Gliders on the storm

Marine scientists are a hardy bunch, but even they aren't keen on working amid 60ft waves in the depths of the Atlantic winter. Luckily, a new generation of marine robots means they don't have to, as Tom Marshall discovered.

Of all the marine robots now prowling the waters around the UK, seagliders may be the most mysterious to the uninitiated. They don't have propellers; they move by simply shifting their centre of gravity back and forth and changing their density, sending them soaring through the top kilometre of the ocean in a series of long, gentle climbs and dives. This 'buoyancy engine' is slow – usually about 25cm a second – but remarkably energy-efficient, letting the gliders keep going for months at a time. Along the way they measure the properties of the water around them. Whenever they come close to the surface – every 5km or so – they transmit the data they've collected back to base via satellite.

Above: Recovering a glider from the water.

Below: The REMUS AUV.

The gliders carry only basic instruments to sense the most essential features of the water – features like temperature, depth, salinity (saltiness), oxygen levels and chlorophyll content, which lets scientists estimate how much plankton is growing. They're built for endurance, so capabilities have to be sacrificed to keep energy consumption as low as possible. They're never going to match the range of science that research ships or bigger marine robots can do, but if you need something to stay out at sea for months collecting oceanographic data in all conditions, they can't be beaten.

Dr Stefan Gary pilots seagliders at the Scottish Association for Marine Science (SAMS). He's also one of the lead scientists on the Extended Ellett Line – a long-term programme to monitor the seas between the UK and Iceland. This is an oceanographically crucial zone, the gateway through which the warmer water of the North Atlantic flows into the Norwegian and Greenland Seas and on to the Arctic. Historically the programme has relied on moored buoys and research ship cruises to get the data it needs. But now seagliders are taking up some of the strain. As well as monitoring large areas of ocean, the gliders take measurements much more frequently and so produce much denser and more detailed

information than research ships, which usually stop to gather data only every few kilometres to keep costs down.

They're also far cheaper to operate, and can be deployed quickly rather than having to be booked months in advance. It takes just a few hours to load one into a small boat, carry it to deep water off the western Scottish coast and release it. The glider then begins the course scientists have set – in this case, to Iceland and back. When it finally returns home, scientists fish it out of the water and take it back to base.

Crucially, the gliders can keep working in the worst conditions a North Atlantic winter can throw at them. 'The last time they tried a research cruise along the Ellett Line in winter was in 2000,' Gary says. 'There were some of the biggest sustained waves ever recorded – about 60ft – and the ship was rolling up to 30°. Even on a big research ship, that's just terrible to work in.'

The gliders don't care about the weather. They may be swept off course by strong currents, or get caught in ocean eddies and gyres and need to be steered out again – an experience Gary compares to 'very, very slow rally driving' – but they get back to where they were supposed to be eventually.

Being able to work in winter is already revealing exciting new things about how the Atlantic works – for instance, the ocean circulation varies much more from season to season than scientists had suspected. Insights from the seagliders are also lending support to the idea that it's subject to long-term cycles – knowledge that could eventually transform our understanding of the region's climate.

The robots are also proving their worth in SAMS' work with industry. Scientists recently used a seaglider in a BP exercise to test emergency response procedures in the event of a spill around an oil rig (see the Winter 2015 issue), and they're now working on a new project with BP and Marine Scotland. The plan is to deploy gliders to investigate ocean conditions around oil wells, providing valuable information on how they affect the environment. They hope this will provide a rich, interactive map that BP and other operators can use to make sure that shutting down old wells causes as little collateral damage as possible.

Dr Stefan Gary is an oceanographer at SAMS. The SAMS seagliders are part of the NERC-funded Scottish Marine Robotics Facility, a pool of equipment that's available to marine researchers in Scotland.

www.sams.ac.uk **http://projects.noc.ac.uk/ExtendedEllettLine**

Sounding out the fjords with Freya

One of the newest members of the SAMS robot family is 'Freya' – the new Gavia Offshore Surveyor autonomous submarine they bought last year and named after the Norse goddess of love and beauty.

Unlike the Autosub family of marine robots developed at the National Oceanography Centre (see p12), Freya is designed for short survey missions in shallow water; she's light, nimble and can be launched from a small dinghy, or even a beach. Her sonar sensors let her map the shape and composition of the seabed, and her cameras help identify the plants and animals living down there.

At the moment Dr John Howe, head of biogeochemistry and Earth science at SAMS, is in Svalbard, using Freya's sensors to understand how the retreat of glaciers due to climate change is affecting the underwater landscape. As the glaciers disappear, they are replaced by rivers, and these can make profound changes to the amount of sediment being deposited on the seabed and the kinds of plant and animal that can thrive there. By comparing a now ice-free fjord to another that's still dominated by glaciers, they want to understand how Svalbard's changing, and how its coastal landscape will look in a warmer future world.

'These areas are very hard to survey – the water is shallow, there are no accurate charts and often chunks of ice are still breaking off the glacier,' says Howe. You certainly don't want to spend too much time hanging about there in a small boat. Instead, the researchers tell Freya the area they want surveyed and she spends a few hours 'mowing the lawn' – moving back and forth along overlapping, parallel tracks to create a comprehensive 3D map of the seabed – before surfacing for collection.

She's already been involved with everything from surveying the SS *Breda*, a World War 2 wreck lying in 100m of water near SAMS' home base in Oban, and helping Wessex Archaeology's uncover the traces of the past hidden beneath the waves off western Scotland. Once she returns from Svalbard, Freya's slated to help researchers at the Centre for Environment, Fisheries and Aquaculture Science understand the impact of gas pipelines on nearby seabed life. After that, Howe hopes to take it to Patagonia to investigate the ecosystems of the region's little-studied fjords.

All images: SAMS