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A traceability framework for diagnostics of global land models

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The biggest impediment to model diagnostics and improvement at present is model intractability. The more processes incorporated, the more difficult it becomes to understand or evaluate model behavior. As a result, uncertainty in predictions among global land models cannot be easily diagnosed and attributed to their sources. We have recently developed an approach to analytically decompose a complex land model into traceable components based on mutually independent properties of modeled core biogeochemical processes. As all global land carbon models share those common properties, this traceability framework is applicable to all of them to improve their tractability. Indeed, we have applied the traceability framework to improve model diagnostics in several aspects. First, we have applied the framework to the Australian Community Atmosphere Biosphere Land Exchange (CABLE) model and Community Land Model version 3.5 (CLM3.5) to identify sources of those model differences. The major causes of different predictions were found to be parameter setting related to carbon input and baseline residence times between the two models. Second, we have used the framework to diagnose impacts of adding nitrogen processes into CABLE on its carbon simulation. Adding nitrogen processes not only reduces net primary production but also shortens residence times in the CABLE model. Third, the framework helps isolate components of CLM3.5 for data assimilation. Data assimilation with global land models has been computationally extremely difficult. By isolating traceable components, we have improved parameterization of CLM3.4 related to soil organic decomposition, microbial kinetics and carbon use efficiency, and litter decomposition. Further, we are currently developing the traceability framework to analyze transient simulations of models that were involved in the coupled Model Intercomparison Project Phase 5 (CMIP5) to improve our understanding on parameter space of global carbon models. This presentation will introduce our traceability framework for diagnostics of global land models with some key applications.