Subtidal Dynamics of the Vietnamese Shelf: Ship- and Glider-Based Observations of Hydrographic Structure and Circulation

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LONG-TERM GOALS

The long-range scientific goal is to understand the dynamics of the subtidal circulation over a continental shelf heavily impacted by seasonal changes in wind and buoyancy forcing. Fundamental understanding of coastal circulation depends on the relative roles and feedbacks between forcing, stratificaiton and turbulent mixing. To advance our understanding, we need observations on continental shelves with large contributions from wind, buoyancy and turbulent mixing. The Vietnamese Shelf and slope is the ideal test case, because of strong seasonal monsoon wind forcing, large buoyancy inputs from the Mekong, Red and numerous smaller rivers, and the potential for highly variable mixing rates associated with winds, tides and large amplitude nonlinear internal waves.

OBJECTIVES

The objectives are to characterize the hydrographic structure, circulation and bio-optical properties over the Vietnamese shelf during the summer (monsoon/upwelling) and winter (downwelling) seasons, and evaluate the competing roles of wind and buoyancy forcing in the seasonal dynamics over the shelf. Specifically, we will test the hypotheses:

1. *During the Winter,* downwelling favorable winds prevail, yielding southward flow over the shelf and slope. One or more salinity fronts should be found at any time: one relatively nearshore, reflecting local outflows, and one closer to the shelf edge, related to integrated regional freshwater outflows. These fronts ought to be clearly associated with along-front jets and some level of submesoscale activity analogous to that found at the shelfbreak front in the Middle Atlantic Bight. Stratification ought to be relatively weak away from the fronts, due to enhanced mixing from strong winds, tides and large amplitude internal waves.

2. *During the Summer,* wind-driven coastal upwelling should dominate over the shelf and should disperse fresher waters offshore without forming substantial salinity fronts. Thus, buoyancy forcing ought not to be very evident. Over the slope, a northward seasonal boundary current ought to form and be associated with energetic eddies and

meanders. There ought to be associated rapidly flowing filaments of cooler water offshore of the shelf break. The exact relation of the filament waters to shelf flow patterns is not likely to be obvious.

In addition, our goal is to foster the scientific collaboration between US and Vietnamese scientists, developing new observational capabilities and creating direct connections for scientific exchange. Specifically, we seek to establish a glider "endurance line" off Vietnam, similar to what we have achieved off the coast of Oregon, maintained by Vietnamese scientists trained at OSU. Other activities to develop scientific exchange include teaching short courses in oceanography and ocean observing.

APPROACH

We propose two major activities. First, we propose to conduct coordinated glider-based and ship-based surveys on cruises that occur during upwelling/monsoon (summer) conditions and during downwelling (winter) conditions. Second, we propose the establishment of a glider endurance line off Vietnam, repeating NAGA sections that have not been occupied since the early 1960s, operated by Vietnamese scientists trained at OSU.

We propose to conduct coordinated ship-based and glider-based surveys of the shelf and slope during two or more cruises (at least one during summer upwelling/monsoon conditions and the other during winter downwelling conditions). The ship-based surveys will be conducted using a towed instrument platform (e.g., SeaSoar, MVP, MiniBat) and ADCP. The towed platform will be outfitted with CTD and bio-optical (chlorophyll, backscatter, CDOM, nitrate and dissolved oxygen) sensors. OSU has a MiniBat, MVP and SeaSoar. The OSU MiniBat is fully outfitted and ready to be deployed. The OSU MVP (PI: Levine) is currently being used as part of the LatMix DRI, but could be available for 2012 or 2013. The OSU SeaSoar (part of an NSF facility) is functional, but would need some refurbishment to prepare it for operation. Ship-based surveys would focus on the cross-shelf hydrographic structure over the shelf and three-dimensional structure at the shelfbreak. In addition to the ship-based measurements, we propose to simultaneously deploy AUV gliders (1-2) to provide detail on along-shelf variability. The ship-based surveys could be conducted from either Vietnamese or US ships.

We propose to establish a glider endurance line off Vietnam in collaboration with Vietnamese scientists. Specifically, we proposed to recreate the 1959-1961 NAGA expedition, using AUV gliders. We propose train the Vietnamese scientists by inviting and supporting them to visit OSU for a 1-2 month period, integrating them into the OSU glider endurance line operations and holding training sessions on glider operations. We propose to purchase two gliders for use on the Vietnamese endurance line. Gliders can be deployed from small boats, following methodology developed off Oregon. We assume that some of the operating costs can be borne by the Vietnamese scientists.

WORK COMPLETED

To date, we have completed several planning workshops with US and Vietnamese colleagues. The objectives in these meetings has been to establish shared scientific goals and identify PIs from VN and US to lead work related to these efforts. My research is focused on two of the key science goals:

Subtopic 1: Seasonal changes in upwelling, coastal circulation and biogeochemistry of the Vietnamese shelf and East Sea

Subtopic 4: Seasonal-to-Interannual changes in the physics and biogeochemistry of the Vietnamese East Sea, including changes since the NAGA Expeditions

In addition to planning, we have also been successful in bringing the RV Revelle to Da Nang, Vietnam from Jun 21-29, and conducting two major training efforts on modern oceanographic instrumentation, experiment design and ship-based field work.

Figure 1: Participants in the June 26-27 2012 training onboard the RV Revelle.

Currently, we are planning for the 29 Mar – 09 Apr pilot cruise, determining what observational and training activities will be conducted. In addition, we are also in the process of purchasing two new AUV gliders for deployment and surveying the previous NAGA expedition stations.

RESULT

Our results are more organizational and less scientific. We have learned what the shared scientific goals are for US and VN scientists, and we have established ties with key VN researchers that will facilite future research.

IMPACT/APPLICATIONS

Collecting observations on the Vietnamese shelf and slope will expand our understanding of shelf circulation, because no other system has the combination of wind and buoyancy forcing.