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Characterizing adsorptive properties and DOC concentrations in soils of Northern European Russian tundra and taiga.

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Subarctic river basins have an enormous potential to mobilize and transport terrestrial OC to the Arctic Ocean, because 23-48% of the worlds soils organic carbon (SOC) is stored in the high latitude region. Currently the Arctic drainage basin (∼24 x 106 km2) processes about 11% of the global dissolved organic carbon (DOC), which is exported to the ocean. About 10-25% of annual C input to the organic surface layer with litter is leached from the organic surface layers. As climate changes, the amount and chemical composition of DOC exported from these basins are expected to change.

Adsorption of DOC on mineral phases is the key geochemical process for the release and removal of DOC from this potentially soluble carbon pool. Most DOC leached from organic horizons is adsorbed and retained in the subsoils. The adsorption depends much on the content of sesquioxides and amount of carbon previously accumulated in soils. Besides adsorption, polyvalent metal ions in solution, such as Al and Ca, can cause precipitation of DOC. Along with the decrease of DOC concentrations on its passage through mineral soil, there are major biochemical alterations of DOC composition. Hydrophobic compounds (humic and fulvic acids) of high molecular weight that are rich in acidic functional groups and aromatic compounds adsorb most strongly. Hydrophilic compounds can contribute to DOC adsorption but are also easily desorbed because of the weaker bonding strength.

The aim of this study was to characterize the DOC concentrations and their chemical composition as well as the DOC adsorptive properties of soils found in a tundra and taiga catchment of Northern Russia. We sampled soil and soil solution from two catchments in the Komi Republic of European Northern Russia: a tundra (67N/62E) and a taiga (62N/50E). The soil samples were analysed for total organic carbon (Ct) and the content of sequioxides. By extracting soil samples with water we got an impression of the potentially extractable organic carbon (EOC). Besides DOC, the easily dissolvable part of the adsorbed organic carbon and precipitated organic carbon will also be extracted. The soil solution and extraction samples were analysed for DOC, DOC composition and cations. Based on the methodological relationship between Ct, EOC and DOC we will demonstrate that for the release of DOC from these soils the chemical process of adsorption and desorption are more important than mineralization.

Our laboratory results showed that adsorbed organic carbon that can easily dissolve can provide a quick release of DOC. We found that about 80-90% of the released EOC was previously adsorbed. Because the process of desorption is quick it is not dependent on mineralization or degradation. Consequently, leaching of DOC as a result of desorption will have a large impact on the transport of DOC, especially under climate change. By being able to model the amount of adsorbed organic carbon we would be able to predict the amount of organic carbon that could be desorbed under different soil and climatic conditions. Using the chemical speciation model Orchestra we modelled the adsorption of humic, and fulvic acids to cations according to the NICA-Donnan model. This model describes the specific binding of cations to the humic reactive sites (NICA) as well as the nonspecific (electrostatic) binding of cations due to the negative charge of the humic substances (Donnan). We compared the modelled amount of adsorbed hydrophobic acids with the measured amounts of adsorbed hydrophobic acids to see if the model is able to reproduce the amount of potentially available organic carbon found in the soils.

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