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Woods Hole Oceanographic Institution

CLIVAR Mode Water Dynamics Experiment (CLIMODE) Fall 2005 R/V *Oceanus* Voyage 419 November 9, 2005–November 27, 2005

by

Lara Hutto, Robert Weller, David Fratantoni, Jeff Lord, John Kemp,
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Woods Hole Oceanographic Institution
Woods Hole, MA 02543

February 2006

Technical Report

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Upper Ocean Processes Group
Woods Hole Oceanographic Institution
Woods Hole, MA 02543
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Approved for Distribution:

Nelson G. Hogg, Chair

Department of Physical Oceanography

Abstract

CLIMODE (CLIVAR Mode Water Dynamic Experiment) is a program designed to understand and quantify the processes responsible for the formation and dissipation of North Atlantic subtropical mode water, also called Eighteen Degree Water (EDW). Among these processes, the amount of buoyancy loss at the ocean-atmosphere interface is still uncertain and needs to be accurately quantified.

In November 2005, a cruise was made aboard R/V *Oceanus* in the region of the separated Gulf Stream, where intense oceanic heat loss to the atmosphere is believed to trigger the formation of EDW. During that cruise, one surface mooring with IMET meteorological instruments was anchored in the core of the Gulf Stream as well as two moored profilers on its southeastern edge. Surface drifters, APEX floats and bobby RAFOS floats were also deployed along with two other moorings with sound sources. CTD profiles and water samples were also carried out.

This array of instruments will permit a characterization of EDW with high spatial and temporal resolutions, and accurate *in-situ* measurements of air-sea fluxes in the formation region.

The present report documents this cruise, the instruments that were deployed and the array of measurements that was set in place.

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I. Project Background and Purpose

CLIMODE, the Clivar Mode water Dynamics Experiment) is a multi-investigator project to study formation of 'Eighteen Degree Water' (EDW). EDW is the subtropical mode water of the North Atlantic. Study of EDW and its formation near a strong baroclinic front will improve understanding of this and other mode waters that form adjacent to strong baroclinic fronts in other locations around the world. These formation regions have energetic air-sea interaction. EDW is created in the winter just south of the Gulf Stream, by convection in the presence of strong shear, with competing effects of vertical/lateral mixing and advection/stirring colluding to set its properties (e.g. Worthington 1959, 1976; Schroeder et al, 1959; Ebbesmeyer and Lindstrom, 1986).

CLIMODE will use both winter measurements and year-round observations to assess the role of each of these processes in EDW formation. A mix of surface moorings and subsurface moorings, together with surface drifters and profiling floats, will collect data from November 2005 through November 2007. Two cruises, one in winter 2005-2006 and one in winter 2006-2007 will make ship-based oceanographic and atmospheric observations and deploy a drifting mooring to observe surface forcing and the evolution of the upper ocean in the region south of the Gulf Stream between the two moored profiler moorings.

This cruise report documents the work done in November 2005 from the Research Vessel *Oceanus*. Voyage 419 initiated the field phase of CLIMODE, sailing from Woods Hole on November 9, 2005, and returning to Woods Hole on November 27, 2005. The objectives of the cruise were as follows:

- To deploy a surface mooring in the core of the Gulf Stream near the annual maximum in air-sea heat exchange for Bob Weller (WHOI) and Jim Edson (University of Connecticut).
- To deploy two moored profiler moorings on the southeastern edge of the Gulf Stream for Fiamma Straneo (WHOI); these profiler moorings also carried sound sources.
- To deploy two additional sound source moorings for Dave Fratantoni (WHOI).
- To launch surface drifters for Rick Lumpkin (NOAA).
- To deploy profiling APEX floats for Lynne Talley (Scripps Institution of Oceanography).
- To deploy bobbing RAFOS floats for Davd Fratantoni.
- To collect CTD profiles and water samples for Lynne Talley and Susan Lozier (Duke University).

The surface mooring was placed in the region of maximum air-sea heat exchange to accurately quantify the area's air-sea fluxes and to observe the vertical structure of the upper ocean. Table 1 gives an overview of the measurements taken from the surface mooring. The two moored profiler moorings were deployed on the southern flank of the Gulf Stream where EDW forms. These subsurface moorings had a flotation sphere at a depth of approximately 65 m and instrumentation to observe velocity, temperature, salinity, and nutrients between 630 m and just below the flotation sphere at the top of the mooring. Sounds sources on these moorings as well as on the fourth and fifth moorings deployed during the cruise provided the means to track the

RAFOS floats. On the track between the mooring sites as well as at the mooring sites, CTD profiles and water samples were collected and floats and surface drifters deployed.

Table 1: Type of measurements taken by the CLIMODE 1 surface mooring F.

Surface Measurements	Subsurface Measurements
Wind speed	Temperature
Wind direction	Conductivity
Air temperature	Current speed
Sea surface temperature	Current direction
Barometric pressure	
Relative humidity	
Incoming shortwave radiation	
Incoming longwave radiation	
Precipitation	

All participants were invited to contribute to this cruise report, which is written to provide documentation of the work done during the cruise and support future data processing efforts.

II. CLIMODE Fall 2005 Cruise

A. Overview

Many tasks were completed during the CLIMODE Fall 2005 Cruise aboard the R/*V Oceanus*, including:

1. Deployment of one surface mooring with meteorological sensors on the buoy tower, and oceanographic instruments attached to the mooring line.
2. Deployment of two subsurface moorings equipped with moored profilers, RAFOS sound sources, and other oceanographic instrumentation.
3. Deployment of two subsurface moorings equipped with RAFOS sound sources, and other oceanographic instrumentation.
4. Deployment of three types of smaller overboard sensors, including APEX floats, bobber floats, and surface drifters.
5. CTD casts were conducted and salinity, oxygen, and nutrient tests were ran.
6. Underway data was collected with the ship's standard equipment, including an IMET suite and ADCP.

This cruise began in Woods Hole, MA, aboard the R/V *Oceanus* (Voyage #419). Tables 2 and 3 list the scientific participants and crewmembers aboard during the cruise. Figure 1 shows the ship's track during the cruise.

Table 2: CLIMODE Fall 2005 science party

Name	Affiliation
Bob Weller	WHOI
Brian Hogue	WHOI
Dave Fratantoni	WHOI
Elena Brambilla	Scripps
George Tupper	WHOI
Jeff Lord	WHOI
Jim Dunn	WHOI
John Kemp	WHOI
John Lund	WHOI
Lara Hutto	WHOI
Sean Whelan	WHOI
Tatiana Rykova	WHOI

Table 3: *R/V Oceanus* ship's crew for Voyage 419

Name	Title
Larry Bearse	Master
Diego Mello	Chief Mate
Paul Carty	2nd Mate
James McGill	Bosun
Pimenio Cacho	Able Seaman
Leonidas Byckovas	Able Seaman
Jose Andrade	Ordinary Seaman
Richard Morris	Chief Engineer
Connor Kadlec	Jr. Engineer
Nelson Botsford	Jr. Engineer
Chris Moody	Steward
Kathryn Eident	Messman
Patrick Rowe	SSSG Technician

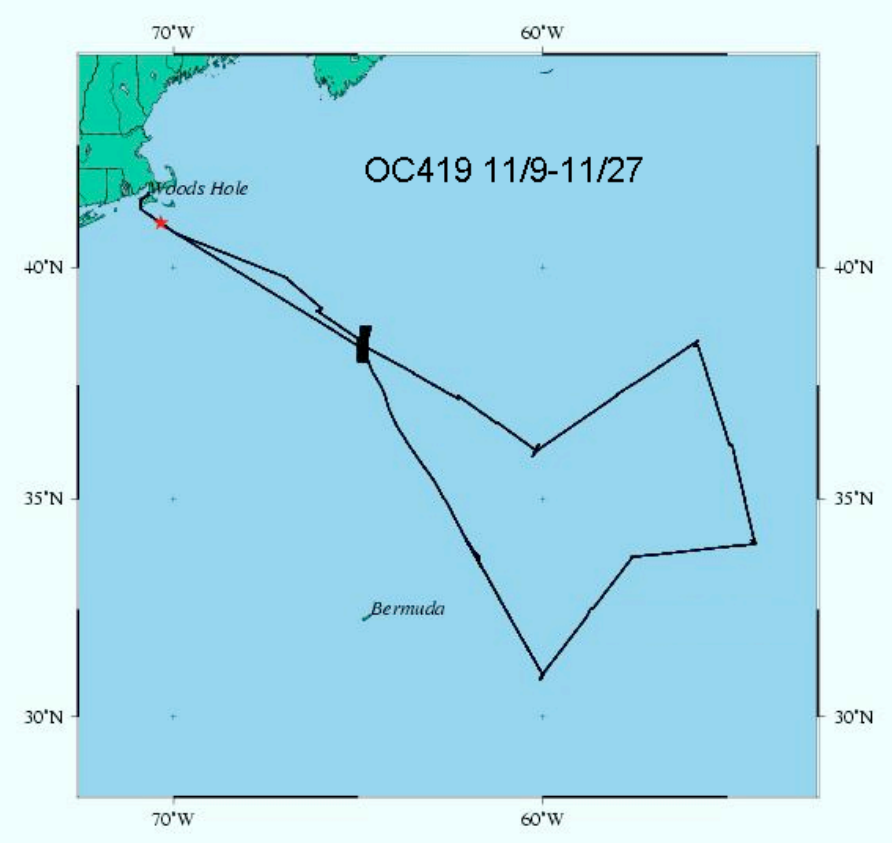


Figure 1: The CLIMODE Fall 2005 cruise track.

B. Pre-Cruise and Cruise Details

Preparation for the CLIMODE cruise began months before sailing with the initial calibration and testing of the instruments. During the summer of 2005 instruments were gathered and placed on the mooring for testing (this is referred to as the burn-in phase). Burn-in details are not presented in this cruise report, but have been documented carefully for instrument performance tracking purposes. Many of the IMET (Improved Meteorological) instruments were also tested in a cold

room to ensure proper functioning during the extreme conditions expected during the winter months in the North Atlantic.

All equipment was loaded on the *Oceanus* in Woods Hole during the week prior to the cruise.

November 9, 2005 – *R/V Oceanus* departed Woods Hole, MA 15:19 UTC. The science party held a science meeting, participated in safety training, and held a short course on CTD work. The ship proceeded along the planned track to the first CTD casts.

November 10, 2005 – The first CTD cast was conducted in the morning, followed by an APEX float launch.

November 11, 2005 – This day was dedicated to doing a survey to find a suitable location for mooring F. The survey's goal was to find a region of uniform bottom topography and also uniform surface current. The ship's ADCP was used to determine the current strength and direction in the area while the ship set adrift and the SST were also recorded. A CTD station was conducted. George Tupper worked to finish analysis of oxygen and salinity water samples collected during CTD casts.

November 12, 2005 – In the morning, the bottom and current survey continued. A practice deployment run was done to see how the currents would impact the drift of the ship. Wind and swell were too high to allow deployment.

November 13, 2005 – A CTD station was conducted at the mooring F site and a drifter deployed. The wind and swell decreased, allowing the deployment to begin. The surface mooring F was deployed, with the anchor being released at 21:18 UTC. Following an anchor survey, the ship got underway to the site of mooring D.

November 14, 2005 – CTD stations were conducted and an APEX float deployed along the way. The CTD station preceding the deployment of C was done to the bottom with the altimeter on the CTD in order to accurately determine bottom depth and the depth correction that needed to be applied to the ship's 12 KHz Knudsen depth sounder. The deck was prepared for the launch of subsurface mooring D.

November 15, 2005 – Mooring D was deployed. The anchor was surveyed and the ship got underway to mooring C.

November 16, 2005 – The deployment of mooring C was started in the evening to capitalize on good weather, and upon completion of the mooring operations a CTD cast was performed and the anchor surveyed. Following that the ship got underway to the site of mooring B.

November 17, 2005 – A CTD cast was conducted between mooring C and mooring B.

November 18, 2005 – Mooring B was deployed in the morning, after a bathymetric survey. An anchor survey and CTD cast were also conducted after mooring operations. The ship got underway to the site for mooring A.

November 19, 2005 – CTD cast #12 was conducted, and went to the full bottom depth. This was done at a site requested by Lloyd Keigwin.

November 20, 2005 – Mooring A was deployed in the early afternoon. An anchor survey was done, and the ship got underway to mooring F.

November 21, 2005 – CTD's conducted while enroute to the northwest. The weather got worse, with higher winds, swell, and wind waves. A strong coastal storm was tracking up the east coast.

November 22, 2005 – The coastal storm was predicted to pass over F, so the ship slowed its northward progress and held position near 34° N to allow conditions along the track to F and at F to improve.

November 23, 2005 – The weather front passed to the north, and the *Oceanus* began it's northward track again.

November 24, 2005 – The *Oceanus* continued to mooring F site so that repairs could be attempted for a failed sensor. A visual inspection of the buoy was conducted from the ship. Argos data was gathered and monitored during daylight hours.

November 25, 2005 – The *Oceanus* held the mooring F position, waiting for a good weather window. A CTD was conducted.

November 26, 2005 – At first daylight, the small boat was launched. Jeff Lord was able to board the buoy and replace an air temperature / humidity sensor that had failed shortly after deployment. Once the small boat was brought back onboard, the *Oceanus* began the voyage back to Woods Hole.

III. Surface Mooring F

A. Overview

The surface moorings used in this project are equipped with meteorological instrumentation, including two Improved Meteorological (IMET) systems. The mooring line also carries current meters, and conductivity and temperature recorders.

This mooring has an inverse catenary design utilizing wire rope, chain, nylon and polypropylene line and has a scope of 1.45 (scope is defined as slack length/water depth). The buoy is a newly designed 2.7 meter diameter foam buoy with an aluminum tower and rigid bridle.

B. Surface Instruments

There are two independent IMET systems on the buoy. These systems measure the following parameters once per minute, and transmit hourly averages via satellite:

relative humidity with air temperature
barometric pressure
precipitation
wind speed and direction
shortwave radiation
longwave radiation
near-surface ocean temperature and conductivity

All IMET modules are modified for lower power consumption so that a non-rechargeable alkaline battery pack can be used. Near-surface temperature and conductivity are measured with a SeaBird MicroCat with an RS-485 interface.

A LOGR53 Main Electronics logger was used. This consists of a two-board set of CPU and interface which handles the power and communications to the individual IMET modules as well as optional PTT or internal barometer or internal A/D board. All modules are sampled at the start of each logging interval. All the "live" interval data is available via the D and E commands on the primary RS232 "console" interface used for all LOGR53 communications.

The LOGR53 CPU board is based on a Dallas Semiconductor DS87C530 microcontroller. DS87C530 internal peripherals include a real time clock and 2 universal asynchronous receiver-transmitters(uart); 2 additional uarts are included on the CPU board as well. Also present on the CPU board is a PCMCIA interface for the 20MB FLASH memory card included with the system; at a 1-minute logging interval there is enough storage for over 400 days of data. A standard CR2032 lithium coin cell provides battery-backup for the real time clock. Operating parameters are stored in EEPROM and are *not* dependent on the backup battery. A normally unused RS485 console interface at P1 is also present on this board.

The LOGR53IF Interface board handles power and communications distribution to the IMET modules as well as interface to various options such as PTT or A/D modules. Connector P12 is the main RS232 "console" interface to the LOGR53 and can also be used to apply external power (up to about 100 MA) to the system during test. The main +12-15V battery stack (for the base

logger with FLASH card) is connected to P13; the "sensor" +12-15V battery stack (which typically powers the IMET modules) is connected to P14; the "aux" battery stack (which typically powers the optional PTT) is connected to P19. Regulated +5V power for the system is produced on this board.

Parameters recorded on a FLASH card:

TIME

WND - wind east and north velocity; wind speed average, max, and min; last wind vane direction, and last compass direction

BPR - barometric pressure

HRH - relative humidity and air temperature

SWR - short wave radiation

LWR - dome temperature, body temperature, thermopile voltage, and long wave radiation

PRC - precipitation level

SST - sea surface temperature and conductivity

ADI - multiplexed optional parameter value from A/D module (only 1 of 8 in each record)

An IMET Argos PTT module is set for three IDs and transmits via satellite the most recent six hours of one-hour averages from the IMET modules. At the start of each hour, the previous hour's data are averaged and sent to the PTT, bumping the oldest hour's data out of the data buffer.

In addition to the two complete IMET systems, there is a partial suite of stand alone modules that internally record. These include HRH, LWR, WND, SWR, and BPR.

