**Integrating New Knowledge of Arctic Tundra Processes into DOE's E3SM Land Model**

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We have identified multiple science areas where new process understanding developed through observation, experimentation, and synthesis can be integrated within the E3SM Land Model (ELM). These areas include improvements to the representation of hydrologic processes, improved representation of vegetation physiology and community ecology, and improved ability to understand and predict biogeochemical dynamics in systems with varying degrees of permafrost extent and thickness. Here we provide a summary of six targeted science areas, with roadmaps for connecting existing knowledge and ongoing research to model algorithms that are appropriate for representing Arctic tundra processes at the grid and sub-grid scales in a highly resolved Earth system model. Three ELM process developments relate to predictions of surface and subsurface hydrology in representative Arctic tundra landscape types. This work relies on aggregation of fine-scale modeling results up to scales of tens of meters to kilometers. We are extending this work to consider the dynamics of lateral transport and hillslope hydrology in more rugged terrain using intermediate scale models that characterize the structure and function of individual hillslopes or flow paths. We are further extending the spatial scope of this model integration effort to consider the interactions of terrain, vegetation, and wind patterns in the seasonal evolution of snowpack and its influence on soil moisture and temperature. We are also building new representative plant function types that capture the observed functional and structural variation in Arctic tundra vegetation, including new types for shrubs, herbaceous species, mosses, and lichens. This work includes the development and parameterization of special physiological traits such as nitrogen fixation in alder and low temperature acclimation for photosynthesis in multiple species. Finally, we are constructing a new representation of subsurface biogeochemical reaction and transport that integrates a mechanistic representation of redox chemistry with predictions of pH, organic matter distribution, and microbial populations and functional groups. The improved soil biogeochemistry reaction networks are being constrained by laboratory incubation studies and field observations. The resulting prediction framework is being tested as a module within ELM, and as a reaction capability for finer-scale models, operating in both cases through a common interface. We demonstrate early results and show various model evaluation metrics being used to assess improvement in prediction skill for different processes at different scales.