WHOI-2004-04

Woods Hole Oceanographic Institution

Stratus Ocean Reference Station (20˚S, 85˚W), Mooring Recovery and Deployment Cruise

R/V *Revelle* Cruise Dana 03, November 10 - November 26, 2003

by

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Nan Galbraith[1]
Chris Fairall[2]
Scott Stalin[3]
Juan Carlos Andueza[4]
Jason Tomlinson[5]

[1]Woods Hole Oceanographic Institution • [2]NOAA Environmental Technology Laboratory
[3]NOAA Pacific Marine Environmental Laboratory • [4]Chilean Navy Hydrographic and Oceanographic Service
[5]Texas A&M University

March 2004

Technical Report

Funding was provided by the National Oceanic and Atmospheric Administration uncer Contract Number NA17RJ1223.

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Upper Ocean Processes Group
Woods Hole Oceanographic Institution
Woods Hole, MA 02543
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Nelson G. Hogg, Chair

Department of Physical Oceanography

ABSTRACT

The Ocean Reference Station at 20° S, 85° W under the stratus clouds west of northern Chile and Peru is being maintained to provide ongoing, climate-quality records of surface meteorology, of air-sea fluxes of heat, freshwater, and momentum, and of upper ocean temperature, salinity, and velocity variability. The Stratus Ocean Reference Station, hereafter ORS Stratus, is supported by the National Oceanic and Atmospheric Administrations (NOAA) Climate Observation Program. It is recovered and redeployed annually, with cruises that have come in October or November.

During the November 2003 cruise of Scripps Institution of Oceanography's R/V *Roger Revelle* to the ORS Stratus site, the primary activities where the recovery of the WHOI surface mooring that had been deployed in October 2002, the deployment of a new WHOI surface mooring at that site, the in-situ calibration of the buoy meteorological sensors by comparison with instrumentation put on board by Chris Fairall of the NOAA Environmental Technology Laboratory (ETL), and observations of the stratus clouds and lower atmosphere by NOAA ETL and Jason Tomlinson from Texas A&M.

The ORS Stratus buoys are equipped with two Improved Meteorological systems, which provide surface wind speed and direction, air temperature, relative humidity, barometric pressure, incoming shortwave radiation, incoming longwave radiation, precipitation rate, and sea surface temperature. The IMET data are made available in near real time using satellite telemetry. The mooring line carries instruments to measure ocean salinity, temperature, and currents. On some deployments, additional instrumentation is attached to the mooring to measure rainfall and bio-optical variability. The ETL instrumentation used during the 2003 cruise included a cloud radar, radiosonde balloons, and sensors for mean and turbulent surface meteorology.

In addition to this work, buoy work was done in support of the Ecuadorian Navy Institute of Oceanography (INOCAR) and of the Chilean Navy Hydrographic and Oceanographic Service (SHOA). The surface buoy, oceanographic instrumentation, and upper 500 m of an INOCAR surface mooring at 2°S, 84°W that had been vandalized were recovered and transferred to the Ecuadorian Navy vessel B. A. E. *Calicuchima*. A tsunami warning mooring was installed at 75°W, 20°S for SHOA. SHOA personnel onboard were trained during the cruise by staff from the NOAA Pacific Marine Environmental Laboratory (PMEL) and National Data Buoy Center (NDBC). The cruise hosted two teachers participating in NOAA's Teacher at Sea Program, Deb Brice from San Marcos, California and Viviana Zamorano from Arica, Chile.

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ABBREVIATIONS

ADCP	Acoustic Doppler Current Meter
CLIVAR	Climate Variability
CTD	Conductivity Temperature Depth
EPIC	Eastern Pacific Investigation of Climate
ETL	NOAA Environmental Technology Laboratory
IMET	Improved Meteorological Systems
INOCAR	Ecuadorian Navy Institute of Oceanography
NDBC	National Data Buoy Center
NOAA	National Oceanic and Atmospheric Administration
PMEL	NOAA Pacific Marine Environmental Laboratory
SBE	Sea Bird Electronics
SCG	Shipboard Computer Group
SHOA	Chilean Navy Hydrographic and Oceanographic Service
SIO	Scripps Institution of Oceanography
SST	Sea-Surface Temperature
TAMU	Texas A&M University
UOP	Upper Ocean Processes Group
VMCM	Vector Measuring Current Meter
WHOI	Woods Hole Oceanographic Institution

I. PROJECT BACKGROUND AND PURPOSE

The primary purposes of this cruise were to recover and then deploy a new well-instrumented surface mooring under the stratocumulus clouds found off Chile and Peru, to make shipboard meteorological and air-sea flux observations to document and establish the accuracy of the moored meteorological observations, and to observe the oceanic and atmospheric variability in the stratus deck region.

The mooring at 20°S, 85°W was first deployed in October 2000 as a component of the Enhanced Monitoring element of the Eastern Pacific Investigation of Climate (EPIC) program and was called Stratus 1. That buoy was recovered and a new buoy (Stratus 2) deployed in October 2001. In October 2002, Stratus 2 was recovered and Stratus 3 was deployed. Stratus 3 was recovered and Stratus 4 deployed during the cruise in November 2003 and operations are documented in this report.

Stratus 4 marks the first deployment supported by NOAA's Climate Observation Program. The Stratus site has been designated an Ocean Reference Station and a Surface Flux Reference Site. The objectives of maintaining a long term surface mooring at the Stratus site are to obtain high quality in-situ time series of surface meteorology, air-sea fluxes, upper ocean temperature, salinity, and velocity variability. This region is of critical importance to climate predictability and science and has previously been poorly sampled and not well replicated in climate models. The instrumentation deployed at the site is designed to observe the air-sea exchanges of heat, freshwater, and momentum, to observe the temporal evolution of sea surface temperature and of the vertical structure of the upper 500 m of the ocean, and to document and quantify the local coupling of the atmosphere and ocean in this region. Air-sea coupling under the stratus clouds is not well understood, and numerical models show broad scale sensitivity over the Pacific to cloud and air-sea interaction parameterization in this region.

Telemetered meteorological data is not inserted on the GTS (Global Telecommunication System) for routine ingestion in numerical weather models; rather, it is made available by FTP from WHOI to provide an independent data set to evaluate operational model performance in the stratus deck region. After recovery, high sampling rate (up to 1 minute rate), internally recorded data are processed, and the calibrated meteorological, air-sea flux, and oceanographic data are made available for validation and improvement of models and remote sensing methods, to support development of improved air-sea flux fields, and to support various climate research activities.

The Stratus moorings carry two redundant sets of meteorological sensors and the mooring line carries a set of oceanographic instruments (Table 1). Acoustic rain gauges placed on the Stratus 3 mooring were provided by Jeff Nystuen of the University of Washington Applied Physics Laboratory.

Table 1. Types of measurements taken by Stratus moorings.

Surface Measurements	**Subsurface Measurements**
Wind speed	Water temperature
Wind direction	Conductivity
Air temperature	Current speed
Sea surface temperature	Current direction
Barometric pressure	Salinity
Relative humidity	Precipitation (Acoustic rain gauge – on Stratus 3 only)
Incoming shortwave radiation	Chlorophyll Absorption (on Stratus 3 only)
Incoming longwave radiation	
Precipitation	

Work for Stratus 3 was carried out aboard the *R/V Roger Revelle* of the Scripps Institution of Oceanography (SIO). The Stratus 2003 work constituted Leg 3 of the Dana expedition of the *R/V Revelle* and began in Manta, Ecuador, on November 10, 2003 and ended on November 26, 2003 in Arica, Chile. To further support ground-truthing satellite data and increased understanding of the ocean in the eastern South Pacific, 45 drogue surface drifters and 9 profiling ARGO floats were deployed in the South Pacific from the *Revelle* along the cruise track. Figure 1 shows the *Revelle* coming into port in San Diego.

Figure 1. R/V *Roger Revelle*.

Because of the importance of establishing and documenting the accuracy of the meteorological and air-sea flux records collected by the Stratus moorings, extensive shipboard meteorological and air-sea flux instrumentation was installed on the *Revelle* and operated by Chris Fairall from the NOAA Environmental Technology Laboratory in Boulder, CO. Time during the cruise was dedicated to carrying out comparisons between the shipboard sensors and those on the Stratus 3 buoy, which had been at sea for 13 months, and those on the newly deployed Stratus 4 buoy. The ETL group also operated a cloud radar and launched radiosonde balloons every 6 hours to further document the stratus cloud region. Observations of aerosols were made by Jason Tomlinson from Texas A&M University. The R/V *Revelle* also carried out routine underway oceanographic and meteorological observations.

The Stratus 4 cruise carried out two additional activities in support of ocean observing projects by Ecuador and Chile. In answer to a request from the Ecuadorian Navy Institute of Oceanography (INOCAR), the surface buoy, SeaBird MicroCats and steel cable from the upper part of an Ecuadorian surface mooring located near 2°S, 84°W were recovered and transferred to an Ecuadorian Navy vessel on *Revelle*'s outbound passage from Manta, Ecuador. The sensor set on the surface buoy had been vandalized, and INOCAR was at that moment unable to affect a recovery of the mooring, which was not equipped with an acoustic release. On the passage east from the Stratus Ocean Reference Site, a day of ship time was dedicated to doing a bottom survey and deploying a tsunami-warning buoy for the Chilean Navy Hydrographic and Oceanographic Service (SHOA). During the cruise staff from the NOAA Pacific Marine Environmental Laboratory (PMEL) and National Data Buoy Center (NDBC) were on board to provide training for four people from SHOA who participated in the cruise.

This NOAA-funded cruise included participation by the NOAA Teacher-at-Sea program, with Deb Brice, a teacher from San Marcos, California, Viviana Zamorano, a teacher from Arica, Chile, and John Kermond from NOAA, on board. They were in contact with classrooms in their respective countries, and developed educational material shared via the Teacher-at-Sea website.