DCFS

A sonic flux system provided by Jim Edson was mounted on the buoy tower. The Direct Covariance Flux System (DCFS) is an autonomous system that provides nearly continuous direct estimates of momentum and buoyancy fluxes. Its primary sensors include a Gill Instruments R3-50 ultrasonic anemometer, Systron-Donner MotionpakII inertial motion unit and a Precision Navigation TCM3 3-axis compass. The DCFS collects and stores raw data from the sensor for 20 minutes out of every hour starting at the top of the hour. Data is collected and logged at a rate of 20 Hz from the anemometer and 5 Hz from the motion unit and compass.

Following the 20 minutes collection period, the DCFS estimates the observed platform motion and corrects the measured wind and calculates the direct covariance fluxes. Information is telemetered via Argos and is updated four times per day. Transmitted data includes mean values of battery voltage, wind speed and direction, temperature, estimated significant wave height, platform tilt, friction velocity (u*), uv, vw and wt.

C. Subsurface Instruments

The following sections describe individual instruments on the buoy bridle and mooring line.

1. Subsurface Argos Transmitter

An NACLS, Inc. Subsurface Mooring Monitor (SMM) was mounted upside down on the bridle of the buoy. This is a backup recovery aid in the event that the mooring parted and the buoy flipped upside down.

2. MicroCat Conductivity and Temperature Recorder

The MicroCat, model SBE37, is a high-accuracy conductivity and temperature recorder with internal battery and memory. It is designed for long-term mooring deployments and includes a standard serial interface to communicate with a PC. Its recorded data are stored in non-volatile FLASH memory. The temperature range is -5° to +35ºC, and the conductivity range is 0 to 6 Siemens/meter. The pressure housing is made of titanium and is rated for 7,000 meters. The shallowest MicroCats were mounted on the bridle of the buoy and wired to the IMET systems. These were equipped with RS-485 interfaces.

3. SBE-39 Temperature Recorder

The Sea-bird model SBE-39 is a small, light weight, durable and reliable temperature logger. These instruments were mounted in custom made cages to lessen the chance they would be snagged on fishing gear or other debris.

4. Nortek

Nortek's Aquadopp current meter is a Doppler current meter that is small and light-weight in size. This instrument provides single point measurements of currents. The Nortek Aquadopp current meter was set to a measurement interval of 900s and an average interval of 60s.

5. Acoustic Release

The acoustic release used on the mooring is an EG&G Model 8242. This release can be triggered by an acoustic signal and will release the mooring from the anchor. Releases are tested at depth prior to deployment to ensure that they are in proper working order.

D. CLIMODE 1 Mooring F Deployment

Mooring F was deployed on November 13, 2005, and is scheduled to be recovered approximately one year later. Table 4 gives an overview of deployment operations.

Table 4: Mooring F deployment details

Deployment	Date	November 13, 2005
	Time	21:18 UTC
	Position at Anchor Drop	38° 19.102' N, 64° 46.954' W
	Deployed by	Kemp, Lord
	Recorder	Hutto
	Ship	R/V *Oceanus*
	Cruise No.	Voyage #419
	Depth	4981 m
	Anchor Position	38° 19.082' N, 64° 47.264' W

1. Mooring Description

Mooring F was equipped with meteorological instrumentation on the buoy, and subsurface oceanographic equipment on the mooring line. Tables 5 and 6 detail the instrumentation. Figure 2 is a schematic representation of the mooring.

Table 5: CLIMODE 1 Mooring F surface instrumentation

Primary System #1			
Instrument	**Serial Number**	**Firmware Version**	**Height/Depth relative to buoy deck (cm) ***
Logger	L14	LOGR53 v2.70	
HRH	231	VOSHRH53 v3.2	203
BPR	204	VOSBPR53 v3.3	226
WND	347	VOSWND53 v3.5	268
PRC	217	VOSPRC53 v3.4	222
LWR	216	VOSLWR53 v3.5	278
SWR	202	VOSSWR53 v3.3	278.5
SST	1840	SBE37 – v2.2A	151.5
PTT	12790 ID's 09203, 09819, 09833, 14925		
Primary System #2			
Logger	L15	LOGR53 v2.70	
HRH	222	VOSHRH53 v3.2	203
BPR	210	VOSBPR53 v3.3	255
WND	344	VOSWND53 v3.5	270.5
PRC	502	VOSPRC53 v3.4	221.5
LWR	211	VOSLWR53 v3.5	278.5
SWR	506	VOSSWR53 v3.3	278.5
SST	1839	SBE37 – v2.2A	151.5
PTT	ID's 14766, 14778, 14901		
Stand Alone's			
HRH	502		216
LWR	210		278
WND	213		271
SWR	201		278.5
BPR	218		226
Sonic Flux	WHOIDCFS01 w/Gill 351		306

* Buoy deck height is 70 cm.

Table 6: CLIMODE 1 Mooring F subsurface instrumentation

Depth (m)	Instrument	Serial Number	Measurement	Sampling Rate (s)
5	SBE37	0009	Temperature, Salinity	300
10	Nortek	1666	Temperature, Currents	Every 900 sec, a 60 sec average is taken
15	SBE39	1498	Temperature	300
20	Nortek	1688	Temperature, Currents	Every 900 sec, a 60 sec average is taken
40	SBE39	1504	Temperature	300
80	SBE39	1499	Temperature	300
120	SBE39	1512	Temperature	300
160	SBE39	1500	Temperature	300
200	SBE39	1506	Temperature	300
240	SBE39	1508	Temperature	300
280	SBE39	1509	Temperature	300
341	SBE37	0010	Temperature, Salinity	300
360	SBE39	1511	Temperature	300
400	SBE39	1501	Temperature	300
440	SBE39	1502	Temperature	300
480	SBE39	1507	Temperature	300
520	SBE39	1510	Temperature	300
560	SBE39	1503	Temperature	300
600	SBE39	1505	Temperature	300
662	SBE37	3733	Temperature, Salinity	300

2. Time Spikes

Timing spikes were applied to some of the CLIMODE 1 Mooring F instrumentation prior to deployment. These spikes will help with data processing by allowing timing to be checked on the instruments. Details are given below.

SST's Temperature spike (IN) Time/Date UTC 12:12:30, 8 Nov 05
SST's Temperature spike (OUT) Time/Date UTC 13:14:30, 8 Nov 05

Bag the Solars (ON) Time/Date UTC 14:52:30, 8 Nov 05
Unbag the Solars (OFF) Time/Date UTC 16:03:30, 8 Nov 05

SBE-37'S: 12:42:00, 2 NOV 05 (IN) Ser. Num.'s 0009, 0010, 3733
14:56:30, 2 NOV 05 (OUT)

SBE-39'S: 12:38:30, 2 NOV 05 (IN) Ser. Num.'s 1498, 1499, 1500, 1501, 1502, 1503,
14:57:00, 2 NOV 05 (OUT) 1504, 1505, 1506, 1507, 1508, 1509, 1510, 1511, 1512

Nortek: 13:39:00, 2 NOV 05 (IN) Ser. Num.'s 1666, 1688
17:27:00, 2 NOV 05 (OUT)

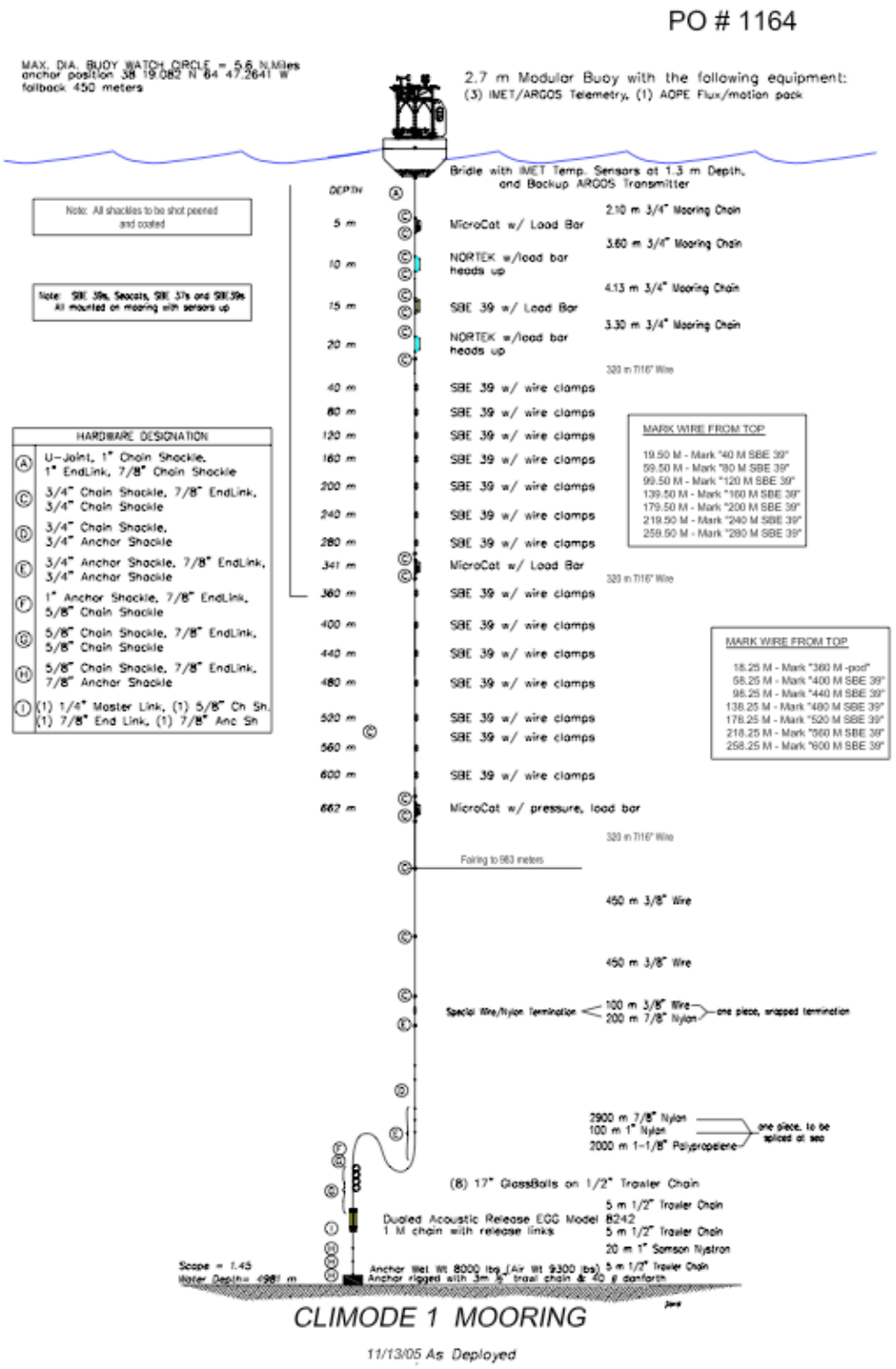


Figure 2: CLIMODE 1 Mooring F Diagram

3. Antifoulant Application

Previous moorings have been used as test beds for a number of different antifouling coatings. These tests have led the Upper Ocean Process group to rely on E Paint Company's, SUNWAVE as the antifouling coating used on the buoy hull, and EPaint ZO on the instruments in the upper part of the CLIMODE surface mooring.

Instead of the age-old method of leaching toxic heavy metals, the patented E Paint approach takes visible light and oxygen in water to create peroxides that inhibit the settling larvae of fouling organisms. Photo generation of peroxides and the addition of an organic co-biocide, which rapidly degrades in water to benign by-products, make E Paint an effective alternative to organotin antifouling paints. These paints have been repetitively tested in the field, and show good bonding and anti-fouling characteristics.

SUNWAVE is a two-part, water-based, antifouling coating that offers a truly eco-friendly approach to the control of biofouling. The product claims superior adhesion and durability. SUNWAVE appears to be a viable alternative to organotin, copper, and other more toxic coatings used on earlier buoys.

Table 7. CLIMODE 1 surface mooring F anti-foul applications

Description	Coating	Color	Coats	Method
Buoy Hull	E-Paint Primer SUNWAVE	Gray White	1 4	Roller Roller
SBE 37s on hull bottom	ZO	White	1	SPRAY
Load Bars	ZO	WHITE	1	SPRAY
**All instruments to 20 Meters	ZO	White	1	SPRAY
Seacat/Microcat shields	ZO	White	1	Spray
Nortek ADCM transducers	E-Paint	White	2	Brush

The potential for biofouling at mooring F is unknown. The first turn around, in 2006 may give more insight to productivity, and coatings may be adjusted based on what is observed after recovery.

E-Paint Bio-Grease will be applied to ADCM transducer heads for the 2006 deployment.

4. Deployment Plan and Survey

The presence of strong Gulf Stream currents presented a challenge for the deployment of the surface mooring. Typically the choice is to steam, if possible, into the current and the wind, which results in the surface mooring streaming out straight behind the ship. This allows a deployment plan to be developed starting from a downwind, downcurrent position with a track directly over the desired anchor site. The payout rate of the mooring is balanced with the speed of the ship through the water so that the flow relative to ship is roughly .5 to 1 knots (keeping tension on the mooring line down). The mooring payout rate is kept lower than the flow rate so that kinks are not allowed to form in the wire rope.

In the Gulf Stream, steaming into the current is not possible as the flow past the ship would greatly exceed the desired .5 to 1.0 kts. Instead, the strategy developed for deployment of mooring F was to point *Oceanus'* bow into the current and fall back toward an anchor site at a rate that kept the flow past the ship low enough to keep tension in the mooring line manageable.

To develop a detailed plan, once daily updated satellite images of sea surface temperature (provided by Kathy Kelly, U. Washington) were used together with a survey of bottom topography and near surface currents to map the conditions in the deployment area.

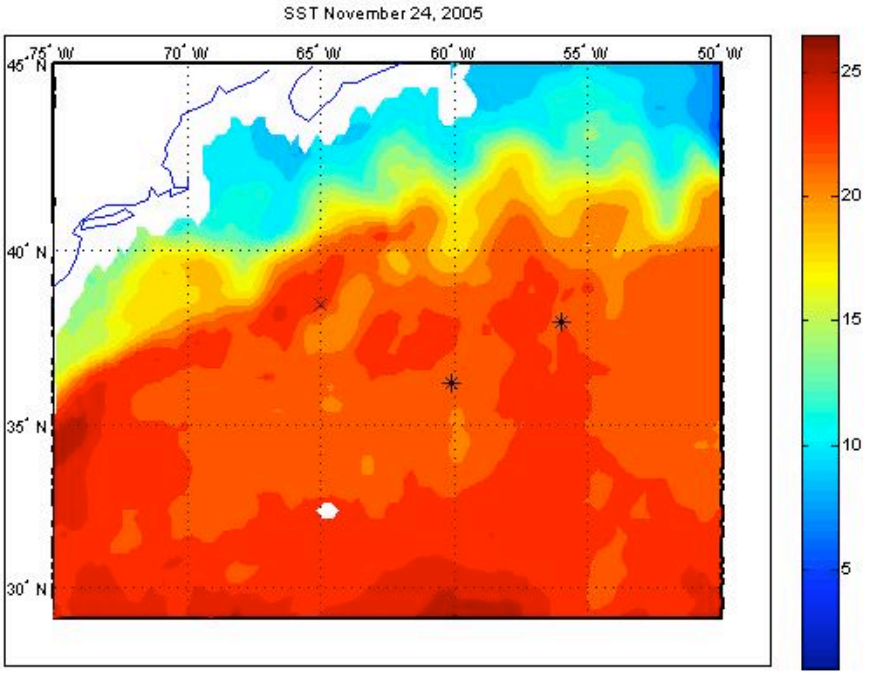
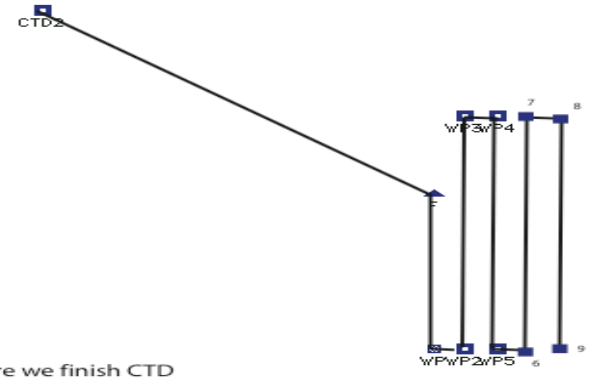


Figure 3. Satellite image of SST provided by Kathy Kelly. Mooring F's target position is 38.5°N, 65°W; the black stars show the target locations of subsurface moorings C and D.

