Cruise Report: *R/V Oceanus* 436

Woods Hole to Woods Hole
April 7 - 15, 2007

Line W: A continuing program of ocean measurements

Background

This cruise constitutes one element of an ongoing observational program – Line W – funded by the U. S. National Science Foundation to investigate the characteristics and consequences of interannual variations in the Northwest Atlantic's deep western boundary current (DWBC). This study is documenting for an initial 4-year period, the temperature, salinity, tracer and velocity variations of the DWBC upstream of its Gulf Stream crossunder point. Line W includes a 5-mooring array of instruments situated in the DWBC flow regime on the continental slope south of Woods Hole and is augmented by twice-yearly occupations of a hydrographic section along this line (Figure 1). A companion research program by U.K. investigators is sampling bottom pressure variability at each of our mooring sites (and an additional site shoreward of the shallowest mooring) plus two additional lines crossing the DWBC to the east of Line W. The moored array, which consists of 3 McLane profilers and 2 moorings of current meters plus T/C sensors, is designed to quantify changes in DWBC water properties, stratification (potential vorticity) and transport. A sixth mooring of current meters, deployed in the mean axis of the Gulf Stream along Line W was added in spring 2005 (This mooring, named GUSTO-05, is maintained by Dr. M. McCartney and funded by WHOI's Ocean and Climate Change Institute.) Shipboard observations using CTD, LADCP and discrete sampling for salinity, oxygen, CFCs, SF_6 and I^{129} measure the water column properties at high spatial resolution to help verify that the array resolves interannual signals.

Cruise Summary

R/V Oceanus cruise # 436
Departed Woods Hole on 8 April 2007.
Returned to Woods Hole on 14 April 2007.
Number of CTD/LADCP/Rosette stations occupied: 17 (of 21 planned).

Science party

Chief Scientist: Ruth Curry (WHOI)
Mooring operations: Scott Worrilow, Brian Hogue, Dan Duffany (WHOI)
CTD operations: Margaret Cook, Julie Deshayes, John Toole (WHOI)
LADCP : Dan Torres, Marshall Swartz (WHOI)
CFC chemistry: Bill Smethie, Abigail Spieler, Matthew Reid (LDEO)
Hydrography (salts and oxygens): Dave Wellwood (WHOI)
SSSG tech: Oya Erez
Cinematographer: Tim Metzger (PBS)

Cruise Narrative

The cruise departed Woods Hole April 8th (one day later than scheduled to avoid a powerful storm in the work region) and tracked along a line between the continental shelf south of Woods Hole and Bermuda (Figure 1). Three sub-surface moorings equipped with McLane moored profilers (MMP), current meters and T/C recorders were recovered and subsequently replaced with new moorings (Figure 2, Table 2). Of 21 proposed CTD/LADCP stations, 17 were successfully occupied (see Table 1). Weather was a limiting factor with a second powerful nor'easter causing the ship to head back to Woods Hole one day earlier than scheduled.

A Seabird 911 CTD system, equipped with dual temperature/conductivity sensors and 1-dissolved oxygen sensor, was used for all casts. A rosette sampler and 22 ten-liter bottles were used to obtain water samples at discrete depths; these were subsequently analyzed for salinity, oxygen, and CFC concentrations. Between stations 8-17, one liter samples were collected for shore-based analysis of Iodine-129 in the deep overflow waters. The LADCP consisted of one downward looking broadband ADCP and one upward looking 300 kHz (Workhorse) transducer from RDI. Between casts, data were downloaded from the instruments. Underway ADCP data were collected with an RDI 75 kHz system. Underway meteorological data included wind speed and direction, precipitation, short wave radiation, barometric pressure, air temperature and humidity were logged during the cruise for subsequent shore-based processing. Sea surface temperature and salinity were collected along the cruise track with a SBE45 thermosalinograph.