All participants were invited to contribute to this cruise report, which is written to provide documentation of the work done during the cruise and to serve as the supporting documentation of the underway data that has been provided to the national observers from Ecuador and Chile who were on board *Revelle* for this cruise.

II. STRATUS 2003 CRUISE

A. Overview

Many tasks were completed during the Stratus 2003 Cruise aboard the R/V *Revelle*, including:

1. Retrieval of the Stratus 3 mooring (Section III).
2. Deployment of the Stratus 4 mooring (Section III).
3. Rescue of a damaged Ecuadorian mooring (Section V).
4. Argos Solo Float and SVAP Drifter Deployments (Section V).
5. PMEL / SHOA Tsunami Mooring Deployment (Section V).
6. ETL Measurements (Section V).
7. TAMU Measurements (Section V).
8. Teacher-at-Sea Program (Section V).

The cruise was designated Dana 3, and began in Manta, Ecuador, on November 10, 2003 and proceeded to the mooring site off the coast of Chile. The R/V *Revelle* then proceeded to Arica, Chile, where it docked on November 26, 2003. Figure 2 shows the cruise track of the Stratus 2003 cruise. Tables 2 and 3 list the participants of the cruise.

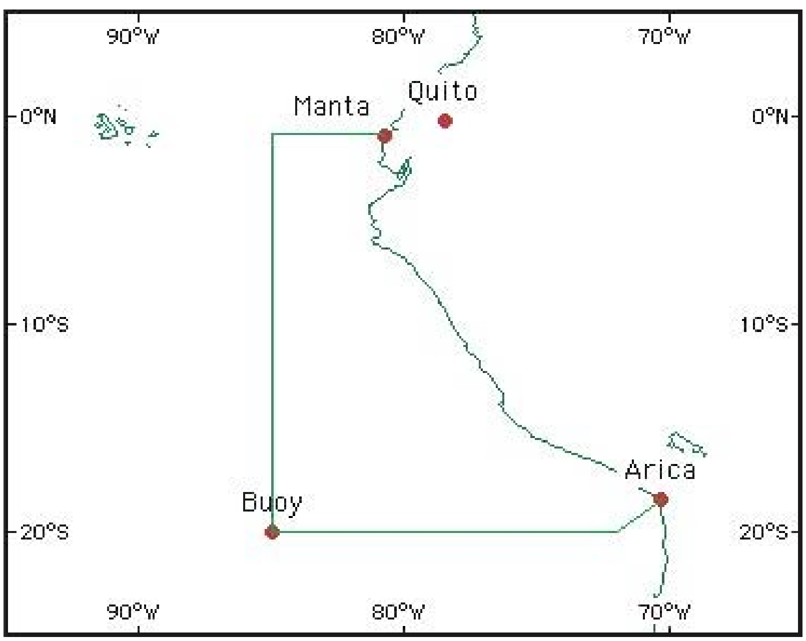


Figure 2. Stratus 2003 Cruise Track.

Locations:

Manta, Ecuador: 00° 55’ S, 80° 43’ W
WHOI Buoy: 20° S, 85° W
Arica, Chile: 18° 28’ S, 70° 20’ W

Table 2. Scientific Party for 2003 Cruise.

Name	Affiliation
Leila Zambrano	INOCAR, Ecuador
Rommel Moran	INOCAR, Ecuador
Chris Fairall	NOAA ETL
Sergio Pezoa	NOAA ETL
John Kermond	NOAA OGP
Mike Strick	NOAA PMEL
Scott Stalin	NOAA PMEL
Debra Brice	NOAA Teacher at Sea (CA)
Viviana Zamorano	NOAA Teacher at Sea (Chile)
Kendall Michel	SAIC / NDBC
Alvaro Vera	SHOA, Chile
Juan Carlos Andueza	SHOA, Chile
Juan Pablo Belmar	SHOA, Chile
Cecilia Zelaya	SHOA, Chile
Jason Tomlinson	Texas A&M
Paquita Zuidema	U. Colorado
Pavlos Kollias	U. Colorado / CIRES
Jason Smith	WHOI UOP Group
Jeff Lord	WHOI UOP Group
Jim Ryder	WHOI UOP Group
Lara Hutto	WHOI UOP Group
Nan Galbraith	WHOI UOP Group
Robert Weller	WHOI UOP Group

Table 3. Ship Crew During 2003 Cruise.

Name	Title
Al Alejo	3rd Mate
Brian Matthiesen	A.B.
Bubba Black	Boatswain
Chris Quijano	3rd A/E
Danny Mitchell	1st A/E
Dave Kramer	2nd Mate
Ed Lograsso	Sr. Cook
Ed Miller	Cook
Eddie Angeles	Oiler
Frank Sanchez	A.B.
Jack Healy	2nd A/E
Joe Anuszczyk	Wiper
Joe Martino	O.S.
Manny Elliot	Electrician
Neil DiPaola	A.B.
Orly Bisquera	Oiler
Ray Esteban	Oiler
Rob Widdrington	1st Mate
Sean Mix	Oiler
Wes Hill	Captain

B. Pre-Cruise and Cruise Details

Preparation for the Stratus 2003 cruise began many months before departure. During the spring of 2003 instruments were gathered and placed on the mooring for testing (this is referred to as the burn-in phase). Burn-in details are not presented in this cruise report, but have been documented carefully for instrument performance tracking purposes.

In September of 2003 members of the UOP group met the R/V *Revelle* in San Diego at the Scripps Institution of Oceanography (SIO) piers to load and prepare equipment. There were two main advantages to loading in San Diego: the Stratus 4 buoy could be powered up and continue burn-in, and equipment did not need to be shipped internationally.

On September 18 the buoy was powered up and it began transmitting data via the Argos satellite connection. On September 22 data from the meteorological loggers was dumped and checked for any instrumentation problems. On September 25 the buoy was moved on to the aft deck of the *Revelle* in an upright position. The UOP group also took advantage of this time to set up and secure equipment in the main science lab. The *Revelle* cruised from San Diego along the Pacific coast of Mexico and Central America, eventually pulling into port in Ecuador on November 6, 2003.

The UOP group transited from Boston to Manta, and after a weather related flight delay, arrived at the Manta large vessel port on November 6, 2003. Bob Weller and Jeff Lord met with members of the Ecuadorian Navy that morning to discuss access to the port area and plans for retrieval of a damaged Ecuadorian mooring. On November 7 data from the meteorological loggers and module flash cards were checked and all instruments were found to be in good working order. A spare relative humidity / air temperature module was added to the buoy tower (SN # 227). On November 8 the buoy was picked up, placed on its side, and the bridle legs were attached. On November 9 the UOP group continued instrument setup and began working to secure the lab after unpacking some containers.

The R/V *Revelle* was scheduled to leave Manta at 14:00 local time (L) on November 10. This departure was delayed for several reasons, including some immigration problems for the Ecuadorian observers leaving the country and a customs delay for a shipment containing the ship's MET sensors, the ETL radiosondes, and the UOP sonic flux system. These problems were resolved and the ship got underway at approximately 22:06 L. An all science team meeting was held at 18:00 L. The captain and resident technician gave a briefing on general ship procedures and safety guidelines, and the chief scientist (Weller) gave an overview of planned underway operations.

At 10:30 L on November 11 a watch meeting was held to brief the science party on the duties to be completed including taking bucket thermometer readings, deploying surface drifters, and Argos floats. Further details of the drifter and float deployments are given in Section V. After lunch the crew and science team participated in fire and abandon ship drills. Shortly thereafter, the ship arrived at the damaged Ecuadorian mooring. At 13:55 L the buoy was brought on deck, and the anchor was cut away from the mooring line at

15:32 L. The recovery of this mooring is discussed in more detail in section V of this report.

On November 12, 13, and 14, the ship was underway to the Stratus mooring site and underway watch standing continued. During the afternoon of November 15, 2003 the R/V *Revelle* sighted the Stratus 3 mooring. The *Revelle* drove close by the mooring for a visual inspection. It was planned to perform a visual inspection of the mooring in the small rescue boat; however problems launching the rescue boat delayed this. The *Revelle* pulled away from the mooring for a test CTD cast and release test. After the test cast, the *Revelle* returned to the mooring and successfully launched the rescue boat, but problems with the engine again delayed the close inspection of the mooring. The *Revelle* returned to the CTD site and two deep CTD casts were completed.

At 9:00 L on November 16, Jeff Lord, Lara Hutto, Al Alejo, and Frank Sanchez used the small rescue boat for a close look at the Stratus 3 mooring. Some fouling was visible, but the floating SST instrument was still moving well in its track. The water line was estimated to be 0.3 m below the deck. Comparisons between the ship's instruments and the Stratus 3 surface instruments were also made (see Section III for more details on intercomparison).

November 17 was the recovery day for the Stratus 3 mooring. The release was fired before breakfast, and the glass balls were sighted at the surface about 40 minutes later. On November 18, Stratus 3 instruments were post-spiked, download of the data began, and preparations were made for the Stratus 4 deployment. The Stratus 4 deployment was completed on November 19, 2003. Details of the recovery and deployment are given in Section III.

November 20 was dedicated to data comparison between sensors onboard the ship and the Stratus 4 surface instruments (see section III). Several trips were made in the small boat to the Stratus 4 mooring for a visual inspection of the mooring; all instruments looked in good condition. Early on the morning of November 21 two deep CTD casts were performed. The *Revelle* began steaming towards the next work site at 04:54 L, where the tsunami warning buoy was deployed off the coast of Chile. On November 22 the UOP group continued dumping data from instruments and processing this data.

