Glacial geoengineering—the key to slowing sea level rise?

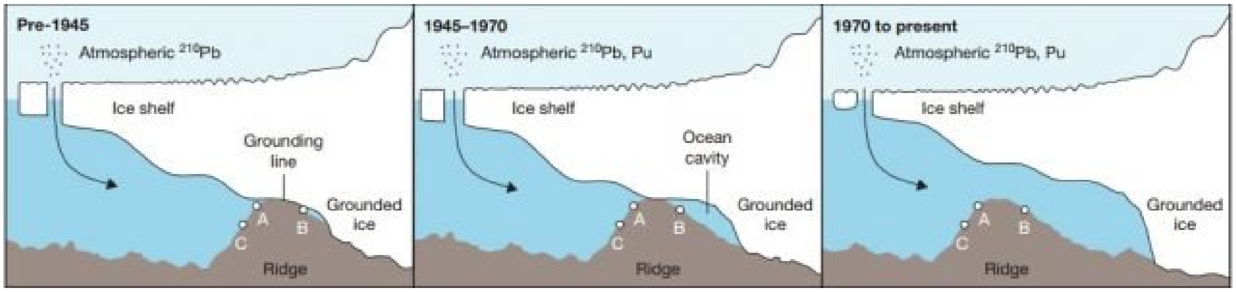
February 2 2018, by Andrew Angle

The calving front of the Jakobshavn glacier in western Greenland. The Jakobshavn is a potential site for the proposal's walls. Credit: NASA Goddard Space Flight Center

The rapid collapse of some of the world's biggest glaciers due to climate change will have devastating consequences for our planet's coastlines due to sea level rise. Compounding this issue is the fact that many of these coastlines are heavily populated and developed. A recent proposal, first reported in The Atlantic, aims to avert potential catastrophe by turning to geoengineering through the construction of massive underwater walls, called sills, which would be built where glaciers meet the ocean in Antarctica and Greenland.

The idea is the work of Michael Wolovick, a glaciology postdoctoral researcher at Princeton University and former student of Columbia's Robin Bell. The uniqueness of Wolovick's geoengineering proposal is its focus on a consequence of climate change—in this case, sea-level rise as a result of glacial collapse—rather than a focus on decreasing greenhouse gases (GHG), the root cause of climate change. Many geoengineering proposals attempt to slow down or even reverse the Earth's rising temperatures as an alternative to reducing GHG emissions. Some propose to add aerosols like sulfur dioxide to the atmosphere, or increase the reflectivity of clouds, to reduce atmospheric heating. Others explore ways to capture and sequester carbon.

When asked about the inspiration behind his distinct work, Wolovick told GlacierHub he has been fascinated by the large-scale societal implications that glacial collapse could have, given the relatively small scales of the glaciers themselves. The so called "doomsday glacier," the Thwaites of West Antarctica, is only around 100 kilometers wide, for example, but its collapse would swiftly destabilize large parts of the West Antarctic ice sheet, potentially leading to sea level rise of up to 13 feet in some parts of the world.



Warm water can melt ice shelves from below. The walls from this proposal would be placed in front of the grounding line pictured here. Credit: Smith et al

So how does Wolovick's plan work? It starts with an engineering project of unprecedented scale: the construction of large underwater walls, composed of an inner layer like sand and an outer layer of boulders. These walls would be strategically built at the grounding line, where a glacier's leading edge meets the ocean, of the world's most unstable glaciers. These walls would be built primarily in Antarctica and Greenland where many glaciers extend beyond the land to float on the ocean.

Glaciers that extend from land into the ocean are exposed to both warming air and water. Warmer sea water melts these glaciers from below in addition to the melting that occurs from the air above, causing them to melt faster than glaciers solely confined to land. This is where the walls built on the ocean-floor would come into play. Once in place, these barriers would "block warm water so you could reduce the melting rate, and also to provide pinning points that the ice shelf could reground on as it thickens," said Wolovick. In addition, because the glaciers are already floating, the walls would prevent warm water from moving further inland and increasing melting rates there.

Would these walls work in actuality? Wolovick's computer modelling is in its early stages, but some models show glaciers stabilizing after walls are put in place, with some glaciers actually gaining in mass. This possible stabilization would buy some time to act decisively on adaptation to sea level rise and perhaps allow the prevention of disastrous ice sheet collapse altogether. Still, Wolovick admits a lot more work needs to be done in the future, including the development of better ocean models to see if the walls would block warmer water in the way intended, allowing a glacier to stabilize.

The calving front of a glacier in West Antarctica. Credit: NASA Goddard Space Flight Center

Lukas Arenson, principal geotechnical engineer at BGC Engineering Inc., spoke with GlacierHub about the proposal. He says that while the proposal has the potential to slow glacial melting, it is still in its very early stages, and there are many questions that need to be answered before implementation. One of Arenson's principle concerns is "the enormous costs for building such a sill or a dike in a stable manner in these areas, as it requires some major engineering and construction efforts." Wolovick recognizes that his proposal would require placing a massive amount of material in front of glaciers, especially for wide ones such as the Thwaites.

There are also a plethora of engineering matters that need to be addressed. First, the foundations for the walls would need to be well-protected. This protection could take the form of boulders and concrete elements or additional sills built in front of or at an angle to the main sill, to redirect currents that could compromise its effectiveness, according to Arenson. Secondly, the seafloor on which the walls would be built could be "quite unstable and soft at places so that placing additional fill for a sill may be extremely challenging, potentially causing some local instabilities," Arenson added. Finally, Wolovick states that it may be necessary to build the wall "underneath floating ice shelves, or in the vicinity of dense iceberg melange." These efforts would further complicate what would already be a mega-engineering project.

In addition to the technical aspects of the proposal, there are other issues to consider. There are questions about where the material for the walls would come from, and whether the walls might have detrimental impacts on sensitive Antarctic sea floor environments.

However, despite the many challenges ahead, the time is right to take action. As climate change progresses and glaciers around the world continue to melt, global sea levels creep up. One recent study projects an increase of 80 to 150 cm (close to five feet) by 2100, which would flood land currently inhabited by 153 million people. This geoengineering proposal will by no means solve every problem associated with climate change, such as unabated human emissions of greenhouse gases, but with millions of people living along the coasts, it could provide humanity with something always in short supply: time.

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