EGU2020-8750
https://doi.org/10.5194/egusphere-egu2020-8750
EGU General Assembly 2020

Targeted Glacial Geoengineering through Seabed Anchored Curtains

Michael Wolovick[1], John Moore[1], Rajeev Jaiman[2], Jasmin Jelovica[2], and Bowie Keefer[2]
[1]Beijing Normal University, College of Global Change and Earth Systems Science, China
[2]University of British Columbia, Vancouver, Canada

Rapid sea level rise due to an ice sheet collapse has the potential to be extremely damaging to coastal communities and infrastructure, and conventional coastal protection techniques (dykes, levees, etc) can be quite expensive. In the past we have proposed that society might employ artificial sills and pinning points at critical marine ice streams in Antarctica to slow the rate of sea level rise at the source (Wolovick and Moore, 2018). However, thick earthen sills are likely to be extremely expensive and difficult to construct. If the goal of the intervention is only to block warm water from reaching the grounding line, then an alternate intervention consisting of thin flexible buoyant curtains anchored to the seabed might be employed instead. Flexible curtains are likely to be cheaper, more robust against iceberg collisions, and easier to remove in the event of unforeseen side effects. Here, we use a simple ice flow model to evaluate the effectiveness of such an intervention at three important Greenlandic outlet glaciers, and we make crude estimates of the forces on the curtain and of the likely cost of construction. We find that the single most important factor controlling the effectiveness of a thin water-blocking intervention (defined as either slowing glacier retreat or causing readvance) is the exposure of the glacier to deep warm water at the time of barrier construction. This means that, for Jakobshavn Isbrae, which has a deep (~1000 m) central trough extending well over 100 km inland, a water-blocking intervention is likely to be effective far into the future, and also that the preventable retreat (in comparison to a no-intervention scenario) is quite large. For Helheim and Kangerdlugssuaq, however, the central trough rises rapidly just a few tens of kilometers inland of the present-day calving front, removing the vulnerability to deep warm water after a relatively small retreat. This means both that the intervention must be begun relatively soon if it is to have an effect at those glaciers, and that the preventable retreat is smaller. With respect to the forces acting on the curtain, we find that the static tensile load on the curtain rises quadratically with the height above the seabed, and linearly with respect to the density contrast between the inner waters and the outer waters. Since the natural sills at the fjord mouths are roughly three times deeper at Helheim and Kangerdlugssuaq than they are at Jakobshavn, curtains at the former would need to be roughly an order of magnitude stronger than curtains at the latter. We estimate that this translates into roughly five times greater cost (per unit barrier length) at the two East Greenland glaciers than at Jakobshavn. Therefore, based on both cost and effectiveness, we find that this type of intervention is more favored for Jakobshavn than it is for Helheim and Kangerdlugssuuaq.