Exploring the saltiness of the ocean to study climate change

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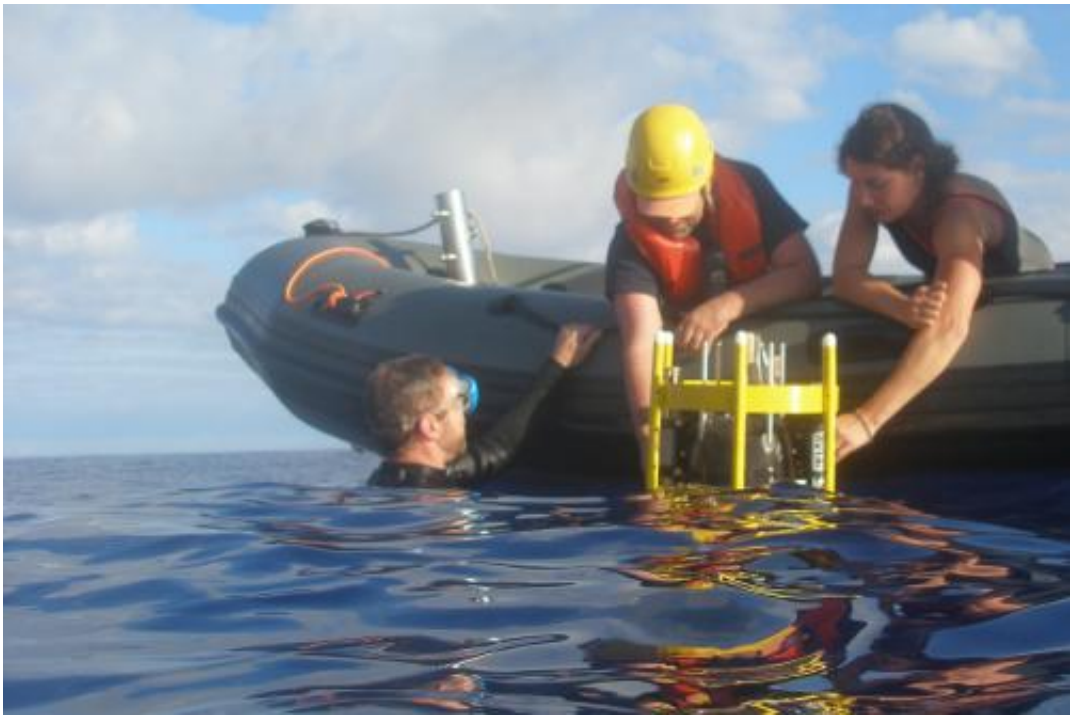

Researchers from the NUI Galway AirSea Laboratory deploy the ASIP device, from left: Dr Brian Ward, and PhD students Graig Sutherland and Anneke ten Doeschate.

Details are emerging from a recent research expedition to the Sub-Tropical North Atlantic. The objective of the expedition was to study the salt concentration (salinity) of the upper ocean. Scientists aboard the Spanish research vessel Sarmiento de Gamboa, including National University of Ireland Galway's Dr Brian Ward with two of his PhD

students, Graig Sutherland and Anneke ten Doeschate, explored the essential role of the ocean in the global water cycle.

This oceanographic research campaign is aimed at understanding the salinity of the upper ocean, which is a much more reliable indicator of the water cycle than any land-based measurement. How the water cycle evolves in response to global warming is one of the most important climate change issues.

The experiment was located in the North Atlantic Salinity Maximum, which has the highest salt concentration of any of the world's oceans. Dr Ward explains: "It is not the depths of the ocean which is its most important aspect, but its surface. Everything that gets exchanged between the ocean and atmosphere, such as water, must cross the air-sea interface. We are trying to better understand how small scale turbulence is responsible for the air-sea exchange of freshwater. What is surprising is that these small-scale processes can affect large-scale patterns over the North Atlantic, and we are trying to connect the dots."

The initial part of this ocean field campaign was to conduct a survey of the area to map out horizontal and vertical distribution of salinity using an instrument that was towed behind the ship. "We found quite a lot of fresher water intermingled with the background salty water, but it is moving around quite a bit due to ocean currents, and when we returned to the fresh patch, it had moved. We were currently hunting for this freshwater, as one of the objectives is to understand the spatial inhomogeneity of the upper ocean salinity", explains Dr Ward.

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Studying the processes at the ocean surface requires specialised instrumentation, as most measurements 'miss' the upper few meters. The National University of Ireland Galway's AirSea Group are measuring the salinity, temperature, and turbulence of the upper 10 metres of the ocean with very fine detail using their Air-Sea Interaction Profiler (ASIP). The torpedo-shaped device, which is deployed into the water to gather data autonomously, is unique and the only one of its kind.

Dr Ward explains: "The ocean surface has been the focus of my research for several years, but there was no easy way to measure what is going on

here as there were no instruments available, so we built our own." The ability to make these unique measurements has resulted in international recognition for the research being conducted at National University of Ireland Galway.

Dr Ward's Research Group is the AirSea Laboratory, which is affiliated with the Ryan Institute and resides in the School of Physics at the National University of Ireland Galway. The main objective of the AirSea Laboratory is to study the upper ocean and lower atmosphere processes which are responsible for atmosphere-ocean exchange. This experiment is concerned with air-sea exchange of water, but other studies that the AirSea Laboratory have been involved with were looking at how carbon dioxide, a major greenhouse gas, is transported between the air and sea.

Dr Ward explains: "The ocean and atmosphere are a coupled system and therefore need to be studied in unison. A major part of our research is to determine how this system affects and is affected by climate and environmental change."

This Irish and Spanish collaboration is part of a bigger international effort called SPURS - Salinity Processes in the Upper Ocean Regional Study. There was also an American research ship in the area participating in the SPURS study, and the Spanish ship was visited by Dr Ray Schmitt from the Woods Hole Oceanographic Institution (WHOI).

Dr Ward collaborates extensively with the WHOI scientists: "The WHOI scientists have autonomous gliders with microsensors attached, similar to our ASIP. During our measurements, they directed their gliders to the same area as ASIP, and we provided them with data to ground-truth their measurements. This was an excellent opportunity to enhance our links with WHOI, who are the largest oceanographic research institution in the USA."

One of the biggest motivators for SPURS was the recent launch of two satellites for measuring ocean salinity: the European Space Agency's Soil Moisture Ocean Salinity (SMOS), and NASA's Aquarius mission. Dr Ward explains: "It is envisioned that with the combination of the in-situ measurements, satellites, and computer models, we can improve our estimates of global climate change and the water cycle. These data will also be used to improve weather forecasting, and we worked with the European Centre for Medium Range Weather Forecasting during this field experiment."

The research vessel left the Canary Islands on 16 March and completed its journey in the Azores on 13 April, during which time the vessel was home to 19 scientists, 6 technicians and 18 crew members.

Provided by National University of Ireland, Galway

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