Turbid water and chlorophyll a distributions near the interface of the ocean and a tidewater glacier in northwest Greenland

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In Greenland, tidewater glaciers control 90% of the freshwater discharge from the ice sheet into the ocean (Rignot et al., 2010). The discharge from tidewater glaciers provides massive freshwater and suspended sediment from glacial erosion (turbid water) to the ocean. Further, fjords in front of the glaciers are well known as important foraging areas for many seabirds and marine mammals. The biological activities near the calving front might be related to turbid meltwater discharge from the glaciers which forms sub-surface plume (Lydersen et al., 2014). Although ice and meltwater discharge from glaciers may therefore have a large impact on the marine ecosystems in Greenland, contribution of the turbid water discharge to changes in nutrient availability and to the subsequent growth of phytoplankton as feed for upper trophic organisms in the fjord are largely unknown. In this study, we investigated spatial and vertical distribution of turbid water and standing stocks of phytoplankton near the ice-ocean interface of Bowdoin Glacier in northwest Greenland in summer 2016. We investigated surface water characteristics from the area within 1 km from the glacier front to the outer area of the Bowdoin Fjord. A CTD profiler was mounted on a pole and hanged from side of a boat to perform continuous measurements of surface water properties (0.3 m depth). Our results show that highly turbid and low salinity water distributed close to the surface near the glacier front and the turbidity decreased towards the outer fjords (Fig. 1a). Concentration of surface chlorophyll a, an indicator of phytoplankton standing stock, was lowest near the glacier front but relatively high (>1 μg/l) in the fjord (Fig. 1b). Additionally, we investigated vertical distribution of these parameters at five sites along a longitudinal transect approximately 1.5 km off the glacier front. An optical sensor was also installed on a CTD profiler to evaluate light transmission through the turbid water. The vertical profile of turbidity showed an extremely high anomaly in the subsurface layer (10–50 m) along the entire transect (Fig. 2c). The high chlorophyll a (>1 μg/l) and low salinity water was lying upon this highly turbid subsurface water (Figs. 2b-d). Therefore, growth of phytoplankton (just below 0.3 m depth) near the glacier front was not limited by low light availability even if the light transmission reduced by 5% of the surface irradiance at 5 m depth. Our results show abundant distribution of chlorophyll a at the surface near the glacier front. To further understand factors controlling the development of phytoplankton growth near the ice-ocean interface, we should consider nutrient transport from the glacial meltwater and/or nutrient supply from the turbid subsurface water.

References

Rignot, E. et al., Rapid submarine melting of the calving faces of West Greenland glaciers, Nature Geoscience 3(3), 187-191, 2010.

Lydersen, C. et al., The importance of tidewater glaciers for marine mammals and seabirds in Svalbard, Norway, Journal of Marine Systems, 129, 452-471, 2014.

