Summer surface water chemistry dynamics in different landscape units from Yedoma Ice Complex to the Lena River

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The effect of climate warming on the degradation of permafrost in Arctic coastal lowlands and associated hydrological and biogeochemical processes varies between different types of permafrost deposits. The Lena River Delta consists of three geomorphological main terraces that differ in their genesis and stratigraphic, cryological, geomorphological and hydrological characteristics. The third terrace was formed during the late Pleistocene and consists mainly of Yedoma-type Ice Complex deposits, whereas the first terrace has formed during the Holocene by deltaic processes. Permafrost degradation on both terraces releases dissolved organic carbon (DOC) to thermokarst lakes and via streams DOC gets transported to the Lena River channels and the Arctic Ocean. This presentation shows

1. differences in the surface water chemistry between the first terrace and the Yedoma Ice Complex and their landforms,
2. analyses of the temporal variability of DOC during the summer, and
3. an estimation of summer DOC flux for the considered catchment of about 6.45 km^2.

Between June and September 2013 and 2014, respectively summer surface water and soil water samples were collected in a small catchment in the south of Kurungnakh Island in the central Lena River Delta. This catchment covers the first terrace as well as the Yedoma Ice Complex and is characterized by thermokarst lakes and streams on both terraces. Two weirs were installed in the main stream along the drainage flow path to continuously measure discharge during summer 2013. We divided the study area into landscape units and compared pH, electrical conductivity, stable isotopic composition and DOC concentrations between units and between terraces. The considered landscape units are streams and thermokarst lakes on Yedoma Ice Complex and on the first terrace, Yedoma uplands, streams, which are fed by the Ice Complex, a relict lake on the first terrace and the Olenyokskaya Channel, a main branch of the Lena River.

DOC concentrations in the landscape units on Yedoma Ice Complex ranged between 3.5 mg L-1 (streams) and 52.5 mg L^{-1} (soilwater of Yedoma uplands) and on the first terrace between 2.8 mg L^{-1} (streams) and 15.6 mg L^{-1} (relict lake). The electrical conductivity on Yedoma Ice Complex ranged between 35 µS cm-1 (soilwater of Yedoma uplands) and 151 μS cm^{-1} (streams) and on the first terrace between 54 μS cm^{-1} (streams and relict lake) and 140 µS cm^{-1} (streams). $\delta^{18}O$ values on Yedoma Ice Complex and first terrace ranged between -22.4 ‰ (soilwater of Yedoma uplands) and -16.4 ‰ (streams) and between -20.4 ‰and -14.7 ‰ (streams), respectively. δD ranged between -165.6 ‰ (soilwater of Yedoma uplands) and 125.5 ‰ (streams, which are fed by the Ice Complex) and between -160.8 ‰ and -119.4 ‰ (streams). Source waters on the Yedoma Ice Complex had higher DOC concentrations and lower electrical conductivity than Yedoma Ice Complex thermokarst lakes and the drainage flow path. This suggests that more labile organic carbon, perhaps derived from permafrost degradation on the Yedoma Ice Complex, enriches the lake but is removed from the lake, for example, by mineralization in the water column. Along the drainage flow path no further decrease of DOC concentration was observed, despite increasing discharge from weir 1 at the beginning of the flow path to almost two and a half times at weir 2 at the end of the flow path, and despite decreasing discharge during the measuring period from 1814 m^3 d^{-1} in the end of July to 199 m^3 d^{-1} in the end of August for weir 1 and from 2819 m3 d^{-1} in the end of July to 567 m^3 d^{-1} in the end of August for weir 2.

The temporal variability of DOC concentration during the sampling periods was low. In 2013 one sample site of soil water collection fluctuated slightly in August between 10.5 mg L^{-1} and 13.3 mg L^{-1}, whereas the remaining landscape units showed no temporal variability. In 2014 the DOC concentration of the relict lake on the first terrace decreased from July (13.5 mg L^{-1}) to September (11.1 mg L^{-1}). Otherwise there were no changes in DOC concentration in the remaining landscape units. DOC measurements of the Olenyokskaya Channel show a decrease in DOC concentration from 12.4 mg L^{-1} in June to 7.6 mg L^{-1} in September.

Using discharge data of 2013 a summer DOC flux of about 220 kg in 29 days for the study site above weir 2 with an area of 6.45 km^2 was calculated.

Contribution of retrogressive thaw slumps to the near shore carbon budget along the Yukon Coast, Canada

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The mechanism of carbon dioxide and methane release to the atmosphere in permafrost regions is not solely restricted to the progressive thawing of the upper part of the ground by warmer air temperatures. Organic carbon and nutrients are released to streams, rivers or coasts by abrupt processes such as thermokarst, thermal erosion and simply river bank or coastal erosion.

Thermo-erosion, as a mechanism of rapid permafrost thaw, reshapes Arctic coasts and has a clear impact on the mobilization and distribution of carbon and nitrogen in permafrost terrains. Retrogressive thaw slumps are one specific and highly dynamic landform, which results from thermo-erosion of ice-rich permafrost and leads to the displacement of large volumes of sediments. Studies reporting on the occurrence and evolution of retrogressive thaw slumps over the Arctic show that in varied Arctic areas, slumps have increased over the last decades. While the processes responsible for the initiation of retrogressive thaw slumps are well defined, little research has been done on a regional scale to define the terrains on which they occur, and to measure the volumes of sediments eroded through their development. There are currently no estimates of the contribution of these permafrost degradation landforms to the carbon budget, therefore thermo-erosional features are not yet accounted in the carbon models. With this study, we highlight the important contribution of retrogressive thaw slumps to the nearshore carbon cycle in the eastern part of the Beaufort Sea by

1. measuring their dynamics on a ca. 105 km coastline along the Yukon Coast over the last 60 years (1952-2011);
2. determining the prevailing factors accounting for their distribution and driving their expansion; and
3. estimating the amounts of carbon mobilized by measuring the eroded volumes of sediment associated with retrogressive thaw slump development.

We used a large set of high-resolution multispectral satellite images from 2011 (GeoEye and WorldView) for geocoding aerial photographs from the 1950s and the 1970s, using the software OrthoEngine (PCI Geomatica). This dataset was the basis for manually digitizing and classifying retrogressive thaw slumps according to morphological characteristics. We gathered additional observations during fieldwork in July and August 2015 on the current development stage of retrogressive thaw slumps and classified them (active and eroded; active and partially vegetated or stabilized). Based on remote sensing, we calculated and compared the surface area occupied by slumps in the 1950s, the 1970s and in 2011. We used principal component analyses to highlight the main environmental factors involved in the development of those landforms. Based on a simple model, we computed the volume of eroded sediments and estimated the amounts of mobilized particulate organic carbon and nitrogen. This model allowed us to measure the contribution of retrogressive thaw slumps to the near shore carbon budget in the area.