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GREENLAND REVISITED: LAKE EFFECTS ON COASTAL NUTRIENT FLUXES

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Retreat of continental ice sheets exposed ~15% of Earth's land surface from the Last Glacial Maximum (LGM) to about 6 ka and recent warming has increased glacial melting and meltwater solute fluxes to the oceans. Additional solutes originate from non-glacial streams in landscapes exposed since the LGM. As presented in last year's pandemic-modified Birdsall-Dreiss lecture, Greenlandic glacial and non-glacial streams have distinct solute concentrations because of differing chemical weathering regimes of comminuted glacial sediment. In this year's lecture, we evaluate an ~46 km^2 non-glacial watershed near Sisimiut, Greenland to assess how lakes may impact non-glacial solute fluxes. Snow accumulates in the watershed from October to freshet in early May, after which discharge responds solely to precipitation events. Three main tributaries provide 92% of flow to the outlet stream and drain sub-watersheds with median slope angles of 16 to 18% and small upland lakes that cover 0.5 and 3.8% of the land area. In contrast, the outlet stream discharges from a landscape with a median slope of ~6% that includes one large and one small lake covering 23% of the area. Streams above and below the outlet lakes show similar variations in solute concentrations through the melt season. However, soon after freshet the outlet stream has major element concentrations ~20% greater than in the tributaries. The excess solute concentrations decrease linearly for ~90 days at which time the tributaries and outlet have similar concentrations. The excess solutes at the outlet may result from over-winter mineral dissolution in lake sediments, cryogenic solute enrichment during lake freeze-in, or dilute runoff in tributaries from snowmelt during and soon after freshet. In contrast, the outlet stream has a 0.6 to 3 times deficit of PO_4, NO_3, and Si compared with the tributaries, suggesting assimilation within the lake. NH_4 concentrations switch from ~60% deficit to ~ 60% excess, reflecting a switch from a lake sink to source. The differences between tributary and outlet stream compositions suggest lake development may have altered coastal nutrient fluxes from non-glacial streams post-LGM. These variations will modify differences in glacial and non-glacial nutrient fluxes to coastal ecosystems, both since the LGM and as melting increases in a future warmer world.

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Back to: GSA Hydrogeology Division Birdsall-Dreiss Distinguished Lecture