The SST images preceding November 12, 2005, (Figure 3) showed the presence of a meander in the Gulf Stream, with the horizontal temperature gradient aligned east-west in the vicinity of the target (38°30'N, 65°W) for mooring F. This implied the presence of current flowing to the north. On the 11th and 12th, winds were 15 to 30 kts out of the northwest, a further complication. In response to this, a survey pattern was run (Figure 4) to map the seafloor (using *Oceanus'* 12 KHz Knudsen) and record the surface currents (an average current in the upper 50 m read off and logged by the watch every 30 minutes).



CTD2 where we finish CTD		
F	38° 30'N,	65°W
WP1	38° N,	65°W
WP2	38° N,	64° 55'W
WP3	38° 45'N,	64° 55'W
WP4	38° 45'N,	64° 50'W
WP5	38°N,	64° 50'W
WP6	38°N,	64° 45'W
WP7	38° 45'N,	64° 45'W
WP8	38° 45'N,	64° 40'W
WP9	38° N,	64° 40'W

Figure 4. Survey pattern conducted in the vicinity of the target site for mooring F.

The survey (Figure 5) showed that the target for F was at the edge of the warm, northward flowing feature seen in the satellite image. To the east of the target site the water was warmer and the northward flowing currents stronger. At the same time the seafloor was flat, typically 4960 m in depth over the survey region. Based on this information it was decided to shift the target for the deployment of F to the east in order to work in a region of persistent northward flow. The northward flow was observed to be as high as 3 kts. With the wind remaining out of the NW, the strategy was developed that a deployment lane would be defined, some 30 nm in length and 10 nm in width, in which both the currents were consistently northward and the bottom topography was flat. The goal then would be to maneuver and deploy the mooring within the lane. The lane was angled to be aligned along a bearing of 020° with a center point of 38°15'N, 64°45'W (marked T in Figure 6). At the same time, since weather maps forwarded to the ship by Don Peters (WHOI) showed that a high pressure center would move eastward and bring calmer seas and lighter winds by the morning of November 13, it was decided to set up for the deployment of F on the morning of November 13, 2005.

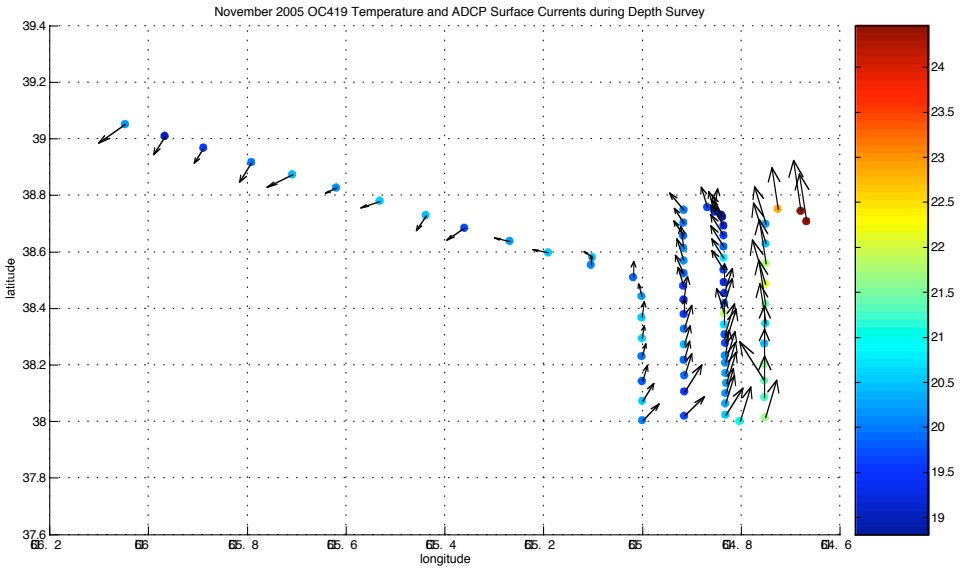
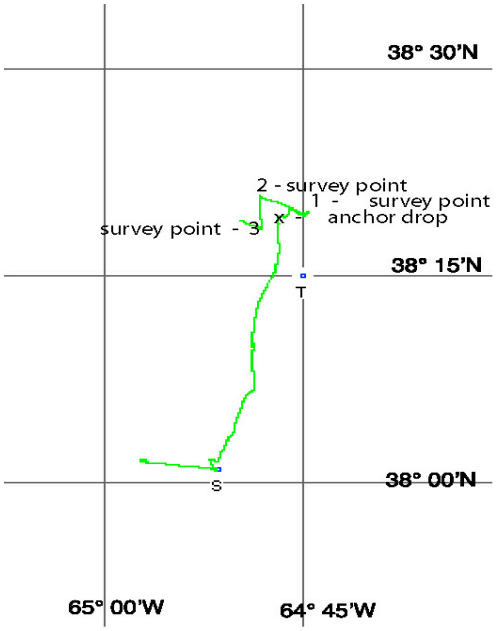


Figure 5. Summary figure for surface currents and surface temperature observed during the survey in the vicinity of the target site for mooring F.

At ~0600 local (~1100 UTC) November 13, *R/V Oceanus* was in position (marked S in Figure 6) at the southern end of the lane, planning to fall back astern first to the north with the prevailing current of the Gulf Stream. While at this position, the surface buoy was deployed over the starboard side. Initially the ship maneuvered to keep the buoy astern and open the separation between the buoy and ship. As the two separated and as more mooring line in the water led to greater drag on the mooring, the goal of the ship was to maneuver roughly along a track bearing 020°. The winds had dropped to 5 to 10 kts and the northerly current of up to 3 kts carried the ship and mooring northward. With maneuvering, *Oceanus* made good on a bearing slightly west 020°. When the anchor was rigged the bottom topography was verified as flat, and the anchor dropped at 21:18 UTC on November 13, 2005.

A 3-point anchor survey was conducted after allowing an hour for the anchor to fall to the bottom. Anchor drop was at 38°19.102'N, 64°46.954'W in a water depth that read as 4939m on the 12 KHz Knudsen (using 1500 m s^{-1}) and corrected using Matthews Tables to 4981 m. The surveyed anchor position was 38°19.0813' N, 64°47.2644'W. The difference between the two positions, or the fallback of the anchor, was 453 m or 9.1%.



S - Deployment of surface mooring (F) begun at ~1200 UTC 11/13/2005
T - nominal target for anchor drop, 15 nm at heading 020° from S

Figure 6. Ship track during Mooring F deployment.

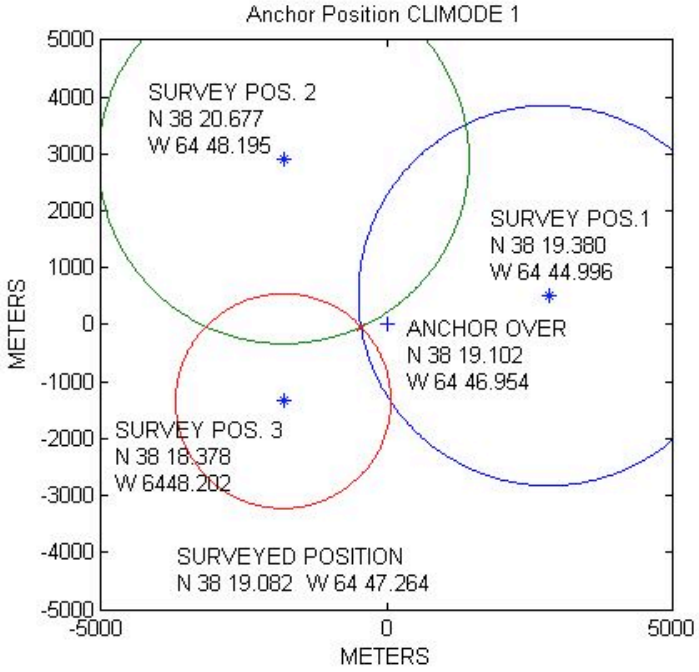


Figure 7. The final anchor position.

5. Deck Work During Deployment

The surface mooring was deployed in a similar fashion to other UOP surface moorings. This two-phase technique involved the lowering of 20 meters of instrumentation and chain segments, followed by the buoy, over the starboard side of the ship. Phase 2 was the deployment of the remaining mooring components using the A-frame on the stern.

One significant deviation from the traditional UOP moorings was the attachment of approximately 950 meters of ABS plastic snap on fairing. Forty meters of fairing was attached to the upper portion of 7/16" wire rope prior to deploying the buoy. This allowed the rapid deployment of the buoy, and payed out enough wire to get some load under the buoy before the ship started towing. The remaining fairing was installed on the three 320 meter shots of wire, after the wire passed through a traveling block on the A-frame. Two MicroCats mounted on titanium strongbacks were inserted between 320 shots of wire at 341 and 662 meters.

The 960 meters of 7/16" wire rope, and 1000 meters of 3/8" wire rope was deployed using the TSE mooring winch. A transitional 200 meter shot of 7/8" nylon line was also on the winch. This nylon was stopped off and spliced into the remaining 3000 meters of nylon and 2000 meters of polypropylene line in wire baskets on the 01 deck. This 5200 meter continuous piece of synthetic line was payed out over an H-bit to control payout speed and maintain control of the mooring load.

Eight glass balls on 1/2" mooring chain were attached to the mooring under the end of the polypropylene section. These were deployed using stopper lines to ease them across the deck and over the stern. Under the glass balls were the dualed acoustic releases and the anchor. Once the tension of the mooring was passed to the anchor, the trawl winch wire was used to lift a top plate and deploy the anchor.

IV. SUBSURFACE MOORINGS

Four subsurface moorings were deployed during the CLIMODE 2005 cruise. These moorings will serve as RAFOS sound sources for floats deployed in the area. In addition, two moored profiling systems were deployed on two of the moorings. All four of the subsurface moorings had a variety of oceanographic instruments deployed on the mooring lines. Figures 8-11 detail the equipment deployed with the subsurface moorings.

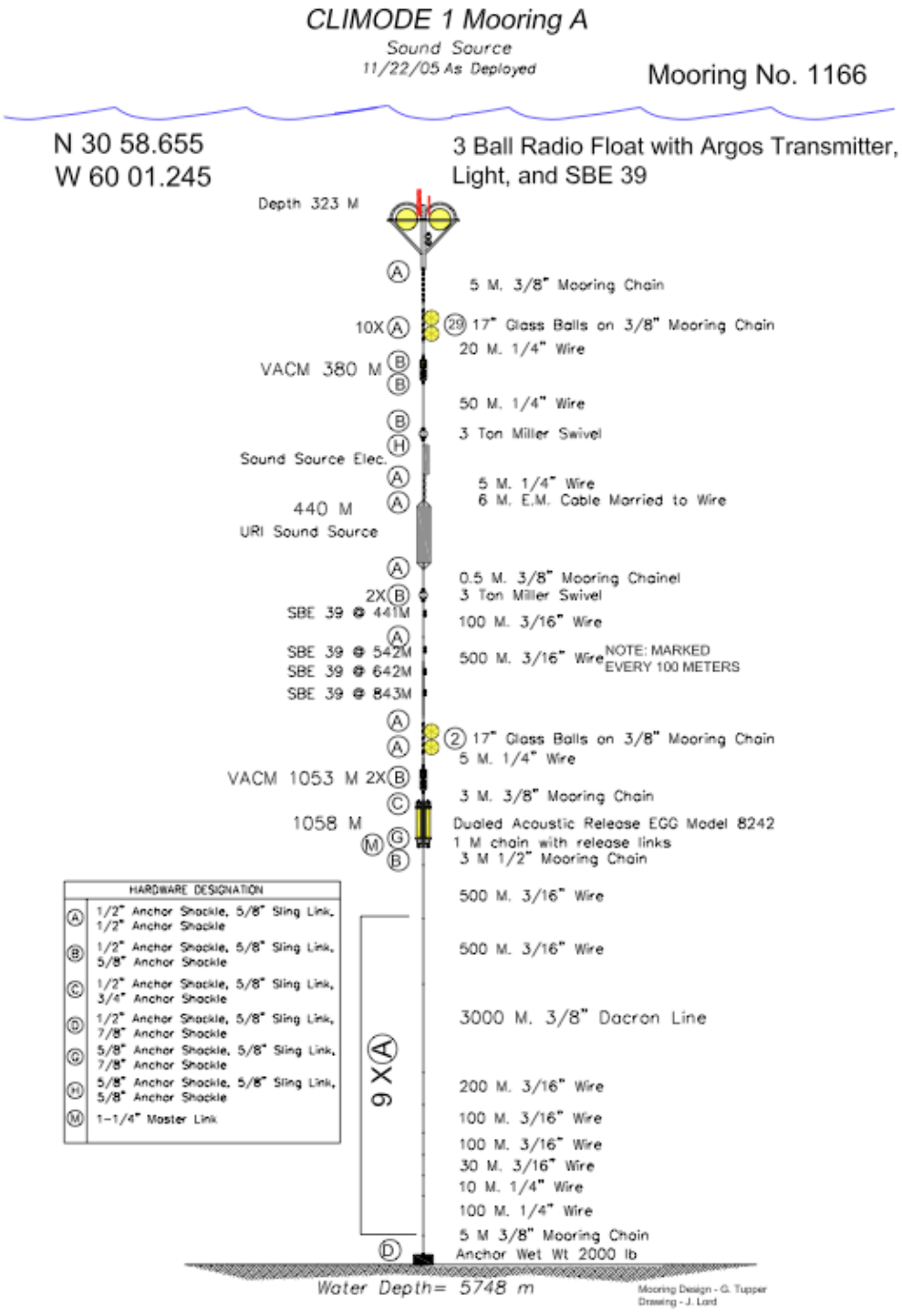


Figure 8. Subsurface Mooring A diagram.

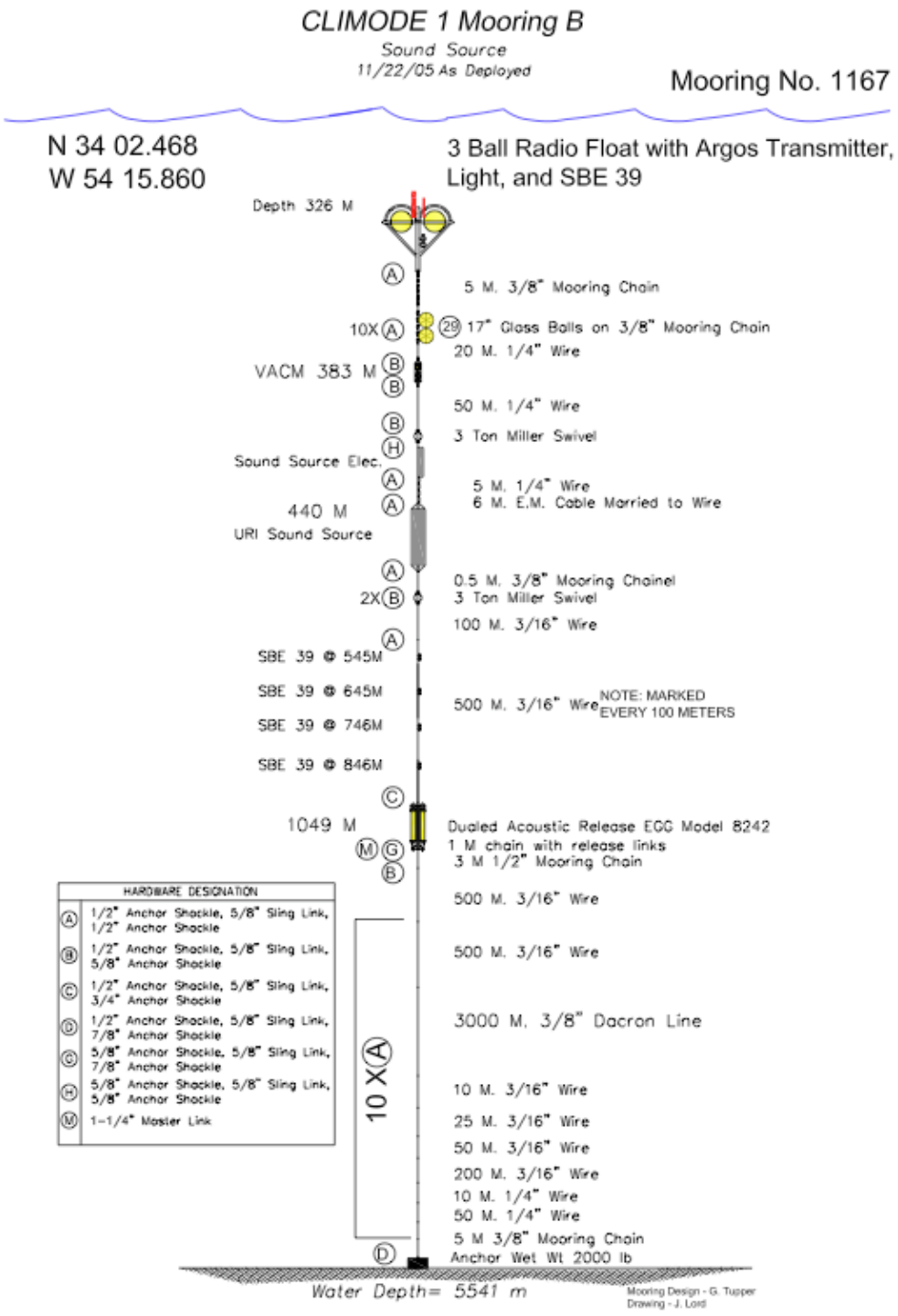


Figure 9. Subsurface Mooring B diagram.

