IN DEEP

Beneath the Drake Passage, a violent stretch of water between Cape Horn and Antarctica, lie three bottom pressure gauges providing vital information about global ocean circulations, says **Steve Mack.**

Steve Mack at the Ukrainian base, Vernadsky, on Antarctica.

A successful recovery of a bottom pressure gauge.

From the southern tip of South America to the Antarctic Peninsula a stretch of water known as the Drake Passage connects three of the world's major oceans. Named after Sir Francis Drake, this bottleneck is notorious for some of the roughest seas on the planet, but it also provides a unique insight into the world's ocean currents.

For almost 20 years scientists from the Proudman Oceanographic Laboratory (POL) in Liverpool have monitored this choke point. Working in such a hostile environment provides some interesting journeys; this is the tale of last year's adventure.

In December 2006, Geoff Hargreaves and I left the UK to travel via Spain and Chile to the Falkland Islands to join the British Antarctic Survey's research ship the *James Clark Ross* on its annual journey to the Rothera base on the Antarctic Peninsula.

There are signs of large internal tides in the Drake Passage.

We have three instruments – bottom pressure gauges – located at the north and south ends of the passage about three kilometres below sea level. We will recover and redeploy two on this trip. A third is for long-term monitoring and will stay on the seabed for up to five years, releasing its data automatically via floating pods which use satellites to send data back to Liverpool.

The Antarctic Circumpolar Current – the world's largest ocean current – whips through the passage with a flow of about 140 million tonnes every second. Pressure changes on the southern side are a good measure of variations in the strength of this current. Bottom pressure here is well correlated with coastal sea-level changes seen in tide gauges all around Antarctica, and changes in the strength of the

Sometimes you lose expensive equipment.

Meeting the *James Clark Ross* at Vernadsky.

circulation are closely linked to the Antarctic Oscillation, an atmospheric feature of the region. The oscillation is a key component of Antarctic climate and a driver of weather in the southern hemisphere. This link to bottom pressure means we can consider the Antarctic Oscillation to extend from the stratosphere to the seafloor.

Within a day of setting sail into a relatively calm ocean we reached the site of our first instrument. We can talk to it by dropping a transmitter into the water and sending it sound commands to determine its location. Everything went as planned. We told the instrument to surface. It duly appeared about an hour later, and we deployed a new gauge.

We continued south, stopping occasionally for researchers from National Oceanographic Centre, Southampton, to take regular temperature, depth and salinity (saltiness) measurements for NERC's climate research programmes. This allowed us time to download data from the northern instrument and, using the onboard permanent internet connection, send to our lab in Liverpool for immediate analysis.

Elephant Island, the gateway to the continent, loomed; the temperature dropped and we felt a true sense of the Antarctic. This was where Earnest Shackleton and his crew beached after their epic journey across the Weddell Sea. Shackleton, with woeful resources, then embarked on another heroic journey across the Southern Ocean to a whaling station on South Georgia and the last outpost of civilisation.

From the ship's GPS we could see we were hovering above our southern instrument. All started well. We spoke to the pressure gauge and told it to release itself from its mooring three kilometres beneath us. It accepted the command. It takes about half an hour for the burnwire to burn through and another hour for the gauge to reach the surface. We waited. Nothing. We waited some more, then tried the release command again, but all indications were that it had already released.

In these situations there comes a point when you realise you are holding up the entire expedition. You must accept defeat and cut your losses. Sometimes science is a risky business. Sometimes you lose expensive equipment. After several hours of head scratching, we were accelerating towards this moment when a shout went up. From nowhere the dials started twitching indicating the frame was on the move. Within an hour, it popped to the surface in time to interrupt the captain's lunch. Sometimes we do lose instruments and never find out why. On this occasion we felt lucky to have the data, but no wiser as to the problem.

Soon we arrived at the peninsula proper, a spectacular journey through the Lemaire Channel, known for obvious reasons as Kodak Alley and to the Ukrainian base of Vernadsky, once called Faraday and owned by the British. This base has three tide gauges including the original 'Munro Gauge', the oldest in Antarctica. These gauges, which provide data on sea-level rise, are so sensitive that they picked up the effects of the 2003 Indonesian tsunami. Again we were there to download data and upgrade equipment, but a trip would not be complete without a visit to the most ornate bar in Antarctica.

Next stop Rothera and the last POL tide gauge. The base staff kindly look after it for us, downloading data and performing modifications when required. This year they've connected the gauge to the base internet so now the Liverpool team receive data live from Antarctica.

With all work complete for another year, it was time to say our thanks and goodbyes to all onboard and to reflect on another successful trip, equipment recovered and deployed, data downloaded and instruments upgraded, new friends made and old friends visited.

Back at home, the gauges are indicating to us that there are signs of large internal tides in the Drake Passage. These may be responsible for a part of the mixing of cold and warm waters necessary to account for the ocean's role in transporting heat around the planet.

There is one other intriguing result from the gauges. At times, cold water sinks down the slope on the southern side of Drake Passage creating deep water – the term used for very cold flows of water close to the seafloor which only form around Antarctica or in the North Atlantic. Deep water flow also helps drive the global ocean circulation, so these flows may form a small but potentially important part of this circulation. ■

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See www.youtube.com Search: 'storm in the Drake Passage' to experience how rough it can get.