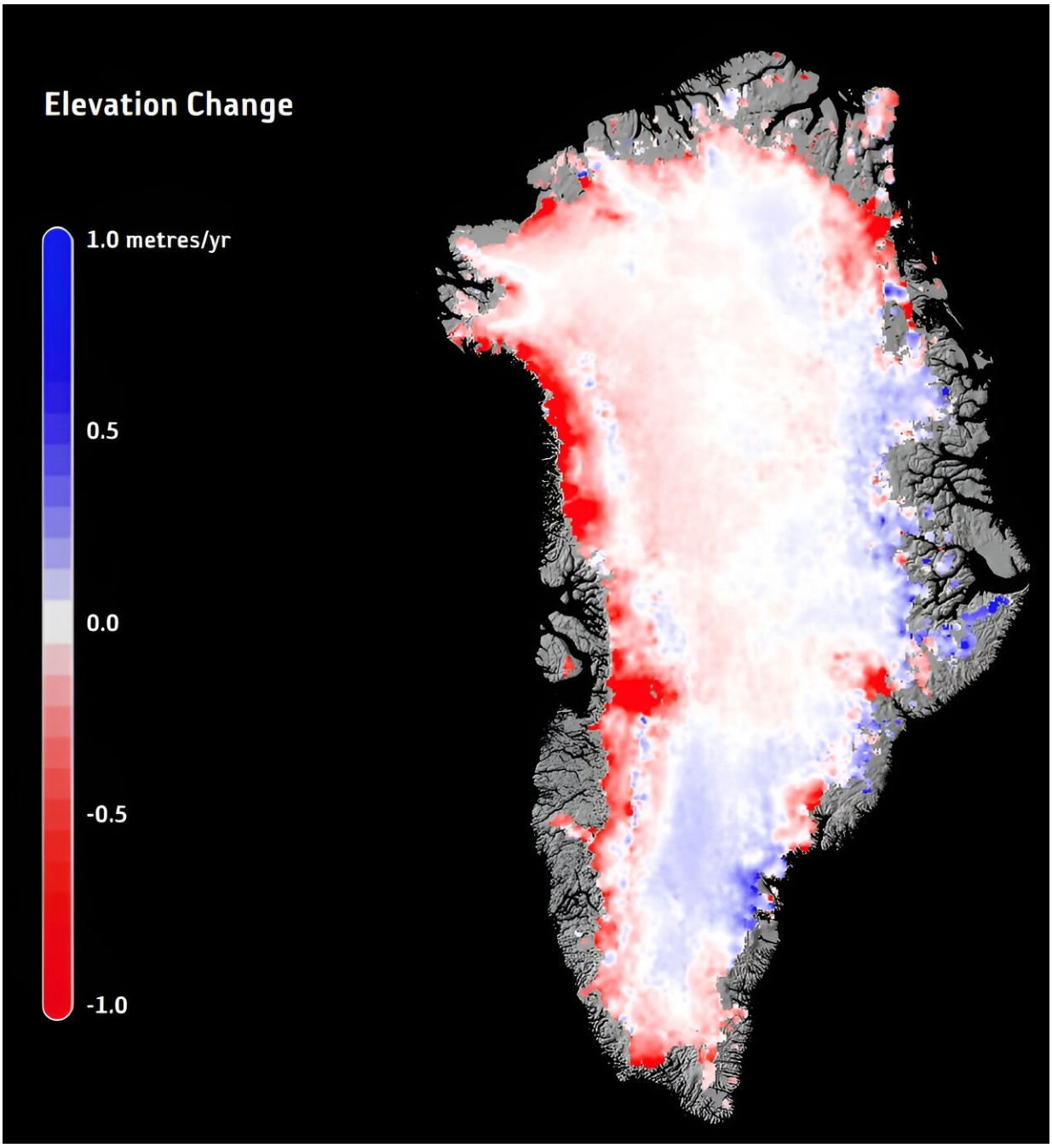
Can geoengineering protect Earth's icesheets?

July 31 2024, by Evan Gough



This image shows the change in Greenland ice thickness in just one year, 2015. Almost 10 years have passed, Greenland is still melting, and our GHG emissions are still rising. Is it time to use geoengineering to stall the melting? Credit: ESA/Planetary Visions

It's time to take a thorough, more serious look at using geoengineering to protect the planet's icesheets, according to a group of scientists who have released a new report examining the issue. Glacial geoengineering is an emerging field of study that holds some hope for Earth's diminishing glaciers and ice sheets.

Collectively, glaciers and icesheets are called the cryosphere. The cryosphere plays an important role in the water cycle. They're massive water reservoirs that release their water into rivers, lakes, and oceans when the temperature rises. They cover about 10% of the Earth's land surface and provide agricultural water for about 2 billion people.

