Poster #20

Migrating Knowledge Across Scales to Improve Simulation of Arctic Tundra Processes in an Earth System Model

Peter Thornton[1], Scott Painter[1], Fengming Yuan[1], Ethan Coon[1,2], Xiaofeng Xu[3], Glenn Hammond[4], and Jitendra Kumar[1]

[1] Oak Ridge National Laboratory
[2] Los Alamos National Laboratory
[3] San Diego State University
[4] Sandia National Laboratories (Albuquerque)

Contact: Peter Thornton [thorntonpe@ornl.gov]

Based on efforts within the NGEE-Arctic project, we use several watersheds in the Barrow and Seward Peninsula regions of Alaska to demonstrate a modeling approach that connects fine-scale information to coarse-scale simulations. Two major benefits of this approach compared to standard practice with Earth System Models (ESMs) are that multiple sources of fine-scale information can be combined to reduce biases associated with uncertain model boundary conditions, and that reasonable parameterizations of processes known to be important from fine-scale studies can be included in large-scale simulations. As an example of the first type of benefit, we show the relationships among surface weather parameters and between these and surface topography in regions of complex terrain, including microtopography. We demonstrate that joint distributions of fine-scale surface weather forcing can be incorporated in a sophisticated ESM sub-grid scheme to capture variation in the major physical drivers of thermal, hydrological, vegetation and biogeochemical processes over the example watersheds. As an example of the second type of benefit, we relate surface microtopography to the simulated fractional inundated area and lateral connectivity from fine-scale and intermediate-scale simulations, to constrain simulations at the ESM scale. As a second example of improved process representation at large spatial scales, we demonstrate the integration of the 3D reactive transport and thermal-hydrology code PFLOTRAN within the ACME Land Model (ALM, where ACME is the Accelerated Climate Model for Energy). We examine the influence of lateral connectivity on predictions of thermal, hydrologic, and biogeochemical processes through simulation experiments that test the coupled ALM-PFLOTRAN model in 3D and 1D modes. These results are steps toward the NGEE-Arctic Phase 2 goal of improved simulation of pan-Alaska tundra processes associated with climate feedbacks.