On November 23 the Chilean tsunami warning buoy was deployed by the ETL, NDBC, and SHOA groups. The deployment was successful and the *Revelle* stayed close by the buoy and continued shipboard measurements. On the morning of the 24th, it was determined that the bottom pressure sensor on the tsunami warning buoy was not functioning properly. It was recovered, a new sensor installed, and redeployed (see section V for further details on these operations). After this redeployment, the mooring system was found to be functioning properly and the *Revelle* left the site early on the morning of the 25th. The *Revelle* entered the port in Arica on the morning of November 26, and unloading began shortly there after. The UOP group returned on November 30.

III. ORS STRATUS MOORINGS

A. Overview

The three-meter discus buoys used in the Stratus project are equipped with meteorological instrumentation, including two Improved Meteorological (IMET) systems. The two WHOI moorings also carried vector measuring current meters, conductivity and temperature recorders, an Acoustic Doppler Current Profiler (ADCP), and an acoustic rain gauge.

These WHOI moorings are an inverse catenary design utilizing wire rope, chain, nylon and polypropylene line and a have a scope of 1.25 (Scope = slack length/water depth). The surface buoys are a three-meter diameter discus buoy with an aluminum tower and rigid bridle.

The design of these surface moorings took into consideration the predicted currents, winds, and sea-state conditions expected during the deployment duration. Further, they were constructed using hardware and designs that had been proven in the recent Pan American Climate Study (PACS) deployment.

The instrument systems recovered on the Stratus 3 mooring and deployed on the Stratus 4 mooring are described in detail below.

B. Surface Instruments

1. Improved Meteorological (IMET) Systems (Stratus 3 and 4)

There are two independent IMET systems on the Stratus buoys (as shown in Figure 3). These systems measure the following parameters once per minute, and transmit hourly averages via satellite:

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

All IMET modules for the Stratus experiment were modified for lower power consumption so that a non-rechargeable alkaline battery pack could be used. Near-surface temperature and conductivity were 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 MET modules are sampled at the start of each logging interval. All the "live" interval data is available via the D and E commands on the primary RS232 "console" interface used for all LOGR53 communications.

The LOGR53 CPU board is based on a Dallas Semiconductor DS87C530 microcontroller. DS87C530 internal peripherals include a real time clock and 2 universal asynchronous receiver-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 ASIMET modules) is connected to P14; the "aux" battery stack (which typically powers the optional PTT) is connected to P19. Regulated +5V power for the system is produced on this board.

Parameters recorded on a FLASH card:

TIME
WND - wind east and north velocity; wind speed average, max, and min; last wind vane direction, and last compass direction
BPR - barometric pressure
HRH - relative humidity and air temperature
SWR - short wave radiation
LWR - dome temperature, body temperature, thermopile voltage, and long wave radiation
PRC - precipitation level
SST - sea surface temperature and conductivity
ADI - multiplexed optional parameter value from A/D module (only 1 of 8 in each record)

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

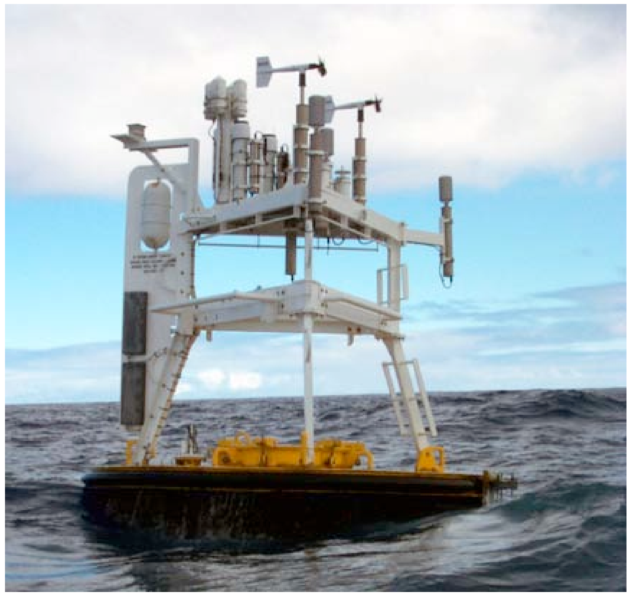


Figure 3. Stratus 3 Mooring.

2. Stand-alone Relative Humidity/Temperature Instrument (Stratus 3 and 4)

A self-contained relative humidity and air temperature instrument was mounted on the tower of the Stratus buoys. This instrument, developed and built by members of the UOP Group, takes a single point measurement of both relative humidity and temperature at a desired record interval. The sensor used was a Rotronics MP-101A. The relative humidity and temperature measurements are made inside a protective Gortex shield. Measurements are taken every two minutes, and are stored on an eight mega-byte FLASH card.

3. Stand-alone-Barometric Pressure Module (Stratus 3)

An Heise DXD (Dresser Instruments) sensor was selected for barometric pressure measurement. The sensor provides output of calibrated engineering units in ASCII for direct input to the processor board. A Gill static pressure port is used to minimize errors due to the wind blowing over the exposed sensor port. Data are recorded every two minutes and saved to an eight mega-byte FLASH card.

C. Subsurface Instruments

The following sections describe individual instruments on the buoy bridle and mooring line. Sections D and E will give more instrumentation information specific to each mooring. Where possible, instruments were protected from being fouled by fishing lines by "trawl-guards" designed and fabricated at WHOI. These guards are meant to keep lines from hanging up on the in-line instruments.

1. Floating SST Sensor (Stratus 3 and 4)

A Sea-Bird SBE-39 was placed in a floating holder (a buoyant block of synthetic foam sliding up and down along 3 stainless steel guide rods) in order to sample the sea temperature as close as possible to the sea surface. The Sea-Bird model SBE-39 is a small, lightweight, durable and reliable temperature logger that was set to record the sea surface temperature every 5 minutes.

2. Subsurface Argos Transmitter (Stratus 3 and 4)

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

3. SeaCat Conductivity and Temperature Recorders (Stratus 3 and 4)

The model SBE 16 SeaCat was designed to measure and record temperature and conductivity at high levels of accuracy while deployed in either a fixed or moored application. Powered by internal batteries, a SeaCat is capable of recording data for periods of a year or more. Data are acquired at intervals set by the user. An internal back-up battery supports memory and the real-time clock in the event of failure or exhaustion of the main battery supply. The SeaCat is capable of storing a total of 260,821 samples. A sample rate of 5 minutes was used on the Stratus SeaCats. The shallowest SeaCat was mounted directly to the bridle of the discus buoy. The others were mounted on in-line tension bars and deployed at various depths throughout the moorings. The conductivity cell is protected from bio-fouling by the placement of antifoulant cylinders at each end of the conductivity cell tube.

4. MicroCat Conductivity and Temperature Recorder (Stratus 3 and 4)

The MicroCat, model SBE37, is a high-accuracy conductivity and temperature recorder with internal battery and memory. It is designed for long-term mooring deployments and includes a standard serial interface to communicate with a PC. Its recorded data are stored in non-volatile FLASH memory. The temperature range is -5° to +35ºC, and the conductivity range is 0 to 6 Siemens/meter. The pressure housing is made of titanium and is rated for 7,000 meters. The MicroCat is capable of storing 419,430 samples of temperature, conductivity and time. The sampling interval of the Stratus 1 MicroCats was five minutes. The shallowest MicroCats were mounted on the bridle of the discus buoy and wired to the IMET systems. These were equipped with RS-485 interfaces. The deeper instruments were mounted on in-line tension bars and deployed at various depths throughout the moorings. The conductivity cell is protected from bio-fouling by the placement of antifoulant cylinders at each end of the conductivity cell tube.

5. Brancker Temperature Recorders (TPOD, Stratus 3 and 4)

The Brancker temperature recorders are self-recording, single-point temperature loggers. The operating temperature range for this instrument is 2° to 34°C. It has internal battery and logging, with the capability of storing 24,000 samples in one deployment. A PC is used to communicate with the Brancker via serial cable for instrument set-up and data download. The Branckers were set to record data every 30 minutes.

6. SBE-39 Temperature Recorder (Stratus 3 and 4)

The Sea-bird model SBE-39 is a small, light weight, durable and reliable temperature logger that was set to record temperature every 5 minutes.

7. Vector Measuring Current Meters (Stratus 3 and 4)

The VMCM has two orthogonal cosine response propeller sensors that measured the components of horizontal current velocity parallel to the axles of the two-propeller sensors. The orientation of the instrument relative to magnetic north was determined by a flux gate compass. East and north components of velocity were computed continuously, averaged and then stored on cassette magnetic tape. Temperature was also recorded using a thermistor mounted in a fast response pod, which was mounted on the top end cap of the VMCM. The VMCMs were set to record every 7.50 minutes.

A new generation VMCM (NGVM) was deployed at the 350m depth on the Stratus 3 mooring and only NGVM's were used on the Stratus 4 mooring. It has all of the same external components as the previous original VMCM but has a new circuit board and flash card memory module. It can store up to 40 Mb of data on the flash card and therefore the sampling rate was set to once per minute.

8. Aanderaa (Stratus 3)

An Aanderaa Recording Current Meter, Model RCM 11, was used on the Stratus 3 mooring. This current meter features the Mk II Doppler Current Sensor DCS 3820. The RCM comes equipped with an eight ton mooring frame and was used in-line with the mooring line. It was set to sample every 10 minutes.

9. Falmouth Scientific Instruments Current Meter (Stratus 3)

The 3D ACM is an acoustic current meter on trial deployment from Falmouth Scientific Instruments, Inc. (FSI). The FSI current meter uses four perpendicularly oriented transducers to extract a single-point measurement. In addition to current values of north, east and up, the instrument also records temperature, tilt, direction and time. The instrument was set to record once every 30 minutes with an averaging interval of 450 seconds.

