ABSTRACT: The physical, chemical, and biological components of the Arctic are inter-related through a complex network of linkages, feedbacks and multi-dependent interactions. Theoretically a change in one variable in a part of the system can initiate a cascade of effects throughout the system, and these connections need to be understood and quantified in order to achieve improved predictability of climate impacts and feedbacks. The Next Generation Ecosystem Experiment, NGEE-Arctic, project has implemented a suite of coupled process observations within and near the Barrow Environmental Observatory in order to develop, initialize and evaluate high resolution process models that will be used to improve the land model component of the DOE-NSF Community Earth System Model, CESM. This landscape is a mosaic of thaw lakes and Drained Thaw lake Basins (DTLBs) characterized by ice-wedge polygons with a wide range of microtopographic properties. Given the very low relief and shallow thaw depth in this region, the microtopography associated with DTLBs and polygonal ground plays a significant role in the redistribution of wind blown snow, standing water, and soil moisture. These in turn impact the distribution of vegetation, soil temperature and soil biogeochemical properties and processes. Together these linked processes and attributes drive energy and carbon fluxes to the atmosphere.

A central theme of the NGEE-Arctic Hydrology and Geomorphology (HG) research focus area is to advance process understanding and prediction of climate-driven Arctic landscape evolution and its impact on Arctic hydrology and climate feedbacks. We are quantifying the interactions between geomorphic, hydrologic and thermal processes and how these processes control the spatial and temporal evolution of thermokarst, changes in microtopography, and the redistribution of soil water and temperature across the landscape. Field activities are being carried out across a gradient of polygonal ground (high-centered to low-centered polygons) nested within a DTLB age gradient. Data from the first year of NGEE-Arctic HG observations focused on measurement of snow depth, water levels, soil temperature, soil moisture and active layer depth at four sites with different ice wedge polygon micro-topographic configurations.

Preliminary results show the largest lateral fluxes of water are control by macro topography during snowmelt. However, micro-topographic differences in polygonal ground control small spatial scale differences in the distribution of snow, Summer precipitation, ponded water, soil moisture, soil temperature, vertical water fluxes and the timing and magnitude of runoff events. Thermal transect data show that at the start of Winter more snow and water accumulate in the ice-wedge polygon troughs and the low centers of the low-center polygons than on high-center polygons and polygon rims. This caused early freezing within the high-center polygons and rims, and prolonged freezing within the central depressions in low-center polygons. Hydrologic data show that polygon morphology significantly impacts seasonal water table height and water pressure gradients between polygon centers and trough networks. Variations in the frost table depth are more dramatic than the ground surface topography which impacts subsurface pathways. These data are now being used to inform high resolution thermal-hydrology and thermal erosion models which will help to parameterize processes for global land models.