A once-stable glacier in Greenland is now rapidly disappearing

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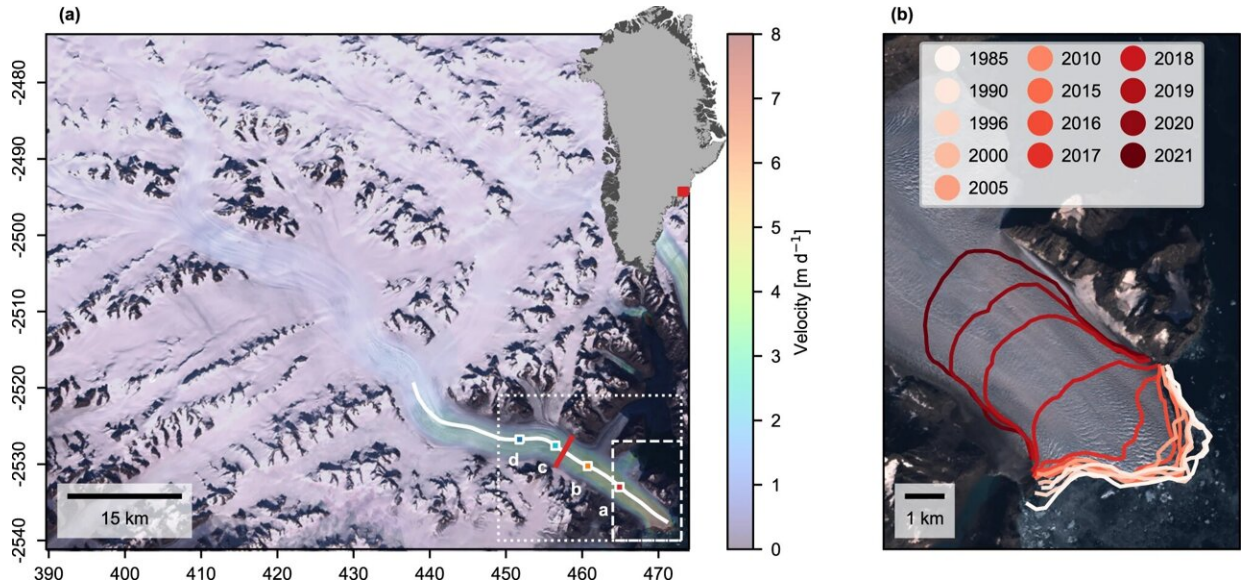

Location of Steenstrup. **a** Location and speed of KIV Steenstrup Nordre Bræ. The color scale indicates the mean 2016 velocity from ITS_LIVE velocity pairs. Colored squares a–d indicate locations used to sample velocity time series in Fig. 2, the white line marks the centreline used to derive profiles in Fig. 3, and the red line marks the flux gate used for ice discharge calculation. The dotted box marks the extent of Fig. 4, and the dashed box marks the extent of panel (**b**). The background is a composite of median Sentinel-2 RGB pixel values from May to October 2016. Coordinates in unit kilometers of NSIDC Polar Stereographic North. Inset shows the location of Steenstrup within Greenland. **b** Changing front position of Steenstrup since 2016, identified using GEEDiT[82]. Credit: *Nature Communications* (2023). DOI: 10.1038/s41467-023-37764-7

As climate change causes ocean temperatures to rise, one of Greenland's previously most stable glaciers is now retreating at an unprecedented rate, according to a new study.

Led by researchers at The Ohio State University, a team found that between 2018 and 2021, Steenstrup Glacier in Greenland has retreated about 5 miles, thinned about 20%, doubled in the amount of ice it discharges into the ocean, and quadrupled in velocity. According to the study, such a rapid change is so extraordinary among Greenland ice formations that it now places Steenstrup in the top 10% of glaciers that contribute to the entire region's total ice discharge.

The study was published today in *Nature Communications*.

The Steenstrup Glacier is part of The Greenland Ice Sheet, a body of ice that covers nearly 80% of the world's largest island, which is also the single largest contributor to global sea rise from the cryosphere, the portion of Earth's ecosystem that includes all of its frozen water. While the region plays a crucial part in balancing the global climate system, the area is steadily shrinking as it sheds hundreds of billions of tons of ice each year because of global warming.

Over the past few decades, much of this loss has been attributed to accelerated ice discharge from tidewater glaciers, glaciers that make contact with the ocean. Many glaciologists believe that this recent uptick in ice discharge can be explained by the intrusion of warming waters that are being swept from the Atlantic into Greenlandic fjords—critical oceanic gateways that can impact the stability of local glaciers and the health of polar ecosystems.

The research team aimed to test that theory by examining a glacier in the southeastern region of Greenland called K.I.V Steenstrups Nordre Bræ, an entity more colloquially known as the Steenstrup Glacier.

"Up until 2016, there was nothing to suggest Steenstrup was in any way interesting," said Thomas Chudley, lead author of the study, who completed this work as a research associate at the Byrd Polar and Climate Research Center. Chudley is now a Leverhulme research fellow at Durham University in the UK.

"There were plenty of other glaciers in Greenland that had retreated dramatically since the 1990s and increased their contribution to sea level rise, but this really wasn't one of them."

As far as scientists knew, Steenstrup had not only been stable for decades but was generally insensitive to the rising temperatures that had destabilized so many other regional glaciers, likely because of its isolated position in shallow waters.

It wasn't until Chudley and his colleagues compiled observational and modeling data from previous remote sensing analyses on the glacier that the team realized Steenstrup was likely experiencing melt due to anomalies in deeper Atlantic water.

"Our current working hypothesis is that ocean temperatures have forced this retreat," Chudley said. "The fact that the glacier's velocity has quadrupled in just a few years opens up new questions about how fast large ice masses can really respond to climate change."

In recent years, glaciologists have been able to use satellite data to estimate the potential volume of glacial ice stored at the poles and how it might affect current sea levels. For instance, if the Greenland Ice Sheet were to melt, Earth's sea levels could rise by nearly 25 feet. In contrast, if the ice sheet in Antarctica were to fall apart, it's possible that oceans would rise by nearly 200 feet, Chudley said.

While Greenland and Antarctica would take centuries to collapse

completely, the global cryosphere has the potential to cause sea levels to rise about six feet this century if the West Antarctic Ice Sheet undergoes collapse.

As around 10% of the planet's population lives in low-lying coastal zones, Chudley said that any significant rise in sea level can cause increased risk to low-lying islands and coastal communities from storm surges and tropical cyclones.

In the United States, sea level rise poses a particular risk to coastal cities in places like Florida or Louisiana, Chudley said. But that doesn't necessarily mean it's too late to stop such a future from happening. If climate policies evolve rapidly, humans might have a chance at halting the worst of sea level rise, Chudley said.

Overall, Steenstrup's unique behavior reveals that even long-term stable glaciers are susceptible to sudden and rapid retreat as warmer waters begin to intrude and influence new environments.

While the research says continued scientific observation of the Steenstrup Glacier should be a priority, it concludes other similar glaciers also deserve attention because of their potential to retreat due to warming waters.

Understanding more about these interactions could provide key insight into how glaciers thrive in other locations around the world and even become an indicator of how these environments might change in the future.

"What's happening in Greenland right now is kind of the canary in the coal mine of what might happen in West Antarctica over the next few centuries," Chudley said. "So it would be great to be able to get into the fjord with real on-the-ground observations and see how and why

Steenstrup has changed."

More information: T. R. Chudley et al, Atlantic water intrusion triggers rapid retreat and regime change at previously stable Greenland glacier, *Nature Communications* (2023). DOI: 10.1038/s41467-023-37764-7