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Spatial and seasonal variability of nutrient export from a subarctic glacial river to the ocean

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Glacial rivers play an important role in transporting dissolved and particulate nutrients from glaciers to downstream ecosystems where they influence ocean primary productivity. Abiotic and biotic processes in glacial environments enrich meltwaters with various nutrients. These may undergo changes in concentration and speciation along the river catchments due to lateral inputs or in-channel processes. However, the temporal and spatial variabilities of such nutrient fluxes are poorly constrained.

We monitored diurnal and seasonal changes in nutrient concentrations along a ~120-km long glacier river in Western Iceland. We combined time-resolved *in situ* chemical analysis using microfluidic sensors for dissolved nitrate ($NO_3^-{}_{aq}$) and phosphate ($PO_4^{3-}{}_{aq}$) with *in situ* temperature, pH, conductivity, and turbidity measurements. We also carried out seasonal sampling along glacier-to-ocean transects of the river catchment and characterized both aqueous and particulate fractions of macro- and micronutrients, dissolved organic matter composition, and DNA.

The *in situ* sensor data revealed diurnal fluctuations in $NO_3^-{}_{aq}$ concentrations of up to 1 µM, with a decrease during the day and an increase at night. These diurnal trends were consistent across seasons. In contrast, $PO_4^{3-}{}_{aq}$ exhibited seasonal variability, with significant changes related to glacial discharge.

The glacier-to-ocean transect showed enrichment in dissolved organic carbon (DOC) and iron (Fe_{aq}) with increasing distance from the glacier, likely reflecting soil-derived lateral inputs and a variation in DSi_{aq} due to geothermal inputs. Downstream, a link between decreasing $PO_4^{3-}{}_{aq}$ and increasing Fe_{aq} concentrations may suggest adsorption or coprecipitation processes. Changes in dissolved inorganic nitrogen (DIN) hint at a potential increase in channel microbial uptake along the river path.

Overall, our findings highlight the spatial and temporal variability in nutrient export from glacial

rivers to the ocean, showing relative contributions of different nutrient sources across seasons and distance from the glacier.