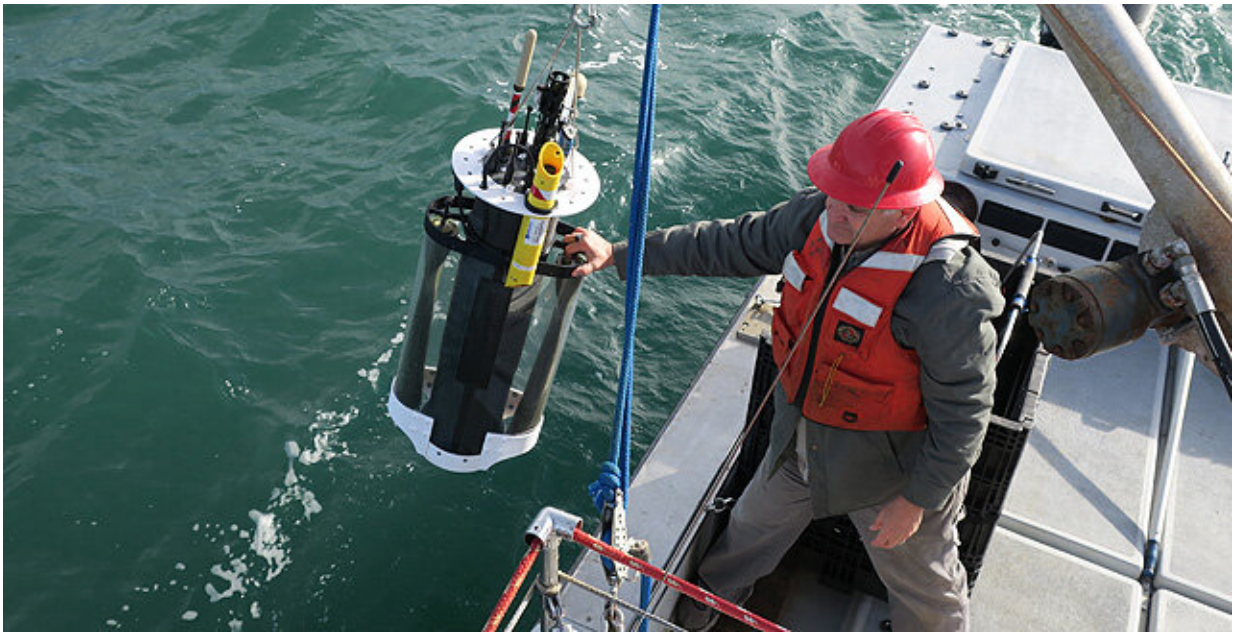
New coastal profiling floats for diagnosing ocean health

February 7 2020, by Lara Streiff



Engineer Gene Massion deploys a prototype coastal profiling float in Monterey Bay. Credit: MBARI

When a doctor checks up on a patient, they might listen to the patient's breathing, take their temperature, and discuss nutrition. When checking up on the ocean, scientists also take oxygen, temperature, and nutrient readings. But because of its size and variability, reading the ocean's vital signs is a lot more challenging than wrangling the average patient.

