ENDEAVOR 283 CRUISE SUMMARY: PRIMER II

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The second cruise of the shelf-slope PRIMER occurred aboard R/V ENDEAVOR from 5 May-11 May, 1996. This served as a pilot cruise for the intensive summer field program to be carried out in July, 1996. The purpose of the pilot was two-fold: (1) to test the shallow water configuration of the SeaSoar (including the bottom-avoidance system), and (2) to re-occupy the slopewater mooring line using standard hydrography. As described below, the cruise was a complete success in both regards.

Slopewater Hydrography

Several hours after leaving port, the shelfbreak portion of the mooring line was sampled with 23 CTD stations spaced roughly 3.5 km apart in conjunction with shipboard ADCP measurements.

This was a re-occupation of the same section occupied last December during PRIMER-I (and will by occupied on all the PRIMER cruises). As seen in Figure 2, the difference in temperature structure between the two seasons (late-fall and mid-spring) is striking. In fall the shelf water is nearly uniform near the surface (presumably influenced by local overturning), whereas in spring a seasonal thermocline has developed atop very cold and nearly neutrally-stable water. Also intriguing is the fact that the shelfbreak front occurs near 14 degrees C in the December occupation, but is much closer to the historical value of 10 degreesC in May. This warrants further investigation, including consideration of the influence of a nearby ring during the fall cruise. The two shelfbreak ADCP moorings (marked in Figure 2), in conjunction with the slopewater moorings further offshore, will undoubtedly help in our study of the frontal variability and its associated dynamics.

After a break for SeaSoar operations following the shelfbreak survey, we returned to hydrography and finished the slopewater line. These were deep casts using a 24-bottle rosette, and included sampling of CFCs by W. Smethie's group at LDEO. It is the fourth such occupation of this section (including PRIMER I) using WOCE-quality hydrography and concurrent LADCP/POGO measurements of absolute velocity. Figure 3 shows the salinity section from PRIMER II overlayed on the alongstream velocity field from the LADCP. At mid-depth in the slopewater the most conspicuous water mass feature is a broad salinity minimum centered at 1500 m due to the Labrador Sea water advecting equatorward. This feature has been growing in intensity since our first occupation of the section. The synoptic velocity field shows a broad jet-like feature of > 10 cm/s also at mid-depth: at present we have little understanding of such features (it should be remembered that these velocity measurements represent the first direct sampling of the entire slope; by the conclusion of PRIMER we'll have 7 synoptic sections in addition to the moored measurements to quantify the slopewater circulation.)

Another feature of note in Figure 3 is the pronounced fresh water cap which extends over most of the line, presumably comprised of shelf water. This layer is interrupted by one of two lenses of Gulf Stream water which penetrate vertically to 300 m. The interaction of shelf and Gulf Stream water is of considerable importance to our study and will be carefully examined using the joint data sets collected in PRIMER.

SeaSoar Operations

SeaSoar operations commenced shortly after the completion of the shelfbreak CTD line. The initial deployment was at the 1000 m isobath in order to ensure deep water beneath the SeaSoar for the initial testing. The SeaSoar configuration for these tests included new skids added to the vehicle body in the event of contact with the bottom. After running several hours of undulations, the SeaSoar developed erratic, tumbling motion. The vehicle was recovered and immediate inspection revealed that one of the skids was angled away from the body at a 45 degree angle and was nearly hitting the outer edge of the wing. After removing the skids, the SeaSoar flew perfectly for several more hours, while numerous transects across the slope were sampled. These revealed further evidence of shelf streamers over the slope, with horizontal scales as small as 5 km. The slopewater distribution was extremely complicated with numerous subsurface salinity maxima which appear to have been fragments of a warm-core ring which had coalesced with the Gulf Stream shortly before the cruise.

After the slopewater CTD stations were sampled, we proceeded to the shelfbreak (towing SeaSoar along the TOPEX altimeter line to compliment the discrete deep water CTD stations). The first crossing of the front required maneuvering past numerous long-lines and lobster pots, so that the SeaSoar was primarily limited to the upper 5 m of the water column. Next, the bottom avoidance system was tested by running along the 130 m isobath. The bottom avoidance system, which involved choices between the ship's chirp sonar, EDO doppler log, and vehicle-mounted altimeter, worked extremely well, and we were able to run in an automated mode consistently within 10 m of the bottom. Three additional cross-frontal transects were sampled, all during the daylight hours. During one crossing, the SeaSoar briefly touched the bottom with no adverse effects.

The shelfbreak sections revealed extremely sharp gradients within the frontal region (Figure 4). The slopewater immediately offshore of the front contained localized salinity maxima of as much as 35.5 PSU, which were probably additional remnants of the ring entrained in the front. Temperature gradients were as large as 6 degrees C in 3 km across the front. As time progressed, crossing the front became less interrupted due to fishing activity as the bridge became more familiar with steering through the various gear. We did not attempt a night-time crossing, however; this issue must be addressed before the summer field program.