Poster #1-10

Conceptual Model of Surface Water Hydrology in Polygonal Terrain Using Stable Isotopes

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Stable isotopes were used to characterize the timing and duration of hydrological transitions in polygonal ground at the Barrow Environmental Observatory (BEO, Utqiaġvik, Alaska; 71.2956°N, 156.7664°W). Daily surface water samples were collected from 11 locations across the BEO and across arctic tundra morphologies (low centered polygon troughs (LCPTs), high centered polygon troughs (HCPTs), lakes, and drainages) during spring and summer of 2013. Previous work on the microclimatic seasons on the tundra have defined six characteristic periods based on the energy and water balances at the surface: winter, pre-melt, melt, post-melt, summer, and freeze-up. In this work, surface water stable isotopes are coupled with local climatological data (temperature, precipitation, incident/outgoing radiation, and observation) to develop a conceptual model of the dominant sources of surface water from the pre-melt period until freeze- up. At a site selected for more intensive study (HCPT), the pre-melt period surface water was dominated by snowmelt severely fractionated by winter sublimation. During the melt-period, fresh precipitation (as rain) forced runoff of the snowmelt and washed-out the remaining winter isotopic signature. The post-melt period, owing to increased incident solar radiation and reduced surface albedo, saw considerable evaporation, which correlated well with local weather observations and was noticeably punctuated by short precipitation events (exemplifying the low volume of surface water and its susceptibility to rapid change). The end of the post-melt period was characterized by a slowing of evaporation that became negligible with the beginning of the summer period. The magnitude of sublimation and evaporation processes were reconstructed using isotopic fractionation first-principals. Surface water from other morphologies (LCPTs and lakes) exhibited far less impact of sublimated snowmelt, and instead were predominately impacted by freeze-out fractionation of water that had been retained on the landscape from the previous year. One sampling location showed very little impact of either snowmelt or old-water, which suggested it was hydrologically disconnected from the low centered polygons nearby. Meanwhile, the isotopic composition of drainages were indicative of the features that supply the drainages. The spatial-temporal trends in surface water hydrology are shown to have geochemical consequences: barium, boron, potassium, and sulfate track with snowmelt, whereas calcium, magnesium, and sodium correlate with soil thaw; redox-sensitive elements are synchronized with hydrological transitions. This work improves the representation of polygonal surface water hydrology for incorporation into Earth System Models, particularly with respect to the water balance associated with the timing and duration of thawed season hydrological transitions.