When we say that something is 'glacial', we usually mean that it's barely moving. But in fact, glaciers are constantly on the move – and a collaboration between Southampton researchers from Geography and Electronics & Computer Science (ECS) is enabling closer study of this movement.

MEASURING THE MELT

"We're trying to understand the response of glaciers to climate change," said Professor of Geography Jane Hart. "We know that as temperatures are warming, glaciers are melting and that water is going into the ocean and causing global sea level rise.

"However, there isn't a linear relationship between rises in temperature and in sea levels due to the multiple factors that determine how glaciers melt."

One key factor, known as subglacial soft bed hydrology, is the slipperiness of the bed beneath the glacier.

"When the sun shines on the glacier's surface, the water goes down to the base of the glacier and allows the glacier to shoot forwards," explained Jane. This subglacial environment is difficult to access – and so it is by closely monitoring movement that scientists can measure slipperiness, seeing how glaciers respond to changes in surface heat.

Delivering data

The invention of GPS offered a new way to measure glaciers' velocity, but installing a GPS system onto a glacier posed many challenges. Traditional systems were too expensive given the high risk of falling into a glacial crevasse. There was also the problem of data-gathering: scientists had to undertake the dangerous task of climbing the glacier to physically recover the sensor.

As this might only happen once or twice a year, any damage to the system would mean large-scale data loss.

Professor of Electronics & Computer Science Kirk Martinez and his team undertook the challenge of designing a system which could meet these challenges: low-cost, able to send live data – and lightweight enough to be delivered into remote environments not by humans but by drone.

"This is the first time that anyone's ever flown a GPS unit onto a glacier using a drone," said Jane. "And we were able to place it in the middle of the glacier where you couldn't physically go."

Above: A drone delivers a sensor to a glacier

Right: The field team working on the sensor

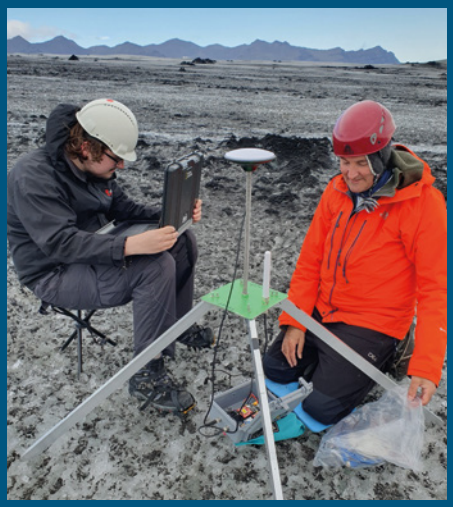
Top: Jane, Kirk and their team on a glacier

"A lot of people are stuck in labs doing theoretical designs and they don't get to experience what the real sun and cold will do to their systems."

Professor Kirk Martinez

The communications systems used to relay the data from far-flung glaciers back to Southampton vary depending on location, from new or custom technologies to the more everyday. "Currently we're using mobile phone networks," explained Kirk, "which are available where we're working because they have 3 million tourists wanting to send TikToks!"

Beyond mitigating the risk of data loss, live data brings other benefits, enabling researchers to perform instant analysis against the latest meteorological data or satellite images. "You can go and dig into the data week to week instead of waiting for the data once per year, which is the traditional way."



Out of the lab

Designing systems to meet real-world needs challenged his team in new ways, Kirk reflected. It wasn't just a matter of creating cutting-edge technology, but of balancing the experimental with the practical. "It's got to work! It can't be so experimental that it crashes and burns on day one.

"This challenges the researchers' methodologies by teaching them what the environment will do to their equipment when it gets out there. A lot of people are stuck in labs doing theoretical designs and they don't get to experience what the real sun and cold will do to their systems."

This exchange of expertise worked both ways, said Jane. "The early career researchers, postdocs and postgrads got to work together and learn different techniques that they wouldn't normally get the chance to learn.

"The electronics people get a chance to learn about real world problems and the geographers get a chance to see different technical aspects."

On-campus collaboration made for a smooth and speedy co-design process, with researchers contributing from Southampton's range of specialisms including mechanical and electrical engineering, satellite imaging and fieldwork. A shared drone kit – available to researchers across the University – allowed the team to borrow otherwise expensive equipment like drone cameras.

Asking new questions

The new technology has the potential to yield fresh insights into how glaciers are responding to climate change. Future applications could include investigating what causes calving (when ice chunks break from the edge of a glacier) and looking at velocity changes associated with lakes on the glacier surface (which can drain and cause sudden speed-ups in movement).

"We know so little about the subglacial environment – you could argue that it's probably one of the least explored environments on Earth," said Jane. "The great thing about the instrumentation is it allows you to ask questions that you wouldn't previously have been able to ask."

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Find out more about the project at glacsweb.org