How is the ice in Greenland melting?

Authors: Michael Wood, Eric Rignot, Ian Fenty, Joshua K. Willis, and others
Associate Editors: Lois Flounders and Lindsay Martin

Abstract

The island of Greenland is almost completely covered in ice. But since the 1990s, the sheet of ice has been melting. This makes the sea level rise, causing problems for people and animals around the world who live on the coast.

We wanted to find out exactly how the Greenland ice sheet is melting. Does the ocean affect how quickly it melts? Could it be melting Greenland’s ice from below?

Introduction

What do you think of when you imagine Greenland? Despite the name, Greenland is almost completely covered in ice – about 1.7 million sq. kilometers/656,373 sq. miles of it! You could fit Florida into the Greenland ice sheet 10 times, with space to spare. But unlike Florida, this island nation is home to polar bears, walruses, and even reindeer.

Ice sheets form over thousands of years. Snow that falls in the winter, but doesn’t melt in summer, creates a layer of ice that grows thicker and thicker. But ice sheets don’t stay in the same place. In fact, they’re constantly moving, slowly flowing downhill. When the ice sheet meets the sea, it makes glaciers. As the ice moves down valleys, it eventually melts or breaks off as an iceberg. For a long time ice sheets were stable. The amount of ice lost to the sea was the same as the amount gained from snow each year. So the ice sheet stayed the same size. But since the 1990s, the Greenland ice sheet has been getting smaller. That’s partly because warmer air is melting the ice from above. But also, the glaciers are flowing faster down the valleys, adding more ice into the ocean.

Since the ocean has become warmer, we posed the hypothesis that the ocean is causing glaciers to flow faster. But we needed more data to investigate how ocean warming is affecting the whole ice sheet. In 2015, we started a special NASA mission called Oceans Melting Greenland (OMG) to find out more. We used our new data to answer our questions on how ocean warming affects the Greenland ice sheet.
Methods

We worked with NASA ships (Figure 1) and aircraft to survey 226 glaciers all around the coast of Greenland. We gathered more data on things like ocean temperature, the amount of salt in the water, and how much the glaciers were thinning.

We carefully measured the depth of the water from the seafloor to the bottom of the glaciers. We then put the glaciers in six different categories based on this data and information on the ocean temperature (Figure 2):

A. Glaciers in deep valleys with warm water below.
B. Glaciers that break up into icebergs on an underwater hill.
C. Glaciers in shallow fjords with cold water below.
D. Glaciers with long pieces that haven’t broken off as icebergs.
E. Glaciers that were already melting in the 1990s.
F. Uncategorized glaciers – where we still didn’t have enough data.

We could then look at how the shape and depth of the seafloor under the glaciers affected how quickly they melted.

We combined all of this new data from our NASA mission with ocean modeling to study exactly how much ocean warming is causing ice sheets to get smaller.

Results

With the new data, we can now be certain that the Greenland ice sheet is melting from below by the warming ocean. It’s also melting from above (like an ice cube melting outside on a hot day). About 50% of the ice loss came from above, and 50% caused by melting from below.

From our temperature measurements, we see the warm waters are at the bottom of the ocean while the cold water is at the top – much different than what you find when swimming in a lake with your family and friends!

We found the ocean melted the glaciers in category A the most often. These glaciers are the deepest and are affected the most by the deep, warm water. Out of the 226 glaciers we surveyed, 74 were in category A. Together, these glaciers caused nearly half of Greenland’s ice loss between 1992 and 2017. This is because the warm and salty water melted the ice from underneath and caused the ice to flow faster.

The shallower glaciers in categories B and C only caused about 15% of the ice loss. This is because the warmer water wasn’t in contact with these glaciers.

In addition to the glaciers in Category A, which other category has glaciers in contact with warmer water?
Discussion

The Greenland ice sheet has been unstable (fragile) since the 1990s. **Glaciers are melting more and more quickly, and the ice sheet is becoming smaller and smaller.** Between 1992 and 2017, Greenland’s glaciers lost the equivalent (in weight) to 650 million African elephants!

A lot of this melt was because of a sudden 1.9°C/35°F increase in ocean temperature between 1998 and 2007. But even when ocean warming paused between 2008 and 2018, the glaciers kept melting. The glaciers had already become thinner, and the ice sheet never went back to its stable (stronger) shape.

Our results are really important to figuring out how the Greenland ice sheet will look in the future. How quickly will it melt as the climate and ocean get warmer? How much will this cause the sea level to rise? As we get more data, we’ll be able to understand this even better and work out ways to adjust to climate change.

Conclusion

The oceans are getting warmer because of climate change. But what exactly is climate change? And how can you help prevent the oceans from rising more? **Our climate becomes warmer when greenhouse gases are released into the atmosphere.** Basically, these gases trap hot air and they’ve been increasing in our atmosphere for years. Lots of greenhouse gases come from industries like meat and dairy and from manufacturing (making things, like clothes and packaging).

There are many little things that you can do in everyday life to reduce the amount of greenhouse gases ending up in the air. You can:

- Reduce, reuse, and recycle. About to throw something away? Think again! Could you make something instead? You can also shop in secondhand shops rather than buying new. This reduces the amount of greenhouse gases released from manufacturing new items.
- Eat less meat. The meat and dairy industry cause a lot of climate warming since the machinery produces carbon dioxide and cow manure releases methane. Both are greenhouse gases!
- Talk about climate change with your friends and family. Ask them to do the same!

Glossary of Key Terms

- **Data** – a collection of information gathered by observation, questioning or measurement. Science wouldn’t exist without data!
- **Fjord** – a long, narrow body of water with steep sides or cliffs. Fjords are created by a glacier moving over land.
- **Glacier** – a slowly moving river of ice formed by lots of snow piling up over thousands of years.
- **Hypothesis** – an educated guess, or a guess you make based on information you already know.
- **Modeling** – in science, a model is a representation of an idea that can’t be experienced in real life. In this study, we modeled ice sheet melt by the ocean and we were able to calculate how strong the melting was using the data to make a model.
- **Stable** – an ice sheet is stable when it is gaining as much ice from snow as it is losing to the sea (melting).
- **Survey** – in science, a survey is a research method used to collect data about a specific thing. In this study, we used fancy technology on ships and aircraft to survey the seafloor.
Check your understanding

1. What’s the difference between a glacier and an iceberg?

2. Describe the two ways that Greenland glaciers are melting.

3. Why did the Greenland ice sheet keep melting from 2008 to 2017 even though ocean warming paused?

4. We suggested some small things anyone can do to help slow climate change. Can you think of other ways you can help to prevent the oceans from warming and the ice from melting?

REFERENCES


Acknowledgment: This article’s adaptation was supported by the Goggio Family Foundation.