Arabian Sea Fronts and Barrier Layers

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LONG-TERM GOALS

The long-term goal is to understand the upper-ocean dynamics in the Arabian Sea and its relationship with the Indian Ocean monsoons and regional climate in general.

OBJECTIVES

The primary objective of this project is to characterize small-scale watermass interleaving, subduction, and barrier layer formation at thermohaline fronts in the interior Arabian Sea.

Specific science questions are:

1. What combination of air-sea interactions and upper-ocean physical processes control mixed layer properties and upper ocean water mass modification in the interior of the Arabian Sea?
2. What are the scales, structure, and seasonality of these processes? How do they relate to semi-annual or monsoonal cycles?
3. What are the distributions of "special cases" ("barrier" and "compensated" layers)? How are they formed, where do they go, how do they disappear?
4. What role do the barrier layers play in warm pool formation and monsoon initiation?

APPROACH

The technical approach is "cooperative autonomy" – using an array of autonomous platforms to conduct coordinated adaptive surveying in a drifting (quasi-Lagrangian) frame of reference (Fig. 1). The core of the observational array will be a group of 3 gliders flying in an equilateral triangle formation. The glider formation will circle one of the drifting Wirewalker profilers providing a quasi-Lagrangian reference point. A second wirewalker profiler will be initially deployed in close proximity; it is expected that it would take a different drift path, so that the growing separation between the two will allow us to assess scale-dependent covariances. The broad-scale context will be established by concurrently deployed surface drifters and profiling floats. The surveying will also be guided by remote sensing imagery and coupled numerical simulations.

Key individuals: NASCar Interior Dynamics working group (17 members).

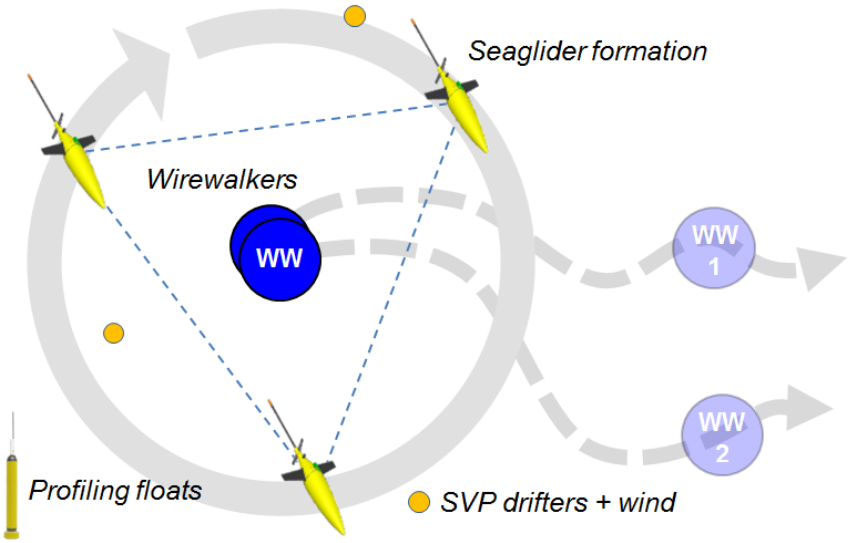

Figure 1. Schematics of the "cooperative autonomy" technical approach.

WORK COMPLETED

The project is in the early stages of planning of the field experiment. During the NASCar planning meeting in June 2015, the key observational objectives of the DRI were identified. Following the meeting, I led a working group drafting the science and experiment plan for the NASCar observational objective #3: Upper-ocean Dynamics of the Interior Arabian Sea. A working document and the discussion summary are available at https://goo.gl/3AjGdl.

In the coming months, the scientific plan will be reconciled with the available NASCar resources and overall program goals and priorities. Preliminary work to identify the optimal experimental site will commence in late 2015, tentatively followed by a reconnaissance deployment of autonomous instruments in summer of 2016.

RESULTS

The NASCar fieldwork is scheduled to start in 2016. There are no scientific results to report to date.

IMPACT/APPLICATIONS

Improved understanding of the upper-ocean processes in the Arabian Sea and their role in warm-pool formation and monsoon initiation will enable accurate prediction of the coupled ocean-atmosphere system that governs the climate of the Northern Indian Ocean.

RELATED PROJECTS

NASA Salinity Processes in the Upper-Ocean Regional Study (SPURS, http://spurs.jpl.nasa.gov/) investigates the processes governing upper-ocean dynamics in extreme high-salinity (tropical Atlantic) and low-salinity (tropical Pacific) regimes. Preliminary results of SPURS suggest an important role for

frontal processes during the initial stages of high-salinity water subduction [Shcherbina et al., 2015]; these observations are directly relevant to the NASCar scientific objectives and will guide the planning of the interior Arabian Sea field efforts. Some aspects of the NASCar's "cooperative autonomy" technical approach will be tested during the SPURS-2 field experiment in 2016 – 2017.

REFERENCES

Shcherbina, A.Y., E.A. D'Asaro, S.C. Riser, and W.S. Kessler (2015). Variability and interleaving of upper-ocean water masses surrounding the North Atlantic salinity maximum. Oceanography 28(1): 106–113, http://dx.doi.org/10.5670/oceanog.2015.12.