Effect of subglacial meltwater plume formation on phytoplankton growth in the fjord of Bowdoin Glacier in northwest Greenland

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In Greenland, marine-terminating outlet glaciers discharge turbid subglacial meltwater into fjords. The area influenced by the turbid water near the calving front is well known as an important foraging hotspot for higher trophic animals. Glaciers may therefore play an important role in ecosystem productivity within the fjords by releasing an essential macronutrient for primary producers. However, since there are few available data on the macronutrient delivery with the meltwater inputs, processes of macronutrient supply to surface waters are poorly understood. Here we present a hydrographic and geochemical dataset from Bowdoin Glacier and its fjord in northwestern Greenland during the summer of 2016.
On the glacier, meltwater contained few macronutrients (<0.5 μM NO_3+NO_2) indicating that supraglacial meltwater is not a significant source of macronutrients in the fjord. At the surface of a meltwater plume near the calving front, water properties were largely different from surface waters outside of the plume. The concentration of surface macronutrients inside the plume was an order of magnitude higher (~12.8 μM NO_3+NO_2) than that outside of the plume (<1.6 μM NO_3+NO_2). Additionally, salinity (~33.0) and the content of suspended particles (~132 mg/L) inside the plume were notably higher than those outside of the plume (salinity ~15.4; suspended particles ~22.3 mg/L), suggesting upwelling of nutrient-rich, saline deep water including substantial sediment derived from subglacial weathering. Oxygen isotopic compositions of the glacial meltwater, plume, and fjord water also indicated that the glacial meltwater upwells as a buoyant flow, drawing the nutrient-rich deep water into the fjord. Within a vertical cross-section along the centerline of the fjord, highly turbid water was observed in sub-surface layer at depths of 10–50 m. Less saline water with low macronutrients concentration was on top of this highly turbid water. Phytoplankton blooms (~6.5 μg/L chlorophyll a) was observed near the boundary between the less saline water and the turbid water. The concentration of macronutrients was sufficiently high (~10 μM NO_3+NO_2) in this area to generate the bloom. Overall, our study results show that turbid meltwater discharge from Bowdoin Glacier affects nutrient availability and the subsequent growth of phytoplankton in the fjord. Upwelling and transport of macronutrients associated with subglacial meltwater plume formation is an important process for phytoplankton growth in the near-surface layer.

Keywords: Greenland, Bowdoin Glacier, Macronutrient, Turbid meltwater discharge

