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WARM CORE RINGS

an

Interdisciplinary Study of Warm Core Ring
Physics, Chemistry and Biology

CRUISE REPORTS

RV / ENDEAVOR - RV / KNORR
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Cruise Narrative

On 22 September 1982, CRUISE REPORT

ENDEAVOR CRUISE NO. 90, 9/22/82 - 10/14/82

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The ENDEAVOR began a closely-spaced section of 13 CTD stations (to the bottom) from NE to SW through the meander beginning with Station 4 at 2255Z, 26 September and ending with Station 16 at 0203Z on 29 September. On this section a shallow pump cast to 110 meters depth was made at the meander center station No. 10 while drops with the free-fall turbulence profiler CAMEL were made at Stations 8, 13, 14. Samples for phytoplankton studies were selected from those collected with the CTD Rosette system. Specific components to the scientific measurement program are detailed in later sections.

Upon completion of the meander transect ENDEAVOR steamed ESE to 38°N , 61°W in the Sargasso Sea to begin an 11 station crossing of the Gulf Stream and Slope Water to the continental shelf break. The first station (No. 17) of this transect began at 1957Z on 29 September and consisted of a deep CTD cast, shallow pump cast, and a CAMEL drop/recovery. Our ARGOS drifter 3481 deployed on the 24th of September was recovered following Station No. 18 on 30 September as it was leaving the meander and heading eastward in the Gulf Stream. The final station (No. 27) was completed at the 150 meter isobath at 43°N , 62°W at 1845Z on 2 October amid worsening weather. The weather deteriorated to such an extent that seawater began to enter the main lab due to a clogged drain. To prevent severe damage to the electronic equipment, we had to heave to for nearly 27 hours.

Before ENDEAVOR departed Woods Hole, we had agreed that were we in the vicinity of the New England Seamounts, we would attempt to recover a URI mooring "TRIFFID" which was deployed near $40^{\circ}26'\text{N}$, $62^{\circ}18'\text{W}$ in January of 1982. The ONR was to pay for up to one day of ship time should it be necessary. Rather than steaming back west to the meander following our

Slope Water section to the east, we made a deep CTD cast near TRIFFID while waiting for daylight. Despite over 12 hours attempting to interrogate/release the mooring with two different AMF deck units, we failed to communicate with the transponder on the AMF release and had to give up at 1550Z on 4 October when we steamed back to the meander.

The following 13 XBT's (76-88) established that the meander had broken off into a newly formed Warm Core Ring (named 82H). Three satellite drifters (No. 3480, 81, 82) were deployed during the following XBT survey with No. 3481 closest to the center of the new ring. A CTD/pump cast was made in the center of the ring and KNORR began intensive station work in the ring center while ENDEAVOR completed the XBT survey and DAWSON recovered its drifters and made Batfish transects of the frontal boundary of 82H. A multiple ship (ENDEAVOR, KNORR) experiment in the interleaving region to the NE of ring center took place on 6 October without DAWSON, as she had to return to port.

At the site of the multi-ship experiment, one CAMEL drop was made as well as two shallow pump casts separated north/south by approximately five nautical miles. Between these two endpoints the CTD was tow-yoed from the surface to 350 decibars spanning a cold water intrusion. The ENDEAVOR's Zodiac was put in the water, and three scientists visited the KNORR for a short discussion and to pick up two cases of XBTs needed by ENDEAVOR to permit a third XBT survey to be made of the newly-formed 82H.

A cross-ring transect of eight stations (Nos. 31-39) was begun from the site of the multi-ship experiment. At each of the eight stations CAMEL was launched/recovered, a shallow pump cast was taken and a deep

CTD cast was made to the bottom. The section began at 1952Z on 6 October and ended at 0123Z on 9 October.

A five-pointed XBT star survey was begun after the above section. At 2221Z on 9 October, near the end of the second XBT leg, a total electrical power loss shut down everything including the ship's gyro; the problem was with one of the two main generators. The backup unit was switched into service and our work continued. Navigation proved difficult for the first hour and a half until the Sperry Gyro had re-settled with a north-pointing mode. Near the end of Leg 3, a severe storm struck with winds increasing from 25 to 65 kts in a 20-minute period. The ship hove to at 0720Z on 10 October and rode out the storm until 1340Z on the following day when winds had reduced to 40 kts. We worked our way back to the eastern side of the ring to be in position to recover drifter 3481 when the weather broke. Unfortunately the seas never subsided to the point where we could make out a radar target amid the sea clutter. We were also plagued by our inability to obtain ARGOS data on drifter positions; the main computer in France was down. We were able to make arrangements with the U.S. Coast Guard to obtain position fixes from their receiving station in Miami. This enabled the ring center drifter to be recovered at 1509Z on 14 October by the KNORR after ENDEAVOR had departed the ring for Woods Hole.

A final ring center CTD station following the storm (No. 40) was begun at 1920Z on 12 October. No CAMEL or pump profile was made due to the rough seas. ENDEAVOR then departed heading due west and taking hourly XBT's to complete the western portion of the interrupted XBT star

survey. At 1037Z on 13 October we stopped for the final station of the cruise in the Slope Water to the west of the ring. It consisted of a deep CTD cast and a shallow pump profile. Before we returned to port a second APOC transducer alignment run was made; this was required after the loss of power to the ship's gyro mentioned above.

The ENDEAVOR finally docked in Woods Hole at 1320Z on 14 October. An arrival attempt in the early morning hours of the same day was aborted due to strong winds and poor visibility.

A detailed event log of the scientific program of ENDEAVOR 90 is given in Table 1. Table 2 contains a log of meteorological observations made during the cruise. In the following sections, short summaries of the different scientific programs will be made.

CTD-O₂ Program

A total of 40 CTD stations were occupied on the cruise. Stations 1 and 2 were to 2000 meters in the Slope Water and were designated test stations for instruments 9 and 7, respectively. Station 30 was a three hour tow-yo station to the north of ring 82H and consisted of nine cycles between the surface and 350 meters as the ship steamed at 2 kts through the water. We focussed on a cold ($< 10^{\circ}\text{C}$) lens of water of 25 m thickness which was at 50 meters depth. All other 37 stations were taken to the bottom which was typically between 4500-5000 meters deep. Except for Station 1, all casts were made with CTD No. 7 which was equipped with J. Bishop's LDGO transmissometer. Stations 3-16 were made in a northward Gulf Stream meander; Stations 17-27 constituted a section across the Slope Water east of the meander from the Sargasso Sea (No. 17) to the

continental shelf (No. 27). Station 28 was made in the HEBBLE area near the site of a URI Mooring TRIFFID which we attempted (unsuccessfully) to recover. Station 29 was taken in the center of the newly formed Warm Core Ring 82H. Stations 31-38 were part of a section through ring 82H. A final ring center station (No. 39) was followed by a Slope Water station (No. 40) while enroute back to Woods Hole.

In addition to deep casts on many of our stations, a shallow cast was made to 110 meter depth. A hose was attached to the Rosette frame, and water was pumped to the surface for phytoplankton biology studies. On most of our deep CTD casts, water samples were taken at 100, 75, 60 and 30 meters below the free surface for other phytoplankton work. Water samples from the remaining 20, 1.2-liter, Niskin bottles were collected for oxygen titration, salinity determination, and for later nutrient analysis ashore. Table 3 summarizes locations and times of CTD stations.

XBT Program

A total of 157 T-7 XBT's were launched during the cruise. XBT's were deployed in a survey of a potential ring south of New England. This ring turned out to be a small eddy with no Sargasso Sea core water inside. The group of XBT's Nos. 10-66 was taken in our first survey of a northward meander of the Gulf Stream. Following the CTD transect across the meander, XBT's Nos. 67-74 were made enroute to our eastern Slope Water section. A series of XBT's (Nos. 75-109) established that the meander had pinched off to form Warm Core Ring 82H. A final group of XBT's (Nos. 110-157) was part of a second survey of 82H. Two cases of probes were obtained from the R/V KNORR so that this second survey of 82H could be made. Times and positions of XBT's are given in Table 4.

At each XBT, a surface water sample was collected and analyzed in the AutoSal. These surface salinities were transmitted on telemail along with depths of selected isotherms from all XBT's. Due to an improper loading of a data cartridge, XBT data from the first 36 probes were not digitized and recorded on the Bathysystems Sea Data cassette.

APOC Program

The NASA-supported Acoustic Profiling of Ocean Currents (APOC) system was aboard ENDEAVOR during the cruise. Data from a 300 kHz Ametek-Straza transducer was logged along with ship gyro, Loran-C, sea surface temperature and temperature and conductivity from the continuously-pumped uncontaminated seawater system. Real-time plotting and printing of data averaged over ten-minute segments was used in our XBT and CTD surveys. A total of 44 nine-track digital tapes were logged. From 0200-0300Z on 24 September, a transducer alignment run determined an offset of 1.9° between the ship gyro and the four-beam hull-mounted transducer. For the first 24 hours no good data were collected while we located and repaired some broken signal wires in the transducer well. These had been broken when someone had taken the electrical connector off the transducer since our previous cruise, and had improperly connected it again.

A second transducer alignment run on 13 October was necessary because at 2221Z on 9 October a total power failure required the Sperry Gyro to be reset. The offset angle for the data collected after this time was determined from a calibration run on 13 October to be 2.4° .

Phytoplankton and Bio-Optical Studies

Horizontal and vertical distributions of phytoplankton which affect the Bio-Optical properties of various water masses within and surrounding

of 30, 60, 75 and 100 meters below the free surface. A surface bucket sample was collected at each of these stations when the CTD was brought aboard. Data from these samples will be analyzed ashore by Patricia Blackwelder.

Turbulent Velocity Program

For the last Warm Core Ring cruise, we brought CAMEL III. This instrument has an internal recording system so that the data is stored inside the instrument as well as transmitted to the surface. The instrument allowed us to profile deeper than before with no loss of data in the high speed portions of the ring.

CAMEL was launched on 21 drops (see Table 6). The first two only went to a few hundred meters depth before a leak in the preamp case terminated the useful portion of the data stream. This problem was finally cured permanently for drop three. Thereafter, all the drops were successful except for drops 4, 9 and 21 which were lost due to release problems with the internal recorder. A very exciting aspect is that the drops reach to depths between 1200 m and 1800 m, much deeper than any of the previous data collected in the Atlantic. The few lost drops are not a serious loss, for their coverage was duplicated by other profiles.

Two deep profiles were collected in the first transect of the ring, one on each side near the high speed sections of the current. We then got five profiles in the transect from the Sargasso Sea to the Slope Water across the Gulf Stream. Seven profiles were collected during the final transect of the ring, one at each pump and CTD station except for the last one (station 38, drop 21) which was lost due to tape loading problems.

The cruise was very successful from our point of view. We got a nice set of data to compare the ring with the Gulf Stream to see if they differ in terms of the turbulent characteristics.

Remote Sensing and Satellite Drifter Program

University of Miami contributions for the September, 1982 Warm Core Rings cruise included two major efforts: shore-based remote sensing of temperature and chlorophyll by O. Brown, J. Brown and S. Emmerson, and ENDEAVOR-90 seagoing efforts of R. Evans and S. Hooker directed towards integration of the remote sensing and in situ data and satellite drifter deployments. Remote sensing opportunities were limited during the September/October cruise period. As imagery became available, it was used to sort and interpret in situ data acquired during periods of ring development. Drifters were deployed twice. The first satellite drifter deployment occurred in the northern segment of the S-shaped Gulf Stream meander, and showed that a ring had not formed. After an XBT star indicated that Ring 82H had formed, a second drifter deployment was made using three ARGOS satellite-tracked drifters. All drifters were drogued at 100 m.

Remote sensing efforts were restricted by the almost continuous cloud cover over 82H. Imagery was processed as available and showed snapshots of the ring separation. The initial S-shaped meander was present for approximately three weeks. Detachment and formation of a warm ring closely followed the impingement of a Gulf Stream meander on the southeastern side of the large S-shaped meander. The newly formed ring nearly filled the Slope Water region and began to move rapidly to the west and southwest

as indicated by satellite imagery and drifter tracks. Abrupt changes in the drifter tracks are suggestive of early ring-stream interactions. The several-day satellite ring-center determination agreed well with the XBT-determined center. Continuous temperature and fluorescence measurements and hourly chlorophyll samples were acquired for Ray Smith.

Participants in Scientific Party

The members of the Scientific party aboard ENDEAVOR for cruise No. 90 are as follows:

Terrence M. Joyce	WHOI	Chief Scientist
Raymond W. Schmitt	WHOI	CTD, XBT Surveys
Robert McDevitt	WHOI	CTD Hardware
Mary Raymer	WHOI	CTD Processing
Cleo Zani	WHOI	APOC Hardware
William McMahon	WHOI	APOC Processing
Maureen Kennelly	WHOI/MIT	Oxygen Titration
Robert Evans	RSMAS	Remote Sensing, Drifters
Stanford Hooker	RSMAS	Drifters
Thomas Osborn	Naval Postgrad School	CAMEL
Michael Heckl	U.B.C.	CAMEL
Dave Phinney	Bigelow Lab	Phyto-Bio-Optical Studies
John Laird	Bigelow Lab	Phyto-Bio-Optical Studies
Margaret Goreau	University of Miami	Coccolithophore Studies
Skip Rousell	U.R.I.	Marine Tech, AutoSal

Acknowledgements

We gratefully thank Captain Tate and all the members of the ship's personnel aboard ENDEAVOR for their cooperation and competence on this last of five Warm Core Rings cruises. We also wish to thank Otis and Jim Brown, Cindy Tynan, and Marv Stalcup for their efforts ashore in obtain-

ing ARGOS fixes for our drifters. We also acknowledge CPO Dennison, USCG, Miami, for his assistance with the ARGOS system. The research program was funded by the Ocean Sciences Division of the National Science Foundation and part by the Oceanic Processes branch of the National Aeronautics and Space Administration.

Table 1: EN90 EVENT LOG

DATE DDMMYY	GMT TIME	JUL DAY	LAT. DEG MIN.	LON. DEG MIN.	EVENT CPXM	COMMENTS AND OBSERVATIONS
220982	1734	265			0000	Depart Woods Hole
230982	0640	266	39 30.00	-69 30.30	0000	H/T 2000m cast to stream wire on forward winch
230982	0820	266			0000	Weight aboard
230982	0830	266	39 29.90	-69 30.80	0010	XBT #1 Sargassum weed around ship U/W CRS-090
230982	0930	266	39 29.80	-69 18.10	0010	XBT #2
230982	1030	266	39 29.70	-69 02.80	0010	XBT #3
230982	1140	266	39 29.50	-68 45.30	0010	XBT #4
230982	1240	266	39 29.50	-68 33.00	1000	CTD #1 in water, test CTD9
230982	1408	266	39 28.40	-68 32.80	0000	CTD out, end lowering
230982	1527	266	39 17.30	-68 33.40	0100	Sta #2 (Pump #1) CTD7
230982	1652	266			1000	CTD #2 in water, test CTD7
230982	1840	266	39 16.90	-68 35.36	0000	CTD 2 out (Northstar 6000 =/= Ns 7000)
230982	1858	266	39 17.00	-68 35.60	0001	Camel launched, sta #2 (drop #1)
230982	2002	266			0000	Camel out
230982	2010	266			0000	U/W to 39 10 N, 69 00 W
230982	2100	266	39 14.20	-68 41.10	0010	XBT #5 G-05 10 C at 273
230982	2200	266	39 10.20	-68 57.30	0010	XBT #6 G-06 10 C at 256
230982	2206	266			0000	C/C to 00.0 T
230982	2300	266	39 19.95	-69 01.11	0010	XBT #7 G-07 10 C at 319
240982	0100	267	39 42.45	-69 00.51	0010	XBT #8 G-08 10 C at 317
240982	0200	267	39 54.20	-68 59.40	0010	XBT #9 10 C at 246
240982	0206	267			0000	C/C 180 T for APDC transducer alignment
240982	0300	267			0000	C/C 090 T end calibration run, go to 81G (?)
240982	0400	267	39 47.70	-68 42.80	0010	XBT #10 G-10 10 C at 270
240982	0500	267	39 47.60	-68 27.20	0010	XBT #11 G-11 10 C at 226
240982	0600	267	39 48.00	-68 10.10	0010	XBT #12 G-12 10 C at 65, 75, 189
240982	0700	267	39 47.90	-67 53.20	0010	XBT #13 G-13 10 C at 282
240982	0800	267	39 47.90	-67 38.50	0010	XBT #14 G-14 10 C at 312
240982	0900	267	39 47.70	-67 22.40	0010	XBT #15 G-15 10 C at 339
240982	1000	267	39 47.68	-67 08.30	0010	XBT #16 G-16 10 C at 315
240982	1100	267	39 47.80	-66 51.50	0010	XBT #17 G-17 10 C at 293
240982	1200	267	39 47.90	-66 37.00	0010	XBT #18 G-18 10 C at 319
240982	1300	267	39 48.10	-66 22.60	0010	XBT #19 G-19 10 C at 340
240982	1400	267	39 48.01	-66 07.51	0010	XBT #20 G-20 10 C at 346
240982	1500	267	39 49.60	-65 51.00	0010	XBT #21 G-21 10 C at 395
240982	1600	267	39 50.70	-65 33.60	0010	XBT #22 G-22 10 C at 500
240982	1700	267	39 50.46	-65 17.04	0010	XBT #23 G-23 10 C at 612
240982	1800	267	39 50.30	-65 00.10	0010	XBT #24 G-24 10 C at 703
240982	1900	267	39 49.70	-64 43.20	0010	XBT #25 G-25 10 C at 728
240982	2000	267	39 49.50	-64 25.99	0010	XBT #26 G-26 10 C at 742
240982	2015	267	39 49.70	-64 24.50	0000	Launch drifter # 3481
240982	2100	267			0010	XBT #27 DUD *****
240982	2105	267	39 49.70	-64 10.90	0010	XBT #28 G-27 10 C at 732
240982	2200	267	39 49.70	-63 55.40	0010	XBT #29 G-28 10 C at 720
240982	2300	267	39 49.58	-63 38.33	0010	XBT #30 G-29 10 C at 681
250982	0000	268	39 49.60	-63 20.30	0010	XBT #31 G-30 10 C at 654
250982	0100	268	39 49.50	-63 02.53	0010	XBT #32 G-31 10 C at 615
250982	0200	268	39 49.10	-62 44.00	0010	XBT #33 G-32 10 C at 515
250982	0300	268	39 49.00	-62 26.70	0010	XBT #34 G-33 10 C at 463
250982	0305	268			0000	C/C 234 T Leg two of star, APDC-Loran problems
250982	0400	268	39 42.50	-62 34.50	0010	XBT #35 G-34 10 C at 530
250982	0500	268	39 34.80	-62 43.90	0010	XBT #36 G-35 10 C at 668
250982	0510	268			0000	Switch Loran to 5930 chain (Canadian), APDC and NS 7000
250982	0600	268	39 29.20	-62 55.90	0010	XBT #37 G-36 10 C at 750
250982	0700	268	39 24.90	-62 08.40	0010	XBT #38 G-37 10 C at 750
250982	0800	268	39 20.30	-63 21.40	0010	XBT #39 DUD
250982	0805	268	39 20.10	-63 22.10	0010	XBT #40 G-38 10 C at 750
250982	0900	268	39 15.70	-63 34.20	0010	XBT #41 G-39 10 C at 750, 15 C at 632

TABLE 1: EN90 EVENT LOG (Continued)

250982	1000	268	39 10.75	-63 46.90	0010	XBT #42 G-40	10 C at 750, 15 C at 613
250982	1100	268	39 05.70	-64 01.10	0010	XBT #43 G-01	10 C at 750, 15 C at 645
250982	1200	268	39 00.60	-64 15.20	0010	XBT #44 G-02	15 C at 649
250982	1300	268	38 55.42	-64 29.18	0010	XBT #45 G-03	10 C at 750, 15 C at 561
250982	1400	268	38 50.00	-64 44.80	0010	XBT #46 G-04	10 C at 580, 15 C at 430
250982	1500	268	38 44.50	-65 00.60	0010	XBT #47 G-05	10 C at 408, 15 C at 240
250982	1600	268	38 37.70	-65 14.19	0010	XBT #48 G-06	10 C at 330, 15 C at 108
250982	1611	268	38 36.66	-65 17.70	0000	C/C to 090	
250982	1700	268	38 35.90	-65 08.40	0010	XBT #49 G-07	10 C at 350, 15 C at 110
250982	1800	268	38 36.20	-64 57.30	0010	XBT #50 G-08	10 C at 375, 15 C at 200
250982	1900	268	38 36.10	-64 46.70	0010	XBT #51 G-09	10 C at 407, 15 C at 252
250982	2000	268	38 36.20	-64 35.90	0010	XBT #52 G-10	10 C at 444, 15 C at 311
250982	2100	268	38 36.20	-64 24.80	0010	XBT #53 G-11	10 C at 478, 15 C at 364
250982	2200	268	38 36.48	-64 13.10	0010	XBT #54 G-12	10 C at 525, 15 C at 404
250982	2330	268	38 36.20	-63 55.80	0010	XBT #55 G-13	10 C at 629, 15 C at 470
260982	0100	269	38 36.20	-63 37.00	0010	XBT #56 G-14	10 C at 719, 15 C at 543
260982	0230	269	38 36.20	-63 16.80	0010	XBT #57 G-15	10 C at 750, 15 C at 506
260982	0400	269	38 35.70	-62 57.10	0010	XBT #58 G-16	10 C at 750, 15 C at 619
260982	0530	269	38 36.04	-62 34.04	0010	XBT #59 G-17	10 C at 750, 15 C at 660
260982	0539	269	38 36.80	-62 32.59	0000	C/C TO 305 T	
260982	0700	269	38 45.20	-62 49.20	0010	XBT #60 A-01	10 C at 750, 15 C at 657
260982	0830	269	38 55.04	-63 09.83	0010	XBT #61 A-02	10 C at 750, 15 C at 677
260982	1000	269	39 04.35	-63 28.76	0010	XBT #62 A-03	10 C at 750, 15 C at 664
260982	1130	269	39 14.05	-63 49.10	0010	XBT #63 A-04	10 C at 750, 15 C at 623
260982	1218	269	39 19.95	-63 59.89	0000	H/T sta. #3	
260982	1224	269	39 20.10	-64 00.00	0100	Sta #3 (Pump #2)	
260982	1333	269	39 21.20	-64 00.50	1000	CTD #3 in water	
260982	1607	269	39 20.54	-64 00.38	0001	Camel launched, sta #3 (drop #2)	
260982	1645	269	39 20.11	-64 00.26	0000	CTD #3 out, light cast	
260982	1728	269	39 20.50	-64 00.70	0000	Camel out	
260982	1739	269	39 21.30	-64 00.40	0000	U/W to 40 19 n ,63 48.5 w	
260982	1900	269	39 36.47	-63 57.99	0010	XBT #64 A-05	10 C at 750, 15 C at 610
260982	2030	269	39 54.50	-63 53.50	0010	XBT #65 A-06	10 C at 750, 15 C at 461
260982	2200	269	40 10.70	-63 50.30	0010	XBT #66 A-07	10 C at 462, 15 C at 224
260982	2247	269			0000	H/T STA #4	
260982	2255	269	40 18.82	-63 48.00	1000	CTD #4 in water	
270982	0155	270	40 17.85	-63 46.93	0000	CTD #4 onboard	
270982	0200	270			0000	U/W to sta. #5	
270982	0258	270	40 09.80	-63 51.60	0000	H/T sta. #5	
270982	0300	270	40 09.80	-63 51.60	1000	CTD #5 in water	
270982	0600	270			0000	CTD #5 out	
270982	0610	270			0000	U/W to sta. #6	
270982	0711	270	40 00.83	-63 54.91	0000	H/T sta. #6	
270982	0717	270			1000	CTD #6 in water	
270982	1019	270	39 58.18	-63 51.36	0000	CTD #6 out	
270982	1021	270			0000	U/W to sta. #7	
270982	1111	270	39 51.53	-63 57.95	0000	H/T sta. #7	
270982	1118	270	39 51.80	-63 57.60	1000	CTD #7 in water	
270982	1428	270	39 49.00	-64 00.80	0000	CTD out	
270982	1526	270	39 43.00	-64 00.80	1000	CTD #8 in water	
270982	1807	270	39 40.90	-63 59.60	0001	Camel launched, sta #8 (drop #3)	
270982	1822	270	39 40.70	-63 59.7	0000	CTD out, sta #8	
270982	1900	270	39 40.14	-64 00.60	0000	Camel at surface	
270982	1930	270	39 39.61	-63 59.67	0000	Camel secure, U/W to sta. #9	
270982	2010	270	39 33.94	-64 04.12	0000	H/T, sta #9	
270982	2013	270	39 33.94	-64 04.12	1000	CTD #9 in water	
270982	2255	270	39 32.10	-64 04.20	0000	CTD out, sta #9	
270982	2300	270	39 32.10	-64 04.20	0000	U/W to sta #10	
270982	2336	270	39 24.90	-64 07.00	0000	H/T sta # 10	
270982	2346	270	39 24.90	-64 07.00	0100	Sta #10 (Pump #3)	
280982	0057	271	39 25.40	-64 07.00	0000	Pump out, sta # 10	

