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Biogeochemistry of glacial runoff along the Gulf of Alaska

E. Hood (1), D. Scott (2), A. Vermilyea (3), A. Stubbins (4), P. Raymond (5), and R. Spencer (6)

(1) University of Alaska Southeast, Juneau, AK, United States (eran.hood@uas.alaska.edu), (2) Virginia Tech University, Blacksburg, VA, United States, (3) Castleton State College, Castleton, VT, United States, (4) Skidaway Institute of Oceanography, Savannah, GA, United States, (5) Yale University, New Haven, CT, United States, (6) Woods Hole Research Center, Falmouth, MA, United States

Glaciers and ice sheets represent the second largest reservoir of water in the global hydrologic system and glacier ecosystems cover 10% of the Earth, however the biogeochemistry of glacier discharge has not been well characterized. Preliminary investigations have shown that runoff from glaciers can be an important contributor of dissolved organic carbon (DOC) and macro- and micro- nutrients such as P and Fe to downstream aquatic ecosystems. There is also mounting evidence that glacier ecosystems may be a source of anthropogenically derived constituents such as fossil fuel combustion by-products and persistent organic pollutants that are deposited in precipitation and released in melting glacier ice. As a result, it is critical to develop our understanding of glacial biogeochemistry, particularly in near-shore marine ecosystems along glacially-dominated coastal margins that receive large volumes of glacial runoff.

To examine the spatial and temporal variability in the biogeochemical properties of glacial runoff, we sampled snow, ice melt, and glacial runoff at the Mendenhall Glacier near Juneau, Alaska during the summer of 2012. Mendenhall Glacier extends from near-sea level to >1700 m.a.s.l. and encompasses $\sim$120 km2 of the 3900 km2 Juneau Icefield. The main sub-glacial drainage channel was sampled weekly throughout the glacier melt season (May-October) for a suite of physical (temperature, conductivity, suspended sediment) and biogeochemical (C, N, P, Fe and trace metals) parameters. In addition, we did opportunistic sampling of snow in the glacier accumulation zone and supra-glacial meltwater streams on the glacier surface. We also analyzed particulate and dissolved Hg in glacial runoff to quantify the export of Hg to downstream aquatic ecosystems.

Preliminary results show that concentrations of dissolved organic carbon in snow, ice melt, and sub-glacial runoff were typically low (<0.5 mg C/L) and not well correlated with discharge. Recent research has shown that glacier-derived DOC represents a quantitatively significant energy subsidy of ancient, yet highly bioavailable carbon to downstream ecosystems. This runs counter to the standard perception of the age-reactivity relationship for DOC, in which the least reactive material withstands degradation the longest and is therefore the oldest. To investigate this phenomenon and determine the origin of glacially-derived DOC, we focused on characterizing the dissolved organic matter being exported from Mendenhall across the melt season. This talk will present results from a variety of organic matter characterization techniques including: carbon isotopes (13C and 14C), fluorescence spectrophotometry, and electrospray ionization coupled to FTICR-MS.