10. RDI Acoustic Doppler Current Profiler (Stratus 3 and 4)

An RD Instruments (RDI) Workhorse Acoustic Doppler Current Profiler (ADCP, Model WHS300-1) was mounted at 135 m looking upwards on the mooring line. The RDI ADCP measures a profile of current velocities. The Stratus 3 RDI was set up as follows: 4 m bin size, 30 bins, 45 pings per ensemble, 1 ping per second, 1 hour sample interval. The Stratus 4 instrument was set differently: 10 m bin size, 12 bins, 60 pings per ensemble, 1 ping per second, 1 hour sample interval.

11. Chlorophyll Absorption Meter (Stratus 3)

A WET Labs Chlorophyll Absorption Meter (CHLAM) was placed on the Stratus 3 mooring at a depth of 25 meters. The CHLAM was mounted on a frame that fits inside a standard VMCM cage. A Sea-Bird pump drew water through a mesh filter and the CHLAM, and past two brominating canisters arranged end-to-end. Between samples, the bromide diffused through the system to reduce bio-fouling. Data were stored in a WET Labs MPAK data logger, serial number PK-023. The CHLAM/MPAK recorded a reference and signal from three optical wavelengths (650, 676 and 712 nanometers) and an internal temperature. The sample interval rate is 2 hours. At each sample, the pump is turned on for 10 seconds to flush the system. Ten seconds of sampling follow, with the 10-second average of signal and reference stored in the MPAK. The complete system was powered by two, 10 D-cell alkaline battery packs and should last for approximately 400 days.

12. Acoustic Rain Gauge (Stratus 3)

An Acoustic Rain Gauge from Jeff Nystuen at the Applied Physics Laboratory at the University of Washington was deployed at a depth of 37.5 meters on the Stratus 2 mooring and the same instrument was deployed at 50 m on the Stratus 3 mooring. This instrument uses a hydrophone and listens to ambient noise. Rain falling on the sea surface produces noise at certain frequencies, and these frequencies are sampled by this instrument. Data from the IMET rain gauges on the surface buoy as well as from the acoustic rain gauge can be compared.

13. Acoustic Release (Stratus 3 and 4)

The acoustic release used on the Stratus moorings is an EG&G Model 322. This release can be triggered by an acoustic signal and will release the mooring from the anchor. Releases are tested at depth prior to deployment to ensure that they are in proper working order.

D. Stratus 3 Recovery

The Stratus 3 mooring was deployed in October 2002 and recovered in November 2003. Table 4 below gives an overview of recovery and deployment operations.

Table 4. Stratus 3 Deployment and Recovery Overview

Deployment	Date	October 24, 2002
	Time	00:16:26 UTC
	Position at Anchor Drop	20° 10.551' S, 85° 6.63' W
	Deployed by	Lord, Ryder, Dunn
	Recorder	Lara Hutto
	Ship	R/V *Melville*
	Cruise No.	Vanc03
	Depth	4440
	Anchor Position	20° 10.4816' S, 85° 6.7273 W
Recovery	Date	November 17, 2003
	Time	12:32 UTC
	Position of Recovery (Release fired)	20° 10.117' S, 85° 06.358' W
	Recovered by	Lord, Ryder, Smith, Weller
	Recorder	Hutto
	Ship	R/V *Revelle*
	Cruise No.	Dana03

1. Mooring Description

The Stratus 3 mooring was instrumented with meteorological instrumentation on the buoy, and subsurface oceanographic equipment on the mooring line. Tables 5 and 6 below detail the instrumentation. Figure 4 is a schematic representation of the Stratus 3 mooring.

Table 5. Stratus 3 Surface Instrumentation

Instrument	**ID Number**	**Height[6] (cm)**
System #1		
Data Logger	L04	
Relative Humidity	HRH 219	257.2
Wind Module	WND 217	303.7
Barometric Pressure	BPR 106	241.8
Shortwave Radiation	SWR 109	316.5
Longwave Radiation	LWR 101	316.5
Precipitation	PRC 206	275.3
Argos Transmitter	ID 27916 ID 27917 ID 27918	
System #2		
Data Logger	L07	
Relative Humidity	HRH 216	255.3
Wind Module	WND 219	303.0
Barometric Pressure	BPR 112	241.8
Shortwave Radiation	SWR 111	316.5
Longwave Radiation	LWR 006	316.5
Precipitation	PRC 205	275.3
Argos Transmitter	ID 27919 ID 27920 ID 27921	
Stand Alone		
Barometric Pressure	BPR 204	219.7
Relative Humidity	HRH 222	269.6
Argos Transmitter	ID 20060	

[6] Heights given are measured from the buoy deck, which was 0.3 meters above the mean waterline.

Table 6. Stratus 3 Subsurface Instrumentation

Depth (m)	Instrument	Serial Number	Measurement
0	SBE 39	0072	Temperature
1.27 m below buoy deck	MicroCat	1836	Conductivity and Temperature (Logged internally and through IMET System #1)
1.32 m below buoy deck	MicroCat	1305	Conductivity and Temperature (Logged internally and through IMET System #2)
1.32 m below buoy deck	SeaCat	1881	Conductivity and Temperature
2.0 m below buoy deck	Argos Transmitter	ID 24337	Satellite transmission in case mooring is overturned.
3.71	SeaCat	1873	Conductivity and temperature
7	SeaCat	1875	Conductivity and temperature
10	VMCM	009	Currents and temperature
13	Aanderaa w/ temp	129	Currents and temperature
16	SeaCat	2325	Conductivity and temperature
20	VMCM	030	Currents and temperature
25	CHLAM w/ SBE 39	CHLAM #1 SB 0049	Chlorophyll-a and temperature
30	SeaCat	1880	Conductivity and temperature
32.5	VMCM	055	Currents and temperature
35	TPOD	4485	Temperature
40	MicroCat	1326	Conductivity and Temperature
45	VMCM	011	Currents and temperature
50	Acoustic Rain Gauge	Ibis	Precipitation
55	TPOD	3836	Temperature
62.5	MicroCat	1330	Conductivity and temperature
70	TPOD	3830	Temperature
77.5	TPOD	3259	Temperature
85	MicroCat	1329	Conductivity and temperature
92.5	TPOD	4495	Temperature
100	TPOD	4228	Temperature
115	TPOD	3831	Temperature
130	MicroCat	2012	Conductivity and temperature
135	ADCP	1218	Currents
145	TPOD	3764	Temperature
160	TPOD	3762	Temperature
190	MicroCat	1328	Conductivity and temperature
220	TPOD	3258	Temperature
235	FSI Acoustic Current Meter	1469	Currents
250	TPOD	4494	Temperature
349	SBE 39	0048	Temperature
350	VMCM	001	Currents and temperature
450	SBE 39	0050	Temperature

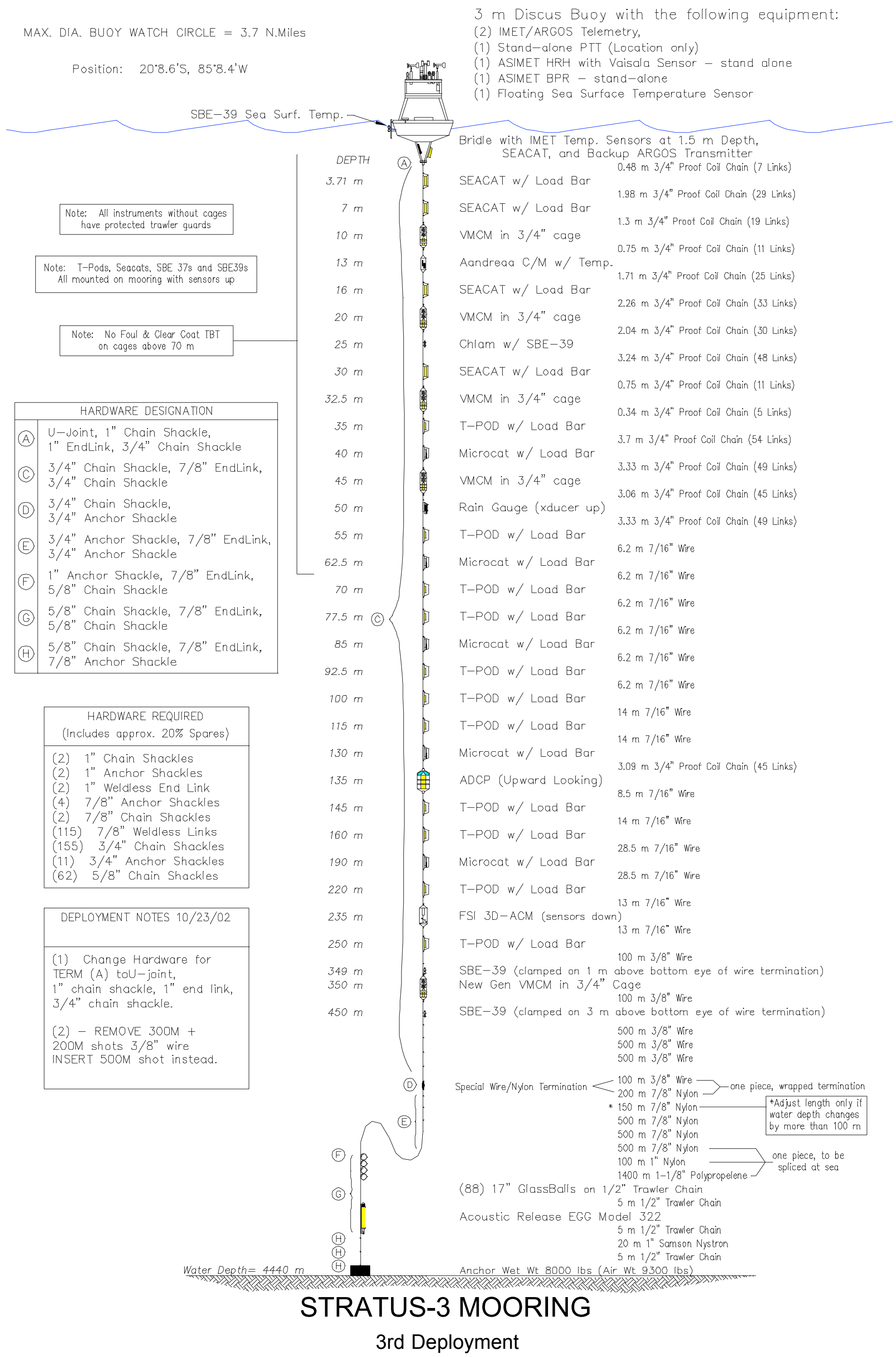


Figure 4. Stratus 3 Mooring Diagram.

