Freshwater Processes in Baffin Bay and the Labrador Sea

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In this presentation, we look at ocean circulation issues related to changes in the Greenland ice sheet. In the first part of the presentation, which is based on the Ph.D. research of Laura Castro de la Guardia, we consider feedbacks between melt of the Greenland ice sheet and the circulation within Baffin Bay. We present results from 8 sensitivity experiments using the numerical model NEMO that study the relation between melt from the Greenland Ice Sheet and warming of shelf waters on the northwest Greenland shelf. We find a positive feedback between increasing runoff (melt) and shelf heat content. The heat content increases in response to a reduction in Arctic Water inflow through the Canadian Arctic Archipelago and a stronger stratification in Baffin Bay. Increasing the meltwater runoff led to positive feedbacks resulting in further freshening of surface waters and warming and shallowing of the West Greenland Irminger Water on the northwest Greenland shelf. These warmer waters can now more easily enter fjords on the Greenland coast, potentially providing additional heat to accelerate the melt of marine terminating glaciers. A schematic of the feedback loop is given in figure 1.

In the second part of the presentation, based on the M.Sc. research of Laura Gillard, we look at pathways of warm waters to the Greenland Ice Sheet, and pathways of freshwater away from the ice sheet. We explore and classify the pathways for the warmer Atlantic waters that reach the fjords along the coasts of Greenland. Additionally, given that the melt of these glaciers is accelerating, we look at the pathways of the low salinity melt waters from these coastal glaciers and where it is taken up in the surrounding basins. This analysis is carried out using an Arctic and North Atlantic configuration of the NEMO ocean/sea-ice general circulation model run at both 1/4 and 1/12 degree resolution. Pathways are determined using the Ariane Lagrangian float package using both forward and reverse trajectory analysis.

The third part of this presentation focussed on examining the same freshwater exchange using the NEMO ocean general circulation model. Several configurations were used, including a global ¼ version (ORCA025) and a 1/12 degree North Atlantic version (NATL12). Both configurations were run as hindcast experiments driven by CORE forcing, covering 1958-2004 (the ORCA025 run) or 1980-2006 (the NATL12 run). As well as estimated freshwater transports at the AZMP sections, and across the 1000 m isobaths at various flux gates between the sections, the model fields were used to drive the offline Lagrangian virtual float tool Ariane. 1000 floats were launched each 3 months through the hindcasts, in the low salinity waters exiting Hudson Strait, Lancaster Sound and Nares Strait. The float trajectories were then followed over 10 years. As shown in figure 2 with the Lancaster Sound floats released using the fields from the ORCA025 run, there is little exchange of freshwater from the Labrador Current north of Flemish Cap and the Grand Banks.

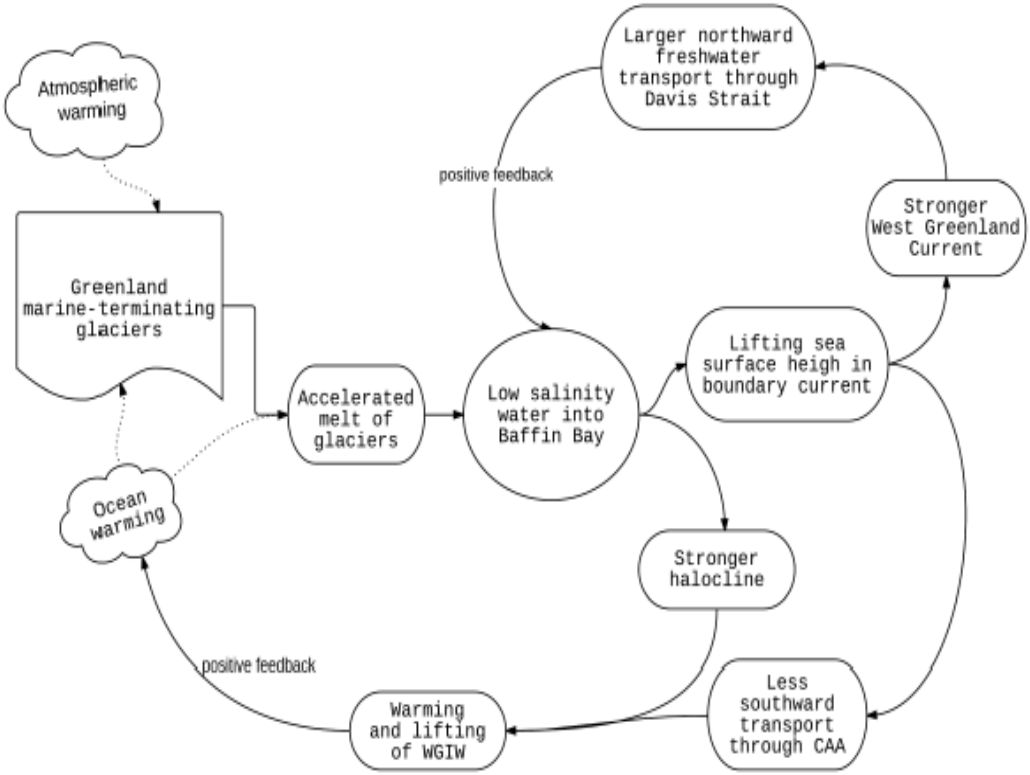

Figure 1: Schematic of findings highlighting the positive feedbacks that developed as meltwater runoff from Greenland Ice Sheet increases.

Figure 2: Probability distribution of efloats released in the freshwater core of Lancaster Sound, using the Ariane Lagrangian tool, and the fields from a hincast experiment over 1958-2004 using a global ORCA025 configuration.