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Greenhouse gas release from warming mountain rivers in the Arctic

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Rivers play an important role in the global carbon cycle, acting as dynamic pathways for greenhouse gas exchange between the terrestrial environment and the atmosphere. This study investigates fluxes of carbon dioxide (CO_2) released by mountain rivers of the Canadian Arctic where warming is increasing chemical weathering rates. Weathering can act as a sink of CO_2 (via carbonic acid driven silicate and carbonate weathering), or a CO_2 source through acidity produced by sulfide oxidation (sulfuric acid) and CO_2 inputs from rock organic carbon oxidation. The latter oxidative weathering processes are more pronounced in erosive settings and may contribute to supersaturation of CO_2 in mountain rivers. However, how changing weathering patterns influence river CO_2 release in Arctic rivers is poorly constrained. To provide new insight on the underlying processes, 42 sites were selected across gradients in lithology, slope and climate in the upper Peel and Yukon River watersheds. A suite of geochemical measurements will be used to constrain weathering processes (dissolved ion concentrations and alkalinity), and CO_2 source (stable isotopes, radiocarbon) and flux (flux chamber measurements) to constrain the source, processes and pathways of CO_2 release, with fieldwork in the Canadian Arctic undertaken in June-July 2024. At 24 sites, CO_2 was collected to quantify the radiocarbon age of river CO_2, a powerful tracer of geological carbon input from sulfide oxidation of carbonate minerals and rock organic matter. Alongside complementary analysis of weathering products and future work to assess sulfide oxidation processes (S and O isotopes of sulfate), we will provide new insight on the drivers of spatiotemporal variability of gas fluxes. Preliminary analysis shows that rivers persistently degas CO_2 and suggest strong chemical weathering forcing on greenhouse gas fluxes. Outputs of this study will improve our understanding of previously unrecognised routes of geological carbon to the atmosphere via mountain streams.