2. Recovery Process

The Stratus 3 mooring was recovered on November 17, 2003. To prepare for recovery the *R/V Revelle* was positioned roughly 1/2 mile upwind from the anchor position. The acoustic release was fired to separate the anchor from the mooring line. After about 45 minutes the glass balls surfaced. Once the glass balls were on the surface, the ship approached the cluster of glass balls along the starboard side.

The TSE mooring winch leader was revved through the gifford block and around to the starboard quarter. A 5-ton pick-up hook was shackled to a 12 foot and 6 foot lift all sling. The pick-up hook was snapped into a section of chain. The lift all sling was walked aft and shackled into the winch leader. The *Revelle* went slow ahead so the glass balls would be astern of the ship. The winch hauled the winch leader and the lift all sling to bring a section of glass balls over the stern. Two stopper lines were snapped into a sling link and then made fast to the deck cleats. The winch leader was payed out and the lift all sling was disconnected. A 12 foot blue amstel pick-up pendent was then shackled to the winch leader and was hooked to a sling link. The winch was hauled in to take the tension from the stopper lines. The two stopper lines were eased out and cleared from the cleats. The winch hauled in the glass balls over the stern.

Figure 5. Retrieval of Stratus 3 Glass Balls.

Two air tuggers were used to control the cluster of glass balls. A stopper line was hooked into a sling link and brought to the capstan. The capstan began to haul in the cluster of glass ball and the TSE winch payed out slowly. Once all the glass balls were on board, a stopper line was hooked into a yale grip that was on the 1-1/8" polypropylene and made fast to the deck cleat. The amstel pendant was then hooked into the sling link above the release. The winch hauled the release on board.

The 1-1/8” polypropylene was cut near the eye splice and a bowline was tied. The winch leader was shackled to the bowline. The winch took up the slack and the stopper line was eased off and cleared. The winch hauled in the polypropylene while glass balls were being disconnected. Once disconnected, the glass balls were brought forward to the rag top container to be loaded using the ship’s crane.

Hauling continued until there was roughly 15 meters of polypropylene line remaining. A yale grip was placed on the polypropylene. A stopper line was hooked into the yale grip and made fast to the deck cleat. The TSE winch payed out slow so the stopper line had the load of the mooring. The polypropylene was then cut free from the winch, and a bowline was made at the cut end. The other stopper line was hooked into the bowline and made fast to a deck cleat. The winch was then off loaded into two wire baskets. Once off loaded, the winch leader was shackled into the bowline. The winch took up the slack and the stoppers where cleared. The yale grip was removed and hauling began with the remainder of the polypropylene, 100 meters of 1 inch nylon, and three 500 meter shots of 7/8” nylon. Hauling stopped at the end of the third 500 meter shot of nylon. Two stopper lines were hooked into the sling link between the 500 and 150 meter shot of nylon and made fast to the deck cleats. The 500 meter shot was disconnected and two 500-meter shots of line were spooled off the winch into a wire basket.

A traveling block was now in place. The air tugger line was revved through the Gifford block and shackled to a 1 inch sling link. The 1 inch sling link was attached to the bail on the rope master block. The 500 meter shot of nylon was revved through the rope master block and shackled to the 150 meter shot of nylon. The winch took up the slack and the two stopper lines were eased off and cleared. Hauling began with the 150 meter shot of nylon and continued with the 200/100 meter nylon and 3/8 wire rope special termination, the three shots of 500 meters of 3/8 wire rope. An SBE-39 was clamped on the 3/8 wire rope and recovered before the rope master block. Hauling continued with the 100 meter shot of 3/8 wire rope. At the end of the 100 meter shot, recovering the instruments took place. The procedure for recovering the instruments went as follows: with A-frame boomed out over the stern, the winch hauled in the wire. The first instrument was stopped about 2 feet above the deck and the A-frame was boomed in. Two stopper lines were hooked into the sling link and made fast to the deck cleats. The winch payed out slowly to lower the instrument to the deck. The instrument was disconnected from the hardware and moved to a staging area for pictures. The wire rope from the winch was then shackled to the load. The winch took up the slack and the stopper lines were eased off and then cleared. The A-frame was boomed out and hauling continued until the next instrument.

Figure 6. Retrieval of a Stratus 3 Instrument.

The above procedure was continued throughout the recovery operation until the rain gauge at 50 meters was recovered. Once the Rain Gauge was recovered, a shackle and 5/8" pear link was shackled to a link on the 3/4" chain. A 20 meter Samson slip line was made fast to one deck cleat and then passed through the pear link and made fast to the other deck cleat. The stopper lines were eased off and cleared so that the Samson slip line had the load. The slip line was eased out so the discus buoy and the remaining 45 meters of instruments went adrift. The ship went slow ahead to move away from the buoy.

Prior to departure, two sections of bulwarks were removed along the port side for recovering the discus buoy. The rescue boat was deployed with two crew members and one mooring tech. The small boat approached the buoy and hooked into the bail, opposite of the wind vane using a 12 foot blue amstel pendent. Attached to the pendent was an 8 foot lift-all sling. A tag line was bent into the 8 foot green sling. The *Revelle* slowly approached the small boat and buoy, keeping the buoy along the port side of the ship. A heaving line was thrown to the small boat and was tied to the tag line. The line was hauled back to the ship with the port side crane standing by. The green sling was hooked into the block of the crane. The crane lifted the buoy from the water and swung inboard so the buoy would rest on the side of the ship. The tugger lines were attached to bails on the buoy. The buoy was hoisted up and then swung inboard while the tuggers kept tension on buoy to keep from swinging.

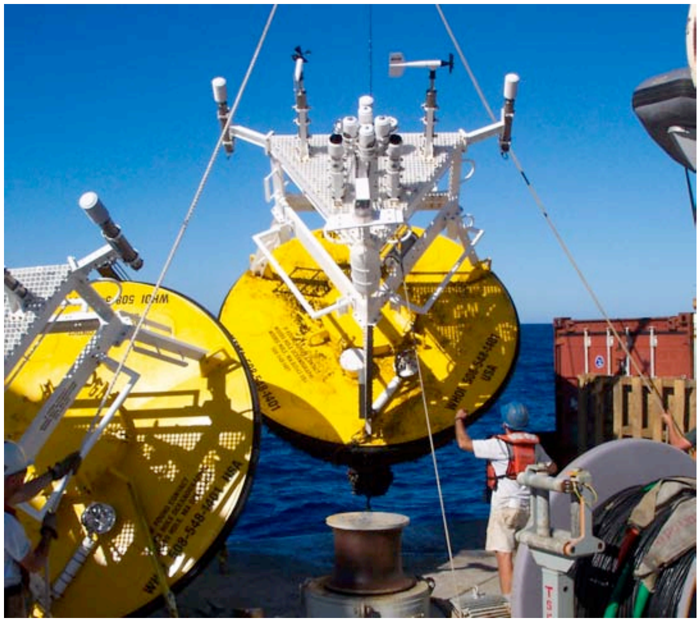


Figure 7. Retrieval of the Stratus 3 Buoy.

Once the buoy was on deck, wooden wedges were placed under the hull and aircraft straps were used to secure the buoy. A stopper line was used to stop off on the 0.48 meter shot of 3/4" chain between the buoy universal and the first instrument. The forward tugger with a chain hook shackled to the thimble was also used to stop off on the chain. The shackle was disconnected from the universal plate located at the bottom of the bridle legs.

An 8 foot lift all sling was placed through the sling link at the top of the first instrument and hooked in the crane's block. The crane took the load, and the stopper line was eased off and cleared. The crane hoisted the first two instruments and stopper line was hooked into a bite of chain. Once the stopper line had the load the crane lowered the instruments to the deck. The instruments were disconnected and the crane was repositioned over the load. The lift all sling was placed through the sling link and hooked into the crane. The crane took the load and the stopper line was eased off and cleared. The crane lifted the next section of instruments and the above procedure was used to recover the remaining instruments. The highest crane pick was roughly 8 meters from the deck.

The Acoustic Rain Gauge (ARG) Ibis was deployed at 50 meters. There was minimal fouling on the case, and the transducer was clear. The ARG was cleaned and stored in the main lab while other instruments were serviced. On 22 November, prior to attempting communications with the ARG, several cracks were observed in the delrin pressure housing. There was no evidence of water intrusion at that time. The vent plug was removed, and there was no pressure or water inside the case. Attempts to communicate with the ARG were not successful. The instrument was removed from its pressure case. Battery voltage was checked and measured at 1 VDC. A minimal amount of leakage was noticed at the bottom of the battery pack. The batteries were removed and discarded. The ARG was packed up and returned to Jeff Nyusten for further evaluation.

3. Time Spikes

Timing spikes were applied to some of the instruments recovered from Stratus 3. These spikes were performed so that responses in the data file could be checked against a known time. Water was added to the precipitation modules. Black bags were placed on the long and shortwave radiation sensors to block as much light as possible. The relative humidity modules were also bagged. Instruments measuring temperature were placed in ice baths or in a large refrigerator. The VMCM rotors were spun and then blocked. Table 7 gives the details of the timing spikes for pre-deployment of Stratus 3 and Table 8 post-recovery. Additional information on clock checks are given in Appendix F.

Table 7. Stratus 3 Pre-Deployment Timing Spikes.

