# Researchers give new hybrid vehicle its first test drive in the ocean

February 7 2008

Taking a page out of a science fiction story, researchers from the Woods Hole Oceanographic Institution (WHOI) and Webb Research Corporation (Falmouth, Mass.) have successfully flown the first environmentally powered robotic vehicle through the ocean. The new robotic “glider” harvests heat energy from the ocean to propel itself across thousands of kilometers of water.

In December 2007, a research team led by oceanographers Dave Fratantoni of WHOI and Roy Watlington of the University of the Virgin Islands launched a prototype “thermal glider” off the coast of St. Thomas. The vehicle has been traveling uninterrupted ever since, crisscrossing the 4,000-meter-deep Virgin Islands Basin between St. Thomas and St Croix more than 20 times.

Engineers and researchers--including research associate John Lund and postdoctoral investigator Ben Hodges from WHOI, and engineers Clayton Jones and Tod Patterson of Webb Research--project that the thermal glider could continue its current, “green-powered” mission for as long as six months.

Unlike motorized, propeller-driven vehicles, gliders propel themselves through the ocean by changing their buoyancy to dive and surface. Wings generate lift, while a vertical tail fin and rudder allow the vehicles to be steered horizontally. Gliding underwater vehicles trace a saw-tooth profile through the ocean’s layers, surfacing periodically to fix their positions via the Global Positioning System and to communicate via

Iridium satellite to a shore lab.

“Gliders can be put to work on tasks that humans wouldn’t want to do or cannot do because of time and cost concerns,” said Fratantoni, an associate scientist in the WHOI Department of Physical Oceanography. “They can work around the clock in all weather conditions.” The vehicles can carry a variety of sensors to collect measurements such as temperature, salinity, and biological productivity. Gliders also operate quietly, which makes them ideal for acoustic studies.

Though the thermal glider is not the first autonomous underwater vehicle to traverse great distances or stay at sea for long periods, it is the first to do so with green energy. Most gliders rely on battery-powered motors and mechanical pumps to move ballast water or oil from inside the vehicle’s pressure hull to outside. The idea is to increase or decrease the displacement (volume) of the glider without changing its mass.

The new thermal glider draws its energy for propulsion from the differences in temperature—thermal stratification—between warm surface waters and colder, deeper layers of the ocean. The heat content of the ocean warms wax-filled tubes inside the engine. The expansion of the warming wax converts heat to mechanical energy, which is stored and used to push oil from a bladder inside the vehicle’s hull to one outside, changing its buoyancy. Cooling of the wax at depth completes the cycle.

“We are tapping a virtually unlimited energy source for propulsion,” said Fratantoni. The computers, radio transmitters, and other electronics on the glider are powered by alkaline batteries, which are, for now, the principal limit on the length of operation. Webb Research is working to reduce the electrical needs of the instruments, while also developing the capability to convert some of the thermal energy to power for the electronics.

The thermal glider concept was conceived in the 1980s by Doug Webb, a former WHOI research specialist who founded the Webb Research Corporation. Webb collaborated extensively with renowned WHOI physical oceanographer Henry Stommel, who championed the idea to the U.S. Navy and the oceanographic community. Stommel even penned a science fiction story—published in the journal *Oceanography*—about a fleet of Webb's gliding sentinels bobbing through the ocean. Webb and Stommel named the vehicles "Slocum" gliders for Joshua Slocum, the first man to single-handedly sail around the world.

Over the past decade, Fratantoni's Autonomous Systems Laboratory has become Webb's chief scientific partner in Woods Hole, testing and deploying the gliders in various underwater environments. Several battery-powered Slocum gliders have been deployed in shallower waters for coastal studies, for acoustics and marine mammal research, and for studies of currents and ocean circulation.

Recent funding for scientific missions and field testing of the glider system has been provided by the U.S. Office of Naval Research and the Grayce B. Kerr Fund.

"The current mission is an engineering test-drive, but it's also occurring in a scientifically compelling location," said Fratantoni. Swirling water currents, known as eddies, form upstream of the Virgin Islands. The data collected by the new glider system will help researchers understand how these eddies affect regional circulation and redistribute the larvae of coral reef fish and man-made pollutants.

The engineering trial for the thermal glider is the first step in a broader plan by Fratantoni and colleagues to launch a fleet of gliders for studies of the waters in the subtropical gyre of the North Atlantic, a key region for assessing the ocean's response to climate change. He plans to test the glider with a trip from St. Thomas to Bermuda later this spring.

Source: Woods Hole Oceanographic Institution