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In just a few short years NERC's Centre for Polar Observation and Modelling has built up an enviable international reputation. Owen Gaffney met CPOM director **Duncan Wingham** (left) to discuss satellites and science in the Arctic.

# Pole to pole

## ■ How important is the Arctic to the climate system?

The two poles are inverses of each other. The Arctic is an ocean surrounded by a continent. The Antarctic is a continent surrounded by an ocean. So their behaviour in the climate system is quite different. The Arctic Ocean has a very thin, rather fragile, layer of ice. The Antarctic has an enormously thick continental ice sheet. Of the two regions we are more exposed to change in the Arctic. The Arctic system is extremely fragile. We estimate we will lose the entire ice cover during the summer months sometime in the next one hundred years.

## ■ When do you think we can be more precise about sea ice loss?

Whether it will be 30 years or 100 years is not very clear. The data we have today is not really good enough. I think the CryoSat\* mission's primary function was to solve this problem.

*\*Duncan Wingham proposed the European Space Agency's (ESA) CryoSat mission in 1999. A fault in the launch vehicle led to catastrophic failure shortly after launch in 2005. CryoSat II is due to be launched in March 2009.*

## ■ How is this ice loss affecting the Earth system?

The changes in the Arctic are going to be extremely dramatic and they are going to affect all kinds of systems. I'm sure the whole biological system in the Arctic will change. For example, there are whole seal populations that have evolved particularly to breed using the snow that sits on top of the ice, so they'll be gone. Anyone living on the continents that surround the Arctic are in for profound changes, no question about it.

The wider issues are less clear because the precise way that Arctic changes will propagate southwards are not well understood, but it is quite clear there are connections, particularly with the oceans. The Arctic Ocean and Atlantic Ocean are closely connected. The seas around Greenland and Norway are a very sensitive part of the ocean, it is where most of the downward circulation occurs. Downward circulation in the ocean is a very rare thing, it only happens in a few places.

There is very clear evidence of changes in the pressure gradient that drives that circulation in the last 30 to 40 years. And there is not much doubt that if we remove the ice cover we will change the Arctic circulation.

■ **CPOM predominantly uses satellite technology to address key issues. How do satellites help?**

We mainly use modern microwave satellites to measure either the rate at which ice is thinning (using altimeters) or the rate at which ice is moving (using interferometry). In recent years the power of these satellites has got to a stage that by using these two sets of measurements we get a complete set of physical surface boundary conditions. So we now know, for example, what is happening in Antarctica by and large. We know what is thinning and what is thickening, and why it is behaving like that. If I went back ten years ago a lot of this was speculation. The power of the two types of microwave sensors – the altimeter on the one hand, CryoSat's main instrument, and interferometry on the other – turn out to be very powerful. The paper we published in *Nature* on flowing rivers beneath the Antarctic ice sheet was just such a combination of these two sensors, (see *Planet Earth*, summer 2006)

The other thing we are doing which is quite unique to us, over the last five or six years, we have developed techniques for measuring sea-ice thickness with radars. Nobody had really thought this was possible before.

We can use a few European Space Agency satellites to get these measurements – ERS 1 & 2 as well as Envisat. But the sensors on those satellites were not designed to measure sea-ice thickness, and there is not complete coverage of the Arctic so the quality could be better – essentially we have to integrate the data over most of the Arctic to see the signals. CryoSat, on the other hand, will go into an almost truly polar orbit. It also has a specialist sensor on it, a high resolution radar, so we will get much higher quality data - essentially a step forward in quality. Of course it has been delayed by events, but this is why CryoSat is so important.

■ **During IPY you plan to take an icebreaker around the entire Arctic Ocean. Could you tell me about this project?**

That's right, we want to push an icebreaker right the way across the Arctic. We want to sample the water column in all ways we can. I should say this is not just us, it is a huge consortium grant involving the British Antarctic Survey, National Oceanography Centre, Southampton, and Bangor University, as well as other researchers – Canada is playing a big role. We will use one of the world's most powerful icebreakers, the Canadian ship *Louis S St-Laurent*.

The expedition will produce unique data – nobody has done this before. The Arctic is definitely freshening, no doubt about it. But where is it coming from? Nobody knows but we can get a lot of clues if we look at isotopes in the water. You can tell if it has fallen from the sky or has come from river-run. And if you are clever enough you can tell if it has come from the Russian side or the Canadian side. So the aim is to find the source of this freshening.

■ **What makes IPY so special?**

There is no question that IPY is likely to produce a sudden injection of resources into polar science. But it is not just a question of money; it has greatly encouraged the international pooling of scientific effort which can only be a good thing.



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