Instrument	Serial #	Pre-Spike On		Pre-Spike Off	
Rel. Humidity	219	N/A	N/A	N/A	N/A
Wind	217	N/A	N/A	N/A	N/A
Pressure	106	N/A	N/A	N/A	N/A
Shortwave	109	15-Oct-02	15:39:00	15-Oct-02	16:34:00
Longwave	101	15-Oct-02	15:39:00	15-Oct-02	16:34:00
Precipitation	206	N/A	N/A	N/A	N/A
Rel. Humidity	216	N/A	N/A	N/A	N/A
Wind	219	N/A	N/A	N/A	N/A
Precipitation	205	N/A	N/A	N/A	N/A
Longwave	006	15-Oct-02	15:39:00	15-Oct-02	16:34:00
Shortwave	111	15-Oct-02	15:39:00	15-Oct-02	16:34:00
Pressure	112	N/A	N/A	N/A	N/A
Pressure	204	N/A	N/A	N/A	N/A
Humidity	222	N/A	N/A	N/A	N/A
MicroCat (SBE 37)	1836	15-Oct-02	15:35:00	15-Oct-02	16:33:30
MicroCat (SBE 37)	1305	15-Oct-02	15:35:00	15-Oct-02	16:33:30
SeaCat (SBE 16)	1881	15-Oct-02	15:37:00	15-Oct-02	16:33:00
SBE 39	0072	16-Oct-02	11:28:30	16-Oct-02	12:31:00
SeaCat (SBE 16)	1873	16-Oct-02	11:29:00	16-Oct-02	12:32:00
SeaCat (SBE 16)	1875	16-Oct-02	11:29:00	16-Oct-02	12:32:00
		Clock Reset	1st Spin	2nd Spin	Bands Off
VMCM	009	10/16/2002, 20:30:00	19-oct-02, 13:55:00	19-oct-02, 17:13:00	24 -oct-02, 13:53:26
Aanderaa	129	16-Oct-02	13:47:00	16-Oct-02	14:51:00
SeaCat (SBE 16)	2325	16-Oct-02	11:29:00	16-Oct-02	12:32:00
VMCM	030	17-oct-02, 13:00:00	19-oct-02, 13:56:00	19-oct-02, 17:14:00	24-oct-02, 13:43:47
Chlam w/ SBE 39	0049	16-Oct-02	11:28:30	16-Oct-02	12:31:00
SeaCat (SBE 16)	1880	16-Oct-02	11:29:00	16-Oct-02	12:32:00
VMCM	055	16-oct-02, 21:00:00	19-oct-02, 13:56:30	19-oct-02, 17:14:30	24-oct-02, 13:40:28
TPOD	4485	19-Oct-02	13:16:00	19-Oct-02	14:39:00
MicroCat (SBE 37)	1326	16-Oct-02	11:28:30	16-Oct-02	12:31:30
VMCM	011	17-oct-02, 13:15:00	19-Oct-02, 13:58:00	19-oct-02, 17:15:30	24-oct-02, 15:14:39
Rain Gauge	Ibis	N/A	N/A	N/A	N/A
TPOD	3836	19-Oct-02	13:16:00	19-Oct-02	14:39:00
MicroCat (SBE 37)	1330	16-Oct-02	11:28:30	16-Oct-02	12:31:30
TPOD	3830	19-Oct-02	13:16:00	19-Oct-02	14:39:00
TPOD	3259	19-Oct-02	13:16:00	19-Oct-02	14:39:00
MicroCat (SBE 37)	1329	16-Oct-02	11:28:30	16-Oct-02	12:31:30
TPOD	4495	19-Oct-02	13:16:00	19-Oct-02	14:39:00
TPOD	4228	19-Oct-02	13:16:00	19-Oct-02	14:39:00
TPOD	3831	19-Oct-02	13:16:00	19-Oct-02	14:39:00
MicroCat (SBE 37)	2012	16-Oct-02	11:28:30	16-Oct-02	12:31:30
ADCP	1218	19-Oct-02	13:33:00	19-Oct-02	14:43:00
TPOD	3764	19-Oct-02	13:16:00	19-Oct-02	14:39:00
TPOD	3762	19-Oct-02	13:16:00	19-Oct-02	14:39:00
MicroCat (SBE 37)	1328	16-Oct-02	11:28:30	16-Oct-02	12:31:30
TPOD	3258	19-Oct-02	13:16:00	19-Oct-02	14:39:00
FSI ACM	1469	17-Oct-02	13:45:00	17-Oct-02	14:54:00
TPOD	4494	19-Oct-02	13:16:00	19-Oct-02	14:39:00
SBE 39	0048	16-Oct-02	11:28:30	16-Oct-02	12:31:00
New Gen VMCM	001	16-Oct-02, 18:00:00	19-Oct-02, 13:59:00	19-Oct-02, 17:16:00	24-Oct-02, 16:35:30
SBE 39	0050	16-Oct-02	11:28:30	16-Oct-02	12:31:00

Table 8. Stratus 3 Post-Deployment Spikes.

Instrument	Serial #	Time 1		Time 2	
Rel. Humidity	219	11/18/2003	13:01:00	11/18/2003	15:09:00
Wind	217	N/A	N/A	N/A	N/A
Pressure	106	N/A	N/A	N/A	N/A
Shortwave	109	11/18/2003	12:57:00	11/18/2003	15:07:00
Longwave	101	11/18/2003	12:57:00	11/18/2003	15:07:00
Precipitation	206	N/A	N/A	N/A	N/A
Rel. Humidity	216	11/18/2003	13:06:00	11/18/2003	15:12:00
Wind	219	N/A	N/A	N/A	N/A
Precipitation	205	N/A	N/A	N/A	N/A
Longwave	006	11/18/2003	12:57:00	11/18/2003	15:07:00
Shortwave	111	11/18/2003	12:57:00	11/18/2003	15:07:00
Pressure	112	N/A	N/A	N/A	N/A
Pressure	204	N/A	N/A	N/A	N/A
Rel. Humidity	222	11/18/2003	13:04:00	11/18/2003	15:11:00
SBE 37	1836	11/18/2003	15:30:33	11/18/2003	18:02:00
SBE 37	1305	11/18/2003	15:30:33	11/18/2003	18:02:00
SBE 16	1881	11/18/2003	15:37:00	11/18/2003	18:01:30
SBE 39	0072	11/18/2003	19:59:49	11/18/2003	20:40:00
SBE 16	1873	11/18/2003	15:49:30	11/18/2003	18:00:00
SBE 16	1875	11/18/2003	15:53:00	11/18/2003	17:58:30
VMCM	009	11/21/2003	18:06:00 – 18:07:00	11/21/2003	18:20:00 – 18:21:00
Aanderaa	129	N/A	N/A	N/A	N/A
SBE 16	2325	11/18/2003	15:47:00	11/18/2003	17:47:00
VMCM	030	11/21/2003	16:53:00 – 16:54:00	11/21/2003	17:10:00 – 17:11:00
Chlam w/ SBE 39	0049	11/18/2003	18:49:30	11/19/2003	00:19:00
SBE 16	1880	11/18/2003	15:44:30	11/18/2003	18:00:30
VMCM	055	11/21/2003	22:01:30 – 22:02:30	11/21/2003	22:17:30 – 22:18:30
TPOD	4485	11/18/2003	18:43:45	11/19/2003	00:22:00
SBE 37	1326	11/18/2003	~13:58:30	11/18/2003	15:17:54
VMCM	011	11/21/2003	20:22:00 – 20:23:00	11/21/2003	20:33:30 – 20:34:30
Rain Gauge	Ibis	N/A	N/A	N/A	N/A
TPOD	3836	11/18/2003	18:45:30	11/19/2003	00:21:15
SBE 37	1330	11/18/2003	~13:58:30	11/18/2003	15:17:00
TPOD	3830	11/18/2003	18:46:45	11/19/2003	00:20:30
TPOD	3259	11/18/2003	18:42:15	11/19/2003	00:22:15
SBE 37	1329	11/18/2003	~13:58:30	11/18/2003	15:16:30
TPOD	4495	11/18/2003	18:44:15	11/19/2003	00:21:30
TPOD	4228	11/18/2003	18:46:30	11/19/2003	00:20:00
TPOD	3831	11/18/2003	18:44:45	11/19/2003	00:21:00
SBE 37	2012	11/18/2003	~13:58:30	11/18/2003	15:17:30
RDI	1218	11/20/2003	19:43:30	N/A	N/A
TPOD	3764	11/18/2003	18:46:00	11/19/2003	00:20:00
TPOD	3762	11/18/2003	18:42:45	11/19/2003	00:22:30
SBE 37	1328	11/18/2003	~13:58:30	11/18/2003	~15:13:45
TPOD	3258	11/18/2003	18:43:15	11/19/2003	00:23:00
FSI ACM	1469	N/A	N/A	N/A	N/A
TPOD	4494	11/18/2003	18:45:00	11/19/2003	00:20:45
SBE 39	0048	11/18/2003	18:49:30	11/19/2003	00:19:45
New Gen VMCM	001	11/21/2003	19:09:00	11/21/2003	19:10:00
SBE 39	0050	11/18/2003	18:49:30	11/19/2003	00:19:30

4. Antifoulant performance

Although no formal testing was carried out on the Stratus 3 mooring, the effectiveness of the antifoulants was monitored. The table below shows methods for coating the buoy hull and instrumentation for the Stratus 3 mooring.

Table 9. Stratus 3 Antifoulant Details.