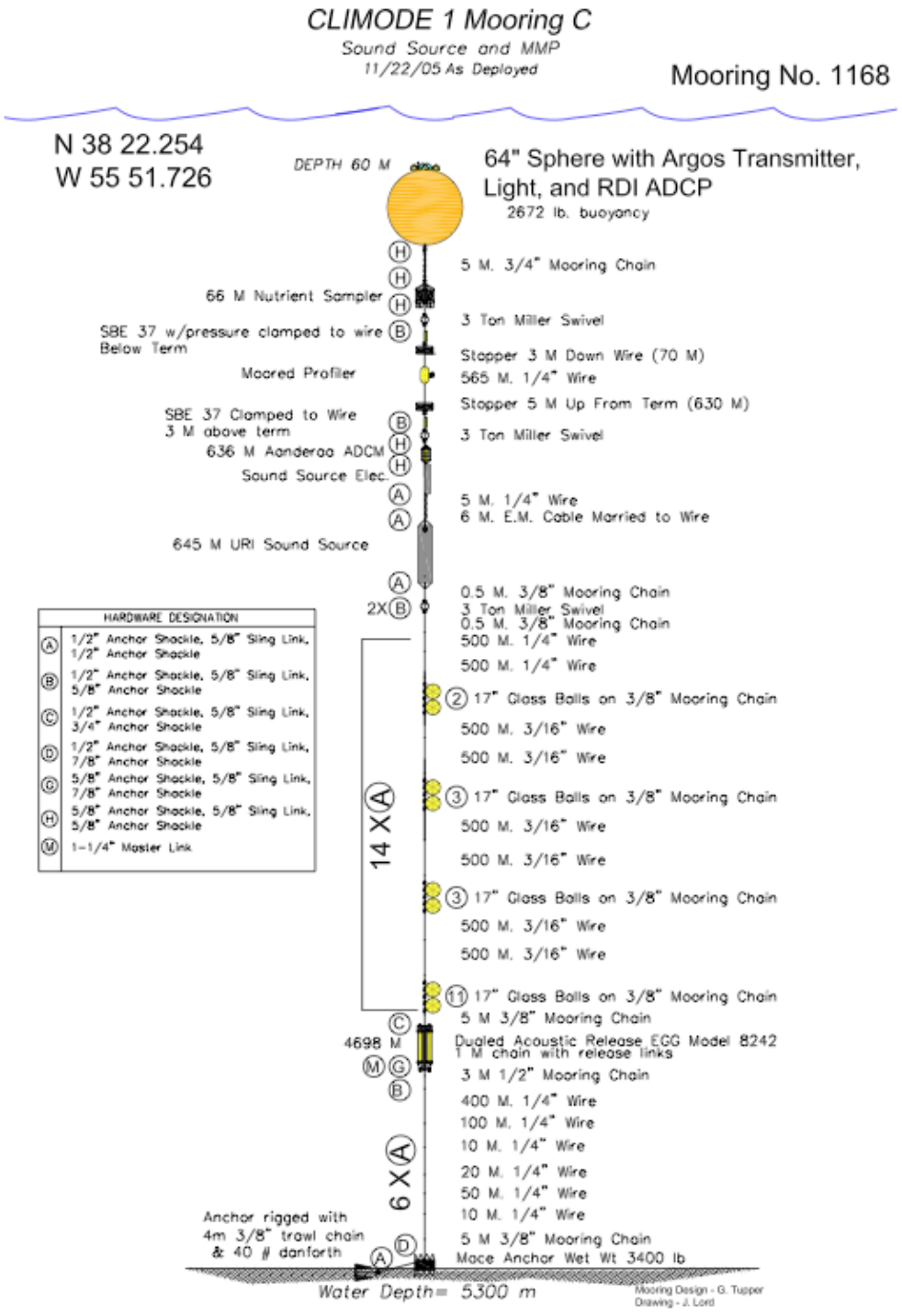


Figure 10. Subsurface Mooring C diagram.

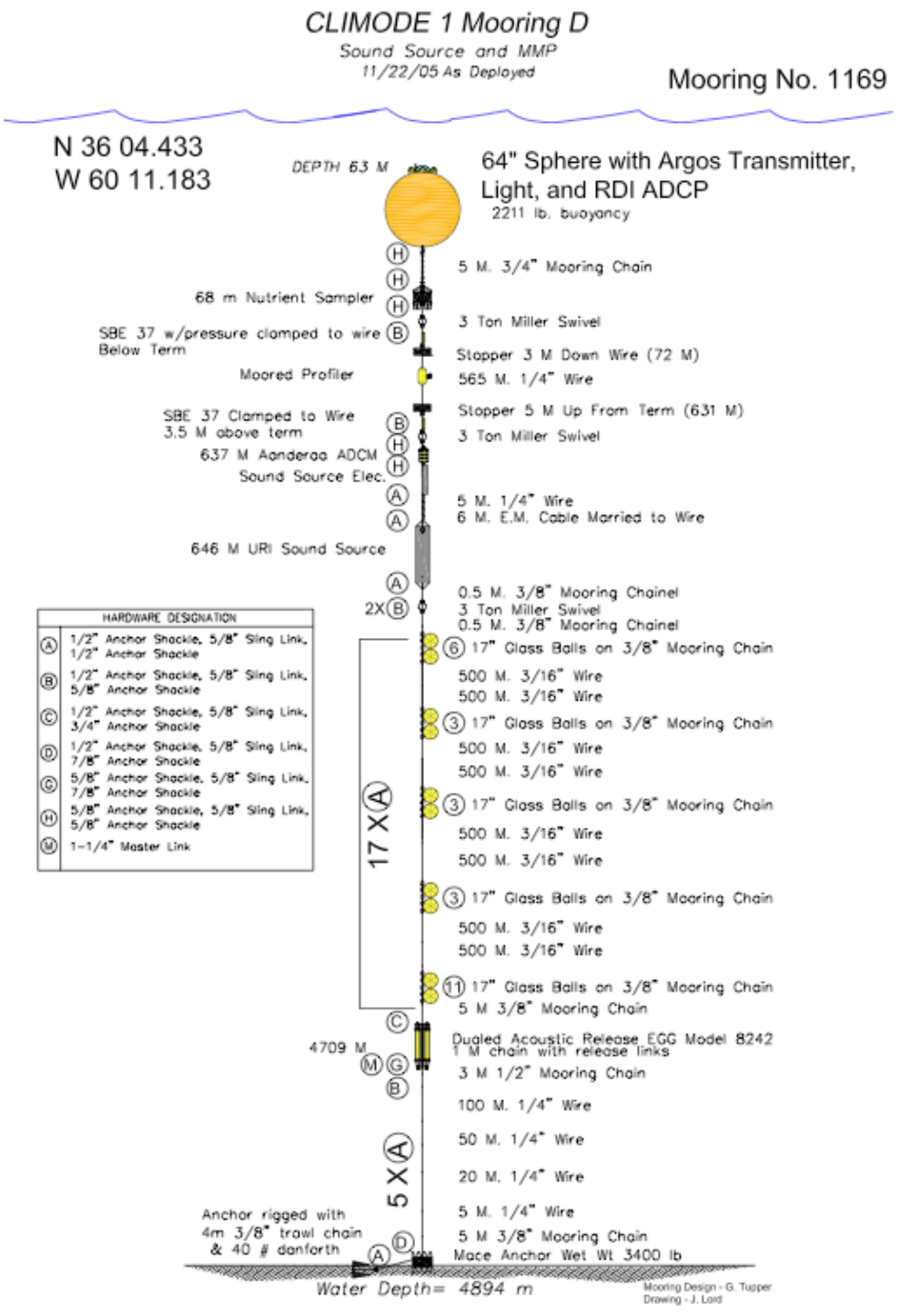


Figure 11. Subsurface Mooring D diagram.

Four RAFOS sound sources were deployed on subsurface moorings A, B, C, and D. See Table 8 for deployment locations and times. The sound sources were manufactured by the University of Rhode Island Graduate School of Oceanography under the direction of Dr H.T. Rossby.

Table 8. Sound source deployment information.

Sound Source	Deployed	Mooring	latitude (deg)	latitude (min)	longitude (deg)	longitude (min)
#21 (00:00:00)	11/18/2005	B	34	2.468	54	15.86
#22 (00:30:00)	11/20/2005	A	30	58.500	60	0.673
#23 (01:00:00)	11/15/2005	D	36	5.413	60	10.285
#24 (01:30:00)	11/17/2005	C	38	22.2539	55	51.726

Each source consists of a resonator pipe and pressure case containing the batteries and electronics. The two pieces are connected with a DSS-2 underwater cable. The resonator is an aluminum pipe with a piezo-electric sphere mounted in the center that excites the tube which is tuned to resonate at specific frequencies for given sound speeds. Sources were set to transmit a single 80 second pong that sweeps through a frequency range of 259.3750 Hz to 260.8980 Hz in 100 steps.

On November 7, 2005, all sources were started and set to pong at 30% power to avoid damaging the ceramics. After 21 cycles the sources increase power to 100%. November 12, 2005, sound source #21 was not heard during the on deck pong check. Noise from the steering blower fan overpowered the source tone. The instrument was confirmed to be running the appropriate program. Resuming the program may have reset the 21 pong full power cycle and therefore source #21 may not be at full power on the same day as the other sources. It should come to full power by December 4, 2005.

Sources were programmed to pong once daily between at 00:00:00 and 02:00:00 GMT during the float listening window. Source #21 started at 00:00:00 and each consecutive source followed on the half hour. Clock times were checked when possible against GPS time. Table 9 shows the time difference in seconds from the target time.

Table 9. Sound source time differences (in seconds).

Pong Watch					
	#21	#22	#23	#24	
Date - Time	00:00:00	00:30:00	01:00:00	01:30:00	
10/28/2005	-2	-1	0	0	
11/3/2005	-2	-1	+1	0	
11/6/2005	0	+1	+2	At shop	
11/7/2005	-5	-4	-3	reset time	Missions set to pong at 30% and go to full power at 21 days
11/9/2005	-1	-0	+2	+2	
11/10/2005	-1	+0	+2	+2	
11/12/2005	too noisy	+ 0	- 2	+ 3	Note #21 was not heard. Mission was checked and reset for 21 days to full power
11/13/2005	-2	+0	- 1	NA	
11/14/2005	+2	+ 0	-1	too noisy	
11/15/2005	-1	+0	Deployed	-3	

The four subsurface moorings were launched using the standard WHOI methods for an anchor last deployment. For the two Source and MMP moorings, the main floatation sphere was launched over the starboard side using the ships crane. The balance of the mooring wire and instrumentation was deployed over the stern using the A-frame, a traveling block, capstan and truck drum payout winch. Prior to deployment, the electromechanical cable between the source electronics was married to the 5m-strength member, which reduced the overall deployment time as the process was time consuming.

The MMP was installed on the mooring wire when roughly half of the 565-meter wire rope shot had been payed out. Prior to deploying the source and electronics, the mooring was stopped off using a slip line. This procedure allowed the deployment of the source packages under a no load situation and would prevent any unnecessary strain on the EM cable between the source and its electronics. Once the source was deployed over the stern, the slip line was eased and the mooring load transferred back to the payout winch.

The next segment of wire was then payed out. For deployment of the glass balls and releases, the mooring was stopped off using stopper lines on the deck and the mooring components inserted, then deployed using the traveling block. Once all the components had been deployed, the mooring load was transferred to the anchor using a slip line. The anchor was then lifted and deployed into the water using the ships trawl wire and quick release hook.

The (2) sound source moorings were deployed in a similar fashion with the exception of the 3000 meters of Yalex dacron rope. At the end of the last upper 500 meter shot of 3/16" wire rope, the mooring was stopped off and the Yalex attached. The 3000 meters of line was then payed out over an H-bit to maintain control and constant mooring tension. The Yalex was stopped off with a Yale grip approximately 10 meters from the bitter end and the mooring load was then transferred off the H-Bit and on to the mooring winch for the balance of the deployment.

After deployment, an anchor position survey was conducted for each subsurface mooring. The results of these surveys are shown in Figures 12-15.

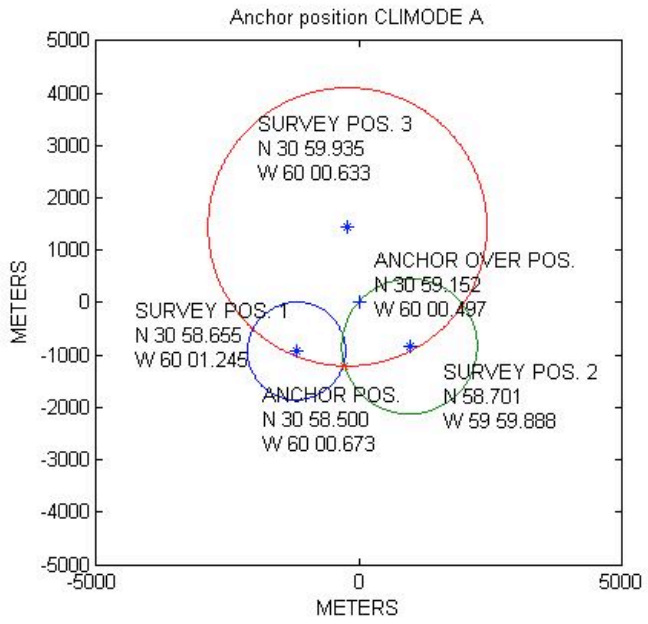


Figure 12. Anchor Survey results for subsurface Mooring A.

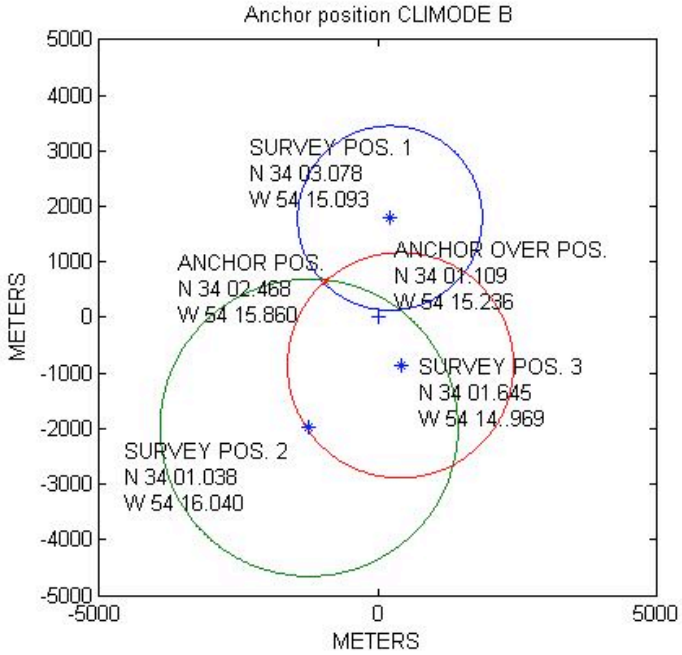


Figure 13. Anchor Survey results for subsurface Mooring B.

