Upper Ocean Stratification in the Bay of Bengal During Asiri

Eric A. D'Asaro
APL/UW
1013 NE 40th Str
Seattle, WA 98105
phone: (206) 685-2982 fax: (206) 543-6785 email: dasaro@apl.washington.edu

Award Number: N00014-13-1-0504
http://apl.uw.edu/dasaro

LONG-TERM GOALS

In collaboration with Indian oceanographers, we seek to measure and understand the processes controlling the stratification of the upper 100m of the Bay of Bengal and to educate a new generation of young Indian oceanographers in the methods used.

OBJECTIVES

Upper ocean physics plays a key role in controlling the intensity and timing of the Northern Indian Ocean monsoons, with the ocean and atmosphere representing a strongly coupled air-sea interaction system, which in turn plays an important role in climate variability at both regional and global scales. The ASIRI program, a Departmental Research Initiative of ONR's code 32, seeks to understand these interactions through measurement and modeling focused on the Bay of Bengal. Existing coupled ocean-atmosphere models in this region show little skill in predicting the summer monsoon, particularly its IntraSeasonal Oscillations (ISO). One possible cause is a poor simulation of the air-sea interaction processes. The northern Bay of Bengal has strong ISO fluctuations in SST, which lead the monsoonal fluctuations by about a week, thereby suggesting a causal relationship between monsoon ISO variations and ocean dynamics. However, most existing models predict surface temperatures that are too cold and mixed layer depths that are too deep. The biases are large and likely reduce the intensity of air-sea interaction by overestimating the thermal inertia of the upper ocean and thus the time scale on which the ocean can respond to the atmosphere. A likely reason for this bias is an improper representation of the role of freshwater input, both from rain and from the enormous river inflow into the northern Bay of Bengal. Specific goals for this grant are:

- Measure the salinity and temperature stratification of the upper 100m with a particular emphasis on the upper 10m and mixed layer, if any, throughout the annual cycle including the summer monsoon and the ocean response to it and recovery from it.
- Understand the relative importance of vertical processes, as represented by wind, flux and wave driven boundary layer models, internal wave mixing, and lateral processes, as represented by submesoscale-resolving process models, in setting the stratification and upper ocean circulation.

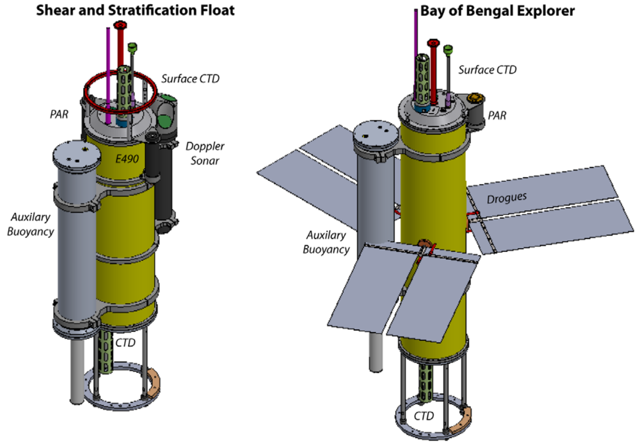

Fig. 1. Two ASIRI floats current under construction for the November 2013 OMM pilot.

APPROACH

Since the early 1990s, ONR has supported the development and use of 'Lagrangian Floats" designed, built and operated at the Applied Physics Laboratory, University of Washington. These are robust platforms for studying upper ocean processes, capable of carrying a wide variety of sensor suites (we have integrated about 30 different sensors) and particularly designed to accurately track water parcels in three-dimensions. They are fully autonomous using Iridium communications for control and data transfer.

A particular challenge for all buoyancy driven vehicles (floats and gliders) in the Bay of Bengal is the presence of very fresh, low density water near the surface, which can prevent such vehicles from profiling all the way to the surface and/or lifting their satellite antennas far enough out of the water to communicate. Salinities as low as 21 psu, can occur here during and after the summer monsoon. Spanning the density range between this and the 100m depth, would require nearly all (~550cc) of the available (650cc) buoyancy control of a standard Lagrangian float.

Two Lagrangian floats are currently under construction for this work with specialized sensors for the Bay of Bengal. The Shear and Stratification Float (SSF) is designed to be deployed from a ship and measure the near-surface shear and stratification in detail. The Bay of Bengal Explorer (BBE) is designed for long-term (6+ months) operation, measuring stratification and turbulence. Systems on these floats are:

- 2 standard SBE-41CT ctd's, on the top and bottom of the float, measure salinity and temperature. Two sensors are needed given the strong density gradients to properly ballast the float and for redundancy since these are crucial sensors for float operation.
- A special Seabird 'Surface CTD' designed to rapidly profile the near-surface salinity as the float penetrates the surface on an upward profile. These sensors will provide very high vertical resolution near the surface where the Bay of Bengal stratification is very strong.
- Light sensors, designed to measure light level as a function of depth and thus the optical clarity of the water. This is crucial for determining the heating of the upper layer. The BBE has PAR sensor equipped with a window-wiper that actively removes fouling of the optical window. In previous deployments, we have found this to be very effective. The SSF has both a PAR and a 490 nm sensor in order to provide a more detailed view of the light field.

- A new auxiliary buoyancy module attached to the side of the float. This doubles the buoyancy control of the float by duplicating the current internal buoyancy system and thus allows the float to easily overcome the large salinity variations in the Bay of Bengal.
- The usual pressure sensors, Iridium communications, ARGOS backup system and software controlling a customized ASIRI float mission. The typical mission will alternate profiles to the surface with extended drifts of the float within the surface boundary layer to measure the turbulence levels and surface waves.

The two floats described above will be deployed the northern Bay of Bengal as part of the OMM pilot in November-December 2013. This will be done in collaboration with Drs. Debasis Sengupta, G. S. Bhat (COAS, Bangalore) and M. Ravichandran (INCOIS, Hyderabad). Work will be done from the *R.V. Sagar Nidhi.* Eric D'Asaro and Michael Ohmart, the technician who builds the floats, will participate in the cruise. We will assist our partners in installing and operating an underway CTD on the ship and work with them and their students to help design the experimental strategy and help to facilitate cooperative measurements with the *R.V. Revelle*. The SSF will be deployed from the ship for periods of a few days and recovered at the end of the cruise. The BBE will be deployed for many months and recovered by an Indian ship in 2014, reconditioned and redeployed by our Indian colleagues with the goal of obtaining a year-long record.

Collaboration with be facilitated by joint analysis of the data with one or more Indian postdocs or students will work on the analysis at APL/UW on Indian funds. Eric D'Asaro expects to make additional trips to India during FY14.

WORK COMPLETED

There has been no fieldwork conducted yet. Planning meetings have been held at Woods Hole in 2011, at IITM Pune and in Columbo, Sri Lanka in 2012 and in Boston and Scripps in 2013. A meeting in October 2013 at INCOIS Hyderabad is anticipated. In February 2013, Eric D'Asaro and Craig Lee travelled to NIOT Chennai, INCOIS Hyderabad, NIO Goa and NCAOR Goa in order to build future collaborations.

RESULTS

No scientific results yet.

IMPACT/APPLICATIONS

None

PUBLICATIONS

None