CTD casts 1-2 were acquired on the continental shelf in water depths < 200 m. On **cast #4**, the CTD frame hit the bottom, came up with some mud, but otherwise suffered no apparent damage. **Mooring W1,** on the northeastern flank of an eroded **warm core ring**, was recovered on the morning of April 9th, and deployed that afternoon/evening re-using the wire from the recovered mooring. The recovered MMP (somehow) became stuck around 2000 m depth on its first down profile after deployment, and remained so for approximately the next month. Then (somehow) it started profiling as programmed. However, on June 15 midway during a downgoing profile, data logging ceased; the MMP battery was found to be totally drained on recovery. We are working now to diagnose the cause of this failure. CTD operations were resumed overnight, arriving at **Mooring W3** mid-morning on April 10th. Recovery and deployment went smoothly, although this mooring wire was determined to not be re-usable. **MMP W3** measured the DWBC for 11 of its 12-month deployment. **CTD cast #8** was done between recovery and deployment in order to test acoustic releases and spool the new wire onto the winch. **CTD #9** was occupied at night with arrival at **Mooring W5** at first light. Wind and sea conditions were exceptionally calm despite being on the northern edge of the **Gulf Stream**, the mooring recovery/deployment went smoothly, and the **MMP W5** cycled for its entire time in the water. **CTD #10** was occupied after the recovery to test acoustic releases. Mooring ops were completed by dusk, and CTD ops were resumed around the clock thereafter. Storm conditions predicted for Saturday/Sunday at the Line W location caused us to turn north after **cast #15** was completed. **Casts 16 and 17** were occupied north of the Gulf Stream on Friday – to fill in gaps between profiles on the outbound trackline.

Acknowledgements

We greatly appreciate the efforts and professionalism of Captain Larry Bearse and the crew of *R/V Oceanus* in facilitating the science objectives of this cruise. The WHOI mooring team of Scott Worrilow, Brian Hogue, Dan Duffany in conjunction with the very capable Bosun, Jim McGill and his deck crew once again carried out the recovery and deployments with remarkable aplomb. The science crew -- including Maggie Cook, Marshall Swartz, Dan Torres, Julie Deshayes, Dave Wellwood, Bill Smethie, Abbie Spieler, Matt Reid, and John Toole -- safely deployed, recovered, sampled the CTD/rosette package, and analysed water samples around the clock and in various weather conditions. Tim Metzger, a cinematographer filming a PBS/NOW documentary left Woods Hole knowing a whole lot more about earth's climate system than when he arrived, and turned out to be a good shipmate in between. Thanks to all for their perseverence and good humor in completing this work. Line W is supported by the National Science Foundation (grant no. OCE-0241354) and contributes to the U.S. CLIVAR and U.K. RAPID programs.

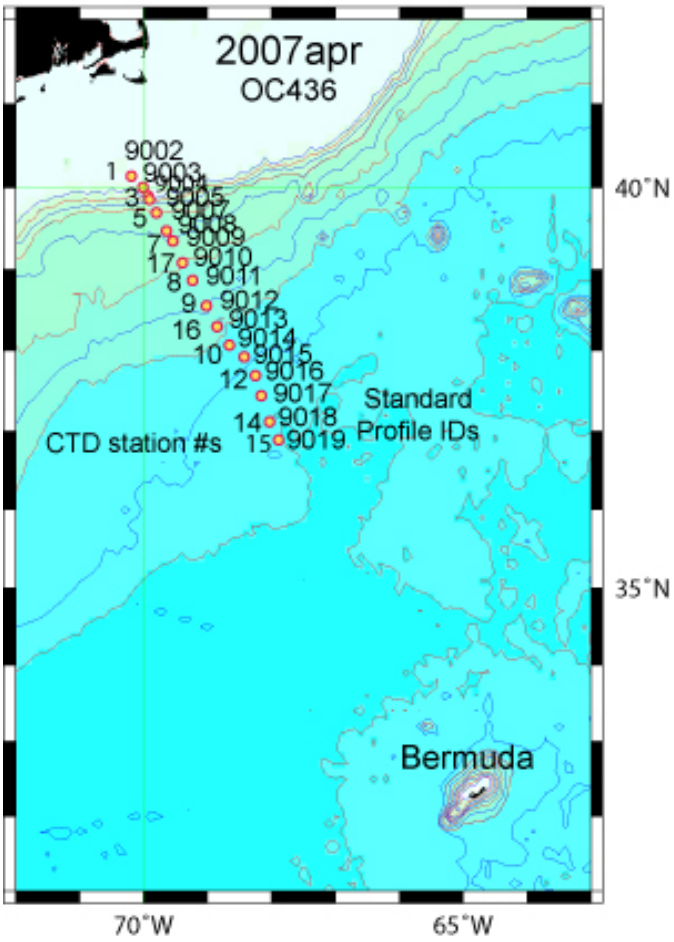

Figure 1. Locations of CTD/LADCP/rosette profiles acquired along cruise track. Background color and contours denote bathymetry Sequentially ordered casts are annotated on left, standard profile IDs are on right.

