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Woods Hole Oceanographic Institution

CLIVAR Mode Water Dynamics Experiment (CLIMODE)

Fall 2006 R/V *Oceanus* Voyage 434
November 16, 2006–December 3, 2006

by

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December 2007

Technical Report

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Robert A Weller

Robert A. Weller, Chair

Department of Physical Oceanography

Abstract

CLIMODE (CLIVAR Mode Water Dynamic Experiment) is a research 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 2006, cruise 434 onboard R/V *Oceanus* traveled in the region of the separated Gulf Stream and its recirculation, where intense oceanic heat loss to the atmosphere in the winter is believed to trigger the formation of EDW. During this cruise, the surface mooring F that was anchored in the core of the Gulf Stream was replaced by a new one, as well as two subsurface moorings C and D located on the southeastern edge of the stream. Surface drifters, ARGO and bobbers RAFOS floats were deployed, 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 EDW formation region.

The present report documents this cruise, the methods and locations for the deployments of instruments and some evaluation of the measurements from these instruments.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF FIGURES (continued)

LIST OF TABLES

I. INTRODUCTION

I.A. 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 the Gulf Stream 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 uses 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, started collecting data since November 2005 and is planned to continue so through November 2007.

This cruise report documents the work done in November 2006 from the Research Vessel *Oceanus*. Voyage 434 concluded the first year of the CLIMODE field phase, sailing from Woods Hole on November 16, 2006 and returning to Woods Hole on December 3, 2006. The objectives of the cruise were:

- Recovery and deployment of 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).
- Deployment and recovery of two moored profiler moorings on the southeastern edge of the Gulf Stream for Fiamma Straneo (WHOI); these profiler moorings also carried sound sources.
- Launching of surface drifters for Rick Lumpkin (NOAA).
- Deployment of SOLO floats floats for Breck Owens (WHOI).
- Deployment of bobbing RAFOS floats for David Fratantoni (WHOI).
- Collecting CTD profiles and water samples for Talley and Susan Lozier (Duke University).

The surface mooring was placed in the region of maximum air-sea heat exchange to accurately quantify air-sea fluxes there and to observe the vertical structure of the upper ocean. 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 two other subsurface moorings deployed in November 2005 provided the means to track the RAFOS floats. At the mooring sites and across the Gulf Stream, CTD profiles and water samples were collected. On the track between the mooring sites, floats and surface drifters were deployed.

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. The science party personnel list is provided in Table 1.1 and the personnel onboard the *Oceanus* in Table 1.1. Ship's track is in Figure 1.1.

Table 1.1: CLIMODE Fall 2006 science party

Name	Affiliation
Bob Weller	WHOI
Sebastien Bigorre	WHOI
Jaime Palter	Duke U.
George Tupper	WHOI
Jeff Lord	WHOI
Jim Ryder	WHOI
John Kemp	WHOI
John Lund	WHOI
Andrew Daly	WHOI

Table 1.2: R/V *Oceanus* ship's crew for Voyage 434

Name	Title
Larry Bearse	Master
Diego Mello	Chief Mate
Carl Christensen	2nd Mate
James McGill	Bosun
Clindor Cacho	Able Seaman
Leonidas Byckovas	Able Seaman
Patrick Hogan	Ordinary Seaman
Patrick Mone	Chief Engineer
Connor Kadlec	Jr. Engineer
Nelson Botsford	Jr. Engineer
Chris Moody	Steward
Jose Andrade	Messman
Kim Phillips	SSSG Technician

I.B. Timeline

Nov 16, 2006. Departure from Woods Hole at 15:17 UTC.

Nov 17, 2006. Steaming southeast towards Climode F.

Nov 18, 2006. 02:00: arrive at Climode F. Station at (38°14.633'N, 64°46.509'W). CTD 1 aborted due to software problem. CTD 2 to 700m. CTD 3,4,5 to 1525m. Acoustic releases test to 1500m. Contact with deployed acoustic releases at 23:17 UTC, 1.2 nm from anchor site, 5356 m slant.

Nov 19, 2006. Recovery Climode1 F. Acoustic releases fired at 09:06 UTC. Buoy on deck at 10:10, last instrument at 13:41 UTC.

Nov 20, 2006. Deployment Climode2 F. Buoy in water at 11:05, last instrument at 14:28, anchor drop at 21:05 UTC, (38°01.587'N, 64°47.491'W). CTD 6 to 1000m at 21:35 UTC, (38°00.705'N, 64°46.234'W). Anchor survey at 23:00 UTC.

Nov 21, 2006. Waterline check on Climode2 F. Underway to Climode D. Solo float 703 and surface drifter 63134 launched at 01:00 UTC (37°56.54'N, 64°41.31'W). Drifter 63133 launch at 13:58, 63135 at 18:55 UTC.

Nov 22, 2006. 00:41 UTC, CTD 7 to 3000m at (35°58.710'N, 60°01.107'W) near Mooring D. 10:00 UTC recovery Mooring D started (ended at 15:15 UTC). 17:30 UTC, CTD 8 to 3000m.

Nov 23, 2006. Deployment Mooring D started at 07:49 UTC, all instruments in at 15:01, anchor drop at 21:24 UTC. Depth (12kHz)=4859m. Rain in afternoon. Anchor survey. CTD 9 to 2000m at 23:45 UTC.

Nov 24, 2006. Underway to C. Solo float 701, drifter 63136 launch at 01:52 UTC. Bobber2376 at 01:59, drifter 63132 at 13:04, drifter 63132 and bobber 2575 at 13:05 UTC. CTD 10 to 2000m at 14:10 UTC. CTD 11 at 23:39.

Nov 25,2006. Drifter 63130 and bobber 2377 at 01:24 UTC. CTD 12 to 700m at 13:08 at (38°21.175'N, 55°54.584'W). Winds too high to recover mooring C.

Nov 26, 2006. 11:30 UTC fired release for mooring C.15:35 UTC mooring C recovered. Bottom survey for new deployment. 21:13 UTC CTD 13 to 700m.

Nov 27, 2006. (38°21'N, 56°08'W), 11:40 UTC deployment mooring C started (ended at 20:41 UTC). Drifter 63131 , bobber 2381at 21:38 UTC. CTD 14 at 23:52 to 2000m.

Nov 28, 2006. Drifter8 (63128), at 14:00 UTC. Bobber 2524 at 15:43 UTC.

Nov 29, 2006. Drifter9 (63129) at 01:56 UTC. Arrival at Climode2 F at 15:30 UTC (38°01'N, 64°44'W). Georges started taking water samples (salinity) from ship's intake (5m depth) every ½ hour for 5 hours.

Nov 30, 2006. 15:30 UTC leave Climode2 F. Start CTD section across Gulf Stream on way back to Woods Hole. 16:20 UTC, CTD 15 to 2000m (37°56'N, 64°38'W). 20:43 UTC, CTD 16.

Dec 01, 2006. 02:06 UTC, CTD 17 (38°19'N, 65°18'W). Near Gulf Stream axis, current 3.5 to 4 knots eastward. 07:11 UTC, CTD 18 (38°31'N, 65°38'W). Current 3.8 knots, SE. 11:43 UTC, CTD 19 (38°43'N, 65°59'W). Temperature at surface=21.3°C. 15:11 UTC, CTD 20 (38°55'N, 66°20'W). Temperature at surface=19.7°C. 18:34 UTC, CTD 21 (39°06'N, 66°41'W). 22:23 UTC, CTD 22 at (39°18'N, 67°02'W).

Dec 02, 2006. 00:17 UTC, float 3 (704) at (39°16'N, 67°02'W). 03:50 UTC, CTD 23 at (39°30'N, 67°23'W).

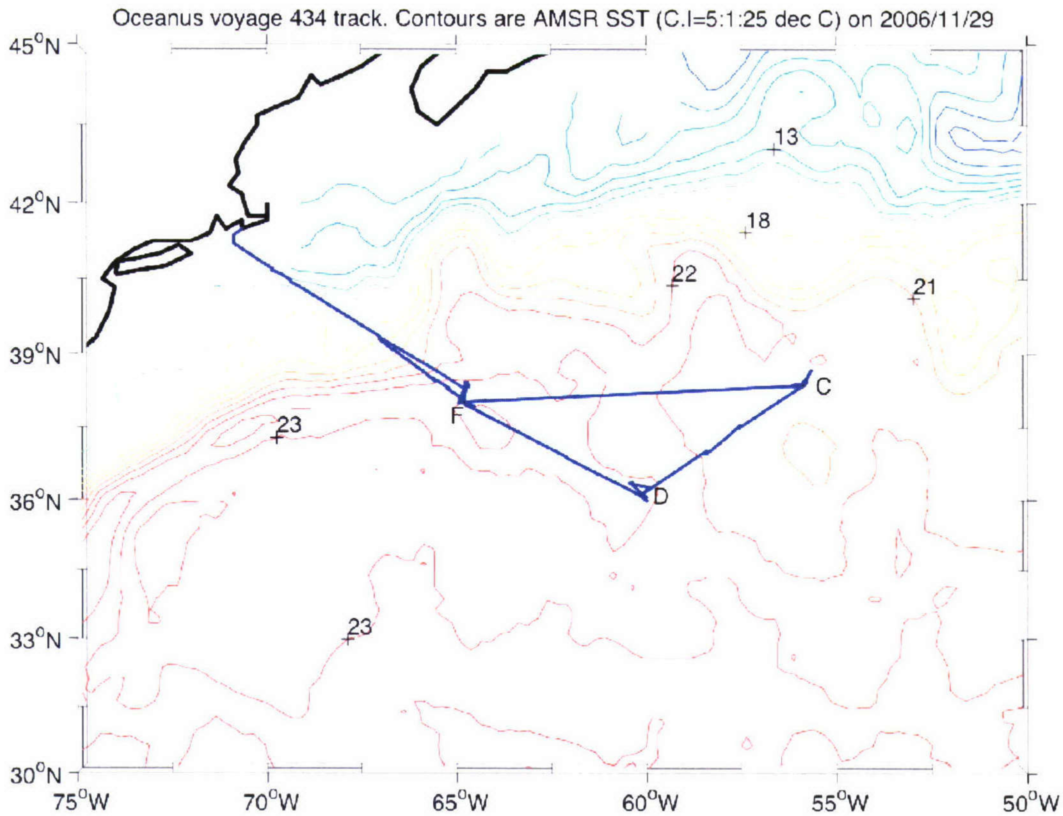


Figure 1.1: Ship's track for *Oceanus* voyage 434, November 2006. F is surface mooring, C and D are subsurface moorings.

II. SURFACE MOORING F

II.A. Overview

The surface mooring is equipped with meteorological instrumentation, including two Air-Sea Interaction METeorology (ASIMET) measuring systems. A third set of ASIMET instruments (without precipitation sensor) is also installed in standalone mode, which is self powered, records data internally on the module flashcards and does not transmit data to satellites as opposed to the two primary systems. The mooring line also carries current meters in the upper 20m, temperature sensors down to approximately 660m depth as well as conductivity and pressure 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. The fan mounted on the buoy has a larger surface area compared to the Climode 1 buoy for a better orientation of the wind sensors into the wind. However it was observed during this cruise that in some situations the buoy was oriented with the strong current rather than the wind. Fig 2.1 shows the design of the Climode mooring and the oceanographic sensors attached to it. The mooring design is similar to Climode 1.

Appendix 1 contains the burn-in notes for Climode 2 buoy and the buoy spin made on 2006/11/10. The buoy spin shows that the wind sensors were within +/- 5 degrees of the reference heading. (See Figure A.1, Appendix 1.)

Appendix 2 has the surface mooring logs for recovery and deployment of Climode 1 and 2.

PO # 1187

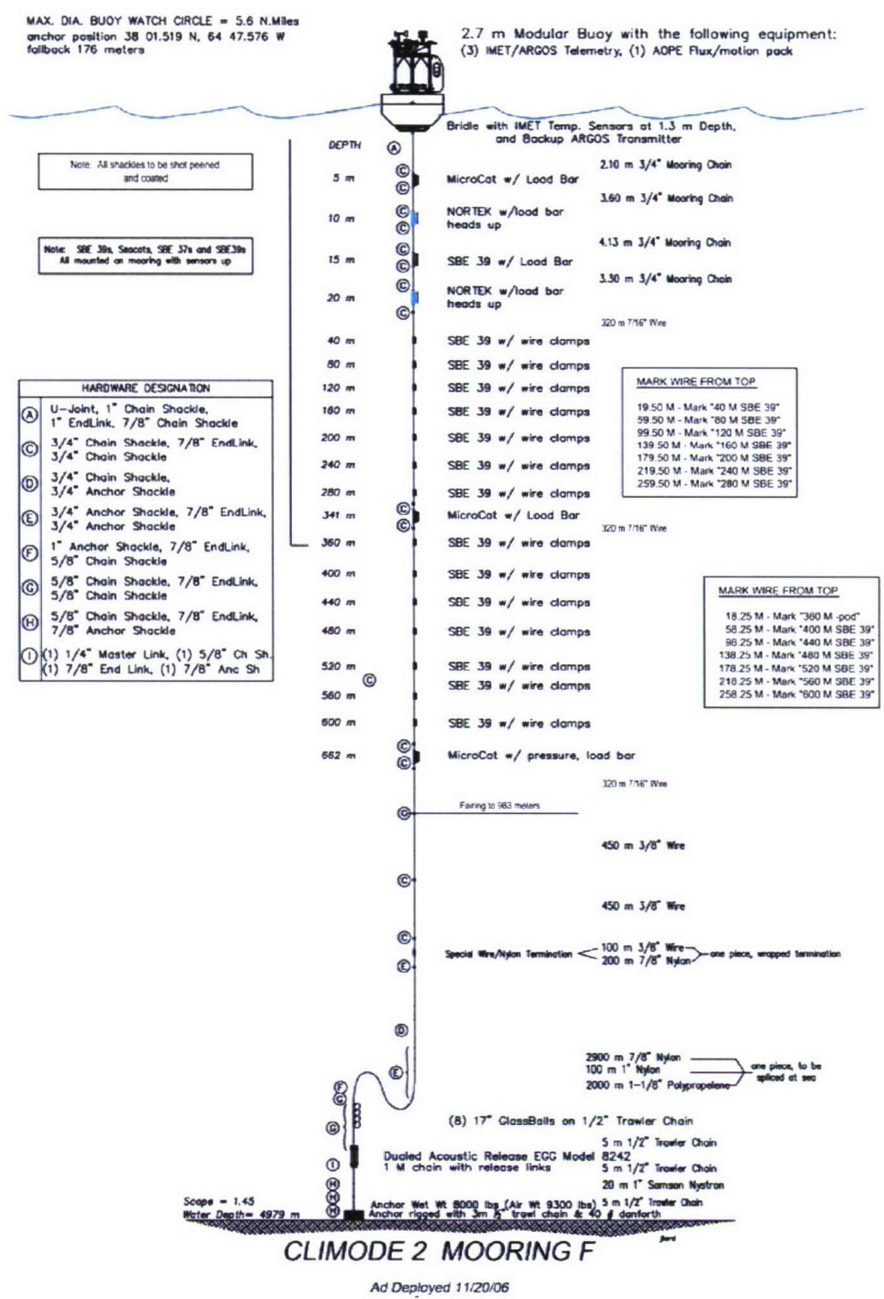


Figure 2.1: Climode 2 surface mooring design

II.B. Surface Instruments

There are two independent ASIMET systems on the buoy that measure the following parameters once per minute and transmit hourly averages via Argos satellite:

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

All ASIMET modules are modified for lower power consumption so that a non-rechargeable alkaline battery pack can be used. Further information on the ASIMET systems can be found at http://frodo.whoi.edu/asimet/. 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 ASIMET modules as well as optional PTT or internal barometer or internal A/D board. All modules are sampled at the start of each minute. This data is temporarily stored in the buffer of the module flashcard. The logger polls the data in the buffer each minute, records it and timestamps according to the logger clock. When the buffer contains an hour of data, it is recorded on the module flashcard and the buffer is erased for the next hour of data. This redundancy allows data to be saved on the logger should a power outage in the module erase a 1 hour long record in the buffer. 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-transmitter (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 ASIMET 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 ASIMET 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 ASIMET systems, there is a partial suite of standalone modules that record internally. These include HRH, LWR, WND, SWR, and BPR.

A Direct Covariance Flux System (DCFS) provided by Jim Edson of University of Connecticut is also mounted on the buoy. This 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, a 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. There is no high frequency LICOR humidity sensor.

II.C. Subsurface Instruments

The following instruments are placed on the buoy bridle and mooring line:

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.

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 +35°C, 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.

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

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. It is deployed with an additional fin to orient and stabilize the instrument in the current. It also records at a high frequency rate in bursts mode for quality control of data and noise evaluation.

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.

II.D. Climode 1 Recovery

II.D.1. Mooring Recovery

Climode 1 surface mooring was recovered on November 19, 2006.

The CLIMODE 1 surface mooring was recovered buoy-first, as the mooring design did not include backup floatation that would allow for the traditional buoy last recovery.

The LEBUS winch, air tuggers, the ship's capstan and assorted WHOI deck lines and hooks were used during the recovery. The winch leader was led through a mooring block hung on the starboard wing of the A-frame, and led forward on the starboard side. Two pieces of removable bulwark were removed from the starboard side, just aft of the winch. Air tuggers were positioned to achieve control of the buoy as it was brought onto the deck. The ship's crane was positioned with the block on the starboard side.

The *Oceanus* was positioned downwind from the buoy. The acoustic release was ranged and fired, releasing the mooring from its anchor. The ship held position near the buoy while continued acoustic ranging confirmed that the release was free of the anchor. Once the release was confirmed, the ship approached the buoy on the starboard side. With moderate winds and current, the approach to the buoy was not easy. On the third attempt, using a pickup pole and hook, the buoy was secured. The soft eye on the pickup pendant was attached to the hook on the ships crane.

At this point, the buoy was lifted from the water and brought up against the side of the ship so tugger lines could be attached. Once the air tugger lines were attached to the buoy well, tower, and base, the buoy was lifted onto the deck. All tugger lines were kept tight as the buoy was maneuvered into position on the deck.

A bull rope on the capstan was shackled into the 2-meter shot of chain just below the buoy. The tension of the mooring was taken up on the capstan to create enough slack to disconnect the mooring from the bottom of the buoy. Once the buoy was free of the mooring, it was moved inboard and secured to the deck.

The crane was used to make vertical picks of the mooring on the starboard side. Each instrument, with a shot of chain, was raised above the level of the deck. The bull rope on the capstan was used to stop off below each instrument so it could be lowered to the deck and disconnected.

After the 20 meters of instruments and chain was removed from the mooring line, the winch leader was shackled into the top of the 320 meter shot of 7/16" wire rope. The capstan eased off and the mooring line, winch leader, and bull rope transitioned back to the stern, with the winch taking the mooring tension. The bull rope was removed. The winch hauled in on the wire, very slowly, as the plastic fairing was removed from the wire.

SBE 39 temperature loggers, clamped to the wire, were removed as they were brought up over the stern. At the end of the first two 320 meter sections of wire, the terminations were stopped off to the deck and the SBE 37 MicroCats on strong backs were removed from the mooring line. As the termination of each shot of wire passed through the drums of the LEBUS winch, the mooring was stopped off with a Yale grip while the reels of wire were removed from the reel handler, and a new reel was inserted.

When all of the 7/16" and 3/8" wire rope had been recovered onto reels, the LEBUS winch was used to recover the synthetic line used in the mooring. The synthetic line was pulled through the LEBUS drums, but instead of being wound onto reels, it was passed up to the 01 deck and loaded into five wire baskets.

The last part of the mooring to recover was the eight glass balls and two acoustic releases. The glass balls, bolted to ½" chain, were shackled to a thimble at the end of the polypropylene line. When the end of the poly line was above the transom, a stopper line to the deck was attached to the termination at the end of the poly. The termination was disassembled and the poly was pulled through the block. The poly was shackled back onto the chain and the winch pulled up, dragging the glass balls onto the deck.

The deck stopper line was moved to the five-meter shot of chain above the releases. The glass balls were disconnected. A chain hook, connected to the air tugger on the A-frame, was connected to the chain about two meters down from the end. The air tugger was used to lift the chain and acoustic releases on board. This completed the recovery.

II.D.2. Time Spikes

Instruments clocks are set to UTC before each deployment. Upon recovery, these clocks are compared to UTC to check for their drift. Furthermore, before deployment and after recovery, a signal is physically introduced in the data records of instruments to check for its clock drift. Solar radiation sensors are covered with a bag, subsurface temperature sensors are plunged in a bucket of water and ice, precipitation gauges are filled up. These procedures are summarized in the following tables.

Table 2.1: Surface instruments post recovery clock checks for Climode 1.

Type	Serial #	Instr. Clock	Time UTC	Records	Notes
HRH	502	12/6/2006 14:16:42	12/6/2006 14:10:30	961	
HRH	225	12/7/2006 16:36:32	12/7/2006 16:37:00	2231	
HRH	222	12/7/2006 18:07:54	12/7/2006 17:46:30	1534	
BPR	218	12/6/2006 14:41:17	12/6/2006 14:31:45	4859	
BPR	502	12/7/2006 13:54:11	12/6/2006 13:47:30	5709	
BPR	210	10/22/1980 34:32:03	12/7/2006 14:14:00	13656	
WND	213	12/6/2006 16:39:26	12/6/2006 16:31:45	531	
WND	345				Flooded
WND	217	12/8/2006 11:52:40	12/8/2006 11:52:00	5702	~1/2 tsp water inside
PRC	502	12/7/2006 11:19:24	12/7/2006 13:05:00	13075	
PRC	211	12/7/2006 13:26:49	12/7/2006 13:29:00	5708	
LWR	210	12/6/2006 19:32:49	12/6/2006 19:25	9568	
LWR	211	12/6/2006 19:13:22	12/6/2006 19:00	10555	
LWR	216	12/6/2006 19:32:52	12/6/2006 19:39:30	9568	
SWR	214	12/6/2006 18:07:17	12/6/2006 18:06	9496	
SWR	202			10704	No comms.
SWR	506	12/6/2006 18:53:19	12/6/2006 18:40:30	9681	

Table 2.2: Subsurface instruments recovery clock checks and time spikes for Climode 1.

Instrument	Serial	Depth (m)	Spike Start (UTC)	Spike Stop (UTC)	Instrument Clock	Reference (UTC)
SBE37 (SST)	1840	Bridle	11/21/06 17:55:00	11/21/06 18:59:00	12/05/06 17:45:16	12/05/06 17:44:30
SBE37 (SST)	1839	Bridle	11/21/06 17:55:00	11/21/06 18:59:00	12/05/06 20:37:47	12/05/06 20:36:30
SBE37	9	5	11/20/06 21:49:00	11/21/06 00:37:00	01/14/80 21:46:51	12/04/06 19:36:00
SBE37	10	341	11/20/06 21:49:00	11/21/06 00:37:00	12/04/06 17:32:41	12/04/06 17:33:45
SBE37 (pressure)	3733	662	11/20/06 21:49:00	11/21/06 00:37:00	12/04/06 19:45:05	12/04/06 19:43:00
SBE39	1498	15	11/20/06 20:25:00	11/20/06 21:47:00	11/29/06 03:43:15	11/29/06 03:42:30
SBE39	1504	40	11/20/06 20:25:00	11/20/06 21:47:00	11/29/06 20:44:27	11/29/06 20:43:30
SBE39	1499	80	11/20/06 20:25:00	11/20/06 21:47:00	11/30/06 01:08:43	11/30/06 01:08:00
SBE39	1512	120	11/20/06 20:25:00	11/20/06 21:47:00	11/29/06 02:16:12	11/29/06 02:15:30
SBE39	1500	160	11/20/06 20:25:00	11/20/06 21:47:00	11/29/06 22:09:45	11/29/06 22:09:00
SBE39	1506	200	11/20/06 20:25:00	11/20/06 21:47:00	11/29/06 23:31:58	11/29/06 23:31:20
SBE39	1508	240	11/20/06 20:25:00	11/20/06 21:47:00	11/29/06 20:08:47	11/29/06 20:08:00
SBE39	1509	280	11/20/06 20:25:00	11/20/06 21:47:00	11/29/06 03:14:29	11/29/06 03:13:30
SBE39	1511	360	11/20/06 20:25:00	11/20/06 21:47:00	11/29/06 02:40:18	11/29/06 02:39:40
SBE39	1501	400	11/20/06 20:25:00	11/20/06 21:47:00	11/29/06 01:30:18	11/29/06 01:29:30
SBE39	1502	440	11/20/06 20:25:00	11/20/06 21:47:00	11/29/06 19:34:43	11/29/06 19:33:40
SBE39	1507	480	11/20/06 20:25:00	11/20/06 21:47:00	11/29/06 11:49:55	11/30/06 00:37:30
SBE39	1510	520	11/20/06 20:25:00	11/20/06 21:47:00	11/30/06 00:07:11	11/30/06 00:06:40
SBE39	1503	560	11/20/06 20:25:00	11/20/06 21:47:00	11/29/06 21:34:08	11/29/06 21:33:00
SBE39	1505	600	11/20/06 20:25:00	11/20/06 21:47:00	11/28/06 22:18:30	11/28/06 22:17:32
Nortek ADCP	1666	10	11/20/06 20:20:00	11/21/06 00:35:00	12/04/06 16:55:01	12/04/06 16:54:00
Nortek ADCP	1688	20	11/20/06 20:20:00	11/21/06 00:35:00	12/04/06 16:33:08	12/04/06 16:32:00

Table 2.3: Surface instruments recovery time spikes for Climode 1.

	Start Spike		End Spike	
SWR 202,506,201	11/21/06	17:41	11/21/06	18:50
LWR 216,211,210	11/21/06	17:41	11/21/06	18:50
SBE37_1840_SST	11/21/06	17:55	11/21/06	18:59
SBE37_1839_SST	11/21/06	17:55	11/21/06	18:59
PRC Fill/Drain 8oz	11/21/06	17:46	11/21/06	

II.D.3. Instruments Performance

All the subsurface instruments had a return data rate of 100% (see Table 2.4). However, SBE 37 #09 had an internal date of January 14, 1980, upon recovery, indicating it had lost power during deployment. We could not retrieve any data from its memory card and sent it back to Seabird. It was then sent back to us and it appeared that the clock's crystal had been broken which Seabird replaced. Data was also recovered up to January 19, 2006, which is when the buoy was hit by a ship. The clock's crystal was probably broken during the collision. Conductivity data from SBE37 #10 is valid for only a few hours after deployment; its temperature record is also suspicious, with values sometimes much lower than instruments at lower depths (see Figure 2.2). Also, SBE39 #1507 had a return data rate of 99.86%, based on the sampling rate set at 1 sample / 5mn and the logging duration. This is because its clock was not reset before deployment and lagged real time by 770 minutes (it is also possible that a 12 hours offset was introduced during setup by a confusion between 13pm and 1pm). Therefore, its startup logging time being set using its internal clock, it started logging data almost 12.8 hours after other instruments which corresponds to about 154 samples.

Many flashcards from the surface modules had partial data or corrupted data. However, the data return from the loggers was good and allowed a continuous record on Climode 1, except for wind data (Fig 2.3 and 2.4). The R. M. Young anemometers suffered several failures due to weather, sea conditions and a collision with a ship on January 19, 2006. Fortunately, the DCFS sonic wind sensor also provides data that can be used to fill in some gaps in the anemometer data record.

Table 2.4. Subsurface Climode 1 setup and record length.

Instrument	Serial	Depth Meters	Sample (mn)	Start Logging	Stop Logging	Number Records
SBE37 (SST)	1840	Bridle	5	11/02/05 01:00:00	12/05/06 17:45:30	114826
SBE37 (SST)	1839	Bridle	5	11/02/05 01:00:00	12/05/06 20:37:00	114860
SBE37	9	5	5	11/01/05 01:00:00	N/A	0
SBE37	10	341	5	11/01/05 01:00:00	12/04/06 17:34:30	114823
SBE37 (pressure)	3733	662	5	11/01/05 01:00:00	12/04/06 19:43:30	114849
SBE39	1498	15	5	11/01/05 01:00:00	11/29/06 03:43:20	113217
SBE39	1504	40	5	11/01/05 01:00:00	11/29/06 20:44:40	113421
SBE39	1499	80	5	11/01/05 01:00:00	11/30/06 01:10:00	113474
SBE39	1512	120	5	11/01/05 01:00:00	11/29/06 02:16:11	113200
SBE39	1500	160	5	11/01/05 01:00:00	11/29/06 22:10:00	113438
SBE39	1506	200	5	11/01/05 01:00:00	11/29/06 23:32:10	113455
SBE39	1508	240	5	11/01/05 01:00:00	11/29/06 20:09:00	113414
SBE39	1509	280	5	11/01/05 01:00:00	11/29/06 03:16:00	113211
SBE39	1511	360	5	11/01/05 01:00:00	11/29/06 02:40:20	113204
SBE39	1501	400	5	11/01/05 01:00:00	11/29/06 01:30:20	113190
SBE39	1502	440	5	11/01/05 01:00:00	11/29/06 19:34:40	113407
SBE39	1507	480	5	11/01/05 01:00:00	11/30/06 00:38:40	113314
SBE39	1510	520	5	11/01/05 01:00:00	11/30/06 00:07:40	113462
SBE39	1503	560	5	11/01/05 01:00:00	11/29/06 21:34:01	113431
SBE39	1505	600	5	11/01/05 01:00:00	11/28/06 22:19:00	113152
Nortek ADCP	1666	10	15	11/01/05 01:00:00	12/04/06 16:54:00	3644556
Nortek ADCP	1688	20	15	11/01/05 01:00:00	12/04/06 16:32:00	3644514

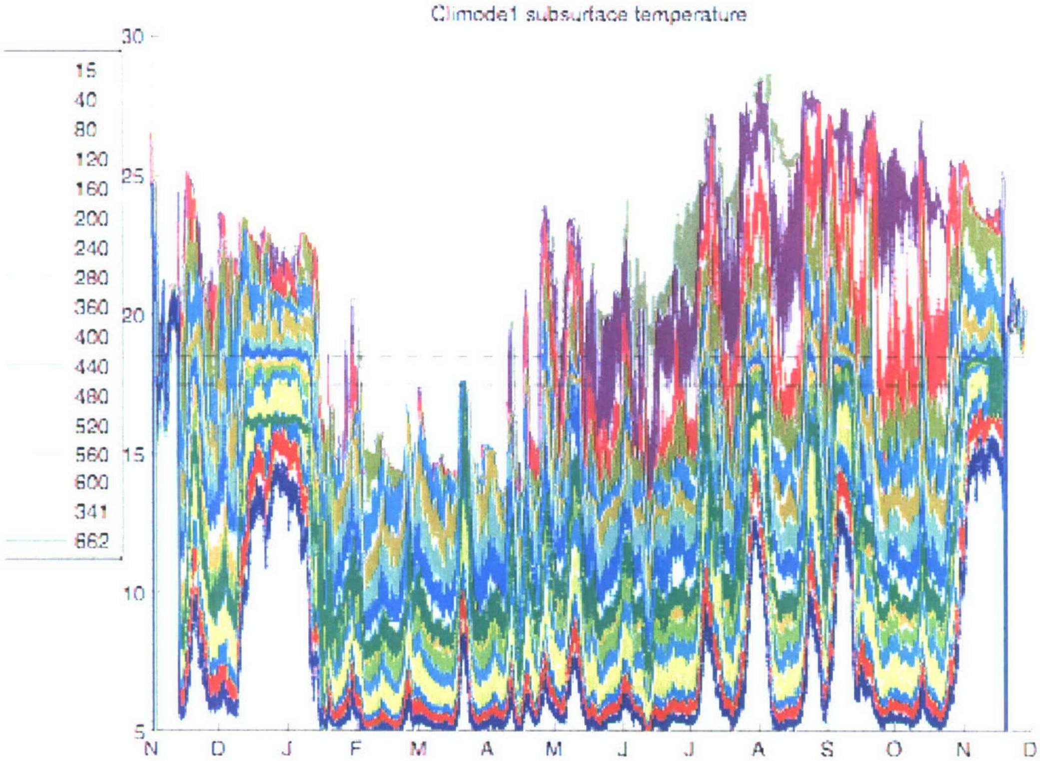


Figure 2.2: Climode 1 subsurface temperature data from instruments between 15 and 662 m depth.

The other sensor that tended to be less reliable was the humidity sensor. From November 2005 to mid December 2005, the 3 instruments worked well, then the standalone failed. In early January 2006, HRH on logger 14 failed. Only HRH #222 (logger 15) has records from early Jan 2006 to mid-April 2006. In mid April 2006, HRH #214 was replaced by HRH #225 (logger 14). Unfortunately its data started drifting two weeks later. Thus, only one HRH (SN 222, on logger 15) recorded values throughout the whole deployment. Air temperature is measured from the HRH units and followed the same pattern.

The radiation sensors performed well and recorded continuously throughout the deployment. However the downward longwave radiation sensors exhibit large biases which also vary seasonally (following the intensity of the LWR signal). LWR on logger 14 (SN216) shows higher values (10 to 25 W/m2 from late winter to late summer) than LWR on logger 15 (SN 210) and lower values (35 to 15 W/m2 from winter to summer and next winter (November 2006), which indicates that the standalone LWR sensor may have started to drift to higher values) than the standalone (SN 210). Comparison of the measurements from the buoy and the sensors onboard the Oceanus shows that data from LWR on logger 14 closely follows data from the LWR on the ship. A postcalibration was done at WHOI for LWR sensors 211 and 216 in September 2007 that indicated they had a high bias of 15 and 6 W/m2 respectively. Thus it appears LWR 216 (on logger 14) had the least bias and should be used as a reference.
Note that the mooring log mentions LWR #210 as the standalone, however when the modules and logger data files were compared it appears that LWR #211 was the standalone and LWR #210 was associated with logger 15.

