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Molecular and radiocarbon compositional variations of the terrestrial organic matter exported from across the Eurasian Arctic by the five Great Russian Arctic Rivers

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The pan-Arctic tundra and taiga hosts nearly 50% of detrital terrestrial organic carbon (terrOC) on Earth, equaling the amount of C present in the atmosphere as CO2. This Siberian Arctic region is predicted to experience the largest climate warming, which may lead to permafrost thawing, enhanced coastal erosion and accelerated vegetation fires. Our initial objective is to provide a benchmark of the composition, provenance, and extent of degradation of the terrOC currently being exported fluvially onto the extensive Russian-Arctic shelf. We employ the Great Russian Arctic Rivers (GRARs; Ob, Yenisey, Lena, Kolyma and Indigirka) as integrators of their extensive watersheds.

The molecular and radiocarbon composition of the terrOC released by the GRARs indicate clear patterns relatable to vegetation and climate variations across this 4000 km continent-scale climosequence of the Siberian Arctic. First, black carbon (BC) ranged from 3-10% of TOC with highest fractions in the permafrost–covered east Siberian region with a 14C mass balance suggesting about 20% from biomass burning and the balance from fossil fuel combustion or relict BC in uplifted source rocks.

Among the lipid biomarkers, there is a large contribution of C23 and C25 n-alkanes

relative to other homologues, suggesting substantial contribution from Sphagnum, with a decreasing trend eastward. Increasing concentrations of both high-molecular weight (HMW) n-alkanoic acids and beta-sitosterol relative to HMW n-alkanes toward east Siberia is consistent with increasing permafrost and a shorter annual thaw period.

Compound-specific radiocarbon analysis (CSRA) yielded similar 14C fraction modern (Fm) values for HMW n-alkanes and n-alkanoic acids increasing toward the east. The 14C signal of the bulk OC had an opposite spatial trend. We hypothesize that this reflects decoupled hydraulic conduits of fresh and aged terrOC. Since this would be related to the extent of permafrost this may have repercussions on terrOC remobilization under a warming climate.