



Ecosystem Responses and Feedbacks Breakout Group Report

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**DOE Regional and Global Model Analysis (RGMA)
Principal Investigator (PI) Virtual Meeting**

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Lightning Presentations (1/3)

High Latitudes

- [Non-growing season plant nutrient uptake controls Arctic tundra vegetation composition under 21st century climate](#) – Bill Riley

Disturbance

- [Biophysical climate impacts of deforestation accelerate tropical vegetation carbon loss](#) – Yue Li
- † [Quantifying the drivers and predictability of seasonal changes in African fire](#) – Jiafu Mao

Soil Carbon

- † [The age distribution of global soil carbon inferred from radiocarbon measurements](#) – Zheng Shi
- † [Deriving functional relationships between environmental factors and soil organic carbon stocks](#) – Umakant Mishra

Extremes

- [Detection and Attribution of Climate-Driven Extremes in Net Biome Productivity from 1850 through 2100](#) – Bharat Sharma

Lightning Presentations (2/3)

Climate–Carbon Cycle Sensitivity

- [Climate sensitivity and biogeochemical feedback](#) – Min Xu
- [Carbon and climate dynamics of CMIP6 models in SSP scenarios past 2100](#) – Charlie Koven

Land–Atmosphere Carbon Exchange

- [Country-level land carbon sink and its causing components by the middle of the 21st century](#) – Lifen Jiang
- [Benchmarking large-scale carbon fluxes in the CMIP6 ensemble using novel CO₂ observations](#) – Gretchen Keppel-Aleks

Plant Physiology

- [Plant Physiology Increases the Magnitude and Spread of the Transient Climate Response to CO₂ in CMIP6 Earth System Models](#) – Claire Zarakas
- [Short-term favorable weather conditions affect long-term trends in water use efficiency](#) – Kuang-Yu Chang

Lightning Presentations (3/3)

Marine Biogeochemistry

- [The impact of a changing environment on Arctic Marine production](#) – Georgina Gibson
- [Evaluation of CMIP5 and CMIP6 models with the IOMB system: Low rates of contemporary carbon sink linked with vertical temperature gradient and transport to the ocean interior](#) – Weiwei Fu
- [Variability in the biophysical environment of the Pacific Arctic](#) – Jaclyn Clement Kinney

Uncertainty

- [†][Reducing uncertainty in CMIP6 model projections with transfer learning](#) – Qing Zhu
- [Treatment of Observational Uncertainty in ILAMB](#) – Nathan Collier
- [Different numerical implementations imply uncertain model parameterizations and responses](#) – Jinyun Tang

Carbon and Water Feedbacks from Rising Carbon Dioxide

- [Prospectus for a workshop on CO₂ fertilization feedbacks](#) – Nate McDowell

[†]4 presentations that used machine learning

Breakout Group Discussion

- AI/Machine Learning is under-represented in the white paper
 - Produce gridded datasets from sparse observations (see presentations from Shi and Mishra)
 - Model surrogates (see presentation from Zhu)
 - Analytics to detect and disentangle drivers and effects (see presentation from Mao)
 - Separating fertilization and VPD effects from rising atmospheric CO₂
 - Parameter uncertainty / estimation / optimization
- Physiologists are concerned about models not representing VPD effects
 - Need more realistic plant hydraulics, demographics, plant stress, and their feedbacks
 - Abby Swann's new project will address parts of this problem
 - Models may overestimate enhanced growth effects of rising CO₂ and nutrient constraints are not rigorously addressed
 - Do we need a workshop to address these issues (involving physiologists and FACE-MDS group)?
- Models need improved coupling of land to coastal ocean to shelf regions and relevant process representations
 - Especially important for evolution of the Arctic ocean carbon sink
 - Pose this as a measurement challenge!

Breakout Group Discussion

- Remote sensing
 - How much integration of remote sensing is happening through ILAMB (quite a bit, but more is better) and in models (e.g., data-driven modeling)? Not enough!
 - New sensors, like GEDI and ECOSTRESS, offer new opportunities for model constraints
 - We may need a more proactive strategy than waiting for NASA to produce a Level 3 product
 - Is data assimilation an appropriate area for development?
- Model evaluation
 - Need better uncertainty characterization in data; we can use it in ILAMB (see Collier presentation); we need good QC on synthesized datasets
 - Can we generate a list of observational datasets critical but not yet used or available? Many are included in the *2016 ILAMB Workshop Report*, but there are more now
 - CLM5 Perturbed Parameter Ensemble (PPE) effort another way to use ILAMB to constrain models and guide decision making about parameters and data needs; do the same for ELM?
 - ILAMB is useful for model evaluation/validation, verification, PPE/parameter optimization, gatekeeping for assessments (e.g., Global Carbon Project), quantitatively tracking model improvement over time for the research community, testing dimensionality reduction, others?

Breakout Group Discussion

- Simulations

- CESM deforestation simulations being analyzed (Li at UCI), but E3SM tropical deforestation response is not reasonable, partly due to a high transpiration capacity of C_4 grass?
- E3SM project focusing on resolution, but for land, resolution is not likely to help as much due to the presence of high parametric and structural uncertainty that exists even at fine scales
- Fixed LAI simulations may be useful for studying land-atmosphere feedbacks; C4MIP experiments, $1\%CO_2/yr$, and large ensembles of low res (2°) runs for PPE would be useful

- Metrics

- Workflows and toolkits are important enabling infrastructure for our science
- Many science communities are converging on Python, Jupyter Notebooks/Lab/Hub, etc.
- Should DOE directly support development of xarray (some things appear missing), and interactive mapping and diagnostic libraries/toolkits?
- ILAMB is already excellent; it is ahead of many segments of the Earth science community, but we could do more, including offer improved methods to probe ILAMB results for discovery
- Can we develop tools to use the datasets in ILAMB to mine relationships, abstract metrics, search for emergent constraints, or apply other analytics methods?