Glider Sampling of the Solomon Sea

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1. PROJECT SUMMARY

The Solomon Sea Glider Project has two principle objectives: first, to demonstrate newly-developed glider technology as a sustainable means of measuring swift western boundary currents, and second, to use this new instrument to monitor the inflow towards the equator from the South Pacific, which is thought to contribute to the variability of El Niño.

Ocean gliders are small autonomous vehicles based on Argo float technology (see http://www-argo.ucsd.edu/FrAbout_Argo.html/), whose only propulsion is to pump oil in and out of an external bladder. This makes the glider sink and rise in the water, and with its wings it slowly glides forward. It typically dives to 700m depth over 3-4 hours, gliding about 25 kilometers per day, while reporting its data and receiving instructions by satellite each time it surfaces. Although the glider moves slowly, it uses very little power and operates unattended for 4 to 6 months, so it covers a substantial distance. It measures profiles of temperature and salinity, and the current velocity is inferred from the glider's motion. The glider has three important advantages over previous technology: it can be deployed and recovered entirely by small boats near shore, making the operations much cheaper and more flexible than a research ship; it makes continuous observations for much longer periods than is practical for a research ship; and it makes densely-spaced profiles right up to the coast. For these reasons, ocean gliders are likely to play a large role in climate monitoring of the ocean, especially for sampling narrow coastal currents. The Spray glider used in this project is designed and built by the Instrument Development Group at the Scripps Institution of Oceanography, funded by NOAA's Climate Program Office as a new tool for the climate observing system. All aspects of the program are a collaboration among scientists and engineers at NOAA/PMEL, Scripps, and the French laboratory IRD in Noumea, New Caledonia.

The Pacific Ocean circulation encompasses a great overturning cell in which cool, salty water sinks in the subtropics, flows at depth towards the equator, and upwells back to the surface in the eastern equatorial Pacific. Variations of the cell produce slow changes in the temperature of equatorial water, which can then influence the occurrence and strength of El Niño events. Because El Niños affect weather of the entire Pacific and beyond, fluctuations of the overturning cell play a major role in the year-to-year and decade-to-decade variations in climate.

Observations show that perhaps 70% of equatorial upwelling due to the overturning cell originates from the South Pacific, with a large fraction arriving via the narrow boundary currents in the Solomon Sea. (Such powerful western boundary currents are analogous to the Gulf Stream, but flow towards the equator in the tropics). However, measuring these currents has lagged other elements of the circulation because the region is remote and difficult to work in, with strong narrow filaments of current flowing among a complex network of islands and reefs; as a result there have been only sparse measurements that have barely outlined the circulation. Producing a time series of this system is recognized as one of the most important challenges in gaining a full picture of the climate of the Pacific.

The Solomon Sea glider project began in mid-2007, and has conducted four deployment cycles (as of October 2008) in continuous rotation since then. Each round-trip mission lasts 3-4 months, crossing the Solomon Sea to within 5km of the coast on each side. In this initial year, the program has demonstrated first, that gliders are capable of sustained sampling of this piece of the climate system relatively cheaply, and second, that the Solomon Sea boundary current system supports dramatic variability, seen especially associated with the La Niña cold event of early 2008. During FY 2009, we propose to continue deployments, pointed towards establishing an ongoing operational monitoring capability, and to use the accumulating glider data to diagnose the circulation in connection with climate model simulations.

2. ACCOMPLISHMENTS

Work done during FY 2008 was aimed at beginning the observations and establishing the local infrastructure for longterm operations.

All previous South Pacific glider work had been one-off experiments done from research vessels and tied to their availability, but the goal of ongoing monitoring requires the ability to work from shore, using local boats and resources. The Solomon Sea glider project began in July 2007, with a deployment from a French ship (R/V Alis, out of Noumea, New Caledonia) off the coast of Papua New Guinea (PNG). This initial deployment represented a commitment to recover the glider from the Solomon Islands in October without any outside assistance. We had never worked on the ground in the Solomon Islands before, so the principal task in FY 2008 was to establish a local infrastructure for these operations. Initial Papua New Guinea and Solomons EEZ clearances had been obtained for the first deployment, but longterm clearances required substantial negotiation.

The program manager (Kessler) traveled to the Solomon Islands in October 2007 to survey ports, and to arrange boat charters, suitable work and storage spaces, customs clearances, and shipping. The port of Gizo was chosen for the operations, as it gives the shortest cross-Solomon Sea distance, has a reliable local charter service and domestic air and sea transport. He also established cooperative liaison with local authorities and with the Solomon Islands Meteorological Service. He spent a week in Port Moresby, PNG, negotiating an extended EEZ clearance for the glider to sample in their national waters. PNG authorities are generally suspicious of international researchers and a requirement of the clearance is that we be available to explain the data and findings to government (weather service) and other local stakeholders.

Recovery/deployment operations were conducted in October 2007, and in February and July 2008 (another is about to get underway in early November 2008). Two people are required for this work. The at-sea glider is steered (remotely) to Gizo and recovered by small boat. It is inspected, dismantled, the internally-stored (engineering) data downloaded, and the instrument prepared for shipping back to the US. The new glider is received from customs, transported to Gizo, assembled and tested, and deployed. All four missions to date have been completed successfully.

Glider oceanographic data (temperature and salinity profiles, and velocity) are received and processed at the Scripps Institution of Oceanography. The initial (raw) data is available online at
http://spray.ucsd.edu/cgi-bin/archive_init.pl?start_archive=ARCHIVE+DATA.
Although these data remain experimental and not appropriate for routine (operational) use, we are

working towards producing a quality-controlled, delayed-mode data set that would be available on the web and suitable for validation of models.

The initial year of work has been successful in three respects: First, the glider has been shown capable of navigating this environment of swift currents amid a complex network of reefs and islands, while making measurements of currents and water properties that can describe the circulation and its variability. This is proof of concept that the technology is suitable for measuring this current system and was the principle objective of the initial year of the program. Second, the operations can be accomplished by a small crew relatively cheaply, and an ongoing infrastructure for operations out of the Solomon Islands has been established. This is essential for the glider's use as a sustained monitoring tool. Third, the year of sampling encompassed the entire sequence of the 2007-2008 La Niña event, and showed the very large signatures of the event expressed in the boundary current variability. This demonstrates that a monitoring program is likely to yield important information about the climate system of the Pacific.

The initial year also showed intense eddy activity in the Solomon Sea that stretches the limits of the glider sampling. To evaluate the extent of aliasing by these eddies, we have directed the glider on several loops in which it is steered back and forth over the same course repeatedly, so the variations on short timescales can be measured and diagnosed. These signatures are being compared with high-resolution model simulations, which can aid both the interpretation of the glider measurements and also evaluate the models fidelity at fine scales.

3. PUBLICATIONS AND REPORTS

Gourdeau, L., W. S. Kessler, R. E. Davis, J. Sherman, C. Maes and E. Kesternare, 2008: Zonal jets entering the Coral Sea. *J. Phys. Oceanogr.*, **38**, 715-725.

Note: This publication describes initial tests of the glider in the nearby Coral Sea, during the year leading up to the Solomon Sea program. This was an essential pilot study of the potential of the Spray glider to operate in nearshore swift boundary current regimes, and to adequately sample the scales involved. It demonstrated the glider's ability to measure both the absolute vertically-average currents and the relative geostrophic currents to within a few km of the coast. This proved crucial in the identification of a previously-unknown boundary current feature, the 80-km-wide North Caledonian Jet.