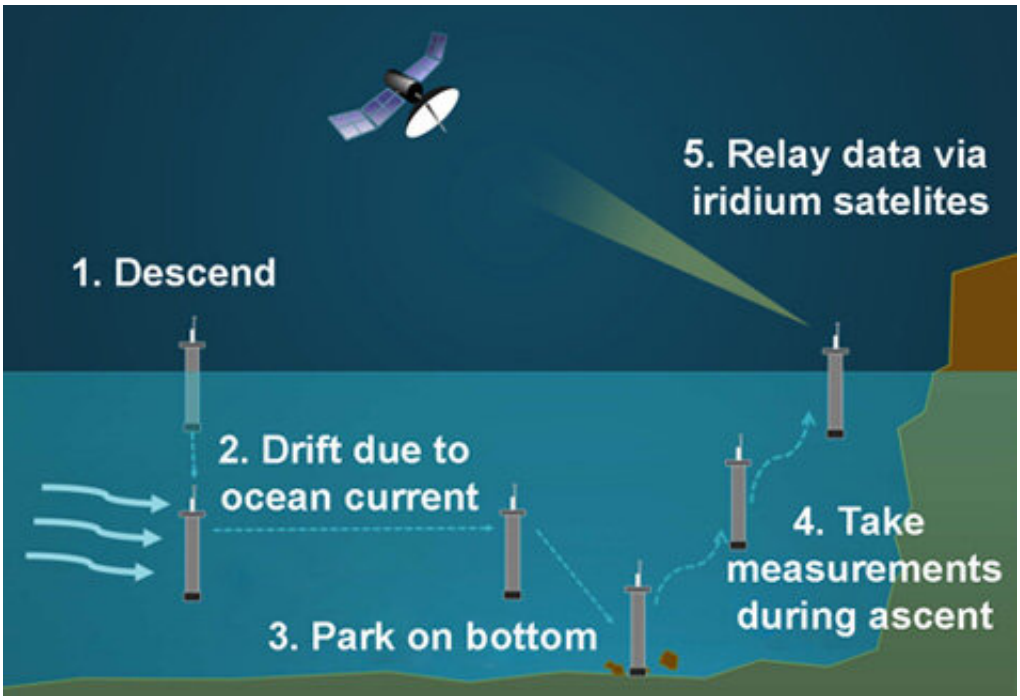
Although moorings and autonomous underwater robots can help monitor ocean health, MBARI engineers and scientists have been working on a new diagnostic tool—a coastal profiling float—that can stay at sea for longer periods of time without requiring an anchor on the seafloor.

For two decades, open-ocean profiling floats have been successfully tracking temperature and salinity. The Argo network boasts around 3,800 drifting floats worldwide, and the Southern Ocean Carbon and Climate Observations and Modeling (SOCCOM) project has roughly 200 floats in the Southern Ocean. All of these floats collect data and send them back to shore within hours.

Contrary to what the name might suggest, profiling floats don't just passively float in the ocean—they move up and down. Open-ocean floats spend most of their time at 1,000 to 2,000-meter (3,280 to 6,560 foot) depths, rising to the surface every 10 days thanks to an engineered swim bladder.

"The external bladder is extendable, and all we're doing is moving oil back and forth from inside to outside," said Gene Massion, MBARI's lead engineer on the project. Moving oil outside of the float and into the external bladder increases its volume without changing the float's mass, causing it to rise through the water. Moving oil back inside the float decreases the volume, and therefore the buoyancy, allowing the float to sink.

"These floats are a system that works," said Ken Johnson, a senior scientist at MBARI. "They are also much cheaper than research vessels, and don't need nearly as much staff to operate or maintain."



This graphic shows the coastal profiling float cycling from the surface to the seafloor and back. Credit: Nick Raymond/Lara Streiff

But there is a vital part of the ocean where these floats are less effective—coastal areas. Like a drifting strand of kelp, floats are at the mercy of the currents. In the open ocean a little back and forth movement isn't concerning. But along the coast, floats can easily strand on the beach, rendering them useless. As a result, scientists lack float data from coastal regions, the most productive parts of the ocean.

"To understand the health of the ocean, you need to work in the coastal zones, where the microscopic phytoplankton and algae at the base of the food chain live," explained Massion. After working on both the SOCCOM and Argo arrays, Johnson and his team are now developing a new float designed for the coast.

A float that parks on the seafloor

MBARI researchers designed the coastal profiling float specifically to overcome the challenges of working in the coastal environment. Their main trick is to have the float park on the seafloor between periods of data collection. The float then spends less time being pushed around in the water column and potentially toward the shore.

A larger, modified bladder gives the coastal profiling float a wider range of buoyancy. Greater negative buoyancy allows the float to park securely on the muddy bottom. Greater positive buoyancy allows the float to pop out of the sticky seafloor mud.

Instead of taking one measurement every 10 days, like the Argo floats, the coastal profiling floats can move up and down in the water column four times a day or more. Due to the rapid variation in the coastal environment, measurements need to be taken more frequently near the coast than in the open ocean.

