

Cruise report: *R/V Oceanus* cruise no. 452

Woods Hole to Woods Hole

June 9 – 13, 2009

Line W: Continuing the measurement program

Background

R/V Oceanus cruise number 452 contributed to a joint Woods Hole Oceanographic Institution and Lamont Doherty Earth Observatory research program funded by the U.S. National Science Foundation that is investigating the characteristics and consequences of interannual variations in the Northwest Atlantic's Deep Western Boundary Current (DWBC). The study is documenting temperature, salinity, tracer, and velocity variations of the DWBC by maintaining a 6-element moored array spanning the continental slope southeast of Woods Hole, and repeatedly occupying a hydrographic section along this line (Figure 1). A companion research program by U.K. investigators from the Proudman Oceanographic Laboratory is sampling bottom pressure variability using instruments called Bottom Pressure Recorders – BPRs - at our line and along an additional measurement line to the north. The array south of New England (named Line W in memory of L. Valentine Worthington) is quantifying changes in DWBC water properties, stratification (potential vorticity), and transport. The high-spatial-resolution sampling possible from the ship is helping to verify that the moored array resolves the structure of the boundary current as well as returning water samples for at-sea and shoreside tracer analyses. We are furthermore encouraging other researchers to build on the Station W infrastructure to augment the fields being sampled. One such effort focusing on biogeochemistry questions is being led by fellow WHOI researcher T. Eglinton.

A 5-element moored array was initially deployed during *R/V Oceanus* cruise 401 in April-May, 2004. Three of these moorings supported McLane Moored Profiler (MMP) instruments that were subsequently serviced annually in spring 2005, 2006 and 2007; fixed-depth sensors were deployed for two year periods on the other two moorings. Later, a 6th offshore mooring using fixed sensors was deployed under funding from the WHOI Ocean and Climate Change Institute. A second phase of observations at Line W was initiated in spring 2008. In combination with the first phase, the full program is planned to sample for a full 10-year time period. Beginning in 2008, the array was redesigned slightly with all moorings planned for a 2-year (or longer) service schedule. Mooring #1, the shallowest in the array at the 2200 m isobath, is the first operational deployment of the *Ultramoored* mooring developed by Nelson Hogg and Dan Frye at WHOI. The *Ultramoored* mooring, that utilizes a series of fixed-depth sensors spanning the water column, is planned to be in place for 4 years. However, at 6-month interval, a data capsule will be released that will telemeter a subset of the observations to shore. Moorings 2 and 4 (counting offshore) support MMPs. In order to achieve the planned 2-year endurance, Mooring 2 was designed with 2 Profilers on it while Mooring 4 supports 3 instruments, each profiling a ~1000 m depth interval. Fixed sensors are located above and below each profile interval. Between profiling operations, a new MMP feature is being used for the first time: the Profilers will park mid-span and sample hourly,

mimicking a fixed-depth sensor. The result, we hope, will be data sets with high temporal resolution at multiple depths spanning the water column in addition to high-vertical-resolution profile data collected at regular interval throughout the deployment. Moorings 3, 5 and 6 are designed with conventional fixed sensors.

High winds and the accompanying big seas severely limited what could be accomplished on the spring 2008 cruise that was planned to recover 5 old moorings and deploy 6 new. A subsequent cruise in the fall ran into similar weather difficulties. While all of the existing moorings were eventually recovered on those 2008 cruises and the new systems at sites 1, 3, 5 and 6 were deployed, the moorings at sites 2 and 4 were not installed. Thus an emergency 4-day trip was granted to complete the array: Oc452. The cruise goals were to deploy moorings 2 and 4 and, if time allowed, recover a sediment trap mooring for our colleagues involved in the Line W companion biogeochemistry program.

Late in the cruise planning process, we were asked to extend cruise Oc452 by 1 day to support qualification activities for a newly-constructed U.S. Navy destroyer. Four individuals from NAVAIR-Norfolk joined our science party to conduct these operations.

Science party:

Chief scientist: J. Toole (WHOI)

Moorings operations: S. WorriLOW, B. Hogue, D. Tebo, D. Montlucon,
A. Doucette, M.-A. White

NAVAIR operations: P. Love, J. Hanson, L. Towell, M. Phillips

Cruise narrative:

R/V Oceanus was loaded with Line W scientific equipment on June 6-8 and departed Woods Hole at 9 AM EDT on June 9. It had been arranged to rendezvous with the Navy destroyer on June 10 at first light at position 39° 25' N 68° 10' W. This site coincidentally was within 10 nmi of the sediment trap mooring. On the transit to the rendezvous position, *R/V Oceanus* was routed along the Line W measurement array to mooring site 2 to collect underway upper ocean velocity and surface water properties, Figure 1. At mooring site 2, the ship turned east and arrived at the meeting point as requested.

