Poster #6

Quantifying Multi-Dimensional Relationships to Estimate Arctic Soil Properties and Ecosystem Functioning at Relevant Scales

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Arctic soils contain large amounts of carbon in permafrost, which could potentially create a positive feedback to warming climate if released during permafrost thaw. Predicting carbon cycling in Arctic requires quantifying tightly coupled surface and subsurface processes. A main challenge has been a lack of means to sense highly heterogeneous surface and subsurface properties in high resolution and over large areas. In this study, we present two new approaches successfully applied in Barrow, AK to co-investigate surface and subsurface properties at intensives site and to use the inferred relationships to constrain estimates at larger scales.

The first approach focused on estimating soil organic matter content using geophysical methods and simulations of hydrological-thermal processes. Using cores extracted from the Barrow site, we first estimated the spatial distribution of soil organic matter density and geochemical properties through sample analysis and X-ray computed tomography. We demonstrate the value of computed tomography and neural network technique to estimate organic matter density and physical/geochemical properties while increasing spatial resolution and coverage. In addition, we developed an approach to assimilate monitoring and soil sample data into a physicaly-based joint inversion model that incorporates electrical resistivity data to investigate the extremely dynamic nature of hydrological-thermal processes associated with the influence of soil organic matter and annual freeze-thaw events. The developed joint inversion scheme can estimate the vertical distribution of organic matter content and its control over hydrological-thermal behavior.

A second effort focused on investigating tightly-coupled above/belowground ecosystem functioning using a range of ground-based data (e.g., soil temperature, moisture, thaw thickness and carbon fluxes) and measurements from a track-mounted tram carrying a suite of near-surface remote sensing sensors. Joint analysis focused on correlating key subsurface and ecosystem properties with surface properties that can be measured by satellite/airborne remote sensing over a large area. Our results provided several new insights including: (1) soil temperature (at >5 cm depth; critical for permafrost thaw) was decoupled from soil surface temperature and was influenced strongly by soil moisture, (2) NDVI and greenness index were highly correlated with both soil moisture and gross primary productivity.