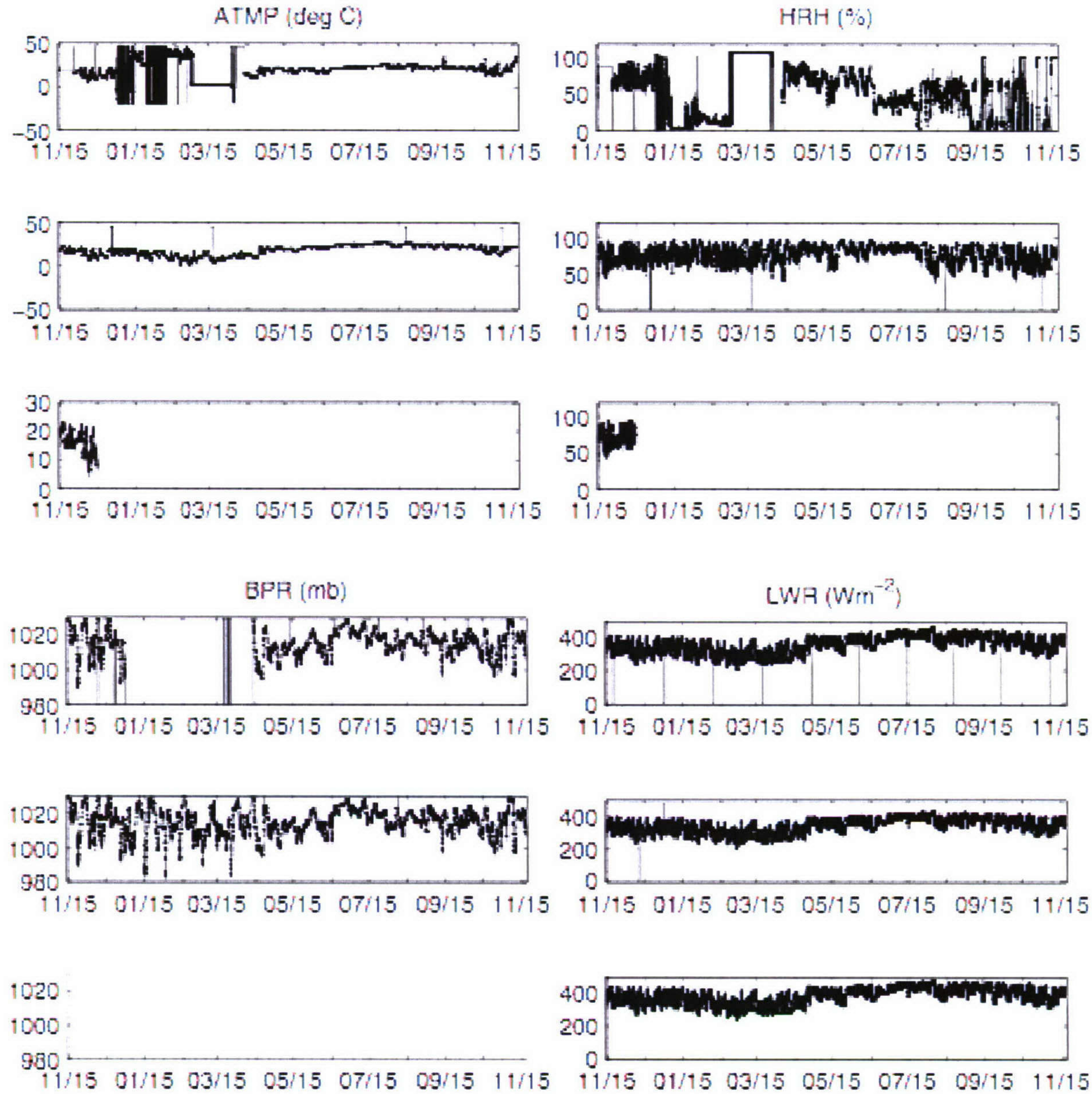


Figure 2.3: Climode 1 surface instruments return. For each subset the order is: logger 14 (top), logger 15 (center), standalone (bottom). Standalone pressure sensor has no record during deployment.

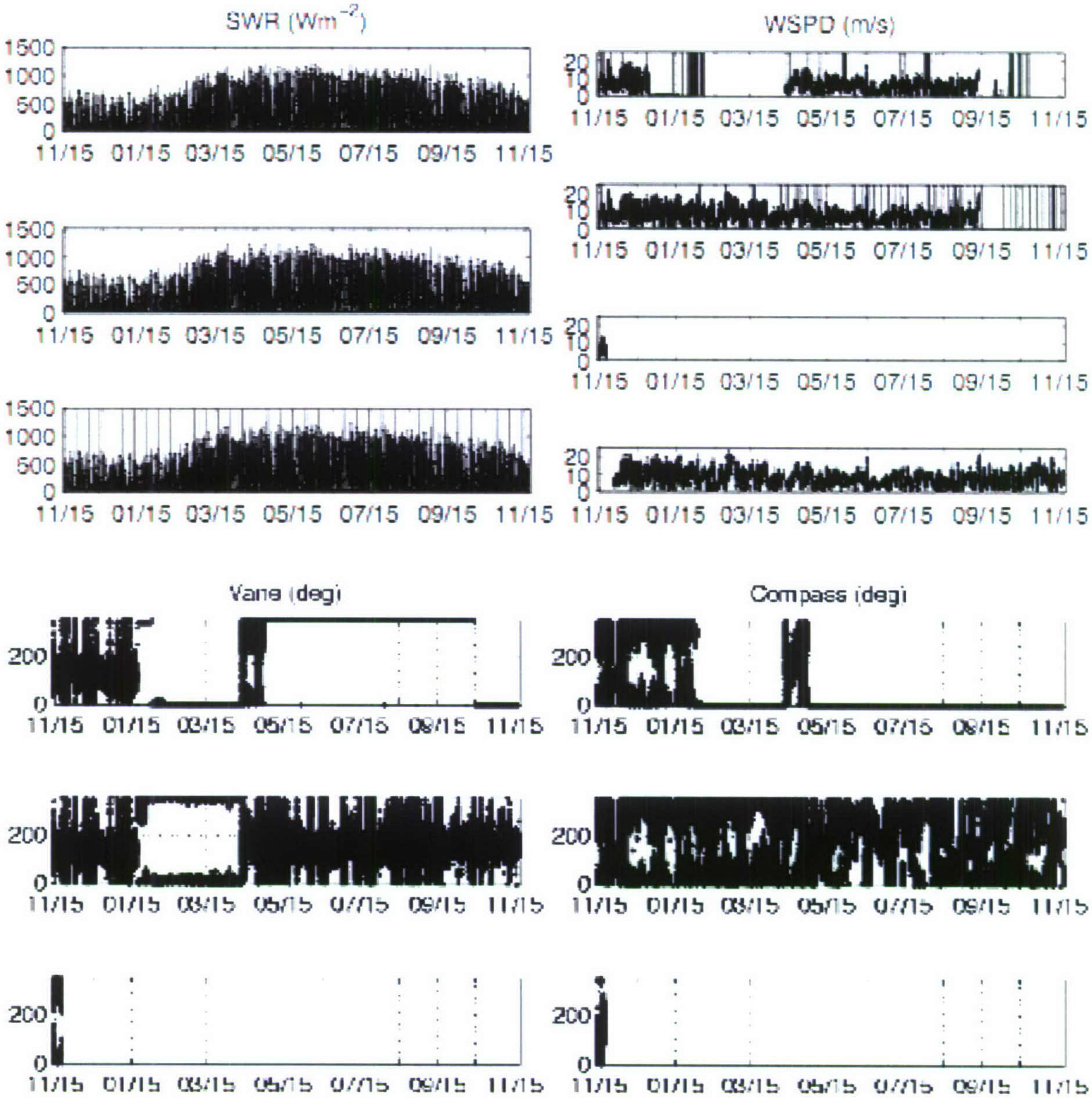


Figure 2.4: Same as Fig. 2.3. Wind Speed (WSPD) has an extra data at the bottom for the DCFS.

II.E. Climode 2

Climode 2 surface mooring was deployed on November 20, 2006, and broke free on January 31, 2007. The surface buoy and subsurface instruments were recovered on February 9, 2007, during cruise *Knorr* 188 (leg 1).

II.E.1. Climode 2 instrumentation set up.

The following tables show the instrumentation set up on the mooring: serial numbers and heights of surface instruments (Table 2.5), sampling and data return for subsurface and surface instruments (Tables 2.6, 2.7).

Table 2.5: Climode 2 surface hardware and firmware set up.

System 1				
Module	**Serial**	**Firmware Version**	**Height Cm**	
Logger	L-17	LOGR53 V2.70		
HRH	223	VOS HRH53 V3.2	238	230 mid shield
BPR	202	VOS BPR53 V3.3	237.5	240 inside tower
SWND	201	VOS WND53 V3.0 ?	265.5	268 head transducer
PRC	210	VOS PRC53 V3.4	235.5	235 bottom cup
LWR	212	VOS LWR53 V3.5	285	283 bottom dome
SWR	211	VOS SWR53 V3.3	285	283 bottom dome
SST	1305	SBE 37	-149	-151
PTT	67718	27906, 27907, 27908		
System 2				
Module	**Serial**	**Firmware Version**	**Height Cm**	
Logger	L-18	LOGR53 V2.71		
HRH	226	VOS HRH53 V3.2	238	230 mid shield
BPR	503	VOS BPR53 V3.3	237.5	238 inside tower
WND	225	VOS WND53 V3.5	265.5	266 mid prop
PRC	209	VOS PRC53 V3.4	234.5	234 bottom cup
LWR	505	VOS LWR53 V3.5	285	283 bottom dome
SWR	502	VOS SWR53 V3.3	285	283 bottom dome
SST	1838	SBE 37	-149	-151
PTT	18136	25078,27969, 27634, 27669		
Stand-Alone Module(s)				
Module	**Serial**		**Height Cm**	
HRH	230			238
BPR	202			238
SWR	222			283
LWR	208			283
WND	205			267
DCFS	1			303 mid volume
Sub ARGOS	268	Id=25702		

Table 2.6: Climode 2 subsurface sampling period and data return.(** SBE39 #54 was missing upon recovery. *Nortek samples including burst mode).

Type	SN	Depth (m)	Setup Time	Start UTC	Stop UTC	Samples	Data return %
SBE 39	35	560	11/15/06 11:22:21	11/15/06 18:00:00	02/10/07 17:48:00	25053	100
	38	40	11/15/06 12:22:06	11/15/06 18:00:00	02/10/07 21:26:00	25098	100
	39	80	11/15/06 12:52:58	11/15/06 18:00:00	02/10/07 22:03:40	25105	100
	40	120	11/15/06 11:12:22	11/15/06 18:00:00	02/10/07 22:56:40	25116	100
	41	160	11/15/06 11:17:05	11/15/06 18:00:00	02/10/07 23:22:30	25120	100
	42	200	11/15/06 11:07:11	11/15/06 18:00:00	02/11/07 00:09:40	25130	100
	44	240	11/15/06 11:27:05	11/15/06 18:00:00	02/11/07 00:32:45	25135	100
	45	280	11/15/06 12:17:32	11/15/06 18:00:00	02/11/07 02:05:45	25154	100
	46	360	11/15/06 11:01:40	11/15/06 18:00:00	02/11/07 02:37:45	25160	100
	47	400	11/15/06 10:57:15	11/15/06 18:00:00	02/11/07 03:29:30	25170	100
	50	440	11/15/06 12:33:37	11/15/06 18:00:00	02/11/07 12:19:40	25276	100
	51	480	11/15/06 12:38:56	11/15/06 18:00:00	02/11/07 13:27:30	25290	100
	101	600	11/15/06 12:12:39	11/15/06 18:00:00	02/11/07 15:32:25	25315	100
	53	520	11/15/06 12:48:16	11/15/06 18:00:00	02/11/07 14:52:30	25307	100
	54 **	15	11/15/06 11:32:54	11/15/06 18:00:00	N/A	N/A	0
SBE 37	11	5	10/24/06 15:15:40	11/04/06 01:00:00	02/11/07 16:37:50	28700	100
	1907	341	10/24/06 15:00:43	11/04/06 01:00:00	02/11/07 17:11:30	28707	100
	3639	662	10/24/06 13:56:07	11/04/06 01:00:00	02/11/07 17:40:30	28712	100
Nortek	2064	10	10/23/06 17:01:42	11/04/06 01:00:00	02/11/07 19:15:00	9577 *910878	100
	2082	20	10/23/06 12:15:58	11/04/06 01:00:00	02/11/07 19:27:00	9578 *910920	100

Table 2.7: Climode 2 surface sampling period and data return.

Instrument	SN	Clock Set at (UTC)	Start	Stop	Records	Comment
System 1	L 17	11/11/06 12:40:00		03/23/2007 14:27:30	192800	
System 2	L 18	11/11/06 12:45:00		03/23/2007 14:32:00	194513	
SYSTEM 1						
HRH	223				3167	
BPR	202				3168	
SWND	201					not responding
PRC	210				3167	
LWR	212				3164	
SWR	211				3166	
SST	1305	11/07/06 19:42:46	11/07/06 17:00:00	03/26/2007 17:39:30	40023	
SYSTEM 2						
HRH	226					not responding
BPR	503				3168	
WND	225				3160	
PRC	209				3158	damaged
LWR	505				3144	
SWR	502				508	
SST	1838	11/07/06 19:42:13	11/07/06 17:00:00	03/26/2007 18:48:30	40037	
Stand Alones						
HRH	230				1951	
BPR	202				3360	
SWR	222				4487	
LWR	208				2974	
WND	205				2849	
DCFS						

II.E.2. Time Spikes

Instruments deployed on Climode 2 were submitted to time spikes before deployment and after recovery to be able to correct for any error in the clock set up and checks. These are shown in Table 2.8 and 2.9 for subsurface and surface instruments at recovery and in Table 2.10 before deployment.

Table 2.8: Climode 2 subsurface clock checks and spikes (* SBE39 #54 was missing upon recovery).

		Clock Checks		Post Recovery Spike		Pre Deployment Spike	
Type	SN	Time UTC	Time Instr.	Time In	Time Out	Time In	Time Out
SBE 39	35	02/10/07 17:47:00	02/10/07 17:47:11	02/09/07 22:33:00	02/10/07 01:30:00	11/15/06 18:30:30	11/15/06 19:30:30
	38	02/10/07 21:25:00	02/10/07 21:25:16	02/09/07 22:33:00	02/10/07 01:30:00	11/15/06 18:30:30	11/15/06 19:30:30
	39	02/10/07 22:03:00	02/10/07 22:03:17	02/09/07 22:33:00	02/10/07 01:30:00	11/15/06 18:30:30	11/15/06 19:30:30
	40	02/10/07 22:56:00	02/10/07 22:56:15	02/09/07 22:33:00	02/10/07 01:30:00	11/15/06 18:30:30	11/15/06 19:30:30
	41	02/10/07 23:22:00	02/10/07 23:22:15	02/09/07 22:33:00	02/10/07 01:30:00	11/15/06 18:30:30	11/15/06 19:30:30
	42	02/11/07 00:09:00	02/10/07 00:09:14	02/09/07 22:33:00	02/10/07 01:30:00	11/15/06 18:30:30	11/15/06 19:30:30
	44	02/11/07 00:32:00	02/11/07 00:32:13	02/09/07 22:33:00	02/10/07 01:30:00	11/15/06 18:30:30	11/15/06 19:30:30
	45	02/11/07 02:05:00	02/11/07 02:05:14	02/09/07 22:33:00	02/10/07 01:30:00	11/15/06 18:30:30	11/15/06 19:30:30
	46	02/11/07 02:37:00	02/11/07 02:37:12	02/09/07 22:33:00	02/10/07 01:30:00	11/15/06 18:30:30	11/15/06 19:30:30
	47	02/11/07 03:29:00	02/11/07 03:29:13	02/09/07 22:33:00	02/10/07 01:30:00	11/15/06 18:30:30	11/15/06 19:30:30
	50	02/11/07 12:19:00	02/11/07 12:19:11	02/09/07 22:33:00	02/10/07 01:30:00	11/15/06 18:30:30	11/15/06 19:30:30
	51	02/11/07 13:27:00	02/11/07 13:27:13	02/09/07 22:33:00	02/10/07 01:30:00	11/15/06 18:30:30	11/15/06 19:30:30
	101	02/11/07 15:32:00	02/11/07 15:32:12	02/09/07 22:33:00	02/10/07 01:30:00	11/15/06 18:30:30	11/15/06 19:30:30
	53	02/11/07 14:52:00	02/11/07 14:52:13	02/09/07 22:33:00	02/10/07 01:30:00	11/15/06 18:30:30	11/15/06 19:30:30
	54 *	N/A	N/A	N/A	N/A	11/15/06 18:30:30	11/15/06 19:30:30
SBE 37	11	02/11/07 16:37:00	02/11/07 16:36:47	02/09/07 22:33:00	02/10/07 01:30:00		
	1907	02/11/07 17:11:00	02/11/07 17:11:31	02/09/07 22:33:00	02/10/07 01:30:00		
	3639	02/11/07 17:40:00	02/11/07 17:40:28	02/09/07 22:33:00	02/10/07 01:30:00		
Nortek	2064	02/11/07 19:17:00	02/11/07 19:17:30	02/09/07 22:33:00	02/10/07 01:30:00		
	2082	02/11/07 19:27:30	02/11/07 19:28:13	02/09/07 22:33:00	02/10/07 01:30:00		

Table 2.9: Climode 2 recovery surface clock check and spikes.

		Recovery Clock Check		Recovery Spikes	
		Time UTC	**Time Instr.**	**Spike IN**	**Spike OUT**
System 1	L 17	03/23/2007 14:28:30	03/23/2007 14:32:26		
System 2	L 18	03/23/2007 14:32:00	03/23/2007 14:33:34		
SYSTEM 1					
HRH	223	03/28/2007 17:27:40	03/28/2007 17:32:28		
BPR	202	03/28/2007 13:34:30	03/28/2007 13:31:22		
SWND	201				
PRC	210	03/28/2007 14:15:10	03/28/2007 14:20:24	03/23/2007 13:05:30	fill/drain
LWR	212	03/28/2007 18:15:15	03/28/2007 18:14:42	03/23/2007 13:01:30	03/23/2007 13:32:30
SWR	211	03/28/2007 18:43:10	03/28/2007 18:45:18	03/23/2007 13:01:30	03/23/2007 13:32:30
SST	1305	03/26/2007 17:38:00	03/26/2007 17:38:08	03/22/2007 20:01:30	03/22/2007 20:50:30
SYSTEM 2					
HRH	226				
BPR	503	03/28/2007 13:44:30	03/28/2007 13:47:04		
WND	225	03/28/2007 17:13:00	03/28/2007 17:15:43		
PRC	209	03/28/2007 13:03:20	03/28/2007 14:07:47	03/23/2007 13:04:30	fill/drain
LWR	505	03/28/2007 18:36:10	03/28/2007 18:38:38	03/23/2007 13:01:30	03/23/2007 13:32:30
SWR	502	03/28/2007 18:58:00	03/28/2007 19:01:33	03/23/2007 13:01:30	03/23/2007 13:32:30
SST	1838	03/26/2007 18:46:30	03/26/2007 18:47:19	03/22/2007 20:01:30	03/22/2007 20:50:30
Standalones					
HRH	230	03/28/2007 17:40:30	03/28/2007 17:42:01		
BPR	202	03/28/2007 13:55:49	03/28/2007 13:59:18		
SWR	222	03/28/2007 18:51:30	03/28/2007 18:57:49	03/23/2007 13:01:30	03/23/2007 13:32:30
LWR	208	03/28/2007 18:07:00	03/28/2007 18:08:21	03/23/2007 13:01:30	03/23/2007 13:32:30
WND	205	03/28/2007 17:00:15	03/28/2007 17:03:37		
DCFS					
Load Cell					

Table 2.10: Climode 2 pre-cruise spikes.

PRC Spike		Fill/Drain	add 100ml	Fill/Drain
System 1	210	11/14/06 12:51:30	11/14/06 15:44:30	11/14/2006 19:04:30
System 2	209	11/14/06 12:48:00	11/14/06 15:42:30	11/14/2006 19:03:30
SST		**Spike IN**	**Spike OUT**	
System 1	1305	11/14/06 13:11:30	11/14/06 14:11:30	
System 2	1838	11/14/06 13:11:30	11/14/06 14:11:30	
Solars		11/16/06 13:08	11/16/06 14:22	

II.E.3. Mooring Deployment

The deployment of surface mooring F was done on November 20, the day following the recovery. This was done instead of having a day in between because of an approaching weather system that might bring high winds and waves. During the recovery of F on November 19, the currents were observed to be flowing south. The ship's Acoustic Doppler profiler showed a surface current of close to 2.5 kts toward 192°. The winds were low. The plan was to run with the current, starting to the north of the area whose bottom was surveyed in November 2005, and thus moving away from a small topographic feature found at that time. The initial plan is shown in Figure 2.5.

As the mooring was deployed and line and instruments deployed behind the ship, it was found that the currents would carry the mooring down onto the ship. In part, this may have happened because the subsurface flow (below 50 m) was even stronger to the SSW than the surface flow. To counter this, the ship's speed over the ground was increased, reaching up to 4.3 kts at times.

This made for a long run to the SSW during the process of getting the mooring over the side. Making use of the bottom survey from the prior year, the deployment track was kept within an area where the bottom was well-known and of suitable depth. In the end the run was 26 nm, as shown in Figure 2.6.

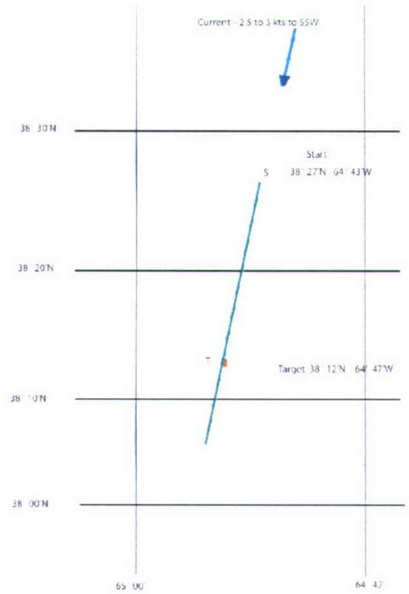


Figure 2.5: Initial plan for deploying F. Target is 15 nm from start along 012°.

Figure 2.6: The track of RV *Oceanus* during the deployment of mooring F and during the subsequent survey of the anchor position. The anchor drop and buoy positions are indicated by blue squares (see next figure for details).

The surface mooring was deployed in a similar fashion to other WHOI surface moorings. This two-phase technique involves 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 off the stern using the A-frame.

One significant deviation from the traditional UOP moorings was the attachment of approximately 960 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 enough wire to get some load under the buoy before the ship started towing. The remaining fairing was installed, piece by piece, on the three 320 meters shots of wire, after the wire passed through a traveling block on the A-frame. Two MicroCats mounted on titanium strong backs were inserted between 320 shots of wire at 341 and 662 meters. Fourteen SBE 39 temperature loggers were attached to the 7/16" wire rope at selected depths from 40-600 meters.

The three reels (960 meters) of 7/16" wire rope, and 2 reels (900 meters) of 3/8" wire rope were deployed using the LEBUS mooring winch. Another reel, containing the final 100 meter shot of 3/8" wire, and a transitional 200 meter shot of 7/8" nylon line was also payed out using the LEBUS. The nylon was stopped with a Yale grip and dressed onto the H-bit. The end was spliced into the 3000 meters of nylon and 2000 meters of polypropylene line in 4 wire baskets on the 01 deck. This 5200-meter continuous piece of synthetic line was payed out over the H-bit to control payout speed and maintain control of the mooring load. Cooling water was sprayed onto the H-bit while the line was being payed out.

Eight glass balls on ½" mooring chain were attached to the mooring under the end of the polypropylene section. These were deployed using a stopper line and the winch to ease them across the deck and over the stern. Below the glass balls were the dual acoustic releases and the anchor. Once the tension of the mooring was passed to the anchor, the ship's crane was used to lift a tip plate and deploy the anchor.

II.E.4. Anchor Survey

A 3-point anchor survey was conducted after allowing an hour for the anchor to fall to the bottom. Anchor drop was at 38°01.587'N, 64°47.491'W in a water depth that read as 4937 m on the 12 KHz Knudsen (using 1500 m s-1) and corrected using Matthews Tables to 4979 m. The surveyed anchor position was 38°01.519'N, 64°47.576'W. The difference between the two positions, or the fallback of the anchor, was 177 m or 3.5%.

Figure 2.7 shows the acoustic survey in more detail, with 3 survey points occupied for acoustic ranging. The acoustic ranging triangulation is shown in Fig. 2.8 and Table 2.11 resumes the anchor survey details.

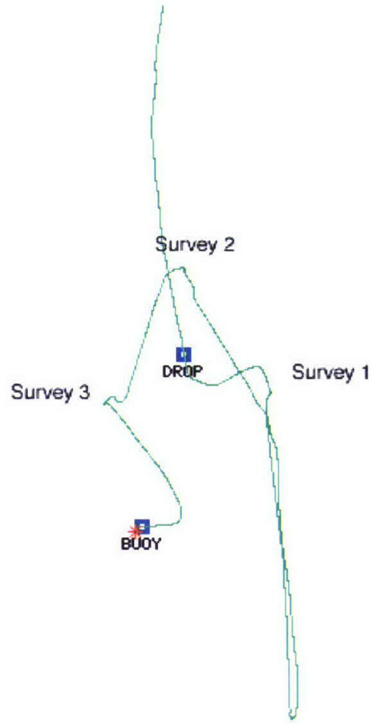


Figure 2.7: Climode 2 F anchor survey track.

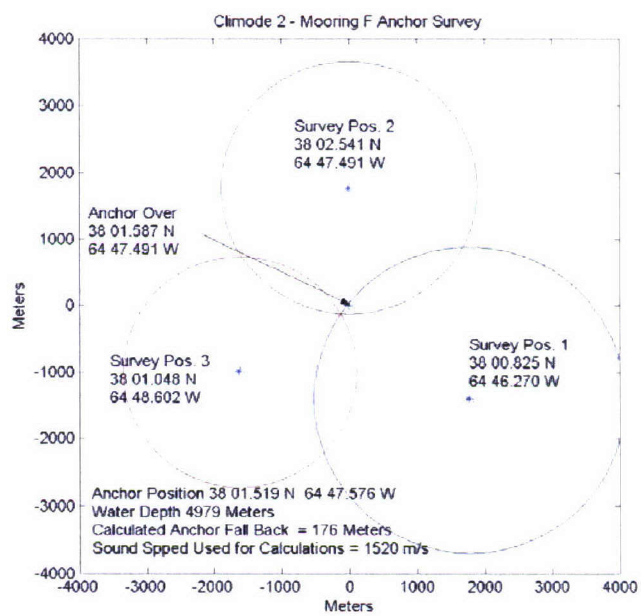


Figure 2.8: Climode 2 F anchor triangulation.

Table 2.11: Climode 2 F anchor survey.

Survey Point	Latitude	Longitude	Slant range (m)	Travel Time (ms)
1	38° 0.825'N	64° 46.270'W	5604	3603
2	38° 2.541'N	64° 47.491'W	5252	3501
3	38° 1.048'N	64° 48.602'W	5194	3463
Anchor drop	38° 1.587'N	64° 47.491'W		
Depth at drop	5077 m			
Anchor location	38° 1.519'N	64° 47.576'W		

III. MEASUREMENTS

III.A. Overview

During the cruise, surface meteorology measurements were made using sensors rigged on the ship. These measurements were also compared to the ones from the buoy once they were available. The UOP also installed 3 ASIMET sensors (BPR 209, LWR 209, HRH 504) in a standalone configuration for *Oceanus* voyage 434. Figure 3.1 shows the ship measurements during the cruise.

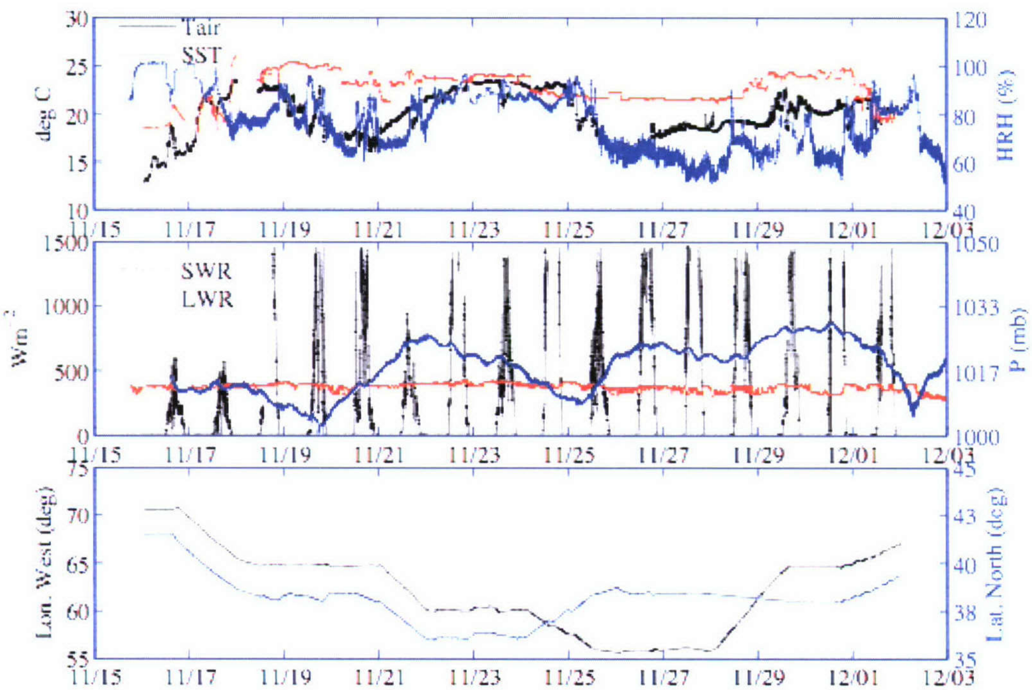


Figure 3.1: *Oceanus* voyage 434 ship measurements. Upper: Tair (black), SST (red) in degrees Celsius. Relative humidity (blue) from HRH 504. Middle: Shortwave (black) and longwave (red) from LWR 209, in W/m^2. Barometric pressure (blue) in mbars from BPR 209. Lower: Ship's position: degrees West (black) and North (blue).

III.B. Instruments Comparisons

Before recovery of Climode 1 and after deployment of Climode 2 the ship was stationed for a period of 24 hours near the buoys for intercomparison of instruments onboard the ship and on the buoys. Table 3.1 shows the clock checks for these 3 standalone units on the *Oceanus*.

Table 3.1: Standalones units mounted on O3 deck rail of *Oceanus* (~10.7m above waterline).

Type	ID	Inst. Clock	Inst. Date	Time UTC	Date UTC	Records
BPR	209	14:29:25	12/05/2010	14:29:00	12/05/2010	432
LWR	209	15:00:53	12/05/2010	15:00:10	12/05/2010	569
HRH	504	15:28:56	12/05/2010	15:27:10	12/05/2010	427

III.B.1. Climode 1

On November 18, R/V *Oceanus* was stationed near Climode 1 at (38°14'N, 64°46'W) and measurements were taken for almost 24 hours. Unfortunately, some of the data gathered by the ship's software was partly lost. This makes the 3 standalones added on the ship for this cruise more valuable. Wind was from the south on November 18 and reversed direction the next day, around 01:00 UTC. The ship was mostly heading south from 09:00 to 17:00, at 21:00 and 24:00 the first day and 04:00 to 05:00 the next day. It was heading north from 21:00 to 04:00 and east from 17:00 to 20:30 and west from 05:00 to 07:00 the next day. The current was relatively weak (~1knot) and shifted from southeastward to mostly at midday on November 18.

The precipitation gauge on Climode 1 buoy was not working properly at the end of the deployment. Both rain gauges did not record correct data for a large part of the year deployment. Precipitation from logger 15 is the better of the two but it started drifting in the winter 2005-2006, probably due to corrosion on the electronic board inside the protective gauge. We use here precipitation data from the *Oceanus* instrument. There is no ASIMET wind speed on the buoy after September 12, 2006, due to tropical storm Florence. Only data on logger 15 has wind direction. Therefore on November 18, we use the ship wind speed (Ship2 in the figures) and precipitation to compensate for the missing data on the buoy. Air temperature and humidity and wind data from ship's sensors are from IMET (Ship1) and Vaisala (Ship2) sensors. The complete data is then used in the COARE 3.0 bulk parameterization code to compute fluxes on that day (Figure 3.2) and to compute bulk variables at a common height of 10m for intercomparison. Most meteorological instruments on the buoy are located between 2.5 and 3.5 meters above the surface (see Table 2.5). The UOP standalones onboard the *Oceanus* (BPR, HRH/ATMP, LWR) were on the O3 deck (~ 10.7m above waterline). The ship sensors were on the bow mast, at about 14.3 meters above the waterline. The water temperature sensors onboard the *Oceanus* were located about 4.3 meters below the waterline. On the buoy, SST sensors were about 0.8m below the waterline. Figure 3.3 shows these values, as well as the values before height adjustment. We discuss here these plots in the order they appear in Fig 3.3.

Air temperature from the buoy agrees with the ship's sensors, except when wind is from the aft (13:00, 22:00 and next day 05:00) and air contamination may be occurring due to the ship's exhaust. However the two ship's sensors do not show the same spikes although they were next to each other according to the person in charge of the scientific equipment on the research vessels. The UOP standalone has higher temperature values (0.5 degrees).

Specific humidity shows a bias between the buoy and ship measurements. Buoy measurements are up to 1 g/kg lower than Ship2 and UOP standalone on O3 deck. This increases to 1.5 g/kg compared to Ship1. The bias decreases during the second half of the comparison period. Postcalibration on HRH222 (logger 15) shows it has a negative bias in relative humidity and temperature of 3 to 2 % and 0.4 degree respectively.

Downward longwave radiation values from the standalone on the ship and the sensors on the buoy have large biases (~20 Wm^{-2}). LWR from logger 15 had the lowest values which is consistent with a postcalibration, although higher (postcalibration indicates standalone and logger 14 have positive biases of 15 and 6 Wm^{-2} respectively. See section II.D.3). There is a good agreement between downward shortwave values from the ship and buoy sensors.

SST from the buoy has marked differences with values from the ship, although the overall trend and level is similar. Temperature sensors at 10m and 20m depths under the buoy agree with the two SST sensors so the difference with the ship is probably due to genuine differences in water temperature. It is improbable the ship's sensors had wrong values since they all 3 agree with each other and with a similar comparison with Climode 2 buoy (see next section). There could also have been some contamination from the ship's water intake. Note the 1 degree drop in water temperature from the ship's sensor is concomitant with the onset of rain near 22:30 UTC on November 18. SST from the buoy also drops but much less and more slowly.

Wind speed from DCFS is higher than Ship1 (IMET) and Ship2 (sonic Vaisala) also the difference with the latter is less pronounced. A linear regression using 9mn averages gives a relative difference of 10% and a constant bias near 1m/s. Ship's wind speed are more spread than the DCFS values. Between 21:00 and 01:00 UTC the wind was from the aft which might explain some difference at that time. However, the ship was oriented upwind from 01:00 to 04:00 on November 19 and the difference is also large in this period. There is a good agreement between values of wind heading, except for DCFS values on November 19.

