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Tracing the Origins and Fate of Dissolved Organic Carbon in Contrasting Continental Environments: Insights from Glacial Catchments and Tropical Rivers

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The role of dissolved organic carbon (DOC) in the global carbon cycle remains under-constrained, particularly in environments undergoing rapid change. While the export of particulate carbon is better understood, the fluxes, origins, and biogeochemical reactivity of DOC from continental systems represent a significant uncertainty. This study addresses this gap by characterizing the concentration and stable isotope composition ($\delta^{13}C$) of DOC in two contrasting end-members: Alpine glacial meltwaters and Amazonian tropical organic-rich black rivers.

In glaciated catchments of the Mont Blanc massif, pro-glacial rivers may export microbially-derived DOC from subglacial biomes, distinct from soil-derived organic matter. However, the annual variability of these fluxes and the relative contribution of different sources remain poorly quantified. In parallel, tropical wet zones of the Amazon basin are key yet uncertain components of the C cycle, where the interaction between organic matter, hydrology, other elements such as iron and bacterial activity controls the fate of DOC exported to major rivers like the Rio Negro.

We present DOC concentrations and corresponding $\delta^{13}C$ signatures from both field sites. In Alpine rivers, preliminary data show DOC concentrations ranging from 0.7 to 9.3 ppm, with $\delta^{13}C_{DOC}$ values ranging from -31.8 to -23.8‰. These isotopic signatures are consistent with a dominant subglacial source of DOC, likely originating from overridden soils and/or in situ microbial production. In the Amazonian studied black water streams and rivers, concentrations vary from 3.8 to 24 ppm, and $\delta^{13}C_{DOC}$ signatures range from -31.7 to -27.8‰. These signatures are compatible with contributions from soil organic matter and in-situ biological cycling. Seasonal variability of the $\delta^{13}C_{DOC}$signal is observed in both continental systems suggesting active and seasonally driven build-up and reworking of this transient organic carbon reservoir.

Our study provides critical field-based constraints for portraying the concentration and isotopic signal variability of the continental DOC reservoir. It also contributes to modeling the evolving role of continental DOC in the global carbon cycle. These findings highlight the need to integrate both cryospheric and tropical systems in future Earth system models.