TABLE 1: EN90 EVENT LOG (Continued)

280982	0101	271	39 25.30	-64 07.00	1000	CTD #10 in water
280982	0400	271	39 24.80	-64 06.50	0000	CTD #10 out
280982	0412	271			0000	U/W to sta. #11
280982	0506	271			0000	H/T sta. #11
280982	0511	271	39 15.90	-64 09.80	1000	CTD #11 in water
280982	0630	271	39 15.14	-64 10.75	0000	CTD #11 at the nadir
280982	0800	271	39 13.70	-64 11.40	0000	CTD #11 out
280982	0812	271			0000	U/W to sta. #12
280982	0855	271	39 06.90	-64 12.80	1000	CTD #12 in water
280982	1145	271	39 05.40	-64 16.00	0000	CTD #12 up
280982	1152	271			0000	U/W to station #13
280982	1240	271			0000	H/T for station #13
280982	1250	271	38 57.94	-64 16.25	1000	CTD #13 in water
280982	1410	271	38 57.60	-64 18.70	0000	CTD off bottom, station #13
280982	1500	271	38 57.30	-64 19.80	0001	Camel launched, sta #13 (drop #4)
280982	1559	271	38 57.08	-64 22.20	0000	CTD out, sta #13
280982	1626	271	38 57.08	-64 22.20	0000	Camel recovered, sta #13
280982	1730	271	38 48.79	-64 19.79	1000	CTD #14 in water
280982	1937	271	38 48.13	-64 23.73	0001	Camel launched, sta #14 (drop #5)
280982	2038	271	38 48.48	-64 25.50	0000	CTD out, sta #14
280982	2048	271	38 47.98	-64 27.03	0000	Camel recovered, sta #14
280982	2056	271			0000	Camel secure, U/W to sta. #15
280982	2155	271	38 39.90	-64 22.40	0000	H/T sta. #15
280982	2159	271	38 39.90	-64 22.40	1000	CTD #15 in water
280982	0103	271	38 39.90	-64 22.40	0000	CTD out, sta #15
280982	0200	272	38 31.20	-64 25.10	0000	H/T sta #16
280982	0203	272	38 31.20	-64 25.07	1000	CTD #16 in water
280982	0430	272			0000	Broken strands in CTD cable
280982	0528	272	38 31.20	-64 28.70	0000	CTD aboard
280982	0530	272			0000	U/W to 38 North, 61 West
280982	0700	272	38 27.80	-64 07.60	0010	XBT #67 G-01
280982	0900	272	38 24.74	-63 40.31	0010	XBT #68 G-02
280982	1100	272	38 20.70	-63 13.82	0010	XBT #69 G-03
280982	1300	272	38 15.93	-62 45.31	0010	XBT #70 G-04
280982	1500	272	38 11.23	-62 14.67	0010	XBT #71 G-05
280982	1700	272	38 05.80	-61 44.40	0010	XBT #72 G-06
280982	1900	272	38 01.10	-61 12.75	0010	XBT #74 G-07
280982	1957	272	38 00.00	-61 00.00	0000	H/T sta #17
280982	2000	272	38 00.00	-61 00.00	0001	Camel launched, sta #17 (drop #6)
280982	2005	272	37 59.79	-60 59.88	0100	Sta #17 (Pump #4)
280982	2109	272			0000	Camel at surface
280982	2115	272	37 59.73	-60 58.91	0000	Retrieved CTD (pump)
280982	2118	272			0000	Retrieved hose, U/W to fetch Camel
280982	2134	272	37 59.55	-60 59.62	0000	Camel retrieved
280982	2138	272	37 59.50	-60 59.60	1000	CTD #17 in water
280982	0101	273	37 58.90	-60 57.50	0000	CTD Aboard sta#17
280982	0408	273	38 29.09	-61 05.72	1000	CTD #18 in water
280982	0748	273	38 29.10	-61 02.26	0000	CTD aboard, sta #18
280982	0750	273			0000	U/W to locate drifter #3481
280982	0911	273	38 35.22	-60 44.53	0000	Located drifter #3481
280982	0954	273	38 35.40	-60 43.34	0000	Drifter #3481 aboard
280982	0955	273			0000	U/W to sta #19
280982	1320	273			0001	Camel launched, sta #18 (drop #7)
280982	1321	273	38 59.70	-61 11.80	0100	Sta #19 (Pump #5)
280982	1448	273	38 58.20	-61 09.40	0000	Pump abd
280982	1500	273	38 58.20	-61 09.40	0000	Camel abd
280982	1530	273	38 59.90	-61 11.90	1000	CTD #19 in water
280982	1750	273	38 57.00	-61 09.00	0000	Light cast in
280982	1820	273	38 57.00	-61 09.00	0000	Light cast out
280982	1821	273	38 57.40	-61 08.20	0000	CTD out, sta #19
280982	2204	273	39 29.75	-61 17.91	1000	CTD #20 in water

TABLE 1: EN90 EVENT LOG (Continued)

011082	0057	274	39 28.00	-61 14.90	0001	Camel launched, sta #20 (drop #8)
011082	0148	274	39 27.10	-61 13.40	0000	CTD abd, sta #20
011082	0219	274	39 26.80	-61 12.90	0000	Camel aboard
011082	0547	274			0000	H/T sta #21
011082	0556	274	40 00.14	-61 24.51	1000	CTD #21 in water
011082	0720	274	39 59.90	-61 24.20	0000	CTD #21 at bottom
011082	0852	274	39 58.93	-61 22.99	0000	CTD #21 out, Loran C on bridge and APOC lost signal
011082	0857	274			0000	U/W to sta #22
011082	1130	274	40 30.06	-61 30.12	0000	H/T for sta #22
011082	1132	274	40 30.06	-61 30.12	1000	CTD #22 in water
011082	1357	274	40 29.60	-61 29.60	0001	Camel launched, sta #22 (drop #9)
011082	1453	274	40 29.60	-61 29.60	0000	CTD abd, sta #22
011082	1500	274	40 29.60	-61 29.60	0000	Camel abd
011082	1748	274	40 59.90	-61 36.30	0001	Camel launched, sta #23 (drop #10)
011082	1752	274	40 59.90	-61 36.30	0100	Sta #23 (Pump #6)
011082	1901	274	41 00.70	-61 35.90	0000	Camel at surface
011082	1913	274	41 00.10	-61 35.80	0000	Pump out
011082	1929	274	41 00.10	-61 36.30	0000	Camel abd
011082	1934	274	41 00.20	-61 36.20	1000	CTD #23 in water
011082	2222	274	40 59.57	-61 35.69	0000	CTD out, sta #23
011082	2228	274	40 59.57	-61 35.69	0000	U/W to sta # 24
021082	0115	275	41 29.90	-61 42.00	1000	CTD #24 in water
021082	0312	275	41 29.80	-61 42.80	0001	Camel launched, sta #24 (drop #11)
021082	0405	275	41 29.03	-61 42.90	0000	CTD out, sta #24
021082	0412	275	41 29.03	-61 42.90	0000	Camel recovered
021082	0420	275	41 29.03	-61 42.90	0000	U/W to sta #25
021082	0720	275	41 59.95	-61 47.98	0000	H/T sta #25
021082	0725	275	41 59.95	-61 47.98	1000	CTD #25 in water
021082	0950	275	42 00.63	-61 49.30	0000	CTD out, sta #25
021082	0952	275	42 00.63	-61 49.30	0000	U/W to sta # 26
021082	1244	275	42 30.03	-61 54.04	0000	H/T at sta #26
021082	1248	275	42 30.03	-61 54.04	1000	CTD #26 in water
021082	1447	275	42 30.21	-61 55.38	0000	CTD out, sta #26
021082	1506	275	42 30.14	-61 55.71	0000	U/W to sta #27
021082	1815	275	43 00.14	-62 00.16	1000	CTD #27 in water
021082	1845	275	43 00.14	-62 00.16	0000	CTD out, sta #27
031082	0200	276			0000	(Mind overboard) H/T, main lab awash
031082	1923	276			0000	U/W CRS 160 T
041082	0450	277	40 29.72	-62 18.64	0000	H/T sta #28
041082	0455	277	40 29.72	-62 18.64	1000	CTD #28 in water
041082	0724	277	40 30.93	-62 19.32	0000	CTD at bottom, sta #28
041082	0918	277	40 29.66	-62 20.30	0000	CTD out, sta #28
041082	0920	277	40 29.66	-62 20.30	0000	Deployed XDCR attempted to contact TRIFFID
041082	0940	277	40 29.66	-62 20.30	0000	U/W to close in on TRIFFID
041082	1009	277	40 26.71	-62 17.97	0000	H/T (closer to TRIFFID)
041082	1034	277	40 26.71	-62 17.97	0000	U/W to east after no reply from TRIFFID
041082	1056	277	40 26.39	-62 14.49	0000	H/T
041082	1135	277	40 26.39	-62 14.49	0000	U/W to SE of TRIFFID
041082	1155	277	40 24.30	-62 14.10	0000	H/T
041082	1207	277	40 24.30	-62 14.10	0000	U/W to S of TRIFFID
041082	1229	277			0000	H/T 2nm south of TRIFFID (nothing)
041082	1305	277			0000	H/T 2nm west of TRIFFID
041082	1322	277			0000	TRIFFID release command sent
041082	1345	277			0000	Bottom transponder detected 2 nm north of Triffid site,
041082	1345	277			0000	(via 10kHz Xdcr), left there on earlier cruise
041082	1550	277	40 26.70	-62 17.30	0000	U/W to XBT survey
041082	2200	277	40 18.79	-63 38.66	0010	XBT #75 G-13 10 C at 305, 15 C at 75,86,95
041082	2212	277			0000	C/C to 195 T
041082	2300	277	40 09.67	-63 45.35	0010	XBT #76 G-14 10 C at 312, 15 C at 132
051082	0000	278	39 58.49	-63 49.05	0010	XBT #77 G-15 10 C at 346, 15 C at 148
051082	0100	278	39 46.35	-63 53.37	0010	XBT #78 G-16 10 C at 389, 15 C at 235

TABLE 1: EN90 EVENT LOG (Continued)

051082	0200	278	39 33.11	-63 58.17	0010	XBT #79 G-17	10 C at 486, 15 C at 355
051082	0300	278	39 19.68	-64 03.22	0010	XBT #80 G-18	10 C at 523, 15 C at 390
051082	0400	278	39 05.97	-64 08.02	0010	XBT #81 G-19	10 C at 460, 15 C at 348
051082	0500	278	38 52.17	-64 13.12	0010	XBT #82 G-20	10 C at 390, 15 C at 228
051082	0600	278	38 40.14	-64 18.80	0010	XBT #83 G-21	10 C at 305, 15 C at 113
051082	0700	278	38 28.31	-64 22.67	0010	XBT #84 G-22	10 C at 289, 15 C at 120
011082	0705	278			0000	C/C underway to 39,38	-65.05
051082	0800	278	38 36.72	-64 29.63	0010	XBT #85 G-23	10 C at 331, 15 C at 126
051082	0900	278	38 45.96	-64 35.66	0010	XBT #86 G-24	10 C at 432, 15 C at 280
051082	1000	278	38 56.27	-64 41.43	0010	XBT #87 G-25	10 C at 570, 15 C at 425
051082	1100	278	39 06.28	-64 47.65	0010	XBT #88 G-27	10 C at 692, 15 C at 507
051082	1105	278			0000	H/T for drifter deployment	
051082	1110	278	39 07.46	-64 48.51	0000	Drifter #3481 deployed	
051082	1111	278			0000	Drifter #3481 recovered; mast torn loose.	
051082	1127	278	39 07.61	-64 48.99	0000	Drifter #3481 redeployed with new mast.	
051082	1230	278	39 17.71	-64 54.96	0010	XBT #89 G-28	10 C at 752, 15 C at 556
051082	1330	278	39 27.68	-65 00.72	0010	XBT #90 G-29	10 C at 750, 15 C at 582
051082	1400	278			0000	H/T for station #29	
051082	1408	278	39 33.50	-65 04.10	0001	Camel launched, sta #29 (drop #12)	
051082	1415	278			0100	Sta #29 (Pump #7)	
051082	1530	278	39 32.60	-65 05.00	0000	Pump cast abd	
051082	1545	278	39 32.09	-65 05.12	0000	Launch drifter #3480, ring center	
051082	1557	278			0000	Camel abd	
051082	1600	278	39 32.70	-65 04.50	1000	CTD #29 in water	
051092	1726	278	39 32.10	-65 05.30	0000	CTD #29 on bottom	
051082	1730	278	39 31.70	-65 05.60	0000	Begin flight cast	
051082	1810	278			0000	Light cast abd	
051082	1907	278	39 31.70	-65 06.40	0000	CTD #29 abd	
051082	1917	278			0000	U/W to continue XBT survey	
051082	2000	278	39 22.05	-65 11.46	0010	XBT #91 G-30	10 C at 775, 15 C at 578
051082	2015	278	39 20.70	-65 12.38	0000	Launch drifter #3482, large RSMAS unit	
051082	2100	278	39 12.70	-65 16.53	0010	XBT #92 G-31	10 C at 750, 15 C at 588
051082	2200	278	39 01.34	-65 22.33	0010	XBT #93 G-32	10 C at 721, 15 C at 515
051082	2300	278	38 49.90	-65 28.50	0010	XBT #94 G-33	10 C at 649, 15 C at 490
061082	0000	279	38 38.70	-65 34.40	0010	XBT #95 G-34	10 C at 524, 15 C at 350
061082	0100	279	38 26.64	-65 40.81	0010	XBT #96 G-35	10 C at 333, 15 C at 120,125,154
061082	0105	279			0000	C/C 345T	
061082	0200	279	38 35.26	-65 45.83	0010	XBT #97 G-36	10 C at 488, 15 C at 330
061082	0300	279	38 47.02	-65 49.89	0010	XBT #98 G-37	10 C at 639, 15 C at 475
061082	0400	279	38 58.50	-65 53.70	0010	XBT #99 G-38	10 C at 719, 15 C at 561
061082	0500	279	39 10.50	-65 57.60	0010	XBT #100 G-39	10 C at 750, 15 C at 562
061082	0510	279			0000	C/C 035	
061082	0600	279	39 21.95	-65 51.67	0010	XBT #101 G-40	10 C at 750, 15 C at 618
061082	0700	279	39 32.72	-65 43.72	0010	XBT #103 G-01	10 C at 750, 15 C at 638, #102 dud
061082	0800	279	39 43.33	-65 35.96	0010	XBT #104 G-02	10 C at 761, 15 C at 592
061082	0900	279	39 54.59	-65 27.90	0010	XBT #105 G-03	10 C at 700, 15 C at 514
061082	1000	279	40 06.28	-65 19.73	0010	XBT #106 G-04	10 C at 554, 15 C at 387
061082	1100	279	40 17.44	-65 12.04	0010	XBT #107 G-05	10 C at 408, 15 C at 190
061082	1200	279	40 28.95	-65 03.92	0010	XBT #108 G-06	10 C at 328, 15 C at 149
061082	1300	279	40 36.60	-64 54.29	0010	XBT #109 G-07	10 C at 312, 15 C at 125
061092	1330	279	40 40.60	-64 50.00	1000	CTD #30 in water, tow-yo station	
061082	1500	279			0000	Pilot whales on surface between KNORR & ENDEAVOR	
061082	1640	279	40 45.60	-64 50.50	0000	CTD abd, sta #30	
061082	1645	279	40 45.60	-64 50.70	0001	Camel launched, sta #30 (drop #13)	
061082	1704	279			0000	Zodiac in water enroute to KNORR	
061082	1703	279	40 45.65	-64 50.92	0100	Sta #30 (Pump #8)	
061082	1818	279	40 46.25	-64 51.99	0000	Pump cast abd, Zodiac returns	
061082	1905	279	40 46.58	-64 52.22	0000	Camel abd	
061082	1952	279	40 40.72	-64 50.05	0000	H/T for sta #31, begin x-ring section	
061082	1955	279	40 40.72	-64 50.05	0100	Sta #31 (Pump #9)	
061082	2103	279	40 42.13	-64 49.48	0000	Pump cast abd	

TABLE 1: EN90 EVENT LOG (Continued)

061082	2107	279	40 42.13	-64 49.48	1000	CTD #31 in water
061082	2346	279	40 41.90	-64 49.00	0000	CTD abd, sta #31
071082	0201	280	40 17.80	-65 01.50	0001	Camel launched, sta #32 (drop #14)
071082	0205	280			0100	Sta #32 (Pump #10)
071082	0314	280	40 17.40	-64 59.10	0000	Pump cast abd
071082	0334	280	40 17.50	-64 59.50	0000	Camel abd
071082	0400	280	40 17.58	-65 01.23	1000	CTD #32 in water
071082	0510	280	40 17.56	-64 59.92	0000	CTD on bottom
071082	0631	280	40 17.22	-64 59.27	0000	CTD abd, sta #32
071082	0901	280	39 54.90	-65 13.30	0100	Sta #33 (Pump #11)
071082	1010	280	39 53.45	-65 11.06	0000	Pump cast abd
071082	1040	280	39 55.20	-65 13.20	1000	CTD #33 in water
071082	1152	280	39 54.40	-65 11.70	0000	CTD on bottom, 10 C at 675, 15 C at 500
071082	1230	280	39 54.26	-65 10.99	0001	Camel launched, sta #33 (drop #15)
071082	1340	280	39 53.60	-65 09.90	0000	CTD abd
071082	1346	280	39 53.68	-65 09.68	0000	Camel at surface
071082	1356	280	39 53.68	-65 09.68	0000	Camel abd
071082	1605	280	39 31.91	-65 21.14	0000	Camel launched & recovered, sta #34
071082	1623	280	39 31.67	-65 25.06	0100	Sta #34 (Pump #12)
071082	1734	280	39 31.22	-65 25.42	1000	CTD #34 in water
071082	1800	280	39 30.60	-65 25.50	0000	Light cast in water
071082	1837	280	39 30.90	-65 24.70	0000	CTD on bottom, sta #34
071082	1850	280			0000	Light cast abd
071082	1926	280	39 30.87	-65 24.61	0001	Re-launch Camel, sta #34 (drop #17)
071082	2000	280	39 30.55	-65 24.35	0000	CTD abd
071082	2044	280			0000	Camel at surface
071082	2058	280	39 30.02	-65 24.60	0000	Camel abd
071082	2229	280			0000	Ray & Bill cock Rosette in 2'09"
071082	2244	280	39 11.77	-65 35.24	0000	Radar target (drifter #3480?) 2.7nm, 290T
071082	2303	280	39 09.50	-65 37.12	0001	Camel launched, sta #35 (drop #18)
071082	2306	280			0100	Sta #35 (Pump #13)
081082	0015	281	39 09.00	-65 39.00	0000	Pump cast abd
081082	0018	281			0000	Camel at surface
081082	0039	281			0000	Camel abd
081082	0056	281	39 09.20	-65 36.80	1000	CTD #35 in water
081082	0409	281	39 09.22	-65 40.26	0000	CTD abd
081082	0621	281	38 46.37	-65 49.78	0001	Camel launched, sta #36 (drop #19)
081082	0622	281			0100	Sta #36 (Pump #14)
081082	0735	281			0000	Camel at surface
081082	0741	281	38 46.89	-65 52.92	0000	Pump cast abd
081082	0804	281	38 46.32	-65 51.93	0000	Camel abd
081082	0828	281	38 46.34	-65 48.49	1000	CTD #36 in water
081082	0941	281	38 46.70	-65 50.90	0000	CTD on bottom, 10 C at 695, 15 C at 498
081082	1123	281	38 46.94	-65 52.29	0000	CTD abd, sta #36
081082	1335	281	38 23.72	-66 00.22	0100	Sta #37 (Pump #15)
081082	1450	281	38 24.70	-66 04.30	0000	Pump cast abd
081082	1524	281	38 23.50	-66 00.30	1000	CTD #37 in water
081082	1722	281	38 22.92	-66 02.85	0001	Camel launched, sta #37 (drop #20)
081082	1825	281	38 23.30	-66 03.53	0000	CTD abd
081082	1832	281	38 23.64	-66 04.16	0000	Camel on surface
081082	1841	281	38 23.64	-66 04.16	0000	Camel recovered
081082	2044	281	38 00.70	-66 11.80	0001	Camel launched, sta #38 (drop #21)
081082	2049	281	38 00.60	-66 11.70	0100	Sta #38 (Pump #16)
081082	2204	281	38 00.20	-66 11.40	0000	Pump cast abd
081082	2209	281	38 00.20	-66 11.60	0000	Camel abd
081082	2220	281	38 00.20	-66 11.80	1000	CTD #38 in water
091082	0123	282	37 59.30	-66 10.20	0000	CTD abd, 10 C at 305, 15 C at 120
091082	0200	282	38 04.60	-66 12.90	0010	XBT #110 G-06 10 C at 313, 15 C at 123
091082	0300	282	38 16.38	-66 17.92	0010	XBT #111 G-07 10 C at 343, 15 C at 141
091082	0400	282	38 28.58	-66 23.25	0010	XBT #112 G-08 10 C at 412, 15 C at 230
091082	0500	282	38 42.14	-66 29.09	0010	XBT #113 G-09 10 C at 582, 15 C at 390

TABLE 1: EN90 EVENT LOG (Continued)

091082	0600	282	38	54.31	-66	33.55	0010	XBT #114 G-10	10 C at 662, 15 C at 488
091082	0700	282	39	06.63	-66	38.27	0010	XBT #115 G-11	10 C at 698, 15 C at 518
091082	0800	282	39	19.98	-66	43.49	0010	XBT #116 G-12	10 C at 682, 15 C at 497
091082	0900	282	39	32.36	-66	48.58	0010	XBT #117 G-13	10 C at 603, 15 C at 450
091082	1000	282	39	45.19	-66	53.89	0010	XBT #118 G-13	10 C at 529, 15 C at 395
091082	1100	282	39	57.44	-66	58.62	0010	XBT #119 G-14	10 C at 372, 15 C at 184
091082	1200	282	40	08.95	-67	03.45	0010	XBT #120 G-16	10 C at 329, 15 C at 159
091082	1217	282					0000	C/C 126T	
091082	1300	282	40	07.90	-66	55.90	0010	XBT #121 G-17	10 C at 319, 15 C at 147
091082	1400	282	40	00.06	-66	41.43	0010	XBT #122 G-18	10 C at 410, 15 C at 252
091082	1500	282	39	52.54	-66	27.49	0010	XBT #123 G-19	10 C at 567, 15 C at 412
091082	1600	282	39	45.11	-66	14.87	0010	XBT #124 G-20	10 C at 670, 15 C at 500
091082	1700	282	39	37.70	-66	02.65	0010	XBT #125 G-21	10 C at 750, 15 C at 566
091082	1800	282	39	29.95	-65	49.29	0010	XBT #126 G-22	10 C at 750, 15 C at 572
091082	1900	282	39	22.66	-65	36.21	0010	XBT #127 G-23	10 C at 750, 15 C at 595
091082	2000	282	39	15.17	-65	23.09	0010	XBT #128 G-24	10 C at 765, 15 C at 598
091082	2100	282	39	07.76	-65	10.71	0010	XBT #129 G-25	10 C at 729, 15 C at 554
091082	2200	282	39	00.50	-64	58.50	0010	XBT #130 G-26	10 C at 664, 15 C at 498
091082	2221	282					0000	Total electrical power loss, gyro tool switch generators	
091082	2300	282	38	53.69	-64	47.31	0010	XBT #131 G-27	10 C at 570, 15 C at 399
101082	0000	283	38	46.63	-64	35.86	0010	XBT #132 G-28	10 C at 433, 15 C at 246
101082	0005	283					0000	C/C 270, leg 3 of star	
101082	0100	283	38	44.69	-64	49.56	0010	XBT #133 G-29	10 C at 517, 15 C at 347
101082	0200	283	38	44.17	-65	05.97	0010	XBT #134 G-30	10 C at 610, 15 C at 453
101082	0300	283	38	44.85	-65	22.58	0010	XBT #135 G-31	10 C at 687, 15 C at 505
101082	0400	283	38	44.92	-65	38.37	0010	XBT #136 G-32	10 C at 708, 15 C at 538
101082	0500	283	38	45.09	-65	54.68	0010	XBT #137 G-33	10 C at 710, 15 C at 525
101082	0600	283	38	45.21	-66	10.77	0010	XBT #138 G-34	10 C at 708, 15 C at 518
101082	0700	283	38	46.00	-66	26.27	0010	XBT #139 G-35	10 C at 642, 15 C at 460
101082	0720	283					0000	H/T doors secured, winds 50-70 kts	
111082	0340	284	39	54.90	-66	20.30	0000	H/T winds down to 40 kts	
111082	1100	284	40	10.87	-65	48.66	0000	H/T winds still 40 kts, supplies low, crew restless	
111082	1340	284	40	15.42	-65	42.62	0010	XBT #140 G-36	10 C at 265, 15 C at 53
111082	1500	284	40	17.60	-65	42.58	0000	Crs 191, U/W to drifter #3481 near ring center	
111082	1600	284	40	07.93	-65	44.84	0010	XBT #141 G-37	10 C at 318, 15 C at 115
111082	1700	284	39	54.90	-65	47.10	0010	XBT #143 G-38	10 C at 450, 15 C at 300, #142 a dud
111082	1800	284	39	44.73	-65	49.84	0010	XBT #144 G-39	10 C at 600, 15 C at 445
111082	1900	284	39	33.36	-65	53.17	0010	XBT #145 G-40	10 C at 739, 15 C at 550
111082	2000	284	39	22.18	-65	56.55	0010	XBT #146 G-01	10 C at 750, 15 C at 581
111082	2100	284	39	10.07	-65	58.24	0010	XBT #147 G-02	10 C at 750, 15 C at 611
111082	2122						0000	H/T near drifter	
121082	1426	285	39	11.38	-65	55.20	0000	U/W crs 218, search for #3481	
121082	1535	285	38	59.40	-66	05.80	0000	C/C 000	
121082	1625	285	39	06.30	-66	05.60	0000	C/C 035	
121082	1710	285	39	11.40	-66	01.10	0000	C/C 200	
121082	1852	285	38	59.30	-66	05.20	0000	C/C 270, no drifter sighted	
121082	1920	285	38	59.90	-66	11.40	0000	H/T sta #39, ring ctr, no Camel & pump — rough weather	
121082	1927	285	38	59.90	-66	11.20	1000	CTD #39 in water	
121082	2250	285	39	01.20	-66	12.10	0000	CTD abd	
121082	2331	285	39	01.50	-66	12.40	0000	U/W crs 270	
131082	0030	286	39	00.98	-66	26.02	0010	XBT #148 G-03	10 C at 750, 15 C at 625
131082	0130	286	39	01.37	-66	40.96	0010	XBT #149 G-04	10 C at 735, 15 C at 568
131082	0230	286	39	01.41	-66	53.36	0010	XBT #150 G-05	10 C at 646, 15 C at 482
131082	0330	286	39	01.26	-67	10.08	0010	XBT #151 G-06	10 C at 469, 15 C at 314
131082	0430	286	39	02.52	-67	25.28	0010	XBT #152 G-07	10 C at 348, 15 C at 138
131082	0530	286	39	02.32	-67	39.39	0010	XBT #153 G-08	10 C at 286, 15 C at 112
131082	0630	286	39	02.15	-67	52.93	0010	XBT #154 G-09	10 C at 262, 15 C at 105
131082	0730	286	39	02.22	-68	07.16	0010	XBT #155 G-10	10 C at 240, 15 C at 84
131082	0830	286	39	02.32	-68	22.24	0010	XBT #156 G-11	10 C at 230, 15 C at 67
131082	0930	286	39	02.06	-68	37.43	0010	XBT #157 G-12	10 C at 236, 15 C at 82
131082	1032	286	39	02.70	-68	52.70	0000	H/T for final station in Slope Water	