There's a dire consequence to not protecting Earth's glaciers and icesheets: global sea rise. The IPCC (International Panel on Climate Change) doesn't pull punches when it comes to our planet's melting ice sheets and glaciers. In their Special Report on the Ocean and Cryosphere in a Changing Climate, published in 2019, the IPCC said that global mean sea levels would probably rise between 0.95 feet (0.29m) and 3.61 feet (1.1m) by the end of the 21st century.

Those estimates may actually be on the conservative side, but they still put vast numbers of people in small island states and coastal cities right in the crosshairs of the unfolding melting cryosphere disaster.

A team of five scientists has released a new white paper on glacial geoengineering, "Glacial Climate Intervention: A Research Vision." In it, they argue that glaciological research should focus on ice-sheet preservation to slow down or prevent sea level rise. They write that we need to determine "if engineered interventions applied to critical icesheet regions may reduce sea-level rise."

In their paper, they focus on icesheets rather than glaciers. The world's glaciers are remote, each one is relatively small, and they're spread

around the world. They're not realistic targets for geoengineering. Conversely, Antarctica and Greenland feature massive, continent-sized icesheets that are accessible and are the main source of meltwater that is raising sea levels.

The authors don't advocate for any particular geoengineering intervention. Instead, they present their vision of a vigorous effort to determine which interventions should or could be used.

"Everyone who is a scientist hopes that we don't have to do this research," said Douglas MacAyeal, a professor of geophysical sciences with the University of Chicago who has studied glaciers for nearly 50 years and is a co-author on the white paper. "But we also know that if we don't think about it, we could be missing an opportunity to help the world in the future."

Every major ice sheet and glacier system in the world is undergoing critical changes. As their melting accelerates, they'll contribute more and more water to the oceans. The global sea level has already risen by about 8 or 9 inches since the late 1800s, and the rise will only accelerate.

Most of the water will come from regions in the Antarctic and Arctic, basically Greenland and the Antarctic Ice Sheet, a continental ice sheet that covers almost the entirety of Antarctica. Could limiting the melt in these key regions help slow the global sea level rise? How could it be achieved, and what undesirable effects would the effort have on ecosystems? According to the authors of the report, it's time to tackle these questions seriously and with a sustained effort.

In the last couple of decades, scientists have focused on two questions about the melting cryosphere. One asks what processes cause the loss of ice that contributes to global sea rise, and the other asks how climate change is driving or affecting these processes. For decades, glaciologists

have been informally discussing what interventions might be possible to slow down sea rise.

For the authors of this report, it's time to take the next step and ask what can be done. "We cannot stop sea-level rise, but we may be able to slow it while humanity makes the necessary shift away from carbon-based energy systems," they write.

Their white paper is organized around three questions:

- What natural processes might limit ice-sheet deterioration?
- Are there human interventions that could enhance these natural processes, thereby slowing sea-level rise?
- What is our window of opportunity for implementing these interventions?

The white paper is a research agenda aimed at answering these questions. It goes beyond geoengineering and also considers "social license and justice, governance, ethics, and the wisdom of any research into glacial climate intervention."

There are two prominent approaches to limiting melt and global sea level rise (GSLR.) One involves intervening in the ocean's heat transport mechanisms, and the other involves basal-hydrology interventions. Basal-hydrology refers to the conditions at the base of the ice. Another less prominent approach involves intervening by pumping seawater.

The issue is extremely complex. In Antarctica, for example, different ice sheets respond differently to warmer temperatures. They have different structures and contact the ocean in different ways. Some are relatively protected from the melt, while others are in far more peril. No single type of intervention will succeed.

In some cases, geoengineering would have to prevent warm water from reaching the underside of ice shelves. This could be done by constructing sediment berms on the ocean bottom or placing fibrous curtains there. Colder water could be directed toward the underside of the shelves instead, limiting and delaying the melting. This could also thicken and lengthen the ice shelves.

This is an example of ocean heat transport interventions. "This would stabilize the ice sheet and slow the rate of collapse," the authors explain. Modeling studies show that modest curtains covering only a fraction of the water column could have an outsized effect on melting.

The obvious question is, what happens to the ecosystem? It would be a tough sell if the environmental destruction was severe.

Basal hydrology interventions are aimed at the base of ice sheets where they contact the ground. Ice streams are fast-flowing streams that discharge ice and sediment into the ocean from under an ice sheet and contribute to GSLR. In the past, some of them have stopped on their own. The Kamb Ice Stream suddenly shut down about 200 years ago from natural causes.

