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Historic Greenland Melt Is a “Glimpse of the Future”

A major heat wave pushed melting into areas of the ice sheet that normally stay frozen year-round

By Chelsea Harvey, E&E News on August 2, 2019

Meltwater ponds atop the ice in northwest Greenland on July 30 near the edge of the ice sheet. While summer melt along the periphery of the ice sheet is typical, melting that day covered a much higher area than usual because of a heat wave. Credit: NASA

Greenland is in the midst of one of its strongest melting events on record, as a major heat wave—the same one that scorched much of Europe last month—grips the Arctic.

Ice sheet experts have been keeping careful watch as the event unfolds, taking note of its extraordinary progress. Throughout July, Greenland lost an estimated total of 197 billion metric tons of ice, researcher Ruth Mottram of the Danish Meteorological Institute tweeted early Wednesday morning. That day, the largest melt day of the month, the institute estimated that more than half the ice sheet was experiencing some level of surface melting, and about 10 billion tons of ice was lost in a single day.

The melting has reached parts of Greenland that typically stay frozen all year round. According to glaciologist Luke Trusel of Pennsylvania State University, melting has now been recorded at Summit Station, a high-altitude research station at the peak of the Greenland ice sheet. It's 10,500 feet high.

"That's an exceptional event because this is the so-called dry snow zone," he told E&E News. "And it's named that because it just doesn't melt there."

The last time ice loss occurred at such an altitude was in 2012, which was also the last time Greenland experienced a melting event on a similar scale to this summer. The time before that was in 1889, Trusel said.

Before that, it had been nearly 700 years.

Concerns about the melting ice sheet are tied mainly to its effects on global sea levels. Sea-level rise is happening at a rate of about 3.5 millimeters per year, and research suggests the process is speeding up, in part because of increasing ice loss in Greenland. The Greenland ice sheet is currently thought to be responsible for about a third of global sea-level rise.

On that note, while extreme surface melt events in Greenland may cause temporary increases in the amount of meltwater flowing into the ocean, it's the long-term ice sheet trends that are really meaningful for scientists monitoring global sea-level rise.

Even so, temporary extreme melts can cause certain changes on the ice sheet that may affect both future rates of melting and the amount of water that actually makes it into the ocean. And the more frequently they occur, the more dramatic these effects might be.

Vicious cycles

When large amounts of surface melt occur in short periods of time, they can lead to certain self-reinforcing processes that cause even more melting.

Much of the Greenland ice sheet tends to be covered by a layer of bright, reflective snow. High levels of melting can cause the snow to thin out or recede, exposing the ice or sometimes bare rock beneath it. These exposed layers are darker in color than the fluffy, white snow, which means they absorb more heat. When this happens, they can cause even more melting.

A recent paper, published in March in *Science Advances*, warned of the effects this feedback process may have on the ice sheet. It found that the position of the snowline in any given year has a major effect on the amount of meltwater produced. It also suggested that as temperatures continue to rise, this effect may become even more pronounced in the future.

Current models don't always accurately capture the position of the snowline during high melt years, the authors added. That means they may not always be accurately projecting the amount of meltwater the ice sheet will produce in the future, or how much will end up running off into the sea.

Similarly, large amounts of meltwater sometimes form pools, or ponds, on the surface of the ice sheet. These dark-colored liquid ponds can also contribute to more heat absorption and more melting, said Lauren Andrews, a NASA ice expert.

"So you can have this feedback where you have a melt event that modifies the surface," she told E&E News. "Then the melt event will be even stronger because of changes to the surface albedo [reflectivity] later on."

They may also have the potential to stress the ice sheet in other ways, she added. Sometimes, cracks will open up in the bottom of the lakes, allowing the water to drain suddenly downward through the ice sheet. In the past, some researchers have suggested that the water may help to lubricate the bottom of the ice sheet once it reaches the bedrock, increasing the rate at which glaciers slip and slide over the ground and potentially causing more ice to flow out into the ocean.

According to Trusel, the Penn State researcher, recent studies have challenged this idea. So, at the moment, there's still some uncertainty about how strong the effect actually is.

But he added that the draining water could have other effects on the behavior of glaciers, for instance, by raising the temperature of the ice as it trickles through, or by mingling with ocean water at the edge of the ice sheet and helping to melt the ice from the bottom up.

More meltwater, more runoff

Not all the meltwater that forms on the ice sheet actually makes it into the ocean, meaning not all of it contributes to sea-level rise. A significant amount trickles down into the spongy snow, or "firn," on top of the ice sheet and becomes trapped.

"With every winter the firn capacity builds up as new fresh snow accumulates at the top, and this new fresh snow can absorb more water in the coming summer," said Baptiste Vandecrux, a postdoctoral researcher with the Geological Survey of Denmark and Greenland.

But some research has suggested that the firn can fill up too quickly during years with high melt rates. When this happens, the meltwater can refreeze into hard layers of ice over the winter, forming an impenetrable barrier just below the surface. During subsequent melt seasons, there's not as much room for new meltwater to trickle in, and a greater amount ends up running off the surface of the ice into the ocean.

A 2016 study in *Nature Climate Change*, focusing on an area of West Greenland, found that the region's firn has already lost much of its ability to soak up new meltwater. The research suggests that the exceptional melting in 2012, along with another strong melting event in 2010, are probably at least partly to blame.

"The fact that there is so much ice now in the firn certainly increases the runoff, compared to a hypothetical situation where the firn would be healthy," said Horst Machguth, an ice sheet expert at the University of Fribourg and the lead author of that study.

Another study published in March of this year in *The Cryosphere* also focused on Western Greenland. It found that the amount of open space in the region's firn has decreased by nearly a quarter since the late 1990s.

It's an important trend to take note of, especially in high-melt years like this one, according to Vandecrux, who led the study.

"We need to understand exactly what is our storage capacity—what is the firn's storage capacity at a precise time—so that we know if certain regions will proceed to run off or not," he told E&E News. "As we're losing this storage capacity, more and more regions of the ice sheet will contribute to runoff and sea-level rise."

In general, these types of extreme melting events are prime learning opportunities, according to Trusel. Summers like this one are clear benchmarks of the progress of climate change, but they also provide the chance to observe and study the effects of melt rates that, while uncommon now, may be the norm in the coming decades.

"It's really a glimpse of the future," he said. "What was once exceptional is becoming more frequent today."