



**National
Oceanography
Centre**

IS THE MARINE HEATWAVE OCCURRING BENEATH THE SURFACE? SHORT ANSWER: WE DON'T REALLY KNOW

DR ZOE JACOBS

The majority of marine life resides beneath the surface, which makes it vital to monitor our seas not just at the surface, but throughout the water column to the seafloor.

Is the ongoing Marine Heatwave happening there too? I spoke with Dr Jenny Graham, a physical oceanographer from the Scottish Association for Marine Science, to find out.

WE CAN SEE THE MHW AT THE SURFACE, BUT DO WE KNOW WHAT'S HAPPENING AT SUBSURFACE?

The short answer is no. The problem is that satellites can't see what's happening beneath the surface. So, to know what's going on deeper in the ocean, we need to measure or observe the temperature directly, which means that we are limited to far fewer measurements, rather than having the nice maps that we're used to seeing for surface temperatures.

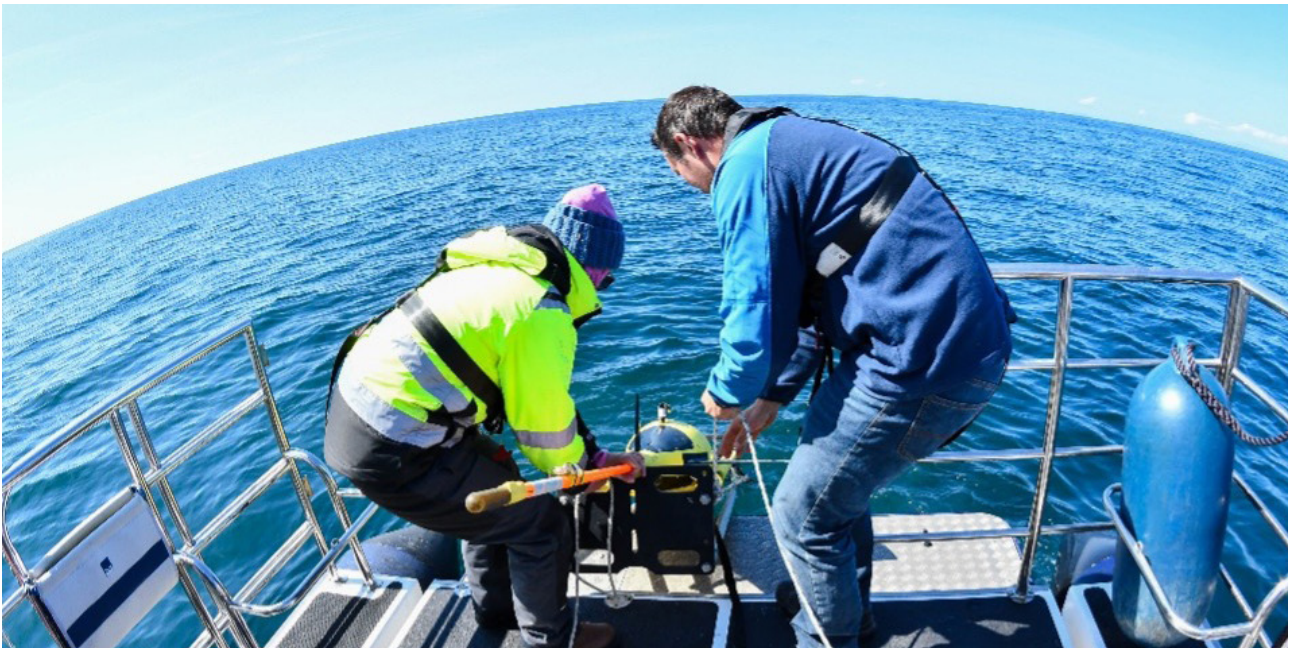
HOW EXACTLY DO WE MEASURE THINGS BENEATH THE OCEAN SURFACE?

In the past, we had to rely completely on ship-based instruments, where temperature and salinity sensors are lowered directly from the ship, or anchored on the seabed. These measurements are still incredibly valuable, but over recent decades, autonomous instruments have become useful for taking more measurements, in more places. These can be deployed from a ship but left to measure properties of the ocean over the following months or even years (depending on the sensors). Some of them simply drift with ocean currents, whereas others can be piloted remotely to chosen locations, long after the ship has gone.



WHY DOES IT MATTER WHAT'S HAPPENING BENEATH THE SURFACE?

Most of the life in the ocean lives beneath the surface. So, to understand the impacts of marine heatwaves on marine life, from small plankton up to large marine mammals, we need to know what is happening there. Many offshore industries also rely on infrastructure beneath the surface, so being able to predict changes in temperature is important for managing economic impacts.



