BAS: Investigating icy waters with Boaty McBoatface

Oceans are not only filled with many weird and wonderful creatures, but they can also slow down climate change – storing human-produced carbon and heat in their oceanic depths. Understanding how this process happens is vital to predicting the impact climate change will have over the coming years. Professor Mike Meredith, science leader at the British Antarctic Survey, focuses on this area – investigating dense waters as they flow from Antarctica into the Atlantic Ocean, as a participant in the Dynamics of the Orkney Passage Outflow (DynOPO) project.

Back in 2014, construction began on a new polar research vessel for the British Antarctic Survey (BAS), to replace two existing ships – the RRS James Clark Ross and RRS Ernest Shackleton. Fast forward two years, and the Natural Environment Research Council (NERC), the institution in charge of the construction, set up an online poll asking members of the public to suggest potential names for this replacement ship.

The RRS Boaty McBoatface quickly became a firm favourite with the public, but ultimately a name was selected that honours Britain's much-loved naturalist, Sir David Attenborough. Nonetheless, due to the widespread publicity received from the naming campaign, the moniker Boaty McBoatface was given to one of the craft's underwater vehicles instead. And, in 2017, it embarked on its first mission.

Professor Mike Meredith is an oceanographer and science leader at the NERC's BAS. He recently spoke to us at Research Features to discuss his latest research venture – the DynOPO project – highlighting the impact Boaty McBoatface has had on improving public appreciation of polar research.

Can you explain what the DynOPO project was? What was the motivation for and background of the project, and what was its goal?

The oceans exert a huge influence on our planet's climate, by sucking down heat and carbon from the atmosphere, and storing them in the ocean depths for decades or even centuries. This does us humans a big favour, by slowing the rate of global warming – but we need to know more about how it works, so that we can predict it better.

A particular focus for us is the waters that form close to Antarctica. These are made incredibly dense by interacting with the freezing atmosphere and ice, and they sink to the seabed and spread out to become the abyssal waters across most of the globe. These waters have warmed in recent decades, and we don't really know why – but we need to figure it out, so that we can better predict how it will change in future. This matters for several reasons, including the global heat budget and sea level rise.

The DynOPO project was created by scientists at the University of Southampton, BAS and the USA to study these dense waters as they flow northward from the Antarctic into the Atlantic Ocean, and what happens to them when they cross an underwater mountain chain called the South Scotia Ridge. We believe that the contorted pathways the water takes as it flows over and around these mountains leads to a lot of mixing, and that this mixing might change over time. We hope to find out exactly how and why this happens, and what it means for the role that these deep waters play in climate change.

The DynOPO project has been created to study dense waters as they flow from the Antarctic into the Atlantic Ocean, and investigate what happens to them when they cross the South Scotia Ridge

You recently lived and worked on board the British Antarctic Survey (BAS) research ship James Clark Ross. Can you describe what life was like there? What did your average day entail? How long were you aboard?

Actually, I was the unlucky one – whilst I am an Investigator on the project, I was not participating in the fieldwork myself (too many other responsibilities!). But I've sailed on the James Clark Ross many times, so I know what the field party will have gone through. It's actually a very comfortable ship, with all mod cons and some of the most advanced science equipment that marine scientists could wish for.

Science expeditions to the Southern Ocean are hugely exciting of course – not just for the chance to make breakthroughs in the things we are studying, but also

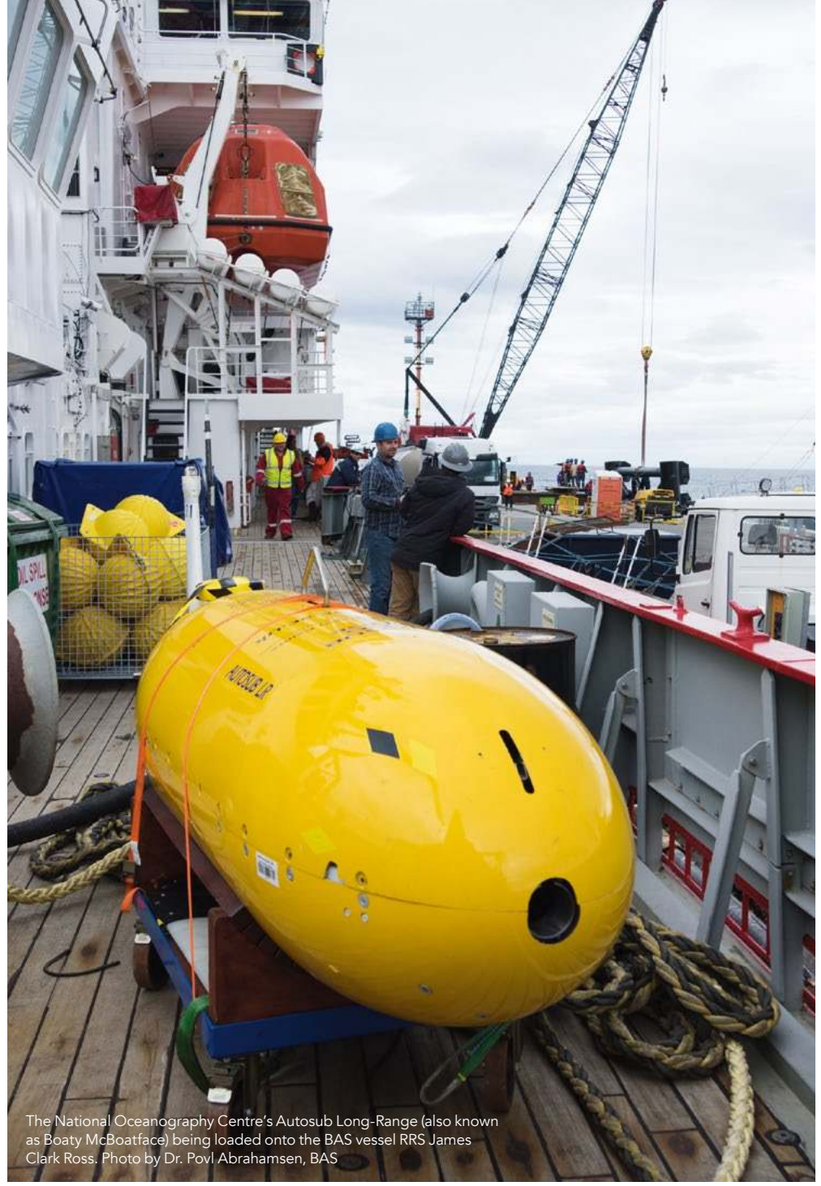
Professor Mike Meredith
of the British Antarctic Survey