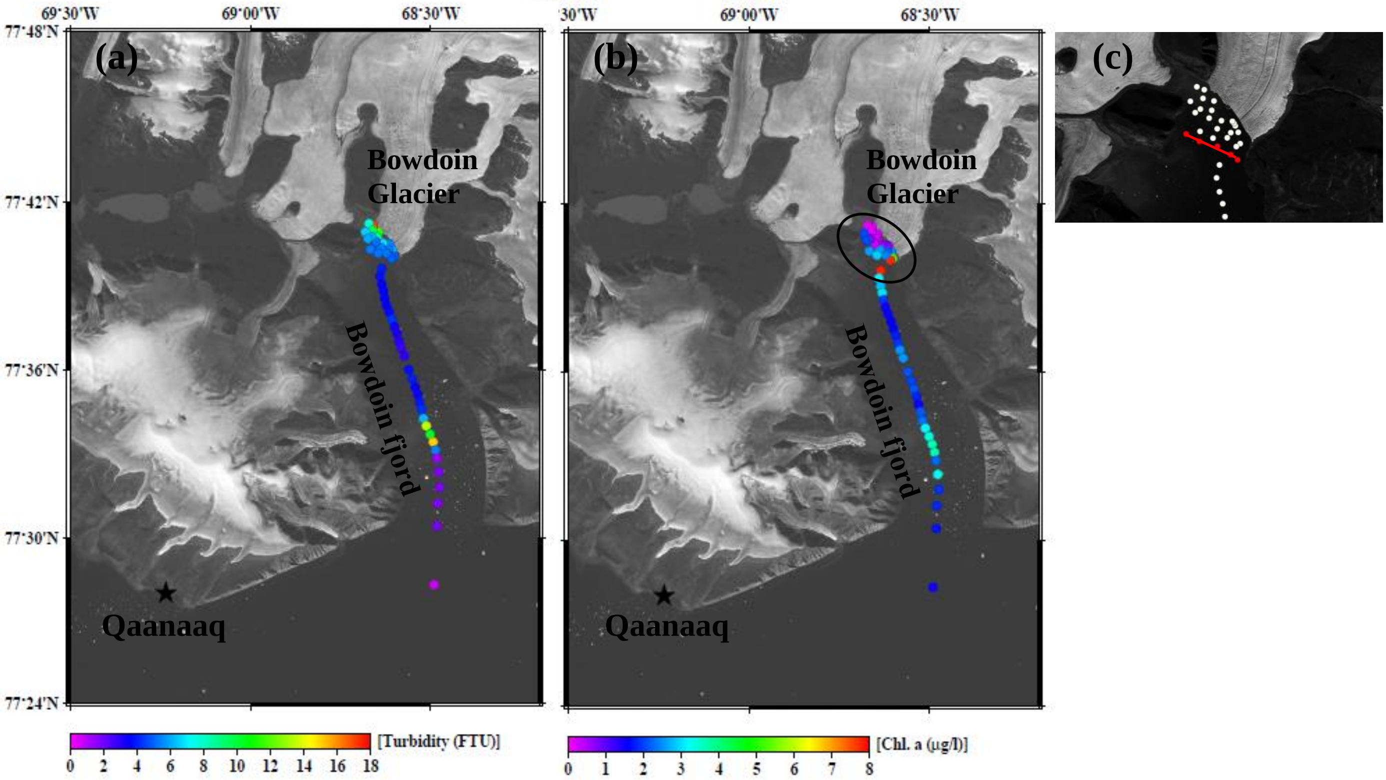

Figure 1. Spatial distributions of surface (a) turbidity (FTU) and (b) chlorophyll a (μg/l) in the Bowdoin Fjord. (c) The area near the glacier front (area circled in (b)). The red line indicates a longitudinal transect for vertical section observation.

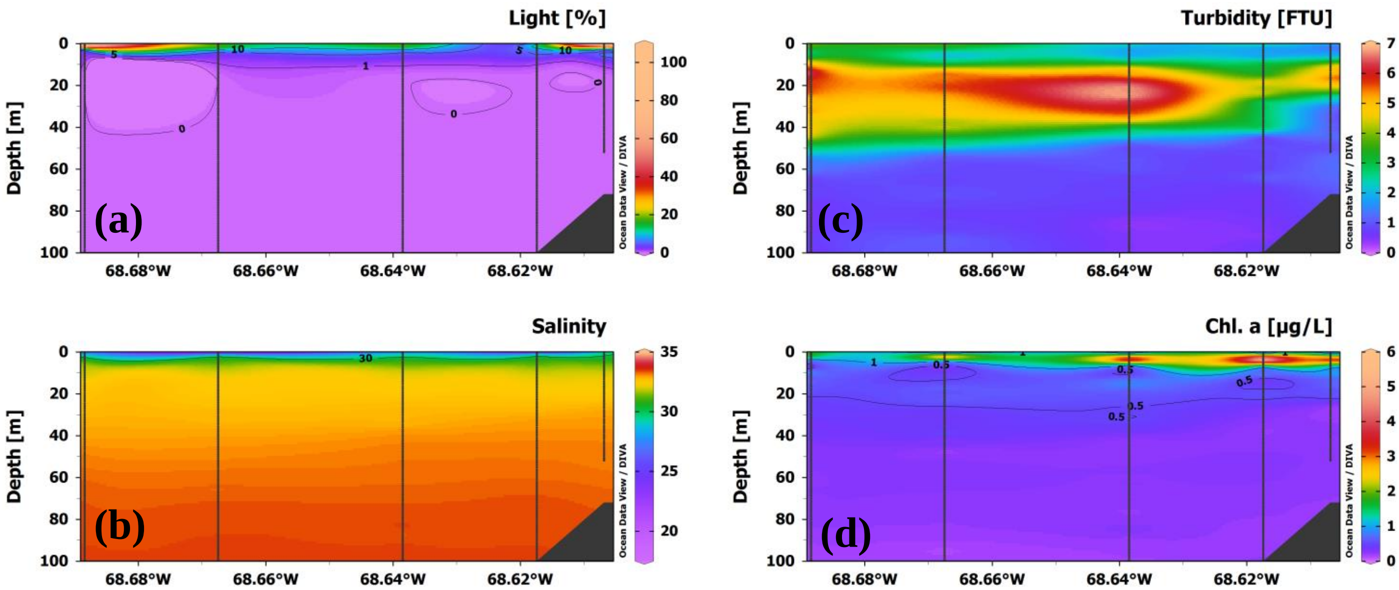

Figure 2. Distribution of (a) light transmission (%), (b) salinity, (c) turbidity (FTU), and (d) chlorophyll a (μg/l) near the Bowdoin Glacier along the longitudinal transect in the Bowdoin Fjord.