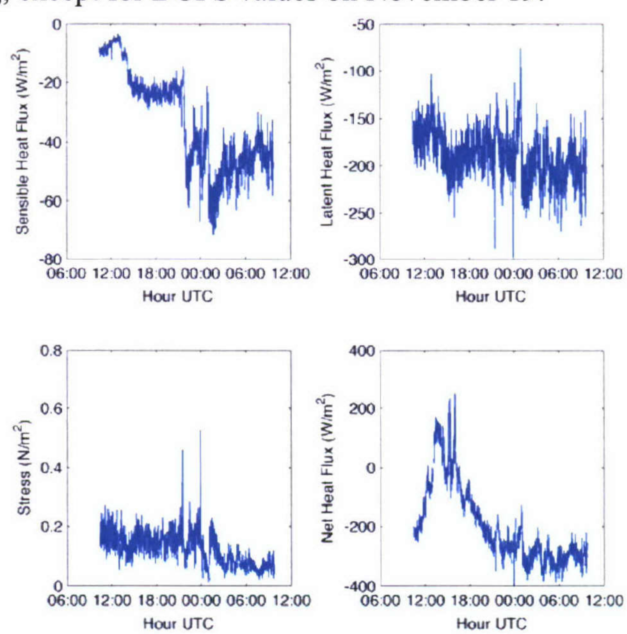


Figure 3.2: Air-Sea fluxes on November 18-19 2006 near Climode 1 buoy.

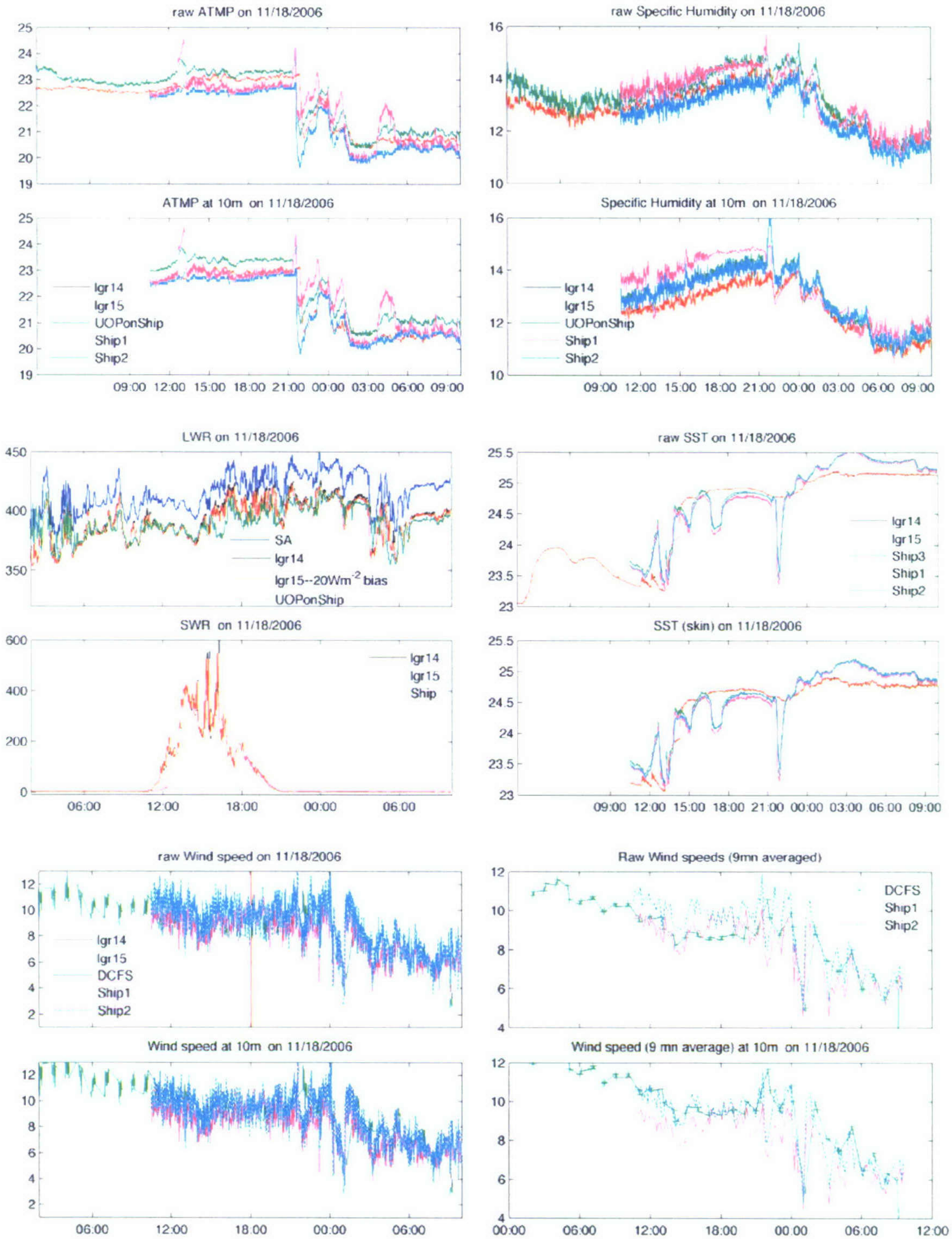


Figure 3.3 (continued next page)

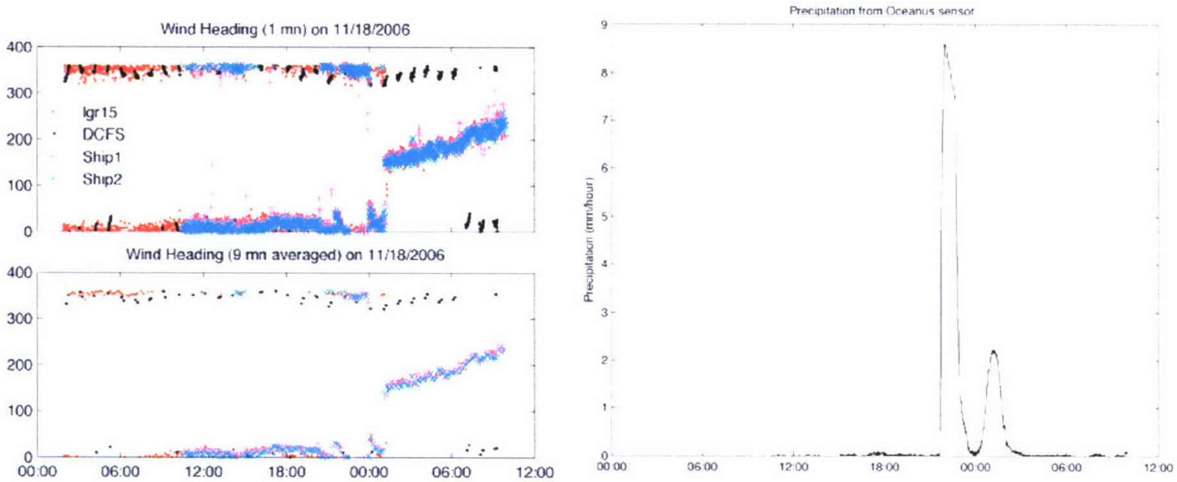


Figure 3.3: Bulk measurements from *Oceanus* (ship's sensors and UOP standalones on O3 deck) and buoy, on November 18-19 2006. Raw data and adjusted at 10m for comparison.

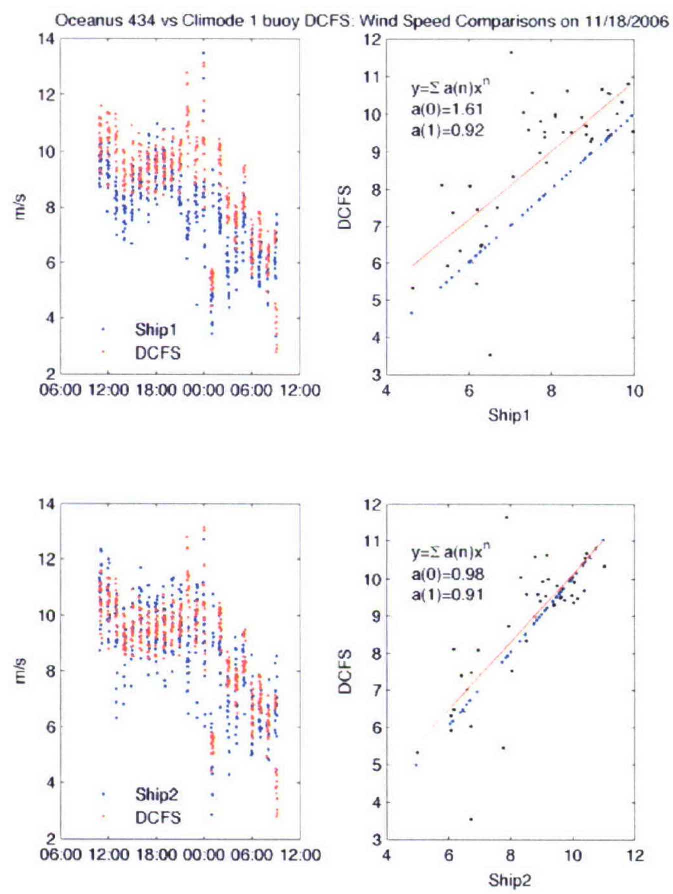


Figure 3.4: Wind speed from DCFS on buoy and ship. There are 414 points of samples for the 1 minute data (left) which are then averaged over 9 minutes (46 points) for the linear regression (right).

III.B.2. Climode 2

The same comparison procedure was undertaken on November 29 when the *Oceanus* was stationed near the buoy at 15:30 UTC and for the next 24 hours. There was only a small rain event during the first half hour of the intercomparison period. All instruments agree well between the ship and buoy measurements. LWR on logger 17 has a positive bias of 9 W m^{-2}. Air temperature and humidity are all within 1 degree and 1 g/kg. Wind speed from the two loggers on the buoy are consistent with each other (Fig. 3.6 and 3.7). DCFS again tends to measure higher values. Ship's wind speed agrees better with buoy values after 03:00UTC, which corresponds to a wind shift and when the ship was oriented more into the wind (averaged over 9mn, the difference is within 1m/s). Wind direction measurements agree well with each other, except for logger 17 which corresponds to a sonic Gill sensor on the buoy which had problems with its compass (Fig. 3.6). The current was strong (3 knots) and remained eastward (~120 True) during the station.

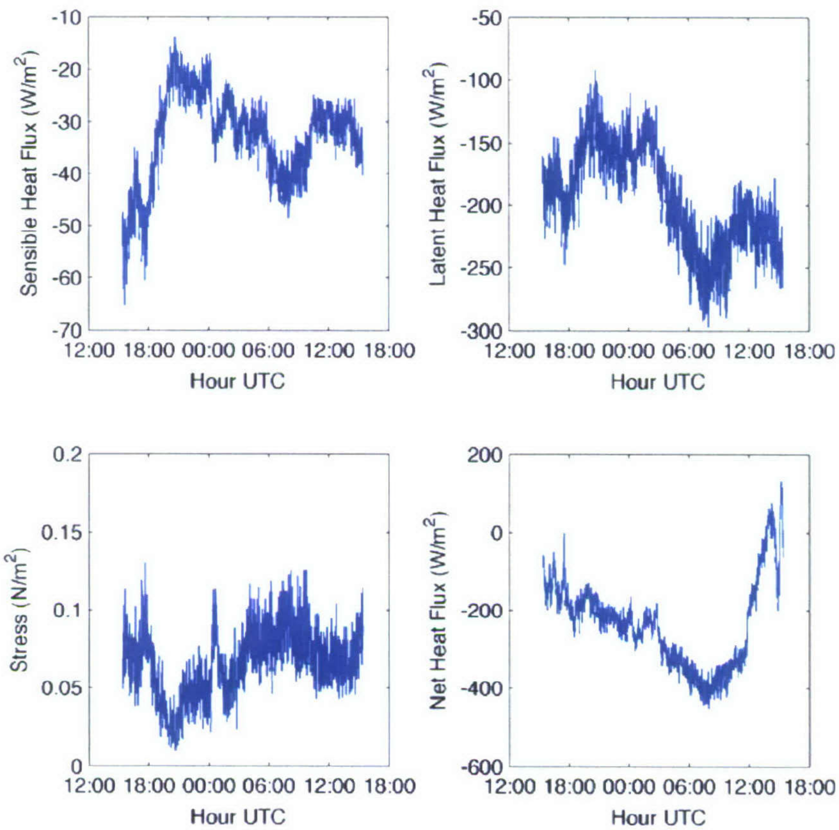


Figure 3.5: Air-Sea fluxes on November 29-30 near Climode 2 F.

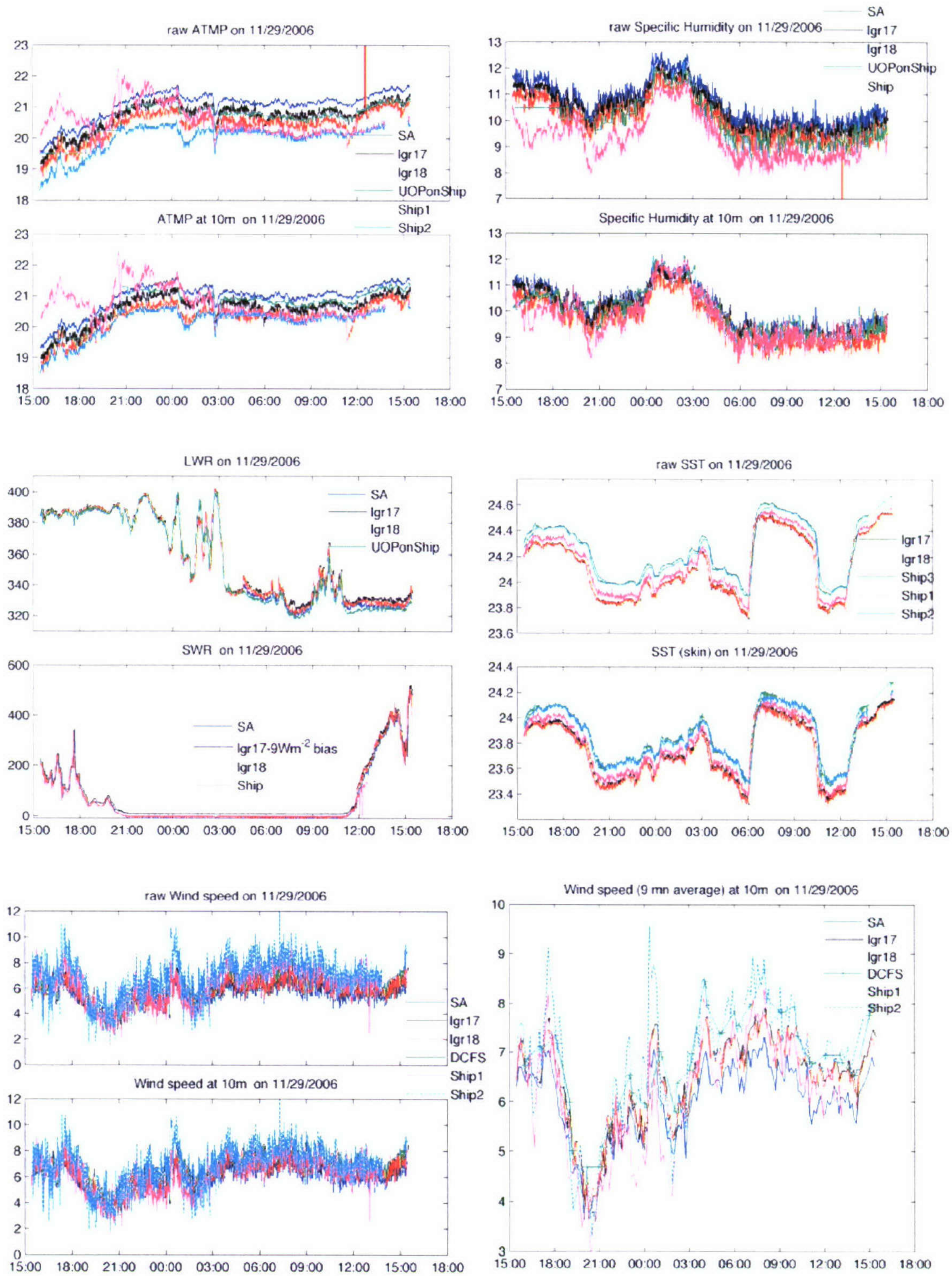


Figure 3.6 (continued next page).

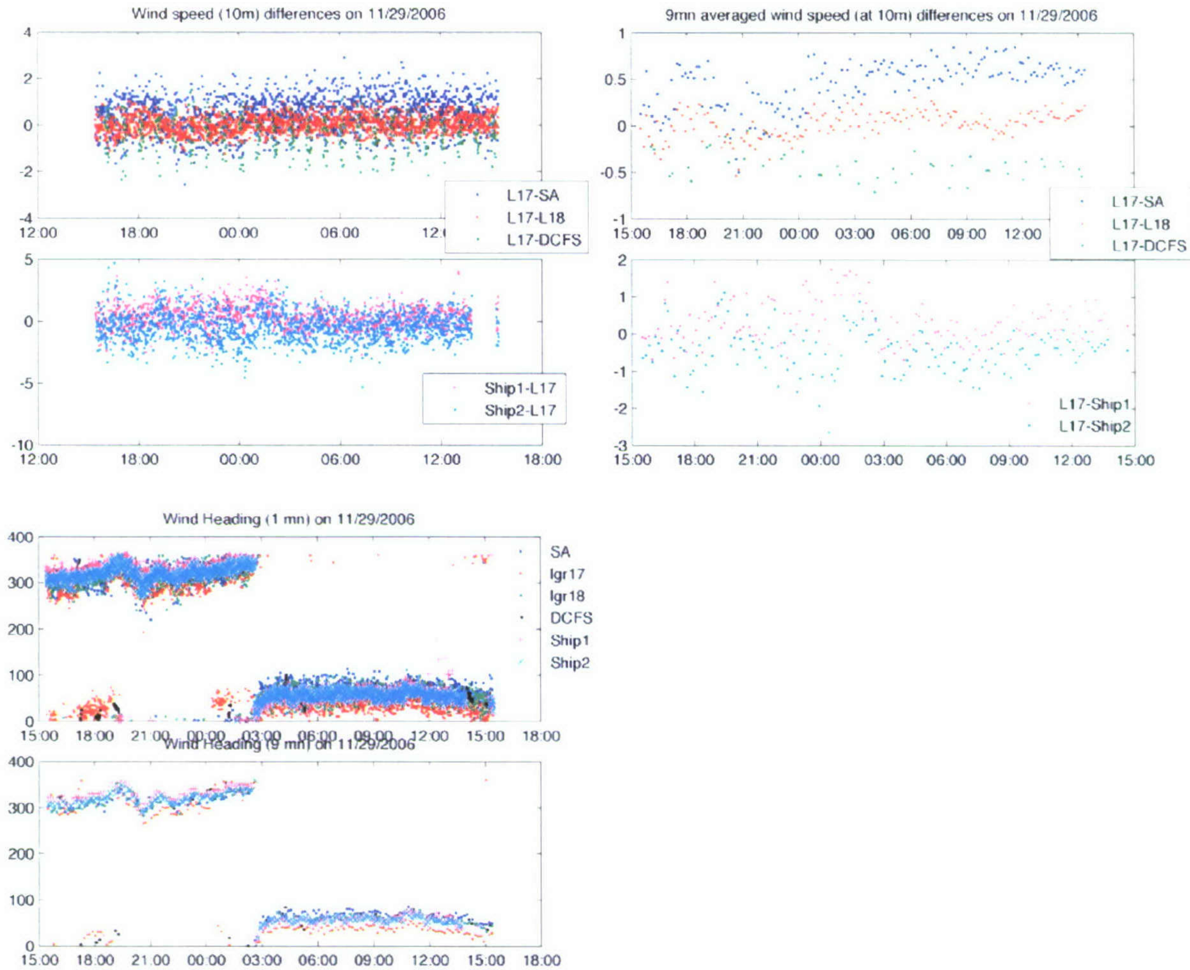


Figure 3.6: Bulk measurements from *Oceanus* (ship's sensors and UOP standalones on O3 deck) and buoy, on November 29-30 2006, near Climode 2 F.

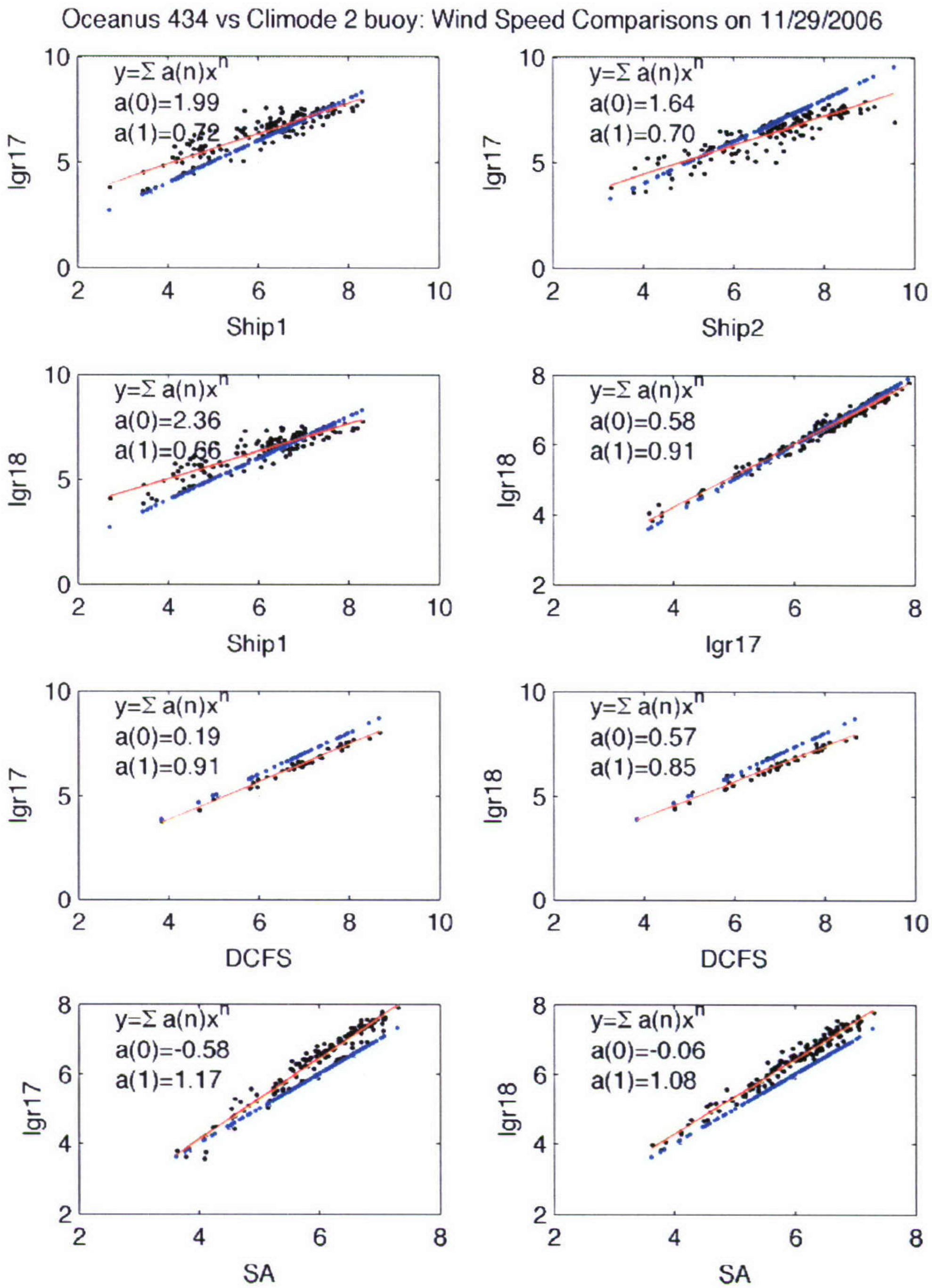


Figure 3.7: Wind measurements from ship and buoy (1mn data). Red lines are linear fits (y=a0+a1x).

IV. SUBSURFACE MOORINGS

IV.A. Overview

Of the four subsurface moorings deployed during the CLIMODE November 2005 cruise, moorings D and C were turned around during the present cruise. These moorings have a few subsurface instruments in addition to the RAFOS sound sources for floats deployed in the area. These instruments include a couple of SBE 37, one of which records pressure, a nutrient sampler, a RDI ADCP, an Aanderaa ADCM and a moored profiling system. Figures A4.1 to A4.4 in Appendix 4 detail the equipment deployed with the subsurface moorings.

Mooring D was a subsurface mooring anchored in 4894 meters and was instrumented with 7 scientific instruments that measure both physical and chemical properties of the ocean in the vicinity of the Gulf Stream where 18 degree MODE water is formed seasonally. Figure 4.1 shows the design of mooring D. The mooring instruments included: an RDI Acoustic Doppler Current Profiler mounted in the subsurface buoyancy sphere; a Satlantic ISUS nitrate sensor just below the sphere; a pair of SBE37s, which measured temperature and conductivity above and below a Mclean Moored Profiler (MMP); and an Aanderaa Current Meter. The MMP was equipped with an ACM and a Falmouth Scientific Instruments CTD. Below all the instrumentation hung a sound source which transmitted an 80 second pong once a day. The pong transmissions are received by profiling floats programmed to seek the 18 degrees isotherm and equipped with a hydrophone for tracking the float underwater. The RAFOS sound sources deployed on subsurface moorings D and C were manufactured by the University of Rhode Island Graduate School of Oceanography under the direction of Dr H.T. Rossby. 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.

Mooring C is identical to Mooring D in its setup and instrumentation (see figure 4.2) and was moored in 5300 meters of water.

Mooring logs are in Appendix 3.

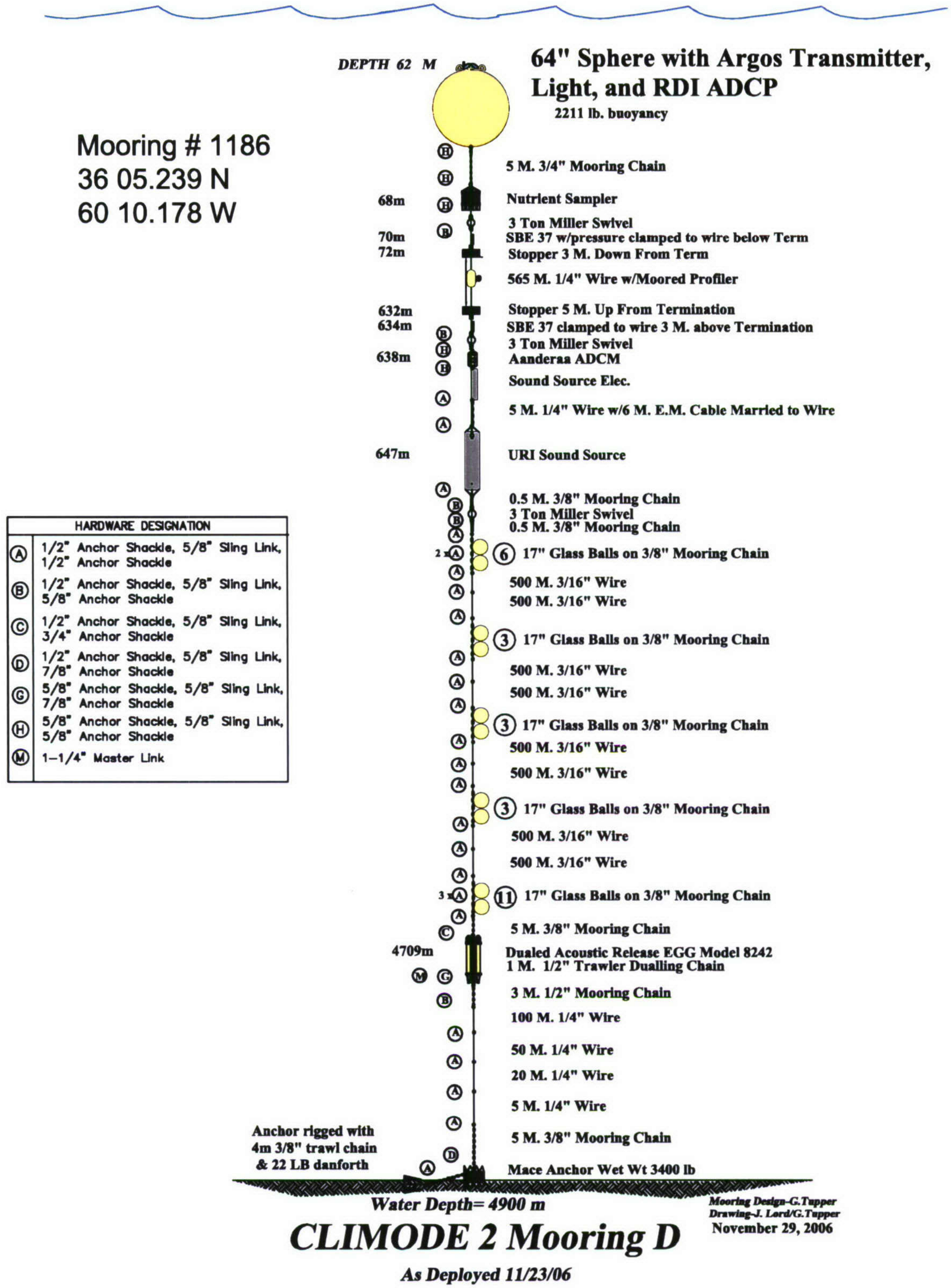
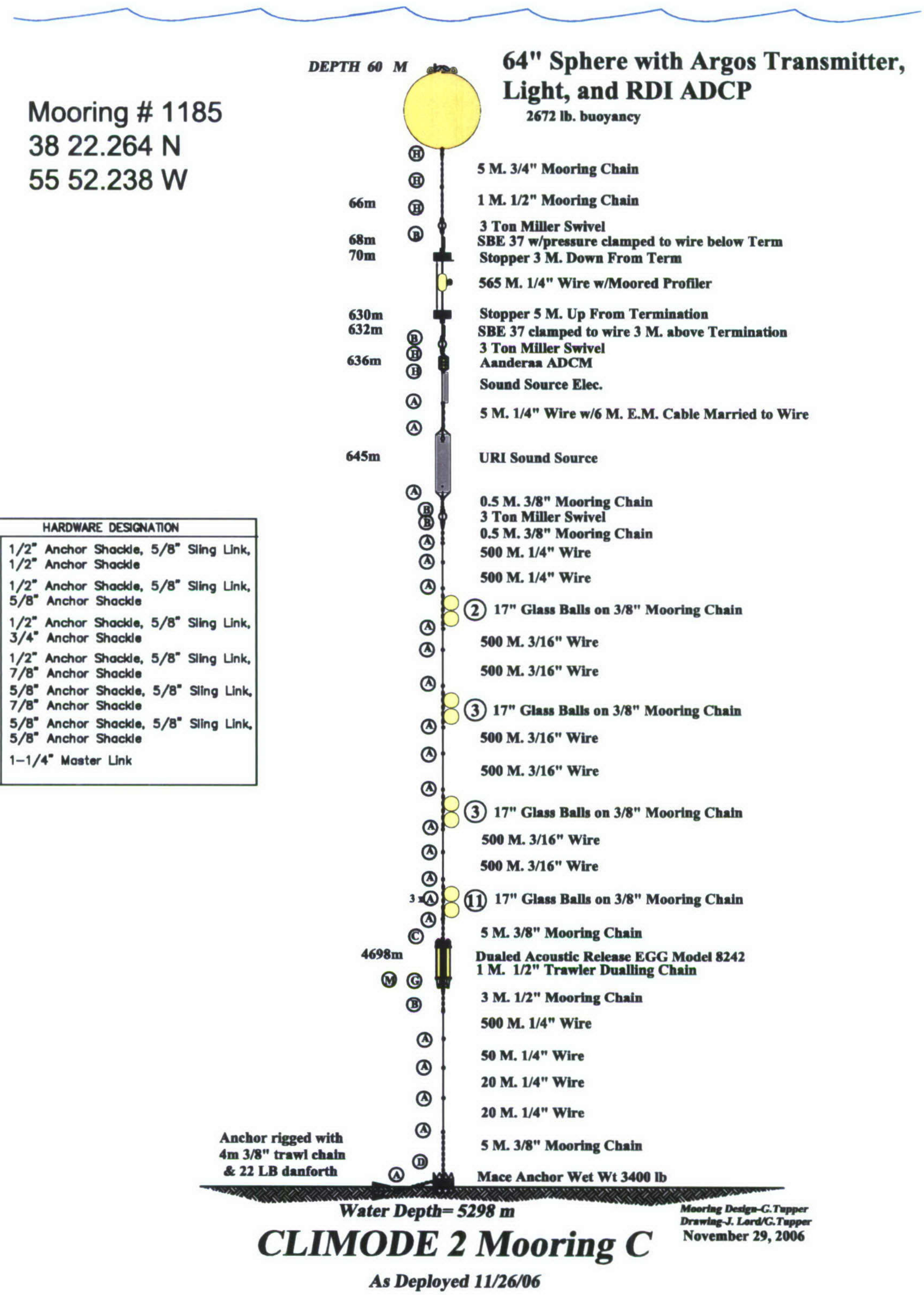


Figure 4.1: Climode 2 mooring D deployed during *Oceanus* voyage 434, November 2006.



HARDWARE DESIGNATION	
A	1/2" Anchor Shackle, 5/8" Sling Link, 1/2" Anchor Shackle
B	1/2" Anchor Shackle, 5/8" Sling Link, 5/8" Anchor Shackle
C	1/2" Anchor Shackle, 5/8" Sling Link, 3/4" Anchor Shackle
D	1/2" Anchor Shackle, 5/8" Sling Link, 7/8" Anchor Shackle
G	5/8" Anchor Shackle, 5/8" Sling Link, 7/8" Anchor Shackle
H	5/8" Anchor Shackle, 5/8" Sling Link, 5/8" Anchor Shackle
M	1-1/4" Master Link

Figure 4.2: Climode 2 mooring C deployed during *Oceanus* voyage 434, November 2006.

IV.A.1. Pre cruise preparations

ADCP – ADCPs were tested using the manufactures pre deployment test procedure. Since the pressure cases of the new instruments had to be swapped with the deeper rated pressure cases deployed on the mooring, most of the pre-cruise prep consisted of confirming the swap procedure and setting up the ADCP for deployment. Dan Torres created specific recovery and deployment procedures.

SBE37 – Serial numbers 2139 and 2140 with pressure were to be recovered and redeployed. Batteries and anti-fouling plugs were packed to turn the instruments around at sea. Lessons on data upload and battery change were part of the prep. Serial number 1645 and 2031 without pressure were started in the lab and were ready to deploy.

MMP – MMP112 and 113 were loaded with firmware v3.18 and checked using the self checking pre-deployment procedure. The MMPs were configured to start sampling in November. The MMPs were ready except for the dive zero time which needed to be programmed during the cruise when the deployment schedule dates were confirmed.