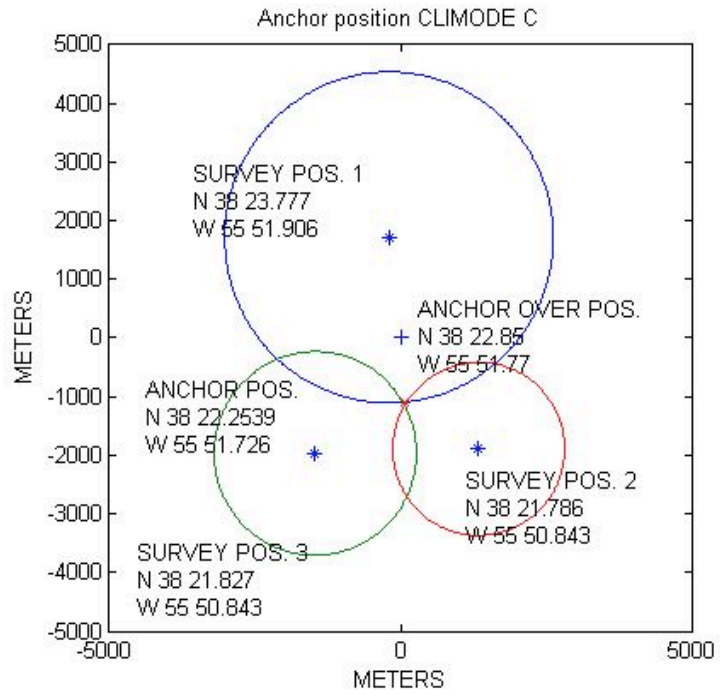


Figure 14. Anchor Survey results for subsurface Mooring C.

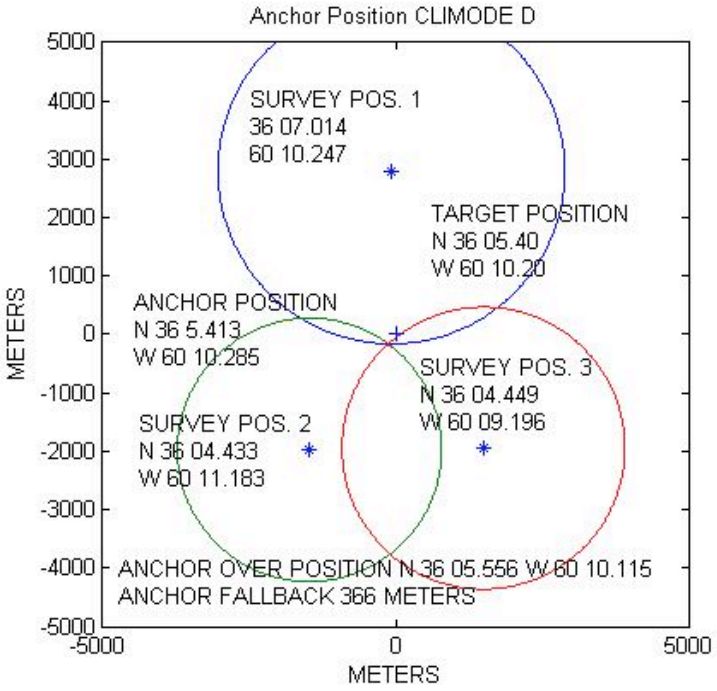


Figure 15. Anchor Survey results for subsurface Mooring D.

V. Floats and Drifters

Nine Autonomous Profiling Expendable (APEX) floats were launched during the OC419 November CLIMODE Cruise. See Figure 16 and Table 10 for deployment locations and times. Each float was equipped with a Seabird model 41 pumped CTD and an Aanderaa Oxygen Optode 3830 sensor. Floats transmit their positions and ocean profile data via the ARGOS network during surfacing intervals. Floats were programmed to dive to 500 db and drift for 101 hours. Every other cycle the float is programmed to make a single deep dive to 1800 db prior to surfacing. The floats surface at 0.08 m/s making a high resolution upcast profile.

Prior to launch floats were checked using the automated LabVIEW software provided by Webb Research Corporation. The software verifies all of the float's systems are functioning properly. As instructed in the APEX manual each float was reset before the launch and completed the auto test. Floats were launched by slipping a line through the dampening ring and lowered gently into the water.

University of Washington ARGO profiling float S/N 5023 was a field trial of two new firmware features of our APF-9a float controller. The first feature was pressure activation of the float. After a checkout of the float to make sure it was going to perform, the float was put in "pressure activation mode" at WHOI. The float turned on for 6 seconds every two hours to sense what pressure it was at. If the float sensed a pressure greater than 25 db, it assumed it was deployed from a vessel and activated its mission programming. If the pressure was less than 25 db, it went to sleep for another two hours. The second feature was a generic mode water detection algorithm. For this purpose, the float was to detect 18.5 C water only during Jan-Apr of 2006 and 2007. After that, it would perform like a normal ARGO profiling float. The pressure activation feature worked and since the deployment on the *Oceanus*, four more floats were deployed with this feature and were successful. We have changed pressure activation from a development feature to a working feature on UW ARGO profiling floats with our own APF-9a controller.

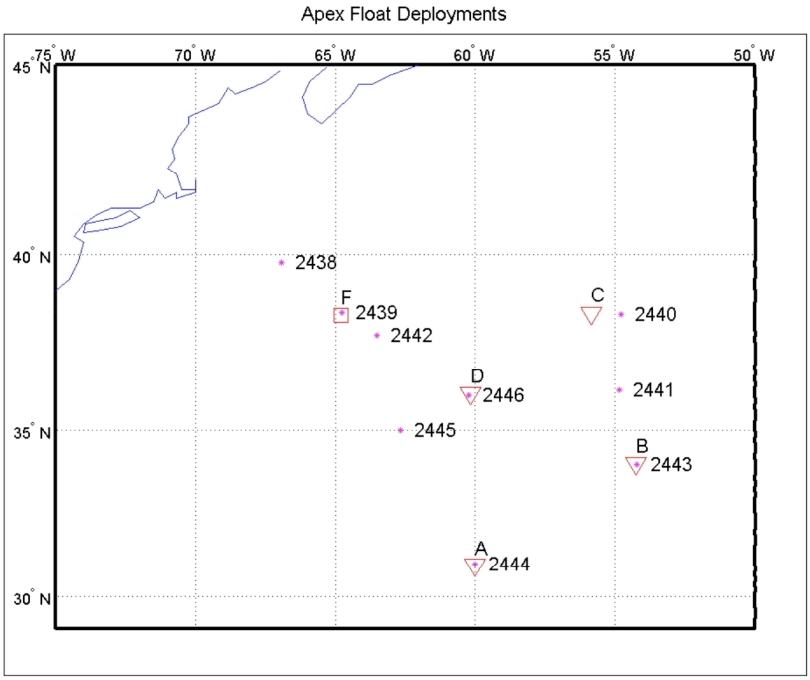


Figure 16. Apex float deployments map.

Bobber floats are APEX floats with TD-RAFOS instrumentation and a modified sampling program. Eight bobbers were deployed during the OC419 November 2005 CLIMODE Cruise. See Figure 17 and Table 10 for deployment times and locations.

Each Bobber was equipped with a RAFOS hydrophone and a Sea Scan TD (temperature, and pressure) sensor. Bobbers make temperature-depth profiles that are acoustically tracked under water using the arrival time from several sound sources located on subsurface moorings deployed during the same cruise.

Bobbers are programmed to seek the 18.5 degree isotherm which is the nominal center of the mode water. They adjust their buoyancy to follow this isotherm. Each day the float listens for 120 minutes starting at 00:00:00 GMT for acoustic pongs from the source moorings. Once every three days the float will bob between the 17 and 20 degrees or 700 meters and surface in order to determine the thickness of the mode water. Every 30 days the float is programmed to make a full ocean profile from 1000 meters to the surface. While at the surface, position and temperature profile data are transmitted via Argos.

Prior to launch floats were checked using the automated LabVIEW software provided by Webb Research Corporation. The software verifies all of the float's systems are functioning properly. As instructed in the APEX manual each float was reset before the launch and completed the auto test. Floats were launched by slipping a line through the dampening ring and lowered gently into the water.

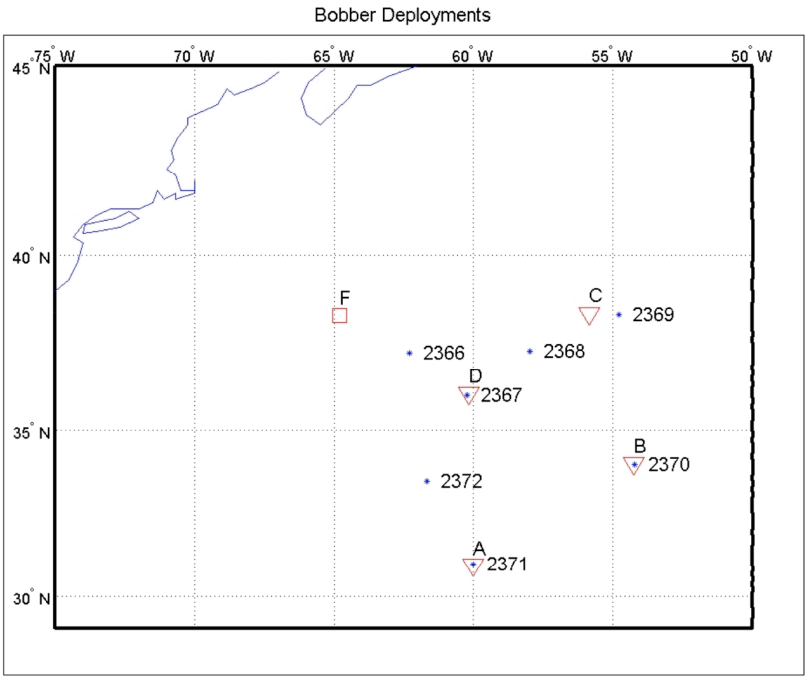


Figure 17. Bobber deployments map.

In addition to the APEX and Bobber floats, five NOAA drifters were deployed. See Figure 18 and Table 11 for deployment locations and times.

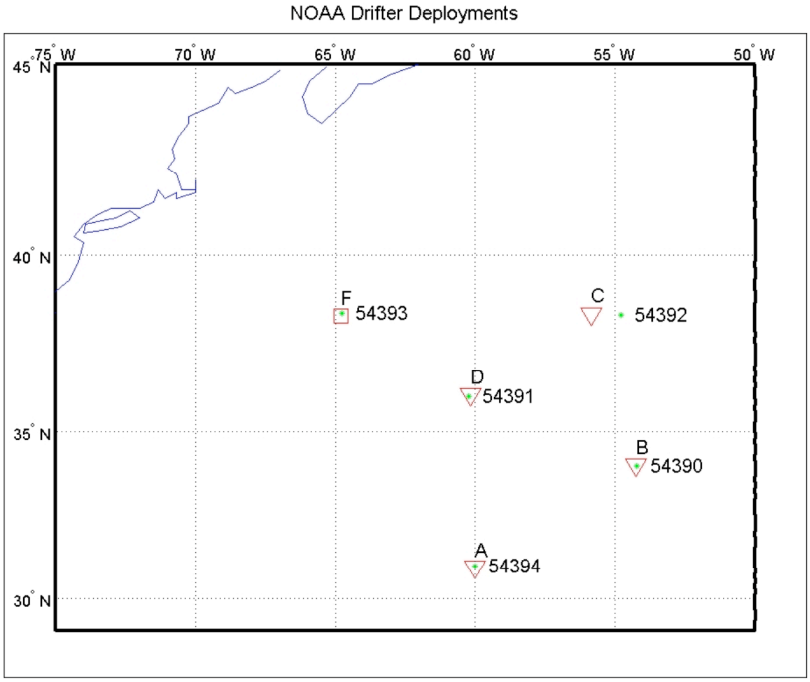


Figure 18. Drifter deployments map.

Table 10. Float and bobber deployment information.

	Date	Time	Serial #	Latitude (deg)	Latitude (min)	Longitude (deg)	Longitude (min)	
APEX Deployment								
1	11/10/05	15:36	2438	39	45.979	66	56.315	
2	11/13/05	0:55	2439	38	24.11	64	45.8	
3	11/14/05	9:10	2442	37	45.59	63	30.89	
4	11/15/05	13:09	2446	36	1	60	14.17	
5	11/17/05	6:13	2440	38	20.94	54	48.04	
6	11/17/05	20:34	2441	36	11.42	54	52.21	
7	11/18/05	20:11	2443	34	0.21	54	14.17	
8	11/20/05	23:59	2444	30	59.709	60	0.657	
9	11/23/05	18:22	2445	34	59.89	62	39.409	
Bobber Deployment								
1	11/14/05	17:27	2366	37	15.62	62	17.04	38576
2	11/15/05	13:13	2367	36	1.08	60	14.06	38577
3	11/16/05	10:13	2368	37	18.49	57	58.68	38581
4	11/17/05	6:12	2369	38	20.94	54	48.04	38582
5	11/18/05	20:13	2370	34	0.21	54	14.15	38585
6	11/20/05	23:55	2371	30	59.782	60	0.719	38589
7	11/23/05	3:26	2372	33	30.48	61	40.67	38590
Box Deployment								
1	11/17/05	20:36		36	11.43	54	52.13	

Table 11. Drifter deployment information.

	Date	Time	ARGOS ID	Latitude (deg)	Latitude (min)	Longitude (deg)	Longitude (min)
Drifter Deployment							
1	11/13/05	0:48	54393	38	23.860	64	46.050
2	11/15/05	13:15	54391	36	1.060	60	13.860
3	11/17/05	6:18	54392	38	20.940	54	48.050
4	11/18/05	20:10	54390	34	0.210	54	14.100
5	11/20/05	22:00	54394	30	59.452	60	0.330

VI. Shipboard Measurements

During the CLIMODE 2005 cruise, numerous CTD casts were made with the *Oceanus'* CTD rosette. In addition to temperature and conductivity measurements, water samples were taken for oxygen, salinity, and nutrient analysis. See Table 12 for details of cast times and locations.

Table 12: CTD depths, times and locations

		cast beginning			cast bottom			cast end				
	date (dd-mm-yy)	lat	lon	time (UTC)	lat	lon	time (UTC)	lat	lon	time (UTC)	cast depth (m)	bottom depth (m)
1	10/11/05	39° 47'N	66° 59' W	12:07	39° 47'N	66° 57' W	13:07	39° 46' N	66° 56' W	14:32	3000	3524
2	11/11/05	39° 8.35'N	66° 0.6' W	0:22	39° 06.27'N	66° 02.58' W	01:31	39° 04.69'N	66° 05.74' W	3:17	3000	4570
3	12/11/05	38° 17.84'N	64° 49.68' W	21:58	38° 20.01'N	64° 48.8' W	22:48	38° 22'N	66° 47.6' W	0:04	3000	4931
4	14/11/05	37° 45.99'N	63° 30.04' W	7:19	37° 45.8'N	63° 30.5' W	08:05	37° 45.66'N	63° 31.03' W	9:03	2000	4999
5	14/11/05	37° 12.2'N	62° 16.81' W	15:47	37° 13.43'N	62° 16.65' W	16:18	37° 15.4'N	62° 17.04' W	17:20	2000	5020
6	14/11/05	36° 39.99'N	61° 13.90' W	23:15	36° 40.27'N	61° 13.17' W	00:12	36° 40.3'N	61° 11.9' W	01:35	3000	4931
7	15/11/05	36° 00.6'N	60° 13.19' W	09:29	36° 01'N	60° 13.7' W	11:01	36° 0.9'N	60° 14.23' W	12:54	bottom	4802
8	16/11/05	37° 16.87'N	57° 58.85' W	07:34	37° 17.4'N	57° 58.8' W	08:33	37° 18.22'N	57° 58.78' W	09:53	3000	5123
9	17/11/05	38° 28.8'N	55° 47.06' W	04:26	38° 21.34'N	55° 47.42' W	5:01	38° 21.01'N	55° 47.92' W	05:59	2000	5257
10	17/11/05	36° 10.75'N	54° 55.67' W	18:54	36° 11.04'N	54° 54.08' W	19:32	36° 11.39'N	54° 52.45' W	20:29	2000	5104
11	18/11/05	33° 59.93'N	54° 15.98' W	18:31	34° 00.05'N	54° 15.30' W	19:13	34° 00.2'N	54° 14.35' W	20:05	2000	5478
12	19/11/05	33° 41.36'N	57° 36.42' W	10:48	33° 40.94'N	57° 35.37' W	12:14	33° 40.61'N	57 35.28' W	13:45	bottom	4548
13	20/11/05	31° 00.17'N	60° 00.16' W	07:05	31° 00.46'N	60° 00.26' W	07:44	31° 01.72'N	60° 00.85' W	10:01	2000	5714
14	21/11/05	32° 14.34'N	60° 49.72' W	11:35	32° 14.13'N	60° 49.52' W	12:17	32° 13.17'N	60° 49.63' W	13:15	2000	4728
15	22/11/05	33° 29.9'N	61° 39.90' W	01:57	33° 30.17'N	61° 40.20' W	2:21	33° 30.36'N	61° 40.49' W	3:07	1500	2107
16	25/11/05	38° 16.07'N	64° 44.17' W	15:30	38° 14.28'N	64° 45.58' W	16:09	38° 12.76'N	64° 46.9' W	17:46	2200	4946

Station by station: interesting events

(each number corresponds to the number of the CTD station)

1. Sample from bottle 5 lost because it smashed on the floor.
2. Leak on bottle 8.
3. Bottle 1 broke before deployment, bottle 8 didn't close.
4. Everything fine.
5. Leak on bottle 21.
6. Everything fine.
7. Everything fine.
8. Everything fine.
9. During the upcast data spike at 500db.
10. Everything fine.
11. Bottle 10 did not close, bottle 11 empty.
12. Leak on bottle 1.
13. During the upcast stop for ~1 hour at1000db due to problems with the winch wire. During this stop the unit was lowered back down to ~1300db. Bottle 23 open.
14. Everything fine
15. The data processing done onboard shows that the data in the downcast from 390db to 1138db are corrupted. This doesn't necessarily mean that the raw data are not valid, but there are high possibilities. The upcast data seem to be fine.
16. During the upcast several stops due to problems with the winch wire. During the first stop at ~1100db the unit has been lowered back down to 1330 db.

