Contribution of permafrost degradation landforms to summer export of DOC from Yedoma-type Ice Complex to rivers, Lena Delta, Siberia

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Thermo-erosional landforms (valleys, gullies) and their associated streams are the main connecting pathways between inland permafrost areas and rivers and coasts. Surface and ground waters are routed along these streams, which transport particulate and dissolved matter from the catchments to the rivers and coastal waters. Regions of ice-rich permafrost, such as the Yedoma-type Ice Complex, are not only characterized by a high abundance of thermo-erosional landforms, which formed during the Holocene, but are subject to extensive degradation under current arctic warming by processes such as thermal erosion, thermokarst, and active layer deepening. In the Siberian Lena River Delta Yedoma-type Ice Complex deposits occur on insular remnants of a Late-Pleistocene accumulation plain that has been dissected by Lena River branches and degraded by thermal erosion and thermokarst during the Holocene. This region serves as suitable exemplary study area for estimating the contribution of 1) different permafrost degradation landforms to the export of water and dissolved matter from Yedoma-type Ice Complex to the river and 2) active degradation of old permafrost versus seasonal runoff from the surface and active layer. In the summers of 2013 and 2014 we sampled surface and soil waters from streams and their watersheds in Yedoma-type Ice Complex landscapes of the Lena River Delta and analyzed them for a range of hydrogeochemical parameters including electrical conductivity (EC), dissolved organic carbon (DOC) and stable isotopic composition. The sampling sites were spread over an E-W-extent of about 150 km and are characterized by very diverse geomorphological and hydrological situations in terms of distance to the river branches, catchment size, discharge, degree of thermo-erosional activity, and connection to other permafrost degradation landforms (thermokarst lakes and basins). Three key sites were sampled three and four times from June to September 2013 and 2014, respectively, in order to analyze intra-seasonal changes.

The results show large variances in EC (25 to 1205 μS/cm), DOC concentrations (2.9 to 119.0 mg/l), $\delta^{18}O$ (-29.8 to -14.6 ‰ vs. SMOW), and δD (-228.9 to -117.9 ‰ vs. SMOW) over the whole dataset, with distinct characteristics in the parameter combination for different degradation landform and water types. The temporal variability at the repeatedly sampled sites is low, which implies that there is not much change in the processes that determine the water composition throughout the summer season. By comparing differences in surface water chemistry between flow path systems that tap into varying amounts of source water (precipitation, surface and ground water, ground ice) and have differing residence times and extents, we explore the effect of future changes in thermokarst and thermo-erosional intensity and resulting changes in flow path hydrogeochemistry for thermo-erosional features draining ice-rich permafrost.