Description	Coating	Color	Coats	Method
Discus Hull	SN-1	White Grey Blue	2 1 3	Roller Roller Roller
Floating SST & Frame	SN-1	White Blue	2 1	Spray Brush
Bridle Legs	SN-1	White Blue	2 1	Spray Brush
Instruments On Bridle Legs	SN-1	Blue	2	Brush
Load Bars and Trawl Guards	SN-1	White	2	Spray/Brush
All instruments to 70 Meters	SN-1	White	2	Brush
SeaCat/MicroCat shields	SN-1	White	1	Spray
VMCM props and stings	SN-1 TBT	White Clear	1 1 (heavy)	Spray/Brush Spray
VMCM Pressure Case and Cage	SN-1	White	2	Spray
Acoustic Rain Gauge (50 M)	TBT	Clear	1 (heavy)	Spray
CHLAM (25 M) Frame and plastic parts only	SN-1	Blue	1 (heavy)	Brush
Aanderaa ADCP Heads (13 M)	Trilux w/Biolux	Red	2	Brush
Aanderaa ADCP Body (13 M)	TBT	Clear	1	Spray
RDI ADCP heads (135 M)	Trilux w/Biolux	Red	2	Brush

Observations of fouling on the Stratus 3 mooring were as follows:

- Fouling on instruments appeared to be slightly less than those recovered from the Stratus 2 mooring. Heavy fouling was evident above 20 meters, moderate to 35 meters and light below that.

- Fouling on SeaCats was heavy for the first 20 meters. Fouling did not appear to be reduced by the addition of SN-1 to the pressure cases. Fouling inside conductivity cells and shields was not reduced, but barnacle adhesion seemed to be weaker on coated areas.

- T-Pods on load bars had moderate fouling down to 45 meters.

- The RDI ADCP at 135 meters showed light fouling on the pressure case. Transducer heads and cage were clear.

- Fouling below 90 meters was negligible. However, small goose neck barnacles were observed on instruments down to 145 meters

Fouling on the hull and bridle was somewhat reduced from the Stratus 2 mooring, and cleanup was relatively easy. Algae coated the submerged area of the hull. Ablation of the SN-1 on the hull was much less than on earlier moorings

E. Stratus 4 Deployment

The Stratus 4 mooring was deployed in November of 2003, and is scheduled to be recovered approximately one year later. Table 10 below gives an overview of deployment operations.

Table 10. Stratus 4 Deployment Overview

Stratus 4		
Deployment	Date	November 19, 2003
	Time	20:31:30 UTC
	Position at Anchor Drop	19° 45.951' S 84° 30.239' W
	Deployed by	Lord, Ryder
	Recorder	Hutto
	Ship	R/V *Revelle*
	Cruise No.	Dana03
	Depth	4441 m
	Anchor Position	19° 45.912' S 85° 30.405' W

Although in the previous two years there had been no evidence of problems with fishing at the mooring, the subsurface instrumentation from the upper part of the recovered Stratus 3 mooring was heavily fouled with long-line fishing gear. Two changes were made to the Stratus 4 deployment plan to counter this.

First, a bottom survey was carried out with *Revelle's* Simrad multibeam sonar in order to identify a new, relatively flat region that was at least 20 nm to the west of the old site. The old site had been occupied for three years and was marked on navigational charts so it was thought likely that fisherman were going specifically to that site to catch the fish that often aggregate around surface moorings. It was hoped that a new site out of radar range of the old site would not be as likely to be visited by fishing vessels.

Second, the locations of some instruments on the Stratus 4 mooring were changed and the new mooring reconfigured in the day between the recovery of Stratus 3 and the deployment of Stratus 4. The VMCMs are most vulnerable to fishing line among the current meters deployed, so two were positioned deeper in the water column while two Sontek acoustic current meters were moved from greater depths to the locations where VMCMs had been removed. As a result, there are three Sontek acoustic current meters in the upper part of the Stratus 4 mooring.

In addition to the responses made to the problems with fishing gear fouling the moored instrumentation, the results of the Stratus 1 and Stratus 2 deployments had led to additional changes in the configuration of the moored instrumentation. Below the base of the mixed layer at this site, as shown by the time series of salinity and temperature from Stratus 1 and 2 and CTD profiles (see section IV for CTD results), there is a layer of relatively fresh water. Because mixing down into this layer entrains fresher water that may play a role in offsetting the tendency to increase the salinity of the surface layer associated with evaporation, moored temperature/salinity were increased in the depth range between 145 and 250 m.

1. Mooring Description

The Stratus 4 mooring was instrumented with meteorological instrumentation on the buoy, and subsurface oceanographic equipment on the mooring line. Tables 11 and 12 below detail the instrumentation. Figure 8 is a schematic representation of the Stratus 4 mooring.

Table 11. Stratus 4 Surface Instrumentation

Instrument	ID Number	Height[7] (cm)	Type
System #1			
Data Logger	L01		
Relative Humidity	HRH 223	257.2	ASIMET
Wind Module	WND 212	297.2	ASIMET
Precipitation	PRC 004	273.1	IMET
Longwave Radiation	LWR 204	316.5	ASIMET
Shortwave Radiation	SWR 102	316.0	IMET
Barometric Pressure	BPR 006	236.5	IMET
Argos Transmitter (Wildcat PTT #14709)	ID 9805 ID 9807 ID 9811		
System #2			
Data Logger	L02		
Relative Humidity	HRH 221	257.2	ASIMET
Wind Module	WND 206	297.0	ASIMET
Precipitation	PRC 109	275.3	IMET
Longwave Radiation	LWR 104	316.6	IMET
Shortwave Radiation	SWR 104	376.0	IMET
Barometric Pressure	BPR 110	236.0	IMET
Argos Transmitter (Wildcat PTT #14612)	ID 24337 ID 27970 ID 27971		
Stand Alone			
Relative Humidity	HRH 227	273.0	ASIMET
Argos Transmitter (SIS #22)	ID 11427		

[7] Heights given are measured from the buoy deck.

Table 12. Status 4 Subsurface Instrumentation

Depth (m)	Instrument	Serial Number	Measurement
Floater	SBE39	0717	Temperature
Bridle	SBE16	1877	Temperature and Salinity
Bridle	SBE37	1834	Temperature and Salinity
Bridle	SBE37	1837	Temperature and Salinity
3.9	SBE16	1882	Temperature and Salinity
7	SBE16	0146	Temperature and Salinity
10	VMCM	033	Currents and Temperature
13	Sontek	D171	Currents and Temperature
16	SBE16	1879	Temperature and Salinity
20	VMCM	066	Currents and Temperature
25	TPOD	3667	Temperature
30	SBE16	2324	Temperature and Salinity
32.5	Sontek	D197	Currents and Temperature
35	TPOD	3839	Temperature
40	SBE16	0927	Temperature and Salinity
45	VMCM	053	Currents and Temperature
50	SBE16	0994	Temperature and Salinity
55	Sontek	D193	Currents and Temperature
62.5	SBE16	1878	Temperature and Salinity
70	TPOD	4483	Temperature
77.5	TPOD	3703	Temperature
85	SBE16	0993	Temperature and Salinity
88.5	VMCM BEARING TEST	TEST	Currents and Temperature
92.5	TPOD	3701	Temperature
100	TPOD	4481	Temperature
115	TPOD	4493	Temperature
130	SBE16	0928	Temperature and Salinity
135	RDI	1220	Currents and Temperature
145	TPOD	3309	Temperature
160	SBE37	2011	Temperature and Salinity
175	TPOD w/ clamp	4488	Temperature
190	VMCM	030	Currents and Temperature
192	SBE16	2322	Temperature and Salinity
222	SBE37	1899	Temperature and Salinity
238	VMCM	073	Currents and Temperature
254	TPOD	4489	Temperature
280	TPOD w/ clamp	3305	Temperature
293.75	VMCM	068	Currents and Temperature
354.35	VMCM	057	Currents and Temperature
400	SBE39	0282	Temperature
450	SBE39	0203	Temperature
~4400	Acoustic Release	339	N/A