The R/V *Oceanus* is equipped with a SeaBird 911+ CTD (Conductivity, Temperature, and Depth) Acquisition System. The instrument provides in-situ measurements of hydrographic parameters as it is lowered through the water column. The SeaBird unit is of modular design and the underwater instrumentation is able to accommodate standard "piggy back" sensors. The package consists of 24 10-liter bottles triggered by a SeaBird Carousel, and data is acquired on a dedicated CTD computer in the main lab.

References

Ebbesmeyer, C. C. and E. J. Lindstrom, 1986. Structure and origin of 18° water observed during POLYMODE Local Dynamics Experiment. *J. Phys. Oceanogr*., **16**, 443-453.

Schroeder, E. H., H. Stommel, D.W. Menzel and W. H.Sutcliffe, Jr. 1959. Climate stability of eighteen degree water at Bermuda. *J. Geophys. Res*., **64**, 363-366.

Worthington, L.V., 1959. The 18° water in the Sargasso Sea. *Deep-Sea Research*, **5**, 297-305.

Worthington, L. V., 1976. On the North Atlantic Circulation. Johns Hopkins Oceanographic Studies, 6.

Acknowledgements

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Appendix A – Mooring Logs

Moored Station Log

(fill out log with black ball point pen only)

ARRAY NAME AND NO. CLIMODE A MOORED STATION NO. 11666

Launch (anchor over)

Date (day-mon-yr) 20 Nov 2005 Time 21:43 UTC

Latitude (N/S, deg-min) 30° 59.1521 N Longitude (E/W, deg-min) 60° 00.497'

Deployed by Kemp Recorder/Observer Hutto

Ship and Cruise No. Oceanus 419 Intended Duration 730 days

At drop site:

Depth Recorder Reading 5679 m Correction Source Matthew's Table

Depth Correction 69 m

Corrected Water Depth 5748 m Magnetic Variation (E/(W)) 16° 10' W

Argos Platform ID No. 5629 Additional Argos Info on pages 2 and 3

Surveyed Anchor Position

Lat ((N)/S) 30° 58.500 N Long. (E/(W)) 60° 00.673 W

Acoustic Release Model EGG Model 8242

Release No. 28289, 26338 Tested to 2,000 m

Receiver No. 028143 Release Command 353605, 342600

Enable Disable

Interrogate Freq. 11 KHz Reply Freq. 12 KHz

Recovery (release fired)

Date (day-mon-yr) Time UTC

Latitude (N/S, deg-min) Longitude (E/W, deg-min)

Recovered by Recorder/Observer

Ship and Cruise No. Actual duration days

Distance from actual waterline to buoy deck m

1

Moored Station Number 1166

Item No.	Length (m)	Item	Inst No.	Time Over	Notes	Data No.	Depth (m)	Time Back	Notes
1		3-ball float		17:42			323		
2		Strobe light	M08-032	17:42			323		
3		SBE39	0078	17:42			323		
4		Argos	5629	17:42					
5	5	3/8" chain		17:42					
6		(29) Glass balls		17:44					
7	20	1/4" wire		17:58					
8		VACM	589	18:05	18:01 foam out		380		
9	50	1/4" wire		18:05					
10		Miller Swivel		18:19					
11		Source Electronics	22	18:19					
12	5	1/4" wire		18:19	} married		440		
13	6	E.M. cable		18:19					
14		Rafos source	22	18:25					
15	0.5	3/8" chain		18:25					
16		miller swivel		18:25					
17	100	3/16" wire		18:28					
18		SBE39	262	18:28	directly under term		441		
19	500	3/16" wire		18:31					
20		SBE39	261	18:31	directly under term		542		
21		SBE39	341	18:34	100 m mark		642		
22		SBE39	336	18:39	300 m mark		~~834~~ 843		

Item No.	Length (m)	Item	Inst No.	Time Over	Notes	Data No.	Depth (m)	Time Back	Notes
23		(2) Glass balls		18:48					
24	5	1/4" wire		18:49					
25		VACM	179	18:54	18:47 foam out		1,053		
26	3	3/8" chain		18:54					
27		Dual releases		18:57			1,058		
28	3	1/2" chain		18:57					
29	500	3/16" wire		18:57					
30	500	3/16" wire							
31	3000	3/8" dacron		19:15					
32	200	3/16" wire		20:40					
33	100	3/16" wire		20:43					
34	100	3/16" wire		20:45					
35	30	3/16" wire		20:47					
36	10	1/4" wire		20:48					
37	100	1/4" wire							
38	5	3/8" chain							
39		Anchor			2,000 lb wet wt.				
40									
41									
42									
43									
44									
45									

Moored Station Log

(fill out log with black ball point pen only)

ARRAY NAME AND NO. CLIMODE B MOORED STATION NO. 1167

Launch (anchor over)

Date (day-mon-yr) 18 Nov 2005 Time 16:19 UTC

Latitude (N/S, deg-min) 34° 02.109' N Longitude (E/W, deg-min) 54° 15.236' W

Deployed by Kemp Recorder/Observer Hutto

Ship and Cruise No. Oceanus 419 Intended Duration 730 days

At drop site:

Depth Recorder Reading 5480 m Correction Source Matthew's Table

Depth Correction 61 m

Corrected Water Depth 5541 m Magnetic Variation (E/W) 17° 1' W

Argos Platform ID No. 23912 Additional Argos Info on pages 2 and 3

Surveyed Anchor Position

Lat (N/S) 34° 02.468' N Long. (E/W) 54° 15.860' W

Acoustic Release Model EGG Model 8242

Release No. 26353, 26355 Tested to 2,000 m

Receiver No. 028143 Release Command 343175, 343234

Enable Disable

Interrogate Freq. 11 KHz Reply Freq. 12 KHz

Recovery (release fired)

Date (day-mon-yr) Time UTC

Latitude (N/S, deg-min) Longitude (E/W, deg-min)

Recovered by Recorder/Observer

Ship and Cruise No. Actual duration days

Distance from actual waterline to buoy deck m

1

Moored Station Number 1167

Item No.	Length (m)	Item	Inst No.	Time Over	Notes	Data No.	Depth (m)	Time Back	Notes
1		3-ballfloat		12:51			326		
2		Strobe	6427	12:51					
3		SBE39	080	12:51			326		
4		Argos	23912	12:51	12:45 Argos turnedon				
5	5	3/8" chain		12:51					
6		(29) glass balls		12:52					
7	20	1/4" wire							
8		VACM	0115	13:12	13:04 foam out		383		
9	50	1/4" wire							
10		Miller swivel		13:25					
11		Source electronics	21	13:25					
12	5	1/4" wire		13:25	} married				
13	6	E.M. cable		13:25					
14		Rafos source	21	13:30					
15	0.5	3/8" chain		13:30					
16		miller swivel		13:32					
17	100	3/16" wire		13:32					
18	500	3/16" wire							
19		SBE39	339	13:36	Ø Mark		545		
20		SBE39	333	13:38	100 Mark		645		
21		SBE39	334	13:40	200 Mark		746		
22		SBE39	337	13:43	300 Mark		846		

Item No.	Length (m)	Item	Inst No.	Time Over	Notes	Data No.	Depth (m)	Time Back	Notes
23		Dual releases	26353/ 26355	13:51			1049		
24	3	1/2" chain		13:51					
25	500	3/16" wire		13:51					
26	500	3/16" wire		13:59					
27	3000	3/8" dacron		14:16					
28	10	3/16" wire		15:32					
29	25	3/16" wire		15:33					
30	50	3/16" wire		15:34					
31	200	3/16" wire		15:36					
32	50	1/4" wire							
33	10	1/4" wire		15:49					
34	5	3/8" chain							
35		Anchor			2,000 lb wet wt.				
36									
37									
38									
39									
40									
41									
42									
43									
44									
45									

Moored Station Log

PAGE 1

(fill out log with black ball point pen only)

ARRAY NAME AND NO. CLIMODE - C MOORED STATION NO. 1168

Launch (anchor over)

Date 17 Nov 2005 (day-mon-year) Time 2:27 UTC

Latitude 38° 22.850' (N) or S (deg-min) Longitude 55° 51.768' (deg-min) E or (W)

Position Source: GPS, LORAN, SAT. NAV., OTHER GPS

Deployed by: Kemp Recorder/Observer: Hutto

Ship and Cruise No Oceanus 419 Intended duration: 365 days

@anchor drop

Depth Recorder Reading 5247 m Correction Source: _____

Depth Correction 53 m Matthew's Table

Corrected Water Depth 5300 m Magnetic Variation: 17°47' E or (W)

Anchor Position: Lat. 38° 22.2539 (N) or S Long. 55° 51.726 E or (W)

Argos Platform ID No. 27332 Additional Argos Info may be found on pages 2 and 3.

Acoustic Release Information

Release No. 18018, 15983 Tested to 3,000 meters

Receiver No. 028143 Release Command 546 213, 533051

Interrogate Freq. 11 KHz Reply Freq. 12 KHz

Recovery (release fired)

Date _____ (day-mon-year) Time _____ UTC

Latitude _____ (deg-min) N or S Longitude _____ (deg-min) E or W

Postion Source: GPS, LORAN, SAT. NAV., OTHER _____

Recovered by: _____ Recorder/Observer: _____

Ship and Cruise No. _____ Actual duration: _____ days

Distance from actual waterline to buoy deck _____ meters

MOORED STATION NUMBER 1168

Item No.	Lgth [m]	Item	Inst No.	Time Over	Notes	Data No.	Calc Dpth	Time Back	Notes
1		64" sphere	0017	23:03	Strobe # M08-036		~~6260~~ *		
2		ADCP	2127	23:03					
3		Argos	27332	23:03					
4	5	3/4" chain		23:03					
5		nutrient sampler	79	23:03			*66 ~~5858~~		
6		miller swivel		23:03					
7		SBE37	2140	23:03	w/pressure		~~6~~ *67		
8		Stopper		23:03			*70 ~~2271~~		
9	565	1/4" wire		23:03					
10		moored profiler	110	23:21					
11		Stopper		23:36			*629 ~~630~~		
12		SBE37	2034	23:37	3m above termination		~~6233~~ *634		
13		miller swivel		23:50					
14		Aandraa	156	23:50			*636 ~~6237~~		
15		SourceElec.	24	23:50					
16	5	1/4" wire		23:50	} married				
17	6	E.M. Cable		23:50	}				
18		Rafos source	24	23:57			646		
19	0.5	3/8" chain		23:57					
20		miller swivel		23:57					

Date/Time	Comments
22 NOV 05 *	Re-calculated mooring with updated release weights and added swivel lengths, using computer program NOYFB. RNJ

MOORED STATION NUMBER 1168

Item No.	Lgth [m]	Item	Inst No.	Time Over	Notes	Data No.	Calc Dpth	Time Back	Notes
21	0.5	3/8" chain		23:57					
22	500	1/4" wire		23:59					
23	500	1/4" wire		0:12					
24		(2) Glass balls		0:24					
25	500	3/16" wire		0:24					
26	500	3/16" wire		0:36					
27		(3) Glass balls		0:46					
28	500	3/16" wire		0:48					
29	500	3/16" wire		0:59					
30		(3) Glass balls		1:13					
31	500	3/16" wire		1:13					
32	500	3/16" wire		1:24					
33		(11) Glass balls		1:31					
34	5	3/8" chain		1:40					
35		Dual 8242 releases		2:00		4698			
36	3	1/2" chain		2:00					
37	400	1/4" wire		2:00					
38	100	1/4" wire		2:06					
39	10 ~~1050~~	1/4" wire		2:10					
40	~~1~~520	1/4" wire		2:10					

Date/Time		Comments
50~~20~~	1/4" wire	2:11
10	1/4" wire	2:20

MOORED STATION NUMBER 1168

Item No.	Lgth [m]	Item	Inst No.	Time Over	Notes	Data No.	Calc Dpth	Time Back	Notes
41	5	3/8" chain		2:27					
42	4	3/8" chain							
43		Mace Anchor		2:27	3,40016 wet wt.				
44	4	3/8" chain		2:27					
45		danforth		2:27					
46									
47									
48									
49									
50									
51									
52									
53									
54									
55									
56									
57									
58									
59									
60									

Date/Time	Comments

Moored Station Log

PAGE 1

(fill out log with black ball point pen only)

ARRAY NAME AND NO. CLIMODE -D MOORED STATION NO. 1169

Launch (anchor over)

Date 15 Nov. 2005 (day-mon-year) Time 18:59 UTC

Latitude 36° 05.556' (deg-min) (N) or S Longitude 60° 10.115' (deg-min) E or (W)

Position Source: GPS, LORAN, SAT. NAV., OTHER GPS

Deployed by: Kemp Recorder/Observer: Hutto

Ship and Cruise No Oceanus #419 Intended duration: 365 days

At drop site:

Depth Recorder Reading 4853 m Correction Source: N/A

Depth Correction +41 m Matthew's Table

Corrected Water Depth 4894 m Magnetic Variation: 17°0' E or (W)

Anchor Position: Lat. 36° 05.413 (N) or S Long. 60° 10.285 E or (W)

Argos Platform ID No. 27333 Additional Argos Info may be found on pages 2 and 3.

