An iceberg model to quantify the stability of the Atlantic MOC to freshwater forcing

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The current generation of Earth System Models (ESMs) are incorrectly simulating the discharge of freshwater to the ocean from continental ice sheets. These models assume that freshwater runoff enters the ocean entirely as liquid along the entire edge of an ice sheet. In reality, a significant fraction of runoff occurs as icebergs (66 % for the Greenland Ice Sheet) focused into narrow fjords. These icebergs will drift many thousands of kilometers from their source and slowly release freshwater as they melt.

Here we present the first results from a comprehensive, thermodynamic iceberg model we are developing to accurately simulate the delivery of freshwater to the ocean from the major continental ice sheets. In addition to simulating the melting and drifting of individual icebergs, our model also considers: grounding, stability (i.e. ability to role), albedo changes, collisions, calving, keel shape, and sediment deposition to the ocean. The iceberg model is being coupled to a state-of-the-art, high resolution (1/6° - 1/25°) ocean-sea ice numerical model (MITgcm) to accurately simulate the trajectories of individual icebergs by resolving narrow coastal fjords and boundary currents. We find that a large fraction (up to 80%) of freshwater is delivered more than 200 km offshore of the Greenland coast, suggesting 'dumping' freshwater into the ocean along the edge of an ice sheet is not an effective way to understand the sensitivity of the climate system to changes in freshwater forcing. Multi-decadal integrations run over the next couple of months will offer additional insight into these preliminary results.