TABLE 1: EN90 EVENT LOG (Continued)

131082	1037	286	39 02.64	-68 52.92	0100	Sta #40 (Pump #17)
131082	1150	286	39 02.15	-68 54.72	1000	CTD #40 in water
131082	1340	286	39 01.71	-68 56.95	0000	Light cast in water
131082	1415	286	39 02.50	-68 56.40	0000	CTD & Light cast abd
131082	1420	286	39 02.50	-68 56.40	0000	APOC xducer alignment run
131082	1540	286			0000	End APOC run, head for home
141082	1320	287			0000	Dock at Woods Hole

TABLE 2: EN90 METEOROLOGICAL LOG

Warm Core Rings Meteorological Log

Ship: ENDEAVOR Cruise: 90 Chief Scientist: T. Joyce Dates: 22 Sept. - 13 Oct. '82

DAY	GMT TIME	WIND SPD.	WIND DIR.	SHIP SPD.	SHIP HDG.	BAR. PRS.	DRY BULB	WET BULB	SEA SURF	SWELL AMP(M)	SWELL DIR.	OKTAS	WIND WAVE	PRES. WEATHR	POSITION
266	0408	4	350	11.5	149	1019	22.0	19.3	23.8	2.0	060	9	1.0	0	30,55.24 -69,50.50
266	0939	3	090	12.1	092	1019	23.4	21.6	24.3	0.5	135	9	0.25	8	30,29.80 -69,15.80
266	2000	18	270	0.3	347	1017	25.5	21.5	24.8	2.0	185	3	0.25	1	39,17.05 -69,01.86
267	0000	20	285	11.7	000	1018	22.0	16.5	24.3	2.0	240	2	0.25	1	39,31.97 -69,01.07
267	0430	8	180	12.1	087	1019	21.3	16.0	23.6	-9	300	5	-9	1	39,47.66 -68,34.29
267	0830	6	240	12.4	090	1020	21.0	16.9	24.7	-9	499	5	-9	1	39,47.76 -67,30.03
267	1215	0	-9	12.2	085	1021	22.5	17.8	23.6	1.0	260	7	0.2	1	39,47.92 -66,33.84
267	1600	2	115	12.2	100	1021	24.8	18.0	26.6	1.0	320	7	0.15	1	39,50.68 -65,33.71
267	2000	4	350	11.9	090	1021	24.0	18.0	26.7	1.0	330	6	0.2	1	39,49.60 -64,25.60
268	0000	10	350	11.9	085	1021	24.0	17.5	26.6	1.5	-99	8	0.2	2	39,49.49 -63,16.60
268	0420	6	310	11.7	238	1022	24.8	21.0	26.5	1.5	250	8	-9	2	39,40.15 -62,33.15
268	0810	2	150	11.7	244	1021	24.6	21.7	26.1	1.0	-99	8	-9	2	39,20.00 -63,24.10
268	1235	11	290	11.5	238	1022	24.4	22.6	26.7	1.5	310	8	0.2	2	38,57.57 -64,23.17
268	1600	10	290	12.0	221	1021	25.5	22.9	27.0	1.5	310	5	0.2	5	38,37.28 -65,15.64
268	2000	24	005	11.7	095	1019	24.9	23.4	27.5	1.5	110	8	0.2	6	38,36.20 -64,35.20
269	0000	22	005	11.7	095	1020	22.5	22.5	27.3	1.5	110	8	0.2	6	38,36.30 -63,50.10
269	0400	25	030	11.6	087	1018	24.5	23.5	25.7	-9	-99	8	-9	6	38,35.64 -62,56.34
269	0830	9	310	11.7	300	1018	26.5	24.7	25.8	-9	-99	8	-9	6	38,53.62 -63,06.66
269	1500	8	310	0.5	165	1017	26.5	24.9	25.6	1.5	110	5	0.1	1	38,20.14 -64,00.41
269	2000	15	060	11.8	000	1016	26.9	25.1	26.5	2.0	110	8	0.2	2	39,48.60 -63,51.60
270	0000	10	060	2.7	290	1017	25.0	24.0	26.5	1.5	110	9	-9	2	40,18.10 -63,47.40
270	0400	10	120	2.2	304	1018	25.0	24.2	27.2	1.5	240	9	0.2	5	40,08.80 -63,50.50
270	0820	13	330	1.4	265	1018	26.4	23.5	26.5	-9	-99	2	-9	1	39,59.46 -63,53.47
270	1330	20	360	1.2	250	1020	26.7	24.0	26.4	1.5	350	3	0.2	1	39,49.06 -63,56.25
270	1500	19	015	1.0	234	1021	27.5	24.8	26.5	2.0	250	4	0.3	1	39,42.17 -64,00.43
270	2000	24	005	11.5	217	1020	28.0	25.9	26.4	2.0	250	4	0.2	1	39,34.82 -64,02.91
271	0000	11	090	0.2	122	1021	27.0	25.5	26.5	1.5	210	1	0.1	1	39,24.57 -64,07.04
271	0407	22	010	2.3	122	1022	26.1	23.9	26.4	-9	-99	2	-9	1	39,24.40 -64,06.51
271	0804	30	010	7.9	190	1021	24.6	23.6	25.9	-9	-99	2	-9	1	39,13.30 -64,11.45
271	1230	27	250	10.4	170	1022	27	24.7	26.8	3.0	270	3	0.3	1	38,59.19 -64,16.09
271	1600	11	060	5.6	140	1022	26.2	23.5	26.8	3.0	210	8	0.3	2	38,57.15 -64,22.46
271	2000	11	100	1.2	120	1021	26.5	24.0	27.0	2.5	210	7	0.15	1	38,48.09 -64,24.08
272	0000	12	120	2.4	085	1023	24.9	23.1	27.7	-9	-99	9	-9	5	38,39.30 -64,25.80
272	0420	3	100	1.6	080	1024	24.8	22.1	25.2	1.0	200	3	.1	1	38,30.68 -64,26.43
272	0815	10	030	12.1	104	1024	26.0	23.6	25.4	1.0	170	1	0.1	1	38,26.02 -63,52.85
272	1202	16	005	12.0	115	1026	25.9	22.5	27.8	0.5	205	6	0.09	1	38,18.46 -62,59.00
272	1600	20	060	11.8	102	1026	27.9	24.2	26.1	0.5	180	1	0.1	1	38,08.41 -61,58.60
272	2000	11	050	1.4	155	1025	27.1	23.9	26.4	1.0	180	4	0.1	1	37,58.63 -60,59.79
273	0000	3	095	0.1	121	1027	26.5	23.1	26.4	0.5	180	2	0.1	1	37,57.98 -60,57.98
273	0441	5	070	0.1	146	1028	26.3	23.2	26.5	0.5	250	1	0.1	1	38,28.76 -61,04.97
273	1015	10	350	12.1	312	1028	26.2	22.6	26.5	0.5	230	1	0.09	1	38,36.93 -60,45.97
273	1600	3	320	0.0	203	1027	28.3	24.6	26.6	0.5	190	2	0.1	1	38,58.62 -61,11.19
273	2000	4	300	11.6	337	1026	28.7	24.0	27.2	0.5	200	2	0.1	1	39,12.17 -61,14.37
274	0000	7	240	3.1	300	1025	25.3	22.4	27.1	0.5	100	2	0.1	1	39,27.50 -61,15.30
274	0420	9	300	12.0	335	1024	26.3	23.0	24.3	0.5	180	8	0.1	1	39,43.41 -61,18.68
274	0821	6	060	0.8	153	1021	25.0	22.7	22.0	-9	-99	8	-9	1	39,59.22 -61,23.45
274	1215	11	015	1.3	182	1020	23.8	22.3	23.2	0.7	200	8	0.2	6	40,29.35 -61,29.75
274	1600	10	270	12.3	345	1017	25.5	22.4	23.4	1.0	200	3	0.3	1	40,39.04 -61,31.76
274	2000	16	015	1.4	218	1013	24.0	22.5	22.4	1.0	220	8	0.2	2	40,59.56 -61,36.77
275	0000	9	290	11.9	347	1010	23.2	21.9	21.5	1.0	255	8	0.2	2	41,17.63 -61,39.45
275	0416	9	250	3.6	347	1005	23.7	21.8	22.1	0.5	200	7	0.2	2	41,28.44 -61,42.70
275	0813	22	350	1.0	307	1002	20.7	17.8	22.1	2.0	300	8	0.25	2	41,59.46 -61,48.10
275	1215	28	310	10.7	350	1001	18.5	15.5	19.2	2.0	300	8	0.3	2	42,25.68 -61,53.20
275	1600	35	230	8.8	350	1002	17.1	13.9	18.0	3.0	300	8	1.0	2	42,38.88 -61,56.82

TABLE 2: EN90 METEOROLOGICAL LOG (Continued)

275	2000	25	130	11.7	170	1003	13.9	12.8	17.9	3.5	300	8	1.0	2	42,45.73	-62,02.64
276	0000	35	130	11.7	180	1005	-9	-9	21.8	-9	-99	-9	-9	-9	41,57.50	-62,07.70
276	0418	35	010	2.2	327	1002	17.0	13.5	21.5	5.0	330	8	0.8	2	41,33.57	-62,18.06
276	0840	40	020	2.1	328	1009	17.2	14.0	21.0	6.0	330	8	1.0	2	41,39.86	-62,32.30
276	1212	32	015	3.1	330	1012	16.6	13.3	20.9	4.0	330	7	0.5	1	41,46.97	-62,45.78
276	1600	30	030	3.0	330	1013	14.4	12.2	20.3	5.0	330	8	1.0	2	41,57.07	-62,54.27
276	2000	8	180	10.8	155	1013	14.5	11.9	20.8	4.0	330	7	0.75	1	41,53.69	-62,55.84
277	0000	10	180	10.7	160	1014	15.6	12.4	21.4	3.5	360	7	0.5	1	41,14.61	-62,39.12
277	0400	6	140	11.0	157	1013	17.6	13.8	20.4	2.0	360	2	0.3	1	40,36.73	-62,22.34
277	1600	25	360	10.8	270	1013	18.4	15.4	21.5	2.5	330	3	0.3	1	40,26.13	-62,20.54
277	2000	30	020	10.7	258	1013	20.5	18.0	20.1	3.0	300	8	0.5	2	40,21.87	-63,13.55
278	0000	15	110	11.8	199	1016	20.5	17.5	26.0	2.5	300	2	0.3	1	39,57.81	-63,49.45
278	0413	5	090	11.7	190	1019	23.0	18.6	25.9	1.5	360	4	0.2	1	39,03.01	-64,09.07
278	0830	24	010	11.4	350	1020	21.8	16.5	26.5	2.0	300	2	0.2	1	38,44.75	-64,34.86
278	1204	14	025	11.2	340	1022	21.6	16.7	25.2	1.0	340	4	0.2	1	39,13.46	-64,52.53
278	1600	10	060	0.3	000	1024	21.7	16.2	25.6	1.0	045	4	0.1	1	39,32.16	-65,04.73
278	2000	9	320	11.7	197	1024	21.6	15.9	25.3	1.0	045	4	0.1	1	39,23.10	-65,10.97
279	0000	15	340	11.7	188	1023	23.2	16.8	26.1	1.0	090	3	0.1	1	38,36.95	-65,35.41
279	0408	10	030	12.2	352	1024	23.0	17.0	25.4	0.5	090	1	-9	1	39,00.26	-65,54.21
279	0815	18	030	12.1	035	1025	22.5	17.9	25.4	0.5	-99	6	-9	1	39,46.56	-65,33.66
279	1210	20	015	12.1	040	1027	21.0	15.8	23.8	0.7	060	1	0.2	1	40,30.56	-65,02.38
279	1600	8	030	2.8	014	1026	17.0	14.8	16.8	0.7	090	1	0.0	1	40,40.72	-64,59.09
279	2000	6	070	0.2	320	1025	19.4	17.0	24.0	0.5	090	4	0.1	1	40,40.77	-64,59.09
280	0100	0	090	12.1	205	1025	21.4	17.0	24.0	0.5	090	3	0.1	1	40,30.06	-64,55.21
280	0407	11	030	0.0	335	1024	21.5	18.0	24.7	0.3	-99	0	0.09	0	40,17.34	-65,00.82
280	0810	8	070	11.6	217	1024	21.9	18.1	26.3	0.3	-99	3	0.09	0	40,01.75	-65,09.16
280	1210	10	025	1.1	334	1025	21.4	17.3	26.1	0.5	360	5	0.2	0	39,53.94	-65,11.50
280	1630	3	060	0.4	284	1024	21.9	17.4	25.1	1.0	360	2	0.1	1	39,31.22	-65,25.23
280	2000	6	310	0.0	070	1023	22.6	18.5	25.1	1.0	360	3	0.1	1	39,30.08	-65,24.50
281	0000	9	060	0.2	326	1024	22.3	18.0	25.6	1.0	045	1	0.1	1	39,08.58	-65,38.69
281	0808	19	360	11.1	092	1022	22.6	18.0	26.0	0.5	350	0	0.1	0	38,45.73	-65,51.93
281	1216	15	360	11.6	176	1022	24.0	18.2	26.0	0.3	060	7	0.1	1	38,36.80	-65,56.21
281	1600	3	330	1.6	096	1021	23.8	18.0	25.7	2.0	045	6	0.1	1	38,22.96	-66,01.95
281	2000	9	350	12.1	191	1019	23.0	18.0	24.5	1.5	045	6	0.05	1	38,07.55	-66,09.28
282	0000	0	270	0.0	150	1018	23.0	18.6	23.8	1.0	045	-9	0.05	-9	37,59.55	-66,11.25
282	0804	14	310	12.2	337	1015	23.8	19.8	25.4	0.5	-99	6	0.09	1	39,21.08	-66,43.95
282	1205	10	300	12.1	335	1013	24.6	20.8	23.2	1.0	200	8	0.2	2	40,10.29	-67,04.30
282	1600	30	030	12.0	134	1009	23.2	20.5	26.3	1.0	220	8	0.2	2	39,46.00	-66,16.34
282	2000	28	040	11.8	124	1006	23.9	20.4	25.0	1.0	200	8	0.3	2	39,14.90	-65,23.09
283	0006	14	290	11.6	277	1006	19.9	18.5	26.1	1.0	200	8	0.3	6	38,45.26	-64,36.20
283	0420	12	310	11.4	270	1001	22.1	18.7	25.4	2.0	270	8	0.3	2	38,45.04	-65,44.07
283	0806	50	020	3.1	350	1000	-9	-9	25.4	5.0	350	8	-9	6	38,47.67	-66,35.92
283	1212	40	350	3.7	015	1007	-9	-9	25.1	8.0	360	8	1.0	6	39,02.63	-66,46.80
283	1600	45	360	2.7	020	1009	-9	-9	25.2	7.0	020	7	1.0	1	39,19.43	-66,49.48
283	2000	45	360	3.0	020	1011	-9	-9	25.0	7.0	020	7	1.0	1	39,32.45	-66,42.61
284	0000	35	360	2.5	020	1014	-9	-9	25.2	7.0	020	7	1.0	1	39,46.86	-66,30.82
284	0400	40	360	2.2	020	1014	-9	-9	25.1	7.0	020	8	1.0	1	39,54.84	-66,19.91
284	0830	38	360	3.2	015	1013	-9	-9	24.2	6.0	015	8	0.8	2	40,06.54	-65,58.09
284	1210	38	360	2.4	018	1015	-9	-9	22.3	6.0	020	8	0.8	2	40,12.96	-65,45.02
284	1320	38	360	3.3	010	1015	16.0	12.7	17.3	5.0	010	8	0.8	2	40,14.84	-65,43.03
284	1600	25	180	11.8	195	1015	16.8	13.0	24.1	5.0	010	8	0.8	2	40,07.14	-65,44.95
284	2000	25	210	9.1	188	1013	19.9	16.4	24.7	6.0	045	8	1.0	2	39,21.14	-65,55.72
285	0000	35	360	2.1	025	1015	18.5	15.2	24.0	6.0	045	8	1.0	2	39,12.95	-65,59.85
285	0405	32	360	2.6	025	1015	18.6	14.3	24.5	6.0	025	8	1.0	2	39,17.16	-65,57.53
285	0805	33	360	2.9	022	1015	18.5	15.6	24.6	6.0	025	7	-9	1	39,24.95	-65,50.17
285	1230	15	150	10.3	222	1017	19.5	15.4	24.4	5.0	025	8	0.8	2	39,28.33	-65,38.78
285	1600	33	360	8.9	010	1015	16.0	14.6	24.0	6.0	045	8	1.0	2	39,09.30	-66,05.87
285	2000	28	360	0.7	340	1015	17.8	14.9	23.8	5.0	025	7	0.8	1	38,59.63	-66,11.45
286	0000	15	090	11.4	270	1016	-9	-9	23.9	5.0	025	8	0.8	1	39,00.82	-66,20.81
286	0430	10	070	10.4	263	1018	19.6	15.9	24.6	4.0	025	8	0.6	2	39,02.56	-67,26.09
286	0930	14	040	11.1	267	1018	18.2	14.0	22.4	2.0	025	5	-9	1	39,02.04	-68,42.47
286	1630	14	010	12.4	330	1019	19.4	13.8	21.9	3.0	045	4	0.1	1	39,11.00	-69,05.85
286	2030	9	360	12.8	328	1017	17.6	13.2	20.0	2.0	090	8	0.1	1	39,54.90	-69,43.20

TABLE 3: EN90 CTD STATIONS

SHIP: ENDEAVOR CRUISE: 90 DATES: SEPT 22 - OCT 14, 1982

DATE DAY MOS.	GMT TIME	JULIAN DAY	LATITUDE DEG. MIN.	LONGITUDE DEG. MIN.	EVENT
23 9	1240	266	39 29.50	-68 33.00	CTD #1
23 9	1652	266			CTD #2
26 9	1333	269	39 21.20	-64 00.50	CTD #3
26 9	2255	269	40 18.82	-63 48.00	CTD #4
27 9	300	270	40 09.80	-63 51.60	CTD #5
27 9	717	270			CTD #6
27 9	1118	270	39 51.80	-63 57.60	CTD #7
27 9	1526	270	39 43.00	-64 00.80	CTD #8
27 9	2013	270	39 33.94	-64 04.12	CTD #9
28 9	101	271	39 25.30	-64 07.00	CTD #10
28 9	511	271	39 15.90	-64 09.80	CTD #11
28 9	855	271	39 06.90	-64 12.80	CTD #12
28 9	1250	271	38 57.94	-64 16.25	CTD #13
28 9	1730	271	38 48.79	-64 19.79	CTD #14
28 9	2159	271	38 39.90	-64 22.40	CTD #15
29 9	203	272	38 31.20	-64 25.07	CTD #16
29 9	2138	272	37 59.50	-60 59.60	CTD #17
30 9	408	273	38 29.09	-61 05.72	CTD #18
30 9	1530	273	38 59.90	-61 11.90	CTD #19
30 9	2204	273	39 29.75	-61 17.81	CTD #20
1 10	556	274	40 00.14	-61 24.51	CTD #21
1 10	1132	274	40 30.06	-61 30.12	CTD #22
1 10	1934	274	41 00.20	-61 36.20	CTD #23
2 10	115	275	41 29.90	-61 42.00	CTD #24
2 10	725	275	41 59.95	-61 47.98	CTD #25
2 10	1248	275	42 30.03	-61 54.04	CTD #26
2 10	1815	275	43 00.14	-62 00.16	CTD #27
4 10	455	277	40 29.72	-62 18.64	CTD #28
5 10	1600	278	39 32.70	-65 04.50	CTD #29
6 10	1330	279	40 40.60	-64 50.00	CTD #30 TOW-YO
6 10	2107	279	40 42.13	-64 49.48	CTD #31
7 10	400	280	40 17.58	65 1.23	CTD #32
7 10	1040	280	39 55.20	65 3.20	CTD #33
7 10	1734	280	39 31.22	65 5.42	CTD #34
8 10	56	281	39 09.20	65 6.80	CTD #35
8 10	828	281	38 46.34	65 8.49	CTD #36
8 10	1524	281	38 23.50	66 0.30	CTD #37
8 10	2220	281	38 00.80	66 1.80	CTD #38
12 10	1927	285	38 59.90	66 1.20	CTD #39
13 10	1150	286	39 02.15	68 4.72	CTD #40

