Geophysical Evidence for Surface-Subsurface Interactions in the Arctic Tundra

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Characterized by vast amounts of carbon stored in permafrost and a rapidly evolving landscape, the Arctic has emerged as an important focal point for the study of climate change. Although recognized as an ecosystem highly vulnerable to climate change, mechanisms that govern feedbacks between the terrestrial and climate system are not well understood. As part of the NGEE-Arctic study, investigations are underway at the Barrow, AK Environmental Observatory to identify interactions that drive feedbacks to the climate system. Characterization of controlling biological, geochemical and physical processes that govern the ecosystem functioning is challenging due to the scale range over which these processes occur and interact. This presentation will discuss illustrate the use of new conceptualizations, geophysical datasets, and integration methodologies to characterize the Barrow Study Site from centimeter to kilometer length scales. The geomorphology of this tundra region is characterized by ice wedge polygons and drained thaw lake basins. We are exploring relationships between land surface, active layer, and permafrost properties using a variety of remote sensing, surface-based geophysical datasets (electromagnetic, seismic, electrical and radar), and point measurements (hydrological-geochemical-microbiological). Our results demonstrate the strong correspondence between the variability of land-surface and subsurface properties relevant to carbon cycling, which suggests that geophysically-identified co-variability can be exploited to characterize complex terrestrial environments across scales. The geophysically-identified landscape zones are providing a framework for the interpretation of carbon flux and metagenomic datasets, and are also expected to be useful for model parameterization. The rich datasets have also allowed us to document other aspects of the system that are expected to be useful for predicting the system evolution, including the influence of polygon type (high centered versus low centered) versus polygon feature (trough, rim, center) on properties that influence the microbial degradation of organic carbon (soil moisture, active layer thickness, temperature) and the presence of a deep unfrozen zone in what was originally interpreted to be the permafrost.