Subglacial meltwater discharge and its impact on water properties in Bowdoin Fjord, northwestern Greenland

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Meltwater runoff from the Greenland ice sheet to the ocean has increased in recent years. Thus, it is important to assess the impact of meltwater runoff on the oceanic structure. In marine-terminating glaciers, subglacial meltwater discharge occurs at the grounding line depth and forms an upwelling plume. To understand the impact of subglacial meltwater discharge on water properties, we carried out CTD observations in Bowdoin Fjord, northwestern Greenland in the summers of 2014 and 2016. A numerical experiment of subglacial meltwater plume was also performed with a non-hydrostatic ocean model to examine the effects of freshwater flux changes.
In ocean observations of 2014 and 2016, a significantly high turbidity layer (> 5 FTU) was observed at the subsurface of 20–40 m depth, which was caused by subglacial meltwater plume. Moreover, the level of turbidity and potential temperature showed interannual variations: turbidity was higher and temperature was lower near the surface (5–15 m depth) in 2016, whereas turbidity was lower and temperature was higher at the layer below (50–100 m depth). The observed structure suggests that a larger discharge of turbid subglacial meltwater in 2016, with a larger buoyant force, mixed with the fjord water at the grounding line depth and extended at the relatively shallower depths. The situation is consistent with the fact that the sum of positive degree days at Qaanaaq Airport, a proxy for meltwater runoff in this region, was approximately 20% greater in 2016 than in 2014. In the numerical experiment with 20% greater amount of freshwater flux, concentration of a meltwater tracer near the surface increased by roughly 20% from that of the control case, whereas the tracer concentration decreased at the layer below. The difference in the vertical distribution of tracer concentration with and without increasing the freshwater flux was consistent with that of turbidity in the two years. These results indicate that the change in amount of subglacial meltwater runoff affects the behavior of turbid subglacial meltwater plume and material transport, which might further impact on biogeochemical cycles.

Keywords: Glacier-ocean interaction, Subglacial meltwater plume, Water properties, Fjord, Greenland