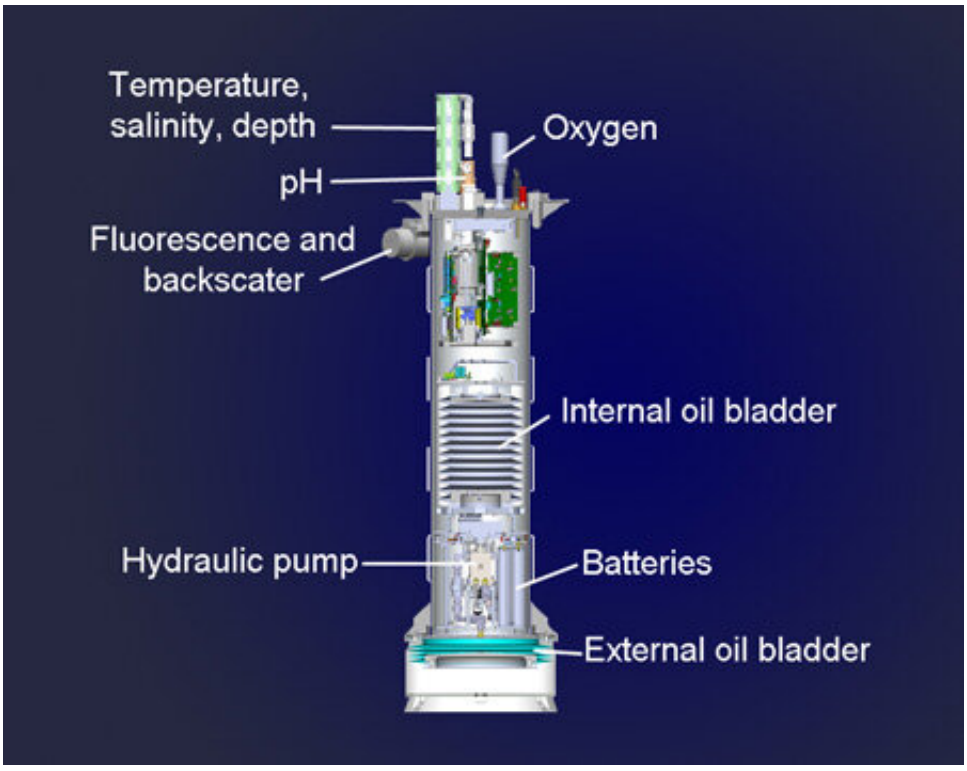


Diagram of the coastal profiling float with the bladder at the base of the instrument. Credit: MBARI

So far, MBARI researchers have built two different models of coastal float with the same core components. Engineers built the first prototype with a buoyancy bladder on the bottom of the cylinder, much like existing Argo float designs. Their second design has bladders on the sides of its body to reduce the chances of getting stuck in the seafloor mud. "These are irritating little problems when working in the real ocean that you have to deal with as an engineer," said Massion, "but both approaches are very viable."

Eventually the engineers hope that the floats will be able to fight current with current. If a current at one depth, or at the surface, is pushing the float perilously close to the beach, there is often a current at another depth flowing offshore. In theory, the float need only find the depth at which the offshore current is flowing. Finding that current is a big challenge—one that Massion and his team are still tackling.

