NAME: Yiqi Luo
ORGANIZATION: University of Oklahoma
PROGRAM AFFILIATION: TES
ABSTRACT TITLE: Evaluating and Improving Performances of Global Land-surface Models through Data Synthesis and Data Assimilation

ABSTRACT: The state-of-the-art global land models usually generate great uncertainties in their simulations of terrestrial biogeochemistry, making their projections difficult to be used by the public and policy makers. In the past few years, the ECOLAB (Ecology Laboratory) at the University of Oklahoma has made great efforts to evaluate and improve the model performances by multi-scale data syntheses and data assimilation. These efforts can be summarized into three areas. (1) Development of methods to identify sources of uncertainty in model intercomparisons. We have developed a traceability framework that decomposes the modeled ecosystem carbon storage capacity into a few traceable components. This framework is applicable to most land models to mechanistically explain their structural differences in the modeled carbon cycle. We have also developed a new analytical method to accelerate the spin-up of global land models. The method can reduce the computational cost of spinning up land models to steady states by >90%, and permits many global analyses that were impossible with traditional spin-up methods. (2) Data syntheses. We have revealed several fundamental properties of terrestrial carbon cycle in responding to environmental changes, which can be used to benchmark and improve the performances of global land models. For example, by analyzing observations from globally distributed eddy-flux sites, we found thermal optimality that optimal temperature of net ecosystem carbon uptake varies with annual mean temperature over years and across sites. We also found a counter-clockwise hysteresis pattern of net ecosystem exchange with temperature at most sites. We also have revealed the spatiotemporal variations of gross primary productivity (GPP) are jointly controlled by the length of carbon uptake period and seasonal maximum GPP. (3) Data assimilation. We have applied data assimilation to improve the performances of two global land models: the Community Land Model with Carnegie-Ames-Stanford Approach biogeochemistry module (CLM-CASA') and Community Atmosphere Biosphere Land Exchange (CABLE) model. Assimilating observed soil carbon data (e.g., IGBP-DIS global gridded product) alone can greatly reduce uncertainty in model prediction of soil carbon. In general, our efforts on developing a general framework for model intercomparisons, data syntheses to reveal underlying mechanisms of carbon-cycle dynamics, and data assimilation for reducing uncertainties of model simulations will improve the performances of current global land models.