A **GLIMPSE** of Greenland's future

Greenland is a savagely beautiful place – a land of snow and mountains, home to the largest body of ice in the northern hemisphere. This wild and remote island is going through rapid changes that could affect millions of people across the world. Laurence Dyke explains how he and his colleagues are busy trying to predict the future of the Greenland Ice Sheet.

4:30 am – the alarm goes off, followed by the unforgettable sound of the marine diesel engine coughing into life; sleeping bags rustle as the first heads poke out. Soon everyone is on deck, steaming coffees in hand, watching the sun rise through the coastal mountains as our little boat navigates through the shifting maze of ice. Lifting clouds reveal an overnight dusting of snow on the highest peaks and large plates of fresh ice yield with a crunch under the steel bow. Another busy day of fieldwork is underway.

The GLIMPSE project (Greenland Ice Margin Prediction, Stability and Evolution), led by Professor Tavi Murray, looks at changes in the ice sheet over different timescales to help us understand how it might change in the future. My own work examines how the ice has behaved over thousands of years in response to changes in the climate. Other members of the group are interested in what is currently happening – they monitor the ice sheet and the surrounding oceans using information from satellites, aircraft and field measurements. Back in Swansea, our colleagues combine all our results in computer models which will help predict the ice sheet's future.

Fieldwork is integral to GLIMPSE, and over the last few years we have focused on south-east Greenland, a spectacular region that has lost significant amounts of ice over the last decade.

We spend most of our time working from a small (45-foot) fishing boat skippered by Siggi Petturson, an Icelander with a lifetime's experience sailing these icy waters. Siggi is something of a legend in the local community; he is said to have once killed a large Greenland shark that threatened his crew by jumping in the frigid waters armed only with a knife. Siggi is also the perfect captain and guide, navigating his tough little boat through mazes of ever-changing ice.

From the boat we take detailed oceanographic measurements within the

Laurence Dyke

Tavi Murray

Far left: Sidegletscher, south-east Greenland. Icebergs are born at the large ice cliff where the glacier meets the sea. Left: Filming above the evocatively-named Vikingevig (Viking Cove), south-east Greenland.

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huge iceberg-filled fjords, as well as further out at sea. Southe-ast Greenland is affected by several different ocean currents. At the surface the very cold and fresh East Greenland Current and East Greenland Coastal Current flow southwards, sourced from melting Arctic pack ice and glacier runoff. Below is the much warmer, saltier water of the Irminger Current, an offshoot of the Gulf Stream that comes from the subtropics.

Irminger water snakes its way deep along the edge of the continental shelf far offshore. In places it finds its way across the shelf through deep glacial troughs. The warm, salty water flows into the many fjords where it meets with enormous glaciers, melting and undercutting the ice and making the glaciers flow faster. We are really interested in how changes in these ocean currents can affect the glaciers.

During our field campaigns we travelled along 750km of Greenland's coast, through narrow fjords and between small islands. I was effectively 'piggybacking' on the boat, getting dropped ashore for a day or two at a time to collect rock samples and make land-based observations.

I am trying to reconstruct how the ice sheet has changed over thousands of years using clues from the landscape and a technique called cosmogenic isotope exposure dating. The Earth is constantly bombarded by high-energy 'cosmogenic' particles from deep space; these collide with rocks on the Earth's surface to form 'exotic' isotopes such as Beryllium-10 (^{10}Be). An isotope is an atom with an irregular number of neutrons; ^{10}Be has one more neutron than the more common Beryllium-9. Over time, these rare isotopes build up in exposed rocks, and by measuring their concentration we can work out how long the landscape has been exposed to the atmosphere since the ice sheet retreated.

We took the samples from Greenland to the NERC Cosmogenic Isotope Analysis Facility in Scotland, where they were analysed in a highly sensitive accelerator mass spectrometer which counts individual atoms of cosmogenic isotopes to give an exposure age. By looking at the exposure history of a large area we can find out, not just when the region was last covered by ice, but also how quickly the ice retreated. This is vital information to understand how ice sheets respond to climate changes.

Earlier results from south-east Greenland, published by Durham University researchers, showed that the land started to become ice-free around 11,000 years ago. Recent work from GLIMPSE shows these changes were dramatic and rapid, with glaciers retreating from the 80km-long Sermilik Fjord in as little as a few hundred years. This fast retreat suggests strong sensitivity to climate warming at the end of the last Ice Age. Results from my samples will build on this work, showing whether glaciers across the region behaved in a similar way; I will also try to identify the different factors that caused deglaciation.

Sharing science with the world

The scientific part of my project takes priority in the field, but I am also involved with communicating our findings more widely. As a NERC CASE student I work with an industrial sponsor, in my case a TV production company: 196 Productions, based in Cardiff. Together, we have produced a 50-minute documentary to tell people about the project and the Glaciology Group's wider work.

Before travelling to Greenland I learned how to use a professional video camera, how to interview and how to film for documentaries. We want to document our research, but also to show what it's like to work in this magnificent landscape. It took a lot of time behind the camera before I shot anything good, but I was lucky enough to go back to Greenland several times, with continual critique and encouragement from 196 Productions.

Filming can be exasperating and time-consuming, but also extremely rewarding – there are few feelings better than knowing you are capturing something truly beautiful.

In Greenland I was privileged to witness some wonderful moments; in retrospect we were incredibly lucky. As a result our film includes spectacular sunrises, a storm amongst the icebergs, a close encounter with a polar bear and, courtesy of GLIMPSE postdoctoral fellow Dr Tim James, time-lapse footage of a huge mass of ice calving off the Helheim Glacier.

On returning to the UK, we worked through nearly 24 hours of video, logging it all and developing rough script ideas. We interviewed members of the Glaciology Group and finished the script before editing the film, fitting the footage to the script. We were also awarded some funding from the Engineering and Physical Sciences Research Council to produce animations to explain some of the more complex scientific concepts. The editing process was tough but really interesting and I learnt a lot more about the shots needed to create a successful film, mostly from my own frustrations at missed opportunities.

The film *A GLIMPSE of Greenland: The disappearing ice* is now complete and a ten-minute trailer is available at the Swansea Glaciology YouTube channel. Over the next few months we hope to find a sponsor to produce DVDs and accompanying educational materials and, if possible, get the documentary aired on television.

MORE INFORMATION

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GLIMPSE film trailer:
www.youtu.be/opid81mxkkI