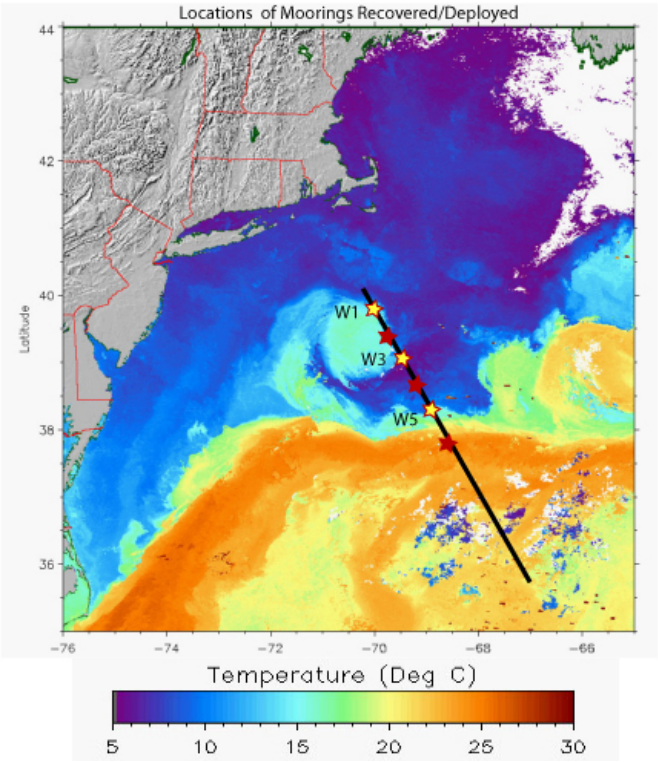

Figure 2. Cruise track and mooring locations overlain on sea surface temperature (source AVHRR, 7 days ending April 14).

Table 1. Summary of CTD station locations.

Line_W R/V Oceanus 436 April 2007

EXPOCODE	SECT	STNNBR	DATE	TIME	LATITUDE	LONGITUDE	DEPTH (m)
320C436	W	1	040907	0522	40 08.46 N	070 11.65 W	113
320C436	W	2	040907	0743	40 00.15 N	070 00.60 W	160
320C436	W	3	040907	0911	39 54.15 N	069 56.05 W	667
320C436	W	4	040907	1051	39 51.22 N	069 54.57 W	1044
320C436	W	5	041007	0212	39 41.64 N	069 47.84 W	2095
320C436	W	6	041007	0520	39 28.41 N	069 38.41 W	2425
320C436	W	7	041007	0846	39 21.07 N	069 32.26 W	2495
320C436	W	8	041007	1818	38 52.42 N	069 14.03 W	3214
320C436	W	9	041107	0541	38 33.74 N	069 00.91 W	3455
320C436	W	10	041107	1519	38 04.30 N	068 39.71 W	4149
320C436	W	11	041207	0039	37 55.78 N	068 25.51 W	4376
320C436	W	12	041207	0445	37 41.79 N	068 15.21 W	4627
320C436	W	13	041207	1124	37 26.84 N	068 09.45 W	4689
320C436	W	14	041207	1646	37 07.29 N	068 01.34 W	4865
320C436	W	15	041207	2207	36 53.43 N	067 53.10 W	4886
320C436	W	16	041307	1200	38 18.32 N	068 51.12 W	3827
320C436	W	17	041307	1956	39 05.13 N	069 23.30 W	2972

Table 2. Summary of mooring locations and instruments

Mooring W1
M# 1189
Date deployed: 10 Apr 2007
Lat/lon 39 36.019 N 69 43.051W
Depth 2226
MMP 101
CTD# 1343
ACM# 1605
MMP sampling 60 – 2175m
Instrument Depths:
TC @ 60, 2176 (sn's 1648, 3407)
VACM @ 60, 2178 (sn's 107P, 271)

Mooring W3
M# 1190
Date Deployed: 11 Apr 2007
Lat/lon 38 50.628 N 69 11.083 W
Depth 3237
MMP 103
CTD# 1348
ACM# 1505
MMP sampling 60 – 3190m
Instrument Depths:
TC @ 60, 3192 (sn's 2034, 2042)
VACM @ 60, 3194 (sn's 591P, 576)

Mooring W5
M# 1191
Date Deployed 11 Apr 2007
Lat/lon 38 04.40N 68 38.999W
Depth 4127
MMP 108
CTD# 1338
ACM# 1598
MMP sampling 985 - 4070
Instrument Depths:
TC @ 984, 4069 (sn's 2045, 2047)
VACM @ 985, 4071 (sn's 195P, 165)