ACM – Aanderaa ACM serial numbers 148 and 149 were set up with new batteries and fresh data loggers by Scott Worrilow. Final time synchronization and instrument close up was completed by Paul Bouchard. John Lund installed the ACMs into the deployment frame and packed the instruments for sea. The ACM needed anti-trawl guards bolted on to complete the frame prior to deployment.

Sound Source – Sound sources were scheduled to be redeployed. Sound sources were originally designed to be expendable. The end caps on the electronics pressure case are held in place by vacuum and tape. There was some concern that if some of the batteries had out-gassed, the caps could have been popped off at recovery, flooding the instrument. Indications of a low battery voltage or a low vacuum measurement would point to a possible problem with the batteries. George Tupper and John Lund went to University of Rhode Island Graduate School Oceanography for training in the event that the batteries needed to be replaced on the sound source.

IV.B. Recovery

Subsurface moorings C and D are essentially the same design, with a slight difference in overall length, wire size, and sphere buoyancy. The procedure for recovering these moorings is the same.

The ship positioned ¼ mile down wind from the surveyed anchor position. The acoustic release was enabled and triggered. Once release was confirmed, people were watching for the sphere to appear at the surface. Once the sphere was spotted, the shipped maneuvered into position to begin recovery.

The ship approached the sphere slowly, keeping it very tight on the starboard side. The sphere was captured using a 12-foot pickup pole with a hook on a 12-foot lanyard. Once the sphere was hooked, the soft eye in the lanyard was attached to the crane hook. The crane lifted the sphere from the water and brought it to the side of the ship. Air tugger lines were attached to the sphere before it was lifted up and pulled inboard.

As the sphere was brought inboard, the air tuggers kept it from swinging. Once stabilized, a bull rope from the capstan was shackled into the 5-meter shot of chain under the sphere. The shackle connecting the chain to the sphere was removed. The sphere was lowered to a cradle and secured to the deck. A sling was passed through the top link of chain and attached to the crane hook. The crane was raised until the nutrient sampler was above the deck. The bull rope on the capstan was attached to the link below the nutrient sampler and took the strain of the mooring. The chain and nutrient sampler were lowered to the deck and disconnected. The crane was secured before continuing the recovery.

The working line for the winch was run from the winch, through a block on the A-frame, and forward to the recovery area on the starboard side. The working line was shackled into the mooring line. The capstan payed out the bull rope, and the mooring line slipped back towards the stern. The winch took up slack, and the load was transferred from the capstan to the winch and the block on the A-frame. As the winch pulled in, the mooring line was stopped off below the 3-ton swivel. The swivel was removed and the winch shackled back into the mooring line. The SBE 37 MicroCat and MMP stopper were removed from the 565-meter wire shot outboard of the block.

The winch continued hauling in on the mooring wire. Once the top end of the wire was on the low-tension side of the LEBUS winch heads, a Yale grip was attached to the wire on the high-tension side and the mooring was stopped off with a stopper line on the deck. The working line was removed from the winch spooler, and an empty reel was mounted in its place. The top end of the wire shot was spooled onto the empty reel. Tension was taken up on the winch, and the stopper and Yale grip were removed. The winch continued the recovery of wire.

Near the bottom of the 565-meter shot of wire, the MMP was pulled from the water. As the MMP cleared the deck, the A-frame was brought in, and the hanging block lowered to ease removal of the MMP from the wire. Once the MMP was removed, the block was raised and recovery continued. At the bottom of the wire, the MMP stopper and SBE 37 clamped to the wire were removed.

Recovery continued until the Aanderaa current meter and 3-ton swivel were above the deck. A stopper line was inserted below the current meter and these components were removed from the mooring line. The mooring line was reattached to the link at the top of the sound source electronics. The hanging block on the A-frame was raised for maximum clearance to the deck. The winch pulled in, lifting the sound source electronics clear off the deck. A stopper line was inserted into a link at the top of the sound source electronics, and the winch payed out, lowering the electronics to the deck. The mooring wire was disconnected, passed through the block, and reattached to the top of the electronics.

The winch pulled the sound source electronics in tight while personnel at the transom kept the umbilical to the resonator from being pinched. A pickup hook attached to the air tugger on the A-frame was used with a pickup pole to connect to the chain bridle at the top of the sound source resonator. The air tugger pulled in tight and the winch continued pulling the electronics up. When the resonator was clear of the deck, a stopper line was attached to the bottom chain bridle and the resonator was lowered to the deck. All sound source components were disconnected and moved to a safe place on the deck.

The mooring wire was reattached to the link below the sound source, and continued to pull in. A series of glass balls was pulled up and onto the deck. The mooring was stopped at the bottom of the glass balls, and the balls were removed from the mooring. The mooring wire was passed through the block, and reattached to the mooring line. Recovery of wire continued until the termination was passed to the low-tension side of the LEBUS winch drums. A Yale grip was attached to the high-tension side of the mooring, and the mooring was stopped off while the full reel was exchanged for an empty one. Once the winch could take tension again, the Yale grip and stopper were removed. Recovery of wire and glass balls continued using the method above until the last glass balls had been recovered.

The deck stopper line was moved to the five-meter shot of chain above the releases. The glass balls were disconnected. A chain hook, connected to the air tugger on the A-frame, was connected to the chain about two meters down from the end. The air tugger was used to lift the chain and acoustic releases on board. This completed the recovery.

IV.C. Mooring Deployments

The subsurface moorings C and D are virtually identical in design for the first 650 meters. After that, the subtle differences do not affect the procedure for deployment. This section will cover the deployment of both moorings.

To prepare for deployment, the syntactic sphere and cradle were positioned in the deployment position at the starboard rail. The ADCP, Argos beacon, and light were mounted. The four stainless steel tie rods were replaced with new ones. A five meter shot of ¾" mooring chain was passed between the cradle and the sphere. The chain was shackled to the bottom of the sphere. The nutrient sampler (mooring D) or one-meter shot of ½" chain (mooring C) was shackled to the ¾" chain. A three-ton swivel was shackled to this. The top end of the 565 meter shot of ¼" wire rope was passed through a Gifford block hung from the A-frame and shackled to the bottom of the swivel. The SBE 37 and MMP bumper stop were clamped onto the wire at 3 and 5 meters from the termination. Prior to deployment, the chain, instruments, and top of wire were positioned outboard of the bulwark and held on a slip line until the buoy was in the water.

A quick release hook was rigged to a lifting ring on the top of the sphere and connected to the hook on the crane using a 6-foot sling. Two slip lines were rigged slightly ahead and slightly behind the sphere to keep it steady during deployment. The buoy was lifted over the bulwark with the crane and lowered to the water about eight feet from the side of the ship. As the slip lines were cleared, and the sphere settled into the water, the quick release was tripped.

The ship moved ahead slowly until the sphere was being towed from the stern. The mooring wire was payed out from the LEBUS winch. When approximately half of the 565-meter shot of wire was deployed, the MMP was attached to wire and lowered to the water using a 3/8" Yalex slip line rigged to the traveling block on the A-frame.

Payout of wire continued until there was approximately 12 meters of wire remaining on the reel. The winch was stopped and a Yale grip was attached to the wire, aft of the winch drums. A stopper line was snapped into the Yale grip to take tension on the wire. The remaining wire was pulled off the reel, and a new reel of wire was placed in the reel spooler for the winch. Tension was reapplied to the winch, the stopper and Yale grip were removed, and payout continued.

Five meters before the end of the 565 shot of wire, the bottom MMP stopper was attached. Two meters below that, an SBE 37 was clamped to the wire. After the termination of the MMP wire passed through the hanging block, the mooring was stopped off with a short slip line. The shackle on the backside of the termination was removed.

A three-ton swivel, Aanderaa ADCM, and the electronics for the sound source were shackled into the mooring line. The top end of the mooring wire (to the winch) was shackled into the chain bridle at the bottom of the sound source. The tugger line attached to the top of the A-frame was lowered to the work area and attached to the lower side of the source electronics tube. The line was pulled tight, raising the electronics tube and ADCM above the deck. The short slip line was eased out until the ADCM was clear of the deck. A long slip line was led through a link in the bottom of the load bar for the source electronics. The short slip line and air tugger on the A-frame payed out until the source electronics was over the stern, being held by the long slip line. The source resonator was repositioned closer to the stern. All slack was removed from the wire on the winch.

A six-foot strap was choked around the resonator tube and attached to a quick release. The quick release was attached to the tugger line on the A-frame. The source was raised from the deck. In unison, the slip line and winch payed out while the A-frame was moved out and the air tugger adjusted to keep the tube off the deck. When the tube was clear off the deck, and all mooring tension was held by the winch, the long slip line was removed and the quick release was tripped.

The winch pulled back on the mooring until the chain below the source resonator tube was at the transom. The chain was stopped off, the wire removed, and a series of glass balls were shackled into the mooring line (2 on "C", 6 on "D"). The mooring wire was shackled into the bottom of the chain attached to the glass balls. Tension was transferred to the winch and the stopper removed. The winch payed out until only one glass ball remained on the deck. This termination was stopped off, the winch wire was removed and passed through the block then reattached to the termination. Payout of the wire resumed.

The remainder of the mooring was payed out. At the end of each reel of wire, a Yale grip was used to hold the mooring for the transfer of reels. At the end of each additional 1000 meters of wire, glass balls were inserted into the mooring using the procedure described earlier.

After the final set of glass balls was attached to the mooring line, the dual acoustic releases were shackled into the mooring. The five-meter shot of chain under the releases was pulled back through the block with the winch, raising the releases off the deck. The A-frame was moved out and the winch payed out, keeping the releases clear off the deck.

Adjustable wire shots were added below the release to "fine tune" the mooring for the ocean depth. The clump anchor was rigged up with a 22-pound Danforth anchor on a short section of chain. A magnesium corrosive link was used to secure the Danforth anchor to the side of the clump for deployment. A five meter shot of 3/8" chain was attached to the clump and led to the mooring work area on the starboard side. A sacrificial line was used to secure the anchor from slipping off the stern as the mooring tension was transferred to it.

At the bottom of the final shot of wire, the mooring was stopped off, and a heavy-duty slip line was passed through the pear link shackled into the wire shot. Both ends of the slip line were tied into a shackle on the end of the Spectra working line that had been spooled onto the winch. The winch took up tension on the mooring, and the stopper line was removed.

In both moorings, it was necessary to tow the mooring, at a nominal speed of 2 knots, to the target location. Towing continued in this configuration until approximately 0.2 miles from the drop site. At this time the ship slowed to 1.5 knots, ands the winch payed out until the five meter shot of chain from the anchor could be attached to the mooring wire. Once the chain was shackled in, payout continued until the load was transferred from the winch to the anchor. The ends of the slip line were untied from the winch leader and carefully pulled through the link until clear.

The ship's trawl wire had been led through a block on the A-frame, directly above the anchor. A quick release was shackled to the trawl wire and rigged on a link in the anchor. After the load had been transferred to the winch, the trawl winch took slight tension on the quick release/anchor setup. At .01miles from the drop site, the sacrificial line on the anchor was cut, the trawl winch raised the anchor, and the A-frame was moved out. As soon as the anchor was clear, the trawl winch lowered it to the water to keep it from swinging too much.

At the signal from the chief scientist, the line from the quick release was secured to a cleat, and the trawl winch lowered the anchor until the quick release tripped. That was the final step of the deployment.

At each mooring site, a 3-point anchor survey was conducted after allowing an hour for the anchor to fall to the bottom.

IV.C.1 Mooring D

A gale developing close to the location of D threatened to bring high winds and waves, so the instrumentation from D was turned around over night and the deployment done on November 23, 2006. On the morning of the 23rd, the wind was out of the southwest at about 15 to 20 kts and there was about 1.1 kts of current seen on the ADCP toward 150°. Because the Lebus winch was thought to lead to slower pay out than the truck brake winch used last year, an estimate 7 hours for the deployment was used. Figuring 1 kt relative to stretch the mooring and moving along with a 1.1 kt flow, a track line of 15 nm toward 230°was chosen as shown in Figure 4.3.

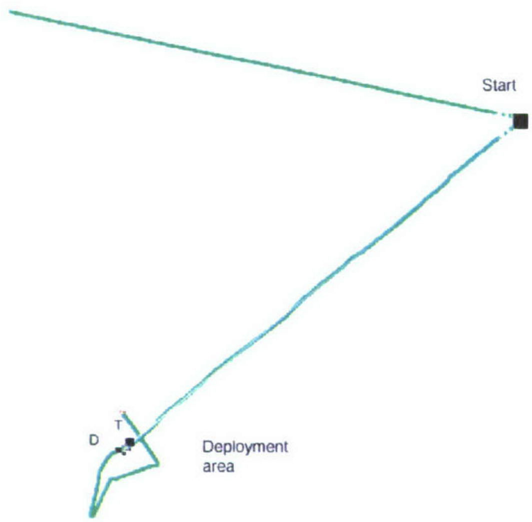


Figure 4.3: Track of the RV *Oceanus* from the start point for the deployment of mooring D. The anchor target (T) was 15 nm from the start, and the anchor drop was 366 m past the target.

The deployment went smoothly and a tow of about 2 hours brought the ship to the anchor drop site. Following the anchor drop a three-point acoustic survey was carried out as shown in Figure 4.4 which allowed triangulation of the anchor (Figure 4.5). Water depth at the drop was 4859 m with 41 m Matthews Table correction, so corrected water depth was 4900 m (Table 4.1).

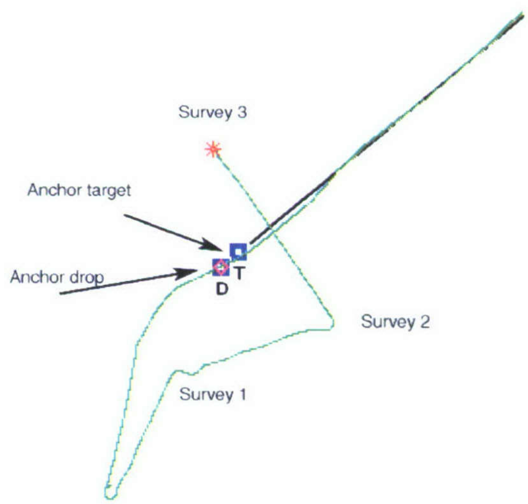


Figure 4.4: Track for anchor survey of Climode 2 mooring D.

Table 4.1: Anchor survey for deployment of subsurface D

Survey Point	Latitude	Longitude	Slant Range (m)	Travel Time (ms)
1	36° 4.345'N	60° 10.998'W	5088	3392
2	36° 4.733'N	60° 9.413'W	4904	3268
3	36° 6.291'N	60° 10.514'W	5089	3392
Anchor drop	36° 5.290'N	60° 10.462'W		
Water depth	4900			
Anchor position	38° 5.239'N	60° 10.178'W		
Anchor fallback	434 m			

The anchor fallback was to the east-southeast of the target, nearly perpendicular to the track line. The release is 184 m off the bottom.

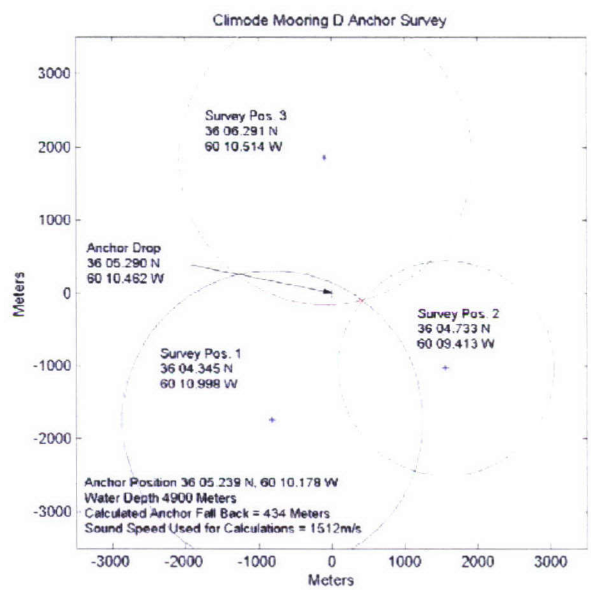


Figure 4.5: Triangulation of anchor for Climode 2 mooring D.

IV.C.2. Mooring C

After the recovery of C on November 26, a brief survey of the bottom was done by running a 10 nm track from the southwest to the northeast across the anchor site from year 1 followed by a similar track from the west to the east. It was found that the bottom sloped downward from the southwest to northeast as the anchor site was crossed over, while on an eastward heading (090°) the bottom was relatively flat. The start was 38°21.1016'N, 56°8.2386'W. The target was 38°22.2539'N, 55°51.726'W. The drop site was 38°22.2708'N, 55°51.4790'W.

On November 27, the weather was fair with wind out of the east, from 085°. The plan for the deployment of mooring C is reflected in the track shown in Figure 4.6. Heading from west to east was into the wind and along a flat bottom. A start position 13 nm out was chosen. The target was the anchor site from the previous year. An anchor drop site 360 m past the target was chosen.

The mooring was deployed without difficulty. All gear was in and the anchor rigged for drop. A tow of 2 hours at 2 kts brought the ship over the drop site, and the anchor was dropped. The anchor drop was at 38°22.267'N, 55°51.483'W; the water depth there was 5245 on the Knudsen with a 53 m Matthews Table correction for 5298 m.

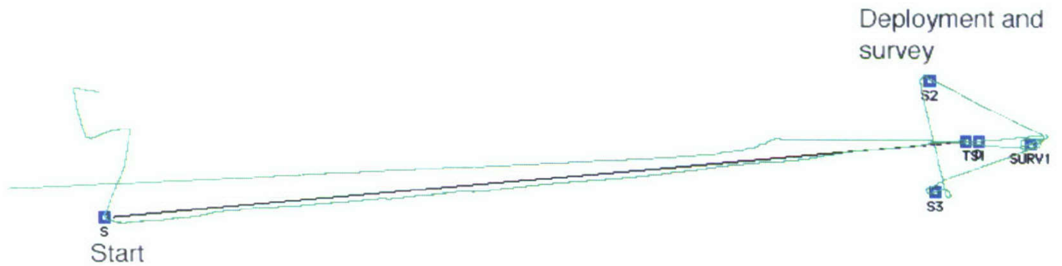


Figure 4.6: Deployment and subsequent survey track for deploying C.

The anchor was allowed to settle for an hour. Then the three point survey shown in Figure 4.7 was carried out to locate the anchor.

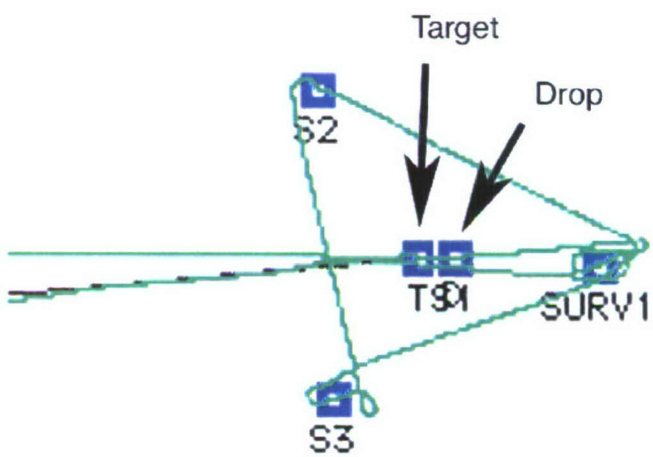


Figure 4.7: Track for anchor survey of Climode 2 mooring C.

The fallback of close to 1100 m was a surprise, much larger than last year. In case the anchor had not settled when the survey was begun, the ranging at Site 1 was repeated and confirmed (see Figure 4.8). The release on this mooring is 600m above the seafloor, so it is possible that the mooring was tilted due to currents. It was also suggested that the mooring had not yet settled out, coming as close to vertical as it would given the currents. The anchor's triangulation for mooring C is summarized in Table 4.2.

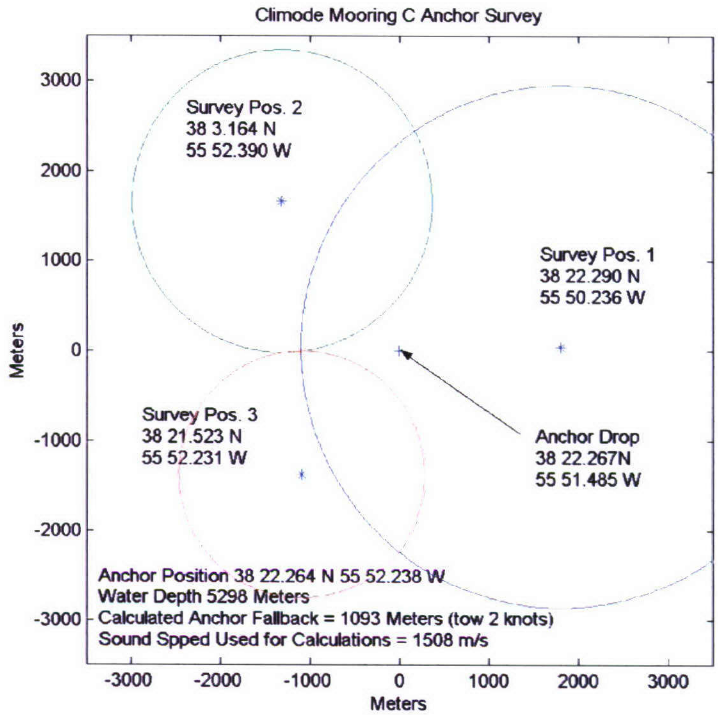


Figure 4.8: Triangulation of anchor for Climode 2 mooring C.

Table 4.2: Anchor survey for deployment of Climode 2 subsurface mooring C

Survey Point	Latitude	Longitude	Slant Range (m)	Travel time (ms)
1	38° 22.290'N	55° 50.236'W	5488	3658
2	38° 3.164' N`	55° 52.390'W	4993	3303
3	38° 21.253'N	55° 52.231'W	4859	3240
Anchor over	38° 22.267'N	55° 52.483'W		
Water depth	5298 m			
Anchor site	38° 22.264'N	55° 52.238'W		
Fallback	1093 m			

IV.D. Recovery observations for mooring D

IV.D.1 Instrumentation on Climode D.

Shallow instruments had more growth than deeper instruments as expected though biofouling growth was not too bad. There were several barnacle type animals on the ADCP but for the most part the transducer heads were clean. The surface CTD sn2139 had slight brown slime but the cell and temperature probe looked clear. The MMP had some of the same brown slime but was mostly clean. The lower SBE37 sn2045, the Aanderaa, and the Sound source were virtually clean. John Kemp and Bob Weller noted slime and 'shark bite' on the upper part of the MMP wire.

The MMP was recovered with two broken fingers. The CTD guard was also bent and some of the yellow paint scraped off of the cage. It is not clear if the damage was done during recovery. There was no evidence of fishing gear caught in the instrumentation (unlike the surface mooring).

Sound source #23 was recovered undamaged. The wire between the electronics and the resonator looked really good and needed no repair. The sound source had good battery voltages and a vacuum. A +27 second time drift was noted and the time was reset. The sound source was scheduled to go to full power on November 23, 2006 at 01:00:00 GMT.

Table 4.3: Climode D and C recovery. Instrumentation clocks.

	Recovered	**Stopped**		
Mooring D	11/22/06	**Date**	**Time**	**Time Drift**
Instrument				
ADCP sn 2231	10:48	11/22/206	14:58:00	plus 10 min 20 sec
ISUS sn 78	10:53			
SBE37 sn 2139	10:54	11/22/06	14:09:23	plus 3 sec
MMP 118	11:49	Dead Battery		
SBE37 sn 2045	11:59	11/24/06	14:51:12	1 min 12 sec
Aandera ACM sn 159	12:03			
SoundSource # 23	12:03	11/22/06	12:39:19	plus 27 sec
	Recovered	**Stopped**		
Mooring C	11/26/06	**Date**	**Time**	**Time Drift**
Instrument				
ADCP sn 2127	11:37	11/26/06	18:32:00	plus 11min 26 sec
ISUS sn 79	11:43			
SBE37 sn 2140	11:55	11/26/06	17:21:10	plus 1 min 10 sec
MMP 110	12:32	11/28/06	17:30:31	plus 11min 36 sec
SBE37 sn 2034	12:39	11/27/06	15:24:16	plus 1 min 26 sec
Aandera ACM sn 156	12:43			
SoundSource # 24	12:47	11/26/06	14:31:17	plus 5 sec

IV.D.2. Data return on Climode D

ADCP sn2231- The ADCP collected a full year of data. The RDI software animate function shows some interesting signal and several events. A plot of the heading pitch and roll data from the ADCP (Figure 4.9) indicates the platform remained stable throughout the deployment. Pitch and roll angles during the deployment remained less than +/- 3 degrees. The peaks are well correlated with blow down events indicated by the pressure signal in the upper SBE37 data. The heading data is reassuring and indicates that the mooring ball is not spinning or oscillating violently when the mooring is blown over. Figure 4.10 shows several bins of raw velocity data. It should be noted that the depth of the bins changes with the depth of the surface ball and that the ADCP data will need to be mapped to a pressure surface. During the large blow down event at the end of January the ADCP measured a $1 ms^{-1}$ current more than 15 bins from the transducer.

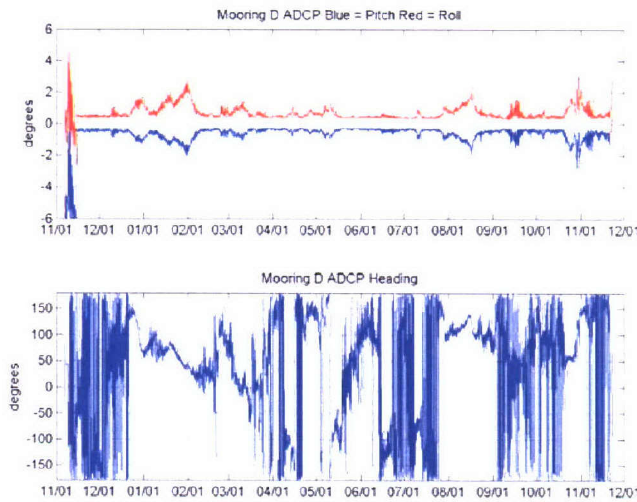


Figure 4.9: ADCP stability during Climode 1 mooring D.

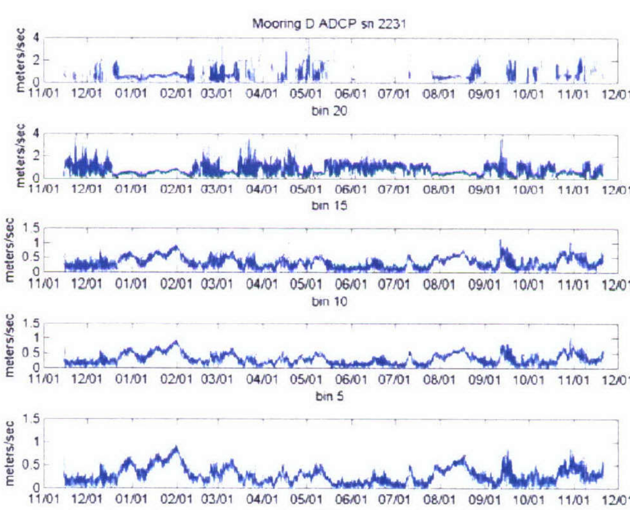


Figure 4.10: ADCP raw binned velocity data from Climode 1 mooring D.

SBE37 sn2139 w/pressure – Figure 4.11 shows the raw time series data from the shallow SBE37 with pressure. The mooring design plan has the no-current-depth to be 70 meters (see Figure A4.2, Appendix 4). There were four events when the SBE37 pressure was greater than 300 meters and two events, in January and August 2006, where the mooring was blown down to 400 meters.

SBE sn2045 without pressure – Although the instrument was set up to measure salinity these data are all zeros, and temperature is the only measured variable (Figure 4.12). Temperatures were approximately 16 degrees C except when the mooring was blown over and the sensor was moved into deeper and colder water. The target depth for this instrument was 634m (Figure A4.2, Appendix 4).

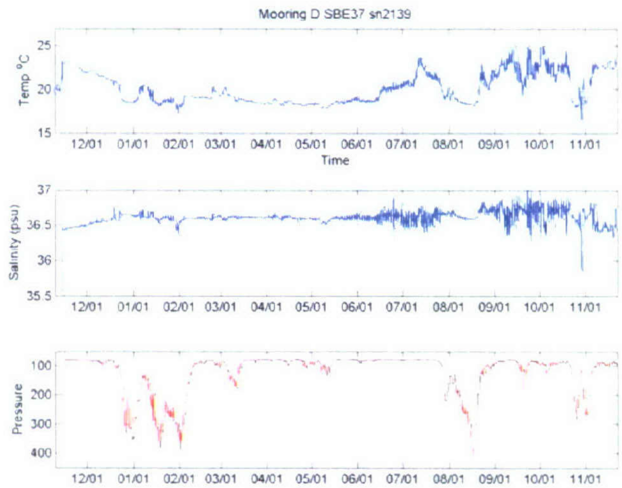


Figure 4.11: Data from SBE37 (SN 2139) on Climode 1 mooring D.

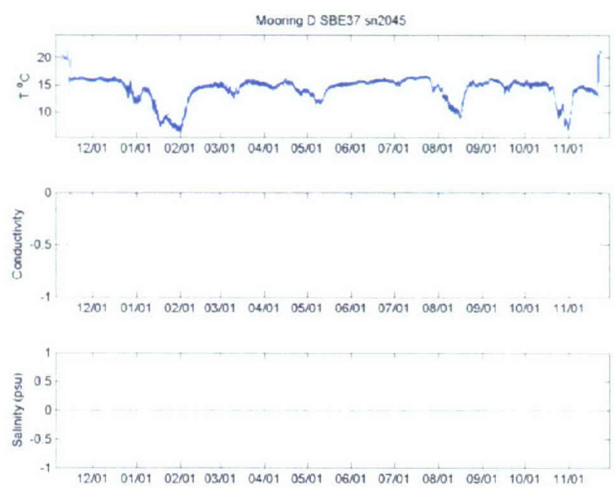


Figure 4.12: Data from SBE37 (SN 2045) on Climode 1 mooring D.

MMP 118 – MMP118 was no longer sampling and communication through the serial port was not possible. Battery voltages were between 1.8 and 2.1 volts per pin on the battery connector. The manual claims that the MMP will not work at voltages below 7.2.

Data on the on the flashcard were backed up. There were 458 profiles taken between 11/16/2005 and 3/20/2006. The A* files from 12/1/2006 on have only 1KB of data. Data from the ACM after profile 22 (December 1, 2005) show that ACM was turned on and powered down after 30 minutes.

A plot of the raw summary data (Figure 4.13) shows maximum and minimum profile pressures during the majority of the deployment. Refer to chart (Table 4.4) to get approximate dates of profiles. The MMP did not always climb to the top, or the mooring may have been blown over at the time so the top was 100 or 200 meters.

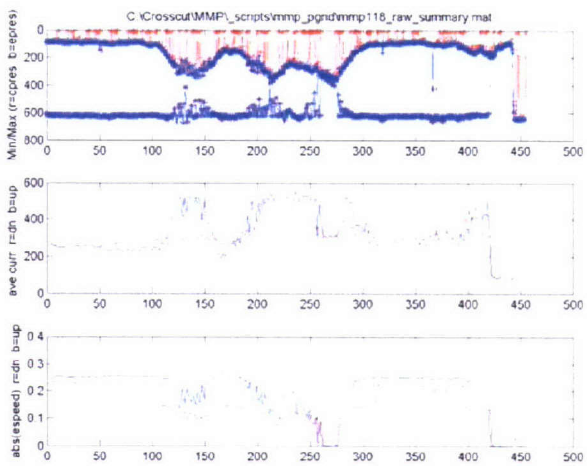


Figure 4.13: Data from mooring profiler MMP 118 on Climode 1 mooring D.

Table 4.4: Time table for profiles on moorings C and D, Climode 1.

Mooring D Profile Number	MMP 118 Date	Mooring C Profile Number	MMP 110 Date
1	11/27/09	1	11/27/09
100	12/21/09	100	12/21/09
200	1/15/10	200	1/15/10
300	2/9/10	300	2/9/10
400	3/6/10	400	3/6/10
458	3/21/10	500	3/31/10
		600	4/25/10
		700	7/15/10
		800	10/23/10
		841	11/29/10

The Aanderaa current meters were not opened during the cruise because there was no data log reader available. These will be opened and downloaded after the cruise.

IV.D.3. Preparations for redeployment of mooring D.

Mooring D was redeployed the following day after recovery on November 23, 2006. The mooring plans were identical and no adjustments were made to the depth of the subsurface float. Figure A4.4 (Appendix 4) shows the instrument deployment locations and serial numbers. ADCP sn 2225 transducer, end cap, and new battery set were installed in the deep pressure case that had been used on the mooring during CLIMODE 1. SBE37 sn 2139 with the pressure transducer was redeployed for CLIMODE 2 after the data were uploaded and the batteries and anti fouling plugs were changed. MMP 113 running firmware v3.18 was programmed for a dive 0 time on 11/23/2006 at 20:00:00. The sound source time drift was noted and reset. ISUS sn 78 was downloaded, cleaned up, checked against standards and redeployed with a new battery. All other instruments including the MMP were exchanged for replacements. Great care was taken to replace the mooring as close to the original anchor site as possible.

IV.E. Recovery observations for mooring C

IV.E.1 Instrumentation on Climode C.

The instruments of Mooring C had very little biofouling growth. The RDI ADCP had a brown slime on the case. The transducer heads were virtually clean and there were no barnacles. SBE37 sn 2140 located under the sphere has some growth but again it was minimal and the temperature probe and conductivity cell were clear. The upper part of the MMP was fuzzy with growth. No evidence of shark bite was seen in the wire jacketing.

The bottom cowling covering the connectors was dangling by the deployment line when the MMP came to the surface against the bottom bumper. The nylon bolt that secures the cowl in position against the key-hole bolts was sheared. The wires and connectors were very clean indicating that the damage could have been done during recovery. John Kemp noted that the MMP was in freewheel mode and he thought the MMP was no longer working. The ACM fingers and CT sensor were not damaged.

The ACM connector retainer that screws over the plug was loose and no longer screwed to the base. During movements on the deck the wire caught on something and was pulled out at an angle bending some of the pins.

The MMP was still running. On the bench prior to stopping the mission and uploading the code the motor was heard running several times. Unfortunately, it seems the connection between the motor and the drive wheel is damaged. The motor shaft is turning and could be felt spinning but the wheel was not turning. Pushing on the wheel would cause it to grab only the slightest bit. Heavy wear is evident on the lower guide wheel.

Sound Source #24 was recovered unharmed. The wires between the electronics and the resonator were undamaged and required no repair. Several of the anodes were changed but otherwise the sound source looked good. Battery voltages and vacuum were both good. A +5 second time drift was measured. The time was reset and the source was programmed to go to full power on 26 November 2006. See Table 4.3 for instrumentation clocks.

