Circulation and heat sources for glacial melt in a subarctic sill fjord (Godthåbsfjord)

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Abstract

Recent warming of Subpolar Mode Water off Greenland has been suggested to accelerate the mass loss from tidal outlet glaciers of the Greenland Ice Sheet. We present a comprehensive analysis of water masses, dynamics, and interannual hydrographic variability in Godthåbsfjord, a sill fjord in contact with tidal outlet glaciers on the west coast of Greenland. Through seasonal observations we recognize an intermediate baroclinic circulation mode driven by tidal currents and an associated important local heat source for the fjord. Four distinct circulation modes are observed in the fjord of which all can contribute to glacial ice melt. Further, we present the first seasonal hydrographic observations from the inner part of Godthåbsfjord, relatively close to and within 4 to 50 km of a fast-flowing tidewater outlet glacier. This region is characterized by a dense glacial and sea ice cover. Freshwater from runoff, subglacial freshwater (SgFW) discharge, glacial and sea ice melt are observed above 50-90 m depth. During summer SgFW and subsurface glacial melt mixed with ambient water are observed as a layered structure in the temperature profiles below the low-saline summer surface layer (<7m). During winter the upper water column is characterized by step-wise halo- and thermoclines formed by mixing between deeper layers and the surface layer influenced by ice melt. The warm (T>1°C) intermediate water mass is a significant subsurface heat source for ice melt.