June 10 was a frustrating day for the science party as conditions were ideal for mooring work but the NAVAIR operations dragged on and on. *R/V Oceanus* was eventually released near sundown. Given that we were still close by the sediment trap mooring and the winds and seas were quite calm, it was decided to attempt a nighttime mooring recovery. The acoustic release was triggered at 0246 Z on June 11 and 15 minutes later the strobe light mounted at the top of the mooring was sighted. Captain Mello skillfully brought *R/V Oceanus* alongside the top cluster of buoyancy balls which were grappled

and guided to the stern. Mooring recovery proceeded straightforwardly, wrapping up around 2 AM EDT.

After the sediment trap samples were extracted, *R/V Oceanus* was directed to mooring site #5, arriving at 10:30AM EDT. During a lowering of the acoustic releases to verify functionality under pressure, the sediment trap mooring wire was offloaded from the TSE mooring winch. Then, test runs were conducted to establish the starting location for mooring deployment. Winds were approximately 5 knots with small swell. It was decided to position the vessel 4.5 nmi to the northwest of the target site to begin the payout. The mooring deployment proceeded smoothly; anchor launch occurred at 2134 Z at position 38° 4.53' N 68° 40.27' W in 4117 m of water (uncorrected for sound speed variation). After verifying that the anchor reached the bottom and disabling the acoustic releases, *R/V Oceanus* headed for mooring #2's deployment location.

Test runs to determine where to start the mooring location were initiated at 6 AM EDT on June 12. Winds were 10-15 knots out of the SE but the waves were still small. These tests indicated a starting point 5 nmi ENE of the target position. This mooring deployment proceeded smoothly as well, but the achieved speed over the ground was less than the tests suggested. This meant that we had to tow the mooring for approximately one hour before dropping the anchor. Given the mild conditions, this was perfectly acceptable. Anchor launch occurred at 1703 Z at 39° 13.00' N 69° 26.70' W in water depth 2757 m (uncorrected) – exactly on target.

After verifying the anchor had reached the bottom and the releases were disabled, we transponded to the POL BPR that was deployed on this site to confirm that it was still operational. It was. This concluded our planned mooring operations. At 1400 EDT, *R/V Oceanus* was directed back to Woods Hole, again traveling along Line W to collect underway velocity and water property data. Return to the WHOI pier occurred at approximately 8:30 AM on June 13. The mooring team and *Oceanus* crew subsequently offloaded all our science gear, completing before noon and leaving the ship ready for the next cruise.

Thanks to the skill of the WHOI mooring team, the abilities of the *R/V Oceanus* officers and crew, and ideal working conditions, all of the science objectives for cruise Oc452 were achieved.

Acknowledgements

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Table 1: The Line W moored array: Spring 2008 – Spring 2010

Mooring 0: BPR only: redeployed spring 2008

Lat: 38 44.3 N
Lon: 69 48.8 W
Bottom Depth: 1800 m

Mooring 1: Ultramoored Fixed sensors & BPR : both successfully deployed spring 2008

Lat: 39 35.821 N
Lon: 69 41.710 W
Bottom Depth: 2227 m

Mooring 2: MMPs & BPR: BPR deployed spring 2006, MMP mooring deployed June 2009

Lat: 39 13.007 N
Lon: 69 26.700 W
Bottom Depth: 2757 m

Mooring 3: Fixed sensors & BPR : deployed fall 2008

Lat: 38 50.690 N
Lon: 69 10.224 W
Bottom Depth: 3245 m

Mooring 4: MMPs & BPR: deployed spring 2008

Lat: 38 26.843 N
Lon: 68 54.508 W
Bottom Depth: 3644 m

Mooring 5: Fixed sensors & BPR: BPR deployed spring 2008, MMP mooring deployed June 2009

Lat: 38 4.53' N
Lon: 68 40.27' W
Bottom Depth: 4117 m

Mooring 6: Fixed sensors GUSTO-08: Mooring deployed spring 2008

Lat: 37 31.159
Lon: 68 16.998
Bottom Depth: 4676

* bottom depths are uncorrected.

MMP denotes a mooring supporting McLane Moored Profiler instruments

Fixed sensors denotes a mooring fitted with multiple fixed-depth current meters and T/S sensors

BPR denotes a bottom pressure gauge deployed separately at the site

Figure 1. Cruise track of Oc452, June 9-13, 2009 superimposed on an image of the regional bathymetry. The anchor symbols mark the positions of Line W moorings 2 and 5.