Aanderraa had no biofouling. It is assumed the current meter was fine and still working. The instrument was not stopped or opened because there was no data logger reading tool on board the ship. These will have to be stopped and uploaded in the lab.

IV.E.2. Data return on Climode C

ADCP in Mooring C collected data just shy of the full year stopping on 6 September 2006. The battery voltage was 26.43 V. Dan Torres commented in an email that if the ADCP was deeper than Mooring D it might have used more power. He also suggested that although new, the battery set installed in the ADCP last year may not have had the same amount of energy. ADCP animation software show interesting current signal throughout the deployment with some high current events. Figure 4.14 shows several events with current velocities greater than 0.5 ms^{-1} and a couple greater than 1 ms^{-1}. As seen in Mooring D, the heading pitch and roll remain quite stable during blow down current events (Figure 4.15).

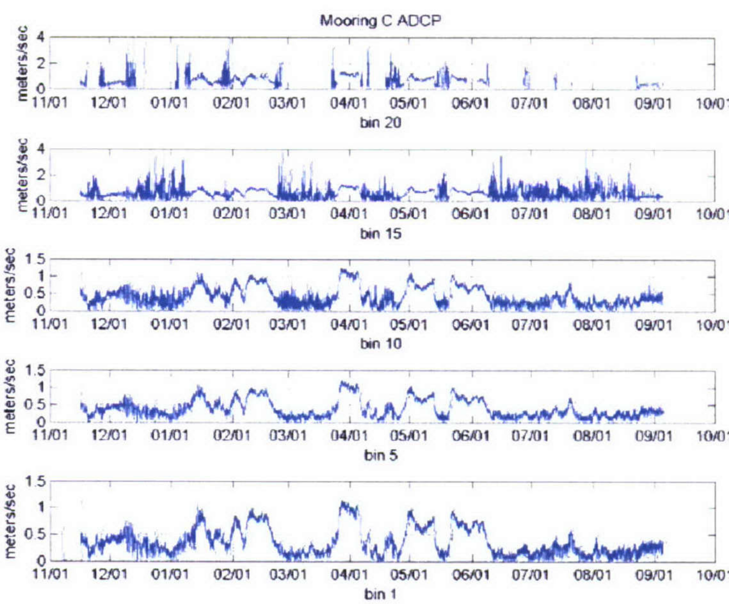


Figure 4.14: ADCP raw binned velocity data from Climode 1 mooring C.

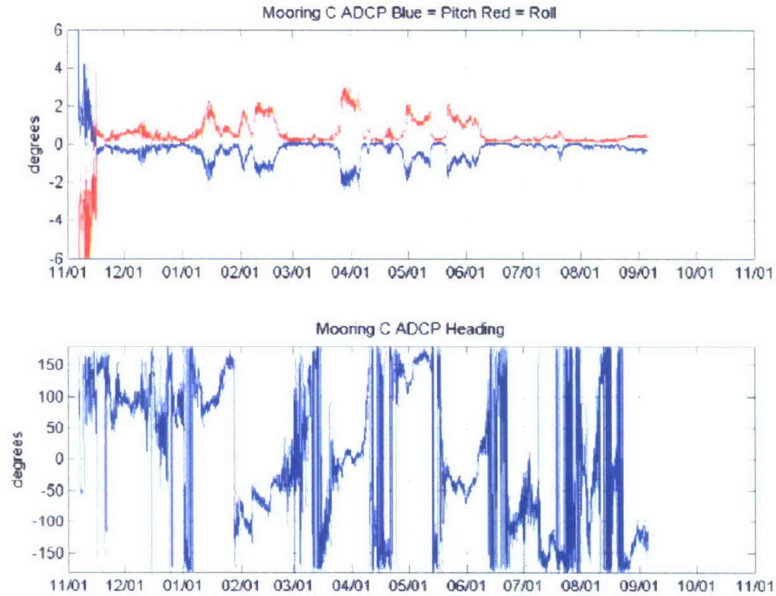


Figure 4.15: ADCP stability during Climode 1 mooring C.

SBE37 sn2034 w/Pressure –Data were collected for the entire deployment. There were several extreme blow-down events. The max pressure observed was 782 meters (Figure 4.16) although its target depth was 68m (Figure A4.1, Appendix A4).

SBE37 sn2140 w/o pressure –This data set had temperature, conductivity and salinity for the entire deployment (Figure 4.17). This instrument had a target depth of 632m (Figure A4.1, Appendix A4).

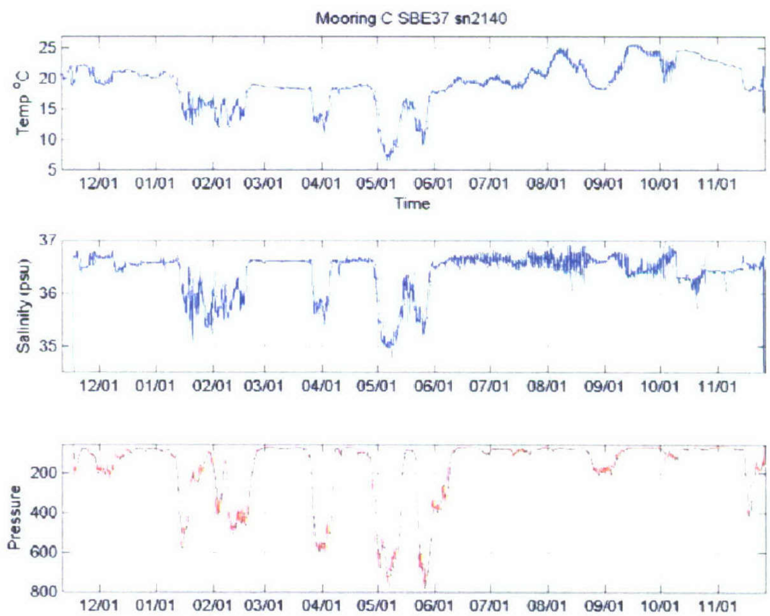


Figure 4.16: Data from SBE 37 with target depth 68m on Climode 1 mooring C.

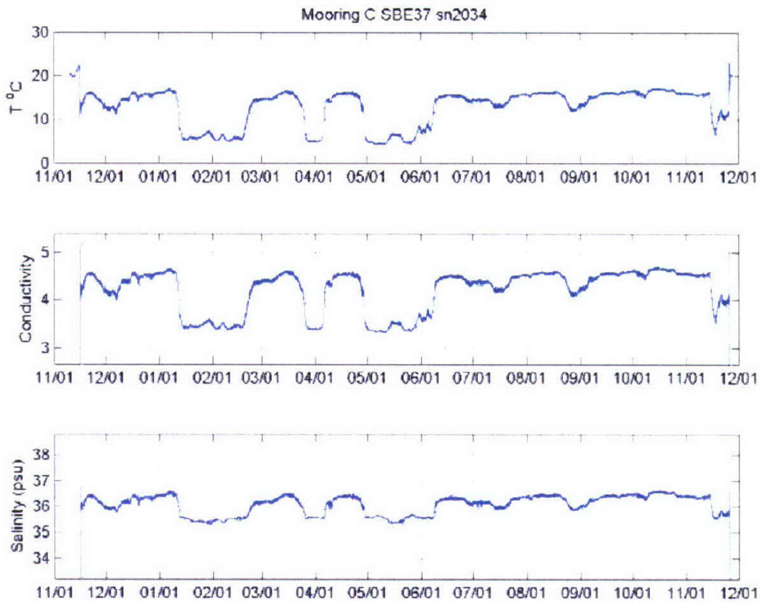


Figure 4.17: Data from SBE 37 with target depth 632m on Climode 1 mooring C.

MMP110 – MMP110 was still attempting to profile after deployment. The battery still had energy and communication through the serial port was possible. The profiler was shut down, the flash card removed and the data backed up on to two laptops. MMP110 collected data through out the entire year. Battery voltage was 11.68 volts on each or the terminal pins. There are 841 profile files for each of the A*, C*, E* data files (Table 4.4).

The raw summary plot (Figure 4.18) and the data file suggest that a full year of data was collected but it appears after about the 200th profile (about the middle of January 2006) the MMP stopped climbing up and down the wire. This is coincident with a strong blow down event to nearly 600 meters and it is possible that damage to the drive wheel occurred at this time. Battery power may have lasted for the year as a result of not driving against the full load of the MMP in current. The MMP pressure record indicates the unit visited various depths but such vertical motions could be caused by blow down currents. Since the wheel-motor connection is damaged it is impossible for MMP110 to brake. It therefore would have been in a freewheel state that could be moved up and down the wire.

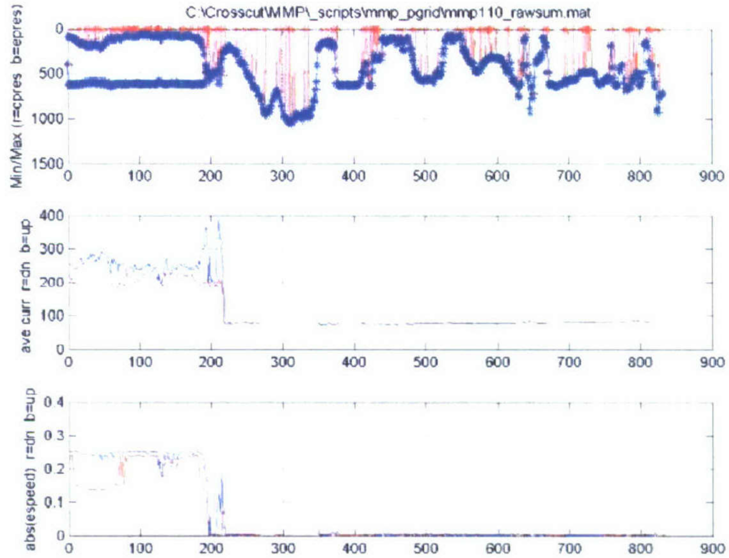


Figure 4.18: Data from profile MMP 110 on Climode 1 mooring C.

IV.E.3. Preparations for redeployment of mooring C.

As with mooring D, deployment followed the day after recovery and no changes were made to the subsurface depth (see Figure A4.3, Appendix 4). SBE37 sn 2140 was uploaded, re-powered and the antifouling plugs were changed. The ADCP pressure case from CLIMODE 1 was reused with new electronics (sn 2222). The ISUS nutrient sampler would not communicate and was not redeployed on CLIMODE 2 mooring C. The sound source time drift was noted and the clock reset. MMP 112 running firmware version 3.18 was programmed for a dive 0 time of November 27, 2006 21:00:00 GMT .

V. LAGRANGIAN DEPLOYMENTS AND NUTRIENT SAMPLING.

V.A. Floats and Drifters

10 NOAA drifters were deployed for Rick Lumpkin (see Figure 5.1 and Table 5.1 for deployment locations and times). In addition SOLO (Table 5.2) and Bobber floats (Table 5.3, Figure 5.2) were deployed. All deployments are shown in Figure 5.3.

The modern drifter is a high-tech version of the "message in a bottle". It consists of a surface buoy and a subsurface drogue (sea anchor), attached by a long, thin tether. The buoy measures temperature and other properties, and has a transmitter to send the data to passing satellites. The drogue dominates the total area of the instrument, and is centered at a depth of 15 meters beneath the sea surface.

The Global Drifter Program (GDP) is the principle component of the Global Surface Drifting Buoy Array, a branch of NOAA's Global Ocean Observing System <http://www.aoml.noaa.gov/phod/goos.php> (GOOS) and a scientific project of the Data Buoy Cooperation Panel <http://www.dbcp.noaa.gov/dbcp/> (DBCP). This program has two principal objectives. Firstly, to maintain a global 5x5 degree array of 1250 ARGOS-tracked surface drifting buoys to meet the need for an accurate and globally dense set of in-situ observations of mixed layer currents, sea surface temperature, atmospheric pressure, winds and salinity. Secondly, to provide a data processing system for scientific use of these data. These data support short-term (seasonal to interannual) climate predictions as well as climate research and monitoring.

Three SOLO floats were deployed for Breck Owens, at site D and south and north of the Gulf Stream (see Table 5.2).

Bobber floats were deployed by John Lund for David Fratantoni (see deployments locations in Figure 5.2 and Table 5.3). Battery installation and final ballasting of the floats was done shortly after the float delivery last year. A small modification to the dive program was made on the six floats to be deployed on OC434. The dive parameter for the bob profile was changed so that the piston extends to the same position as it does during the deep profile. This ensures the float will dive as fast as possible during the bob profile. Each float was fully checked out using the Webb Research Corporation automated self check program. Argos ID's and test messages were confirmed through the email data system.

Table 5.1: Argos drifter deployment information during voyage *Oceanus* 434, November 2006.

	Date	Time	Drifter ID	Latitude (deg N)	Latitude (min)	Longitude (deg W)	Longitude (min)	SST at deployment
1	11/21/06	00:55	63134	37	56.80	64	42.19	23.20
2	11/21/06	13:56	63133	36	53.48	62	06.83	24.28
3	11/21/06	18:55	63135	36	27.56	61	05.28	23.20
4	11/24/06	01:54	63136	36	07.58	60	08.48	24.12
5	11/24/06	13:00	63132	36	57.00	58	33.00	22.58
6	11/25/06	01:24	63130	37	31.01	57	31.22	22.09
7	11/27/06	21:38	63131	38	22.00	55	50.00	21.50
8	11/28/06	14:00	63128	38	15.00	58	56.00	21.66
9	11/29/06	01:56	63129	38	08.00	61	56.00	22.71
10	11/30/06	16:06	63127	37	56.00	64	38.00	23.72

Table 5.2: Float deployment locations during voyage *Oceanus* 434, November 2006.

Float S/N	Start time UTC	Deployment		Latitude North		Longitude West		Notes
		Date	UTC	deg	min	deg	min	
703	11/15/06 14:15	11/21/06	01:01	37	56.54	64	41.31	south of Gulf Stream
701	11/15/06 14:14	11/24/06	01:52	36	07.587	60	08.486	Bobber 2376 Drifter 63136 near D
704	11/15/06 14:16	12/02/06	00:17	39	15.896	67	02.408	north of Gulf Stream

Table 5.3: Bobber deployment locations during voyage *Oceanus* 434, November 2006

Bobber SN	Argos ID	Deployment Time UTC	Latitude North		Longitude West		Notes
			deg	min	deg	min	
2375	38599	11/24/2006 01:02	36	57.085	58	33.392	Drifter 63132
2376	38600	11/24/2006 01:59	36	07.408	60	08.516	Drifter 63136 SOLO 701
2377	38601	11/25/2006 01:27	37	30.931	57	31.357	Drifter 63130
2381	38608	11/27/2006 21:40	38	22.279	55	50.323	Drifter 63131
2524	39474	11/28/2006 15:43	38	14.152	59	20.369	

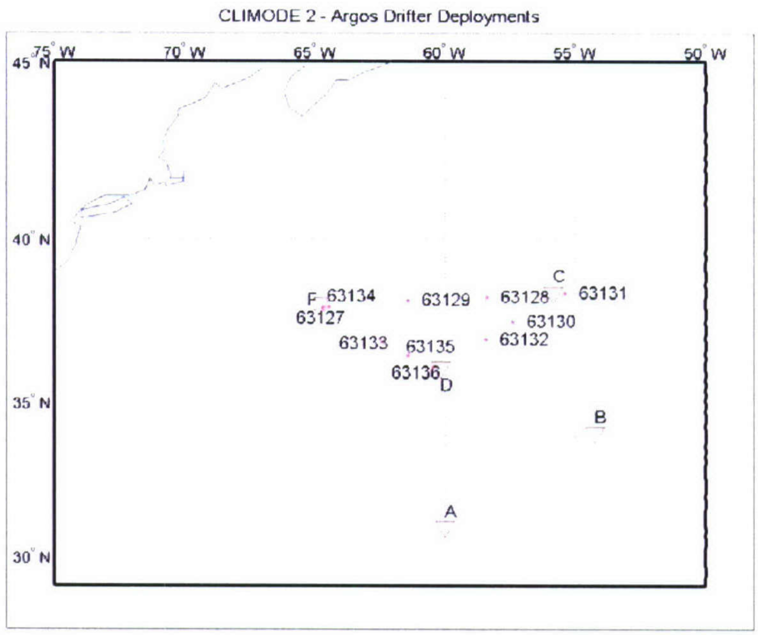


Figure 5.1: Argos drifter deployment locations during voyage *Oceanus* 434, November 2006.

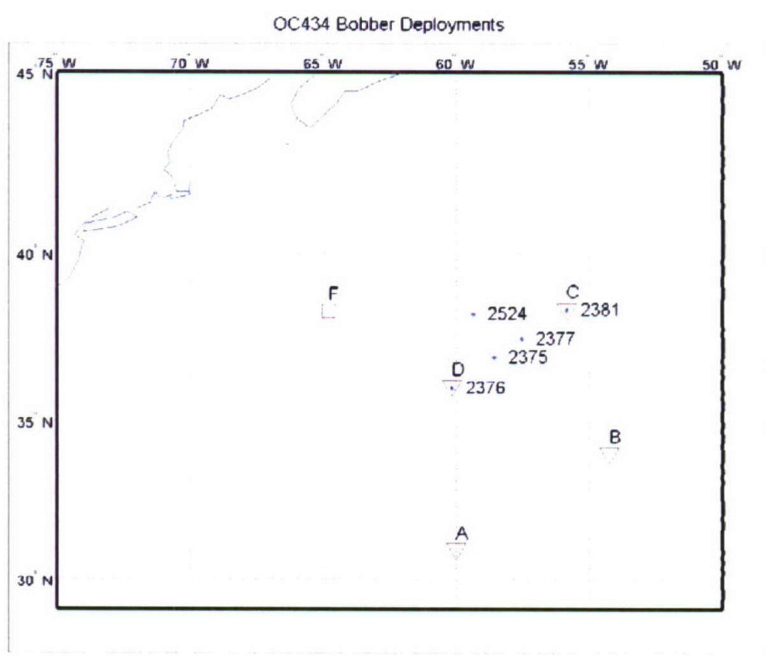


Figure 5.2: Bobber deployment locations during voyage *Oceanus* 434, November 2006.

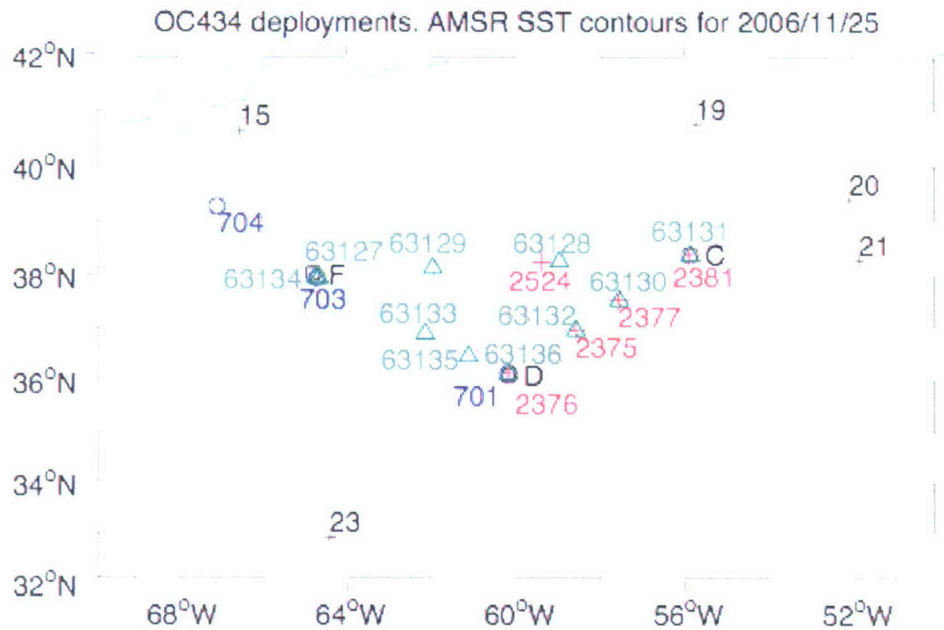


Figure 5.3. Locations of all deployments during *Oceanus* voyage 434, November 2006: floats (o, blue), bobbers (+, red) and drifters (Δ, green). Black squares are Climode moorings C, D and F. Colored contours denote SST from AMSR satellite sensor on 2006/11/25.

V.B. Nutrient Measurements with ISUS

As part of CLIMODE, a collaboration with Duke University was set (involving Suzan Lozier and Jaime Palter) to study the biological cycle in the formation region of EDW. The subsurface moorings are equipped with a nitrate sensor called ISUS (In Situ Ultraviolet Spectrophotometer) from Satlantic.

V.B.1. Cruise preparations.

Prior to the cruise, new batteries and battery cables were purchased for the ISUS instruments. On route to the mooring, the chief engineer crafted a sacrificial anode in the event that the instrument's anodes were irreparably corroded. The anodes were not badly corroded and we saved the new one for future use. We also bought 50ml bottles to collect nutrient samples at the moorings and secured a -70ºC freezer to store the samples in for analysis on land.

V.B.2 ISUS recovery on Climode D.

The ISUS 078 Nitrate Sensor was recovered from the Mooring D at roughly 10:30AM, 372 days after its deployment. The battery was disconnected, the ISUS removed from its tension bar, and its outside casing was cleaned. In the main laboratory, the instrument was connected to a 12-V power source and to an HP laptop via serial port. Data appeared to have been collected hourly between the November 15, 2005 deployment and the removal of the battery on the morning of November 22, 2006. About 5 days were inexplicably missing from the data archive. Downloading to the computer was initiated using a hyperterminal, which allows access to the internal flash drive of the ISUS. After 100 days of data were downloaded using the DAD (Download All Data) command, a glitch in the ISUS software aborted downloading. Two calls were placed to Satlantic to try and resolve the problem. Satlantic realized that ISUS was errantly programmed with an imposed maximum of 100 files on the automated downloading process. With no solution available while at sea, each daily log file had to be downloaded individually using the command DD (download data). Downloading was completed at midnight EST. During the manual download, other tasks were completed to ready the ISUS for deployment the next day: the probe tip was cleaned with isopropyl alcohol on a cotton swab, the pressure purge valve was placed on the new battery, the dummy-plugs were greased, and the copper bio-fouling guard was cleaned and its O-ring was greased. It is interesting to note that the swab that cleaned the probe tip did seem to show a residue of algae, although the plastic components inside the copper biofouling had a thin film of algae. The exterior of the copper biofouling guard was not noticeably damaged or eroded.

V.B.3. ISUS performance on mooring D.

The ISUS 078 sensor at mooring D outlasted the battery life we had projected for it. After the data was fully downloaded, the ISUS was switched into continuous sampling mode for calibration. Using SATview (Satlantic firmware for real-time ISUS data viewing) four calibration samples were logged for 1-minute each: miliQ water (0uM Nitrate), 0.513 μM, 1.026μM, and 3.077μM. Jaime Palter mixed these samples in Matt Charette's lab with the help of Paul Henderson on November 15, 2006 and placed them in the main lab refrigerator on November 16. For the ISUS calibration, the probe tip was held in small plastic vial of each sample for 1 minute, as was done in November 2005, prior to deployment. The results from this post-deployment calibration have not yet been processed.

The raw, binary ISUS data from the year-long deployment was post-processed with Satlantic's firmware ISUSpro, after negotiating several bugs with the help of emails from Satlantic's technicians. The data, which was recorded in binary format for disk space considerations, must be processed using binary calibration (.cal) and telemetry definition files (.tdf) provided from Satlantic. These filenames end with the letter 'b' for binary. However, ISUSpro malfunctions if the .tdf filenames end with anything other than an 'f', so the binary filename must be changed. The batch processing was also not functioning properly, so each file was processed individually.

The time series of ISUS 078 nitrate concentration at Mooring D shown in Figure 5.4. For the first several months of the record, there is a clear visual correlation between nitrate concentration and pressure from the SeaBird 37 (see figure 4.11). Pressure readings from the SeaBird 37 (just below the ISUS) indicate that the blowdown of the instrument was between 10m and 400m for the previous year. When the instrument is pushed to anomalously deep pressures, it records high nitrate concentions (Figure 5.5). Such correlation is the result of the ISUS nitrate sensor being dragged into the nitricline (the vertical nitrate gradient). The correspondence between these variables is reassuring, as the calibration tests in November 2005 had raised concerns about sensor drift and accuracy (Figure 5.4). During laboratory testing in November 2005, both ISUS sensors yielded negative nitrate concentrations for all the samples (Figure 5.5), suggesting a negative sensor drift between the setup of the instrument by Satlantic and our laboratory testing a month later. Indeed, during the year-long deployment there is a clear negative, linear trend in the data that is likely caused by sensor drift. The calibration samples run after the recovery should help resolve this issue. Nevertheless, ISUS 078 appears to have recorded real variability and the sensor drift may simply be a linear trend that can easily be removed (Figure 5.5).

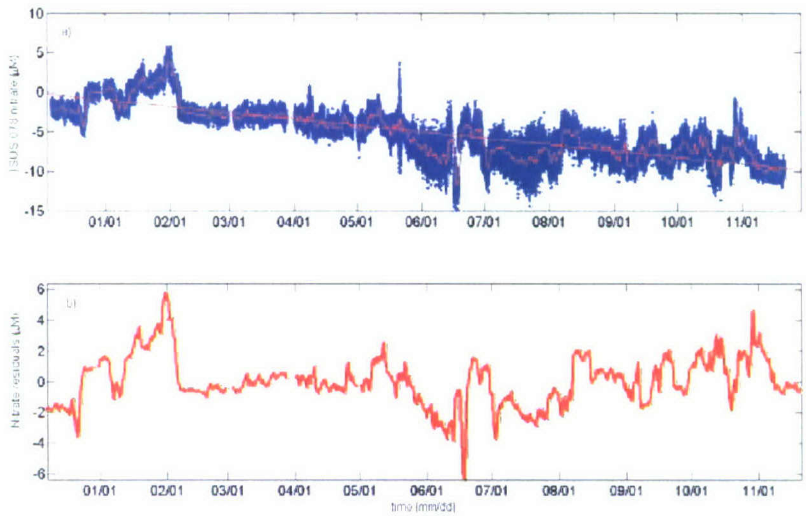


Figure 5.4: The nitrate time series from the ISUS 078 at mooring D. These are made using the original calibration files, and are not corrected for the drift observed during laboratory testing. (a) The blue dots show the nitrate concentration for each frame collected during 20 second sampling period each hour. The red curve is the 450-point (approximately 1-day) filtered data, and the straight red line is the linear regression of the filtered data. (b) The residuals of the filtered data after subtracting the linear regression line, which is likely caused by sensor drift.

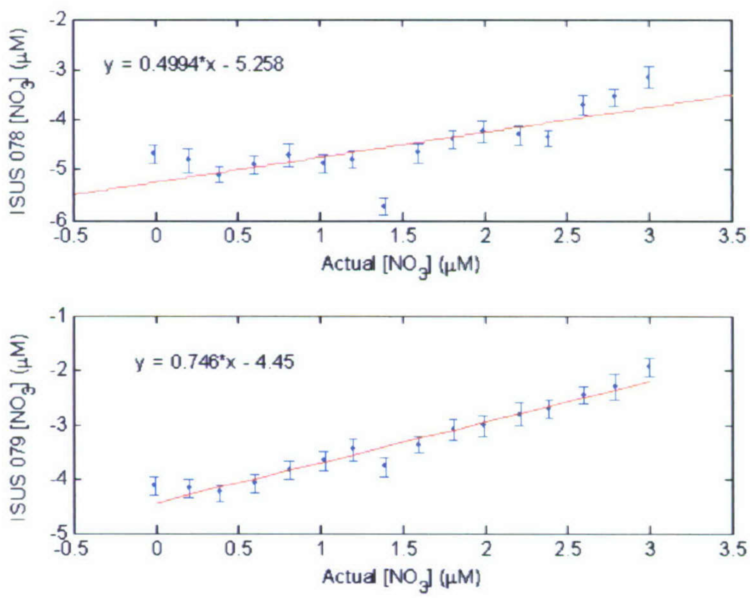


Figure 5.5: The ISUS nitrate concentration versus the known sample concentration for each of the ISUS sensors, made during laboratory testing in November 2005. (a) ISUS 078, recovered and redeployed at Mooring D. (b) ISUS 079, recovered at Mooring C.

V.B.4 Redeployment of ISUS on mooring D.

Subsequent to calibration, the ISUS disk was purged of most of its data using the command EAD (erase all data). A programming glitch required that only 100 files were erased at a time, and about 100 files were accidentally left on the ISUS internal flash drive. We anticipate ample disk space for the 2007 sampling year, despite this abandoned data. Finally, the ISUS was switched back to scheduled mode and left for the mooring crew to connect to the new battery and tension bar for deployment at first light. Jeff Lord connected the new battery and tension bar and the ISUS entered the water at 13:04UTC. The anchor on Mooring D dropped at 21:24:15UTC. Given the water depth at the new anchor position (4900m, after fallback calculations), ISUS should reside between 70m and 80m (neglecting the impact of currents) for this second year of deployment.

V.B.5 Recovery of ISUS on mooring C.

The ISUS 079 nitrate sensor was recovered from mooring C at 11:15UTC on November 26, 2006, 374 days after its deployment. It had slight biofouling: a smooth film of algae and a small number of barnacles and clams. The copper biofouling guard was noticeably corroded, with green and purple oxidation. Algae coated its plastic interior and grew on the ISUS probe tip. Because ISUS 079 at mooring C was still collecting data upon recovery, it was decided to run the calibration samples on ISUS 079 directly after recovery and before cleaning, an approach recommended for next year's recovery. Unfortunately, after connecting ISUS 079 via serial port to the HP laptop, it became clear that the ISUS was no longer functioning.

We checked all the cables for shorts (and used backup cables to be sure), tried various computers, and checked continuity across pins. None of these troubleshooting efforts yielded any results. There was no obvious sign of leakage or flooding and the casing was intact. After several hours of trouble shooting, Jeff Lord and others helped to open the ISUS casing, check for signs of damage and leaking, and remove the flash drive. There were no obvious signs of damage, no seawater inside the instrument, and the reason for failure is still unknown. One small, cylindrical silver piece (possibly a capacitor) on the ISUS interface was loose. We soldered it into place and again tried to communicate with ISUS with no success.

We pulled the flash card and reassembled the ISUS. A crimp on one of the ground connections broke and we left it detached. The flash card had about 70 days of data and showed that the last day of data collection was February 4, 2006. The last error message was, *01/01/2006 00:00:27: ERROR: Suspension failed due to bad wakeup time. Skip to next.* Instead of redeploying the instrument, we will be shipping it to Satlantic in Halifax for repairs. Nevertheless, the 70 days of data appears to have recorded some of the high current events inferred from the SeaBird CTD pressure data, during which the mooring line was blown down as deep as 600m from its target depth (see Figure 4.16). As for mooring C, the nitrate concentration rises sharply as the sensor descends into the nutricline during times of strong currents (Figure 5.6). However, the calculated nitrate concentrations are much lower (<-15) than those for pure water during laboratory testing and may signal early problems with the accuracy of the sensor.

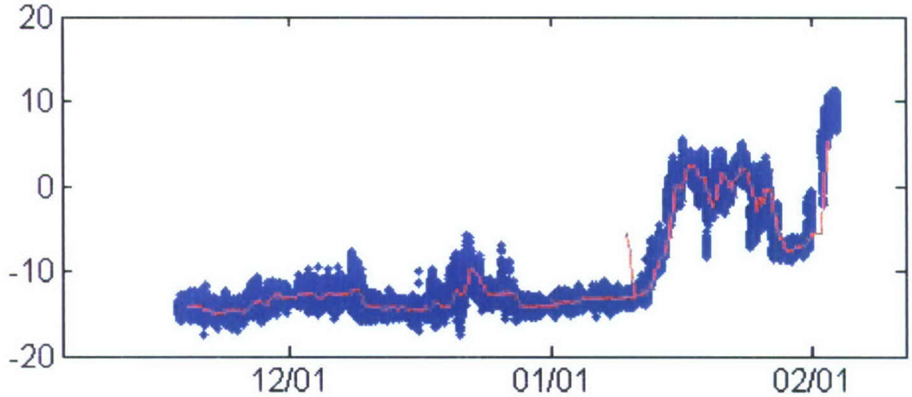


Figure 5.6: As for Figure 5.4, except for ISUS 079 at mooring C. Note that the calculated nitrate values are large and negative, much below the value for deionized water during laboratory testing.

ISUS 079 was not redeployed as it was no longer working upon recovery.

VI. CTD CASTS

22 CTD stations were occupied during the Climode November 2006 cruise. They are numbered 2-23 since the first station resulted in no data because of computer problems. The locations of the casts are shown in Fig 6.1 and 6.2. CTDs were conducted near the mooring sites as a way to intercalibrate instruments on the moorings. A series of casts were also conducted across the Gulf Stream from the mooring F site on the way back to Woods Hole. Table 6.1 has the CTD depths, times and locations corresponding to Fig 6.2.

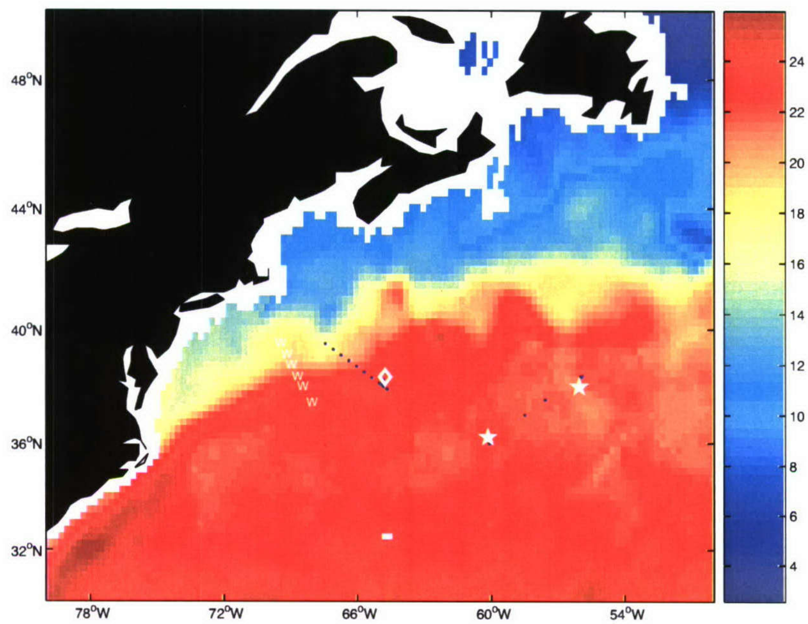


Figure 6.1: SST map (from K. Kelly) on Nov 26, 2006. White stars are subsurface moorings, white diamond is surface mooring F, Ws denote line W and white rectangle is Bermuda. The blue dots show the locations of the CTD casts during cruise *Oceanus* 434.

