Interaction between marine terminating glaciers and the ocean circulation in Northeast Greenland

T. Kanzow, C. Wekerle, Q. Wang and R. Timmermann*, University of Bremen and Alfred Wegener Institute for Polar and Marine Research in the Helmholtz Association*

In Short

- North east Greenland's glaciers are melting
- Strong interaction with the ocean circulation through warm Atlantic Water
- Ice shelf-sea ice-ocean simulations help to better understand the long-term variability and reveal possible driving mechanisms

The Greenland ice sheet has been subject to strong mass loss in the last decades. Greenland freshwater fluxes have implications for the global sea level, and can affect the strength of the Atlantic Meridional Overturning Circulation. Anomalously high transport of Atlantic Water through the Nordic Seas was observed in the last decades, and is thought to increase melting of marine terminating glaciers around Greenland.

Future projections of climate warming around Greenland indicate particularly large melting rates on the east coast of Greenland, between Fram Strait and Denmark Strait. The two largest glaciers in this region are the Zachariæ Isstrøm and the 79 North Glacier (79NG), which drain the Northeast Greenland Ice Stream. The Zachariæ Isstrøm lost its entire floating ice tongue between 2012 and 2014, and warming in Atlantic Water has been suggested to be the main driver for the collapse of the ice tongue. Warm Atlantic Water has to pass through the trough system of the Northeast Greenland continental shelf to reach the glacier fronts. Oceanographic measurements from 1979–2016 showed that warm Atlantic Intermediate Water mainly reaches the 79NG via the southern trough, i.e. the Norske Trough. Mooring measurements in Norske Trough from 2014–2016 revealed a $\sim$10-km-wide bottom-intensified jet carrying warm AW towards the glaciers. The variability of this jet is likely related to Ekman pumping over the shelfbreak which generates topographic Rossby waves. Nonetheless, the recent study by Schaffer et al. (2020) showed that the local bathymetry in front of the 79NG plays an important role too. Their observations indicate that a year-round bottom-intensified inflow of warm Atlantic Water into the cavity is constrained by a sill. However, observational data covers either a short time period of only two years or only the summer season. High resolution model integrations will help to better understand the long-term variability and reveal possible driving mechanisms.

This study has three aims: First, we plan to carry out a high resolution ice shelf-ocean-sea ice simulation focused on the ocean dynamics on the Northeast Greenland shelf, which will be used as a control run for further experiments. Second, a number of sensitivity experiments will be carried out to investigate the effect of sea ice decline and changing Atlantic Water transport on the ocean circulation of the Northeast Greenland shelf and the ice shelf at 79NG. Third, we plan to perform coupled ice sheet-ocean-sea ice simulations to investigate the interaction of the Greenland ice sheet with the 79NG and the local ocean circulation on the Northeast Greenland continental shelf. Some of the important scientific questions that we can investigate with our simulations are listed below:

- Which processes are responsible for the heat transport into the cavity of the 79NG? What is its variability from seasonal to decadal time scales? What determines the thickness of the Atlantic Water layer on the East Greenland continental shelf?
- What is the impact of melt water at the base of the ice shelf and at the grounding line?
- To what an extent and how do recent changes occurring in the Arctic Ocean and Nordic Seas (sea ice decline and changing Atlantic Water transport) impact the glaciers?

References:

Schaffer, J., Kanzow, T., von Appen, W. et al. Bathymetry constrains ocean heat supply to Greenland's largest glacier tongue. Nat. Geosci. 13, 227–231 (2020). https://doi.org/10.1038/s41561-019-0529-x.

More Information

[1] This project is part of the BMBF funded project GROCE (www.groce.de)