Robots aid better understanding of phytoplankton blooms

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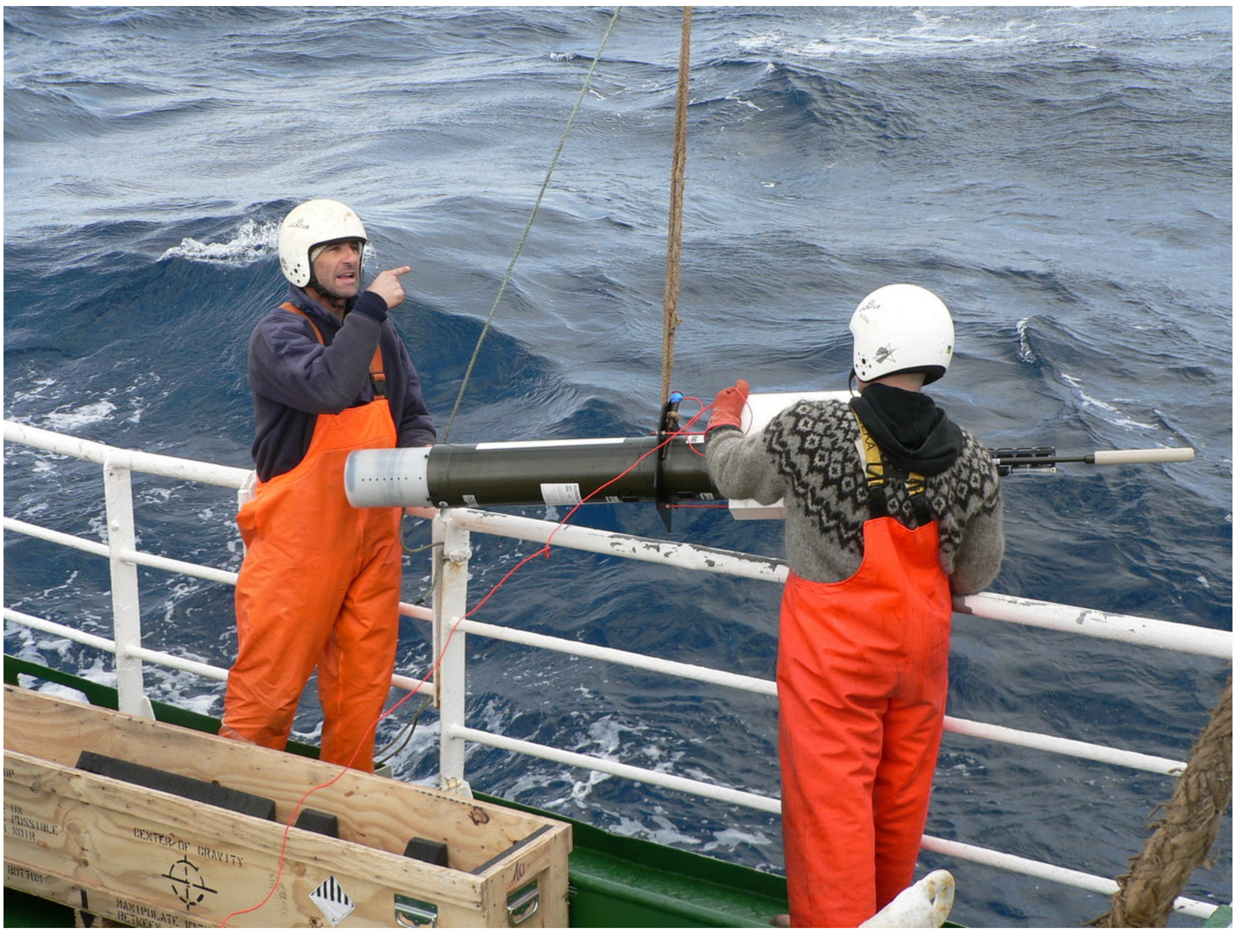

Deployment of a float. Credit: Léo Lacour

Phytoplankton blooms are one of the most important factors contributing to the efficiency of the carbon pump in the North Atlantic Ocean. To better understand this phenomenon, the ERC remOcean project, led by researchers at the Laboratoire d''Océanographie de Villefranche (CNRS/UPMC), has developed a new class of robots: biogeochemical profiling floats, the first robots able to collect data in the ocean throughout the year. Using these unparalleled data, the researchers have identified the starting point for the explosive spring phytoplankton bloom. Their results are the subject of two articles published in *Nature Geoscience* and *Nature Communications*.

The North Atlantic Ocean located above the 50th parallel north is one of the most efficient carbon sinks in the world. Although it accounts for less than 1.5 percent of the total surface area of the world's oceans, it captures about 20 percent of the CO_2 sequestered by the oceans. Its very cold surface waters and relatively extreme weather conditions in winter enable efficient capture of CO_2 from the atmosphere. At the same time, blooms of phytoplankton—a plant micro-organism that transforms the inorganic carbon present in the ocean into organic carbon via photosynthesis—also contribute to capture of CO_2 and its potential export to the deep ocean.

Traditionally, phytoplankton blooms are observed via satellites that reveal the presence of chlorophyll by identifying the ocean color, although they prove ineffective in the event of cloud cover; and also by oceanographic missions, which are more expensive to operate and limited in time.

To better understand the conditions conducive to phytoplankton blooms, researchers at the Laboratoire d''Océanographie de Villefranche (CNRS/UPMC) have deployed robots called biogeochemical profiling floats since 2012-2013. These robots—which operate between the surface and a depth of 2,000 meters—have made it possible to record data never before collected over a full annual cycle, including not only the depth, temperature and salinity of the water, but also the light intensity, the density of suspended particles, and the concentration of both chlorophyll (an indicator of the presence of phytoplankton) and oxygen.

Using the data collected, the scientists were able to determine precisely when and how the phytoplankton bloom in the North Atlantic Ocean is triggered. Their study, to be published in *Nature Communications*, confirms the hypothesis that an explosive increase in phytoplankton biomass occurs in spring after a "winter simmer," a phase of reduced activity during the winter.

In addition, the researchers focused on the months of January, February and March in order to study this poorly understood 'winter simmer' phenomenon. In another study published in *Nature Geoscience*, they show that (reduced) phytoplankton blooms may occur in winter under certain conditions. Phytoplankton cannot grow in very rough and turbulent waters because there is a lack of light at this time of year. However, this study shows that during periods of relative calm, the reduced mixing of waters allows phytoplankton to receive more light, thus promoting blooms of a type of phytoplankton called diatoms. These local blooms lasting a few days could be the starting point for the explosive spring blooms a few months later. These observations have been replicated by numerical models and will certainly feed into future forecasting models of the state of oceanic ecosystems.

Over and above these results, the ERC remOcean project demonstrated the importance of robots in improving our understanding of the ocean. It also helped to launch an international robotic ocean biogeochemistry monitoring program, Biogeochemical-Argo, which began in 2016. Its medium-term goal is to operate 1,000 profiling floats in order to continuously monitor marine life in the oceans and its sensitivity to climatic disturbances.

More information: A. Mignot et al, Floats with bio-optical sensors reveal what processes trigger the North Atlantic bloom, *Nature Communications* (2018). DOI: 10.1038/s41467-017-02143-6

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