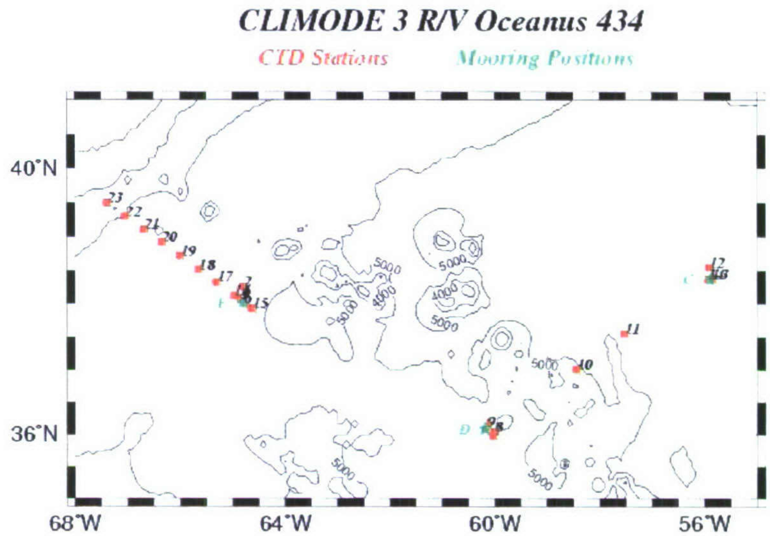


Fig.6.2: CTD station locations and numbers corresponding in Table 6.1.

Table 6.1: CTD locations, depths and times during Climode cruise (November 2006).

Sta. No.	Date (dd/mm/yy)	Nominal Position (Deg/Min) (Bottom of cast) N. Lat.	W. Long	Time(UTC) (Bottom of cast)	Max Pressure(db)	Corrected Bottom Depth(m)
1.	Station 1 was aborted due to computer problems					
2.	18/11/06	38 15	64 47	1430	699	4981
3.	18/11/06	38 06	64 51	1657	1500	4965
4.	18/11/06	38 05	64 50	1841	1529	4965
5.	18/11/06	38 04	64 50	1947	1526	4965
6.	18/11/06	37 60	64 46	2203	996	4984
7.	22/11/06	35 59	60 01	0139	3013	4840
8.	22/11/06	36 02	60 00	1828	3001	4892
9.	24/11/06	36 08	60 08	0026	2002	4932
10.	24/11/06	36 59	58 26	1454	1998	3337
11.	25/11/06	37 32	57 31	0030	2000	5218
12.	25/11/06	38 21	55 55	1324	700	5289
13.	26/11/06	38 23	55 51	2132	700	5307
14.	28/11/06	38 22	55 56	0031	2002	5299
15.	30/11/06	37 56	64 35	1655	1998	4998
16.	30/11/06	38 07	64 55	2133	2001	4958
17.	1/12/06	38 19	65 15	0249	2006	4892
18.	1/12/06	38 29	65 37	0758	1988	4730
19.	1/12/06	38 43	66 00	1218	2003	4621
20.	1/12/06	38 54	66 20	1550	2000	4576
21.	1/12/06	39 06	66 41	1914	2000	4428
22.	1/12/06	39 17	67 02	2306	1998	4164
23.	2/12/06	39 29	67 23	0259	2001	3726

VI.A. Instrumentation

The CTD rosette used was a WHOI-manufactured stainless steel frame with 24 WHOI-manufactured 3.3 liter sampling bottles (Fig. 6.3). A Seabird 911+ CTD sensor was mounted at the bottom of the frame. Also mounted on the rosette was a Datasonics altimeter. A Seabird 24-position carousel triggered the sampling bottles.

Figure 6.3: Climode CTD/Rosette onboard *Oceanus* voyage 434.

A prototype CTD under development by Ray Schmitt was hose-clamped to one of the lower vertical frame members for intercomparison with the Seabird CTD (Fig. 6.4).

Figure 6.4: Prototype CTD strapped to frame

On the 22 CTD stations occupied on this cruise, 417 samples each of oxygen and salts were collected and analyzed on board.

The oxygen analysis was carried out using the automated Winkler titration apparatus designed and described by Knapp et al. in the WHOI Technical Report "WHOI-90-35." The thiosulphate solution used for titrations is calibrated each day against a solution of potassium biiodate standard with a normality of exactly .01. This system measures the titrant needed to reach the endpoint with a resolution of better than .001 ml. The standard deviation of replicate samples is .005 ml/l and the accuracy is about .02 ml/l.

All salinity samples were processed using an Autosal 8400B, WHOI serial number 11. It was standardized daily with batch No. P-146 standard water. It performed well. It was installed in the forward part of the main lab of Oceanus, which has poor temperature regulation.

For the best accuracy, the lab temperature should be constant and 1-2 degrees below the bath temperature. This is because the bath has very little cooling capacity. Precise temperature regulation is accomplished by having the instrument in an environment one to two degrees cooler than the bath temperature. Thermistors in the bath measure the temperature and cycle the heaters on and off to maintain the temperature at precisely 24 degrees, plus or minus .02 degrees.

Bottle salts from station two thru station seven were done at a salinometer bath temperature of 24 degrees C. On November 24, the lab temperature rose above 24 degrees so the bath temperature was raised to 27 degrees C. Salts from stations eight thru twenty-three were done at bath temperature of 27 degrees.

After the cruise, the bottle data were processed and applied to the CTD calibration by Jane Dunworth-Baker.

VI.B. Rosette/Bottle System Performance

Throughout the cruise, we had many problems with the rosette performance and misfiring bottles. These problems were not resolved due, in part, to operator unfamiliarity with the Seabird software/hardware coupled with a brand new ship's technician who was not familiar with the system. According to Marshall Swartz, an expert user of this system, the problem could have been caused by not having a computer dedicated only to CTD data acquisition.

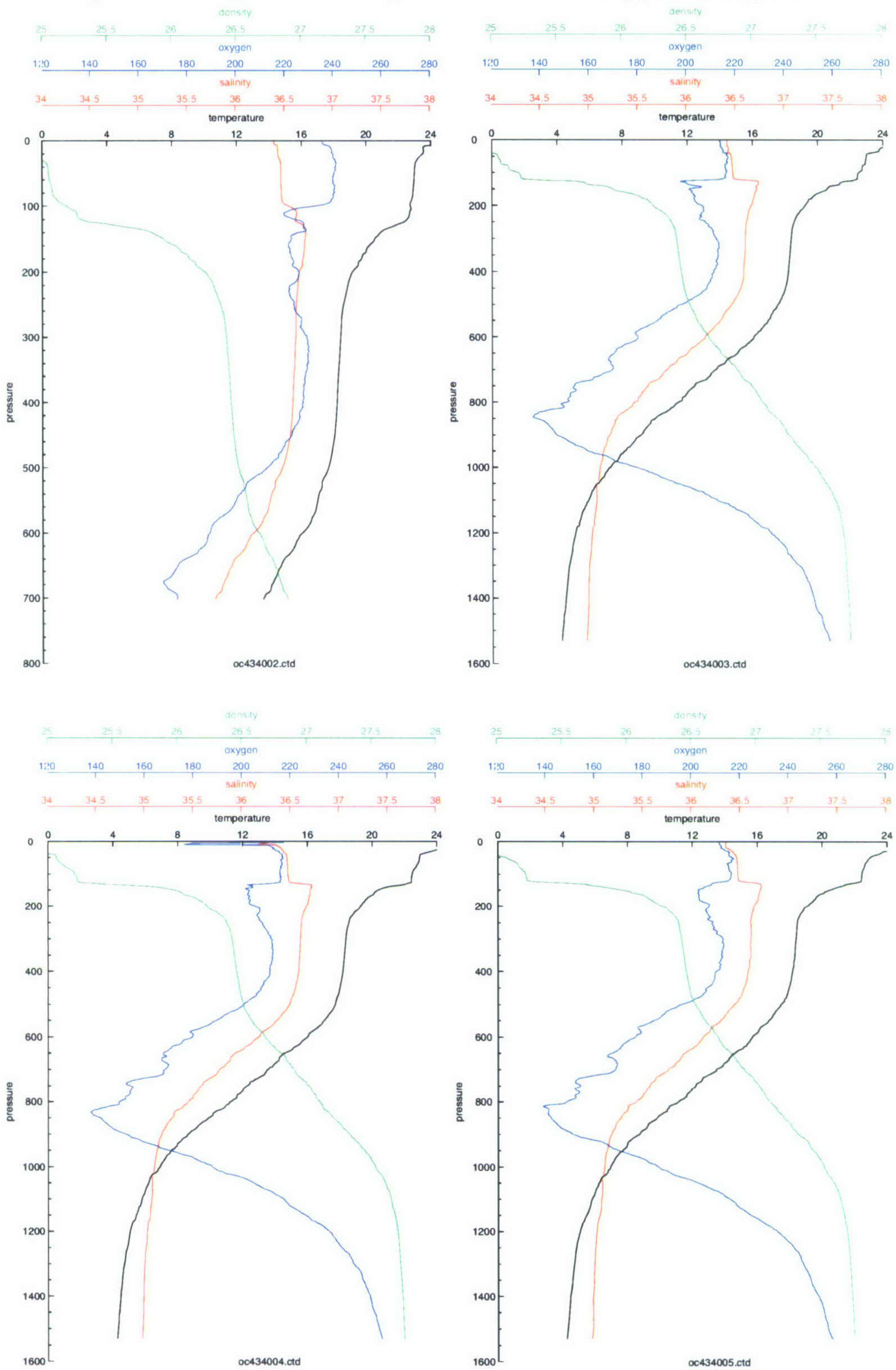
Station-by-Station Comments
(Numbers refer to CTD Station Numbers)

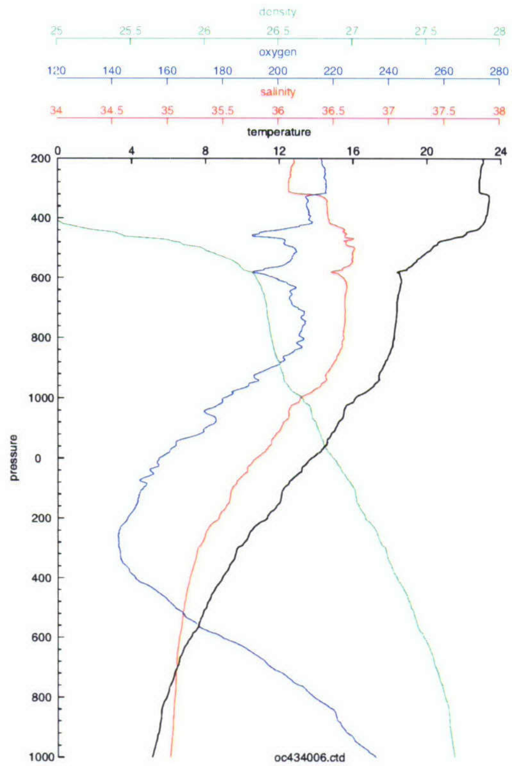
1. No data – computer problems
2. Bottle 9 (300m) no sample – lanyard hangup
3. No bottles fired – Acoustic release test lowering
4. No bottles fired – Acoustic release test lowering
5. No bottles fired – Acoustic release test lowering
6. Station done 1 mile from new Climode "F" surface mooring

7. Many bottle firing malfunction indications – bottle 21 did not fire, all others did
8. 1200 m. bottle didn't fire first time
9. OK
10. Many firing problems – only bottles 1-13 fired
11. All bottles fired - No. 12 did not confirm firing
12. OK – some bottles didn't confirm
13. Bottle 4 no fire – had to revert to manual control
14. OK, but no salt sample from bottle 11 – watchstander/sampler error
15. OK
16. OK
17. 4.2 Knots of current. CTD wire snagged on hull. At 1052m on the wire there is a slight dent in the wire due to the snag on the hull. It was determined still usable.
18. 2.8 knots of drift speed. Large wire angle
19. Bottle 24 did not fire
20. Much firing trouble. 24 bottles fired
21. OK
22. OK
23. Much firing trouble. 24 bottles fired. Bottle 15-lanyard hangup

VI.C Results.

Individual CTD plots. A composite T/S diagram for all stations appear in Fig.6.5.

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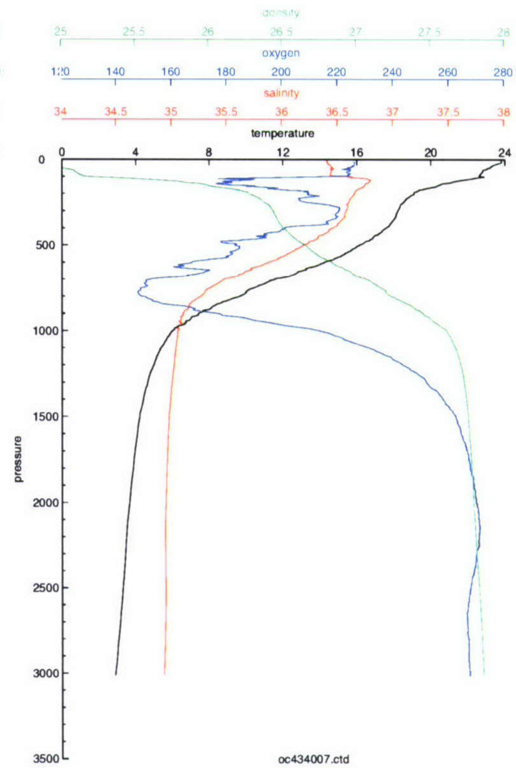
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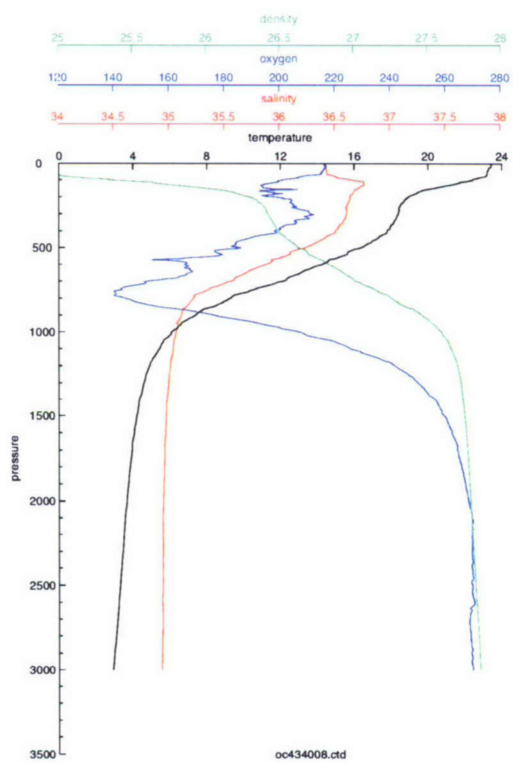
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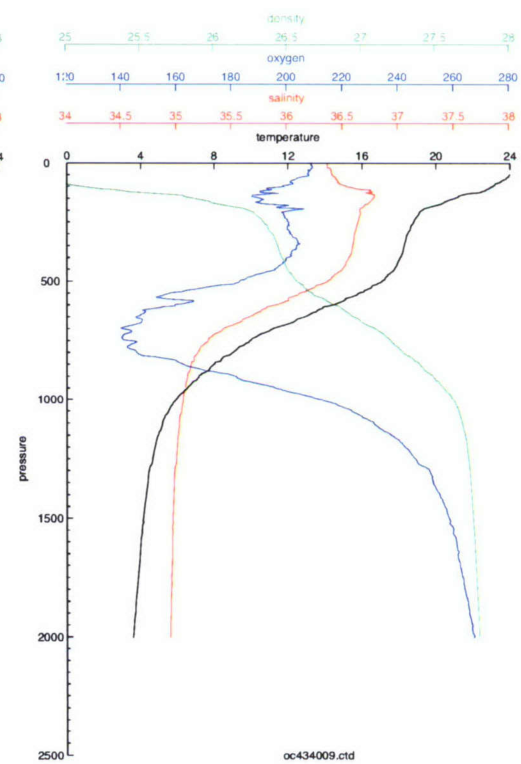
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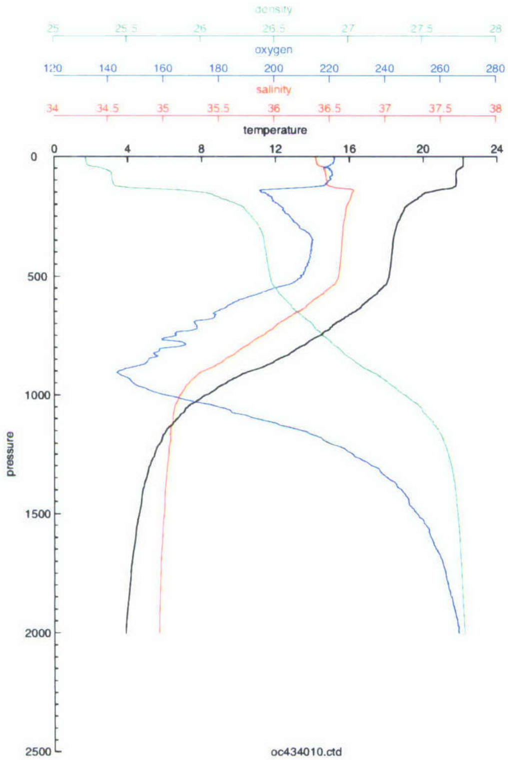
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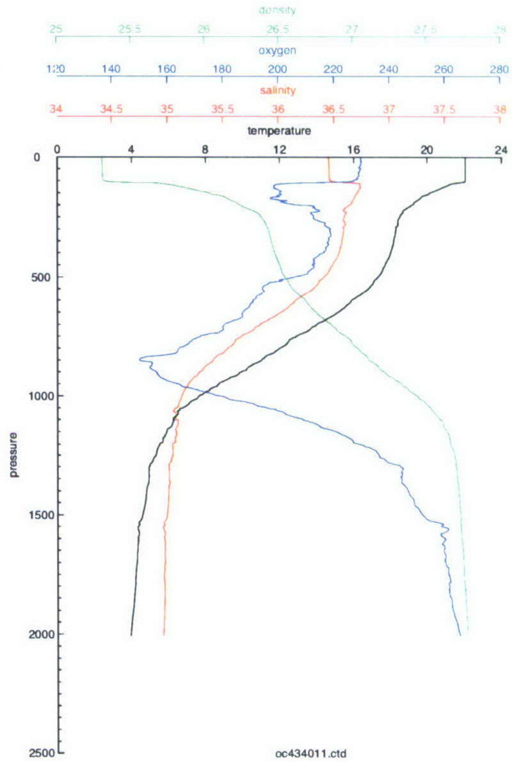
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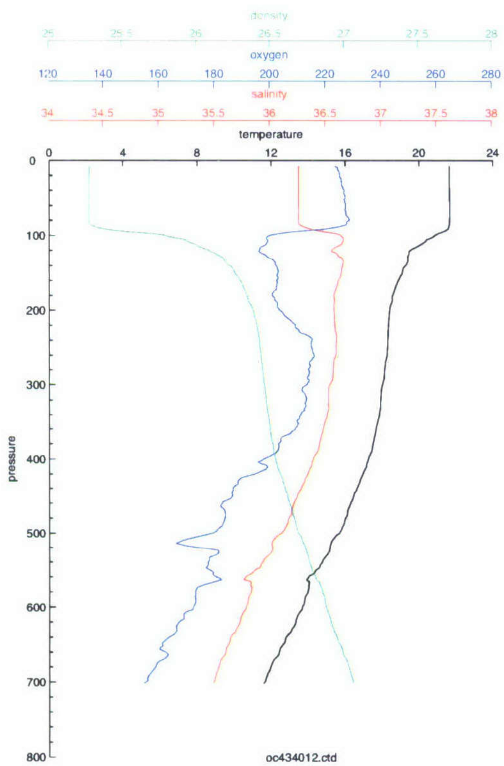
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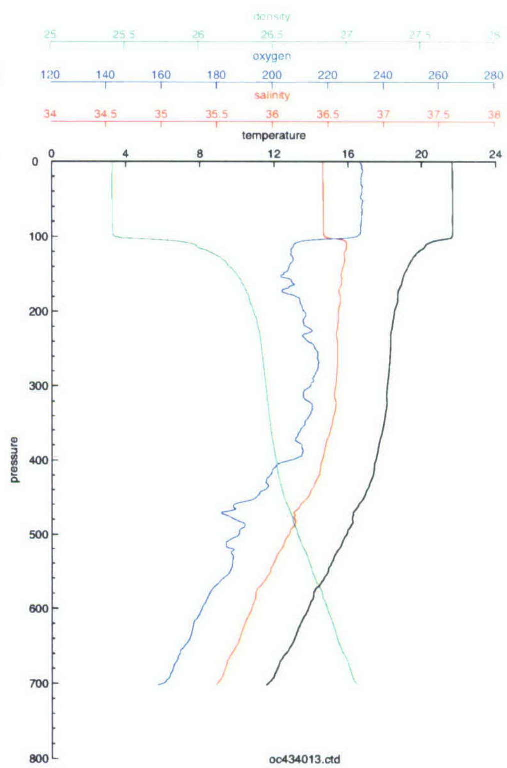
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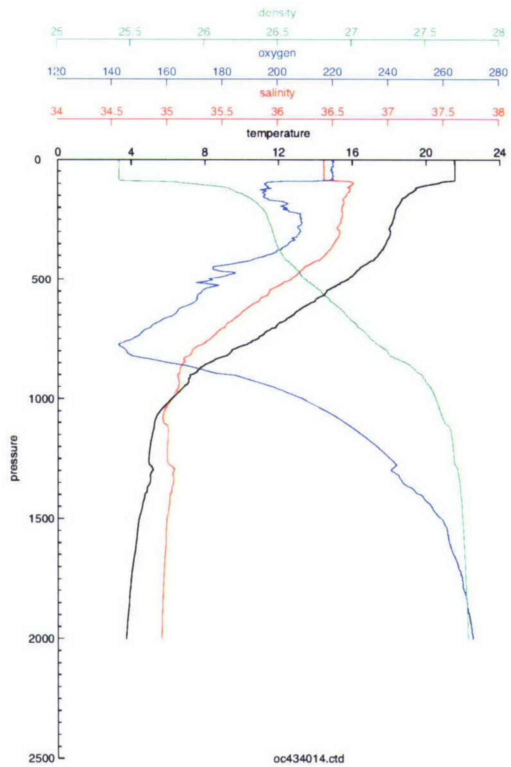
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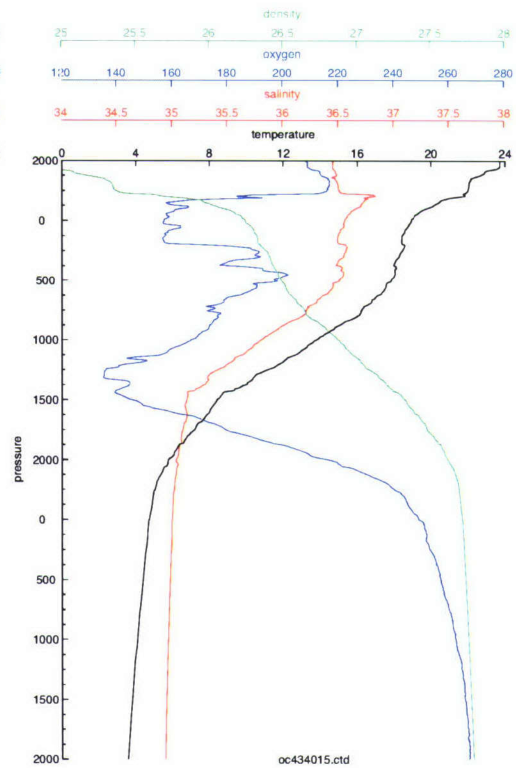
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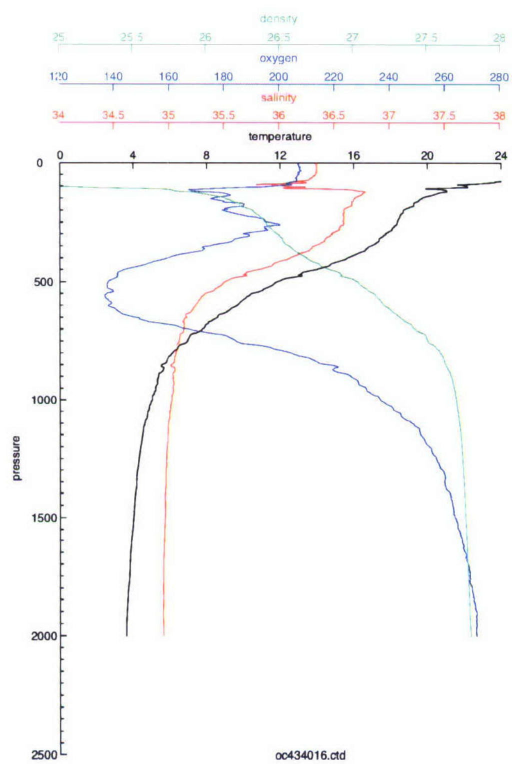
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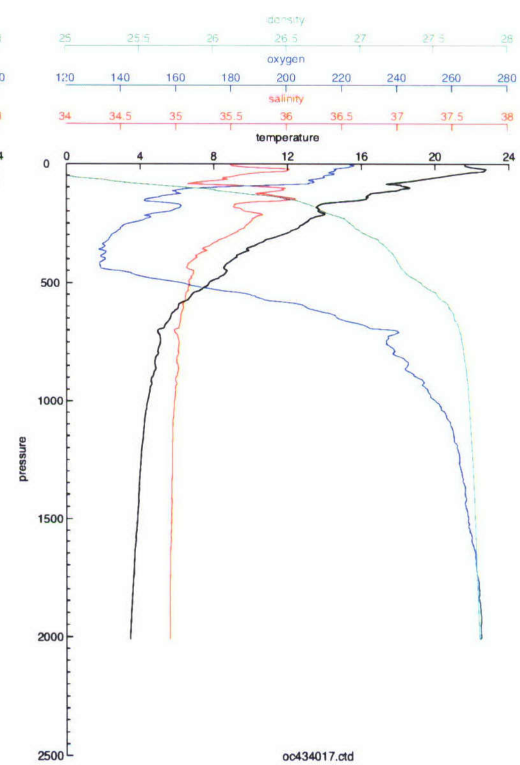
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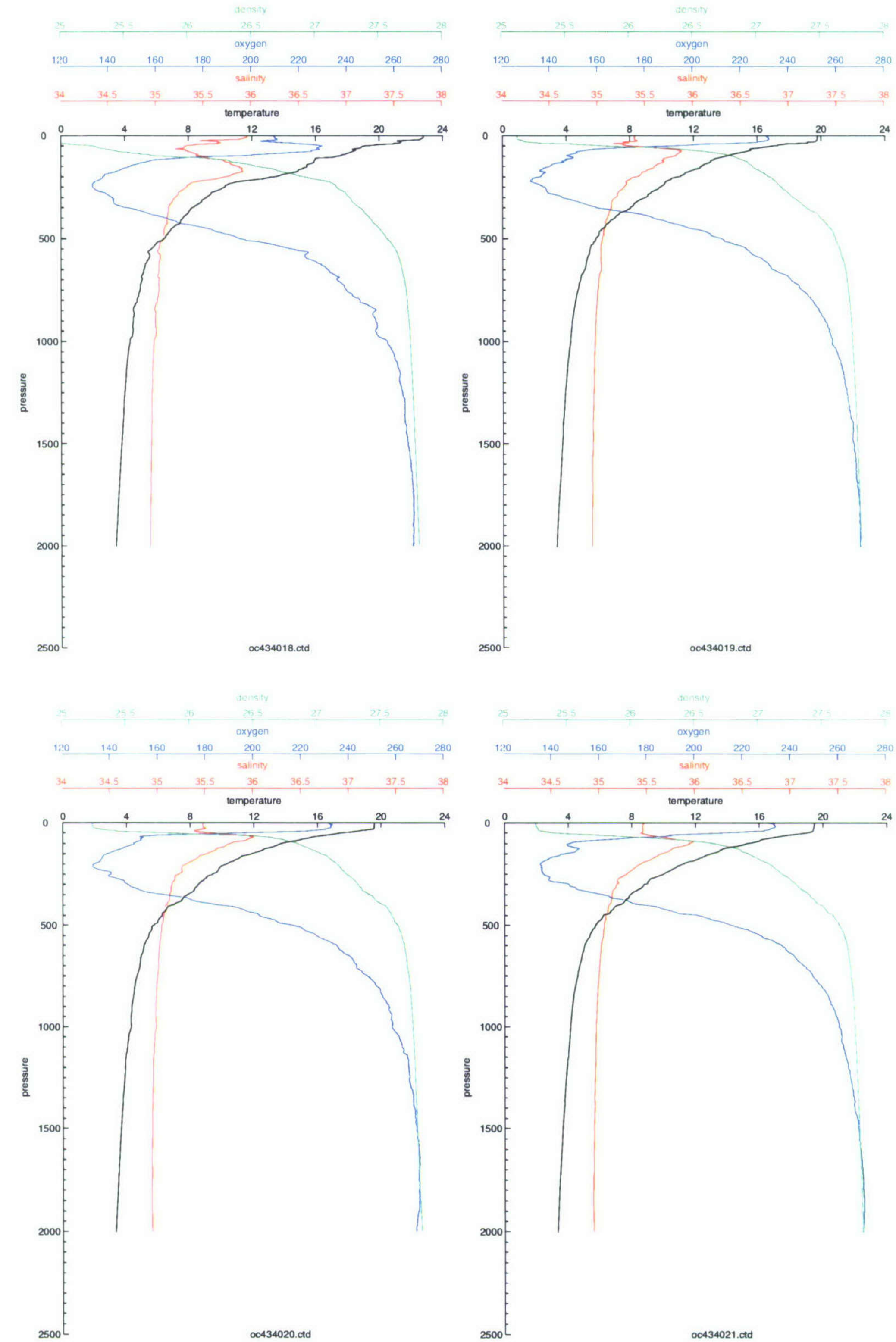
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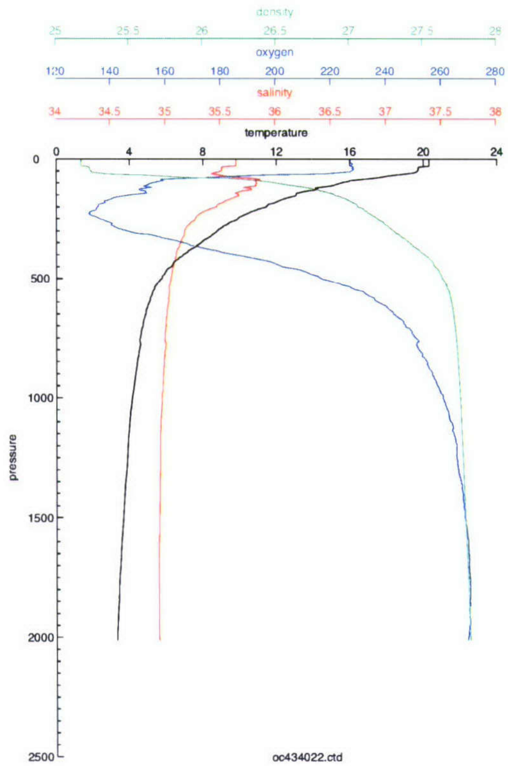
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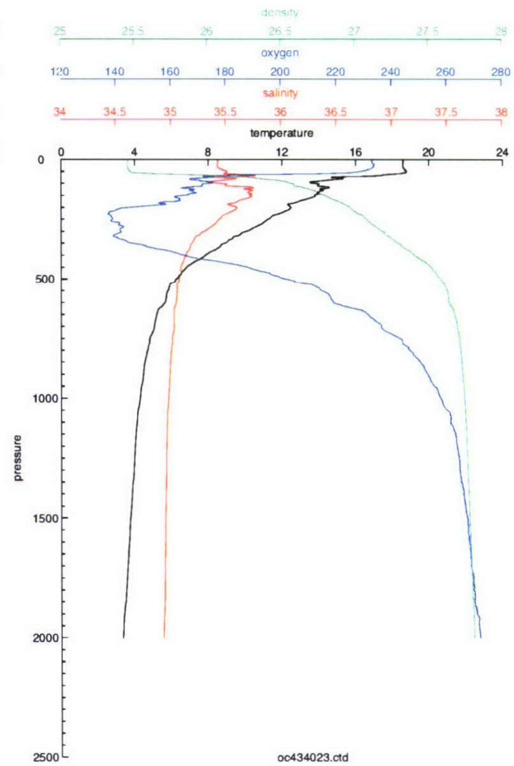
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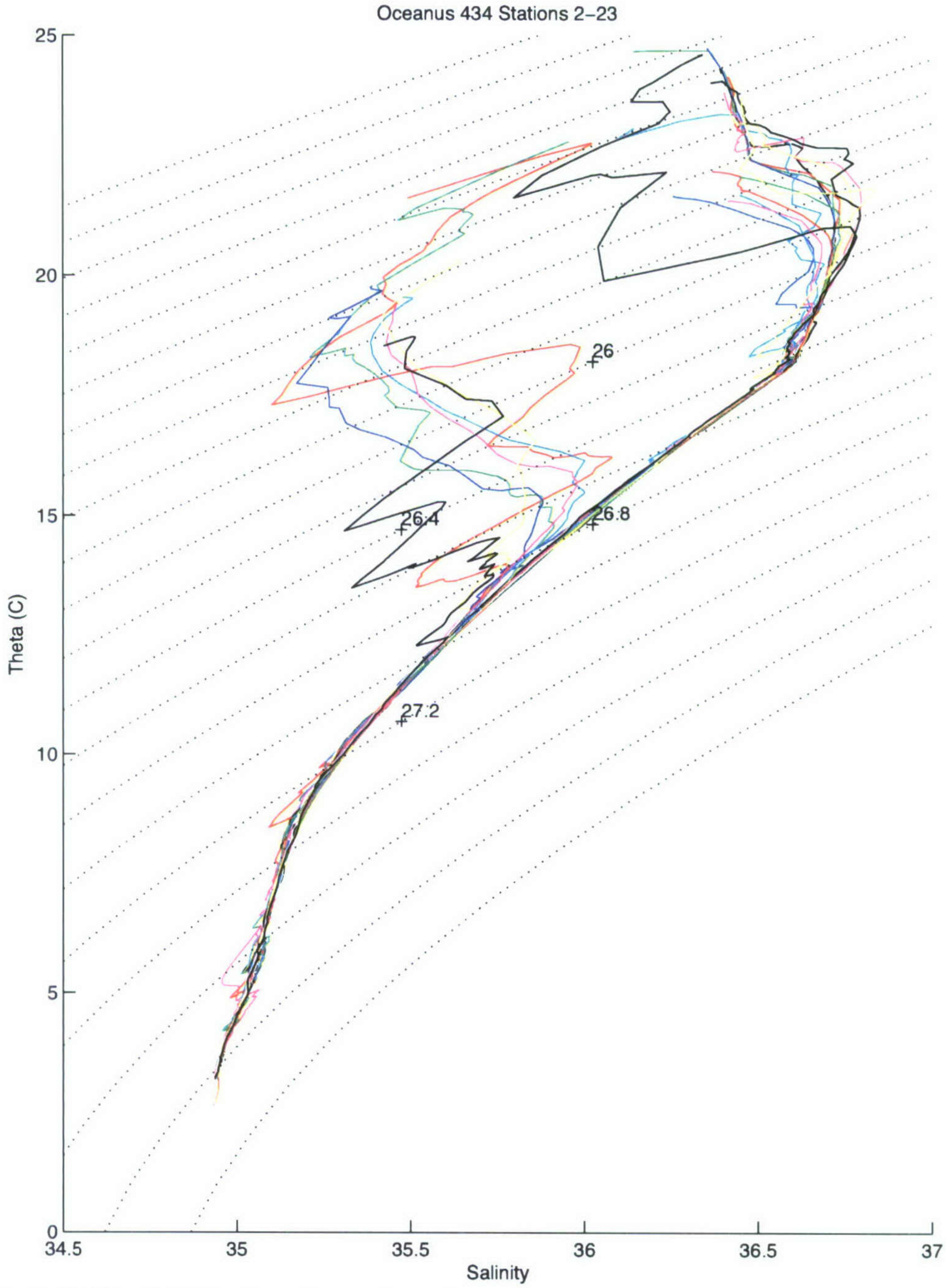

Figure 6.5: Individual CTD plots for each station and temperature-salinity diagram for 22 CTD stations of cruise *Oceanus* 434, November 2006.