TABLE 4: EN90 XBT SUMMARY

SHIP: ENDEAVOR CRUISE: 90 DATES: SEPT 22 - OCT 14, 1982

DATE DAY MOS.	GMT TIME	JULIAN DAY	LATITUDE DEG. MIN.	LONGITUDE DEG. MIN.	EVENT	
23	9	830	266	39 29.90	-69 30.80	XBT #1
23	9	930	266	39 29.80	-69 18.10	XBT #2
23	9	1030	266	39 29.70	-69 02.80	XBT #3
23	9	1140	266	39 29.50	-68 45.30	XBT #4
23	9	2100	266	39 14.20	-68 41.10	XBT #5 G-05 10 C at 273
23	9	2200	266	39 10.20	-68 57.30	XBT #6 G-06 10 C at 256
23	9	2300	266	39 19.95	-69 01.11	XBT #7 G-07 10 C at 319
24	9	100	267	39 42.45	-69 00.51	XBT #8 G-08 10 C at 317
24	9	200	267	39 54.20	-68 59.40	XBT #9 10 C at 246
24	9	400	267	39 47.70	-68 42.80	XBT #10 G-10 10 C at 270
24	9	500	267	39 47.60	-68 27.20	XBT #11 G-11 10 C at 226
24	9	600	267	39 48.00	-68 10.10	XBT #12 G-12 10 C at 65, 75, 189
24	9	700	267	39 47.90	-67 53.20	XBT #13 G-13 10 C at 282
24	9	800	267	39 47.90	-67 38.50	XBT #14 G-14 10 C at 312
24	9	900	267	39 47.70	-67 22.40	XBT #15 G-15 10 C at 339
24	9	1000	267	39 47.68	-67 08.30	XBT #16 G-16 10 C at 315
24	9	1100	267	39 47.80	-66 51.50	XBT #17 G-17 10 C at 293
24	9	1200	267	39 47.90	-66 37.00	XBT #18 G-18 10 C at 319
24	9	1300	267	39 48.10	-66 22.60	XBT #19 G-19 10 C at 340
24	9	1400	267	39 48.01	-66 07.51	XBT #20 G-20 10 C at 346
24	9	1500	267	39 49.60	-65 51.00	XBT #21 G-21 10 C at 395
24	9	1600	267	39 50.70	-65 33.60	XBT #22 G-22 10 C at 500
24	9	1700	267	39 50.46	-65 17.04	XBT #23 G-23 10 C at 612
24	9	1800	267	39 50.30	-65 00.10	XBT #24 G-24 10 C at 703
24	9	1900	267	39 49.70	-64 43.20	XBT #25 G-25 10 C at 728
24	9	2000	267	39 49.50	-64 25.99	XBT #26 G-26 10 C at 742
24	9	2100	267			XBT #27 DUD *****
24	9	2105	267	39 49.70	-64 10.90	XBT #28 G-27 10 C at 732
24	9	2200	267	39 49.70	-63 55.40	XBT #29 G-28 10 C at 720
24	9	2300	267	39 49.58	-63 38.33	XBT #30 G-29 10 C at 681
25	9	0	268	39 49.60	-63 20.30	XBT #31 G-30 10 C at 654
25	9	100	268	39 49.50	-63 02.53	XBT #32 G-31 10 C at 615
25	9	200	268	39 49.10	-62 44.00	XBT #33 G-32 10 C at 515
25	9	300	268	39 49.00	-62 26.70	XBT #34 G-33 10 C at 463
25	9	400	268	39 42.50	-62 34.50	XBT #35 G-34 10 C at 530
25	9	500	268	39 34.80	-62 43.90	XBT #36 G-35 10 C at 668
25	9	600	268	39 29.30	-62 55.90	XBT #37 G-36 10 C at 750
25	9	700	268	39 24.90	-63 08.40	XBT #38 G-37 10 C at 750
25	9	800	268	39 20.30	-63 21.40	XBT #39 DUD
25	9	805	268	39 20.10	-63 22.10	XBT #40 G-38 10 C at 750
25	9	900	268	39 15.70	-63 34.20	XBT #41 G-39 10 C at 750, 15 C at 632
25	9	1000	268	39 10.75	-63 46.90	XBT #42 G-40 10 C at 750, 15 C at 613
25	9	1100	268	39 05.70	-64 01.10	XBT #43 G-01 10 C at 750, 15 C at 645
25	9	1200	268	39 00.60	-64 15.20	XBT #44 G-02 15 C at 649
25	9	1300	268	38 55.42	-64 29.10	XBT #45 G-03 10 C at 750, 15 C at 561
25	9	1400	268	38 50.00	-64 44.80	XBT #46 G-04 10 C at 580, 15 C at 430
25	9	1500	268	38 44.50	-65 00.60	XBT #47 G-05 10 C at 408, 15 C at 240
25	9	1600	268	38 37.70	-65 14.19	XBT #48 G-06 10 C at 330, 15 C at 108
25	9	1700	268	38 35.90	-65 08.40	XBT #49 G-07 10 C at 350, 15 C at 110
25	9	1800	268	38 36.20	-64 57.30	XBT #50 G-08 10 C at 375, 15 C at 200
25	9	1900	268	38 36.10	-64 46.70	XBT #51 G-09 10 C at 407, 15 C at 252
25	9	2000	268	38 36.20	-64 35.90	XBT #52 G-10 10 C at 444, 15 C at 311
25	9	2100	268	38 36.20	-64 24.80	XBT #53 G-11 10 C at 478, 15 C at 364
25	9	2200	268	38 36.48	-64 13.10	XBT #54 G-12 10 C at 525, 15 C at 404
25	9	2300	268	38 36.20	-63 55.80	XBT #55 G-13 10 C at 629, 15 C at 470
26	9	100	269	38 36.20	-63 37.00	XBT #56 G-14 10 C at 719, 15 C at 543

TABLE 4: EN90 XBT SUMMARY (Continued)

26	9	230	269	38 36.20	-63 16.80	XBT #57	G-15	10 C at 750, 15 C at 606
26	9	400	269	38 35.70	-62 57.10	XBT #58	G-16	10 C at 750, 15 C at 619
26	9	530	269	38 36.04	-62 34.04	XBT #59	G-17	10 C at 750, 15 C at 660
26	9	700	269	38 45.20	-62 49.20	XBT #60	A-01	10 C at 750, 15 C at 657
26	9	830	269	38 55.04	-63 09.83	XBT #61	A-02	10 C at 750, 15 C at 677
26	9	1000	269	39 04.35	-63 28.76	XBT #62	A-03	10 C at 750, 15 C at 664
26	9	1130	269	39 14.05	-63 49.10	XBT #63	A-04	10 C at 750, 15 C at 623
26	9	1900	269	39 36.47	-63 57.99	XBT #64	A-05	10 C at 750, 15 C at 610
26	9	2030	269	39 54.50	-63 53.50	XBT #65	A-06	10 C at 750, 15 C at 461
26	9	2200	269	40 10.70	-63 50.30	XBT #66	A-07	10 C at 462, 15 C at 224
29	9	700	272	38 27.80	-64 07.60	XBT #67	G-01	
29	9	900	272	38 24.74	-63 40.31	XBT #68	G-02	
29	9	1100	272	38 20.70	-63 13.82	XBT #69	G-03	
29	9	1300	272	38 15.93	-62 45.31	XBT #70	G-04	
29	9	1500	272	38 11.23	-62 14.67	XBT #71	G-05	
29	9	1700	272	38 05.80	-61 44.40	XBT #72	G-06	
29	9	1900	272	38 01.10	-61 12.75	XBT #74	G-07	
4	10	2200	277	40 18.79	-63 38.66	XBT #75	G-13	10 C at 305, 15 C at 75,86,95
4	10	2300	277	40 09.67	-63 45.35	XBT #76	G-14	10 C at 312, 15 C at 132
5	10	0	278	39 58.49	-63 49.05	XBT #77	G-15	10 C at 346, 15 C at 148
5	10	100	278	39 46.35	-63 53.37	XBT #78	G-16	10 C at 389, 15 C at 235
5	10	200	278	39 33.11	-63 58.17	XBT #79	G-17	10 C at 486, 15 C at 355
5	10	300	278	39 19.68	-64 03.22	XBT #80	G-18	10 C at 523, 15 C at 390
5	10	400	278	39 05.97	-64 08.02	XBT #81	G-19	10 C at 460, 15 C at 348
5	10	500	278	38 52.17	-64 13.12	XBT #82	G-20	10 C at 390, 15 C at 228
5	10	600	278	38 40.14	-64 18.80	XBT #83	G-21	10 C at 305, 15 C at 113
5	10	700	278	38 28.31	-64 22.67	XBT #84	G-22	10 C at 289, 15 C at 120
5	10	800	278	38 36.72	-64 29.63	XBT #85	G-23	10 C at 331, 15 C at 126
5	10	900	278	38 45.96	-64 35.66	XBT #86	G-24	10 C at 432, 15 C at 280
5	10	1000	278	38 56.27	-64 41.43	XBT #87	G-25	10 C at 570, 15 C at 425
5	10	1100	278	39 06.28	-64 47.65	XBT #88	G-27	10 C at 692, 15 C at 507
5	10	1230	278	39 17.71	-64 54.96	XBT #89	G-28	10 C at 752, 15 C at 556
5	10	1330	278	39 27.68	-65 00.72	XBT #90	G-29	10 C at 750, 15 C at 582
5	10	2090	278	39 22.05	-65 11.46	XBT #91	G-30	10 C at 775, 15 C at 578
5	10	2100	278	39 12.70	-65 16.53	XBT #92	G-31	10 C at 750, 15 C at 588
5	10	2200	278	39 01.34	-65 22.33	XBT #93	G-32	10 C at 721, 15 C at 515
5	10	2300	278	38 49.90	-65 28.50	XBT #94	G-33	10 C at 649, 15 C at 490
6	10	0	279	38 38.70	-65 34.40	XBT #95	G-34	10 C at 524, 15 C at 350
6	10	100	279	38 26.64	-65 40.81	XBT #96	G-35	10 C at 333, 15 C at 120,125,154
6	10	200	279	38 35.26	-65 45.83	XBT #97	G-36	10 C at 488, 15 C at 330
6	10	300	279	38 47.02	-65 49.89	XBT #98	G-37	10 C at 639, 15 C at 475
6	10	400	279	38 58.50	-65 53.70	XBT #99	G-38	10 C at 719, 15 C at 561
6	10	500	279	39 10.50	-65 57.60	XBT #100	G-39	10 C at 750, 15 C at 562
6	10	600	279	39 21.95	-65 51.67	XBT #101	G-40	10 C at 750, 15 C at 618
6	10	700	279	39 32.72	-65 43.72	XBT #103	G-01	10 C at 750, 15 C at 638, #102 dud
6	10	800	279	39 43.33	-65 35.96	XBT #104	G-02	10 C at 761, 15 C at 592
6	10	900	279	39 54.59	-65 27.90	XBT #105	G-03	10 C at 700, 15 C at 514
6	10	1000	279	40 06.28	-65 19.73	XBT #106	G-04	10 C at 554, 15 C at 387
6	10	1100	279	40 17.44	-65 12.04	XBT #107	G-05	10 C at 408, 15 C at 190
6	10	1200	279	40 28.95	-65 03.92	XBT #108	G-06	10 C at 328, 15 C at 149
6	10	1300	279	40 36.60	-64 54.29	XBT #109	G-07	10 C at 312, 15 C at 125
9	10	200	282	38 04.60	66 2.90	XBT #110	G-06	10 C at 313, 15 C at 123
9	10	300	282	38 16.38	66 7.97	XBT #111	G-07	10 C at 343, 15 C at 141
9	10	400	282	38 28.58	66 3.25	XBT #112	G-08	10 C at 412, 15 C at 230
9	10	500	282	38 42.14	66 9.09	XBT #113	G-09	10 C at 582, 15 C at 390
9	10	600	282	38 54.31	66 3.55	XBT #114	G-10	10 C at 662, 15 C at 408
9	10	700	282	39 06.63	66 8.27	XBT #115	G-11	10 C at 698, 15 C at 518
9	10	800	282	39 19.98	66 3.49	XBT #116	G-12	10 C at 682, 15 C at 497
9	10	900	282	39 32.36	66 8.58	XBT #117	G-13	10 C at 603, 15 C at 450
9	10	1000	282	39 45.19	66 3.89	XBT #118	G-13	10 C at 529, 15 C at 395
9	10	1100	282	39 57.44	66 8.62	XBT #119	G-14	10 C at 372, 15 C at 184

TABLE 4: EN90 XBT SUMMARY (Continued)

9	10	1200	282	40	08.96	67	3.45	XBT #120 G-16	10	C at 329,	15	C at 159
9	10	1300	282	40	07.90	66	5.90	XBT #121 G-17	10	C at 319,	15	C at 147
9	10	1400	282	40	00.06	66	1.43	XBT #122 G-18	10	C at 410,	15	C at 252
9	10	1500	282	39	52.54	66	7.49	XBT #123 G-19	10	C at 567,	15	C at 412
9	10	1600	282	39	45.11	66	4.87	XBT #124 G-20	10	C at 670,	15	C at 500
9	10	1700	282	39	37.70	66	2.65	XBT #125 G-21	10	C at 750,	15	C at 566
9	10	1800	282	39	29.95	65	9.29	XBT #126 G-22	10	C at 750,	15	C at 572
9	10	1900	282	39	22.66	65	6.21	XBT #127 G-23	10	C at 750,	15	C at 595
9	10	2000	282	39	15.17	65	3.09	XBT #128 G-24	10	C at 765,	15	C at 598
9	10	2100	282	39	07.76	65	0.71	XBT #129 G-25	10	C at 729,	15	C at 554
9	10	2200	282	39	00.50	64	8.50	XBT #130 G-26	10	C at 664,	15	C at 498
9	10	2300	282	38	53.69	64	7.31	XBT #131 G-27	10	C at 570,	15	C at 399
10	10	0	283	38	46.63	64	5.86	XBT #132 G-28	10	C at 433,	15	C at 246
10	10	100	283	38	44.69	64	9.56	XBT #133 G-29	10	C at 517,	15	C at 347
10	10	200	283	38	44.17	65	5.97	XBT #134 G-30	10	C at 610,	15	C at 453
10	10	300	283	38	44.85	65	2.58	XBT #135 G-31	10	C at 687,	15	C at 505
10	10	400	283	38	44.92	65	8.37	XBT #136 G-32	10	C at 708,	15	C at 538
10	10	500	283	38	45.09	65	4.68	XBT #137 G-33	10	C at 710,	15	C at 525
10	10	600	283	38	45.21	66	0.77	XBT #138 G-34	10	C at 708,	15	C at 518
10	10	700	283	38	46.00	66	6.27	XBT #139 G-35	10	C at 642,	15	C at 460
11	10	1340	284	40	15.42	65	2.62	XBT #140 G-36	10	C at 265,	15	C at 53
11	10	1600	284	40	07.93	65	4.84	XBT #141 G-37	10	C at 318,	15	C at 115
11	10	1700	284	39	54.90	65	7.10	XBT #143 G-38	10	C at 450,	15	C at 300, #142 a dud
11	10	1800	284	39	44.73	65	9.84	XBT #144 G-39	10	C at 600,	15	C at 445
11	10	1900	284	39	33.36	65	3.17	XBT #145 G-40	10	C at 739,	15	C at 550
11	10	2000	284	39	22.18	65	6.55	XBT #146 G-01	10	C at 750,	15	C at 581
11	10	2100	284	39	10.07	65	8.24	XBT #147 G-02	10	C at 750,	15	C at 611
13	10	30	286	39	00.98	66	6.02	XBT #148 G-03	10	C at 750,	15	C at 625
13	10	130	286	39	01.37	66	0.96	XBT #149 G-04	10	C at 735,	15	C at 568
13	10	230	286	39	01.41	66	3.36	XBT #150 G-05	10	C at 646,	15	C at 482
13	10	330	286	39	01.26	67	0.08	XBT #151 G-06	10	C at 469,	15	C at 314
13	10	430	286	39	02.52	67	5.28	XBT #152 G-07	10	C at 348,	15	C at 138
13	10	530	286	39	02.32	67	9.39	XBT #153 G-08	10	C at 286,	15	C at 112
13	10	630	286	39	02.15	67	2.93	XBT #154 G-09	10	C at 262,	15	C at 105
13	10	730	286	39	02.22	68	7.16	XBT #155 G-10	10	C at 240,	15	C at 84
13	10	830	286	39	02.32	68	2.24	XBT #156 G-11	10	C at 230,	15	C at 67
13	10	930	286	39	02.06	68	7.43	XBT #157 G-12	10	C at 236,	15	C at 82

TABLE 5: EN90 PUMP STATIONS

SHIP: ENDEAVOR CRUISE: 90 DATES: SEPT 22 - OCT 14, 1982

DATE DAY MOS.	GMT TIME	JULIAN DAY	LATITUDE DEG. MIN.	LONGITUDE DEG. MIN.	EVENT
23 9	1527	266	39 17.30	-68 33.40	Sta #2 (Pump #1)
26 9	1224	269	39 20.10	-64 00.00	Sta #3 (Pump #2)
27 9	2346	270	39 24.90	-64 07.00	Sta #10 (Pump #3)
29 9	2005	272	37 59.79	-60 59.88	Sta #17 (Pump #4)
30 9	1321	273	38 59.70	-61 11.80	Sta #19 (Pump #5)
1 10	1752	274	40 59.90	-61 36.30	Sta #23 (Pump #6)
5 10	1415	278			Sta #29 (Pump #7)
6 10	1708	279	40 45.65	-64 50.92	Sta #30 (Pump #8)
6 10	1955	279	40 40.72	-64 50.05	Sta #31 (Pump #9)
7 10	205	280			Sta #32 (Pump #10)
7 10	901	280	39 54.90	65 3.30	Sta #33 (Pump #11)
7 10	1623	280	39 31.67	65 5.06	Sta #34 (Pump #12)
7 10	2306	280			Sta #35 (Pump #13)
8 10	622	281			Sta #36 (Pump #14)
8 10	1335	281	38 23.72	66 0.22	Sta #37 (Pump #15)
8 10	2049	281	38 00.60	66 1.70	Sta #38 (Pump #16)
13 10	1037	286	39 02.64	68 2.92	Sta #40 (Pump #17)

TABLE 6: EN90 CAMEL STATIONS

SHIP: ENDEAVOR CRUISE: 90 DATES: SEPT 22 - OCT 14, 1982

DATE DAY MOS.	GMT TIME	JULIAN DAY	LATITUDE DEG. MIN.	LONGITUDE DEG. MIN.	EVENT
23 9	1858	266	39 17.00	-68 35.60	Camel launched, sta #2 (drop #1)
26 9	1607	269	39 20.54	-64 00.38	Camel launched, sta #3 (drop #2)
27 9	1807	270	39 40.90	-63 59.60	Camel launched, sta #8 (drop #3)
28 9	1500	271	38 57.30	-64 19.80	Camel launched, sta #13 (drop #4)
28 9	1937	271	38 48.13	-64 23.73	Camel launched, sta #14 (drop #5)
29 9	2000	272	38 00.00	-61 00.00	Camel launched, sta #17 (drop #6)
30 9	1320	273			Camel launched, sta #18 (drop #7)
1 10	57	274	39 28.00	-61 14.90	Camel launched, sta #20 (drop #8)
1 10	1357	274	40 29.60	-61 29.60	Camel launched, sta #22 (drop #9)
1 10	1748	274	40 59.90	-61 36.30	Camel launched, sta #23 (drop #10)
2 10	312	275	41 29.80	-61 42.80	Camel launched, sta #24 (drop #11)
5 10	1408	278	39 33.50	-65 04.10	Camel launched, sta #29 (drop #12)
6 10	1645	279	40 45.60	-64 50.70	Camel launched, sta #30 (drop #13)
7 10	201	280	40 17.80	65 1.50	Camel launched, sta #32 (drop #14)
7 10	1230	280	39 54.26	65 0.99	Camel launched, sta #33 (drop #15)
7 10	1926	280	39 30.87	65 4.61	Re-Launch Camel, sta #34 (drop #17)
7 10	2303	280	39 09.50	65 7.12	Camel launched, sta #35 (drop #18)
8 10	621	281	38 46.37	65 9.78	Camel launched, sta #36 (drop #19)
8 10	1722	281	38 22.92	66 2.85	Camel launched, sta #37 (drop #20)
8 10	2044	281	38 00.70	66 1.80	Camel launched, sta #38 (drop #21)

TRUE WIND SPEED KTS
TRUE WIND DIR. DEG.
BARO PRS (MBARS)
SWELL AMP (M)
SWELL DIRECTION

Figure 1: Selected meteorological variables for EN90.

Figure 2: XBT and CTD stations (a) made in first ring meander survey on EN90 together with 15°C isotherm depth, tracks of drifters (b) and 28 m depth currents from APOC system (c).

Figure 2 (b)

Figure 2 (c)

Figure 3: XBT and CTD stations (a) made in Slope Water section, site of TRIFFID mooring and in newly formed ring 82H; (b) 15°C isotherm depths and tracks from four satellite drifters; (c) 28 m depth currents from APOC system.

Figure 3 (b)

Figure 3 (c)

Figure 4: Same as Figures 2 and 3, but for final survey of ring 82H.

Figure 4 (b)

Figure 4 (c)

CRUISE REPORT

KNORR CRUISE NO. 98, 9/24/82 -- 10/17/82

Peter H. Wiebe

Woods Hole Oceanographic Institution

Woods Hole, Massachusetts

I. CRUISE NARRATIVE

KNORR Cruise No. 98, 9/24/82 - 10/17/82

Peter H. Wiebe
Woods Hole Oceanographic Institution

RV/KNORR left Woods Hole on the 24th of September about 1530 on the fourth and last of the 1982 Warm Core Rings Program time-series cruises. Two other vessels participated in this study of a warm core ring, the RV/ENDEAVOR (from URI) and the RV/DAWSON (from the Bedford Institute, North Dartmouth, Nova Scotia). The overall objective of the scientific research aboard the KNORR was to measure the temporal and spatial changes in the standing crop of the major biotic components of the ring ecosystem (bacteria, phytoplankton, micro- and macrozooplankton, and micronekton) in the upper 1000 m, their turnover rates to the extent permitted by current technology and techniques, nutrient elements and trace metal structure and dynamics, and to study the vertical distribution of size fractionated particulate matter, radon, radium ²²⁶, and radium ²²⁸. Additionally, we planned to look closely at mixed layer breakdown and its affects on the biota during fall cooling, and small-scale spatial and temporal variability within the core of a ring.

The KNORR headed east out the Nantucket Sound for a location in the Slope Water (39°40' N; 64°W) where a newly formed ring was thought, on the basis of satellite imagery, to be located (see Figure 1, Overall Cruise Track). Ring 82-B, which had been the primary focus of the first three cruises, had disappeared, and 82-E, which KNORR surveyed during a portion of the August cruise, had also been recaptured by the Gulf Stream. ENDEAVOR had left port 2 days earlier and had surveyed a portion of the Slope Water southeast of Cape Cod where another ring (82-G) was thought to have formed. Ring 82-G proved to be a non-entity as a result of XBT work done by the ENDEAVOR.

After only a few hours steaming, problems with the alignment of one of the bearings on the drive shaft between the main engine and the aft cycloid caused us to return to Woods Hole early on the 25th. We lay anchored just outside of Woods Hole until mid-afternoon while the engineers made the necessary adjustments. Twenty-four hours after we first left Woods Hole, we left again.

Once out of the sound, we headed for 39°30' N; 66°W, a point where T. Joyce on the ENDEAVOR wanted us to start taking XBT's to fill in areas they had not yet reached. In fact, we started dropping XBT's once we were clear of the shelf. After passing the above point which was hydrographically Slope Water, we XBT'd our way south to 39°N; 66°W and then east until entering the western edge of what we now know was a very extended meander of the Gulf Stream.

As we moved into the core of the meander during the 27th and 28th, we made observations at 4 station locations where the 15°C isotherm depths were 150, 350, 450, and >600 m. At each station, shallow (100 m) and deep (800 - 1000 m) 30-liter CTD casts for measuring particulate and dissolved standing

Wiebe
Figure 1.
Overall Cruise Track

stocks were made along with short vertical net tows for phytoplankton. Prior to the first 30 l cast, a six-shooter profile to 798 m was obtained. Tows to 1000 m were made with the double MOCNESS-1 (1 m² nets) and the MOCNESS-20 (20 m² nets) during the night of the 27th, and a particulate profile was obtained with MULVFS (Multiple Unit Large Volume Filtration System) the following night.

Based on ENDEAVOR's APOC (Acoustic Profiling Ocean Current) data and the maximum depths of the 10 and 15°C isotherms, an estimate of the center of the meander was determined. At this location (39°30' N; 64°W), we conducted our first 48-hour station which consisted of first light, midday, and post sunset primary productivity casts in the upper 100 to 200 m with a 12 bottle, 30-liter CTD/rosette system, a deeper cast to 1000 m with the 30 liter system, a 2000 m cast with the 24-bottle, 5 liter CTD/rosette system, a light cast in the upper 100 m, several ring-net tows to collect live phytoplankton and zooplankton for experimental purposes, an in situ grazing cast using 5-liter grazing chambers, a six-shooter radon-radium cast to 1000 m, a daytime MOCNESS-1/4 (with 1/4 m² nets) tow to 200 m, a day-night pair of double MOCNESS and MOCNESS-20 tows to 1000 m, and a MULVFS particulate matter cast in the upper 1000 m. A second 48-hour station was conducted in the meander core some 15 miles to the west during the period 1-2 October when meander pinch off had started. In fact, closure of the ring took place in the region of the first 48-hr station. A third, partial 48-hr station was conducted to the northwest of the first two in an area (39°40' N; 65°W) which became the center of the newly formed ring. Lacking at this station were the pairs of MOCNESS tows to 1000 m.

On the 4th of October, we conducted a second radial transect on a northerly course from ring center to just outside of the High Velocity region. At each of five stations (stations 8 to 12), spaced 18 km apart, a 30-liter CTD cast to 250 m was done. The section actually is composed of seven station locations with the ring center station at the start of the transect and the station in the Slope Water at the end of the transect.

