Particulate and dissolved organic carbon composition in the Lena River and its Delta, from Yakutsk to the Arctic Ocean.

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Rapid climate warming in the Arctic intensifies permafrost thaw, increases active layer depth in summer and enhances riverbank and coastal erosion. All of these cause additional release of organic matter (OM) into streams and rivers. OM will be (1) transformed and modified during transport and subsequently discharged into the Arctic Ocean, or (2) removed from the active cycling by sedimentation. Here, the nearshore zone (which includes deltas, estuaries and coasts) is of great importance, where the major transformation processes of terrestrial material take place. Despite the importance of deltas for the biogeochemical cycle, their functioning is poorly understood. For our study we examined the Lena River nearshore, which represents the world’s third largest delta and supplies the second highest annual water and sediment discharge into the Arctic Ocean. Running through almost the entirety of East Siberia from Lake Baikal to the Laptev Sea, the Lena River drains an area of ∼2.61×10⁶ km² with approximately 90% underlain by permafrost. Our aims were to investigate the spatial variation of OM concentration and isotopic composition during transit from terrestrial permafrost source to the ocean interface, and to compare riverine and deltaic OM composition. We measured particulate and dissolved organic carbon (POC and DOC) concentrations and their associated δ¹³C and Δ¹⁴C values in water samples collected along a ∼1500 km long Lena River transect from Yakutsk downstream to the river outlet into the Laptev Sea.

We find significant qualitative and quantitative differences between the OM composition in the Lena River main channel and its delta. Further, we found suspended matter and POC concentrations decreased during transit from river to the Arctic Ocean. DOC concentrations in the Lena delta were almost 50% lower than OM from the main channel. We found that deltaic POC is depleted in ¹³C relative to fluvial POC, and that its ¹⁴C signature suggests a modern composition indicating phytoplankton origin. This observation likely reflects the difference in hydrological conditions between the delta and the river main channel, caused by lower flow velocity and average water depth. We propose that deltaic environments provide favorable growth conditions for riveine primary producers such as algae and aquatic plants. Deltaic DOC is depleted in ¹⁴C compared to riverine, especially in samples taken from the water surface, which indicates
contributions from an additional old carbon stock source, specific for the Lena Delta. We suggest that this C is released from deltaic bank erosion and partly stays floating on the surface. In conclusion, we found a strong impact of deltaic processes on the fate and dominant signatures of OM discharged into the Arctic Ocean.