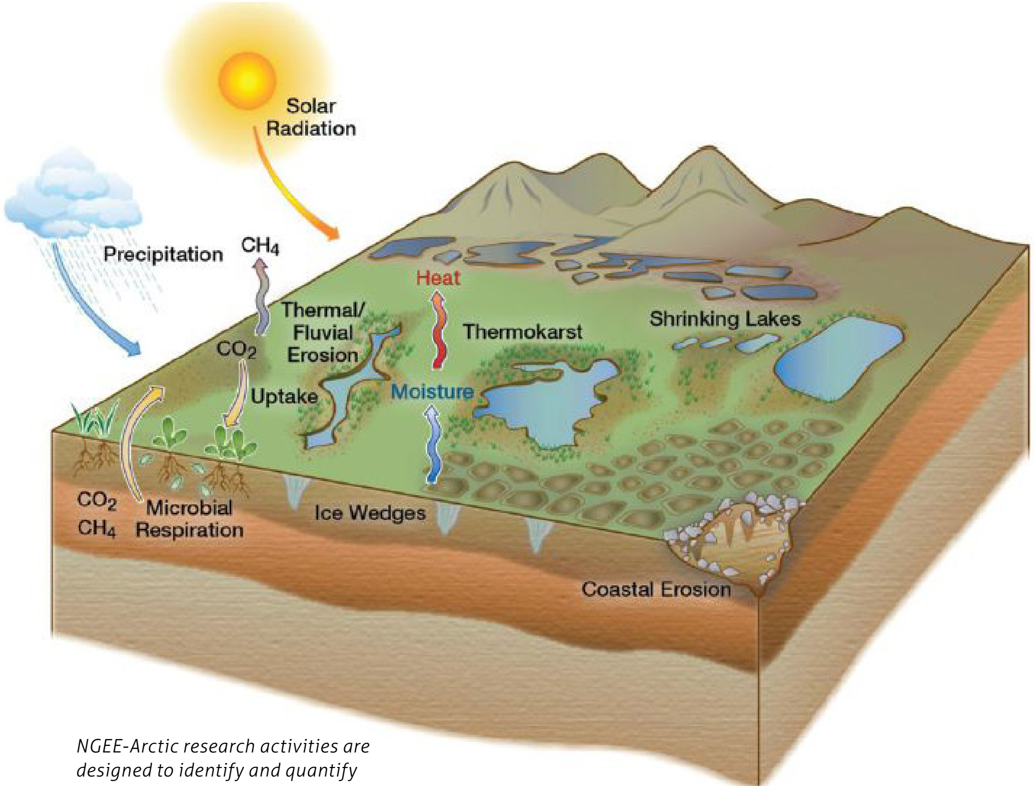
New algorithm enables unprecedented sampling, modeling of Arctic



NGEE-Arctic research activities are designed to identify and quantify mechanisms underlying processes that control carbon and energy transfer in the Arctic biosphere, as well as how those processes play out in a changing Arctic landscape. Image: NGEE-Arctic project

The Arctic is a big, cold and desolate place—not to mention that much of it is fairly inaccessible.

For these reasons, conducting meaningful on-the-ground research there is a tricky business. To characterize the environment, researchers need tools to extend their limited observations to the larger landscape. For example, how different are conditions on one piece of land from those hundreds of miles away? How will those conditions shift in 10, 20 or 30 years?

To answer questions like these, a team of researchers from ORNL and the US Department of Agriculture's Forest Service used a unique algorithm to divide the state of Alaska into "bioclimatic" regions based on the results of climate and permafrost models. The team produced decadal maps of representative regions at multiple levels of division. Data from 2000 to 2009 and an ensemble of model results from 2090 to 2099 revealed how current ecosystems may shift under a changing climate.

"You want to be sure that you take samples that are representative of the larger ecosystem," says team member Forrest Hoffman of ORNL's Climate Change Science Institute, who presented results from the project Aug. 5 in Minnesota at the 98th annual meeting of the Ecological Society of America. The findings were also published online in June in *Landscape Ecology*. "Resource and logistical constraints limit the frequency and extent of environmental observations, particularly in the Arctic, necessitating the development of a systematic sampling strategy to maximize coverage and objectively represent environmental variability at desired scales."

Team members include Jitendra Kumar and Richard Mills of ORNL and William Hargrove of the US Forest Service. Their effort employed a quantitative methodology for delineating sampling domains and showed how the representativeness of eight possible sampling sites may change in the future. The research is useful for informing site selection for the US Department of Energy's Next-Generation Ecosystem Experiments project, or NGEE–Arctic, and determining if measurement sites and networks accurately represent vast and potentially vulnerable high-latitude ecosystems in which natural responses to human-caused global warming are amplified.

Team members developed software that enables a unique algorithm, based on a cluster algorithm, to work on parallel computing systems, thus allowing the analysis of larger datasets.

Ultimately the team hopes to demonstrate that these techniques can be applied at different temporal and spatial scales to meet the needs of individual research groups and climate modelers.

Soon the team will apply the same methodology at a smaller spatial scale to define domains within the Barrow Environmental Observatory in Alaska, where the NGEE–Arctic project is under way. The researchers will use remote sensing to categorize the region's unique polygonal ground features and create input for models to simulate the behavior of Arctic tundra. ®

—*Gregory Scott Jones*