The station north of ring 82-H was the site of a short joint ship study with the ENDEAVOR. Prior to the arrival of the ENDEAVOR, a nearly complete set of 48-hr station observations was obtained; primary productivity casts were, however, made only at noon on two successive days. The upper 150 m of this area was characterized by high variability in the temperature and salinity field; temperatures ranged from 9 to 25°C and salinity ranged from 32.5 to 36.1 PSU. Joint ship work consisted of ENDEAVOR and KNORR making tows across a sharp frontal feature with a CTD and the double MOCNESS, respectively. At the end of the tows, the ships hove to for joint water column profiling: ENDEAVOR did a vertical pump profile to 100m and a CAMEL drop (to measure vertical turbulence); KNORR did a 30 l productivity cast. During this period, T. Joyce, R. Evans, and R. McDevitt came over to the KNORR to review work completed on the cruise to date and the plans for the remainder of the cruise. In addition to up-to-date color printouts of satellite images, they also brought transmissometer data obtained on their CTD lowerings. These provided a spatial picture of particulate matter distributions on a section through the meander on a parallel course to the second radial section.

23e returned to ring center on the evening of the 6th to start the fourth 48-hr station (no. 14). For a good portion of the time spent at this station, we worked in close proximity to satellite drogue 3481 which was one of three drogues set out at various radii in the ring by the ENDEAVOR. This particular drogue was offset from the ring center about 20 km. Work at this station was extended 24 hrs in order to carry out a special set of observations designed to closely examine trophic coupling in the mixed layer and seasonal thermocline of the ring. Complimenting the normal primary production and in situ grazing casts, high resolution sampling was done with the 5 l CTD to look at fine-scale vertical variation in plant, bacteriological, and nutrient parameters, and with the MOCNESS-1/4 and the double MOCNESS-1 to determine how micro- and macrozooplankton were distributed with respect to the subsurface peak in chlorophyll. An XBT-internal wave study was run concurrently with the other work. On this day, internal wave amplitudes were maximally 20 m. In addition, a dusk toyo was made with the double MOCNESS to see when diel vertical migrating zooplankton came up into the surface layer. This station was cut short by a large and very intense gale which made it impossible to work for over 2 days.

The gale, however, caused extensive changes to the physical, chemical, and biotic structure of the upper 100 m of the ring water column which we had an opportunity to document during the fifth and last 48-hr station (no. 15) in the ring center. During this station, the second XBT-internal wave study was conducted; larger wave amplitudes (up to 40 m) were observed. Only a night MOCNESS-20 tow had to be dropped because of rough seas which persisted after the most intense winds had passed. Our studies of ring 82-H were completed during the early morning of October 14. We steamed west across the ring center on our way toward a Slope Water station location, pausing only to search for satellite drogue 3480 and recover it.

Despite persistent strong winds, the threat of another gale, and the fact that time was running out, a nearly complete set of 48-hr station observations were completed at the Slope Water station. Reduction had to be made only in the number of primary production water casts. Work in the Slope Water ceased about noon on the 16th, and we set sail for Woods Hole stopping only at the Continental Shelf/Slope break to do a final six-shooter cast. We arrived mid morning on October 17th.

Communication between the ENDEAVOR, KNORR, and the shore stations (Miami and Woods Hole) was greatly facilitated by use of the OCEAN NETWORK on ATS-1 AND ATS-3 satellites (Applications Technology Satellite) which is very ably administered by Paul Eden, Malabar, Florida and by use of the TELEMAIL electronic mail system. The ATS voice communication channel was available three hours a day, and the data channel was available continuously. Only by means of rapid exchange of key ship-obtained oceanographic data (temperature vs depth, APOC velocity data, satellite tracked drogue positions) and processed satellite images of sea surface temperature provided by O. Brown and colleagues at the University of Miami and the NMFS Image Analysis Center at Narragansett, R. I. were we able to successfully track and sample the meander/ring development.

This cruise can be considered highly successful from several points of view. Scientifically, we fulfilled most, if not all, of our objectives. We observed, for the first time, the process of ring formation: we sampled the ring environs from the time it was a meander until it was a full-fledged ring. We were able to study the effects of storm-induced mixing upon the biotic and chemical components of the mixed layer; in this regard, it was indeed fortunate that the trophic-coupling experiment came before the gale. Furthermore, we obtained reasonably high resolution data on transects from ring center through the high velocity region which should permit evaluation of coarse-scale variation in near-surface dwelling organisms and chemical parameters. Operationally, all of the major pieces of equipment on board, a number of which were developed for use in this program, worked reliably. There were no major failures of equipment, and the few minor problems caused no significant loss of wire time or data acquisition. Cooperation between scientists was superb! Individuals short on man power received the assistance they needed and program common tasks (CTD's, XBT's etc) were well supported.

Our success in gathering data on this fourth Warm Core Ring cruise is due in large part to the full and friendly cooperation of the officers and crew of the KNORR. Without the KNORR's extraordinary deck crew's willingness to put in long hours in getting our equipment over the side and back on deck, our list of accomplishments would be much shorter. We must also express our appreciation to Woods Hole's Marine Facility and Shops Services personnel for the excellent service we received in preparing for this cruise.

II. INDIVIDUAL REPORTS

Introduction to CTD/Rosette Sampling

Hugh Ducklow and Gary Hitchcock coordinated all 30 1 GoFlo rosette casts and productivity sampling on this cruise. The group of projects using this consists of the following principal investigators and their respective fields of interest:

James McCarthy	Nitrogen cycling; phosphorus uptake, POC, PON, PP
Theodore Smayda	Phytoplankton photosynthesis, chlorophyll, ATP, O_2
David Nelson	Silicon cycling and standing crop
Hugh Ducklow	Bacterial abundance and production
Greta Fryxell	Phytoplankton taxonomy
Timothy Cowles	Coulter count biovolume, feeding experiments
Dana Kester/Mary Brown	Inorganic nutrient concentrations

The primary aim of this group is to make a series of measurements of biological rate processes and standing stocks in order to characterize production and nutrient cycling rates within warm core rings.

On KNORR 98, this group participated in five major productivity stations at which samples were collected at 0600 (first light, FL); 1200 (midday, MD); and 1900 hours (NT). Each cast (or pair of casts) sampled at the depths of the isolumens representing 100, 60, 36, 22, 8, 3, 1, 0.3, and 0.1 percent of the surface illumination. Following each FL cast, a silica deep cast was also made to approximately 1000 meters.

The 30 1 rosette was also used for two transect studies; a four-station transect from the Slope Water across the high velocity region at which casts were made from 0-100 and from 0-1000 m, and a six-station section from near ring center back out into the Slope Water, during which one cast of 0-250 m was made at each station. At these stations, the emphasis was on measurement of standing stocks only.

Productivity experiments were also carried out in the High Velocity/Slope Water region (Stations 13 and 16) and as part of the trophic coupling experiment in ring center at station 14.

KNORR 98 productivity experiments have resulted in a detailed time series of standing stock and rate measurements covering at least two and perhaps three different events. Our measurements at ring center cover the period from 0600 on September 29 through 2100 on October 12, during which the Gulf Stream meander closed to form WCR 82-H. Several 25-50 knot gales passed our area, and the mixed layer deepened at least 20 meters, bringing nitrate into the euphotic zone.

BACTERIAL ABUNDANCE, BIOMASS AND ^3H -THYMIDINE INCORPORATION
IN GULF STREAM WARM CORE RINGS

Principal Investigator: Hugh Ducklow
Cruise Participants: Hugh Ducklow and Susan Hill
Lamont-Doherty Geological Observatory

1. Objectives:

The primary objective of this research has been to measure the abundance and rates of incorporation of (methyl) ^3H -thymidine by planktonic heterotrophic bacteria within warm core ring systems. Our overall aim is understanding the distributions, population dynamics, and trophic roles of bacteria in warm core rings and open ocean waters.

2. Work Performed

a) Productivity experiments: We participated in 5, 48-hour long stations at which 30 l GoFlo hydrocasts were made through the euphotic zone (to 0.1 percent surface illumination, ca, 130 m) three times a day (0600, 1200, 1900). The objectives of these experiments were (1) to derive time series information (within-day and day-to-day scale) on standing stocks and production levels of bacteria, and to examine these parameters in the context of ring formation and storm events which occurred during the cruise

b) Trophic coupling experiment: This was essentially a sixth productivity experiment, with emphasis placed on the photosynthesis and chlorophyll a maxima. Three casts were made as above, in conjunction with high resolution 5-l hydrocasts and net tows in the upper 200 m. We added measurements of amino acid turnover and protozoan density to our work at this station.

c) High resolution bacterial abundance: In order to characterize more closely the vertical distribution of bacterial abundance in the upper 200 m, samples were collected from three, 24-bottle GoFlo hydrocasts. Two were in ring center, before and after a storm, while the third was at a final Slope Water station.

d) Radial sections: Two transects across the High Velocity region from ring center into Slope Water were made. Bacterial abundance samples were collected from every depth, and thymidine incorporation was measured at the top six depths on the September 27-28 section.

e) Incubation experiments: At each productivity station, 2 or 3 water samples were incubated for 8-12 hours and sampled periodically for abundance and thymidine assays. These results will be used to calibrate the thymidine incorporation data for estimating bacterial production, and to take a closer look at bacterial growth in unamended seawater.

f) Copper experiments: We participated with Carol Sakamoto-Arnold and Gary Hitchcock in a copper and organic matter addition experiment to look at the effects of copper chelation on bacterial and algal production (see Carol's report for details).

g) Kinetics and specific incorporation experiments: The objective of these was to examine thymidine incorporation as a function of time and initial substrate concentration, and to resolve the incorporation of thymidine into bacterial DNA, RNA, and protein. Five experiments were done in ring center and Slope Water.

h) Additional single hydrocasts for production estimates were made at three Slope Water stations, including the joint ship station, where detailed kinetics were examined in three interleaved water masses.

3. Measurements

a) Bacterial abundance samples for AODC analysis (acridine orange direct count) were collected from 420 depths, and 130 other experimental time points.

b) ^3H thymidine incorporation was measured on samples from 189 depths.

c) ^3H amino acid turnover was measured on samples from 31 depths.

d) Protozoan density was estimated on samples from 8 depths.

4. Preliminary Results

^3H thymidine incorporation rates were quite low throughout the cruise in both Slope Water and ring center.

At stations 5, 6, and 7 in ring center, rates were higher than in the Slope Water and High Velocity Region. Activity declined throughout the cruise to about 25 percent of the level at station 5. Is this decline associated with ring formation or was a high-activity streamer sampled early in the cruise? Bacterial activity appears to be closely coupled to phytoplankton, but diel changes were not as apparent as in earlier cruises. Vertical distribution of activity was increasingly uniform as the mixed layer deepened. There was a generalized increase in bacterial abundance throughout the euphotic zone within the ring.

SIZE-FRACTIONATED PRIMARY PRODUCTION, CHLOROPHYLL A, ATP, AND CELL NUMBERS

Principal Investigators: Theodore Smayda and Gary Hitchcock
Cruise Participants: Gary Hitchcock and Christopher Langdon
University of Rhode Island

1. Objectives

The proposed objectives of our group during Knorr 98 were to examine the temporal changes in phytoplankton biomass, as ATP-carbon and chlorophyll a, and primary production during a period of autumnal destratification in a warm core ring. Since Knorr 98 was fortunate enough to occur during a period of ring formation, our objectives were altered so that we could follow the

temporal and spatial changes in the phytoplankton biomass and productivity of three different size fractions (20μ , $20-63\mu$, and $63-153\mu$) during the process of meander 'pinch-off' to form a ring. This required more time spent at ring center than initially proposed, but allowed us to document a process not observed during the four previous WCR cruises. We additionally collected samples from the 'silica-deep' casts to assess the viability of phytoplankton (by growth experiments, C-14 uptake and ATP content) from the sub-euphotic zone. Estimates of phytoplankton growth are to be made from the diel increase in phytoplankton carbon (estimated from ATP) of the 3 size fractions at each productivity station.

2. Biomass data

In all, about 1500 ATP samples were taken. Nine stations were analyzed on shipboard, and preliminary analysis indicates that phytoplankton biomass was quite low, $15-25 \text{ mgC/m}^3$, similar to levels observed in the northern Sargasso Sea. The initial radial section into the meander revealed a subsurface maximum at 60-80 meters. Comparison of water column profiles from 9/29, 10/1 and 10/7 indicate very little change in abundance over this time interval in ring (meander) center.

A total of 790 chlorophyll samples were taken with approximately 300 analyzed on board. Prior to the closure of the meander, chlorophyll a biomass was similar to that found previously in the northern Sargasso Sea with surface concentrations of $<0.10 \mu\text{g/l}$ and a subsurface maximum (DCM) coincident with the seasonal thermocline. A phaeopigment maximum occurred below the DCM. This pattern persisted throughout the period of ring closure, but by October 9 the DCM was found at 60-65 m with a peak concentration of $0.5 \mu\text{g/l}$. Following a two day gale, the chlorophyll a was uniform throughout the mixed layer- (90 m), although the total standing crop on October 13 had not increased appreciably from that seen four days previously (21.8 mg/m^2 vs. 19.6 mg/m^2); on October 13, however, measureable nitrate was found in the water column, and clear skies gave a relatively high productivity measurement (estimated as light minus dark cpm). On October 14 the mixed layer chl a biomass had increased to 34.2 mg/m^2 ; if spatial variation in the ring can be eliminated, it would appear that the phytoplankton within the new ring rapidly responded to favorable conditions following a wind-mixing event. ATP analyses should confirm this increase in phytoplankton biomass. Within the contiguous Slope Water, the chl a biomass (27 mg/m^2) was similar to that within the ring; a sub-surface maximum was evident at 35 m, just above the relatively shallow seasonal thermocline. Oxygen concentrations within the mixed layer were near 100 percent saturation, suggesting a low level of net daily production; this is consistent with the steady-state ATP profiles (9/29-10/7) observed before the wind mixing event. There was no subsurface oxygen maximum (SOM) associated with the DCM as had been observed in 82-B in June suggesting that there is negligible net daily production at this depth. Slightly deeper, 80-120 m, an oxygen minimum was observed indicating that at these depths respiration and grazing exceed production. In all, 151 oxygen determinations were made using the pulsed oxygen electrode. Samples to assess the growth potential of sub-euphotic zone phytoplankton were taken from the 5

'silica-deep' casts in ring center at depths from 200 m to 800 m. Four series of photosynthesis measurements over a range of 6 light intensities were made on samples from 400 m or 800 m to determine whether or not the sub-euphotic zone phytoplankton exhibit viable photosynthesis rates. Continuous light measurement was made with a LAMBDA integrating recorder and 2PI collector at 1-hour intervals. On days when productivity measurements were done, the light integration was at 10-min. intervals.

<u>Date</u>	<u>Sta.</u>	<u>Descr.</u>	<u>Depth</u>
9/27-9/28	1-4	Radial section into the meander 4 casts ATP <153 18 depths 4 casts Chl a <153 6 depths 1 light cast	0-1000m 0-120m
9/29	5	Meander Center 48 hr prod 3 casts ATP <153,<64,<20 9 depths 1 cast Chl a <153 9 depths 1 cast ATP <153 12 depths 2 casts Chl a <153 9 depths 2 casts C-14 prod. 6 depths	0-150m 0-150m 0-1000m 0-150m 0-63m
9/30	5	1 light cast	
10/1	6	2nd Meander Center 48 hr prod 3 casts ATP <153,<64,<20 9 depths 3 casts Chl a <153 9 depths 1 cast ATP <153 12 depths 2 casts C-14 prod. 6 depths 1 light cast	0-150m 0-150m 0-1000m 0-63m
10/3	7	82H Ring Center 48 hr prod 3 casts ATP <153,<64,<20 9 depths 3 casts Chl a <153 9 depths 1 cast ATP <153 12 depths 2 casts C-14 prod. 6 depths	0-150m 0-150m 0-1000m 0-63m
10/4	8-12	High resolution section (center to HVC) 5 casts ATP <153 12 depths 6 casts Chla <153 12 depths	0-250m 0-250m
10/4-10/6	13	Slope Water Sta. 1 cast ATP,Chl a <153 12 depths 1 cast C-14 prod. 6 depths 1 light cast	0-250m 0-100m

<u>Date</u>	<u>Sta.</u>	<u>Descr.</u>	<u>Depth</u>
10/7	14	82H Ring Center 48 hr prod 3 casts ATP <153, <64, <20 9 depths 3 casts Chl a <153 9 depths 1 cast ATP <153 12 depths 2 casts C-14 prod. 6 depths 1 light cast	0-150m 0-150m 0-1000m 0-100m
10/9	14	Trophic Coupling Exp. 1 cast ATP, Chl a <153 24 depths 3 casts ATP <153, <64, <20 9 depths 3 casts Chl a <153 9 depths 2 casts C-14 prod. 7 depths	0-200m 0-200m 0-200m 0-100m
10/12-10/14	15	82H Ring Center after 2 day gale 3 casts ATP <153, <64, <20 9 depths 1 cast ATP <153 12 depths 1 light cast 1 cast ATP, Chl a <153 24 depths 2 casts C-14 prod. 6 depths	0-200m 0-2000m 0-200m 0-100m
10/15-10/16	16	Slope Water Sta. 1 cast ATP, Chl a <153 24 depths 1 cast ATP <153 9 depths 1 cast C-14 prod. 6 depths 1 light cast	0-400m 0-150m 0-100m

NITROGEN UPTAKE EXPERIMENTS

Principal Investigator: James J. McCarthy
Cruise Participants: Mark Altabet, John Nevins, and Cara Adler
Harvard University

Objectives

As with previous warm core rings cruises, our principal objective was the characterization of the utilization of nitrogen and phosphorus by phytoplankton in the upper layer of a warm core ring. The remineralization of nitrogen in the form of ammonia was also examined. Initially, it was hoped that these measurements would coincide with erosion of the seasonal thermocline and subsequent nutrient pumping into the euphotic zone. As it turned out, this process did not commence until the last week of the cruise. However, a unique data set was obtained during the formation of a warm core ring, which has been designated 82-H. These data, in the form of a time series, should provide information on changes in nitrogen cycling that occur due to ring formation and during the first few weeks thereafter.

Methods

At each productivity station, three casts were made at first light, mid-day, and evening. Samples from six light depths were taken; 100, 60, 36, 22, 8, and 3 percent of surface intensity. For the first light and mid-day casts, measurements were made for particulate carbon, nitrogen, and phosphorus, uptake of ammonia, urea, and nitrate, the concentration of dissolved ammonia and urea, and the remineralization of ammonia. Measurements of ammonia uptake at a saturating concentration were also made. Mid-day casts were the same, except urea uptake and concentration was not measured but those for phosphate were. Additionally, samples for natural N-15 isotope abundance were taken at the mid-day casts. At the ring edge, there was only one mid-day cast at which we made measurements.

On the first radial section, composed of four stations, twelve depths were sampled down to 1000 meters. Samples were collected for particulate carbon, nitrogen, and phosphorus measurements and for analysis of the natural abundance of N-15 isotope. This section was made at the beginning of the cruise from the Slope Water into the then meander center. A second section consisting of six stations was made just after ring formation. In this section, twelve depths were analyzed at each station for particulate carbon, nitrogen, and phosphorus. The section was on a northwest radius from ring center to its edge.

A special experiment was performed on October 9 in conjunction with the trophic coupling experiment. Measurements were made at six depths at first light and evening. At all depths, particulate carbon, nitrogen, and phosphorus samples were taken, and measurements for nitrate, ammonia, and saturated ammonia uptake and ammonia remineralization were made. At the four lower depths, nitrite uptake and nitrification were measured. Samples for natural N-15 abundance were also taken.

List of Measurements

Particulate carbon	234
Particulate nitrogen	234
Particulate phosphorus	222
Urea concentration	60
Urea uptake	60
Ammonia concentration	114
Ammonia uptake	114
Saturating ammonia uptake	114
Nitrate uptake	114
Phosphate uptake	42
Nitrification	8
Natural abundance N-15	125

SILICA PRODUCTION AND DISSOLUTION

Principal Investigator: David Nelson
Cruise Participants: Mark Brzezinski and Joe Jennings
Oregon State University

During KNORR 98, we continued our study of the cycling of biogenic silica in warm core rings. Our field effort consists of water sample collection with only preliminary sample processing. The final analysis of these samples will be completed in our laboratory at Oregon State University. Thus, we have no results to report at this time. However, the following overview of our sampling scheme may prove useful to those interested in our work.

We participated in the initial radial transect of the Gulf Stream meander which proved to be the precursor of ring 82-H. The transect consisted of four stations beginning in the Slope Water and ending at our best estimate of meander center. At each station, a total of eighteen depths, half in the euphotic zone and half extending from the 0.1 percent I_0 light depth to 1000 m, were sampled for suspended biogenic and mineral particulate silica.

On several occasions, we were able to participate in the phytoplankton productivity casts to measure particulate silica distributions, the uptake of ^{30}Si by the phytoplankton in the euphotic zone and the dissolution rate of biogenic silica in the water column down to a depth of 1000 m. Our general station plan was to sample nine depths extending from the surface to the 0.1 percent of surface light depth for biogenic and mineral particulate silica, silicic acid uptake, and silica dissolution rates. Eight additional depths between the 0.1 percent light level and 1000 m were sampled to determine subsurface distributions of particulate silica and dissolution rates. This sampling scheme was applied in its entirety at sunrise on each experimental productivity day and repeated, with the omission of the dissolution and deep water column work that night. Additional experiments were conducted each morning to examine the kinetics of silicic acid uptake by the phytoplankton community residing at the depth of maximum productivity (assumed to be 60 percent of surface light). Complete day-night productivity series were carried out on 29 September, 1 October, and 3 October as the meander pinched off to form warm core ring 82-H on or about the third of October. On October 6, we did a complete morning segment of our productivity series in the High Velocity region of the newly formed ring. Ring center was resampled on October 7th and then again on October 12 after a severe storm. Full productivity series were conducted at each of these ring center stations. These data will provide information on the temporal variability in diatom standing crops and growth on several time scales and will serve to document changes that occur in these parameters at ring center during pinch-off. Questions pertaining to the effects of mixing on the vertical distribution and production of biogenic silica in the mixed layer may be addressed due to the chance occurrence of the storm of October 10 and 11 after ring formation.

A second, radial transect of the ring was conducted on October 4 and 5 along a radius where seven stations from ring center to the Slope Water were occupied. At approximately 10 m intervals, we sampled 12 depths down to 200 m for biogenic and mineral particulate silica in conjunction with measurements made by several other groups.

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Table 1. KNORR 98 Silica Work

STATION	DATE	TIME	BIOGENIC SiO ₂	MINERAL SiO ₂	³⁰ Si UPTAKE	SiO ₂ DISSOLUTION	NO. DEPTHS	DEPTH RANGE (M)
<u>Slope Water</u>								
<u>First Radial Transect</u>								
1	09/27/82		X	X			18	0-1000
2	09/27/82		X	X			18	0-1000
3	09/28/82		X	X			18	0-1000
4	09/28/82		X	X			18	0-1000
<u>Meander Center</u>								
5	09/29/82	Fl. Prod. 0600	X	X	9 depths, 0-130m	X	18	0-1000
5	09/29/82	Nt. Prod. 1900	X	X	X		9	0-130
6	10/01/82	Fl. Prod. 0600	X	X	9 depths, 0-130m	X	16	0-1000
6	10/01/82	Nt. Prod. 1900	X	X	X		9	0-130
7	10/03/82	Fl. Prod. 0700	X	X	9 depths, 0-130m	X	18	0-1000
7	10/03/82	Nt. Prod. 1900	X	X	X		0	0-130
<u>High Resolution Transect</u>								
8	10/04/82	1000	X	X			12	0-220
9	10/04/82	1200	X	X			12	0-220
10	10/04/82	1500	X	X			12	0-220
11	10/04/82	1645	X	X			12	0-220
12	10/04/82		X	X			12	0-200

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Table 1. KNORR 98 Silica Work (cont.)

STATION	DATE	TIME	BIOGENIC SiO ₂	MINERAL SiO ₂	³⁰ Si UPTAKE	SiO ₂ DISSOLUTION	NO. DEPTHS	DEPTH RANGE (M)
<u>Slope Water</u>								
13	10/04/82		X	X			12	0-220
13	10/05/82	1230	X	X			11	0-220
<u>High Velocity Region/ Slope Water</u>								
13 (HVR)	10/06/82	1345	X	X	9 depths, 0-90m	X	18	0-1000
<u>Ring Center</u>								
14	10/07/82	0600	X	X	9 depths, 0-150m	X	18	0-1000
14	10/07/82	1900	X	X	X		9	0-150
14	10/09/82	0600	X	X	X		6	0-100
14	10/09/82	1200	X	X			6	0-100
14	10/09/82	1900	X	X	X		6	0-100
15	10/12/82	0600	X	X	9 depths, 0-140m	X	18	0-1000
15	10/12/82	1900	X	X	X		9	0-140
15	10/14/82	0600	X	X	X		9	0-140
16	10/17/82	0600	X	X			9	0-80

A specialized experiment to study the coupling of phytoplankton production and zooplankton grazing was conducted on October 9. Our contribution to the experiment was to sample the euphotic zone at several depths, including the production and chlorophyll a maximum for particulate biogenic silica levels and ^{30}Si incorporation rates. Samples for particulates and rates were gathered at sunrise and at night with particulates being measured a third time at noon. The information from these samples will aid in determining the impact of grazing on the diatom community at various depths in the euphotic zone.