because of the environment around us – the scenery can be amongst the most spectacular in the world, and the richness of the wildlife is staggering.

Life on board typically settles into a routine quite quickly, and things tend to revolve very much around mealtimes. The food is normally very good, and plentiful – scientists often leave expeditions several pounds heavier than when they start! Work will have been full-on – the ship works around the clock, so the scientists split into shifts, with some working nights to ensure that data collection never stops. The ship collected data continuously, even when it was steaming along between target sites, but many of the key measurements required the ship to be stopped and equipment lowered into the ocean, sometimes down to a couple of miles or deeper. Water samples were collected and analysed in the ship's laboratories, and a great deal of computer-based work was carried out to make sense of all the data as it was collected.

Expeditions on James Clark Ross are typically a few weeks long; the DynOPO was a long one being around seven weeks in total. This was excellent – it offered scope to collect a huge and unique dataset with which we can tackle the questions we are trying to answer.

What are the main challenges of carrying out research in the Antarctic?
Antarctic fieldwork in general is challenging because of the harshness of the environment, which must be treated with utmost respect. Ship-based fieldwork brings its own challenges – the seas around Antarctica can be some of the roughest in the world, so you are working in an environment that can make you feel nauseous just by being there. It's also the case that you are working inclose confines with your colleagues for several weeks, so a lot of tolerance and patience is required by all. And simply being away from family and loved ones for such a long period can be emotionally challenging. But typically, a camaraderie develops on-board, and people enjoy working together in a team on problems that they are all interested in – so whilst the challenges are undoubtedly real, people usually deal with them very well.



The National Oceanography Centre's Autosub Long-Range (also known as Boaty McBoatface) being loaded onto the BAS vessel RRS James Clark Ross. Photo by Dr. Povl Abrahamsen, BAS

Boaty McBoatface was one of the research tools at your disposal on this trip. Can you tell us a bit about Boaty's mission? And what impact the publicity generated by Boaty has had on the research mission?
Boaty was one of the key tools that DynOPO used – it was deployed into one of the key deep gaps in the underwater mountain chain through which the dense water flowed, and it completed missions in and around that gap to collect data on ocean temperature, how salty it is, how much it is mixing, and so on. By being able to stay submerged for days or even weeks, it could build up datasets of a complexity and detail that has never been possible before – so it enables a real leap forward for the science. The publicity surrounding Boaty was wonderful – the way it caught the public's imagination gave us scientists the chance to engage with a much wider section of the general community than we would otherwise have been able to, and explain the science we are doing to them, and why it matters.

Boaty McBoatface on the deck of the James Clark Ross, prior to the DynOPO expedition. Photo by Dr. Povl Abrahamsen, BAS

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Can you tell us about some of the other research tools and processes you used?
The workhorse of the science we conduct is called a "CTD" (Conductivity-Temperature-Depth instrument). It is basically an extremely advanced thermometer that is lowered on a wire from the ship down to the seabed. (It also measures salinity and a number of other things that we care about.) It collected samples of water that we brought on-board and measured in the ship's labs. There are other instruments we used too, including free-fall probes for measuring mixing – these are nerve-wracking, because they aren't tethered to the ship, so each deployment is a heart-in-mouth experience. Luckily, they are normally well-trained about coming back when they should.

What is the wider significance of understanding the complex physical processes occurring in the Southern Ocean?
The Southern Ocean is key to the functioning of all of Planet Earth. It is the main site globally where deep waters from 1–2 km down rise to the surface and can interact with the atmosphere and the ice; once they have done this, they sink back into the ocean interior for very long periods. This means that the Southern Ocean can draw down heat and carbon from the atmosphere much more effectively than other regions, and hence can slow the rate of climate change. This matters for societies in all parts of the planet, but we need to know more about how it works, so that we can improve how well we can predict it.

And finally, what initially triggered your interest in polar ocean research?
I originally trained as a physicist, which seemed to involve a lot of time spent working in darkened laboratories, but I have always been fascinated by extreme environments. Like most people, I was amazed by the early documentaries showing the wildlife and environment of Antarctica – so having finished my physics degree, I jumped at the chance to study for a PhD in Antarctic oceanography. Soon after that, a job became available at the British Antarctic Survey, and the rest is history!

• To find out more information about the DynOPO Project, or about the BAS in general, please visit their excellent website at www.bas.ac.uk.

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