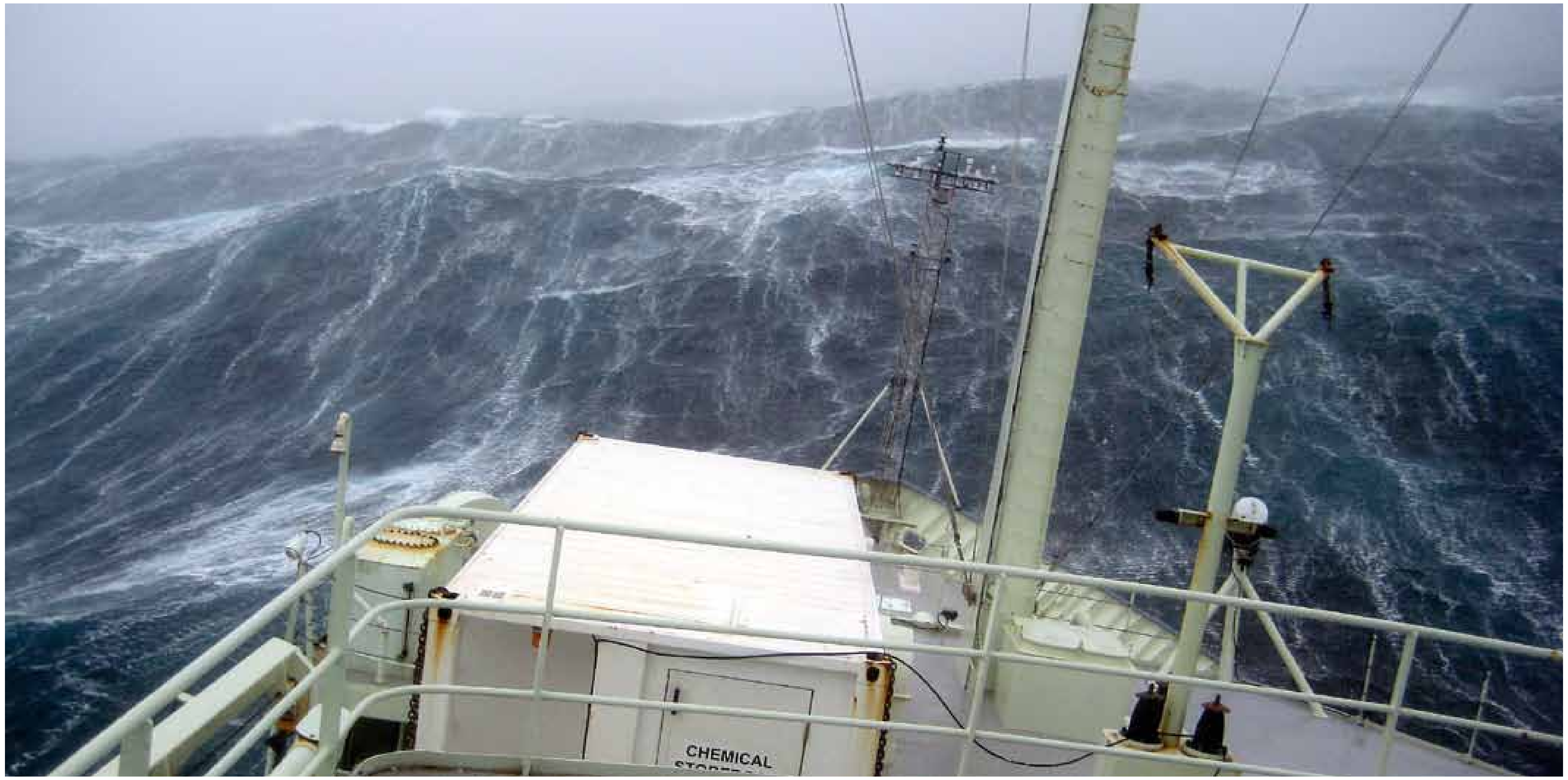
A mighty wind

The effects of Greenland's extraordinary weather patterns are felt worldwide – they influence the movement of water all around the globe. To find out more, intrepid scientists have to brave some of the harshest conditions imaginable. Ben Harden describes his recent trip to Arctic waters.



Thomas Spengler

South of Greenland are the stormiest seas in the world, and that's where I found myself aboard a research vessel in October 2008. I was there to measure the strong winds along the coast using radiosondes – weather balloons equipped with instruments to measure wind speed, pressure, temperature and humidity and relay that information back to us as they rise into the atmosphere.

