Coastal erosion and fluxes of dissolved organic carbon from ground ice in the Canadian Arctic

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Arctic regions are highly vulnerable to climatic change processes and are currently undergoing the most rapid environmental transition experienced on Earth. Changing environmental conditions affect the sensitive ice-rich permafrost coasts in northern Canada that erode due to warmer climate, longer open water seasons and stronger storms. Coastal erosion in the Canadian Arctic that is among the highest in the world releases terrestrial organic carbon stored in ice-rich permafrost into the Arctic Ocean, which fosters the feedback mechanisms between carbon cycle and climate.

The Yukon Coastal Plain, located in the western Canadian Arctic, is characterized by the occurrence of ice-rich permafrost and large massive ground ice bodies. This ice contributes to facilitate coastal erosion, which is known to occur at great pace during the short summer season. Ground ice in permafrost contains organic carbon in the dissolved state that will be released to the ocean by coastal erosion. However, the amounts of DOC present in the ground and eventually lost to the sea as well as the origin of this DOC are still unknown or poorly understood.

Several massive ground ice bodies and ice wedges exposed by coastal erosion or thermal denudation were sampled on Herschel Island and along the mainland coast of the Yukon Territory. DOC concentrations were determined on melted solutions of 41 ice samples. These values were then combined with existing datasets on coastal erosion, morphometry, and stratigraphy to calculate annual DOC fluxes into the Beaufort Sea.

First estimations yielded DOC concentrations in massive ground ice bodies and ice wedges in a range of 1.0 and 19.5 mg/L. DOC concentrations in ice wedges were up to eight times higher than in massive ground ice bodies. Calculated DOC fluxes varied greatly, depending on the scenario. A low-case scenario revealed a DOC flux of 148 kg/yr, a moderate-case scenario yielded 274 kg/yr and a high-case scenario gave a DOC flux of 466 kg/yr for the whole coast.

DOC fluxes from the erosion of massive ground ice at the coast seem to play only a minor role in the carbon budget as it is much lower than DOC fluxes from arctic rivers and fluxes of particulate organic carbon derived from coastal erosion. However, DOC released by coastal erosion is assumed to be more labile and could therefore be more bioavailable in the nearshore zone. Furthermore, pore ice, which makes up the biggest part of the ground ice and is assumed to be a greater source of DOC was not taken into consideration yet but will be subject to upcoming investigations.