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Reactivity and mobilization of permafrost-derived organic matter along the Lena River Delta – Laptev Sea transition

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The impact of global warming on organic carbon budgets in permafrost systems are not well constrained. Changes in organic carbon fluxes caused by permafrost thaw depend on microbial activity, coastal erosion, mobilization of organic matter by increased porewater fluxes, and the inherent chemical stability of organic matter in permafrost soils. Here we aim at the identification and molecular characterization of active and inactive dissolved organic matter (DOM) components within the river-ocean transition. We studied four transects in the coastal Laptev Sea characterized by steep physico-chemical gradients. Molecular information on solid-phase extracted DOM was derived from ultrahigh resolution mass spectrometry. Changes of the chemical composition with salinity were used as a measure for DOM reactivity. Although changes of dissolved organic carbon (DOC) in the estuary suggested conservative mixing, only 27% of the identified molecular formulas behaved conservatively, 32% were moderately affected, and 41% were actively involved in estuarine processes. The molecular complexity in the DOM samples increased with growing marine influence and the average elemental composition (i.e. relative contribution of organic nitrogen and oxygen compounds) changed significantly with increasing salinity. These chemical changes were consistent with the results of a 20-day microbial incubation experiment, during which more than half of the permafrost-derived DOC was mineralized. We conclude that, although the DOC gradient in the estuary suggests conservative behavior, terrestrial DOM is substantially affected by estuarine processes which in turn also impact organic carbon budgets in the Lena Delta.