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NSF Grants \$53 Million to Create a Global Fleet of Robotic Floats to Monitor Ocean Health

New grant will support a consortium of research institutions, including Scripps Oceanography, to build a global array of robotic floats with biogeochemical sensors

On Oct. 29, 2020 the National Science Foundation (NSF) approved a \$53 million grant to a consortium of the country's top ocean-research institutions to build a global network of chemical and biological sensors that will monitor ocean health. Scientists at the Monterey Bay Aquarium Research Institute (MBARI), Scripps Institution of Oceanography at UC San Diego, University of Washington, Woods Hole Oceanographic Institution, and Princeton University will use this grant to build and deploy 500 robotic ocean-monitoring floats around the globe.



Deployment of a biogeochemical float. Photo: SOCCOM Project

This new network of floats, called the Global Ocean Biogeochemistry Array (GO-BGC Array), will collect observations of ocean chemistry and biology between the surface and a depth of 2,000 meters. Data streaming from the float array will be made freely available within a day of being collected, and will be used by scores of researchers, educators, and policy makers around the world.

“The Global Ocean Biogeochemistry Array will be transformational,” said Lynne Talley, a physical oceanographer at Scripps Oceanography and one of the co-principal investigators on the GO-BGC project. “It’s an evolution of how we’re observing the ocean.”

Funding for the GO-BGC Array is provided through the NSF Mid-scale Research Infrastructure-2 Program (MSRI-2). Data from the array will allow scientists to pursue fundamental questions about ocean ecosystems, observe ecosystem health and productivity, and monitor the

elemental cycles of carbon, oxygen, and nitrogen in the ocean through all seasons of the year. Such essential data are needed to improve computer models of ocean fisheries and climate, and to monitor and forecast the effects of ocean warming and ocean acidification on sea life.

Although scientists can use Earth-orbiting platforms and research vessels to monitor the ocean, satellites can only monitor near-surface waters, and the small global fleet of open-ocean research ships can only remain at sea for relatively short periods of time. As a result, ocean-health observations only cover a tiny fraction of the ocean at any given time, leaving huge ocean regions unvisited for decades or longer.

A single robotic float costs the same as two days at sea on a research ship. But floats can collect data autonomously for over five years, in all seasons, including during winter storms, when shipboard work is limited.

This new monitoring program (the GO-BGC Array) is the National Science Foundation's contribution to the Biogeochemical-Argo (BGC-Argo) project. It extends biological and chemical observing globally, and builds on two ongoing efforts to monitor the ocean using robotic floats, both of which have been highly successful.

The first of these programs, the Argo array, consists of 3,900 robotic floats that drift through the deep ocean basins, providing information on temperature and salinity in the water column. Since its inception at Scripps Institution of Oceanography in 1999, the Argo Program has grown to include participation from 26 countries across the globe, and data from the program have been used in 4,100 scientific papers. As the first global, subsurface ocean observing system, the Argo array has done an incredible job of measuring the physical properties of our ocean, but Argo floats do not provide information about the ocean's vital chemical and biological activity.

Starting in 2014, the Southern Ocean Carbon and Climate Observations and Modeling (SOCCOM) program deployed a large array of robotic "biogeochemical" floats, based on the Argo design, but carrying sensors to monitor the chemical and biological properties of the ocean. Scripps scientist Talley is also a co-principal investigator of the SOCCOM program, and is responsible for organizing float deployments as an observational team leader. The floats are produced at the University of Washington and MBARI, and Scripps scientists provide shipboard support during deployments.

SOCCOM floats have operated for nearly six years in the remote, stormy, and often ice-covered Southern Ocean—arguably one of the harshest marine environments on Earth. These floats have already provided critical new information about how the Southern Ocean interacts with

the earth's atmosphere and winter sea ice.

Similar to the SOCCOM floats, the new GO-BGC floats will carry a number of sensors in addition to the core Argo sensors for temperature, depth, and salinity. These include instruments to measure oxygen concentration, pH (ocean acidity), nitrate (an essential nutrient for microscopic algae), sunlight (required for algal growth), chlorophyll (an indicator of algal populations), and particles in the water (including microscopic algae). Over the last few years, researchers have been testing, refining, and calibrating these sensitive instruments as part of the SOCCOM program and other international efforts.

The instruments on these floats will allow researchers to monitor the health of the ocean, including the growth and respiration of phytoplankton (drifting algae and microbes that use sunlight as a source of energy) and the nutrients and light that control these processes. In addition to supporting most of life in the ocean, including commercial fisheries, phytoplankton supply oxygen to and remove carbon dioxide from the ocean and the atmosphere. These microscopic plankton have huge impacts on our climate through their control on carbon dioxide. The new floats will also provide first-hand data on long-term changes in the ocean, including ocean acidification and the expansion of low-oxygen zones.

This five-year effort involves five research institutions. MBARI will coordinate the project, refine the sensors, take the lead in processing data from the floats, and perform outreach for the program. Scripps Institution of Oceanography, the University of Washington, and Woods Hole Oceanographic Institution will build and deploy floats in collaboration with commercial partners. Scripps will coordinate the global deployments of the floats and ocean measurements during the deployments. Researchers at Princeton University will contribute to the array design and project management, and ensure that the data are linked to global computer models of the Earth's ocean and climate. This program will also have a significant impact on the ocean technology industry, including a number of commercial suppliers of ocean sensors and profiling floats.

A broad public-outreach program, including workshops, web-based curricula, and hands-on activities, will help scientists, teachers, students, and others use these data. In an expansion of the existing SOCCOM [Adopt-A-Float](#) program, the floats will be adopted by elementary- to college-level classes. Student activities will be developed through a partnership with the national [Marine Advanced Technology Education](#) program. In addition, courses based on GO-BGC technology will be offered through The Sandbox, a makerspace at Scripps Oceanography.

The researchers hope that GO-BGC will inspire other countries to contribute similarly instrumented floats, as part of the new global biogeochemical Argo effort. Ideally, this expanded network would grow to a sustained array of 1,000 biogeochemical floats uniformly distributed around the world ocean, and spaced about 1,000 kilometers (620 miles) apart.

“Until now, biogeochemical data has not been collected for the vast majority of the world’s ocean. GO-BGC will transform our ability to observe and understand the chemical and biological cycles that are the foundation of marine food webs,” said Ken Johnson, a marine chemist at MBARI and principal investigator on the project. “These observations will establish the baseline rates of photosynthetic production, respiration, and nutrient supply in present ocean ecosystems and they will alert us to possible changes in the future.”

- *Adapted from MBARI*

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