Unifying Concepts Linking Dissolved Organic Matter Composition to Persistence in Aquatic Ecosystems

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Summary

The link between composition and reactivity of dissolved organic matter (DOM) is central to understanding the role aquatic systems play in the global carbon cycle; yet, unifying concepts driving molecular DOM composition across aquatic ecosystems have yet to be established. We characterized 37 DOM isolates from diverse aquatic ecosystems, including their stable and radiocarbon isotopes (δ13C- issolved organic carbon (DOC) and Δ14C-DOC), optical properties (absorbance and fluorescence), and molecular composition (using the custom-built 9.4 tesla Fourier transform ion cyclotron resonance mass spectrometer with negative electrospray ionization at the National High Magnetic Field Laboratory in Tallahassee, Florida). Isolates encompassed end-members of allochthonous and autochthonous DOM from sites across the United States, the Pacific Ocean, and Antarctic lakes. Modern Δ14C-DOC and optical properties reflecting increased aromaticity, such as carbon specific UV absorbance at 254 nm (SUVA254), were directly related to polyphenolic and polycyclic aromatic compounds, whereas enriched δ13C-DOC and optical properties reflecting autochthonous end-members were positively correlated to more aliphatic compounds. Furthermore, the two sets of autochthonous end-members (Pacific Ocean and Antarctic lakes) exhibited distinct molecular composition due to differences in extent of degradation. Across all sites and end-members studied, we find a consistent shift in composition with aging, highlighting the persistence of certain biomolecules concurrent with degradation time.

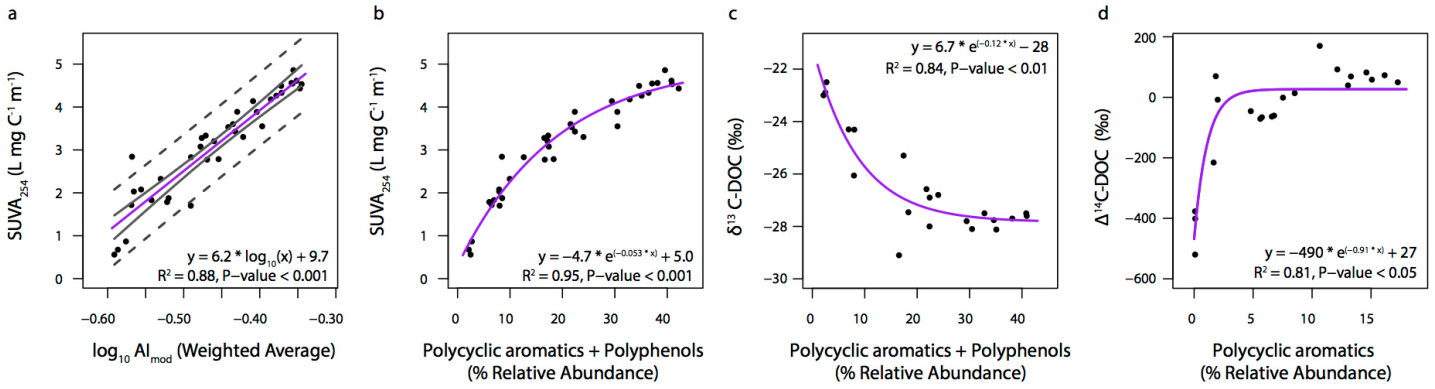

Fig. 1: Relationships between molecular composition, optical properties and isotopic content. Changes in $SUVA_{254}$ against (a) log_{10} transformed modified aromaticity index and (b) percent relative abundance of polycyclic and polyphenolic aromatic compounds (n = 37), and changes in isotopic composition against molecular composition; (c) δ13C-DOC against percent relative abundance of polycyclic and polyphenolic aromatic compounds and (d) Δ14C-DOC against polycyclic aromatic compounds (n = 21).

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References

[1] Kellerman, A.M., *et al*., Environmental Science & Technology, **52**, 2538-2548 (2018).