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Adaptive Glider Studies of Synoptic Frontal Variability during the Shallow Water 2006 Experiment

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LONG-TERM GOALS

The long-range goals of this research are to understand the dynamics of complex frontal variability, such as how fronts interact with wind, internal waves and bottom topography, and to understand how frontal variability influences optic and acoustic properties over the shelf.

OBJECTIVES

The specific objectives of the research are to characterize the synoptic three-dimensional structure and evolution of the shelf-break front and to provide adaptive, real-time in situ observations in support of the Shallow Water Acoustics Experiment (SW06) and the Non-Linear Internal Waves Initiative (NLIWI).

APPROACH

The Shallow Water Acoustics Experiment (SW06) and the Non-Linear Internal Waves Initiative (NLIWI), two major ONR sponsored efforts for 2006, were conducted on the outer continental shelf of New Jersey during the highly stratified summer season. The experiments pooled a wide variety of resources from numerous Navy and academic groups. I deployed an autonomous underwater vehicle (AUV) glider in collaboration with Rutgers University (R.U.) Coastal Ocean Observation Lab (COOL) PIs (Glenn and Kohut) and their AUV glider fleet. These valuable observations for describing the time-evolution of the three-dimensional environment are extremely useful for placing the intensive SW06/NLIWI observations in a broader spatial and temporal context.

Long-duration autonomous underwater gliders are rapidly gaining acceptance within the Navy fleet as a cost effective means to collect environmental data for assimilation into physical oceanographic models and coupled acoustic or bio-optical models. OSU has two Slocum Electric Gliders (Figure 1), delivered in early 2005, built by Webb Research, that are similar to gliders currently in operation for coastal ocean studies at Rutgers University (Glenn et al., 2004). The Slocum Glider is an autonomous vehicle which moves through the ocean by changing its buoyancy; wings and a tail rudder allow steerable gliding, generating horizontal propulsion much like a sailplane. The OSU Slocum Gliders are equipped with SeaBird Electronic conductivity-temperature-depth sensors, WET Labs' sensors for chlorophyll fluorescence, CDOM fluorescence and single-wavelength light scattering, and Aanderaa dissolved oxygen sensors. The gliders undulate from the surface to a maximum of 200 m depth at a forward

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speed of 0.2-0.4 m/s (resulting in sub 1 km along-track resolution), and have a maximum endurance of 30 days. The gliders navigate using GPS and internal dead reckoning. While at the surface, the gliders communicate using RF modem (about 20 mile range in low sea state), Iridium satellite modem (primary), and ARGOS satellite (mainly as a backup). The gliders can transmit data stored during previous undulations and receive new instructions that change or alter its current mission. The gliders are 1.5 m long, weigh 52 kg (in air) and are easily deployed and recovered by 2-3 people from a small boat.



Figure 1: The OSU Slocum gliders during operations on the central Oregon Shelf.

WORK COMPLETED

In mid-July 2006, we deployed the OSU glider “Jane” on the New Jersey shelf along with a Rutgers glider. Jane completed her three week mission in early August, covering 400 km of distance traveled, collecting 7 cross-shelf transects and 2900 profiles. We successfully achieved integration of the OSU glider within the Rutgers glider operations, and control was maintained at both OSU and Rutgers. An OSU glider technician and I were at Rutgers for about a week surrounding deployment and recovery. We shared our limited expertise with Rutgers, and transferred Rutgers greater experience and capabilities to our own operations where applicable.

RESULTS

The glider observations show detailed horizontal and vertical hydrographic structure, including extremely strong stratification (top-to-bottom density differences of 7 or more sigma-t units), variations in the position of the shelfbreak front, propagating nonlinear internal waves and high salinity intrusions of slope water onto the continental shelf (Figure 2). The observations show large cross-shelf scales for very thin high salinity intrusions riding along the intense thermocline. These salty intrusions are potential an important mechanism for cross-shelf exchange (Lentz, 2003).

