develop benchmark datasets in collaboration with NGEE Tropics
- To leverage the ACME model for biogeochemical cycle forecasting
Decadal-Scale Predictability of Ecosystem Responses

This research leverages the ACME model (ESM Program) to study ecosystem responses to climate variability (RGCM Program) and to support research and model development in NGEE Tropics (TES Program).

Objectives

- To study model responses of the 2005 and 2010 Amazon droughts, which were a consequence of Atlantic Ocean conditions.
- To construct meteorological forcing data, including strong tropical land-atmosphere interactions, from CAM5-SE for use in NGEE Tropics process model development and testing for the FATES model.
- To test the utility of the ACME framework for decadal-scale biogeochemistry predictions and tropical ecological forecasting.
Decadal-Scale Predictability of Ecosystem Responses

- **Model Configuration**
  - ACME v0.3 and v1.0-pre run at 1-degree (ne30np4) AMIP-style (F compset)
  - Data ocean model reads NOAA Optimum Interpolation (OI) version 2 daily sea surface temperature (SST) (September 1981–present)
  - Sea ice fractions are also provided by the OISSTv2 data set
  - Future SST projections come from 9-month seasonal forecasts of the NOAA Climate Forecasting System (CFSv2)
  - Beyond 9 months from present, SSTs and ice fractions are drawn from historical OISSTv2 data (match SST magnitude and direction) for 5 years
Global Gross Primary Production (GPP) Responses

Correlation of annual gross primary production with 5-month averages of sea surface temperatures over the Niño 3.4 region (November-February) during 1995-2016. The hatching indicates areas where the correlation is at a 90% confidence level or higher.
Regional PFT-level GPP Anomalies
Decadal-Scale Predictability of Ecosystem Responses

- ILAMB evaluation showed a +0.5 K bias in mean surface air temperature over land and a positive bias in mean precipitation at high elevations.
- Patterns of 2-m air temperature and precipitation correlations with Niño 3.4 SSTs were consistent with NCEP and ERA-Interim reanalyses.
- Patterns of GPP correlations with Niño 3.4 SSTs were consistent with expectations, especially GPP reductions in the Amazon and Indonesia.
- Patterns of precipitation and soil moisture for the 2010 Amazon drought were consistent with data reported by Lewis et al. (2011).
- Next: decompose carbon fluxes (growth, respiration, fire), compare atmospheric CO₂ variability with observations, and compare with site measurements.
- Ready to upgrade to ACME v1.0 model and use methodology to investigate ENSO-related energy, water, and carbon questions.
Future Tropical Research Collaboration

- Understanding how changes in water availability (thus evapotranspiration and latent heat) influence regional temperatures (Paul Levine, UCI)
- Decomposing continental influences on global precipitation (Gabe Kooperman, UCI)
- Understanding the influence of tropical biomass burning, deforestation, and afforestation on global biogeochemical cycles
- Constraining ecosystem responses by confronting models with land, ocean, and atmosphere measurements and informing field activities
- Develop tropical-specific metrics for evaluating ACME and community models