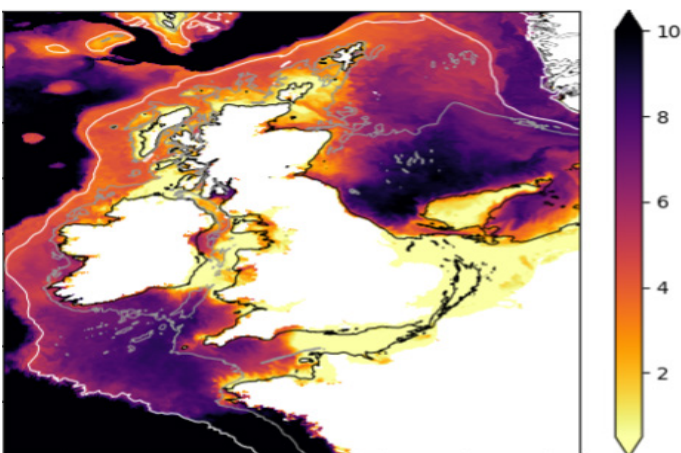
AUTONOMOUS INSTRUMENTS, SUCH AS GLIDERS, CAN OFTEN BE DEPLOYED FROM SMALL BOATS, AS WELL AS LARGE RESEARCH SHIPS. CREDIT: THE SCOTTISH ASSOCIATION FOR MARINE SCIENCE

IS WHAT'S GOING ON BENEATH THE SURFACE DURING A MHW LIKELY TO BE DIFFERENT ACROSS UK SEAS?

Yes, a combination of different depths, tidal ranges and strength of currents means that some parts of UK seas remain well mixed all year, whereas others develop warmer surface layers during the spring and summer months. So, when we see a marine heatwave at the surface, knowing where it is can give us some clues for what might be happening below. For deeper regions like the northern North Sea, as more heat from the sun arrives during spring and summer, this creates a warmer, lighter surface layer that lies above the cooler, denser deep water. However, where we have strong tidal currents or shallow depths, such as the English Channel and southern North Sea, this keeps the ocean well mixed throughout the year. So, warmer temperatures at the surface are also what you're likely to see at the seabed.

"In shelf seas, conditions can vary dramatically with depth. Using underwater autonomous vehicles, we've observed substantial changes in subsurface phytoplankton during a recent marine heatwave that were far larger and more persistent than those seen at the surface. These vehicles are vital to provide sustained, high-resolution measurements throughout the water column."

DR CHARLOTTE WILLIAMS, NOC - PHYSICAL OCEANOGRAPHER SPECIALISING IN OCEAN GLIDERS



MAP SHOWING VARYING DIFFERENCE BETWEEN TEMPERATURE AT SURFACE AND BOTTOM OF THE OCEAN, ACROSS THE UK SHELF SEAS. BLACK, GREY AND WHITE LINES SHOW CONTOURS OF DEPTH AT 40, 100 AND 200 M, RESPECTIVELY. DATA SHOWN IS FROM AN OCEAN FORECAST MODEL ON 11 JULY 2026 (EU COPERNICUS MARINE INFORMATION).

WHY DON'T WE HAVE MANY SUBSURFACE OBSERVATIONS IN OUR SHELF SEAS?

For the open ocean, a lot of the subsurface coverage comes from Argo floats. These drift with deep ocean currents (around 1000 m depth), so they can't drift into the shallower regions around the UK. Instead, we mostly rely on autonomous underwater gliders. Rather than drifting with currents, these instruments can be piloted remotely to chosen locations. So, it's great to be able to direct these gliders to where we want them. However, they are more expensive than drifting floats, so we can only usually afford to have them in a couple of locations at any one time.

	COST	DEPLOYMENT DIFFICULTY	LIFE SPAN	CHARISMA
ARGO FLOAT 	£	● ●	● ● ●	● ● ●
GLIDER 	£ £	● ● ●	● ● ● ●	● ● ● ●
ALR 	£ £ £	● ● ● ●	● ●	● ● ● ● ●
CTD 	£ £ £ £	● ● ●	●	● ●
MOORINGS 	£ £ £ £ £	● ● ● ● ●	● ● ● ● ●	●

“Increasing our observations throughout the water column and all the way to the seabed is of critical importance to fully understand how marine heatwaves affect the totality of our ocean, which enables effective management of our seas and protection of our marine life”

PROF. IR. VEERLE HUVENNE, NOC - RESEARCH LEADER IN MARINE HABITAT MAPPING AND DEEP-SEA ECOLOGY

“There remains a lot of unanswered questions about what is happening beneath the ocean surface due to the lack of available observations. We would like to improve our ability to model, monitor and forecast subsurface MHWs and to determine whether there are certain ocean conditions that would make a MHW more likely.”

MARK WORSFOLD, UK MET OFFICE - OCEAN OBSERVATIONS SCIENTIST WHO HAS DEVELOPED OUR MHW MONITORING TOOL

WHAT CAN WE DO TO GET MORE SUBSURFACE OBSERVATIONS TO UNDERSTAND WHAT’S HAPPENING IN GENERAL AND DURING A MHW?

A lot of it comes down to money. We need to invest more in autonomous instruments, to be able to make more measurements, in more places. However, in the meantime, we can think about how to make the best of the observations and sensors that we currently have. For example, we can target measurements in those regions (and times of year) where we know that the surface and deep ocean conditions will differ. This is crucial to understand how deep the surface heat is penetrating through the ocean. We'll never be able to measure the subsurface everywhere, all the time though, so combining our measurements with ocean model simulations will also be needed, to help understand and predict changes throughout the ocean.

Acknowledgements

Neil Fraser, The Scottish Association for Marine Science & Alice Marzocchi, National Oceanography Centre

National Oceanography Centre is a company limited by guarantee, set up under the law of England and Wales, (Company no. 11444362) and a registered charity (England & Wales: 1185265 & Scotland: SC049896). Registered address: European Way Southampton SO14 3ZH. Registered with the Fundraising Regulator.

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