IMPACT/APPLICATIONS

The AUV glider observations will be essential for detailing the three-dimensional mesoscale structure impacting the internal wave and acoustics fields. The glider observations will be used in assimilative modeling schemes. The observations of salinity intrusions will be applicable to a wide extent of the

Middle Atlantic Bight and other continental shelf systems, improving our knowledge of cross-shelf exchange in the coastal ocean.

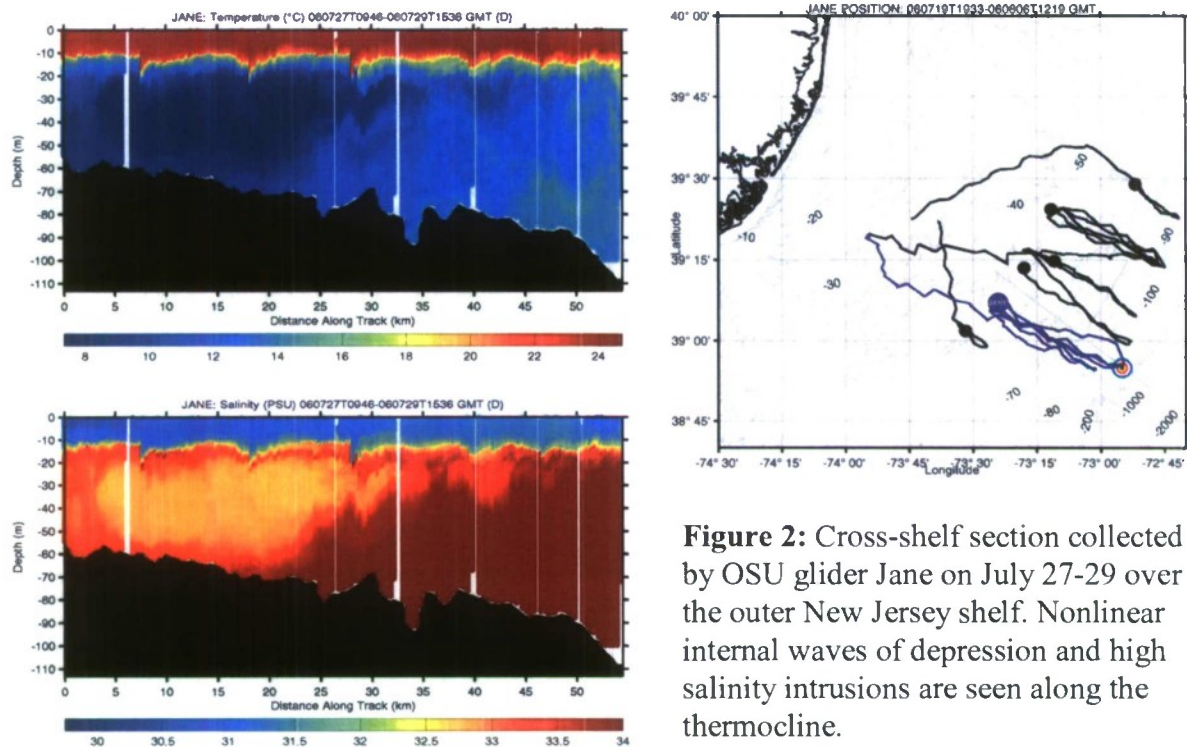


Figure 2: Cross-shelf section collected by OSU glider Jane on July 27-29 over the outer New Jersey shelf. Nonlinear internal waves of depression and high salinity intrusions are seen along the thermocline.

RELATED PROJECTS

The OSU gliders have been used off the central Oregon shelf since May 2005, in conjunction with the extensive observational system now in place, including HF radar (Kosro), moorings (Levine/Boyd/Kosro), satellites (Strub), assimilative modeling (Allen/Samelson/Kurapov) and ship-based observations (Barth). Beginning in April 2006, Barth and I have maintained glider observations along the Newport endurance line off the central Oregon coast, collecting more than 50 cross-shelf sections and 10,000 profiles, and over 4000 km of distance travelled. The glider observations are important, because they reveal the interior processes that influence the more easily observed surface properties. The experience gained from the 2006 NLIWI/SW06 experiments have benefited the fledgling glider operations at OSU.

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