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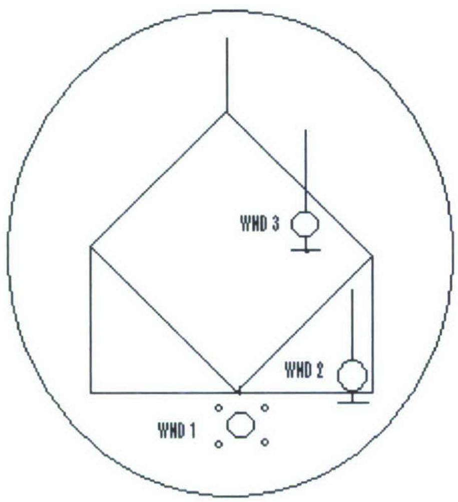
Appendix 1: CLIMODE 2 Buoy spin and burn-in notes.

CLIMODE 2 Primary Buoy Spin
Woods Hole

309 deg. Heading



Vanes Secured Time/Date UTC: 10:43:00 , 10 NOV 06

System 1	Sonic calibrated output	Time UTC
Logger #: L-17		
Stop Sampling: 11:21:30		
Wind #: SWND201	-0.18, 0.39, 0.7, 1.9, 238.3, 87.7	11:22:00
Restart Sampling: 11:22:30		

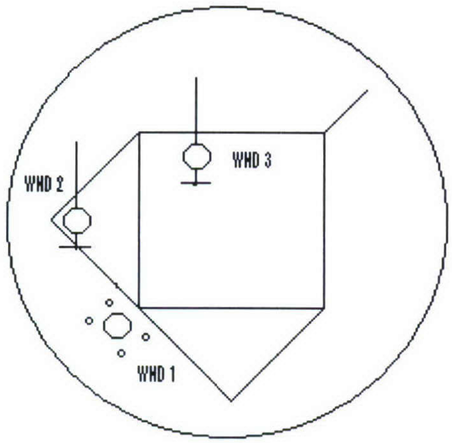
System 2	Compass	Vane	Direction	Time UTC
Logger #: L-18				
Stop Sampling: 11:23:30				
Wind #: WND225	147.1	165.7	311.8	11:24:00
Restart Sampling: 11:24:30				

Stand alone wind	Compass	Vane	Direction	Time UTC
WND205:	123.4	182.7	306.1	11:28:00

Spare System	Compass	Vane	Direction	Time UTC
Logger #: L-22				

Vane blocked: 19:00:00				
Stop Sampling: 19:18:30				
Wind #: WND207	53.3	257.3	310.6	19:19:00
Restart Sampling: 19:19:30				

309 deg. Heading



Vanes Secured Time/Date UTC: 11:49:00 , 10 NOV 06

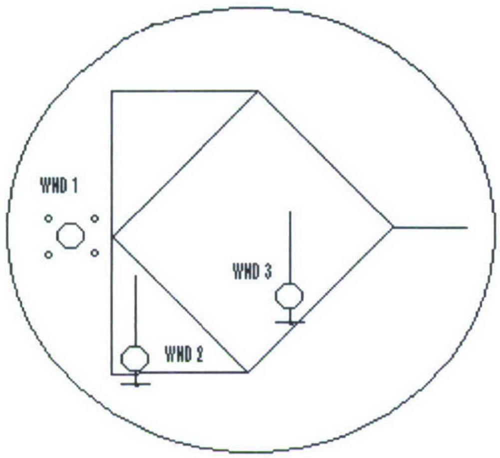
System 1	Sonic calibrated output	Time UTC
Logger #: L-17		
Stop Sampling: 12:20:30		
Wind #: SWND201	-0.03, -0.15, 0.5, 1.1, 155.9, 31.0	12:21:00
Restart Sampling: 12:21:30		

System 2	Compass	Vane	Direction	Time UTC
Logger #: L-18				
Stop Sampling: 12:22:30				
Wind #: WND225	187.7	121.0	308.7	12:23:00
Restart Sampling: 12:23:30				

Stand alone wind	Compass	Vane	Direction	Time UTC
WND205:	167.7	137.7	305.4	12:24:00

Spare System	Compass	Vane	Direction	Time UTC
Logger #: L-22				
Vane blocked: 19:21:00				
Stop Sampling: 19:37:30				
Wind #: WND207	101.3	212.0	313.3	19:38:00
Restart Sampling: 19:38:30				

309 deg. Heading



Vanes Secured Time/Date UTC: 12:45:00 , 10 NOV 06

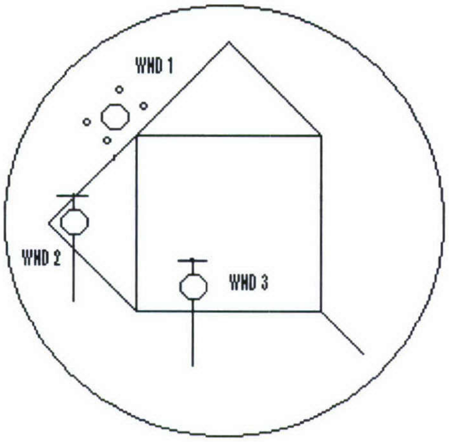
System 1	Sonic calibrated output	Time UTC
Logger #: L-17		
Stop Sampling: 13:15:30		
Wind #: SWND201	-0.55, 0.32, 0.7, 1.3, 216.2, 78.4	13:16:00
Restart Sampling: 13:16:30		

System 2	Compass	Vane	Direction	Time UTC
Logger #: L-18				
Stop Sampling: 13:17:30				
Wind #: WND225	230.0	78.0	308.0	13:18:00
Restart Sampling: 13:18:30				

Stand alone wind	Compass	Vane	Direction	Time UTC
WND205:	213.4	95.8	309.2	13:19:00

Spare System	Compass	Vane	Direction	Time UTC
Logger #: L-22				
Vane blocked: 19:39:00				
Stop Sampling: 19:55:30				
Wind #: WND207	155.6	158.1	313.7	19:56:00
Restart Sampling: 19:56:30				

309 deg. Heading



Vanes Secured Time/Date UTC: 13:45:00 , 10 NOV 06

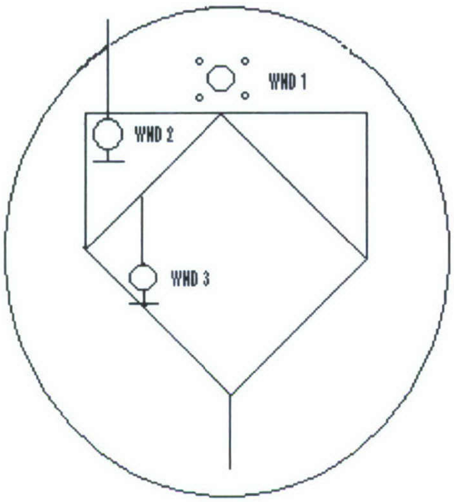
System 1	Sonic calibrated output	Time UTC
Logger #: L-17		
Stop Sampling: 14:15:30		
Wind #: SWND201	0.26, -0.11, 0.6, 1.0, 200.7, 23.2	14:16:00
Restart Sampling: 14:16:30		

System 2	Compass	Vane	Direction	Time UTC
Logger #: L-18				
Stop Sampling: 14:17:30				
Wind #: WND225	275.6	35.0	310.6	14:18:00
Restart Sampling: 14:18:30				

Stand alone wind	Compass	Vane	Direction	Time UTC
WND205:	257.3	53.2	310.5	14:19:00

Spare System	Compass	Vane	Direction	Time UTC
Logger #: L-22				
Vane blocked: 19:58:00				
Stop Sampling: 20:15:30				
Wind #: WND207	193.5	120.0	313.5	20:16:00
Restart Sampling: 20:16:30				

309 deg. Heading



Vanes Secured Time/Date UTC: 14:48:00 , 10 NOV 06

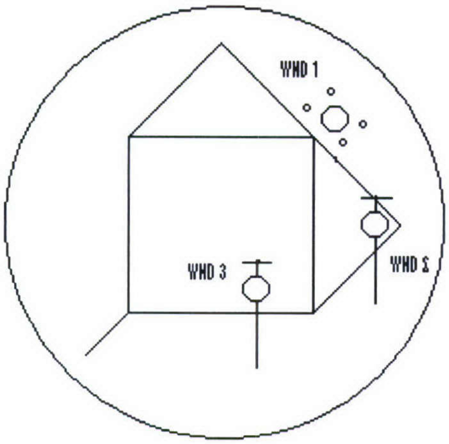
System 1	Sonic calibrated output	Time UTC
Logger #: L-17		
Stop Sampling: 15:20:30		
Wind #: SWND201	0.22, -0.96, 1.11, 2.3, 133.6, 72.3	15:21:00
Restart Sampling: 15:21:30		

System 2	Compass	Vane	Direction	Time UTC
Logger #: L-18				
Stop Sampling: 15:22:30				
Wind #: WND225	328.1	345.9	314.0	15:23:00
Restart Sampling: 15:23:30				

Stand alone wind	Compass	Vane	Direction	Time UTC
WND205:	308.0	2.0	310.0	15:24:00

Spare System	Compass	Vane	Direction	Time UTC
Logger #: L-22				
Vane blocked: 20:18:00				
Stop Sampling: 20:18:30				
Wind #: WND207	193.5	120.0	313.5	20:19:00
Restart Sampling: 20:19:30				

309 deg. Heading



Vanes Secured Time/Date UTC: 15:46:00 , 10 NOV 06

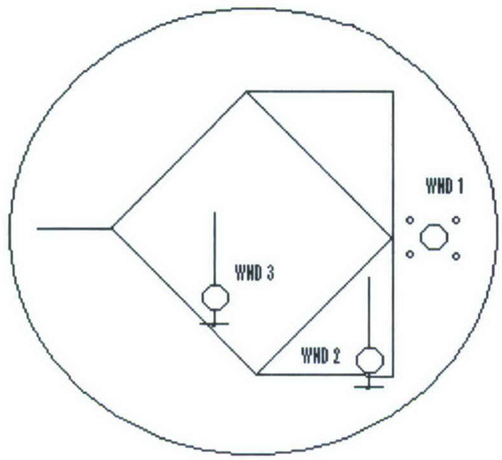
System 1	Sonic calibrated output	Time UTC
Logger #: L-17		
Stop Sampling: 16:19:30		
Wind #: SWND201	0.67, 0.47, 1.3, 2.0, 310.9, 15.7	16:20:00
Restart Sampling: 16:20:30		

System 2	Compass	Vane	Direction	Time UTC
Logger #: L-18				
Stop Sampling: 16:21:30				
Wind #: WND225	10.5	301.9	312.4	16:22:00
Restart Sampling: 16:22:30				

Stand alone wind	Compass	Vane	Direction	Time UTC
WND205:	352.7	316.2	308.9	16:23:00

Spare System	Compass	Vane	Direction	Time UTC
Logger #: L-22				
Vane blocked: 20:20:00				
Stop Sampling: 20:33:30				
Wind #: WND207	352.7	77.4	310.7	20:34:00
Restart Sampling: 20:35:00				

309 deg. Heading



Vanes Secured Time/Date UTC: 16:42:00 , 10 NOV 06

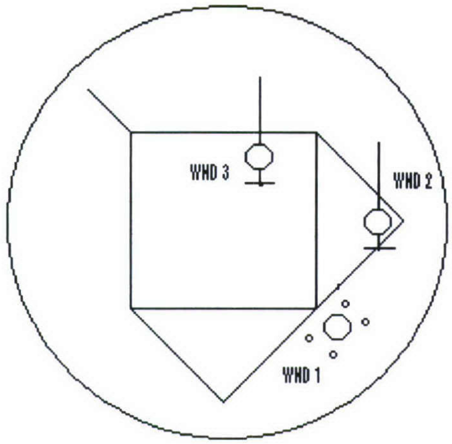
System 1	Sonic calibrated output	Time UTC
Logger #: L-17		
Stop Sampling: 17:11:30		
Wind #: SWND201	1.04, 0.30, 1.2, 2.1, 350.9, 59.8	17:12:00
Restart Sampling: 17:12:30		

System 2	Compass	Vane	Direction	Time UTC
Logger #: L-18				
Stop Sampling: 17:13:30				
Wind #: WND225	55.9	257.9	313.8	17:14:00
Restart Sampling: 17:14:30				

Stand alone wind	Compass	Vane	Direction	Time UTC
WND205:	36.4	275.9	312.3	17:16:00

Spare System	Compass	Vane	Direction	Time UTC
Logger #: L-22				
Vane blocked: 20:36:00				
Stop Sampling: 20:50:30				
Wind #: WND207	283.2	29.3	312.5	20:51:00
Restart Sampling: 20:51:30				

309 deg. Heading



Vanes Secured Time/Date UTC: 17:40:00 , 10 NOV 06

System 1	Sonic calibrated output	Time UTC
Logger #: L-17		
Stop Sampling: 18:10:30		
Wind #: SWND201	-0.20, 0.25, 0.4, 0.8, 291.9, 42.3	18:11:00
Restart Sampling: 18:11:30		

System 2	Compass	Vane	Direction	Time UTC
Logger #: L-18				
Stop Sampling: 18:12:30				
Wind #: WND225	101.0	212.5	313.5	18:13:00
Restart Sampling: 18:13:30				

Stand alone wind	Compass	Vane	Direction	Time UTC
WND205:	78.1	232.6	308.7	18:14:30

Spare System	Compass	Vane	Direction	Time UTC
Logger #: L-22				
Vane blocked: 20:53:00				
Stop Sampling: 21:11:30				
Wind #: WND207	334.0	338.6	312.6	21:12:00
Restart Sampling: 12:21:30				

Unblocked buoy wind vanes @ 18:16:00
Unblocked spare wind vane @ 21:15:00

The difference between the true heading (309 deg) and the reading from the wind sensors (vane+compass) is summarized in the following plot and gives an estimate of the error in the wind direction from these sensors. It also contains an error due to the procedure where the vanes are visually aligned with the heading reference (309 deg).

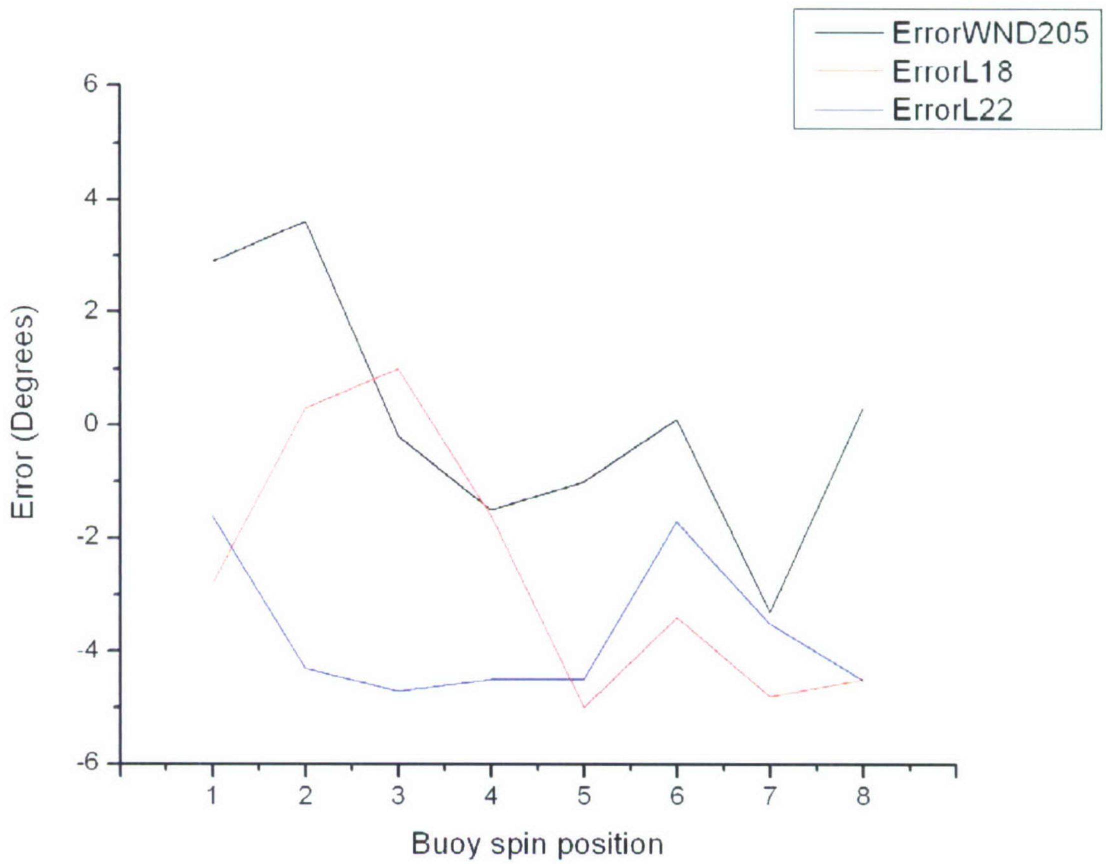


Figure A1.1: Buoy spin for Climode 2.

Climode 2 Burn-in notes.

DATE:	ACTIVITY:
17 MAY 06	L-17 (system 1) and L-18 (system 2) clocks set, FLASH cards erased and burn in started with HRH's, BPR's, and SST's. L-18 also has a SWR.
31 MAY 06	L-17 Stop: 13:10:30 UTC File:C2L17_01.DAT= records 1 to 16380 Records = 19895 C2L17_02.DAT= records 16350 to 19895 Restart sampling: 14:05:30 L-18 Stop: 14:06:30 UTC File:C2L18_01.DAT= records 1 to 16380 Records = 19951 C2L18_02.DAT= records 16350 to 19951 Restart sampling: 15:40:30
2 JUN 06	Both SST's put into a bucket of mixed water @ 12:51 UTC.
15 JUN 06	L-17 Stop: 14:10:30 UTC File:C2L17_03.DAT= records 19850 to 36230 Records = 41498 C2L17_04.DAT= records 36200 to 41498 Restart sampling: 15:21:30 L-18 Stop: 15:22:30 UTC File:C2L18_03.DAT= records 19950 to 36330 Records = 41532 C2L18_04.DAT= records 36300 to 41532 Restart sampling: 17:36:30
6 JUL 06	SWR211 plugged in to L-17 @ 15:40 UTC.
17 JUL 06	Removed SWR212 and HRH504 from L-18 17:35 UTC.
10 AUG 06	SWR502 and HRH226 plugged in to L-18 by 13:50 UTC.
30 AUG 06	Removed HRH217 from L-17 for use with STRATUS @ 17:32
1 SEP 06	Placed both primary systems (L-17 & L-18) into the cold room.
14 SEP 06	Zero'ed Flash cards, set the RT clocks, on both loggers, BPR's, HRH's, SWR's, and SST's. Zero'ed the FLASH and set the RT clock on the sonic wind (SWND201). Added SWND201 to L-17.
15 SEP 06	Powered up L-17 & L-18 @ 19:05 UTC inside the cold room @ room temp. PRC's and WND added to both systems.
18 SEP 06	Cold room set to 10c at 13:05 UTC. Water in PRC's @ 13:24am UTC.
19 SEP 06	Cold room set to 5C at 15:10 UTC.
20 SEP 06	Cold room set to 0C at 16:15 UTC.
21 SEP 06	Cold room set to -5C at 16:15 UTC.
28 SEP 06	L-17 Stop: 10:35:30 UTC File:C2L17_05.DAT= records 1 to 16380 Records = 18089 C2L17_06.DAT= records 16350 to 18089 Restart sampling: 11:13:30 L-18 Stop: 09:55:30 UTC File:C2L18_05.DAT= records 1 to 16380 Records = 18049 C2L18_06.DAT= records 16350 to 18049 Restart sampling: 10:34:30
13 OCT 06	BPR202 plugged in to L-17 @ 14:51 UTC. Powered up DCFS @ 15:25 UTC.
16 OCT 06	J. Ware replaced the processor card in the DCFS @ 13:30 UTC. Cold room set to 5 C @ 13:40 UTC.
17 OCT 06	Cold room set to 0 C @ 13:54 UTC.
18 OCT 06	Cold room set to 20 C @ 13:00 UTC. Cold room set to -5 C @ 15:30 UTC
19 OCT 06	Cold room set to -10 C.
20 OCT 06	Cold room set to 20 C @ 12:30 UTC.

L-17 Stop: 14:35:30 UTC File:C2L17_07.DAT= records 18000 to 34430
Records = 44150 C2L17_08.DAT= records 34400 to 44150
Restart sampling: NA – Powered down @ 15:38 UTC.
L-18 Stop: 13:23:30 UTC File:C2L18_07.DAT= records 18000 to 34380
Records = 44069 C2L18_08.DAT= records 34350 to 44069
Restart sampling: NA – Powered down @ 14:35 UTC.

26 OCT 06	Powered up both systems @ 12:20 UTC.
27 OCT 06	Both systems powered down and taken out of the cold room for mounting on the buoy.
30 OCT 06	Both the RM Young and the Gill sonic winds removed for wind tunnel testing.
31 OCT 06	Both systems powered up on the buoy. Found that the sonic wind needed an address change. L-17 transmitting-ok (1 watt), L-18 transmitting-bad (1/2 watt).
2 NOV 06	LWR's mounted on both systems.
3 NOV 06	DCFS mounted and plugged in. Logger FLASH cards erased and clocks reset. Buoy moved outside and transmitting by 20:00 UTC.
6 NOV 06	Stand alone HRH plugged in and running @ 15:10 UTC.
7 NOV 06	SST's removed from buoy @ 15:01:30 UTC. DCFS not coming through on ARGOS. L-18 had wrong firmware. Powered down L-18 and changed firmware, powered up L-18. And seen all 4 id's. Powered up radar enhancer @ 16:45 UTC. Replaced L-18 transmitter. Plugged in stand alone wind @20:30 UTC.
8 NOV 06	L-17 Stop: No comms/cycled power File:C2L17_09.DAT= records 1 to 2572 Records = 2572 Restart sampling: L-18 Stop: 11:06:30 UTC File: NA – FLASH card reads 0 Records = Restart sampling: HRH230 Records = 45 File: HRH230_01.dat = 1 to 45 BPR208 Records = 118 File: BPR208_01.dat = 1 to 118 WND205 Records = 16 File: WND205_01.dat = 1 to L-17 removed and L-15 put in place for system #1. Replaced and zero'ed L-18's FLASH card. Restarted both loggers sampling approx. 12:00 local. DCFS not updating the PTT. Found wiring issue and corrected. Buoy outside @ 22:05 UTC.
9 NOV 06	Unplugged stand alone LWR @ 16:03:30 UTC. Moved the LWR and plugged in LWR @ 16:34:30 UTC. Found L-15 not updating the PTT. Put L-17 (with new board set and FLASH card) in as system #1. L-22 powered up as spare system with SWR, LWR, HRH, SST and PTT.
10 NOV 06	Buoy moved to buoy spin area @ 10:30 UTC. Spare system L-22 outside @ 12:15 UTC. Vane @ 309 deg. @ 10:40:00 utc @ 354 deg. @ 11:45:00 utc @ 039 deg. @ 12:45:00 utc @ 084 deg. @ 13:45:00 utc @ 129 deg. @ 14:45:00 utc @ 174 deg. @ 15:45:00 utc

@ 219 deg. @ 16:40:00 utc
@ 264 deg. @ 17:40:00 utc
Buoy moved back to burn in area @ 19:00:00 UTC.
Spare moved to burn in area @ 21:17:00.

11 NOV 06	L-17 Stop: 12:35:30 Records = 2613 Restart sampling: 12:42:30		File:C2L17_10.DAT= records 1 to 2613
	L-18 Stop: 12:43:30 UTC Records = 4337 Restart sampling: 12:54:30		File: C2L18_10.DAT= records 1 to 4337
	L-22 Stop: 12:56:30 UTC Records = 3972 Restart sampling: 13:06:30		File: C2L22_01.DAT= records 1 to 3972
	HRH230	Records = 118	File: HRH230_02.dat = 1 to 118
	BPR208	Records = 191	File: BPR208_02.dat = 1 to 191
	WND205	Records = 89	File: WND205_02.dat = 1 to 89
	LWR208	Records = 191	File: LWR208_02.dat = 1 to 191
	SWR222	Records = 1319	File: LWR222_02.dat = 1 to 1319

Found evidence of water intrusion in the Sonic wind module. Water did not damage the electronics. Replaced internal connector effected by the water and RTV'd the sensor extension. Put Sonic back on buoy.

HRH223	Records = 118	File: HRH223_01.dat = 1 to 118
HRH226	Records = 118	File: HRH226_01.dat = 1 to 118
BPR202	Records = 191	File: BPR202_01.dat = 1 to 191
BPR503	Records = 191	File: BPR503_01.dat = 1 to 191
SWND201	Records = 89	File: SWND201_01.dat = 1 to 89
WND225	Records = 89	File: WND225_01.dat = 1 to 89
LWR212	Records = 191	File: LWR212_01.dat = 1 to 191
LWR505	Records = 191	File: LWR505_01.dat = 1 to 191
SWR211	Records = 1319	File: LWR211_01.dat = 1 to 1319
SWR502	Records = 1319	File: LWR502_01.dat = 1 to 1319
PRC210	Records = 118	File: PRC210_01.dat = 1 to 118
PRC209	Records = 118	File: PRC209_01.dat = 1 to 118

12 NOV 06 Buoy moved inside for build up. Spare moved inside for packing.
13 NOV 06 Found that the radar enhancer was not working correctly.
14 NOV 06 Tension Cell added and powered up @ 16:30 UTC.

Appendix 2. Climode 1 and 2 surface mooring log

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: N — Longitude 64° 46.954' (deg-min) E or W: 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: Matthews Table

Depth Correction 42 m

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

Anchor Position: Lat. 38° 19.082 N or S: N — Long. 64° 47.264 E or W: 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 19/11/2006 (day-mon-year) Time 09:06:45 UTC

Latitude 38° 17' 370 (deg-min) N or S — Longitude 64° 47' 755 (deg-min) E or W

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

Recovered by: Kemp/Lord Recorder/Observer: Brigorcu

Ship and Cruise No. OC 434 Actual duration: 1 yr days

Distance from actual waterline to buoy deck ____ meters

Flooring 1164 **PAGE 2**

Surface Components

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

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

Logged on 04/11/2006

Surface Instrumentation

	Item	ID	Height *	Comments
	Logger	L-14		
225	HRH	~~231~~ 214	203	Changed post deployment 11/26/05 ~1137
502	BPR	204	226	
217	WND	347	268	VanBack on ~ 10:05 UTC
211	PRC	217	222	
	LWR	216	278	
	SWR	202	278.5	
	~~SST~~	~~1844~~		
	PTT #12790	09203, 09869		
		09833, 14925		
	Logger	L-15		
	HRH	~~203~~ 222	203	
	BPR	210	255	
345	WND	341	270.5	Vane Back on ~ 10:05 UTC
	PRC	502	221.5	
	LWR	211	278.5	
	SWR	506	278.5	
	PTT #	14766,		
		14776, 14901		
	HRH	502	216	
	LWR	210	278	
	WND	213	271	Stand Alone's
	SWR	~~201~~ 216	278.5	wrong serial number. See comments in back of log sheet.
	BPR	218	226	
02	Sonic	01	306	w/ Gill 351
	Sub-surf Argos #267	ID 25689		

*** Height above buoy deck**

Mix up in SN → see comments at the end

Mooring 1164

Sub-Surface Instrumentation on Buoy and Bridle			
Item	ID	Depth†	Comments
SBE37	1840	151.5	L-14
SBE37	1839	151.5	L-15

† 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	10:29	
3	3.6	3/4" chain							
4		Nortek	1666	11:25	heads up		10	10:33	vane broken load bar broken at weld point
5	4.13	3/4" chain							
6		TPOD	1498	11 21			15	10:35	
7	3.3	3/4" chain							
8		Nortek	1688	11:17	heads up		20	10:39	vane broken
9	320	7/16" wire							
10		TPOD	1504	11:13			40	11:10	[illegible]
11		TPOD	1499	12 05			80	11:32	
12		TPOD	1512	12:15			120	11:36	
13		TPOD	1500	12:29			160	11:43	
14		TPOD	1506	12:39			200	11:48	
15		TPOD	1508	12:52			240	11:56	
16		TPOD	1509	13:04			280	12:01	
17		SBE37	0010	13:22			341	12:20	
18	320	7/16" wire		13:22					
19		TPOD	1511	13:33			360	12:25	
20		TPOD	1501	13:47			400	12:46	

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° 52.130' W
11/19/06	10:10 buoy on deck

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	12:59	
22		TPOD	1507	14:15			480	13:13	
23		TPOD	1510	14:28			520	13:17	
24		TPOD	1503	14:42			560	13:23	
25		TPOD	1505	14:55			600	13:28	
26		SBE37	3733	15:16			662	13:41	
27	320	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	17:38					
31	200	7/8" nylon	wrapped	17:44					
32	400	7/8" nylon		18:34					
33	2500	7/8" nylon							
34	100	1" nylon	one piece						
35	2000	1 1/8" poly	spliced	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	1/2" Chain		21:18					
43		Anchor		21:18	Wet wt. 8000 lbs.				
44	~~3~~	~~1/2" chain~~		~~21:18~~					
45		~~[illegible]~~		~~[illegible]~~					
46									
47									
48									
49									
50									
51									
52									
53									
54									
55									
56									
57									
58									
59									
60									

Date/Time	Comments
	Buoy deck height ≈ 70 cm (using pictures PB090025 from
	Tatiana Rykova's folder on deck 2005-4-3? [illegible]
	Lara Hutto → row 13 → DSCN0443.jpg
	John Lund → DSC1312.jpg)

MOORED STATION NUMBER 1164

Date/Time	Comments
12.07.06	All modules and logger flashcards are now dumped.
	It appears there has been confusion with serial
	number of 2 instruments MET:
	1) HRH on logger 14
	231 was deployed
	214 replaced 231 which failed, on 11.26.05
	225 replaced 214 on 04.12.06
	→ data for HRH 214 is in Repair 06 folder on Borg machine.
	2) SWR standalone
	serial number is not 201 but 214
	Reminder of changes during repair in 04.12.06:
	Several modules were changed:
	Old SN → changed to → New SN
	HRH 214 → HRH 225
	BPR 204 → BPR 502
	WND 347 → WND 217
	PRC 217 → PRC 211
	WND 344 → WND 345
	Sonic DCF3 01 → Sonic DCF3 02

Moored Station Log

(fill out log with black ball point pen only)

ARRAY NAME AND NO. Climode 2-F MOORED STATION NO. 1187

Launch (anchor over)

Date (day-mon-yr) 20-11-06 Time 21:05,05 UTC

Latitude (N/S, deg-min) 38° 01.587 Longitude (E/W, deg-min) 64 47.491

Deployed by Lord/Kemp Recorder/Observer Bigorre

Ship and Cruise No. R/V Oceanus #434 Intended Duration 1 yr

Depth Recorder Reading 4937 m Correction Source Matthews Table

Depth Correction 42 m

Corrected Water Depth 4979 m Magnetic Variation (E/W)

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

Surveyed Anchor Position

Lat (N/S) ~~38 01.587 01.499 N~~ 38° 01.579' N Long. (E/W) 64° ~~47.5865~~ 47.536'

Acoustic Release Model

Release No. 31336/31337 Tested to 1500 m

Receiver No. Edgetech 8242XS BACS Release Command 447775/450006

Enable ~~336~~ 471461/471533 Disable 471510/471556

Interrogate Freq. 11 kHz Reply Freq. 12 kHz

Recovery ~~(release fired)~~ free drift

Date (day-mon-yr) 09-02-2007 Time 11:47:40 UTC
Buoy out of water

Latitude (N/S, deg-min) 39° 02.452' Longitude (E/W, deg-min) 60° 17.344

Recovered by Kemp Recorder/Observer Plueddemann

Ship and Cruise No. OC 434 Actual duration ______ days

Distance from actual waterline to buoy deck 62 cm m

1

Surface Components

Mooring 1187

Buoy Type modular 2.5m Color(s) Hull Yellow Tower White

Buoy Markings If found contact Woods Hole Oceanographic Woods Hole MA 02543 USA 508 548 140

Surface Instrumentation

Item	ID #	Height*	Comments
Logger	L-17		
HRH	223	230 mid shield	
PRC	210	235 bottom cup	
BPR	202	240 inside tower	
SWR	211	283 bottom dome	
LWR	212	283 bottom dome	
SWND	201	268 head transducers	destroyed during recovery
SST	1305		
PTT 67718	27906, 27907, 27908		
Logger	L-18		
HRH	226	230	damaged during recovery
PRC	209	234	damaged during recovery
BPR	503	238	
SWR	502	283	
LWR	505	283	
WND	225	266 mid prop	no prop upon recovery
PTT 18136	15078, 27969 27636, 27669		
subsurface ARGOS	SN-268 ID = 25702		
Standalones			
HRH	230	238 inside tower	
BPR	202	238 inside tower	
SWR	222	283	
LWR	208	283	
WND	205	267 inside shaft	no prop upon recovery
DLFS	1	303 mid volume	

*Height above buoy deck in centimeters

2

Subsurface Instrumentation on Buoy and Bridle

Mooring 1127

Item	ID #	Depth†	Comments
SBE37	1305	151	Logger L-17
SBE37	1832	151	Logger L-18

†Depth below buoy deck in centimeters

3

Moored Station Number 1187

02-09-07

Item No.	Length (m)	Item	Inst No.	Time Over	Notes	Data No.	Depth (m)	Time Back	Notes
1	2.1	3/4" chain							
2		SBE 37	0011	11:04:20			5	1150	
3	3.6	3/4" chain							
4		Nortek	2064	10:54:09			10	1209	
5	4.13	3/4" chain							
6		SBE 39	~~0035~~ 0054	10:52:40 ~~10:51:45~~			15	1216	sensor is gone, empty bracket
7	3.5	3/4" chain							
8		Nortek	2082	10:51:45 ~~10:50~~			20	1217	
9	320	7/16" wire						1220	upper termination tied off
10		SBE39	0038	10 50			40	?	
11		SBE 39	0039				80	?	
12		SBE 39	0040	11:38:00			120	1324	
13		SBE 39	0041	11:50			160	1331	
14		SBE39	0042	12:00:10			200	1338	
15		SBE 39	0044	12:11:20			240	1346	
16		SBE39	0045	12:20:50			280	1355	
17		~~SBE39~~							
18		SBE 37	1907	12:49			341	1405	
19	320	7/16" wire							
20		SBE 39	0046	12:56:45			360	1415	
21		SBE 39	0047	13:08:50			400	1422	
22		SBE 39	0050	13:21:40			440	1428	

Mooring 1127

Item No.	Depth (m)	Item	Inst No.	Time Over	Notes	Data No.	Depth (m)	Time Back	Notes
23		SBE 39	0051	13:31:35			480	1436	
24		SBE 39	0053	13:39:25			520	~~1445~~ 1437	
25		SBE39	~~0014~~ 0035	13:50			560	1450	#35
26		SBE 39	0101	14:00:40			600	1455	
27		SBE37	3639	14:28:25			662	1504	
28	520	7/16" wire		15:50				1557*	end of Spring 1555
29	450	3/8" wire		16:26					
30	100	3/8" wire							
31	200	7/8" Nylon							
32	2900	7/8" Nylon							
33	100	1" Nylon		end 19:35					
34	2000	1 1/8" Polypropylene							
35		glassballs (8)		20:50					
36	5	1/2" trawler chain							
37		Acoustic Releases		20:57					
38	5	1/2" trawler chain							
39	20	1" Samson Nystron							
40	5	1/2" Trawler chain							
41	3m	1/4" trawl chain Anchor +							wt (wet): 8000 lbs wt (dry): 9300 lbs
42									
43									
44									
45									

#35

450 m 3/8" wire 17:20

end pied

spliced at sea

*mooring cast off at this point, no further items recovered

Moored Station Number 1187

Item No.	Length (m)	Item	Inst No.	Time Over	Notes	Data No.	Depth (m)	Time Back	Notes
91									
92									
93									
94									
95									
96									
97									
98									
99									

Date/Time	Comments
20 Nov 06: 11:05:30	Buoy in water
01/31/2007	Buoy broke free between 20:00 and 24:00 UTC
09/Feb/2007	Buoy recovered during free-drift. Hooked buoy bale at 1147 UTC
	39° 02.452 N, 60° 17.394 W. Recovered buoy and all instrumentation
	cast off at 983 m termination, 1629 UTC, 38° 39.63564 N,
	60° 16.1577 W, 1531 m depth. No response from releases

X

Appendix 3. Subsurface moorings C and D: Climode 1 recovery logs.

