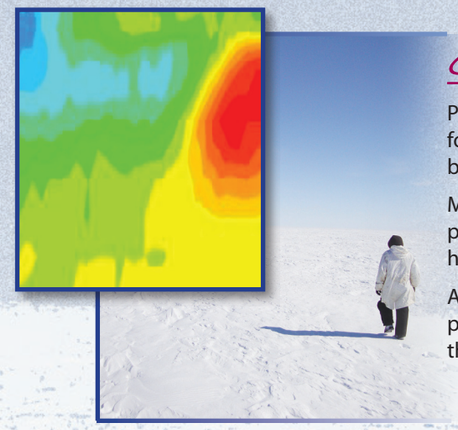
Arctic Landscapes – Complex, Connected and Vulnerable to a Changing Climate

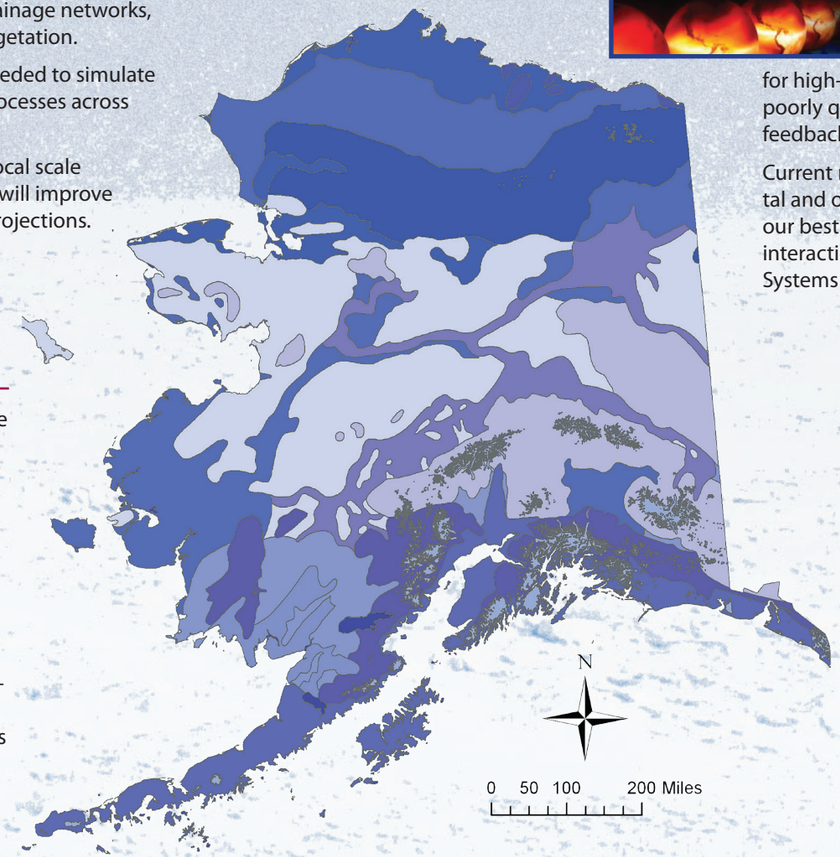


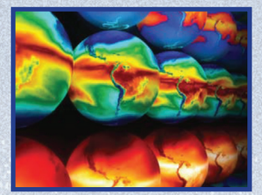
Geophysical Dynamics

Permafrost degradation in a warming climate will lead to thermokarst formation, with cascading effects on drainage networks, biogeochemistry, carbon fluxes, and vegetation.

Mechanistic, multi-phase models are needed to simulate permafrost dynamics and associated processes across heterogeneous landscapes.

A fundamental understanding of how local scale properties aggregate to regional scales will improve the accuracy and reliability of climate projections.





Earth System Models

Models serve as tools for integration and synthesis of existing knowledge, platforms for generation of new and testable hypotheses, and for prediction.

While current land-surface models include some processes important for high-latitude systems, omissions lead to poorly quantified uncertainties in predicting feedbacks with the atmosphere.

Current models will help inform experimental and observational studies, and will frame our best understanding of land-atmosphere interactions and their representation in Earth Systems Models.

Ecosystem Science

A shift in the distribution of plant communities due to warming or hydrology will drive important interactions between ecosystems and local to regional energy balance.

Improved understanding of resource availability, particularly nitrogen and water, is needed to predict changes in plant community composition and expected feedbacks to atmospheric and climatic systems.

Quantifying processes that underlie vegetation dynamics will help refine models of arctic ecosystems by linking biogeochemistry to land-climate models at regional and global scales.

Landscape Dynamics

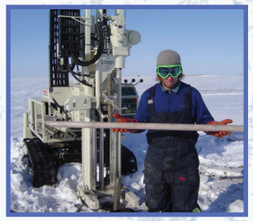
Greenhouse gas fluxes from degrading permafrost will depend on complex interactions at the soil column to landscape scales between hydrology, soil physical and mechanical properties, and ecosystem dynamics.

Capabilities to measure and monitor permafrost degradation, landscape dynamics, and evolution of the Arctic carbon cycle across spatial and temporal scales are needed for projections of future climate.

Representation of heterogeneity in Earth System Models will be advanced through new process algorithms that couple physical, biological, and chemical processes at local to regional scales.

Subsurface Processes

Increased temperatures will deepen the seasonal thaw layer, enabling the biological transformation of organic carbon buried in the permafrost to greenhouse gases that provide a positive feedback to warming.



Subsurface microbial, geochemical, and hydrologic processes that determine the fate of organic carbon will need to be characterized to better predict CO_2 and CH_4 emissions from arctic landscapes.

An improved understanding of carbon bioavailability in permafrost soils will greatly advance modeling greenhouse gas fluxes between subsurface environments and the atmosphere.

Land-Atmosphere Interactions

Land surface processes drive strong interactions with the atmosphere and the subsequent storage and exchange of mass and energy generate feedbacks upon the atmosphere and with climate.

Characterizing how climate change will affect exchange of greenhouse gases, momentum, and energy at the land-atmosphere interface is needed for an improved understanding of land-atmosphere processes and climate.

An improved description of land-atmosphere interactions will enhance the accuracy of regional and global predictions of future climate.

Next-Generation Ecosystem Experiments (NGEE Arctic)