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Members of the research team from the National University of Singapore, the Institute of Geophysics in Poland and the Scripps Institution of Oceanography in the US collecting seawater off the Norwegian archipelago of Svalbard in 2019. The researchers have gone on several expeditions to take measurements, but at least one more remains – an important one that will enable them to derive a "formula" that equates the popping sounds of bubbles to the speed of ice melting. PHOTOS: MANDAR CHITRE

Sound of melting glaciers could help predict sea-level rise

Dr Mandar Chitre in front of the Hansbreen glacier during a mission to Svalbard in 2019.

MORE THAN MEETS THE EYE

Traditionally, researchers try to measure glacial melt by looking at satellite photographs to see how much the glacier is receding, but this often doesn't give you a complete picture since most of the melting actually happens underwater.

DR MANDAR CHITRE, head of the Acoustic Research Laboratory at the National University of Singapore's Tropical Marine Science Institute.

NUS researchers part of team aiming to measure rate of glacial melt from acoustic clues

Cheryl Tan

A colossal chunk of ice breaks from a glacier and plunges into the ocean, its thunderous splash punctuating the seemingly quiet and frigid landscape of the Arctic.

The glacial ice continuously pops, crackles and bubbles underwater – almost like the sound of a frying egg – as it gradually turns into meltwater.

This process usually occurs in the summer months from May to August and can be difficult to measure as much of the melting occurs underwater, said Dr Mandar Chitre, head of the Acoustic Research Laboratory at the National University of Singapore's (NUS) Tropical Marine Science Institute.

Warming seas, which trap more heat from greenhouse gases like carbon dioxide, have led to the world losing some 21 per cent of its glaciers over the last two decades.

Through analysis of two decades' worth of satellite data, a recent study has shown that even if the world were to limit its temperature rise to 1.5 deg C, it could still lose about half of its glaciers.

This could go up to 68 per cent if global warming continues at its current rate, with a temperature increase of 2.7 deg C.

With more glaciers disappearing over the century, the implications for sea-level rise could be all the more drastic for low-lying island states like Singapore.

But how quickly is the ice melting, and how will this affect the extent of sea-level rise?

To understand this, Dr Chitre embarked on a mission about five years ago – with researchers from the Institute of Geophysics in Poland and the Scripps Institution of Oceanography in the United States – in the Norwegian archipelago of Svalbard to eavesdrop on the secret language of oceans: the sound of melting glaciers.

"When glaciers were formed thousands of years ago, they had air bubbles trapped in them. Because of the weight of the snow and ice above them, the air bubbles are under high pressure and stay trapped inside the ice," Dr Chitre said.

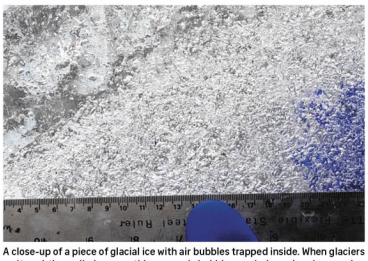
"But when the glaciers melt and the walls become thinner, the bubbles explode through the glacier wall as it is no longer able to contain the pressure, thus making the popping noise."

Dr Chitre and the team are analysing the sounds of these popping bubbles to see if they provide clues to the speed of glacial melt.

But the terrain surrounding the glaciers in the warmer months tends to be unstable and dangerous. As these glaciers melt, large chunks of ice often break off and fall into the water as icebergs, he noted.

Therefore, the researchers place underwater microphones, or hydrophones, about half a kilometre from the glaciers to monitor the sounds remotely.

"Traditionally, researchers try to measure glacial melt by looking at satellite photographs to see how much the glacier is receding, but this often doesn't give you a complete picture since most of the melting actually happens underwater," Dr Chitre said.



A close-up of a piece of glacial ice with air bubbles trapped inside. When glaciers melt and the walls become thinner, such bubbles explode and make popping sounds – which may provide clues to the speed of glacial melt.

The acoustic methods being developed are meant to complement other methods such as measuring the salinity of the water around the glacier, he said. "As the glacier is composed primarily of fresh water, when it melts into seawater, the salinity of the water in the glacier bay would be reduced."

But the most accurate way would be to develop a technique to directly measure how much the glacier has melted underwater, which the team is coming close to completing.

They have gone on several expeditions to make sound recordings and other measurements, but at least one more remains – an important one that will enable them to derive a "formula" that equates the popping sounds of bubbles to the speed of ice melting.

This expedition will be the toughest, as they will have to get a lot closer to the glacier than they have previously to take these sound recordings and other measurements.

Dr Hari Vishnu, a senior research fellow at the Acoustic Research Laboratory, will accompany Dr Chitre on the mission.

To prepare for the trip in the summer, Dr Chitre and his colleagues at the laboratory are creating robots that can go close to the glacier to place the sensors and collect measurements.

"We might end up losing some of these robots or sensors, but these are important measurements to make in order to calibrate our model," said Dr Chitre, adding that the robots they design will have to be cost-effective.

Once the formula has been created, the team hopes to take its technology to Greenland, which is known to have a larger mass of glaciers than Svalbard.

But unlike Svalbard, which is largely a land mass, Greenland is primarily a mix of ice sheets and glaciers, making the environment more difficult to work in, Dr Chitre said.

Greenland also has a large proportion of ice melange – a mixture of types of ice, such as icebergs, sea ice and snow – covering the surface of water bodies.

"Ice melange makes its own sound, so being able to differentiate between the sounds of glaciers melting and the noise coming from ice melange is an additional problem we have to address in Greenland," said Dr Chitre.

Greenland is surrounded by major ocean bodies such as the North Atlantic Ocean. Therefore, when its ice sheets and glaciers melt, they contribute directly to sea-level rise.

A 2019 study found that the giant ice sheets of Antarctica and Greenland contain enough water to raise global sea levels by about 70m if they were to all melt.

With this project, the team hopes to contribute critical information on the rate of glacial ice melt to enable predictions of the rate of sea-level rise to be more accurate. This would allow countries like Singapore to better prepare and come up with measures to adapt and guard against future sea-level rise.

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