Could we recreate those causes with geoengineering? "Better understanding of why the Kamb Ice Stream shut down of its own accord will tell us whether there are human interventions that could make it happen again," the authors write.

The authors point out that the Kamb Ice Stream likely slowed down because it lost water content. Water acts as a lubricant that allows the streams to flow faster, increasing the melt.

One idea is to drill a field of holes through ice sheets and extract water from the basal region. That would reduce the lubrication effect and slow

down the ice streams. "These holes would be used to extract either water or heat from the subglacial system, possibly using passive, unpowered thermosiphons," the authors explain. Another similar method would involve creating channels under the ice sheet where water could drain away.

One advantage to these types of basal hydrology interventions is that there could be less ecological impact.

There are a handful of other potential interventions that haven't been as well studied. For example, windbreaks could be employed on the surface to help snow build up on the top of ice sheets. We could place reflective materials on the surface of ice sheets to reduce ablation. Another one is to use cables and anchors to prevent ice sheets from breaking up. Yet another one is to pump seawater onto the surface of ice sheets during winter to create more ice.

"It will take 15 to 30 years for us to understand enough to recommend or rule out any of these interventions," said co-author John Moore, a professor with the Arctic Center at the University of Lapland.

There are many uncertainties. Altering the flow of water with berms or curtains could have unintended consequences elsewhere that might work against our geoengineering efforts. Basal hydrology interventions could cause the grounding line, the place where subsurface ice meets rock, to retreat. Pumping seawater onto the top of an ice sheet could create or exacerbate existing fractures, hastening the sheet's breakup.

The authors acknowledge how uncertain this all is. "All glacial climate interventions are scientifically new and not yet proven to work, and are technically and socially complex projects with multiple uncertain impacts," they write. It'll take a coordinated and committed effort to remove these uncertainties.

There are arguments against the effort, of course.

This type of research could end up disincentivizing other research into reducing GHG emissions. But for the authors, reducing emissions is always the top priority. "We can never say often enough that that is the first priority," said Moore.

Some say it might create an overreliance on technological solutions. Others argue that there might be too many unintended and adverse reactions.

There might be a moral hazard, too, with the actions of one generation imperiling the next. That's already happening with GHG emissions. Another argument against geoengineering points out that it will be the developed nations that undertake it, and they may optimize the effort for their own desired outcomes, ones that benefit them unevenly. An additional argument is that the population of scientists is small and that if they're the only ones discussing this, valuable perspectives might be missed.

In the end, the authors are calling for a vigorous debate on all aspects of the issue, not just the engineering methods themselves. "We need vigorous public debate of potential benefits and harms, informed by research that creates evidence regarding those concerns," they write. "We need to know and discuss how such interventions will affect people across the globe, natural systems, perceptions of "nature," and pressure to reduce anthropogenic climate change."

They say that the overall effort is to engage as many stakeholders as possible in discussion and research.

Our carbon emissions are still climbing. The rate isn't the same across countries and economies because more developed economies have more

resources to combat emissions. But ultimately, that doesn't really matter. The problem is global, and the solution will be, too.

It's possible that the world's glaciers and ice sheets have a tipping point. We may have already reached it. "Humans have already released so much carbon dioxide that we are seeing profound changes in every glacier system around the world," said MacAyeal. "Many of these are likely to have a tipping point where even if we were to stop emitting all carbon worldwide tomorrow, the system would still collapse. And we are not in a position now to say that we haven't already crossed those points."

The detailed approach that the authors recommend will take time to develop. If we implement these types of solutions, it will take time to see any benefits. As that time passes, ice sheets will continue to melt, and the seas will continue to rise. There's a sense of panic, but that can't drive our decisions. "Without research, we cannot know if there are viable interventions," the authors write. Without research we also can't know if there are tipping points.

This is another familiar refrain from scientists, one in a long line of refrains that were unheeded at first and pushed aside in the face of more pressing, short-term concerns. We've wasted time and have to stop wasting more. "Without the concurrent practical planning, engineering, and consultation, there will be an unconscionable delay in action, should there be a solution," the authors explain.

They envision a large-scale expansion of the science and engineering behind glaciers and the measures we can take to slow their melt.

"We are proposing such an ambitious program because we see examining options for reducing sea-level rise from icesheet melting as a global imperative," they write.

"Our argument is that we should start funding this research now so that we aren't making panicked decisions down the road when the water is already lapping at our ankles," said MacAyeal.

More information: Glacial Climate Intervention: A Research Vision. climateengineering.uchicago.ed … -Research-Vision.pdf

Provided by Universe Today

Citation: Can geoengineering protect Earth's icesheets? (2024, July 31) retrieved 31 July 2024 from https://phys.org/news/2024-07-geoengineering-earth-icesheets.html