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Icebergs in the North Atlantic during the Pliocene?

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Unprecedented warming in the Arctic will have a significant contribution to 21st century sea level rise. The Greenland Ice Sheet (GRIS) is estimated to contain ∼7.36 m of sea level equivalent and it is therefore crucial to understand its behaviour in a warming world. The Pliocene is the last time in Earth's history that CO_2 levels were similar to present and that are comparable with model predictions for 2100. The mid-Piacenzian Warm Period (mPWP; 3.264 to 3.025 Ma) is a particularly well studied/constrained period of the Pliocene and we have chosen this and the glacial Marine Isotopic Stage (MIS) M2 (3.3 Ma) as end members of Pliocene climate.

During the M2, CO_2 was at ∼220ppmv and sea level significantly lower than present suggesting a North America ice sheet. The exact nature of sea level is difficult to constrain during MIS M2, however, evidence supporting this has been found in the James Bay Lowland. Climate model results show that a medium/large northern hemisphere ice sheet produces a climate state not inconsistent with available proxy data. During the mPWP, modelling shows retreat of the GRIS to higher altitudes with ∼400ppmv CO_2. The extent of GRIS remains, however, unclear.

Ice rafted debris (IRD) provides proxy evidence of marine terminating glaciers (MTGs) and can help us to constrain the location of them and, hence, the extent of GRIS and a North America ice sheet. This evidence in marine sediment cores can be provenance tested and the geo-signature of the IRD potentially matched with a Greenlandic and North American location. The distribution of IRD in space and time in a marine sediment core provides important information about the potential state of GRIS. Using M2 and mPWP climate scenarios, iceberg trajectories were modelled for the North Atlantic in an attempt to constrain potential locations for IRD deposition for further research.

The results of this work provide defined potential locations of IRD depending on the source region of icebergs. Iceberg seeding locations to the NE of Greenland produce trajectories which follow the East Greenland Current through the Denmark Strait into the northern North Atlantic. Trajectories from the SE Greenland have a wider extent across the northern North Atlantic and icebergs seeded from the West coast of Greenland follow a trajectory which takes them further south into the North Atlantic.

Future work should combine geological provenance studies within a modelling framework to further understanding of the GRIS and MTGs in the late Pliocene and the future.