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Scientists hope to solve mystery of algae blooms in open ocean

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Researchers are trying to discover how microscopic algae can flourish in open ocean areas with few nutrients. University of Washington researcher Rick Rupan, aboard the University of Hawaii vessel Ka'imikai-O-Kanaloa, prepares to release an Apex float with an oxygen sensor and a spectrometer to measure nitrate concentrations in sea water.

Scientists are deploying a fleet of robotic instruments in Hawaiian waters to try to solve an oceanographic puzzle: how microscopic algae thrive in vast ocean areas with few nutrients needed to grow and reproduce.

University of Hawaii microbial oceanographer Dave Karl has been collaborating with chemical oceanographer Ken Johnson of the Monterey Bay Aquarium Research Institute and oceanographer Stephen Riser of the University of Washington on investigations of mid-ocean algae.

Oceanographers for nearly three decades have been trying to solve the mystery of how the tiny algae can flourish in surface waters of vast open-ocean areas with almost no nitrate, an essential algal nutrient, or other plant nutrients.

There isn't enough sunlight for algae to grow below about 330 feet, yet somehow it's obtaining nitrate from deeper waters, the scientists reported in a recent issue of the journal Nature.

This finding is significant because it will help to predict how open-ocean ecosystems could respond to global warming, they said.

Karl said two kinds of underwater robots—floats and gliders—are being used at Station ALOHA, a Hawaii Ocean Time series (HOT) research site about 60 miles north of Oahu where scientists have monitored the ocean since 1988.

The Apex floats, or robotic drifters, are equipped with oxygen sensors and a custom version of an In-Situ

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Ultraviolet Spectrophotometer developed by Johnson that measures nitrate concentrates in sea water.

The drifter floats around in the ocean and periodically goes up and down to profile the water column, said Karl, director of the Hawaii Center for Microbial Oceanography, Research and Education at UH-Manoa.

"We keep it down most of the time, out of the lighted zone at 1,000 meters or so to keep things from growing on it, and it pops up every five days and makes a series of measurements."

The gliders can move into and around currents and can be directed to go to designated locations, Karl said, adding that four are being deployed in Hawaiian waters for his program in the coming weeks.

"One glider will follow a float, which will go up and down, and the glider will go horizontal and vertical, to map the entire region around the float," he said, adding it is hoped that the combined instruments will provide a three-dimensional ocean view.

More floats will be deployed around Hawaii in the next year or two and also near Bermuda in the mid-Atlantic, in the far North Pacific and in the Southern Ocean, according to a news release on the recent experiments.

These ocean studies are important because algae remove huge amounts of carbon dioxide from the Earth's atmosphere and help control climate, the scientists pointed out.

Instruments on the first drifter, placed off Oahu in December 2007, showed a gradual increase in oxygen concentrations in the upper 330 feet of the ocean, the researchers said. The float also detected a gradual decrease in nitrate concentrations in deeper waters.

The oceanographers found that the amount of oxygen produced near the surface through photosynthesis was directly proportional to the amount of nitrate being consumed in deeper water.

They still don't know how the algae obtain deep ocean nutrients but said data show swirling ocean eddies carry nitrate to about 230 feet below the ocean surface.

Planning has started for a comprehensive study later this summer at Station ALOHA including the robots, a research vessel, an airplane and the space station, Karl said.

Funding also has been requested from the National Science Foundation to place someone at Station ALOHA for six-month periods for one year "to really understand the features we're missing by going out once a month," he said.

A research vessel, an airplane and the space station are being coordinated to join the robots in looking at certain ocean properties, Karl said.

"We thought the ocean was constant for years and years and it's not," Karl said. "It's constant maybe for days and days, then it changes. It's becoming a huge puzzle to figure out what's driving short-term variability. ... coupled with the physical processes that we don't understand either."