Our work in the Slope Water was rather restricted. However, we did obtain particulate silica profiles in Slope Water at the end of each transect and at the last station which was well removed from the ring.

Additional samples were collected by a graduate student, Mark Brzezinski, for thesis research. At each ring center productivity station water samples from each light depth were preserved for diatom species identification and enumeration. Vertical net tows in the mixed layer were also done to sample the net plankton. Single cell isolations of various diatom species collected in the water bottles and net tows were made. Approximately two hundred isolates were inoculated into culture medium to be brought back to the lab for physiological studies. The clones obtained through these efforts will be used to study the effect of major nutrient distributions and supply rates on diatom species succession in warm core rings.

PHYTOPLANKTON SPECIES COMPOSITION

Principal Investigator: Greta Fryxell
Cruise Participant: Richard Gould
Texas A and M University

Our objectives on this cruise were to characterize and enumerate the phytoplankton in a warm core ring, in both a spatial and temporal sense. By chance, we were fortunate to observe the pinch-off of ring 82-H, and obtained samples before and after ring formation. Vertical distributions of cells in the upper 125 m of the water column were sampled from the water collected by the CTD/Rosette Systems. The two radial transects provided samples to describe the horizontal distribution.

Two scales of temporal variation can be observed as well. By examining the samples from the repeated visitations to ring center, changes on the order of days can be detected, while hourly variation can be observed using the FL, MD, and NT productivity casts. There is some spatial variability in these measurements as well, however.

Living material provided by the net tows was examined under the light microscope during the cruise to give a rough estimate of the species present in a given area. Isolations were also made from this material in an attempt to obtain unialgal cultures for study back at Texas A and M. In addition,

permanent light and scanning electron mounts prepared from the net tows are valuable aids in species identifications. The 1/4 M MOCNESS was employed in the upper 80 m of the water column (4 nets, 20 m intervals to the surface) to estimate the degree of stratification of the phytoplankton to determine if separate species assemblages occur in the surface and chlorophyll maximum layers.

Preliminary shipboard observations indicate that the meander center and ring center stations exhibited similar species composition, as one would expect, suggesting that ring closure around 5 October did not initiate an immediate change in this respect. After the mixing event on 10 and 11 October, greater numbers of single centric diatoms of the genera Thalassiosira and Coscinodiscus were present at ring center. Gelatinous colonies of diatoms, which were very abundant in the newly formed ring 82-E in August, were rarely observed in ring 82-H during this cruise. The last station, in Slope Water, appeared to have greater species diversity and higher cell numbers of diatoms and dinoflagellates than the ring.

From the 16 stations, 230 discrete water samples for cell counts were collected; 10 stations along two radial transects, 3 meander center stations, 2 ring center stations, and a Slope Water station. The filtered samples from 11 stations totaled 137. In addition, 16 ring-net hauls and 7 MOC-1/4 tows were taken. One hundred fourteen isolations were attempted from several meander center, ring center, and Slope Water stations.

WCR SEPTEMBER/OCTOBER 1982 SAMPLES COLLECTED

OP. NO.	STA.	CTD	SAMPLE	NET TOW	FILTERS	1/4-MOC	ISOLATIONS
KN0927.02	1	6 Depths			X		
KN0927.03				X	X		
KN0927.05	2	6 Depths			X		
KN0927.06				X	X		
KN0928.02	3	6 Depths			X		
KN0928.03				X	X		
KN0928.05	4	6 Depths			X		
KN0928.06				X	X		
KN0929.02	5	9 Depths					
KN0929.05						X	
KN0929.07		9 Depths			X		
KN0929.09				X			X
KN1001.01	6	9 Depths			X		
KN1001.03						X	
KN1001.08		8 Depths					
KN1001.09				X			
KN1001.10				X			X

<u>OP. NO.</u>	<u>STA.</u>	<u>CTD</u>	<u>SAMPLE</u>	<u>NET TOW</u>	<u>FILTERS</u>	<u>1/4-MOC</u>	<u>ISOLATIONS</u>
KN1003.01	7	6 Depths					
KN1003.04				X			X
KN1003.07		5 Depths			X		
KN1003.09						X	
KN1004.01	8	7 Depths					
KN1004.02	9	7 Depths					
KN1004.03	10	8 Depths			X		
KN1004.04	11	6 Depths					
KN1004.05	12	7 Depths					
KN1004.06	13	8 Depths					
KN1005.07	13	9 Depths			X		
KN1005.12				X			
KN1006.02	13	9 Depths				X	
KN1006.05							
KN1007.02	14	9 Depths			X		
KN1007.05						X	
KN1007.10				X	X		
KN1007.11				X			X
KN1008.05	14			X			X
KN1009.01	14	20 Depths					
KN1009.07		10 Depths			X		
KN1009.10		6 Depths					
KN1012.01	15	9 Depths			X		
KN1012.03				X			X
KN1012.05		9 Depths					
KN1013.02	15					X	
KN1013.06				X			X
KN1014.03	15	9 Depths			X		
KN1015.02	16	18 Depths					
KN1015.04				X			X
KN1015.07						X	
KN1016.03	16	9 Depths					

NUTRIENT STUDIES OF WARM CORE RINGS

Principal Investigator: Dana R. Kester
Cruise Participants: Mary F. Brown and Peter P. Bates
University of Rhode Island

Our research objectives (Kester and Brown) are to investigate the variation of nutrients in a warm core ring. The horizontal and vertical distribution of nutrients (nitrate, nitrite, phosphate, silica, and dissolved oxygen) in a warm core ring, the seasonal variability of these nutrients in a ring, and their variability with time after ring formation have been studied.

On the KNORR 98 cruise, water samples were collected at each station and analyzed for nutrients, dissolved oxygen and salinity (Table 1). Nutrient analyses for nitrate, nitrite, phosphate and silica were performed in real time on 792 samples. The results of these analyses were available to other investigators to assist them in the design of their experiments. A computer controlled, automated oxygen titrator, based on the Winkler method for the determination of dissolved oxygen in seawater, was used to analyze 173 oxygen samples. These analyses were used to characterize dissolved oxygen distribution in the water column and to calibrate the oxygen sensor of the two CTD's used for water sampling. Salinity samples were analyzed at selected casts to calibrate the salinity sensors of both CTD units.

INVESTIGATION OF TRACE METAL DISTRIBUTIONS AND SPECIATION

Principal Investigators: Alfred Hanson and Dana Kester
Cruise Participants: Carol Sakamoto-Arnold
University of Rhode Island

The trace metal investigations employed a clean portable laboratory for shipboard trace metal sample processing. Dissolved copper was partitioned into organically bound (retained by C18 reverse phase liquid chromatography, C18-RPLC and eluted with methanol), and "silica labile" (retained by C18-RPLC and eluted with an aqueous acid). Total metal samples were also collected for analysis on shore. Copper speciation measurements were made on 329 samples from the deep and shallow 5-liter CTD's, productivity and Si deep casts, and both radial section transects.

Dissolved organic matter was isolated by C18-RPLC at selected stations and during the trophic coupling experiment for further characterization of organic complexing ligands by high performance liquid chromatography (HPLC) on shore.

Two sets of experiments were conducted to assess the effects of copper complexation by organic ligands on copper toxicity. In the first set of experiments, seawater collected from 10m depth at station 15 was incubated with either increasing levels of dissolved copper or dissolved organic matter which had previously been isolated from a large volume (30 l) of seawater from

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Table 1

Summary of Water Column Sampling for KNORR 98

Sta. No.	CTD No.	Operation No.	Location	Description	No. of Nutr. Samp.	No. of O ₂ Samp.	No. of Sal. Samp.
1	-	KN0927.01	Rad. Sec. No. 1	Six shooter	8	6	8
1	1	KN0927.02	Rad. Sec. No. 1	Shall. Rad. Sec./150 m	6	-	-
1	2	KN0927.04	Rad. Sec. No. 1	Rad. Sec./800 m	12	6	12
2	3	KN0927.05	Rad. Sec. No. 2	Shall. Rad. Sec./150 m	6	-	-
2	4	KN0927.07	Rad. Sec. No. 2	Rad. Sec./800 m	12	6	6
3	5	KN0928.02	Rad. Sec. No. 3	Rad. Sec./150 m	6	-	-
3	6	KN0928.04	Rad. Sec. No. 3	Rad. Sec./800 m	12	6	-
4	7	KN0928.05	Rad. Sec. No. 4	Rad. Sec./150 m	6	-	-
4	8	KN0928.07	Rad. Sec. No. 5	Rad. Sec./800 m	12	6	6
5	-	KN0929.01	Mndr. Cnt. No. 1 82 H	Six Shooter	8	-	8
5	9	KN0929.02	Mndr. Cnt. No. 1 82-H	FL. Prod.	6	-	-
5	10	KN0929.03	Mndr. Cnt. No. 1 82-H	SI Deep	12	-	-
5	11	KN0929.07	Mndr. Cnt. No. 1 82-H	MD Prod.	9	-	-
5	12	KN0929.10	Mndr. Cnt. No. 1 82-H	5 L CTD/2000 m	24	12	12
5	-	KN0929.11	Mndr. Cnt. No. 1 82-H	Six Shooter	8	-	8
5	13	KN0929.12	Mndr. Cnt. No. 1 82-H	NT Prod.	12	-	-
6	14	KN01001.01	Mndr. Cnt. No. 2 82-H	FL. Prod.	6	-	-
6	15	KN01001.02	Mndr. Cnt. No. 2 82-H	SI Deep	12	12	12
6	16	KN01001.08	Mndr. Cnt. No. 2 82-H	MD. Prod.	12	-	-
6	17	KN01001.11	Mndr. Cnt. No. 2 82-H	5 L CTD/2000 m	24	12	12
6	-	KN01001.12	Mndr. Cnt. No. 2 82-H	Six Shooter	9	-	9
6	18/19	KN01001.15	Mndr. Cnt. No. 2 82-H	NT Prod.	12	-	-
7	20/21	KN01003.01	Mndr. Cnt. No. 1 82-H	FL. Prod.	6	-	-
7	22	KN01003.06	Mndr. Cnt. No. 1 82-H	SI. Deep	12	12	12
7	23/24	KN01003.07	Mndr. Cnt. No. 1 82-H	MD. Prod.	12	-	-
7	25/26	KN01003.12	Mndr. Cnt. No. 1 82-H	NT Prod.	12	-	-
8	27	KN01004.01	Rad. Sec. No. 8	Rad. Sec./200 m	12	-	-
9	28	KN01004.02	Rad. Sec. No. 9	Rad. Sec./200 m	12	-	-
10	29	KN01004.03	Rad. Sec. No. 10	Rad. Sec./200 m	12	-	-
11	30	KN01004.04	Rad. Sec. No. 11	Rad. Sec./200 m	12	-	-
12	31	KN01004.05	Rad. Sec. No. 12	Rad. Sec./200 m	12	-	-

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Table 1. cont.

Summary of Water Column Sampling for KNORR 98

Sta. No.	CTD No.	Operation No.	Location	Description	No. of Nutr. Samp.	No. of O ₂ Samp.	No. of Sal. Samp.
13	32	KN01004.06	Rad. Sec. No. 13	Rad. Sec./200 m	12	-	-
13	-	KN01005.02	HVR 82-H	Six Shooter	12	-	12
13	33/34	KN01005.07	HVR 82-H	MD. Prod.	12	-	-
13	35	KN01005.09	HVR 82-H	5 L CTD/2000 m	24	12	24
13	36	KN01006.01	HVR 82-H	5 L CTD/700 m	24	12	-
13	37	KN01006.05	HVR 82-H	MD. Prod.	6	-	-
13	38	KN01006.06	HVR 82-H	SI Deep	12	-	-
14	39	KN01007.02	Ring Cnt. 82-H	FL. Prod.	6	-	-
14	40	KN01007.03	Ring Cnt. 82-H	SI. Deep	12	-	-
14	41	KN01007.09	Ring Cnt. 82-H	MD. Prod.	12	-	-
14	42	KN01007.12	Ring Cnt. 82-H	5 L CTD/2200 m	24	12	24
14	-	KN01007.13	Ring Cnt. 82-H	Six Shooter	9	-	9
14	43	KN01007.14	Ring Cnt. 82-H	NT. Prod.	9	-	-
14	-	KN01008.02	Ring Cnt. 82-H	Six Shooter	9	-	-
14	-	KN01008.08	Ring Cnt. 82-H	Six Shooter	9	-	9
14	44	KN01009.01	Ring Cnt. 82-H	5 L CTD/200 m	24	7	-
14	45	KN01009.02	Ring Cnt. 82-H	FL. Prod.	6	-	-
14	46	KN01009.07	Ring Cnt. 82-H	MD. Prod.	12	-	-
14	-	KN01009.08	Ring Cnt. 82-H	NT. Prod.	12	-	-
14	-	KN01009.09	Ring Cnt. 82-H	Six Shooter	9	-	9
15	47/48	KN01012.01	Ring Cnt. 82-H	FL. Prod.	6	-	-
15	49	KN01012.02	Ring Cnt. 82-H	SI. Deep	12	12	12
15	50	KN01012.05	Ring Cnt. 82-H	MD. Prod.	12	-	-
15	51	KN01012.06	Ring Cnt. 82-H	5 L CTD/2000 m	24	12	12
15	-	KN01012.07	Ring Cnt. 82-H	Six Shooter	9	-	9
15	53	KN01012.	Ring Cnt. 82-H	Nt. Prod.	24	8	-
15	54	KN01013.03	Ring Cnt. 82-H	5 L CTD/200 m	24	8	-
15	55	KN01014.02	Ring Cnt. 82-H	30 L CTD/3000 m	12	12	12
15	56	KN01014.03	Ring Cnt. 82-H	FL. Prod.	12	-	-
16	57	KN01015.02	Slope	5 L CTD/400 m	24	-	-
16	-	KN01015.09	Slope	Six Shooter	9	-	9
16	58	KN01016.02	Slope	30 L CTD/2300 m	12	12	12
16	59	KN01016.03	Slope	FL. Prod.	12	12	-

the chlorophyll maximum at station 6. During the second set of experiments, the seawater was incubated with a copper spike of 2 nM/kg and increasing levels of dissolved organic matter. The biological rate and biomass measurements were carried out by H. Ducklow (thymidine incorporation by bacteria), G. Hitchcock (^{14}C uptake by phytoplankton; chlorophyll), and C. Langdon (ATP determinations).

A set of experiments were conducted to test the recovery efficiency of the C_{18} Sep-Pak at various depths in the water column. Samples for dissolved and total organic carbon were preserved for analysis on shore.

The pH and total alkalinity (TA) were routinely determined as ancillary parameters with respect to copper speciation modeling. The following table provides a summary of the work completed during KNORR 98.

Hanson and Kester

Table 1.

Type of Operation/ Sample Processing	Organically- bound Cu (C_{18} - RPLC eluted w/methanol	'Silica labile' Cu (C_{18} -RPLC eluted w/ 5 percent HCl	Total Metals	HPLC	pH/Ta
Radial Section Stations (to 1000 m)	88	88	88		88
Radial Section Stations (high resolution)	66	66	66		66
5 l deep CTD/5 l Shallow Thermocline	108	108	154	4	108
Productivity and Si Deep Casts	26	26	26		26
Trophic Coupling Experiment	10	10	10	22	10
Copper-organic Additions Experiment	26	26	13	1	1
Copper-organic Recovery Experiment	5	5	10	5	
TOTALS	329	329	367	32	299

RADON AND RADIUM IN WARM CORE RINGS

Principal Investigators: David R. Schink and Norman L. Guinasso, Jr
Cruise Participant: James C. Orr
Texas A and M University

The objectives of this cruise were to characterize mixing in warm core ring 82-H and its surrounding waters utilizing the radioisotopes ^{222}Rn , ^{226}Ra , and ^{228}Ra . Analyses for these three radioisotopes are undertaken to estimate horizontal and vertical mixing rates across ring boundaries.

This cruise utilized the device known as the six shooter for all of the sampling. The six shooter consists of a twelve, 30-liter bottle rosette, a Neil Brown CTD, and an in situ pumping system attached to the bottom of the rosette. The pumping system utilizes a battery-powered pump and valves which can direct flow to one of six, ^{228}Ra extraction channels. Each channel consists of a prefilter and two MnO_2 -impregnated wound-acrylic cartridges. The radium removal efficiency is approximately 93 percent at 1.4 liters/sec. The six shooter is designed to sample large volumes of seawater (about 1000 liters/sample) necessary for ^{228}Ra analysis; it requires about 12 minutes of pumping for each of six samples collected per lowering. The ^{222}Rn and ^{226}Ra are collected in the 30 l Niskin bottles on the rosette.

The six shooter was developed for the Warm Core Rings program to minimize the wire time previously required to collect ^{228}Ra from the large volume water. The six shooter performed only intermittently on earlier WCR cruises; however, the instrument performed flawlessly on this cruise. When not enough wire time was available for large volume sampling, only a 30 l rosette cast was taken. The following table lists ten complete six shooter casts and two where ^{228}Ra pumping was not performed:

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Table 1.

Type Station	Station-Cast	Position °N °W		Depths
SW	1-927.1	39.02.20	65.33.60	798,498,302,144,60,32,17,5
MC	5-929.1*	39.28.10	64.05.76	1000,650,400,250,125,60,20,2
MC	6-930.5	39.31.40	64.18.54	1000,630,300,130,80,40,15,2
MC	6-1001.2	39.20.32	64.27.30	1000,630,300,130,80,40,15,2
SW	13-1005.12	40.38.26	64.56.46	1000,602,294,127,81,42,17,2
RC	14-1007.13	39.32.16	65.25.53	1002,636,298,132,84,42,18,2
RC	14-1008.2*	39.25.08	65.19.35	1018,638,248,99,50,15,7,2
RC	14-1008.8	39.28.94	65.39.64	1001,619,296,130,79,42,16,2
RC	14-1009.9	39.25.21	65.21.06	930,501,246,125,76,49,24,3
RC	15-1012.7	39.06.51	66.05.46	1005,505,254,132,77,56,20,8
SW	16-1015.9	38.58.72	68.26.32	1009,397,199,102,71,52,20,3
SHW	17-1016.8	39.56.73	69.38.91	-7,-20,-30,-50,-85,-140, -190,-260

* ^{222}Rn and ^{226}Ra only (no ^{228}Ra pumping)
SW - Slope Water
MC - Meander Center
RC - Ring Center
SHW - Shelf Water

Negative numbers are representative of depth off bottom in last cast (bottom depth = 265 m).

PARTICULATE MATTER AND 12 KHZ ECHO SOUNDING STUDIES

Principal Investigator: James K. B. Bishop
Cruise Participants: Robert Sherrell and James Bishop
Lamont-Doherty Geological Observatory

The purpose of this program is to understand the factors governing the distributions and sedimentation of oceanic particulate matter in Warm Core Gulf Stream Ring systems. During KNORR 98, we visited a large meander in the Gulf Stream which showed indications of forming a warm core ring. Subsequent to our arrival in the area, the meander pinched off and formed ring 82-H. We deployed the Multiple Unit Large Volume In Situ Filtration System (MULVFS) at 8 stations and collected 79 samples of size-fractionated particulate matter for subsequent laboratory analysis (Table 1). Sediment traps were deployed for approximately 6-hour periods in the upper kilometer during all MULVFS casts.

Additional activities aboard R/V ENDEAVOR were the deployment of sediment traps attached to the Loran drifters and the collection of transmissometer data during CTD casts.

The abundance of $>53\ \mu\text{m}$ material in 82-H was high in the deep chlorophyll maximum below the mixed layer but dropped off sharply in deeper samples. This was similar to the pattern observed in the Sargasso Sea during August. Samples collected from the Slope Water showed a similar trend but with maximum large particulate abundances in the mixed layer; deeper samples were lightly loaded compared with previous Slope Water stations, but were more heavily loaded compared with 82-H samples. Taken together, these data suggest that ring 82-H began its life with particle distributions typical of the Sargasso Sea. Furthermore, sedimentation (inferred from relative abundances of large particles on MULVFS samples) was low in ring 82-H compared with both 81-D and 82-B and was also lowest in the Slope Water compared with Slope Water stations from the April, June and August cruises this year.

1. MULVFS Operations:

a) System performance

This cruise was the third sea trial of the complete MULVFS and the second cruise that it was the core of our sampling program. The Large Volume Filtration System (LVFS) was aboard but was never used.

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Table 1. MULVFS Cast Summary: KNORR 98

<u>Date</u>	<u>Day</u>	<u>Cast</u>	<u>Sta.</u>	<u>Time (Local)</u>	<u>Depths Sampled</u>	<u>Mean Position</u>		<u>Dist.</u>
						<u>°N</u>	<u>°W</u>	
820928.09	271	1M	4	+4 1535 0004	30,78,176, 372,567,762	39.28.6	64.50.8	
820930.02	273	2M	5	+4 0350 1042	49,120,168, 266,365,462, 559,657,754,852	39.20.0	63.59.1	
821001.17	274	3M	6	+4 2049 0540	10,81,129, 227,326,423, 520,618,715,813	39.14.6	64.42.1	
821003.16	276	4M	7	+4 2340 0815	50,74,145, 193,291,390, 487,584,682,779,877	39.40.1	64.57.2	
821005.13	278	5M	13	+4 2137 0410	10,81,129, 326,423,520, 618,715,813	40.37.9	64.56.5	
821007.17	280	6M	14	+4 2040 0404	81,129,326 423,520,618 715,813	39.29.2	65.22.9	
821008.01	281	6BM	14	+4 0404 0515	50,147,245	39.26.2	65.20.0	
821013.08	286	7M	15	+4 1730 0115	30,78,275 372,469,567, 664,762	39.03.8	66.01.9	
821014.01	287	7BM	15	+4 0120 0403	50,147,245	39.01.3	66.00.3	
821015.11	288	8M	16	+4 1922 0205	30,78,275 372,469,567 664,762	38.58.2	68.31.6	
821016.01	289	8BM	16	+4 0205 0422	50,147,245			

elapsed wire time - 67.5 hrs.

- 1,2,3,4 - radial section in to meander
- 5 - meander center; first 48-hour station
- 6 - meander center; second 48-hour station
- 7 - meander/ring center; partial 48-hour station
- 8,9,10,11,12 - high resolution section; ring 82-H center; Slope Water
- 13 - Slope Water station north of 82-H High Velocity Region
- 14 - Ring 82-H center; 4th 48-hour station
trophic coupling experiment
- 15 - Ring 82-H center after 2-day gale
- 16 - Slope Water station west of 82-H
- 17 - Shelf/Slope break station

The MULVFS, which is powered by 480 VAC 3-phase ship's power, consists of a drum winch, level wind, electromechanical cable, twelve pump units, and an Apple II control computer. The electromechanical cable is radically different from that used with the Large Volume In Situ Filtration System (LVFS) in that it is composed of a KEVLAR strength member mated in parallel to the electrical cable. This arrangement permitted us to mechanically and electrically attach twelve pump/filter units at any of the fifteen electrical "pigtails" distributed along its 1000 m length. The numbering of pigtails ran from 1 (near surface) to 15 at the end of the cable. Pigtail spacing varied from 25 m near the surface to 100 m at the end of the cable. Due to problems with the electromechanical cable during OCEANUS 125 and repairs at L-DGO prior to this cruise, the number of available terminations was reduced to 11, and the maximum depth range of sampling was reduced to 900 m.

During this cruise, we were able to collect 8 complete MULVFS profiles with no major problems. The problems that we did have were attributable to the fact that the electrical cable had been strained badly on the June and August OCEANUS cruises. We have solved the problem of mating the electrical and mechanical cables completely.

b) Sampling program

Seventy-nine samples were collected using the MULVFS, 15 of which were taken using stainless steel prefilters for subsequent organic fraction analysis.

Integrated zooplankton samples from 0-1000 m were obtained from 8 MOC-1D tows. A portion of these samples was placed in chloroform:methanol for analysis of the lipid fraction in living zooplankton; a second portion was preserved in 5 percent formalin for identification of the contributing plankton. These samples will allow comparison between the lipid fraction in living and particulate organic material.

2. R/V ENDEAVOR Program:

The transmissometer, which had performed well in June and August, was once again working on all CTD casts, including the "toyo" series. This cruise was the first where we were able to obtain data from the ENDEAVOR while at sea. Data from two CTD sections, one through the meander and one north of the meander from the shelf to the Sargasso Sea were contoured and used to guide MULVFS sampling. The data through the meander (Figure 1) show that particulate matter was distributed symmetrically in the upper 500 m, particularly in the High Velocity region relative to the center of the meander. Details of the distribution in the upper 100 m showed that distribution of material near the meander center was quite variable. Deeper data show a subsurface particle maximum penetrating from 200-400 m depths to >900 m from the edge to the center of the ring/meander. Data also indicate that deep particle distributions are not symmetric.