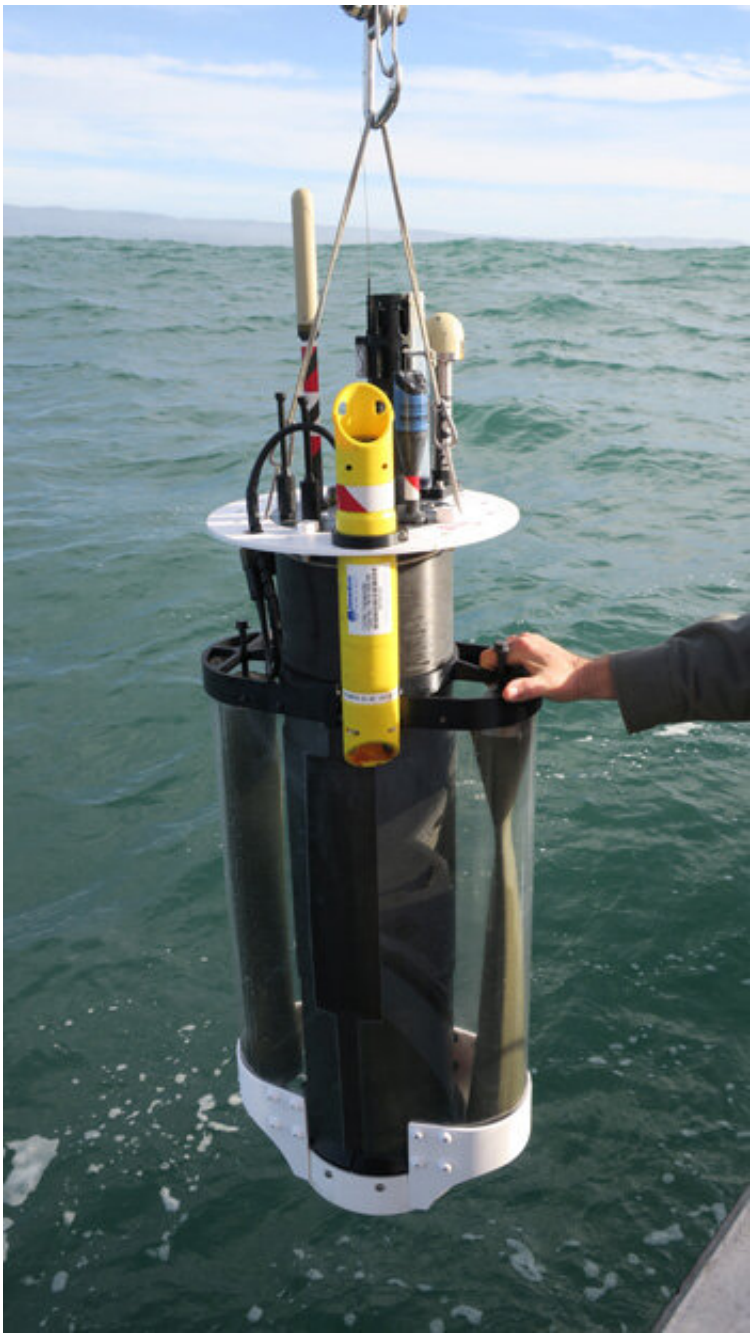
Massion is also testing inertial measurement units (IMUs), like those used in some of MBARI's robots, to determine which direction the float is moving. This technology is very expensive but keeps getting cheaper and better.

Testing in the water

Over the last year or two, Massion and his fellow engineers have worked out most of the bugs and tested the mechanical aspects of the float. "The thing worked great; it went up and down; we controlled velocity, we held depth; It was awesome," said Massion. Now the team's scientists want to

demonstrate its functionality by running science missions. In scientific applications, data do all the talking.

One group of MBARI researchers has already conducted preliminary experiments using a coastal profiling float in Monterey Bay. The prototype float, equipped with a sediment trap to collect sinking particles of organic material (food for deep-sea animals), spent a day hovering around 130 meters (426 feet) below the surface, sampling at six-hour intervals. MBARI scientists are still analyzing the data from this experiment.



A coastal profiling float with external bladders on the sides of the instrument. Credit: MBARI

Later this year, the team plans to place three prototype coastal profiling floats in a triangular array in Monterey Bay. Every spring and summer,

large algal blooms appear off the northern coast of the bay. The researchers expect that these floats will help identify the source of the nutrients that fuel these blooms. These floats will be deployed for a month or more. If needed, the scientists can collect them, recharge their batteries, and send them back out.

The researchers hope that coastal profiling floats can also be used to study low-oxygen "dead zones" —areas of the ocean where most marine life dies or leaves due to low-oxygen levels. Outside of coastal regions, the float could prove useful studying Arctic and freshwater systems. The large bladder will work well in such areas, where melting ice or coastal river outfalls result in low-density fresh water at the surface and increasing density with depth.

The floats currently carry instruments that measure oxygen, nitrate, pH, temperature, salinity, particles, sunlight, and chlorophyll (an indicator of algae). Sensors can be swapped out or added on according to scientists' needs. "Right now, the float is more like a pickup truck than, let's say, a Ferrari," said Johnson. As the researchers continue to refine the float design, he foresees both the floats and the instruments becoming more streamlined and compact.

"With these instruments, we can measure the basic pulse of the ocean," said Johnson, "If there are problems in an area, we can then direct ships to conduct more detailed studies." For the time being, these floats will provide scientists with enough data to get a read on the health of the patient.

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