Acoustic Release Information

Release No. 18020, 18022 Tested to 3,000 meters

Receiver No. 028143 Release Command 546324, 546341

Interrogate Freq. 11 KHz Reply Freq. 12 KHz

Recovery (release fired)

Date _____ (day-mon-year) Time _____ UTC

Latitude _____ (deg-min) N or S Longitude _____ (deg-min) E or W

Postion Source: GPS, LORAN, SAT. NAV., OTHER _____

Recovered by: _____ Recorder/Observer: _____

Ship and Cruise No. _____ Actual duration: _____ days

Distance from actual waterline to buoy deck _____ meters

MOORED STATION NUMBER 1169

Item No.	Lgth [m]	Item	Inst No.	Time Over	Notes	Data No.	Calc Dpth	Time Back	Notes
1		64" Sphere	008	14:06	00		*~~63~~62		
2		ADCP	2231	14:06					
3		ArgosTrans	27333	14:06	magnet off 13:57				
4	5	3/4" chain		14:06					
5		Nutrient Sampler	78	14:06			*~~67~~68 ~~62~~		
6		Miller Swivel		14:06					
7		SBE37	2139	14:06			*~~70~~71		
8		Stopper		14:06			*~~72~~73		
9	565	1/4" wire		14:06					
10		Profiler	118	14:22			*630		
11		Stopper		14:30			~~629~~631		
12		SBE37	2045	14:33	3.50 m from term to sensor		*633 ~~625~~634		
13		Miller Swivel		14:44					
14		Aanderaa	159	14:44			*637 ~~624~~638		
15		Source Electronics	23	14:44					
16	5 →	1/4" wire		14:45	married				
17	6 →	E.M. cable		14:45					
18		RAFOS Source	23	14:53			~~636~~647		
19	0.5	3/8" chain		14:53					
20		Miller Swivel		14:54					

Date/Time	Comments
	M08-040 Strobe light
24 Nov 05 *	Re-calculated component depths after adjustm. for swivels & release weights using NOYFB. BMB

MOORED STATION NUMBER 1169

Item No.	Lgth [m]	Item	Inst No.	Time Over	Notes	Data No.	Calc Dpth	Time Back	Notes
21	0.5	3/8" chain		14:54					
22		(6) glass balls		14:58					
23	500	3/16" wire		15:00					
24	500	3/16" wire		15:11					
25		(3) glass balls		15:26					
26	500	3/16" wire		15:26					
27	500	3/16" wire		15:38					
28		(3) glass balls		15:53					
29	500	3/16" wire		15:53					
30	500	3/16" wire		16:07					
31		(3) glass balls		16:20					
32	500	3/16" wire		16:20					
33	500	3/16" wire		16:29					
34		(11) glass balls		16:43					
35	5	3/8" chain		16:47					
36		8242 releases (2)		18:34			4709		
37	3	1/2" chain		18:34					
38	100	1/4" wire		18:35					
39	~~450~~	1/4" wire		18:40					
40	~~420~~	1/4" wire		18:42					

Date/Time	Comments
5 1/4" wire 18:44	

MOORED STATION NUMBER 1169

Item No.	Lgth [m]	Item	Inst No.	Time Over	Notes	Data No.	Calc Dpth	Time Back	Notes
41	5	3/8" chain		18:59					
42		Mace anchor		18:59	3400 wet weight				
43	4	3/8" Chain		18:59					
44		danforth		18:59					
45									
46									
47									
48									
49									
50									
51									
52									
53									
54									
55									
56									
57									
58									
59									
60									

Date/Time	Comments

Moored Station Log

PAGE 1

(fill out log with black ball point pen only)

ARRAY NAME AND NO. CLIMODE - F MOORED STATION NO. 1164

Launch (anchor over)

Date 11/13/05 (day-mon-year) Time 21:18 UTC

Latitude 38° 19.102' (deg-min) (N) or S Longitude 64° 46.954' (deg-min) E or (W)

Position Source: GPS, LORAN, SAT. NAV., OTHER GPS

Deployed by: Kemp / Lord Recorder/Observer: Hutto

Ship and Cruise No R/V Oceanus #419 Intended duration: 365 days

Depth Recorder Reading 4939 m Correction Source:

Depth Correction 42 m Matthews Table

Corrected Water Depth 4981 m Magnetic Variation: _____ E or W

Anchor Position: Lat. 38° 19.082 (N) or S Long. 64° 47.264 E or (W)

Argos Platform ID No. _____ Additional Argos Info may be found on pages 2 and 3.

Acoustic Release Information

Release No. 30841 / 30843 Tested to 3,000 meters

Receiver No. Edgetech Model 8011A SN # 028143 Release Command 151241 / 151313

Interrogate Freq. 11 KHz Reply Freq. 12 KHz

Recovery (release fired)

Date _____ (day-mon-year) Time _____ UTC

Latitude _____ (deg-min) N or S Longitude _____ (deg-min) E or W

Postion Source: GPS, LORAN, SAT. NAV., OTHER _____

Recovered by: _____ Recorder/Observer: _____

Ship and Cruise No. _____ Actual duration: _____ days

Distance from actual waterline to buoy deck _____ meters

Surface Components

Buoy Type Modular **Color(s) Hull** white/yellow **Tower** white

Buoy Markings 508-548-1401, Woods Hole, etc.

Surface Instrumentation

Item	ID	Height *	Comments
Logger	L-14		~~System~~
HRH	~~231~~ 214	203	Changed post deployment 11/26/05 ~ 11:57
BPR	204	226	
WND	347	268	Vane Back on ~ 10:05 UTC
PRC	217	222	
LWR	216	278	
SWR	202	278.5	
~~SST~~	~~1810~~		
PTT #12790	09203, 09819		
	09833, 14925		
Logger	L-15		~~System~~
HRH	~~203~~ 222	203	
BPR	210	255	
WND	344	270.5	Vane Back on ~ 10:05 UTC
PRC	502	221.5	
LWR	211	278.5	
SWR	506	278.5	
PTT #	14766,		
	14778, 14901		
HRH	502	216	} Stand Alone's
LWR	210	278	
WND	213	271	
SWR	201	278.5	
BPR	218	226	
Sonic	01	306	w/ Gill 351
Sub-surf Argos	ID 25689		
# 267			

*** Height above buoy deck**

Sub-Surface Instrumentation on Buoy and Bridle

Item	ID	Depth†	Comments
SBE37	1840	151.5	System # 1
SBE 37	1839	151.5	System # 2

† Depth below buoy deck (cm)

Sub-Surface Components

	Type	Size(s)	Manufacturer
Chain			
Wire Rope			
Synthetics			
Hardware			

Flotation	Type (G.B.s, Spheres, etc)	Size	Quantity	Color

No. of Flotation Clusters _____

Anchor Dry Weight _____ lbs

MOORED STATION NUMBER 1164

Item No.	Lgth [m]	Item	Inst No.	Time Over	Notes	Data No.	Calc Dpth	Time Back	Notes
1	2.1	3/4" chain							
2		SBE37	0009	11:32	came back on, when buoy over		5		
3	3.6	3/4" chain							
4		Nortek	16606	11:25	heads up		10		
5	4.13	3/4" chain							
6		TPOD	1498	11:21			15		
7	3.3	3/4" chain							
8		Nortek	16488	11:17	heads up		20		
9	320	7/16" wire							
10		TPOD	1504	11:13			40		
11		TPOD	1499	12:05			80		
12		TPOD	15812	12:15			120		
13		TPOD	1500	12:29			160		
14		TPOD	1506	12:39			200		
15		TPOD	1508	12:52			240		
16		TPOD	1509	13:04			280		
17		SBE37	0010	13:22			341		
18	320	7/16" wire		13:22					
19		TPOD	1511	13:33			360		
20		TPOD	1501	13:47			400		

Date/Time	Comments
*	All TPOD's are SBE39's. *
11/13/05	Buoy Over at 11:52
11/13/05	First inst in water at 38° 01.630' N
	64° 52.138' W

MOORED STATION NUMBER 1164

Item No.	Lgth [m]	Item	Inst No.	Time Over	Notes	Data No.	Calc Dpth	Time Back	Notes
21		TPOD	1502	14:01			440		
22		TPOD	1507	14:15			480		
23		TPOD	1310	14:28			520		
24		TPOD	1503	14:42			560		
25		TPOD	1505	14:55			600		
26		SBE37	3733	15:16			662		
27	320	~~37~~ 7/16" wire		15:16					
28	450	3/8" wire		16:44					
29	450	3/8" wire		17:12					
30	100	3/8" wire	one piece wrapped	17:38					
31	200	7/8" nylon		17:44					
32	400	7/8" nylon		18:34					
33	2500	7/8" nylon	one piece spliced						
34	100	1" nylon							
35	2000	1 1/8" poly		20:02					
36	~~5~~	~~1/2" chain~~							
37		(8) Glass balls		21:05					
38	5	1/2" chain		21:06					
39		Release Model 8242		21:12					
40	5	1/2" chain		21:12					

Date/Time	Comments
11/13/05	Release 30841 enabled for anchor survey ~17:31 UTC
	This release was then disabled prior to deployment. Because of difficulties w/acoustics this cruise, it was decided to be more cautious and deploy them disabled in case comm's could not be established.

MOORED STATION NUMBER 1164

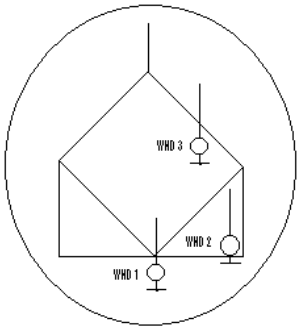
Item No.	Lgth [m]	Item	Inst No.	Time Over	Notes	Data No.	Calc Dpth	Time Back	Notes
41	20	1" Nystron		21:13					
42	5	½" chain		21:18					
43		Anchor		21:18	Wet Wt. 8000 lbs.				
44		½" chain		21:18					
45		Navtech		21:18					
46									
47									
48									
49									
50									
51									
52									
53									
54									
55									
56									
57									
58									
59									
60									

Date/Time	Comments

APPENDIX B – MOORING F BUOY SPINS

CLIMODE 1 Primary Buoy Spin, Woods Hole

309 deg. Heading

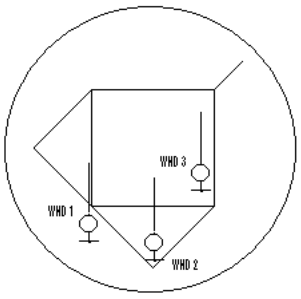


Vanes Secured Time/Date UTC: 11:06:00, 1 NOV 01

System 1	Compass	Vane	Direction	Time UTC
Logger #: L-14				
Stop Sampling: 12:47:30				
Wind #: 347	7.6	303.6	311.2	12:48:00
Restart Sampling: 12:48:30				

System 2	Compass	Vane	Direction	Time UTC
Logger #: L-15				
Stop Sampling: 12:45:30				
Wind #: 344	0.5	308.0	308.5	12:46:00
Restart Sampling: 12:46:30				

309 deg. Heading



Vanes Secured Time/Date UTC: 13:24:00, 1 NOV 05

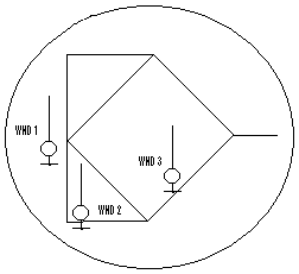
System 1	Compass	Vane	Direction	Time UTC
Logger #: L-14				
Stop Sampling: 13:48:30				
Wind #: 347	53.6	262.9	316.5	13:49:00
Restart Sampling: 13:49:30				

System 2	Compass	Vane	Direction	Time UTC
Logger #: L-15				
Stop Sampling: 13:50:30				

Wind #: 344 45.2 266.5 311.7 13:51:00
Restart Sampling: 13:51:30

Note: System 1 vane moved a little from the wind.

309 deg. Heading

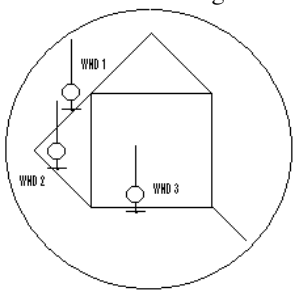


Vanes Secured Time/Date UTC: 13:55:00, 1 NOV 05

System 1	Compass	Vane	Direction	Time UTC
Logger #: L-14				
Stop Sampling: 14:11:30				
Wind #: 347	102.2	209.0	311.2	14:12:00
Restart Sampling: 14:12:30				

System 2	Compass	Vane	Direction	Time UTC
Logger #: L-15				
Stop Sampling: 14:09:30				
Wind #: 344	93.1	216.3	309.4	14:10:00
Restart Sampling: 14:10:30				

309 deg. Heading

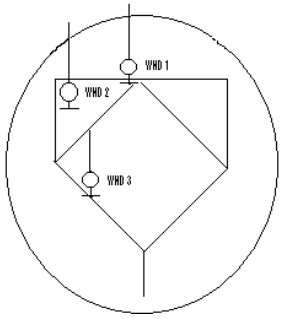


Vanes Secured Time/Date UTC: 14:15:00, 1 NOV 05

System 1	Compass	Vane	Direction	Time UTC
Logger #: L-14				
Stop Sampling: 14:30:30				
Wind #: 347	138.9	171.7	310.6	14:31:00
Restart Sampling: 14:31:30				

System 2	Compass	Vane	Direction	Time UTC
Logger #: L-15				
Stop Sampling: 14:31:30				
Wind #: 344	128.8	176.8	305.6	14:32:00
Restart Sampling: 14:32:30				

309 deg. Heading

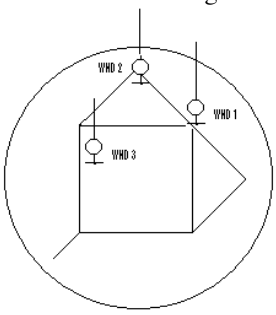


Vanes Secured Time/Date UTC: 14:37:00, 1 NOV 05

System 1	Compass	Vane	Direction	Time UTC
Logger #: L-14				
Stop Sampling: 15:05:30				
Wind #: 347	185.6	124.4	310.0	15:06:00
Restart Sampling: 15:06:30				

System 2	Compass	Vane	Direction	Time UTC
Logger #: L-15				
Stop Sampling: 15:04:30				
Wind #: 344	175.8	130.2	306.0	15:05:00
Restart Sampling: 15:05:30				

309 deg. Heading



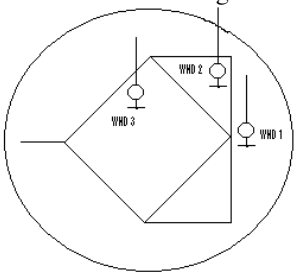
Vanes Secured Time/Date UTC: 15:10:00, 1 NOV 05

System 1	Compass	Vane	Direction	Time UTC
Logger #: L-14				
Stop Sampling: 15:39:30				
Wind #: 347	233.6	77.5	311.1	15:40:00
Restart Sampling: 15:40:30				

System 2	Compass	Vane	Direction	Time UTC
Logger #: L-15				

Stop Sampling: 15:41:30
Wind #: 344 224.5 82.2 306.7 15:42:00
Restart Sampling: 15:42:30

309 deg. Heading

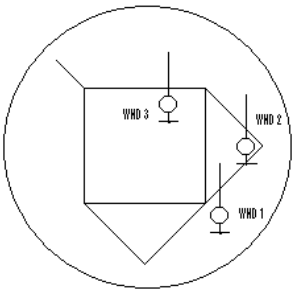


Vanes Secured Time/Date UTC: 15:45:00, 1 NOV 05

System 1	Compass	Vane	Direction	Time UTC
Logger #: L-14				
Stop Sampling: 16:08:30				
Wind #: 347	277.2	33.8	311.0	16:09:00
Restart Sampling: 16:09:30				

System 2	Compass	Vane	Direction	Time UTC
Logger #: L-15				
Stop Sampling: 16:06:30				
Wind #: 344	269.5	37.4	306.9	16:07:00
Restart Sampling: 16:07:30				

309 deg. Heading



Vanes Secured Time/Date UTC: 16:12:00, 1 NOV 05

System 1	Compass	Vane	Direction	Time UTC
Logger #: L-14				
Stop Sampling: 16:41:30				
Wind #: 347	320.0	352.0	312.0	16:42:00
Restart Sampling: 16:42:30				

System 2	Compass	Vane	Direction	Time UTC
Logger #: L-15				
Stop Sampling: 16:43:30				
Wind #: 344	311.8	356.2	307.0	16:44:00
Restart Sampling: 16:45:30				

Vane blocks removed @ 16:45:00, 1 NOV 05

APPENDIX C – MOORING F INSTRUMENT NOTES

Nortek Aquadopp Climode Memory Test

Date & UTC	Activity
	Instrument AQD 1499
29 June 05 1800	Start
06 July 05 1930	Data Dump
	Instruments AQD 1499 & AQD 1464
06 July 05 2100	Start
06 July 07 1256	Move to Jason
06 July 07 1300	Bath Cool down to 0.1 C
06 July 08 1300	Bubbles added
06 July 08 1720	Refrigeration off warm-up
06 July 08 2030	Out of water
06 July 13 1200	Data dump

==========

Deployment : C1test
Current time : 6/29/2005 5:44:52 PM
Start at : 6/29/2005 6:00:00 PM
Comment:
Climode memory test

Measurement interval (s) : 2
Average interval (s) : 1
Blanking distance (m) : 0.35
Diagnostics interval(min) : N/A
Diagnostics samples : N/A
Measurement load (%) : 70
Power level : HIGH-
Compass upd. rate (s) : 1
Coordinate System : ENU
Speed of sound (m/s) : MEASURED
Salinity (ppt) : 35
File wrapping : OFF

Assumed duration (days) : 5.0
Battery utilization (%) : 98.0
Battery level (V) : 15.9
Recorder size (MB) : 9
Recorder free space (MB) : 9.000
Memory required (MB) : 8.7
Vertical vel. prec (cm/s) : 4.8
Horizon. vel. prec (cm/s) : 2.8