The sediment traps were not deployed in 82H due to the problems with the Loran drifters.

3. 12 kHz Echo Sounding

12 kHz sounder records were obtained for the upper 750 m during this cruise. The data have not been reduced at this time.

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Figure 1.

Transmissometer section through meander (82-H). $\Delta\%T$ contours are proportional to particle concentration with a crude calibration of 1 $\Delta\%T$ unit equal to 30 $\mu\text{g}/\ell$ dry weight. Also shown are sampling depths for MULVFS station 2.

MICROZOOPLANKTON GRAZING

Principal Investigator: Michael R. Roman
Cruise Participants: Michael R. Roman and Ann Gauzens
University of Maryland

One of the general objectives of KNORR 98 was to focus on the dynamics of breakdown of the seasonal thermocline in a warm core ring. As part of this experiment, in situ grazing measurements and the sampling of the 1/4 M MOCNESS sampler at fine-scale intervals (5-10 m) were to be concentrated above and below the thermocline. As the cruise progressed and the water column was cooled and mixed, we hoped to find inorganic nutrient input into the euphotic zone. The zooplankton grazing and biomass estimates were intended to document how these nutrient inputs effected the microzooplankton community. These preliminary objectives were not realized, as the first part of the cruise was dedicated to studying the formation of a warm core ring.

General Impressions

We were most fortunate to witness the genesis of a warm core ring, to study a mixing event in this ring, and to perform detailed experiments on the distribution of plankton biomass and carbon production in the euphotic zone. Initially, ring 82-H was similar to the Sargasso Sea in zooplankton composition, the level of phytoplankton biomass (chlorophyll a) and contained a large population of Trichodesmium. Over our cruise period, the Trichodesmium in the ring decreased dramatically. Compared to live tows taken on September 29, those taken on October 7 had little or no Trichodesmium and that present was in a moribund state. It may be that Trichodesmium was grazed down by the harpacticoid copepods, Macrosetella and Miracia. I have rarely seen these copepod species as abundant as found in WCR 82-H. The zooplankton population also seemed to change, with more juveniles present as the ring aged. The greatest concentration of zooplankton occurred between 70 and 55 m on October 9, the depth of the chlorophyll a maximum. Initially in the ring (September 29), over 50 percent of the zooplankton biomass was in the surface 50 m. As the ring aged and was mixed by the storm, the zooplankton distribution in the water column changed. At our last station (October 13) in ring center, only 8 percent of the zooplankton biomass was present in the surface 50 m, the greatest concentration occurring between 150-100 m. This deepening of the "planktostad" coincided with the deepening of the mixed layer from 50 to 90 m.

Work Done

Microzooplankton tows (1/4 M MOCNESS):

Ring Center; September 29, October 1, 3, 7, 13 -- all tows 200 m to the surface with the nets sampling 25 m increments. Slope Water; October 6 (0 to 200 m, 25 m increments), October 15 (0 to 80 m, 10 m increments). During the trophic coupling experiments in Ring Center (October 9), we sampled 110-100, 100-90, 90-80, 80-70, 70-55, 55-40, 40-20, 20-0 m day and at night.

In situ grazing: In situ grazing incubations were performed at the 100, 60, 36, 22, 8 and 3 percent light depths at Ring Center (September 29, October 1, 3, 7, 13), and in the Slope Water (October 6 and 16), similar observations were made at Ring Center (October 9 AM and PM) at the 60, 36, and 22 percent light levels, and at the base of the mixed layer (55 m) and in the oxygen minimum layer (105 m).

Shipboard Grazing Experiments:

Each day that an in situ grazing experiment was performed, day and nighttime shipboard grazing experiments were also conducted. Water was collected from the chlorophyll maximum layer (30 l Niskin), and zooplankton were collected in the surface 100 m (64 μ m net). Uptake of autotrophic particles (14 C-labelled) and heterotrophic particles (3 H-labelled) by the >333 μ m and <333 μ m zooplankton fractions was measured at 0.5, 1.0, and 1.5 hr. The water used in these feeding experiments was filtered for dry weight, protein, carbohydrate, lipid, carbon, nitrogen, chlorophyll a (>3.0 μ m, >0.22 μ m) and free and attached bacteria.

Summary of Activities

MOC 1/4 tows - 9 (note these are the same as described by Cowles); In situ grazing estimates - 54; Daytime shipboard grazing experiments - 54; Nighttime shipboard grazing experiments - 48; chlorophyll a, >3.0 μ m - 34; chlorophyll a, >0.22 μ m - 34; Proteins - 51; Carbohydrates - 51; Lipids - 51; Seston dry weight - 51; Particulate carbon - 51; Particulate nitrogen - 51; Free and attached bacteria - 51.

COPEPOD FEEDING AND EGG PRODUCTION

Principal Investigator and Cruise Participant: Timothy Cowles
Woods Hole Oceanographic Institution

The overall objective has been to characterize the feeding rates and egg production rates of copepods within and around warm core rings, as these animals experience changes to their habitat as the ring changes through time. These data are put into a larger context through later analysis of preserved samples from the MOCNESS tows.

The shipboard work for our group is summarized as follows:

Water samples were analyzed for particulate matter at every station with an electronic particle counter, providing size distributions of particulate matter at multiple depths.

Day and night collections of zooplankton were made at every station for determination of feeding rates and egg production rates of the dominant copepods.

The impact of microzooplankton grazing was estimated through a series of dilution experiments at most stations.

Microzooplankton and juvenile stages of macrozooplankton were sampled at all major stations with the 1/4 meter MOCNESS (in collaboration with Michael Roman), to provide high vertical resolution of this poorly understood element of the planktonic system.

The number and location of different activities is summarized in the following table.

Cowles

Table 1.

<u>ACTIVITY</u>	<u>REGION</u>		
	<u>Slope</u>	<u>Within Ring</u>	<u>Ring Edge</u>
Part. Profiles	2	17	2
Feeding Expts.	2	8	2
Egg Prod. Expt.	1	7	1
Dilution Expts.	---	9	1
MOC Tows	1	7	1

General Impressions

Meander/Ring 82-H was quite a change from the previous rings we have observed during the course of this field year. The center of 82-H had less particulate matter available for grazers, and we observed low feeding rates for the copepods in the upper 100 meters. The calanoid copepods in the daylight live tows were dominated by adults and copepodites of the genus Undinula, with occasional large numbers of Nannocalanus. Night tows were usually dominated by various species of Pleuromamma. We found no cold-water species in the live tows within the meander/ring. Of the several species examined for egg production, Undinula seemed to be the most fecund for this time of year. Much of the experimental data awaits further analysis after our return to Woods Hole.

ZOOPLANKTON SPATIAL PATTERNS

Principal Investigator: Peter H. Wiebe

Cruise Participants: Alfred Morton, Valerie Barber, and Peter Wiebe
Woods Hole Oceanographic Institution

Our objectives for this fourth and last of the 1982 time-series cruises to Gulf Stream warm core rings were to sample at stations in the center of the ring selected for study and at a station in the Slope Water in order to provide a picture of the vertical structure in the upper 1000 meters of the ring for a variety of species, especially the euphausiids, and to characterize the diel vertical movements of these species as well as the total

zooplankton biomass. In addition to this gross vertical structure, we intended to determine when (time of day) the vertical migrators entered the surface layer (upper 100 m) and how, on a fine scale, they were distributed with respect to the subsurface chlorophyll maximum. As on previous cruises, we intended to collect individuals of a number of euphausiid species for biochemical analysis in order to study the effects of spatial and temporal changes in rings on their physiological and biochemical properties.

We used a double MOCNESS-1 (1 m² nets) equipped with SEABIRD temperature and conductivity probes to sample the zooplankton in the upper 1000 meters. Attached to the towed frame are 20 nets made from 335 μ m nitex nylon gauze, 16 of which can be opened and closed upon command from the surface. Our deck unit was interfaced to a Commodore Business Machines 8032 microcomputer which processed data coming from the underwater unit once every 4 seconds. Processed data were then printed out and stored on a floppy disc, and a plot of temperature and salinity versus depth was made on an Houston Instruments DPM-7 digital plotter. On each 3- to 3-1/2-hour haul, we generally obtained 8 samples integrating 100 m intervals from 1000 to 200 m, and 8 samples integrating 25-m intervals from 200 to 0 m. Thirteen oblique hauls to 1000 m were made: 9 in the core of the meander/ring 82-H; 2 in the entrainment field just to the north of the ring's High Velocity Region; and 2 in the Slope Water at a location where ENDEAVOR had worked and far from the influence of 82-H or other rings. In addition, two toyo tows and 3 high resolution tows were made as described below. A total of 325 samples were obtained. Tow data is in Table 1.

During the joint ship work with the ENDEAVOR on the 7th of October, we toyoed the double MOCNESS between 120 m and the surface while steaming along side the ENDEAVOR while they were toyoing a CTD to approximately 300 m (Figure 1). The tow was across an extremely intense front just outside of the High Velocity Region on the northern side of the ring. Over the 8 km distance of the tow, surface temperatures ranged from 25 to 16°C, and salinities ranged from 36.1 to 32.5 (PSU); a strong temperature and salinity inversion gave rise to similar variations in these properties between the surface and 120 m. On this toyo, we alternately fished a single net from the surface to 120 m and then opened and closed three nets on the leg back to the surface. The intermediate depths for opening and closing nets were based on the vertical temperature structure. The lower net was closed at the depth where the subsurface temperature maximum peaked; the second net was closed when the 20°C isotherm was crossed, marking the bottom of the mixed layer. Thus, on the up-legs of the tow, the lower net fished the zone below the inversion, the middle net fished the inversion, and the third net fished the surface mixed layer. This procedure was repeated four times during the tow (8 oblique sections); two additional sections - an up-leg and a down-leg - were each made with a single net. Initial processing and plotting of the temperature and salinity data were completed at sea. Loran C positions taken periodically during the tow were plotted on an expanded chart, and distances from the start of the tow for the times of the position fixes were determined. The relationship between distance and time was determined using linear regression and was highly significant ($r = .96$). The regression equation was used to

Table 1. Summary of Double MOCNESS-1 Tow Statistics
WARM CORE
GULF STREAM TIME SERIES CRUISE
KNORR Cruise No. 98, September 24--October 17, 1982

MOCNESS No.	Lat. °N	Long. °W	Local			GMT			Isotherm Depths 15°C 10°C		Station Area Depth Interval, Remarks
			Date (Start Down)	Time Start Up	Time Up	Date (Start Down)	Time Start Up	Time Up			
MOC-1D-210	39.20.4 39.18.71	65.46.37 65.45.46	27 Sept. 1958	2107	2320	27 Sept. 2358	0107	0320	379 390	531 528	MC;1000-200m at 100m inter; 200-0m at 25m inter; w/T,S One net didn't open; net 16 fished 75-25 m
MOC-1D-211	39.25.84 39.29.21	64.06.10 64.01.13	29 Sept. 2003	2117	2310	30 Sept. 0003	0117	0310	621 625	851 849	MC;1000-200m at 100m inter; 200-0m at 25m inter; w/T,S
MOC-1D-212	39.18.66 39.22.73	64.03.58 64.03.86	30 Sept. 1102	1203	1359	30 Sept. 1502	1603	1759	623 615	822 831	MC;1000-200m at 100m inter; 200-0m at 25m inter; w/T,S
MOC-1D-213	39.29.49 39.30.37	64.18.47 64.14.51	30 Sept. 2014	2115	2310	1 Oct. 0014	0115	0310	671 657	851 852	MC;1000-200m at 100m inter; 200-0m at 25m inter; w/T,S
MOC-1D-214	39.25.36 39.28.89	64.27.66 64.35.9	2 Oct. 0826	1008	1217	2 Oct. 1246	1408	1617	615 629	830 844	MC;1000-200m at 100m inter; 200-0m at 25m inter; w/T,S
MOC-1D-215	40.40.25 40.45.00	65.00.6 65.02.99	4 Oct. 2158	2255	0037	5 Oct. 0158	0255	0437	130 104	319 299	MC;1000-200m at 100m inter; 200-0m at 25m inter; w/T,S
MOC-1D-216	40.37.3 40.41.5	64.57.3 65.02.01	5 Oct. 0807	0910	1050	5 Oct. 1207	1310	1450	78 117	330 316	MC;1000-200m at 100m inter; 200-0m at 25m inter; w/T,S
MOC-1D-217	40.40.1 40.44.9	64.50.2 64.50.72	6 Oct. 0938	--	1229	6 Oct. 1338	--	1629	num. cross.	NP	Toyo (w/ENDEAVOR) in Entr. Field 1 net on down leg; 3 nets on up leg
MOC-1D-218	39.52.93 39.47.62	65.12.14 65.14.43	6 Oct. 2043	2145	2335	7 Oct. 0043	0145	0335	523 540	713 727	RC;1000-200m at 100m inter; 200-0m at 25m inter; w/T;no S

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Table 1. Summary of Double MOCNESS-1 Tow Statistics
WARM CORE
GULF STREAM TIME SERIES CRUISE
KNORR Cruise No. 98, September 24--October 17, 1982

MOCNESS No.	Lat. °N	Long. °W	Local			GMT			Isotherm Depths		Station Area Depth Interval, Remarks
			Date (Start Down)	Time Start Up	Time Up	Date (Start Down)	Time Start Up	Time Up	15°C	10°C	
MOC-1D-219	39.24.14 39.27.99	65.18.91 65.21.04	8 Oct. 0728	0832	1020	8 Oct. 1128	1232	1420	637 643	845 844	RC;1000-200m at 100m inter; 200-0m at 25m inter; w/T,S
MOC-1D-220	39.29.34 39.28.88	65.33.03 65.39.79	8 Oct. 1640	--	1948	8 Oct. 2040	--	2348	NP	NP	RC;dusk toyo,0-100m each net at 100m inter.
MOC-1D-221	39.29.75 39.28.48	65.28.55 65.23.59	9 Oct. 0947	1004	1113	9 Oct. 1347	1404	1513	NP	NP	RC; high resol. 160-0m at 10m inter.
MOC-1D-222	39.18.79 39.20.12	65.12.07 65.11.66	9 Oct. 2040	2100	2215	10 Oct. 0040	0100	0215	NP	NP	RC; high resol. 160-0m at 10m inter.
MOC-1D-223	39.07.30 39.13.52	66.04.81 66.04.04	12 Oct. 2230	2351	0150	13 Oct. 0230	0351	0550	619 624	833 828	RC;heavy seas;1000-200m at 100m inter;200-0 at 25m inter;w/T,S bucket 16 cracked; sample lost
MOC-1D-224	39.07.83 39.11.78	66.04.15 65.59.64	13 Oct. 0836	0958	1145	13 Oct. 1236	1358	1545	622 626	841 838	MC;1000-200m at 100m inter; 200-0m at 25m inter; w/T,S
MOC-1D-225	39.03.76 39.04.75	67.61.16 67.59.88	14 Oct. 2100	2210	0001	15 Oct. 0100	0210	0401	105 91	262 250	SW;1000-200m at 100m inter; 200-0 at 25m inter;w/T,S
MOC-1D-226	39.03.16 39.00.91	68.08.44 68.16.06	15 Oct. 0753	0855	1057	15 Oct. 1153	1255	1457	99 96	262 245	SW;1000-200m at 100m inter; 200-0 at 25m inter.
MOC-1D-227	38.56.73 38.56.51	68.35.51 68.40.81	16 Oct. 0853	0931	1046	15 Oct. 1253	1331	1446	76 72	NP	SW; high resol. 160-0m at 10m inter.

determine the distance of a given temperature or salinity and depth from the start of the tow. Section plots of temperature and salinity versus depth are given in Figures 2 and 3.

A second toyo was done in the center of the ring on 9 October to determine when diel migrators entered the surface layer during their dusk migration (Figure 4). This tow was started at 1630, approximately 1-1/2 hrs. before sunset and ended at 1930 hrs. Each of 18 nets was fished obliquely to 100 m; the nets alternately sampling on a down-leg and an up-leg. Loran positions were again used to determine the relationship between distance and time and the regression equation ($r = .99$) used to determine the distance of a given temperature or salinity and depth from the start of the tow. Physical conditions over the course of the tow were quite uniform, and internal wave activity was weak (Figures 5 and 6). In conjunction with this tow, on the following day we made two high resolution oblique tows, one during the day and one at night, to determine how zooplankton biomass and species were distributed relative of the subsurface chlorophyll maximum and where diel migrators tended to reside at night. On each tow, 10 m intervals from 160 m to the surface were sampled.

Incident solar radiation data were collected at 10-minute intervals for the duration of the cruise with an MR-5 pyranometer (Hollis Observatory product). These data, combined with chlorophyll a and light cast data collected by G. Hitchcock, and the transmissometer data collected by J. Bishop, will be used to calculate downwelling light levels in the upper 1000 meters. These light data will also be used by M. Conte (LDGO) for comparison with the movements of the scattering layers observed with the 12khz echo sounder (see Bishop report).

Euphausiids from 8 MOCNESS-20 trawls were preserved for carbon, nitrogen, and hydrogen analysis, or lipid fractionation studies. A total of 10 species were processed (Table 2).

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Table 2. Number of Individuals Collected for Biochemical Analysis According to Intended Treatment

<u>Tow/Area</u>	<u>Species</u>	<u>CHN</u>	<u>Chlor-Meth</u>	<u>Frozen</u>
MOC-20-55-RC (Net 5; 200-0 m)	<u>E. hemigibba</u>	6	3	
	<u>T. monocantha</u>	5	4	
	<u>N. microps</u>		3	
	<u>S. abbreviatum</u>		4	
	<u>E. gibboides</u>		2	

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Table 2. Number of Individuals Collected for Biochemical Analysis According to Intended Treatment (cont.)

<u>Tow/Area</u>	<u>Species</u>	<u>CHN</u>	<u>Chlor-Meth</u>	<u>Frozen</u>
MOC-20-56-RC (Net 5; 200-0 m)	<u>T. tricuspidata</u>	7		
	<u>E. hemigibba</u>	9		
	<u>T. monocantha</u>	3		
	<u>N. microps</u>	8		
	<u>S. abbreviatum</u>	1		
MOC-20-57-RC (Net 4; 400-200 m)	<u>N. microps</u>	5		
	<u>S. abbreviatum</u>	2		
	<u>S. elongatum</u>	1		
	<u>N. flexipis</u>	1		
(Net 5; 200-0 m)	<u>S. abbreviatum</u>	5		
	<u>T. monocantha</u>	5		
MOC-20-59-EF (Net 4; 400-200 m)	<u>E. krohnii</u>	10	7	8
	<u>N. megalops</u>	6	7	6
MOC-20-60-EF (Net 4; 400-300 m)	<u>E. krohnii</u>	10	11	10
MOC-20-61-RC (Net 4; 400-200 m)	<u>N. microps</u>	8		
(Net 5; 200-0 m)	<u>S. abbreviatum</u>	2		
	<u>N. microps</u>	7	5	
	<u>S. abbreviatum</u>	5		
	<u>T. monocantha</u>	4		
	<u>E. hemigibba</u>	2		
MOC-20-63-RC (Net 5; 375-0 m)	<u>N. microps</u>	5		15
	<u>S. abbreviatum</u>	5		
	<u>E. hemigibba</u>	6		
MOC-20-65-SW (Net 4; 400-300 m)	<u>N. megalops</u>	5		
(Net 5; 300-0 m)	<u>E. krohnii</u>	17	10	20
MOC-20-66-SW (Net 4; 400-200 m)	<u>N. megalops</u>			8
	<u>E. krohnii</u>	3		
(Net 5; 200-0 m)	<u>E. krohnii</u>	20	13	

RC = Ring Center
EF = Entrainment Feature
SW = Slope Water

Figure 1.

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Figure 2.

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Figure 3.

MOC -1D-217
TOYO IN RING FRINGE
SALINITY SECTION
DISTANCE (km)

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Figure 4.

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Figure 5.

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Figure 6.

MIDWATER FISHES

Principal Investigator: Richard H. Backus
Cruise Participants: James E. Craddock and Mary Ann Daher
Woods Hole Oceanographic Institution

During KNORR 98, the MOCNESS 20 trawl was successfully used twelve times, 8 times at or near ring (meander) center, and 4 times in Slope Water. The trawl was used each time with 6 nets to sample a 1000 m water column; 72 collections were thus made (Table 1).

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Table 1. Summary of MOCNESS 20 Collections, KNORR 98

<u>MOC 20</u>	<u>Position</u>		<u>Date</u>	<u>Time (+4)</u>	<u>Locality, Depths (m)</u>
	<u>°N</u>	<u>°W</u>			
55	39.16.7	65.43.9	09/28/82	0111-0355	Meander Center;0-1000;997-797; 797-600;600-400;400-204;204-0
56	39.28.0	64.00.6	09/30/82	0012-0333	Meander Center;0-1023;1006-802; 802-602;602-401;401-201;201-0
57	39.30.1	64.14.3	09/30/82 10/01/82	2331-0329	Meander Center;0-1007;1001-800; 800-602;602-401;401-203;203-0
58	39.28.7	64.36.3	10/02/82	1241-1627	Meander Center;0-1000;998-800; 800-599;599-400;400-305;305-40
59	40.45.0	65.03.0	10/05/82	0056-0435	Slope Water;0-1002;1002-800;800- 599;599-401;401-200;200-7
60	40.42.0	65.00.3	10/05/82	1344-1700	Slope Water;0-1010;1000-800;800- 600;600-399;399-302;302-10
61	39.46.7	65.14.0	10/06/82 10/07/82	2350-0400	Ring Center;0-1005;1002-800;800- 600;600-400;400-200;200-12
62	39.26.5	65.21.7	10/08/82	1121-1535	Ring Center;0-1004;999-802;802- 602;602-400;400-301;301-5
63	39.27.4	65.35.2	10/08/82 10/09/82	2313-0326	Ring Center;0-1000;1000-800;800- 600;600-402;402-370;370-5
64	39.09.7	65.57.9	10/13/82	1337-1649	Ring Center;0-1015;999-800;800- 600;600-502;502-400;400-3
65	39.04.9	68.00.3	10/15/82	0022-0430	Slope Water;0-1020;1014-800;800- 599;599-400;400-199;199-6
66	38.58.2	68.18.6	10/15/82	1307-1629	Slope Water;0-1018;1000-799;799- 601;601-400;400-299;299-7

III. SCIENTIFIC OBSERVATION LOG

ST NO.	CTD NO.	OP NO.	START TIME	LATITUDE °N	LONGITUDE °W	DESCRIPTION	INVESTIGATOR
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RADIAL SECTION INTO MEANDER

1		927.1	0215	39 02.20	65 33.60	Six Shooter No. 1	Orr
1	1	927.2	1213	39 08.00	65 57.00	30 1 CTD/100m	Hitchcock
1		927.3	1300	39 09.64	65 58.45	Vertical net tow	Gould
1	2	927.4	1404	39 11.93	66 00.11	30 1 CTD/1000m	Ducklow
2	3	927.5	1644	39 16.37	65 45.87	30 1 CTD/100m	Hitchcock
2		927.6	1720	39 17.66	65 46.19	Vertical net tow	Gould
2	4	927.7	1740	39 18.00	65 46.60	30 1 CTD/1000m	Ducklow
2		927.7	1958	39 20.40	65 46.37	MOC-1D-210 (0-1000m)	Wiebe
2		928.1	0111	39 16.69	65 43.86	MOC-20-55	Craddock
3	5	928.2	0605	39 22.69	65 37.01	30 1 CTD/100m	Ducklow
3		928.3	0637	39 23.89	65 37.64	Vertical net tow	Gould
3	6	928.4	0658	39 24.72	65 38.32	30 1 CTD/1000m	Hitchcock
4	7	928.5	1249	39 27.99	64 42.93	30 1 CTD/100m	Ducklow
4		928.6	1314	39 27.79	64 43.25	Vertical net tow	Gould
4	8	928.7	1343	39 28.15	64 44.24	30 1 CTD/1000m	Hitchcock
4		928.8	1455	39 27.55	64 45.27	Light cast	Hitchcock
4		928.9	1535	39 27.70	64 45.90	MULVFS cast No. 1	Bishop