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' (deg-min) N or S 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° 22.15396 N or S Long. 55° 51.726 E or W

Argos Platform ID No. 27337 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 546243, 533051

Interrogate Freq. 11 KHz Reply Freq. 12 KHz

Recovery (release fired)

Date 11.26.06 (day-mon-year) Time 11:15:49 UTC

Latitude ~~38 22.324~~ 38° 22'.224 (deg-min) N or S Longitude 55° 52'.082 (deg-min) E or W

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

Recovered by: Recorder/Observer:

Ship and Cruise No. OC 434 Actual duration: 374 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		61" sphere	0017	23:03	Strobe # M08-03		~~62~~ 60*	11:37	
2		ADCP	2127	23:03				11:37	
3		Argos	27332	23:03				11:37	
4	5	3/4" chain		23:03					
5		nutrient sampler	79	23:03			~~58~~ *66	11:43	
6		miller swivel		23:03					
7		SBE37	2140	23:03	w/pressure		~~69~~ *67	11:55	
8		Stopper		23:03			~~71~~ *70		
9	565	1/4" wire		23:03					fuzz on wire upper part
10		moored profiler	110	23:01				12:32	bottom open
11		Stopper		23:36			~~63~~ *629		
12		SBE 37	2034	23:37	3 m above termination		~~633~~ *634	12:39	
13		miller swivel		23:50					
14		Benthos	156	23:50			~~637~~ *636	12:43	
15		Sonardyne	24	23:50				12:47	
16	5	1/4" wire		23:50	married				
17	6	E.M. cable		23:50					
18		Radios source	24	23:57			646	12:52	
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.
26 Nov 06	~~[illegible]~~ BND

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		(3) Glass balls		0:24				13:48	
25	500	3/16" wire		0:24					
26	500	3/16" wire		0:34					
27		(3) Glass balls		0:46				14:40	
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		(4) Glass balls		1:31					
34	5	3/8" chain		1:40					
35		Dual 8242 releases		2:00		4698		15:44	
36	3	1/2" chain		2:00					
37	400	1/4" wire		2:00					
38	100	1/4" wire		2:06					
39	10 ~~[illegible]~~	1/4" wire		2:10					
40	~~1~~520	1/4" wire		2:10					

Date/Time	Comments
50 ~~0~~ 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		Mate Anchor		2:27	3,400 lb 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: ~~###~~ Mathew's Table

Depth Correction +41 m

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 22 Nov 2006 (day-mon-year) Time 10:33:10 UTC

Latitude 36° 05'.333 N (deg-min) N or S Longitude 60° 10'.632 W (deg-min) E or W

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

Recovered by: Kemp Recorder/Observer: Bigorre

Ship and Cruise No. OC 434 Actual duration: 372 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		61" Sphere	008	14:06	00		~~63~~ *62	10:48:40	
2		ADCP	2231	14:06					
3		Argos Trans	27333	14:06	magnet off 13:57				
4	5	3/4" chain		14:06					
5		Nutrient Sampler	78	14:06			~~70~~ *68	10:54:30	
6		Miller Swivel		14:06					
7		SBE37	2134	14:06			~~71~~ *70	10:53:30	
8		Stopper		14:06			~~73~~ *72	11:18:20	
9	565	1/4" wire		14:06				11:48	
10		Profiler	118	14:22				11:49:50	Fish bites on plastic jacket prongs (2) **
11		Stopper		14:30			~~631~~ *630	11:49:50	
12		SBE37	2045	14:33	3.50 m from term to sensor		~~634~~ *633	11:59	
13		Miller Swivel		14:44					
14		Aanderaa	159	14:44			~~638~~ *637	12:03	
15		Source Electronics	23	14:44				12:03	
16	5 →	3/8" wire		14:45	married				
17	6 →	E-M Cable		14:45					
18		RAFOS Source	23	14:53			~~656~~ 647	12:10	
19	0.5	3/4" chain		14:53					
20		Miller Swivel		14:54					

Date/Time	Comments
	M08-040 Strobe light
24 Nov 05 *	Re-calculated component depths after adjusting for
	swivels + release weights using NOYFB. DMB
22 Nov 06	Strobe light spotted @ 10:34
**	Metal cage around conductivity sensor is bent on MMP

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				12:16	
22		(6) glass balls		14:55				12:16	
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				13:44	
28		(3) glass balls		15:53					
29	500	3/16" wire		15:53					
30	500	3/16" wire		16:07					
31		(4) glass balls		16:20					
32	500	3/16" wire		16:20					
33	500	3/16" wire		16:29					
34		(11) glass balls		16:43				14:54	
35	5	3/8" chain		16:47					
36		8242 releases (2)		18:34			4709	14:55	
37	3	1/2" chain		18:34					
38	100	1/4" wire		18:35					
39	~~[illegible]~~50	1/4" wire		18:40					
40	~~[illegible]~~20	1/4" wire		18:42					

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

PAGE 6

MOORED STATION NUMBER 1169

Item No.	Lgth [m]	Item	Inst No.	Time Over	Notes	Data No.	Calc Dpth	Time Back	Notes
41	5	3/4" chain		18:59					
42		Marc anchor		18:59	3400 wet weight				
43	4	7/8" 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

Appendix 3: Subsurface moorings C and D: Climode 2 deployment logs.

Moored Station Log

(fill out log with black ball point pen only)

ARRAY NAME AND NO. Climode 2-C MOORED STATION NO. 1185

Launch (anchor over)

Date (day-mon-yr) 11-26-06 Time 20:41:46 UTC

Latitude (N/S, deg-min) 38° 22' 7.67 Longitude (E/W, deg-min) 55° 51'.483

Deployed by Kemp/Lord Recorder/Observer Bigorre

Ship and Cruise No. OC434 Intended Duration 1yr

Depth Recorder Reading 5245 m Correction Source Matthew's table

Depth Correction 53 m

Corrected Water Depth 5298 m Magnetic Variation (E/W) ______

Argos Platform ID No. 5662 Additional Argos Info on pages 2 and 3

Surveyed Anchor Position

Lat (N/S) 38 22.264 Long. (E/W) 55 52.238

Acoustic Release Model 8242X tandem

Release No. 27687 / 30555 Tested to 1500 m

Receiver No. ______ Release Command 447661 / 134224

Enable 471277 / 121062 Disable 471306 / 121113

Interrogate Freq. 11 KHz Reply Freq. 12 kHz

Recovery (release fired)

Date (day-mon-yr) ~~11-27-06~~ Time ______ UTC

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

Recovered by ______ Recorder/Observer ______

Ship and Cruise No. OC434 Actual duration ______ days

Distance from actual waterline to buoy deck ______ m

1

Surface Components Climode 2-C 1185			
Buoy Type	Color(s) Hull	Tower	
Buoy Markings			

Surface Instrumentation

Item	ID #	Height*	Comments
			Argos PTT 5662
			on spike

*Height above buoy deck in centimeters

2

Moored Station Number 1185

Item No.	Length (m)	Item	Inst No.	Time Over	Notes	Data No.	Depth (m)	Time Back	Notes
1		64" sphere	017	11:50					
2		Argos Transmitter	5662	11:50					
3		75 ADCP	2222	11:50					
4		light		11:50					
5	5	3/4" chain							
6	1	~~Nutrient~~ chain ~~sampler~~							
7		3 ton miller swivel							
8		SBE 37 with pres	2140	11:53					
9		stopper							
10	565	1/4" wire							
11		profiler	112	12:20					
12		stopper							
13		SBE 37 with pres	~~[illegible]~~ 2031	13:14					
14		3 ton miller swivel							
15		Aanderaa ADCM	148	13:14					
16		Sound source electronics	24	13:19					
17	5	1/4" wire							
18	6	MEM cable							
19		Kafos sound source	24	13:19					
20	0.5	3/8" chain							
21		3 ton miller swivel							
22	0.5	3/8" chain							

Mooring 1185

Item No.	Length (m)	Item	Inst No.	Time Over	Notes	Data No.	Depth (m)	Time Back	Notes
23	500	1/4" wire		13:52					
24	500	1/4" wire							
25		17" glass balls (2)		14:22					
26	500	3/16" wire							
27	500	3/16" wire							
28		17" glass balls (3)		15:27					
29	500	3/16" wire							
30	500	3/16" wire							
31		17" glass balls (3)		16:23					
32	500	3/16" wire		16:53					
33	500	3/16" wire							
34		17" glass balls (11)		17:23					
35	5	3/8" chain							
36		Acoustic Release		17:25					
37	1	1/2" trawler chain							
38	3	1/2" chain							
39	500	1/4" wire							
40	50	1/4" wire							
41	20	1/4" wire							
42	20	1/4" wire							
43	5	3/8" chain							
44		Nace Anchor		20:41	wet wt = 3400 lbs				
45									

5

Moored Station Number 1185

Item No.	Length (m)	Item	Inst No.	Time Over	Notes	Data No.	Depth (m)	Time Back	Notes
91									
92									
93									
94									
95									
96									
97									
98									
99									

Date/Time	Comments
11.27.06	Nutrients sampler #79 was defective after 1 yr recovery and was not included
	on 2nd yr mooring -> replaced by 1m chain
27 Nov 06 1320Z	- Towing mooring for 4.2 miles to anchor drop site

02-00463

Moored Station Log

(fill out log with black ball point pen only)

ARRAY NAME AND NO. Clmode2 - D MOORED STATION NO. 1186

Launch (anchor over)

Date (day-mon-yr) 23 Nov. 2006 Time 21:24:15 UTC

Latitude (N/S, deg-min) 36° 05'.290 N Longitude (E/W, deg-min) 60° 10'.462 W

Deployed by Kemp / Lord Recorder/Observer Bigorre

Ship and Cruise No. OC 434 Intended Duration 1 yr

Depth Recorder Reading 4859 m Correction Source Matthew's table

Depth Correction +41 m

Corrected Water Depth 4900 m Magnetic Variation (E/W)

Argos Platform ID No. 27330 (subsurf. sphere) Additional Argos Info on pages 2 and 3

Surveyed Anchor Position using Acoustic Survey Software

Lat (N/S) 36° 05.239' N Long. (E/W) 60° 10.178' W

Acoustic Release Model

Release No. ~~44770~~ 31333 / 32480 Tested to 1500 m

Receiver No. Release Command 447710 / 132111

Enable 471325 / 114556 Disable 471340 / 114575

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 1186

Item No.	Length (m)	Item	Inst No.	Time Over	Notes	Data No.	Depth (m)	Time Back	Notes
1		64" Sphere	008	13:04					
2		ADCP	2225	13:04					
3		Argos transmitter	27330	13:04	Turned on at 12:53				
4		Probe light		13:04					
5	5	3/4" chain							
6		Nutrient sampler	78	13:04					
7		3 Ton Tritan swivel							
8		SBE 37	2139	13:04					
9		Stopper							
10	565	1/4" wire							
11		Profiler	113	13:41					
12		Stopper		14:20					
13		SBE 37	1645	14:28					
14		3 Ton Miller swivel							
15									
16		Aanderaa ADCM	149	14:30	head up				
17		Sound source electronics							
18	5	1/4" wire							
19	6	EM cable		14:45					
20		Rafos sound source	23	14:47					
21	0.5	7/8" chain							
22		3 Ton Miller swivel							

married

Mooring 1186

Item No.	Length (m)	Item	Inst No.	Time Over	Notes	Data No.	Depth (m)	Time Back	Notes
23	0.5	3/8" chain							
24		17" glass balls (6)							
25	500	3/16" wire							
26	500	3/16" wire							
27		17" glass balls (3)		16:05					
28	500	3/16" wire		16:35					
29	500	3/16" wire							
30		17" glass balls (3)		17:05					
31	500	3/16" wire		17:35					
32	500	3/16" wire							
33		17" glass balls (3)		18:10					
34	500	3/16" wire		18:40					
35	500	3/16" wire							
36		17" glass balls (11)		19:15					
37	5	3/8" chain							
38		Acoustic Releases	31333 32480	19:23					
39	1	1/2" trawler chain							
40	3	1/2" chain							
41	100	1/4" wire		19:41					
42	50	1/4" wire							
43	20	1/4" wire							
44	5	1/4" wire		19:54					
45	5	3/8" chain							

Moored Station Number 1126

Item No.	Length (m)	Item	Inst No.	Time Over	Notes	Data No.	Depth (m)	Time Back	Notes
46		Race Anchor			Web Wt 3400 lbs				
47									
48									
49									
50									
51									
52									
53									
54									
55									
56									
57									
58									
59									
60									
61									
62									
63									
64									
65									
66									
67									

Appendix 4. Instrumentation Subsurface Moorings.

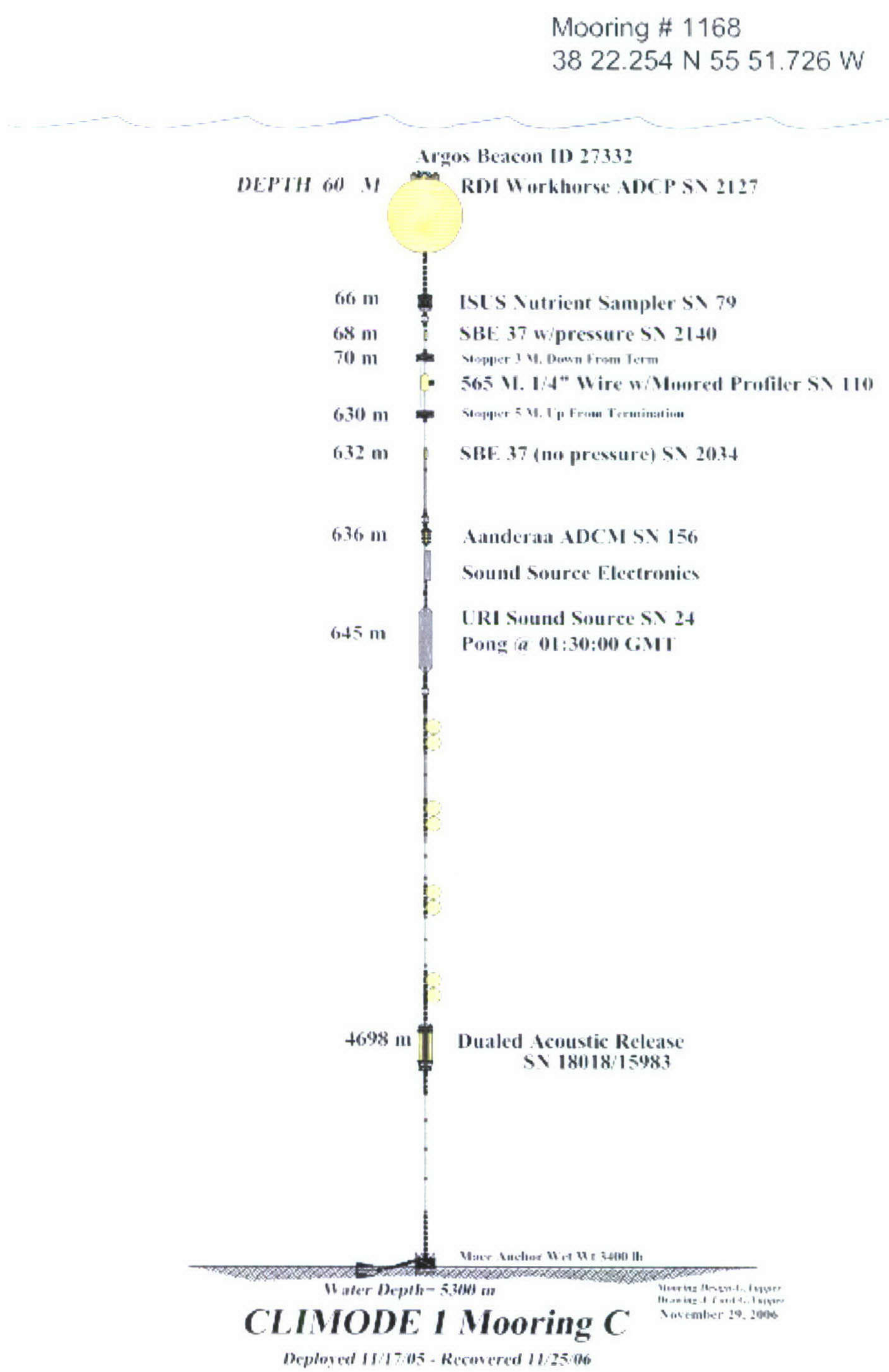
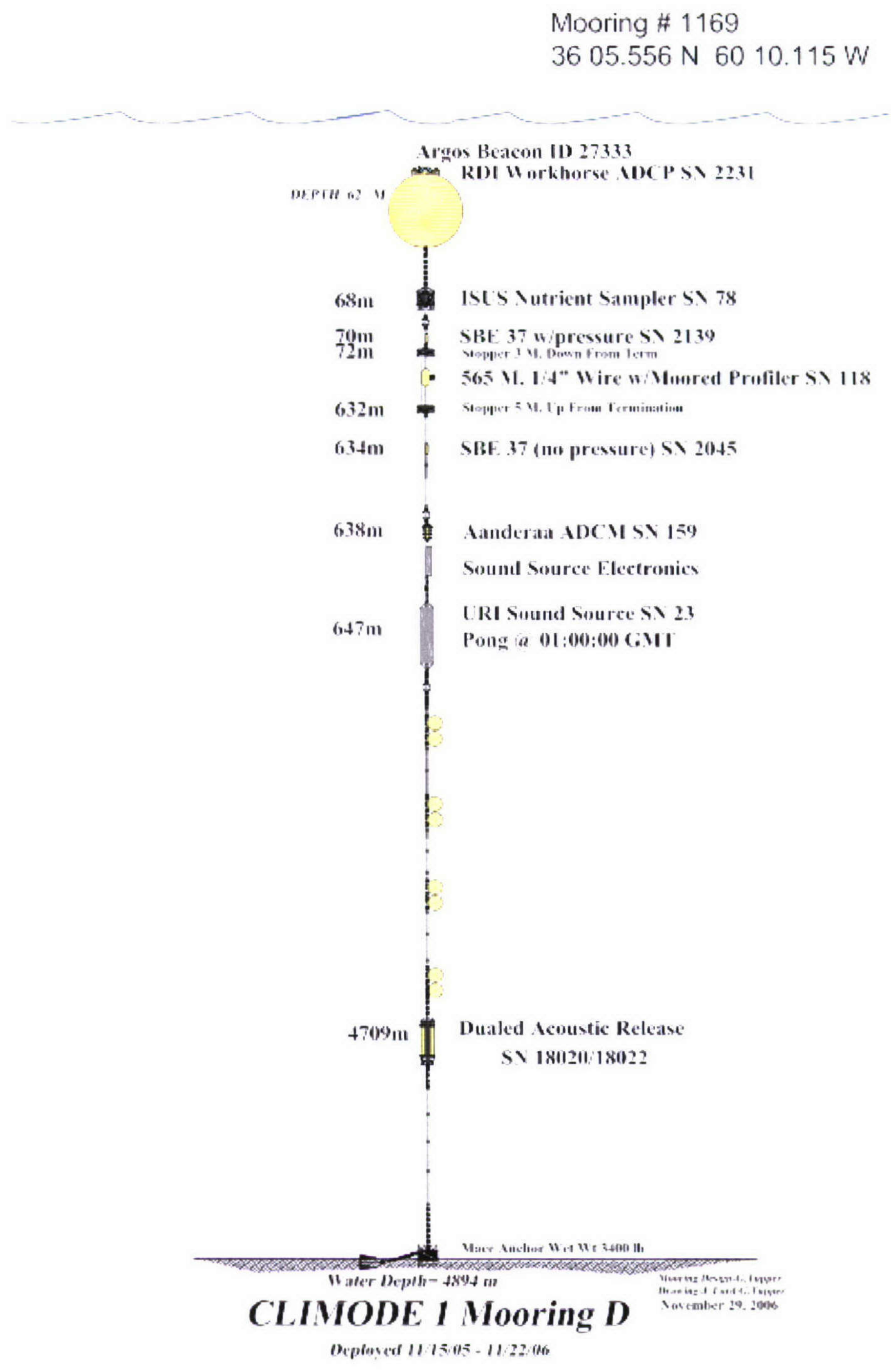


Figure A4.1.



Mooring # 1169
36 05.556 N 60 10.115 W
Argos Beacon ID 27333
RDI Workhorse ADCP SN 2231
DEPTH 62 M
68m
ISUS Nutrient Sampler SN 78
70m
SBE 37 w/pressure SN 2139
72m
Stopper 3 M. Down From Term
565 M. 1/4" Wire w/Moored Profiler SN 118
632m
Stopper 5 M. Up From Termination
634m
SBE 37 (no pressure) SN 2045
638m
Aanderaa ADCM SN 159
Sound Source Electronics
647m
URI Sound Source SN 23
Pong @ 01:00:00 GMT
4709m
Dualed Acoustic Release
SN 18020/18022
Mace Anchor Wet Wt 3400 lb
Water Depth= 4894 m
November 29, 2006
CLIMODE 1 Mooring D
Deployed 11/15/05 - 11/22/06

Figure A4.2.

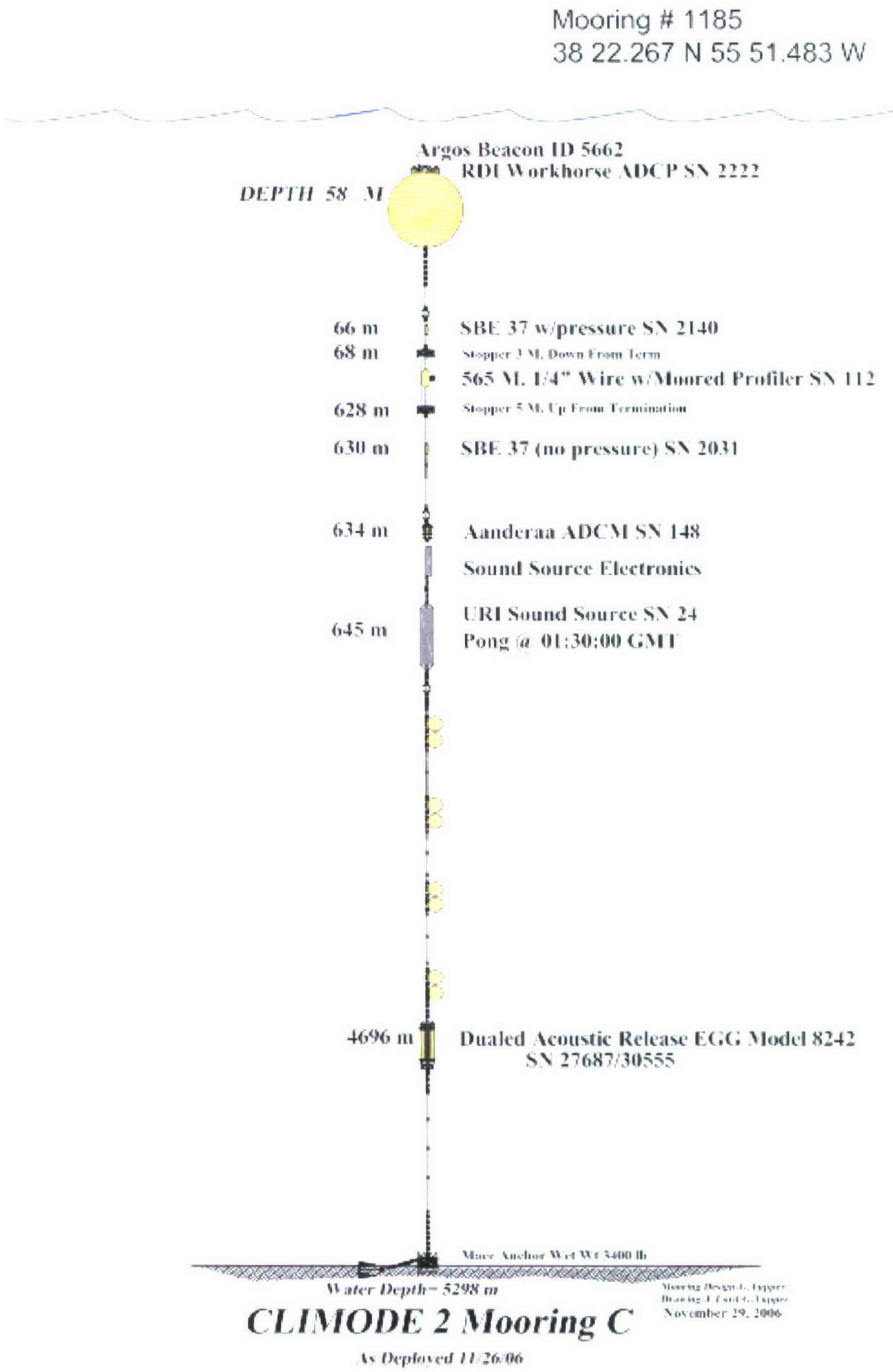

Mooring # 1185
38 22.267 N 55 51.483 W
Argos Beacon ID 5662
RDI Workhorse ADCP SN 2222
DEPTH 58 M
66 m
SBE 37 w/pressure SN 2140
68 m
Stopper 3 M. Down From Term
565 M. 1/4" Wire w/Moored Profiler SN 112
628 m
Stopper 5 M. Up From Termination
630 m
SBE 37 (no pressure) SN 2031
634 m
Aanderaa ADCM SN 148
Sound Source Electronics
645 m
URI Sound Source SN 24
Pong @ 01:30:00 GMT
4696 m
Dualed Acoustic Release EGG Model 8242
SN 27687/30555
Mace Anchor Wet Wt 3400 lb
Water Depth= 5298 m
November 29, 2006
CLIMODE 2 Mooring C
As Deployed 11/26/06

Figure A4.3.

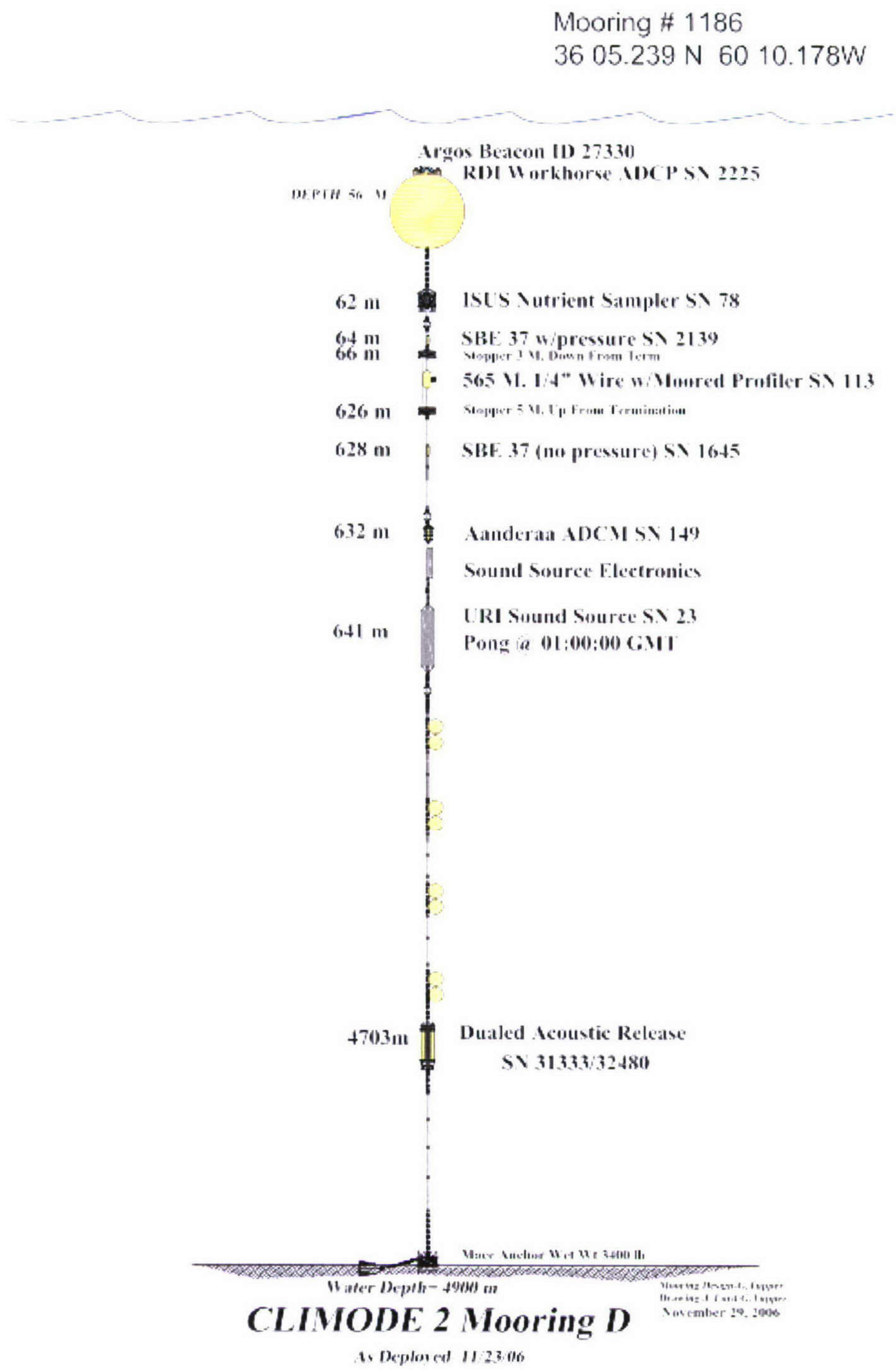

Mooring # 1186
36 05.239 N 60 10.178W
Argos Beacon ID 27330
RDI Workhorse ADCP SN 2225
DEPTH 56 M
62 m
ISUS Nutrient Sampler SN 78
64 m
SBE 37 w/pressure SN 2139
66 m
Stopper 3 M. Down From Term
565 M. 1/4" Wire w/Moored Profiler SN 113
626 m
Stopper 5 M. Up From Termination
628 m
SBE 37 (no pressure) SN 1645
632 m
Aanderaa ADCM SN 149
Sound Source Electronics
641 m
URI Sound Source SN 23
Pong @ 01:00:00 GMT
4703m
Dualed Acoustic Release
SN 31333/32480
Water Depth= 4900 m
CLIMODE 2 Mooring D
As Deployed 11/23/06
November 29, 2006

Figure A4.4.

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16. Abstract (Limit: 200 words)

CLIMODE (CLIVAR Mode Water Dynamics Experiment) is a research 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 2006, cruise 434 onboard R/V *Oceanus* traveled in the region of the separated Gulf Stream and its recirculation, where intense oceanic heat loss to the atmosphere in the winter is believed to trigger the formation of EDW. During this cruise, the surface mooring F that was anchored in the core of the Gulf Stream was replaced by a new one, as well as two subsurface moorings C and D located on the southeastern edge of the stream. Surface drifters, ARGO and bobbers RAFOS floats were deployed, 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 EDW formation region.

The present report documents this cruise, the methods and locations for the deployments of instruments and some evaluation of the measurements from these instruments.

17. Document Analysis a. Descriptors

CLIMODE
cruise
report

b. Identifiers/Open-Ended Terms

c. COSATI Field/Group

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