Dissolved Organic Matter in Arctic Rivers: Synchronous molecular stability, shifting sources and subsidies

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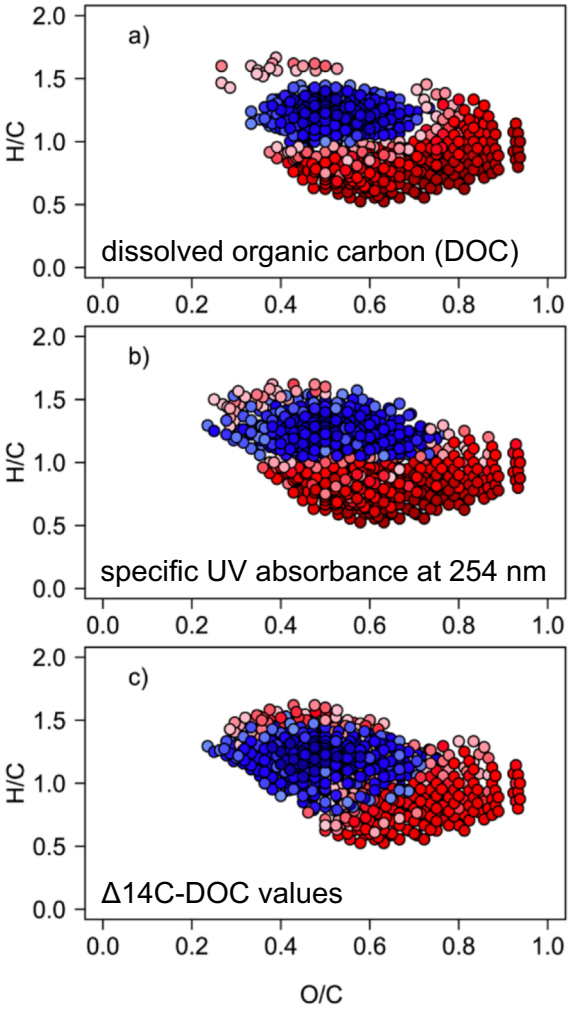
Funding Grants: G.S. Boebinger (NSF DMR-1644779); Arctic Great Rivers Observatory (110774; 1602615; 1603149; 1602680; 1913888; 1914081; 1914215; NSF GRFP)

Climate change in the Arctic is thawing permafrost soils and changing vegetation, altering the amount and composition of organic matter transferred from land to ocean. Riverine samples of this dissolved organic matter (DOM) provide detailed information about changes occurring throughout vast Arctic watersheds - much like a medical doctor can take a blood sample and diagnose a patient's health. The assessment shows how some DOM may be rapidly converted to greenhouse gases with ramifications for climate change, while other DOM may be moved from long-term storage on land to long-term storage in the ocean.

Water samples collected over six years from major Arctic rivers (www.arcticgreatrivers.org) were analyzed using the MagLab's record-setting 21T ultra-high-resolution Fourier-transform ion cyclotron resonance mass spectrometer. This magnet system's resolving power is capable of determining elemental composition for tens of thousands of individual molecules in a single water sample. Combined with isotopic data, these formulae revealed both a common core amongst samples, as well as unique tracers of seasonality and a changing Arctic.

These tracers showed a high-energy subsidy at the time of maximum spring river discharge, as well as more permafrost thaw leading to older more stable carbon exported to the coastal ocean. The findings highlight the molecular-level signature of a changing Arctic, as well as the coupling between changes on land and impact on the Arctic Ocean.



Molecular associations between individual formulae and bulk characteristics for the core Arctic riverine fingerprint (i.e. the formulae found in every sample). Significant Spearman rank coefficients (red = positive; blue = negative) between molecular formulae and a) dissolved organic carbon (DOC), b) specific UV absorbance at 254 nm, and c) Δ14C-DOC values. The blue universal central region is old, stable, microbially degraded DOM sourced from groundwater that appears to persist in the ocean. The red outer region is younger, freshly leached, aromatic DOM.

Facilities and instrumentation used: Ion Cyclotron Resonance (21 T FT-ICR MS)

Citation: Behnke, M.I.; McClelland, J.W.; Tank, S.E.; Kellerman, A.M.; Holmes, R.M.; Haghipour, N.; Eglinton, T.I.; Raymond, P.A.; Suslova, A.; Zhulidov, A.V.; Gurtovaya, T.; Zimov, N.; Zimov, S.; Mutter, E.A.; Spencer, R.G.M., *Pan-Arctic Riverine Dissolved Organic Matter: Synchronous Molecular Stability, Shifting Sources and Subsidies,* Global Biogeochemical Cycles, **35**, e2020GB006871 (2021) **DOI:10.1029/2020GB006871**