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Nortek Setup Information

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Deployment : CL1666
Current time : 10/28/2005 10:16:38 AM
Start at : 11/1/2005 1:00:00 AM
Comment:
CLIMODE 1

Measurement interval (s) : 900
Average interval (s) : 60
Blanking distance (m) : 0.35
Diagnostics interval(min) : 720
Diagnostics samples : 60
Measurement load (%) : 9
Power level : HIGH-
Compass upd. rate (s) : 1
Coordinate System : ENU
Speed of sound (m/s) : MEASURED
Salinity (ppt) : 35
File wrapping : OFF

Assumed duration (days) : 420.0
Battery utilization (%) : 300.0
Battery level (V) : 15.9
Recorder size (MB) : 9
Recorder free space (MB) : 9.000
Memory required (MB) : 3.7
Vertical vel. prec (cm/s) : 1.7
Horizon. vel. prec (cm/s) : 1.0

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==========
Deployment : CLIM1
Current time : 10/28/2005 10:12:52 AM
Start at : 11/1/2005 1:00:00 AM
Comment:
CLIMODE 1

Measurement interval (s) : 900
Average interval (s) : 60
Blanking distance (m) : 0.35
Diagnostics interval(min) : 720
Diagnostics samples : 60
Measurement load (%) : 9
Power level : HIGH-
Compass upd. rate (s) : 1
Coordinate System : ENU
Speed of sound (m/s) : MEASURED
Salinity (ppt) : 35
File wrapping : OFF

Assumed duration (days) : 420.0
Battery utilization (%) : 300.0
Battery level (V) : 15.9

Recorder size (MB) : 9
Recorder free space (MB) : 9.000
Memory required (MB) : 3.7
Vertical vel. prec (cm/s) : 1.7
Horizon. vel. prec (cm/s) : 1.0

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SeaBird Instrument Setup

#01ds
SBE37-SM 485 V 2.2 SERIAL NO. 1840 01 Nov 2005 19:05:02
not logging: waiting to start at 02 Nov 2005 01:00:00
sample interval = 300 seconds
samplenumber = 0, free = 233016
store time with each sample
do not output salinity with each sample
do not output sound velocity with each sample
reference pressure = 0.0 db
do not output density with each sample
do not output depth with each sample
A/D cycles to average = 4
temperature = 23.13 deg C
S>

#01ds
SBE37-SM 485 V 2.1 SERIAL NO. 1839 01 Nov 2005 19:16:08
not logging: waiting to start at 02 Nov 2005 01:00:00
sample interval = 300 seconds
samplenumber = 0, free = 233016
store time with each sample
do not output salinity with each sample
do not output sound velocity with each sample
reference pressure = 0.0 db
A/D cycles to average = 4
temperature = 22.53 deg C
S>

ds
SBE 39 V 2.0 SERIAL NO. 1512 26 Oct 2005 13:12:41
battery voltage = 8.7
not logging: waiting to start at 01 Nov 2005 01:00:00
sample interval = 300 seconds
samplenumber = 0, free = 599186
serial sync mode disabled
real-time output disabled
SBE 39 configuration = temperature only
binary upload does not include time
temperature = 19.77 deg C
S>

ds
SBE37-SM V 1.6 SERIAL NO. 0009 26 Oct 2005 15:05:45

not logging: waiting to start at 01 Nov 2005 01:00:00
sample interval = 300 seconds
samplenumber = 0, free = 112867
do not transmit real-time data
store time with each sample
A/D cycles to average = 4
reference pressure = 0.0 db
serial sync mode disabled
wait time after serial sync sampling = 30 seconds
temperature = 20.41 deg C
S>

ds
SBE37-SM V 1.6 SERIAL NO. 0010   26 Oct 2005 15:08:01
not logging: waiting to start at 01 Nov 2005 01:00:00
sample interval = 300 seconds
samplenumber = 0, free = 115598
do not transmit real-time data
store time with each sample
A/D cycles to average = 4
reference pressure = 0.0 db
serial sync mode disabled
wait time after serial sync sampling = 120 seconds
temperature = 19.77 deg C
S>

ds
SBE37-SM V 2.6 SERIAL NO. 3733   26 Oct 2005 14:26:13
not logging: waiting to start at 01 Nov 2005 01:00:00
sample interval = 300 seconds
samplenumber = 0, free = 190650
do not transmit real-time data
do not output salinity with each sample
do not output sound velocity with each sample
store time with each sample
number of samples to average = 4
serial sync mode disabled
wait time after serial sync sampling = 30 seconds
internal pump not installed
temperature = 19.98 deg C
S>

ds
SBE 39 V 2.0   SERIAL NO. 1498   26 Oct 2005 12:45:03
battery voltage = 9.2
not logging: waiting to start at 01 Nov 2005 01:00:00
sample interval = 300 seconds
samplenumber = 0, free = 599186
serial sync mode disabled
real-time output disabled
SBE 39 configuration = temperature only
binary upload does not include time
temperature = 19.58 deg C
S>

ds
SBE 39 V 2.0   SERIAL NO. 1499   26 Oct 2005 12:25:10
battery voltage = 9.1
not logging: waiting to start at 01 Nov 2005 01:00:00
sample interval = 300 seconds
samplenumber = 0, free = 596845
serial sync mode disabled
real-time output disabled
SBE 39 configuration = temperature only
binary upload does not include time
temperature = 19.33 deg C
S>

ds
SBE 39 V 2.0   SERIAL NO. 1500   26 Oct 2005 12:31:34
battery voltage = 9.0
not logging: waiting to start at 01 Nov 2005 01:00:00
sample interval = 300 seconds
samplenumber = 0, free = 597430
serial sync mode disabled
real-time output disabled
SBE 39 configuration = temperature only
binary upload does not include time
temperature = 19.28 deg C
S>

ds
SBE 39 V 2.0   SERIAL NO. 1501   26 Oct 2005 13:26:13
battery voltage = 9.0
not logging: waiting to start at 01 Nov 2005 01:00:00
sample interval = 300 seconds
samplenumber = 0, free = 599186
serial sync mode disabled
real-time output disabled
SBE 39 configuration = temperature only
binary upload does not include time
temperature = 20.68 deg C
S>

ds
SBE 39 V 2.0   SERIAL NO. 1502   26 Oct 2005 13:31:12
battery voltage = 9.1
not logging: waiting to start at 01 Nov 2005 01:00:00
sample interval = 300 seconds
samplenumber = 0, free = 599186
serial sync mode disabled
real-time output disabled
SBE 39 configuration = temperature only
binary upload does not include time
temperature = 21.16 deg C
S>

ds
SBE 39 V 2.0   SERIAL NO. 1503   26 Oct 2005 13:17:46

battery voltage = 9.1
not logging: waiting to start at 01 Nov 2005 01:00:00
sample interval = 300 seconds
samplenumber = 0, free = 599186
serial sync mode disabled
real-time output disabled
SBE 39 configuration = temperature only
binary upload does not include time
temperature = 19.41 deg C
S>

ds
SBE 39 V 2.0   SERIAL NO. 1504   26 Oct 2005 13:21:58
battery voltage = 8.9
not logging: waiting to start at 01 Nov 2005 01:00:00
sample interval = 300 seconds
samplenumber = 0, free = 599186
serial sync mode disabled
real-time output disabled
SBE 39 configuration = temperature only
binary upload does not include time
temperature = 20.39 deg C
S>

ds
SBE 39 V 2.0   SERIAL NO. 1505   26 Oct 2005 12:49:50
battery voltage = 9.1
not logging: waiting to start at 01 Nov 2005 01:00:00
sample interval = 300 seconds
samplenumber = 0, free = 599186
serial sync mode disabled
real-time output disabled
SBE 39 configuration = temperature only
binary upload does not include time
temperature = 19.15 deg C
S>

ds
SBE 39 V 2.0   SERIAL NO. 1506   26 Oct 2005 13:44:17
battery voltage = 9.1
not logging: waiting to start at 01 Nov 2005 01:00:00
sample interval = 300 seconds
samplenumber = 0, free = 597430
serial sync mode disabled
real-time output disabled
SBE 39 configuration = temperature only
binary upload does not include time
temperature = 21.23 deg C
S>

ds
SBE 39 V 2.0   SERIAL NO. 1507   26 Oct 2005 01:00:45
battery voltage = 9.0
not logging: waiting to start at 01 Nov 2005 01:00:00
sample interval = 300 seconds

samplenumber = 0, free = 598601
serial sync mode disabled
real-time output disabled
SBE 39 configuration = temperature only
binary upload does not include time
temperature = 21.00 deg C
S>

ds
SBE 39 V 2.0   SERIAL NO. 1508   26 Oct 2005 13:53:50
battery voltage = 9.1
not logging: waiting to start at 01 Nov 2005 01:00:00
sample interval = 300 seconds
samplenumber = 0, free = 599186
serial sync mode disabled
real-time output disabled
SBE 39 configuration = temperature only
binary upload does not include time
temperature = 21.15 deg C
S>

ds
SBE 39 V 2.0   SERIAL NO. 1509   26 Oct 2005 13:58:13
battery voltage = 9.1
not logging: waiting to start at 01 Nov 2005 01:00:00
sample interval = 300 seconds
samplenumber = 0, free = 599186
serial sync mode disabled
real-time output disabled
SBE 39 configuration = temperature only
binary upload does not include time
temperature = 21.03 deg C
S>

ds
SBE 39 V 2.0   SERIAL NO. 1510   26 Oct 2005 13:35:41
battery voltage = 9.1
not logging: waiting to start at 01 Nov 2005 01:00:00
sample interval = 300 seconds
samplenumber = 0, free = 599186
serial sync mode disabled
real-time output disabled
SBE 39 configuration = temperature only
binary upload does not include time
temperature = 20.98 deg C
S>

ds
SBE 39 V 2.0   SERIAL NO. 1511   26 Oct 2005 13:40:18
battery voltage = 9.1
not logging: waiting to start at 01 Nov 2005 01:00:00
sample interval = 300 seconds
samplenumber = 0, free = 599186
serial sync mode disabled

real-time output disabled
SBE 39 configuration = temperature only
binary upload does not include time
temperature = 20.43 deg C
S>

IMET Setup Information

LOG01
Model: LOGR53
SerNum: L14
CfgDat: 12OCT01
Firmware: LOGR53 v2.71 - Climode
RTClock: 2005/11/07 18:28:09
Logging Interval: 60; Current Tick: 48
EDI Intel-compatible 40MB PCMCIA CARD present - CARD OK!
FLASH card capacity: 41811968
Records used: 0; available: 653312
Main Battery Voltage: 12.50
Last PTT module update OK
9BC5C201E29A05801C9F046827D3AB9BC1C213E192027FDA1E746027D3A55DAE
9BBDC6071FAE037F9BA0345827D39B9BB9C5FB9E1E007F1E19E46027D392CFDE
9BB5C5E45B56037FA314846C27D3819BB1C5D4998E017FA788F4A427D3762197
CF7B960125BA7E1172001C6C0B1C191A0207048384726B681B6D0C183140021B
Last FLUX message OK - Loaded!
Sampling STOPPED
Sampling GO - synchronizing...

LOG01
Model: LOGR53
SerNum: L14
CfgDat: 12OCT01
Firmware: LOGR53 v2.71 - Climode
RTClock: 2005/11/07 18:29:07
Logging Interval: 60; Current Tick: 7
EDI Intel-compatible 40MB PCMCIA CARD present - CARD OK!
FLASH card capacity: 41811968
Records used: 0; available: 653312
Main Battery Voltage: 12.50
Last PTT module update OK
9BC5C201E29A05801C9F046827D3AB9BC1C213E192027FDA1E746027D3A55DAE
9BBDC6071FAE037F9BA0345827D39B9BB9C5FB9E1E007F1E19E46027D392CFDE
9BB5C5E45B56037FA314846C27D3819BB1C5D4998E017FA788F4A427D3762197
CF7B960125BA7E1172001C6C0B1C191A0207048384726B681B6D0C183140021B
Last FLUX message OK - Loaded!
Sampling GO

LOG01
Model: LOGR53
SerNum: L14
CfgDat: 12OCT01
Firmware: LOGR53 v2.71 - Climode
RTClock: 2005/11/07 18:30:16
Logging Interval: 60; Current Tick: 16

EDI Intel-compatible 40MB PCMCIA CARD present - CARD OK!
FLASH card capacity: 41811968
Records used: 1; available: 653311
Main Battery Voltage: 12.50
Last PTT module update OK
9BC5C201E29A05801C9F046827D3AB9BC1C213E192027FDA1E746027D3A55DAE
9BBDC6071FAE037F9BA0345827D39B9BB9C5FB9E1E007F1E19E46027D392CFDE
9BB5C5E45B56037FA314846C27D3819BB1C5D4998E017FA788F4A427D3762197
CF7B960125BA7E1172001C6C0B1C191A0207048384726B681B6D0C183140021B
Last FLUX message OK - Loaded!
Sampling GOLOGR1
Model: LOGR53 Rev D
SerNum: L15
CfgDat: 13NOV00
Firmware: LOGR53 v2.70
RTClock: 2005/11/07 18:54:39
Logging Interval: 60; Current Tick: 35
EDI Intel-compatible 40MB PCMCIA CARD present - CARD OK!
FLASH card capacity: 41811968
Records used: 0; available: 653312
Main Battery Voltage: 12.50
Last PTT module update OK
9BC5C204E2A605805C9FB43427D3AC9BC1C60FA18A027FDAA1C42C27D3A5F67A
9BBDC603DFA6037F9C1FF42827D39B9BB9C5FB9D76017F5E9A743037D38EA2D8
9BB5C9EB5B46047FE391644437D3819BB1C5D59986017FA889847837D376B59A
Sampling STOPPED
Sampling GO - synchronizing...

LOGR1
Model: LOGR53 Rev D
SerNum: L15
CfgDat: 13NOV00
Firmware: LOGR53 v2.70
RTClock: 2005/11/07 18:59:04
Logging Interval: 60; Current Tick: 4
EDI Intel-compatible 40MB PCMCIA CARD present - CARD OK!
FLASH card capacity: 41811968
Records used: 0; available: 653312
Main Battery Voltage: 12.50
Last PTT module update OK
9BC5C204E2A605805C9FB43427D3AC9BC1C60FA18A027FDAA1C42C27D3A5F67A
9BBDC603DFA6037F9C1FF42827D39B9BB9C5FB9D76017F5E9A743037D38EA2D8
9BB5C9EB5B46047FE391644437D3819BB1C5D59986017FA889847837D376B59A
Sampling GO

LOGR1
Model: LOGR53 Rev D
SerNum: L15
CfgDat: 13NOV00
Firmware: LOGR53 v2.70
RTClock: 2005/11/07 19:00:09
Logging Interval: 60; Current Tick: 9
EDI Intel-compatible 40MB PCMCIA CARD present - CARD OK!
FLASH card capacity: 41811968
Records used: 1; available: 653311

Main Battery Voltage: 12.50
Last PTT module update OK
9BC9C205A2D204805E9C343827D3AD9BC5C204E2A605805C9FB43427D3AC211D
9BC1C60FA18A027FDAA1C42C27D3A59BBDC603DFA6037F9C1FF42827D39B166B
9BB9C5FB9D76017F5E9A743037D38E9BB5C9EB5B46047FE391644437D3812B46
Sampling GO

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16. Abstract (Limit: 200 words)

CLIMODE (CLIVAR Mode Water Dynamic Experiment) is a program designed to understand and quantify the processes responsible for the formation and dissipation of North Atlantic subtropical mode water, also called Eighteen Degree Water (EDW). Among these processes, the amount of buoyancy loss at the ocean-atmosphere interface is still uncertain and needs to be accurately quantified. In November 2005, a cruise was made aboard R/V *Oceanus* in the region of the separated Gulf Stream, where intense oceanic heat loss to the atmosphere is believed to trigger the formation of EDW. During that cruise, one surface mooring with IMET meteorological instruments was anchored in the core of the Gulf Stream as well as two moored profilers on its southeastern edge. Surface drifters, APEX floats and bobby RAFOS floats were also deployed along with two other moorings with sound sources. CTD profiles and water samples were also carried out. This array of instruments will permit a characterization of EDW with high spatial and temporal resolutions, and accurate in-situ measurements of air-sea fluxes in the formation region. The present report documents this cruise, the instruments that were deployed and the array of measurements that was set in place.

17. Document Analysis **a. Descriptors**

CLIMODE
cruise
report

b. Identifiers/Open-Ended Terms

c. COSATI Field/Group

18. Availability Statement
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