Where the **Arctic** and **At**

John Howe and Finlo Cottier explore marine science in the Fram Strait.

Between Svalbard and Greenland in the deep waters of the Fram Strait, lies an important gateway, where oceanic waters converge, ice grows and melts and ecosystems must adapt to change. Here, the warm salty Atlantic waters flowing north meets the cold and relatively fresh water from the high Arctic. The water movements in this region are driven by, and respond to, the world's global oceanic circulation. The area's delicate balance is susceptible to natural and human-caused environmental change, and studying it is important if we're to understand climate change.

Last September, 20 scientists, from the Scottish Association for Marine Science (SAMS), ventured into the Arctic region of the North Atlantic onboard the UK polar research ship the RRS *James Clark Ross*. We voyaged to the waters west of the Norwegian island of Spitsbergen to investigate environmental change in the shallow, coastal and deeper offshore waters around Svalbard.

Change, from either climate warming, pollution, or a combination of both, is affecting the unique deep-sea and coastal habitats that support a rare and diverse fauna in this sensitive region. Arctic sea ice is thinning, and the effects are felt throughout the marine environment, from ocean currents through the food chains to polar bears. More melting could even open up new shipping routes through the Arctic, linking the Atlantic and Pacific oceans and bringing economic growth, but also threatening pollution and perhaps carrying invasive species.

Pollution affects all of the world's oceans, but none more so than the Arctic. These icy waters are surrounded by the landmasses of Scandinavia, Russia, the United States and Canada, all with developed industries and all with rivers draining north into the sea. Even the highly diluted outflow of radionuclides (eg caesium) from the Sellafield nuclear reprocessing plant in Cumbria is detectable in the waters off Spitsbergen. Whilst this makes depressing reading, these contaminants can be useful markers, showing how water circulates into and through the Arctic. We also study the concentration of lead isotopes in the sediments. We can tell where the lead has come from by its unique isotopic fingerprints. In the Fram Strait, lead pollution has clearly come from Western Europe. Using it as a marker, combined with knowledge of the region's currents and sea ice drift, SAMS geochemists have been able to reveal the pathway of pollution into the Arctic from Europe.

Onboard the ship, the scientists retrieved data from long-term monitoring instruments mounted, rather like a vertical washing line, on wires moored to the seabed. These supplemented snap-shot information about the water column's temperature, salt levels, nutrients and trace chemicals collected during the cruise.

In the Fram Strait, and particularly along the Spitsbergen coast, the mixing between warm Atlantic and cool Arctic water masses determines how much heat is

Want to know more?
The work described here is part of the Northern Seas programme, examining the climatic and ecological impacts of warmer high latitude ocean waters. You can find out more about the work of the Scottish Association for Marine Science at www.sams.ac.uk.

lantic meet

delivered to the Arctic, an important control on sea ice formation and melt. We've already witnessed massive and rapid exchanges of Atlantic water with Arctic waters on the Spitsbergen coast. As well as a shift to warmer and saltier conditions, there are also important changes in nutrient levels and in biological communities. By combining these physical, chemical and biological measurements, we are able to track the switch from an Arctic-dominated environment to one that is mainly Atlantic.

To investigate longer-term changes over past centuries, the team also looked into the sediments that are being continuously laid down on the seabed. Cores taken from below the seafloor record material settling down in layers, letting us investigate what formed then and why, and giving evidence of long-term climatic change up to 20,000 years ago (during the last glaciation). In the deep-waters of the Fram Strait, sediment cores revealed a complex past with extreme cold periods of glaciation, and warmer open-water conditions with icebergs melting and stones and sediment dropping onto the seafloor below.

It's still not clear what the changes we're finding will mean for the plants and animals in these fragile communities, though they're likely to be felt as additional stresses. As the research continues, we hope to find out more, and even start to understand how change in the North Atlantic may affect the UK.

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Getting **science** into **policy**

Researcher Amanda Thomson was 'behind the scenes' in Montreal.

The United Nations Climate Change Conference in Montreal last December wasn't just for politicians. Many scientists worked hard to influence its outcomes. Countries that have signed up to the Kyoto Protocol are committed to achieving legally-binding emissions reductions for greenhouse gases by 2012. In Montreal, the rules for the Protocol were finally agreed, and the conference took the first steps towards further action after 2012. This may not sound much, but I saw the frantic work that went into getting agreement between all countries—only reached in the early hours of the final day.

Around 10,000 people participated, from government ministers, policy-makers, scientists, business people, non-governmental organisations to even a polar bear! (Or rather, someone in a polar bear costume, highlighting the melting of the Artic sea ice.) I was helping with policy-making for the land-use change and forestry sector, as the section of the Centre for Ecology & Hydrology, where I work, has a contract with Defra to produce the UK's greenhouse gas inventory for this sector. I made sure that people were in the right place, at the right time, with the right papers. In the final stages, this involved frantic activity, such as trying to collect 20 forestry experts together in five minutes, so that we could agree on a policy position to take back to the negotiating table.

But it was worth it to see science in all parts of the policy process at this historic conference—the first intergovernmental meeting since the Kyoto Protocol came into force. Science was there, from providing information on the rates and effects of climate change, to developing technology to reduce emissions, to monitoring Kyoto Protocol compliance using Earth observation.

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