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## Arctic: On the trail of the next glacier break with underwater microphones

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The Hornsund is the southernmost fjord in Svalbard. Surrounded by rugged mountain peaks, table mountains and impressive glacier fronts, it is one of the most varied and beautiful in the Svalbard Archipelago. The branched bay extends 25 kilometers inland. As everywhere in the Arctic, the effects of global warming can also be seen very clearly here. A closed winter ice cover is rarely found and the fronts of the tidal glaciers are retreating further and further.

Explore here [Grant Deane](#) and [Hari Vishnu](#) how the melting of the glaciers can best be observed over the long term. Because a large part of this takes place in seawater under the ice. Warmer water thaws the glacier tongues and dissolves them from below so that they float up. As a result, large blocks of ice break off with a tremendous roar and slide into the water of the Hornsund.

Deane is an oceanographer at [Scripps Marine Research Institute](#) in San Diego, California, and Vishnu is an expert in underwater acoustics and machine learning at [National University of Singapore acoustic research laboratory](#). Your base is that [Polish polar research station in Isbjørnhamna](#) on the north bank of the fjord entrance. She belongs to [Geophysical Institute of the Polish Academy of Sciences](#) that supports the two. From here, the researchers started their measurement campaigns in a rubber dinghy on the edge of the glaciers Hans, Paiertl and Mühlbacher on the north bank and the Samarin glacier on the south bank.

### What exactly happens when the glaciers melt?

The Arctic is a real hotspot for climate change. Nowhere else is the earth feverish as it is here. Between 1971 and 2019 alone the surface temperature around the North Pole rose three times more

between 1771 and 2012 along, the surface temperature around the North Pole rose three times more than the global average.

If the sea ice melts, it can no longer reflect the rays of the summer sun back into space. The exposed, dark water surfaces absorb the heat and thus accelerate global warming, but not the rise in sea level. However, when the inland glacier masses on Svalbard and Greenland melt, the world's oceans rise. In the central ice sheet of Greenland alone, there is enough water stored for a worldwide sea level rise of seven meters.

But ice and marine researchers have not yet fully understood what actually happens when the tidal glaciers melt. Satellite images only show an image of the surface – and only if there are no clouds to obscure the ice flows. What happens in and under the glacier tongues has so far remained hidden.

## Listen to the crack of the glaciers

Precisely this is increasingly the domain of acousticians. Underwater microphones, known as hydrophones, are already registering the creaking and cracking when a block of ice on the front of a glacier loosens and rushes into the sea. However, only rough conclusions can be drawn from this about the loss of ice.

But the scientists are on the trail of even more promising sounds. There are [Cracking noises \(audio sample – sound on\)](#) in thawing ice in different volumes and with varying frequencies, which are propagated under water. With the right measurement methods, they could provide more precise information on how and when a glacier front begins to become unstable before an ice block breaks off.

The cause of the cracking are air bubbles that were trapped far inland a long time ago during the formation of glacier ice. These are the same bubbles in which chemists measure the greenhouse gas concentrations of past geological times in the solid, kilometer-thick ice sheet in Central Greenland, for example. Under the load of the superficial re-formation of ice in flowing glaciers, the bubbles come under pressure, which can be up to 20 atmospheres. If, years later, the tongue of ice slides into the sea, the bubbles burst.

“We have observed that the noise generated by melting glacial ice tends to increase when the water temperature rises,” explains Deane, who has devoted his research life to bubbles of all kinds, whether in the crests of sea waves or trapped in the ice .

300 meters from each of the four abrupt edges, the two researchers sank about ten hydrophones into the water, one every two meters. “Once we have a better understanding of sound generation and how sound travels down the glacier bay, we plan to use a single sensor on the ocean floor,” explains Deane. An algorithm would then be sufficient to convert the noises captured on the ground to the other depths.

“We assume that the terminus, the end of the glacier tongue, melts faster in warmer water, which means that the bubbles also escape faster into the ocean and make more noise,” explains Deane.

## Work on a network of long-term sound measuring stations

Satellite images show where the end of a glacier is, but not how much of it actually melts in a given time. The combination of forward flow, calving (breaking off larger ice masses) and melting of the glacier determines the position of the end point of a glacier tongue. “Satellite images only provide information about the net result of these effects. In contrast, we want to determine how much the ice is melting.”

Vishnu adds: “Monitoring the noises around the clock gives a better impression of the underwater glacier melt, which accounts for a considerable part of the ice loss.”

The two marine and ice acoustics researchers presented the results of their measurement campaign in the Hornsund Fjord on December 3, 2021 [181. Meeting of the Acoustic Society of America](#) in Seattle, Washington, [for discussion](#).

“But our goal is actually to set up long-term sound measuring stations in front of the glaciers around Greenland and Spitsbergen,” Vishnu describes the future. “However, it is still quite a challenge to develop our system to such an extent that it works accurately and autonomously on such a large scale over a long period of time.” But at least he and Deane have now laid the foundation for this.

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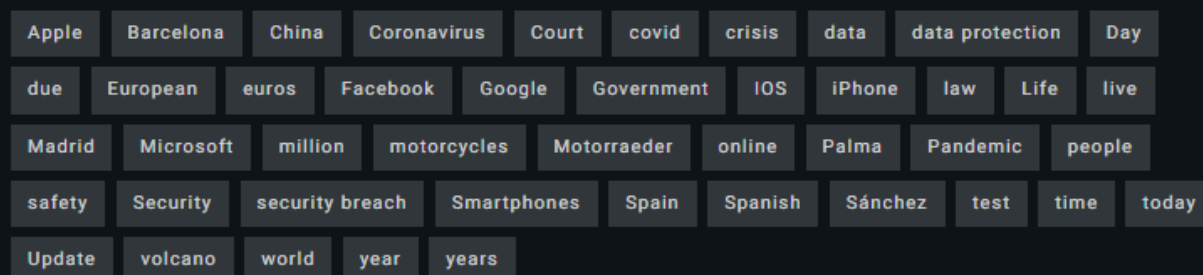
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