MEANDER CENTER - FIRST 48 HR STATION

5		929.1	0410	39 28.10	64 05.76	Six shooter no. 2	Orr
5	9	929.2	0601	39 28.65	64 04.50	30 1 CTD/100m fl pr	Hitchcock
5	10	929.3	0650	39 29.53	64 03.71	30 1 CTD/1000m/si dp	Ducklow
5		929.4	0840	39 29.82	64 02.46	MOC-1/4-58	Cowles/Roman
5		929.5	1010	39 29.90	64 02.07	MOC-1/4-58 F	Gould
5		929.6	1100	39 29.90	64 02.07	In situ grazing	Roman
5	11	929.7	1226	39 27.00	64 05.68	30 1 CTD/100m md pr	Ducklow
5		929.8	1302	39 26.40	64 05.99	30 1 Niskin - hydro	Roman
5		929.9	1311	39 26.28	64 06.16	Live tows	Cowles/Roman/Gould
5	12	929.10	1358	39 25.55	64 07.20	5 1 CTD/2000m	Brown
5		929.11	1803	39 27.25	64 05.76	Six shooter no. 3	Orr
5	13	929.12	1905	39 26.94	64 05.81	30 1 CTD/100m nt pr	Hitchcock
5		929.13	2003	39 25.84	64 08.10	MOC-1D-211 (0-1000m)	Wiebe
5		929.14	2327	39 29.13	64 00.87	30 1 Niskin - hydro	Roman
5		925.15	2337	39 28.98	64 00.83	Live tows	Cowles
5		930.1	0012	39 28.02	64 00.58	MOC-20-56	Craddock
5		930.2	0350	39 22.20	63 55.30	MULVFS cast no. 2	Bishop
5		930.3	1102	39 18.66	64 03.58	MOC-1D-212 (0-1000m)	Wiebe
5		930.4	1410	39 22.82	64 03.91	Light cast	Hitchcock

ST NO.	CTD NO.	OP NO.	START TIME	LATITUDE °N	LONGITUDE °W	DESCRIPTION	INVESTIGATOR
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MEANDER CENTER - SECOND 48 HR STATION

6		930.5	1735	39 31.40	64 18.54	Six shooter no. 4	Orr
6		930.6	2004	39 29.49	64 18.47	MOC-1D-213 (0-1000m)	Wiebe
6		930.7	2330	39 30.05	64 14.33	MOC-20-57	Craddock
6	14	1001.1	0611	39 31.99	64 17.70	30 l CTD/100m/fl pr	Hitchcock
6	15	1001.2	0653	39 30.66	64 16.66	30 l CTD/1000m/si dp	Brzezinski
6		1001.3	0802	39 28.92	64 18.55	MOC-1/4-59 F	Gould
6		1001.4	0854	39 27.29	64 19.08	MOC-1/4-59	Cowles/Roman
6		1001.5	1000	39 27.29	64 19.08	In situ grazing	Roman
6		1001.6	1122	39 24.32	64 21.47	Live tows	Cowles
6		1001.7	1145	39 24.29	64 22.24	30 l Niskin	Cowles
6	16	1001.8	1200	39 24.16	64 22.50	30 l CTD/100m md pr	Ducklow
6		1001.9	1240	39 23.61	64 23.25	Vertical net tow	Gould
6		1001.10	1304	39 23.47	64 23.73	Vertical net tow	Brzezinski
6	17	1001.11	1406	39 23.21	64 24.23	5 l CTD/2000m	Brown
6		1001.12	1623	39 20.32	64 27.30	Six shooter no. 5	Orr
6	18	1001.13	1902	39 17.28	64 31.31	30 l CTD/100m nt pr	Hitchcock
6		1001.14	1930	39 17.28	64 31.31	30 l Niskin - hydro	Cowles/Roman
6	19	1001.15	1955	39 17.76	64 31.71	30 l CTD/100m nt pr	Ducklow
6		1001.16	2030	39 17.76	64 31.71	Live tows	Cowles
6		1001.17	2100	39 16.7	64 34.50	MULVFS cast no. 3	Bishop
6		1002.1	0846	39 25.36	64 27.66	MOC-1D-214 (0-1000m)	Wiebe
6		1002.2	1241	39 28.73	64 36.33	MOC-20-58	Craddock

MEANDER/RING CENTER - PARTIAL 48 HR STATION

7	20	1003.01	0610	39 40.20	65 00.81	30 l CTD/100m/fl pr	Ducklow
7	21	1003.02	0705	39 40.28	65 01.07	30 l CTD/1000m/si dp	Ducklow
7		1003.03	0840	39 40.28	65 01.07	In situ grazing	Roman
7		1003.04	0946	39 40.37	64 59.79	Live tows	Cowles/Roman/Gould
7		1003.05	1020	39 40.79	64 59.02	30 l Niskin - hydro	Cowles
7	22	1003.06	1044	39 40.72	64 58.92	30 l CTD/1000m/si dp	Hitchcock
7	23	1003.07	1300	39 41.06	64 59.70	30 l CTD/100m md pr	Ducklow
7		1003.08	1341	39 41.33	65 00.22	MOC-1/4-60	Cowles
7		1003.09	1523	39 40.94	65 01.44	MOC-1/4-60 F	Gould
7	24	1003.10	1610	39 40.00	65 00.00	5 l CTD/2000m	Brown
7		1003.11	1835	39 40.02	65 00.00	30 l Niskin - hydro	Roman
7	25	1003.12	1855	39 40.02	65 00.13	30 l CTD/100m nt pr	Hitchcock
7	26	1003.13	1945	39 40.01	65 00.13	30 l CTD/150m nt pr	Hitchcock
7		1003.14	2030	39 40.01	65 00.13	Live tows	Cowles
7		1003.15	2104	39 41.90	65 59.30	Six shooter no. 6	Orr
7		1003.16	2340	39 41.20	64 58.4	MULVFS cast no. 4	Bishop

HIGH RESOLUTION SECTION - RING 82-H CENTER TO SLOPE WATER

8	27	1004.01	1050	39	49.97	64	59.96	30 1 CTD/250m	Ducklow
9	28	1004.02	1245	40	00.08	64	59.84	30 1 CTD/250m	Hitchcock
10	29	1004.03	1445	40	10.08	64	59.79	30 1 CTD/250m	Ducklow
11	30	1004.04	1649	40	20.09	64	59.71	30 1 CTD/250m	Hitchcock
12	31	1004.05	1838	40	30.07	64	59.98	30 1 CTD/250m	Ducklow

SLOPE WATER STATION NORTH OF 82-H HIGH VELOCITY REGION

13	32	1004.06	2032	40	39.91	65	00.11	30 1 CTD/250m	Hitchcock
13		1004.07	2158	40	40.25	65	00.60	MOC-1D-215 (0-1000m)	Wiebe
13		1005.01	0056	40	45.02	65	02.97	MOC-20-59	Craddock
13		1005.02	0512	40	38.26	64	56.46	Six shooter no. 7	Orr
13		1005.03	0807	40	40.25	64	57.30	MOC-1D-216 (0-1000m)	Wiebe
13		1005.04	1115	40	41.61	65	01.91	Light cast	Hitchcock
13		1005.05	1144	40	41.42	65	01.82	30 1 Niskin - hydro	Roman
13		1005.06	1150	40	41.36	65	01.81	Live tow	Cowles/Roman
13	33	1005.07	1213	40	41.01	65	01.67	30 1 CTD/100m	Ducklow
13	34	1005.08	1302	40	41.40	65	01.85	30 1 CTD/200m	Ducklow
13		1005.09	1344	40	41.97	65	00.30	MOC-20-60	Craddock
13	35	1005.10	1800	40	39.93	64	57.93	5 1 CTD/2000m	Brown
13		1005.11	2036	40	38.67	64	59.31	30 1 Niskin - hydro	Cowles/Roman
13		1005.12	2043	40	38.58	64	59.20	Live tow	Cowles/Roman
13		1005.13	2137	40	37.46	64	57.11	MULVFS cast no. 5	Bishop
13	36	1006.01	0410	40	38.08	64	55.25	5 1 CTD/710m	Brown
13		1006.02	0540	40	38.50	64	53.74	MOC-1/4-61/80m F	Gould
13		1006.03	0622	40	39.98	64	52.96	MOC-1/4-61/200m	Cowles/Roman
13		1006.04	0729	40	40.64	64	51.00	In situ grazing	Roman
13		1006.05	0807	40	37.30	65	50.20	MOC-1D-217 (toyo)	Wiebe
13	37	1006.06	1248	40	45.13	64	50.72	30 1 CTD/150m	Hitchcock
13	38	1006.07	1332	40	46.00	64	61.15	30 1 CTD/1000m	Ducklow

RING 82-H CENTER - FOURTH 48 HR STATION

14		1006.08	2043	39	52.90	65	12.14	MOC-1D-218 (0-1000m)	Wiebe
14		1007.01	0019	39	46.72	65	14.03	MOC-20-61	Craddock
14	39	1007.02	0610	39	32.28	65	23.75	30 1 CTD/150m/fl pr	Ducklow
14	40	1007.03	0658	39	31.30	65	23.70	30 1 CTD/1000m/si dp	Hitchcock
14		1007.04	0808	39	30.77	65	23.89	MOC-1/4-62	Cowles
14		1007.05	0931	39	31.86	65	26.26	MOC-1/4-62 F	Gould
14		1007.06	1015	39	31.86	65	26.26	In situ grazing	Roman
14		1007.07	1130	39	32.29	65	25.01	Live tow	Cowles
14		1007.08	1147	39	32.23	65	24.46	30 1 Niskin - hydro	Roman
14	41	1007.09	1204	39	32.17	65	24.20	MD prod. 30 1 CTD/200	Ducklow
14		1007.10	1241	39	32.19	65	24.63	Live tow	Gould
14		1007.11	1323	39	32.13	65	24.41	Live tow	Brzezinski
14	42	1007.12	1357	39	32.13	65	24.44	5 1 CTD/2000m	Brown
14		1007.13	1632	39	32.16	65	25.53	Six shooter no. 8	Orr
14	43	1007.14	1918	39	32.27	65	25.66	30 1 CTD/150m/nt pr	Ducklow
14		1007.15	1952	39	32.48	65	25.95	30 1 Niskin - hydro	Roman

ST NO.	CTD NO.	OP NO.	START TIME	LATITUDE °N	LONGITUDE °W	DESCRIPTION	INVESTIGATOR
14		1007.16	2004	39 31.50	65 25.92	Live tows	Cowles
14		1007.17	2040	39 31.63	65 25.41	MULVFS no. 6	Bishop
14		1008.01	0404	39 26.80	65 20.30	MULVFS no. 6 B	Bishop
14		1008.02	0545	39 25.08	65 19.35	Six shooter no. 9	Orr
14		1008.03	0728	39 24.14	65 18.91	MOC-1D-219 (0-1000m)	Wiebe
14		1008.04	1030	39 27.92	65 20.92	Light cast	Hitchcock
14		1008.05	1100	39 27.08	65 21.19	Live tow	Brzezinski
14		1008.06	1122	39 26.51	65 21.68	MOC-20-62	Craddock
14		1008.08	2010	39 28.94	65 39.64	Six-shooter no. 10	Orr

Begin Trophic Coupling Experiment

14		1008.08	1640	39 29.34	65 33.03	MOC-1D-220 dusk toyo	Wiebe
14		1008.09	1121	39 29.56	65 25.63	MOC-20-63	Craddock
14	44	1009.01	0407	39 33.14	65 35.92	5 l CTD/200m	Brown
14	45	1009.02	0558	39 31.56	65 35.92	30 l CTD/200m fl pr	Ducklow
14		1009.03	0700	39 30.84	65 34.78	In situ grazing	Roman
14		1009.04	0820	39 30.84	65 34.78	MOC-1/4-63	Cowles/Roman
14		1009.05	0947	39 29.75	65 28.55	MOC-1D-221 (0-160m)	Wiebe
14		1009.06	1115	39 28.35	65 23.43	Light cast	Hitchcock
14	46	1009.07	1200	39 27.85	65 23.30	30 l CTD/200m md pr	Ducklow
14		1009.08	1300	39 27.85	65 23.30	In situ grazing	Roman
14		1009.09	1444	39 25.21	65 21.06	Six-shooter no. 11	Orr
14	47	1009.10	1825	39 21.86	65 16.75	30 l CTD/200m nt pr	Hitchcock
14		1009.11	1930	39 20.19	65 14.76	MOC-1/4-64	Roman/Cowles
14		1009.12	2040	39 18.79	65 12.07	MOC-1D-222 (0-160m)	Wiebe
14		1009.13	2228	39 20.00	65 11.46	Live tow	Cowles

End Trophic Coupling Experiment

RING 82-H CENTER AFTER 2-DAY GALE

15	48	1012.01	0610	39 07.47	66 02.98	30 l CTD/200m/fl pr	Ducklow
15	49	1012.02	0712	39 07.90	66 02.80	30 l CTD/2000m/si dp	Hitchcock
15		1012.03	0940	39 08.71	66 02.08	Live tows	Cowles/Roman
15		1012.04	1015	39 08.71	66 02.08	30 l Niskin - hydro	Roman
15	50	1012.05	1137	39 05.50	66 07.70	30 l CTD/200m md pr	Ducklow
15	51	1012.06	1251	39 06.10	66 07.30	5 l CTD/2000m	Brown
15		1012.07	1625	39 06.51	65 05.46	Six-shooter no. 12	Orr
15		1012.08	1945	39 06.12	66 04.61	30 l Niskin - hydro	Cowles
15		1012.09	2000	39 06.12	66 04.61	Live tows	Roman
15	52	1012.10	2031	39 06.12	66 04.61	30 l CTD/80m/nt-pr 1	Ducklow
15	53	1012.11	2137	39 06.66	66 04.80	30 l CTD/140/nt-pr 2	Hitchcock
15		1012.12	2230	39 07.30	66 04.81	MOC-1D-223 (0-1000m)	Wiebe
15		1013.01	0232	39 14.34	66 04.09	MOC-1/4-65	Cowles/Roman
15		1013.02	0400	39 15.53	66 05.21	MOC-1/4-65 F	Gould
15	54	1013.03	0552	39 07.40	66 04.10	5 l CTD/2000m	Brown
15		1013.04	0835	39 07.83	66 04.15	MOC-1D-224 (0-1000m)	Wiebe

ST NO.	CTD NO.	OP NO.	START TIME	LATITUDE °N	LONGITUDE °W	DESCRIPTION	INVESTIGATOR
15		1013.05	1210	39 05.93	66 03.52	In situ grazing	Roman
15		1013.06	1700	39 05.93	66 03.52	Live tow	Brzezinski/Gould
15		1013.07	1337	39 09.70	65 57.87	MOC-20-64	Craddock
15		1013.08	1730	39 05.93	66 03.57	MULVFS cast no. 7	Bishop
15		1014.01	0120	39 01.90	66 00.65	MULVFS cast no. 7B	Bishop
15	55	1014.02	0403	39 00.40	65 59.61	30 l CTD/2000m	Brown
15	56	1014.03	0728	39 00.50	65 59.80	30 l CTD/150m/fl pr	Ducklow

SLOPE WATER STATION WEST OF 82-H

16		1014.04	2100	39 03.76	67 51.16	MOC-1D-225 (0-1000m)	Wiebe
16		1015.01	0022	39 04.90	68 00.30	MOC-20-65 (0-1000m)	Craddock
16	57	1015.02	0458	39 02.88	68 08.55	5 l CTD/400m	Brown
16		1015.03	0655	39 02.75	68 08.17	30 l Niskin - hydro	Cowles
16		1015.04	0658	39 02.86	68 08.15	Live tows	Cowles/Roman Gould/Brzezinski
16		1015.05	0753	39 03.16	68 08.44	MOC-1D-226 (0-1000m)	Wiebe
16		1015.06	1105	39 00.85	68 16.16	Light cast	Hitchcock
16		1015.07	1129	39 00.67	68 16.50	MOC-1/4-66 F	Gould
16		1015.08	1204	38 59.71	68 17.42	MOC-1/4-66	Cowles
16		1015.09	1307	38 58.17	68 18.56	MOC-20-66	Craddock
16		1015.10	1644	38 58.72	68 26.32	Six-shooter no. 13	Orr
16		1015.11	1922	38 57.33	68 29.87	MULVFS cast no. 8	Bishop
16		1016.01	0225	38 59.07	68 32.55	MULVFS cast no. 8 B	Bishop
16	58	1016.02	0425	38 59.17	68 32.83	30 l CTD/2300m	Brown
16	59	1016.03	0700	38 57.83	68 33.00	30 l CTD/100m fl pr	Ducklow
16		1016.04	0727	38 57.47	68 33.35	In situ grazing	Roman
16		1016.05	0853	38 56.73	68 35.51	MOC-1D-227 (0-160m)	Wiebe
16		1016.06	1053	38 56.55	68 41.14	Live tows	Cowles
16		1016.07	1108	38 56.78	68 41.56	30 l Niskin - hydro	Cowles

SHELF/SLOPE BREAK STATION

17		1016.08	1940	39 56.73	69 38.91	Six-shooter no. 14	Orr
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IV. XBT DIGITIZING LOG

XBT NO.	DATE	TIME (LOCAL)	LATITUDE °W	LONGITUDE °W	XBT SURFACE TEMP. (°C)	DEPTH (M)	
						15	10
1	NG						
2	09/26/82	1305	40.19.0	67.21.1	22.5	51,75,109	276
3	09/26/82	1555	40.03.3	66.51.7	24.4	150	302
4	09/26/82	1956	39.46.4	66.09.7	27.2	153	333
5	09/26/82	2103	39.41.0	65.59.71	27.5	210	346
6	09/26/82	2300	39.33.65	66.00.34	27.7	190	325
7	09/27/82	0229	39.00.00	66.03.06	24.9	94	300
8	09/27/82	0400	39.01.10	65.44.94	27.7	219	382
9	09/27/82	0500	39.02.21	65.33.59	27.5	344	477
10	09/27/82	1000	39.06.26	65.51.49	27.4	190	370
11	09/27/82	1551	39.09.07	65.55.84	27.6	205	375
12	09/27/82	1603	30.08.33	65.57.57	27.6	172	359
13	09/27/82	2030	39.16.2	65.46.7	28.0	350	480
14	09/28/82	0845	39.22.02	65.38.29	27.5	443	NR
15	09/28/82	0940	39.22.9	65.37.1	27.5	455	623
16	09/28/82	1258	39.32.5	65.30.0	27.4	505	687
17	09/28/82	1430	39.31.0	65.10.8	26.6	587	NP
18	09/28/82	1621	39.28.5	64.46.8	26.3	637	NP
19	09/28/82	2243	39.28.3	64.49.8	26.0	610	NP
20	09/29/82	0402	39.29.5	64.53.8	25.9	617	NP
21	09/29/82	0818	39.28.2	64.05.0	26.3	622	NP
22	09/30/82	0800	39.22.0	63.55.4	26.1	588	NP
23	09/30/82	1200	39.19.6	63.59.8	26.2	605	NP
24	09/30/82	2015	39.23.5	64.07.2	26.4	598	NP
25	09/30/82	2120	39.31.3	64.18.1	26.9	630	NP
26	NG						
27	10/01/82	0800	39.24.40	64.22.8	26.5	630	NP
28	10/02/82	0045	39.16.7	64.34.4	26.7	595	NP
29	10/02/82	0412	39.14.8	64.40.5	26.2	615	NP
30	10/02/82	1011	39.13.5	64.48.6	26.6	600	NP
31	NG						
32	10/02/82	1245	39.25.4	64.27.7	25.9	602	NP
33	10/02/82	2050	39.32.1	64.43.9	25.8	600	NP
34	10/02/82	2305	39.37.1	64.54.5	25.7	608	NP
35	10/03/82	0201	39.41.9	65.03.9	25.5	575	NP
36	10/03/82	0404	39.48.2	65.17.5	25.3	567	755
37	10/13/82	0608	39.54.76	65.30.46	27.1	510	690
38	10/03/82	2000	39.41.63	65.00.00	25.2	590	NP
39	10/04/82	0321	39.41.01	64.58.14	25.4	570	NP
40	10/04/82	0400	39.41.01	64.58.14	25.2	580	NP
41	10/04/82	1008	39.39.04	64.55.94	25.2	576	NP
42	10/04/82	1144	39.49.85	64.59.78	26.4	550	749
43	10/04/82	1245	40.00.08	64.59.75	26.0	488	740
44	10/04/82	1840	40.10.00	65.00.03	26.5	394	570
45	10/04/82	2046	40.20.09	64.59.71	26.4	242	416

XBT NO.	DATE	TIME (LOCAL)	LATITUDE °W	LONGITUDE °W	XBT SURFACE TEMP. (°C)	DEPTH (M)	
						15	10
46	10/04/82	2237	40.30.07	64.59.98	25.6	140	331
47	10/05/82	0027	40.39.91	65.00.11	21.8	128	305
48	10/06/82	0405	40.37.31	64.57.14	23.6	118	317
49	10/06/82	0628	40.37.64	64.56.48	23.9	102	287
50	10/06/82	0826	40.38.08	64.54.82	24.1	107,113,123	304
51	10/06/82	1302	40.40.18	64.50.34	24.1	60,75,115	310
52	10/06/82	1636	40.45.13	64.50.73	17.0	29,40	250
53	10/06/82	1930	40.38.87	64.56.01	22.3	103,112	290
54	10/06/82	2029	40.30.06	64.58.72	24.4	133	325
55	10/06/82	2135	40.20.61	65.01.96	24.7	133	382
56	10/06/82	2226	40.12.59	65.03.54	26.3	205	415
57	10/06/82	2329	40.03.10	65.06.32	26.5	392	550
58	10/07/82	0030	39.54.32	65.11.47	25.7	510	680
59	10/07/82	0945	39.32.54	65.23.03	25.4	626	NP
60	10/07/82	1600	39.32.17	65.24.20	25.4	628	NP
61	NG						
62	10/07/82	1615	39.32.19	65.24.36	25.4	623	NP
63	10/07/82	1620	39.32.19	65.24.41	25.4	626	NP
64	10/07/82	1630	39.32.19	65.24.49	25.3	616	NP
65	10/07/82	1700	39.32.19	65.24.56	25.4	625	NP
66	10/07/82	1740	39.32.12	65.24.29	25.3	614	NP
67	10/07/82	1800	39.32.13	65.24.43	25.5	615	NP
68	10/07/82	2000	39.31.97	65.25.22	25.3	621	NP
69	10/07/82	2200	39.32.21	65.25.67	25.2	620	NP
70	10/08/82	0100	39.31.53	65.25.03	25.1	638	NP
71	10/08/82	0200	39.30.98	65.24.02	25.1	643	NP
72	10/08/82	0800	39.26.8	65.20.32	25.0	624	NP
73	10/08/82	1200	39.24.76	65.18.61	24.9	612	NP
74	NG						
75	10/09/82	1600	39.27.70	65.23.14	25.2	593	NP
76	10/10/82	0020	39.18.56	65.12.09	24.8	566	749
77	10/10/82	0404	39.17.31	65.11.20	25.0	560	755
78	10/10/82	1335	39.11.94	65.16.02	24.7	570	750
79	10/10/82	1602	39.14.19	65.15.10	25.0	565	748
80	10/10/82	1951	39.14.46	65.17.56	24.9	556	745
81	10/11/82	0003	39.13.62	65.21.42	24.8	571	748
82	10/11/82	0355	39.12.28	65.24.69	24.5	568	760
83	10/11/82	0800	39.11.50	65.26.38	24.4	486	693
84	10/11/82	1232	39.11.74	65.29.13	24.7	522	726
85	10/11/82	1756	39.12.27	65.29.18	24.7	557	738
86	10/11/82	2353	39.11.81	65.24.74	24.8	312	500
87	10/12/82	0400	39.05.79	65.53.76	24.2	605	NP
88	10/12/82	1400	39.08.73	66.01.62	24.1	625	NP
89	10/12/82	1410	39.08.73	66.01.47	24.1	630	NP
90	NG						
91	NG						

XBT NO.	DATE	TIME (LOCAL)	LATITUDE °W	LONGITUDE °W	XBT. SURFACE TEMP. (°C)	DEPTH (M)	
						15	10
92	10/12/82	1435	39.08.55	66.01.13	24.0	619	NP
93	10/12/82	1500	39.05.76	66.02.10	24.3	612	NP
94	10/12/82	1540	39.05.47	66.07.67	24.1	621	NP
95	10/12/82	1600	39.05.79	66.07.51	23.9	622	NP
96	10/12/82	1800	39.06.53	66.06.51	23.8	632	NP
97	10/12/82	2000	39.06.76	66.05.86	check	608	NP
98	10/12/82	2231	39.05.91	66.05.48	24.2	600	NP
99	10/12/82	2300	39.05.93	66.05.44	24.1	611	NP
100	10/12/82	2310	39.05.93	66.05.43	24.1	602	NP
101	10/12/82	2315	39.05.93	66.05.42	check	602	NP
102	10/13/82	2400	39.05.99	66.04.75	check	604	NP
103	10/13/82	0600	39.13.65	66.03.96	24.4	606	NP
104	10/13/82	1000	39.07.50	66.03.26	check	606	NP
105	10/13/82	1218	39.07.76	66.04.16	24.1	612	NP
106	10/14/82	0011	39.04.42	66.02.45	24.4	598	NP
107	10/14/82	0403	39.02.54	66.01.04	24.6	590	NP
108	10/14/82	1400	39.07.16	66.21.27	23.8	628	NP

NR = not recorded
 NP = not present
 NG = no good