This was no mean feat – with wind speeds in excess of 50 miles per hour, hanging on to a metre-wide helium balloon while creeping out on to the deck of a ship being tossed on waves the height of a four-storey building was both frightening and exhilarating.

Along with coordinating the launch between two people, it also proved extremely difficult. Timing was everything – would the balloon be consumed by the sea? Crash back into the boat? Have its instruments doused in water and destroyed? Would I be able to hold in the umpteenth bout of seasickness? All of the above occurred at one time or another, but perseverance resulted in many successful launches and some unique data.

This was very exciting – although these winds have been measured once before by aircraft (see *Planet Earth* Summer 2007, pp. 22-23), this was the first time that we were in a position to find out how they develop as a storm passed us by. Measurements of the winds near Greenland are very rare due to the severe conditions and the usual coating of sea ice.

Greenland is massive. More than two kilometres up, the Greenland plateau is as high as much of the Alps and covers an area the size of Western Europe. Over 80 per cent of this is covered by the largest ice sheet in the Northern Hemisphere, containing enough ice to raise global sea levels by over seven metres were it to melt. Greenland's size and freezing temperatures cause many strong wind phenomena around the island.

Much as a boat's hull travelling through the sea pushes water to the side and produces a turbulent wake, Greenland deflects and distorts the air flowing towards it. The situation on Greenland is a little more complicated though. The air that travels over and around the island rarely comes from one direction. Swirling weather systems constantly arrive from the south and west, pushing and pulling air on and off the continent from all directions.

This leads to a variety of strong coastal winds: winds that whip around the southern tip of Greenland; winds that cool down and flow down the steep coastline; winds that stir up new weather systems; winds that are forced along the coast because they can't climb Greenland's mountains. Many of these winds can reach 60 miles per hour at the surface, and they lead to incredibly stormy seas.

Arctic winds, global ocean circulation

OK, so this is an interesting set of wind conditions. But why is it important to study them? Well, apart from the need for accurate predictions of dangerous conditions at sea, there is mounting evidence that winds produced around Greenland could be affecting the wider climate system.

To put it briefly, they can make surface waters sink. To see why this is important, let's look at how water moves around the Atlantic.

Dan Torres

Warm surface water from the Caribbean flows northward to Western Europe in the Gulf Stream. With no exit to the north, these waters have to sink somewhere in the subpolar North Atlantic before returning south at depth. Oceanographers have been debating where in the North Atlantic these sinking regions are for going on 100 years.

In fact, even now, there are only a few generally agreed-upon locations where sinking is believed to take place. These are the Nordic Seas (between Greenland and Norway) and the Labrador Sea (between Greenland and Canada). Here, surface waters are held in one place.

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Subjected to cold winds blowing for a long time over a wide area, the water loses a lot of heat and as a result becomes denser, eventually making it sink. The need for cold winds is why sinking mainly happens in subpolar regions.

But how could the winds off Greenland cause sinking? Yes, they are cold. But they're neither consistent nor spread over a large area. Amazingly, one wind type – the tip jet – can. Tip jets are strong eastward winds that accelerate around the southern tip of Greenland, like a wake from a boat, and out into the Irminger Sea, a small stretch of water between Greenland and Iceland.

They last for a day or two, with only a handful occurring each month. They are very cold and follow a curved path as they pass Greenland. This pushes surface water to one side, exposing slightly deeper water.

Surface water is very stratified – it forms a distinct layer, within which its density increases very quickly with depth. This means it takes a large amount of cooling before it sinks. In contrast, slightly deeper waters in the region are much less stratified and hence easier to sink when exposed to the freezing winds.

The amazing revelation is that these small, sharp winds are affecting the huge, slow process of waters moving around the world's oceans. It's like keeping a bicycle wheel spinning by applying small pushes with your hand. The pushes are small and sharp but keep the wheel continuing on its slow rotations.

This begs the question: if the tip jet can do this to the ocean, what effects do all the other wind phenomena around Greenland have? The task ahead now is to look closely at the other types of winds around Greenland and, as with the tip jet, start to ask questions. How strong are they? How often do they occur? How much heat do they remove from the ocean? How much of a push do they impart? The answers should yield some exciting revelations about how small but intense wind storms can affect the slow progress of water around the planet.

MORE INFORMATION

Ben Harden is a NERC-funded PhD student in the School of Environmental Sciences at the University of East Anglia. His research is part of the NERC-funded Greenland Flow Distortion Experiment on which a special issue of *The Quarterly Journal of The Royal Meteorological Society* was published recently.
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