Effects of spatially variable snow cover on thermal regime and hydrology of an Arctic ice wedge polygon landscape identified using ground penetrating radar and LIDAR datasets

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Ice wedge polygons are common in Arctic terrains underlain by permafrost. Permafrost degradation could transform low- into high centered polygons, causing profound changes in the hydrologic regime of Arctic lands, which in turn, could affect the energy balance and subsurface biodegradation of organic carbon responsible for greenhouse gas production. Understanding the linkages between microtopography, snow cover, thermal properties, and thaw depth is critical for developing a predictive understanding of terrestrial ecosystems and their feedbacks to climate. In this study, we use high frequency (500-1000 MHz) ground penetrating radar (GPR) data acquired in spring 2012 within the Next Generation Ecosystem Experiment (NGEE) study site in Barrow, AK to characterize the spatial variability of snow distribution. We compare it's distribution to microtopography, estimated using LIDAR data, and thaw depth, also estimated using ground penetrating radar collected at different times during the year and simulated over time using mechanistic thermal-hydrologic modeling.

The high spatial resolution offered by LIDAR and ground penetrating radar permit detailed investigations of the control of microtopography on snow and thaw layer depth.

Results suggest that microtopographical variations are responsible for substantial differences in snow accumulation. In low centered polygons, snow depth can be up to four times greater in the troughs than on the rims. Both modeling and observations suggest that the microtopography-governed snow thickness affects the thermal properties of the subsurface and thus the thaw layer thickness; regions with thicker snowpack generally correspond to regions of greater thaw depth. We conclude that a transition from low- to high centered polygons will not only impact watershed runoff but, since snow accumulation is

sensitive to the microtopography, it will also impact snow distribution. In turn, snow distribution affects thaw depth thickness, and the propensity for microbial degradation of organic carbon and production of greenhouse gasses. http://ngee.ornl.gov/