

Permafrost thawing provides more reactive nitrogen in the transition from soil to river and ocean – an isotopic perspective on the Lena Delta

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Abstract

Permafrost-affected soils around the Arctic Ocean contain a large reservoir of organic matter including nitrogen, which partly reaches the riverine system after thawing, degradation and erosion of permafrost. After mobilization, reactive nitrogen in form of dissolved organic nitrogen (DON) or dissolved inorganic nitrogen (DIN: ammonium and nitrate) is either used for primary production, microbial turnover and/or is transported to coastal waters where it serves as a key source of nutrition for the marine food web. In this study, we have followed the nitrogen released from permafrost soil via the Lena River into the Laptev Sea and used the natural abundance of ^{15}N stable isotopes to identify sources, sinks and processes. Therefore, we have investigated different soil. We present a comprehensive data set from two transect cruises (03/08 2019) through the delta, and the outcome of a monitoring program (2018 - 2021) at Samoylov Island in the central delta. High-frequency monitoring and cruise data shows that the nitrogen transported from the river to the Laptev Sea was dominated by DON and nitrate, which occurred in similar amounts of approx. $10 \mu\text{mol L}^{-1}$ in the river water. The nitrate concentration decreased during the early summer and increased from late summer throughout the winter until the spring flood. During the spring flood, the nitrogen concentration was up to ten times higher. Thus, spring floods transport approx. 20 % of the annual load of reactive nitrogen into the Laptev Sea just at the onset of the growing season. The nitrogen stable isotope values of the different nitrogen components ranged mainly between 0.5 and 4.5‰, and were subsequently enriched from the permafrost soils via suspended particulate matter/sediment and DON to nitrate, which indicate an oligotrophic ecosystem. Using a Bayesian mixing model, the stable isotope signature of nitrate suggested a strong source of atmospheric deposition during the spring flood. During the rest of the year, soils are the main source of the reactive nitrogen, which is transported to the marine realm.