Topic 2b - Cryosat-2: Measuring changes in ice thickness

This is now the launch of the European Space Agency's CryoSat mission in 2010. And it was the first successful satellite mission designed to measure the polar regions. It's a satellite altimeter.

And it flies in an orbit that covers most or the great majority of Antarctica and the Arctic sea ice cap. It flies to within 200 kilometres of the north and south poles. The altimeter on board CryoSat measures the height of Earth's surface from space.

It does this all over the planet. But in the polar regions, this tells us about how the ice sheets, the sea ice, the glaciers, and the ice caps, and in fact icebergs as well, are thickening or thinning over time. And they are thickening and thinning over time.

It has quite a novel sensor on board as well. It's not just a conventional satellite altimeter. We've had those for 20 or 30 years now looking at the oceans, but the oceans are pretty well-behaved surfaces. The ice sheets and mountain glaciers are quite rugged and you need finer spatial resolution to be able to sample those and the altimeter has an interferometer on board, which allows us to do that.

And so we can measure changes in the elevation or thickness of quite small regions on Earth about 400 or 500 meters across. And that allows us to look at the vast majority of the ice that's in Antarctica, or Greenland, or in fact floating in the Arctic and Antarctic waters.

So CryoSat's principle mission objectives were to monitor effectively the Arctic sea ice cap and to monitor changes in Antarctica and Greenland land ice. And it's been doing that now for seven years. This sequence of animated measurements from CryoSat illustrates the observations that we've collected to date, overall elements of the cryosphere, but also some other parts of the planet.

So we're seeing here now the continent of Antarctica building up through the strips of the satellite measurements over time. And that allows it to first of all paint a picture of the shape of the ice sheet at any one time period and then how big it is, the surface. We can do that repeatedly to measure changes in the elevation and that tells us how the ice is responding to various environmental changes.

So here in West Antarctica, the red area, the ice has been thinning quite rapidly up to 10 meters per year in places over the past 10 to 20 years. And this is making a significant contribution to global sea level rise. Travelling north now, we can see that the CryoSat measurements have allowed us to map the depths of the sea floor from space as well.

And so this is the seafloor bathymetry, and it's measured by monitoring very, very small changes in marine gravity, the gradients of the ocean surface over time. That's a really powerful tool for oceanography, not just for cryospheric research. Here we see changes in the elevation of Greenland as well.

And similarly to Antarctica, there are areas, pockets of rapid thinning of up to five to 10 meters per year over the past five or 10 years. And these are around the edges of the ice sheet, which has warmed the most.

so Greenland is a more southerly latitude than Antarctica is in the southern hemisphere, and it's experienced rapid warming over much of its coastline. This is also contributing to global sea level rise. And today Greenland, although it's a tenth of the area of Antarctica, contributes 2/3 of all sea level rise due to the polar ice sheets.

And finally, we've been able to look at changes in the thickness of arctic sea ice as it waxes and wanes through seasons and as it changes over five to 10 year time periods, which is a signal of environmental change that most people are familiar with. Up until recently, we haven't been able to monitor the thickness of the ice.

And it turns out that measuring the thickness of the ice is just as important as measuring the aerial extent, because thicker ice can last longer and thinner ice cannot. And so CryoSat, in its seven years of operation, has been able to measure all elements of the climate system for the first time in the cryospheric regions.

We don't have a successor panned right now, but the European Space Agency are working very hard with the European Commission to design and launch, a follow-on mission sometime in the 2020s or around that time period. We hope to be able to keep this current satellite running until then.

It has about 35 years of fuel left on board, but we know that satellites fail for other reasons, and so we can't guarantee that it's going to continue making the measurements that it has done for the past few years.