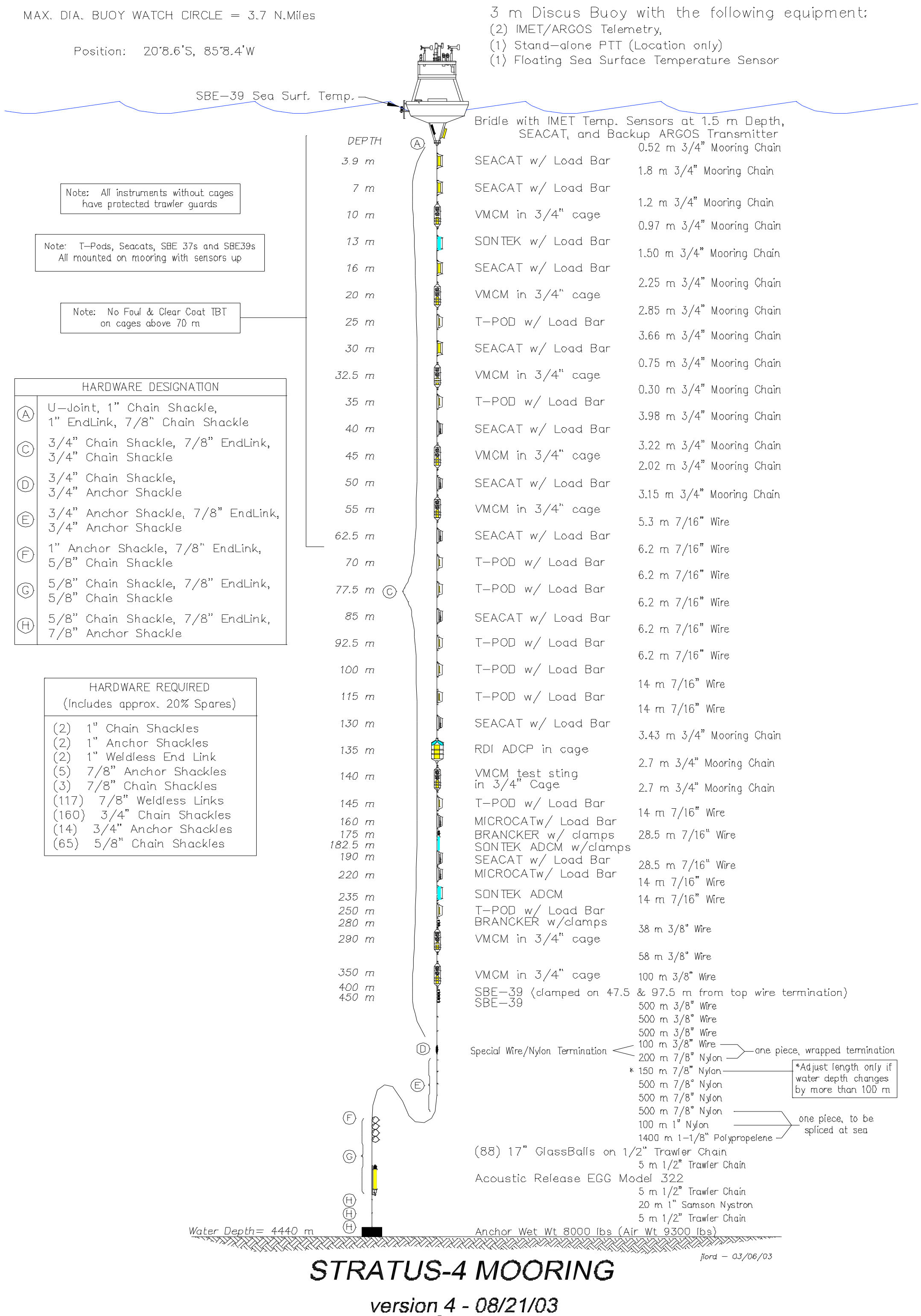


Figure 8. Stratus 4 Mooring Diagram.

2. Antifoulant Application

Previous discus moorings have been used as test beds for a number of different antifouling coatings. The desire has been to move from organotin-based antifouling paints to a product that is less toxic to the user, and more environmentally friendly. These tests have led the Upper Ocean Process group to rely on E Paint Company's, SN-1 as the antifouling coating used on the buoy hull and the majority of instruments deployed.

Instead of the age-old method of leaching toxic heavy metals, the patented E Paint approach takes visible light and oxygen in water to create peroxides that inhibit the settling larvae of fouling organisms. Photogeneration of peroxides and the addition of an organic co-biocide, which rapidly degrades in water to benign byproducts, make E Paint's SN-1 an effective alternative to organotin antifouling paints. This paint has been repetitively tested in the field and has shown good bonding and anti-fouling characteristics, as well as a good service life up to 8 months.

However, certain instruments are adversely affected by even the slightest fouling. To date, adjuncts must be used to insure the most protection on those instruments.

For Stratus 4, E Paint is interested in determining the erosion rates and fouling resistance of two new antifoul coatings; commercial grade SN-1 and SUNWAVE. Commercial grade SN-1 is a harder, less soluble, version of the original product. The product is well suited for use in the photic zone where UV degradation is problematic. SUNWAVE is a two part water-based antifouling coating that offers a truly eco-friendly approach to controlling biofouling. The product should offer superior adhesion and durability. Results from this study will validate the new version of SN-1 and SUNWAVE as viable alternatives to organotin, copper, and other more toxic coatings.

In addition to the hull tests, a proprietary product from E Paint is being tested as an alternative to TBT on mechanical current meters. This product has been applied to two load bars deployed near the surface where fouling is greatest.

The table below shows methods for coating the buoy hull and instrumentation for the Stratus 4 deployment.

Table 13. Stratus 4 Antifoulant Details.

Description	Coating	Color	Coats	Method
Discuss Hull Right half – facing anemometer	CG SN-1	White Grey Black	2 1 1	Roller Roller Roller
Discuss Hull Left Half – facing anemometer	SUNWAVE	Black Yellow White	1 1 2	Roller Roller Roller
Floating SST SST Frame	SN-1 E Paint P	White Brown	2 1	Brush Spray
Bridle Legs	SN-1	White	3	Spray
Instruments On Bridle Legs	SN-1 Mylar Wrap	White Clear	2	Brush Taped 2 legs\
Load Bars and Trawl Guards	SN-1 E Paint P	White Brown	2 2 @ 3.7,1@ 7	Spray/Brush Spray
All instruments to 70 Meters[8] 40 M SeaCat _ radially 62.5 M SeaCat axially	SN-1	White	1	Brush
SeaCat MicroCat shields	SN-1	White	1	Spray
VMCM props	SN-1 TBT	Blue Clear	1 2	Spray/Brush Spray
VMCM cage & case clamps	SN-1	White	2 2	Spray Brush
RDI ADCP heads (135 M)	Trilux w/Biolux	Red	1	Brush

3. Time Spikes

Timing spikes were applied to some of the Stratus 4 mooring instrumentation prior to deployment. These spikes will help with data processing by allowing timing to be checked on the instruments. Table 14 below details the timing spike information.

[8] Sontek moved to 32.5 meters was not coated.

Table 14. Stratus 4 Pre-Deployment Spikes.

Instrument	Serial #	Time 1		Time 2	
Relative Humidity	HRH 223	11/9/2003	18:19:00	11/9/2003	20:17:30
Wind	WND 212	11/14/2003	14:23:00	11/15/2003	12:30:00
Precipitation	PRC 004	11/7/2003	20:14:00	N/A	N/A
Longwave Radiation	LWR 204	11/9/2003	18:05:00	11/9/2003	20:10:30
Shortwave Radiation	SWR 102	11/9/2003	18:16:30	11/9/2003	20:12:00
Barometric Pressure	BPR 006	N/A	N/A	N/A	N/A
Relative Humidity	HRH 221	11/9/2003	18:22:45	11/9/2003	20:14:30
Wind	WND 206	11/14/2003	14:23:00	11/15/2003	12:30:00
Precipitation	PRC 109	11/7/2003	20:15:00	N/A	N/A
Longwave Radiation	LWR 104	11/9/2003	18:07:00	11/9/2003	20:11:00
Shortwave Radiation	SWR 104	11/9/2003	18:14:00	11/9/2003	20:13:00
Barometric Pressure	BPR 110	N/A	N/A	N/A	N/A
Relative Humidity	HRH 227	11/9/2003	18:21:00	11/9/2003	20:16:00
SBE39	0717	11/8/2003	17:35:00	11/8/2003	19:13:45
SBE16	1877	11/8/2003	16:51:00	11/8/2003	19:13:30
SBE37	1834	11/9/2003	17:04:30	11/9/2003	18:10:00
SBE37	1837	11/9/2003	17:04:30	11/9/2003	18:10:00
SBE16	1882	11/13/2003	13:39:30	11/13/2003	15:15:45
SBE16	0146	11/13/2003	13:42:30	11/13/2003	15:18:15
VMCM	033	N/A	N/A	N/A	N/A
Sontek	D171	11/12/2003	13:55:30	11/12/2003	15:11:00
SBE16	1879	11/13/2003	15:40:00	11/13/2003	17:43:00
VMCM	066	N/A	N/A	N/A	N/A
TPOD	3667	11/13/2003	19:58:45	11/13/2003	21:33:30
SBE16	2324	11/13/2003	19:55:45	11/13/2003	21:35:00
Sontek	D197	11/12/2003	13:51:30	11/12/2003	15:08:00
TPOD	3839	11/14/2003	13:29:00	11/14/2003	15:40:30
SBE16	0927	11/13/2003	17:55:00	11/13/2003	19:22:45
VMCM	053	N/A	N/A	N/A	N/A
SBE16	0994	11/14/2003	13:25:45	11/14/2003	15:41:45
Sontek	D193	11/12/2003	~14:01:00	11/12/2003	~15:13:00
SBE16	1878	11/13/2003	19:52:45	11/13/2003	21:37:00
TPOD	4483	11/14/2003	13:28:10	11/14/2003	15:39:15
TPOD	3703	11/14/2003	13:30:00	11/14/2003	15:37:50
SBE16	0993	11/13/2003	17:58:00	11/13/2003	19:24:15
TPOD	3701	11/13/2003	15:41:45	11/13/2003	17:45:45
TPOD	4481	11/13/2003	20:06:15	11/13/2003	21:31:30
TPOD	4493	11/13/2003	18:00:15	11/13/2003	19:20:15
SBE16	0928	11/13/2003	15:36:10	11/13/2003	17:40:20
RDI	1220	11/11/2003	22:57:00	11/12/2003	00:35:00
TPOD	3309	11/15/2003	13:41:30	11/15/2003	15:20:30
SBE37	2011	11/15/2003	13:41:00	11/15/2003	15:20:45
TPOD w/ clamp	4488	11/13/2003	18:03:00	11/13/2003	19:25:45
VMCM	030	N/A	N/A	N/A	N/A
SBE16	2322	11/15/2003	13:39:15	11/15/2003	15:21:15
SBE37	1899	11/15/2003	13:40:00	11/15/2003	15:21:00
VMCM	073	N/A	N/A	N/A	N/A
TPOD	4489	11/13/2003	13:46:00	11/13/2003	15:12:45
TPOD w/ clamp	3305	11/13/2003	18:03:00	11/13/2003	19:27:00
VMCM	068	N/A	N/A	N/A	N/A
VMCM	057	N/A	N/A	N/A	N/A
SBE39	0282	11/13/2003	18:07:00	11/13/2003	19:29:45
SBE39	0203	11/13/2003	18:07:00	11/13/2003	19:28:30

4. Deployment Process

The Stratus 4 surface mooring was set using the UOP two phase mooring technique. Phase 1 involved the lowering of approximately 40 meters of instrumentation over the port side of the ship. Phase 2 was the deployment of the buoy and remaining mooring components. The benefits from lowering the first 40 meters of instrumentation are: (1) it allows controlled lowering of the upper instrumentation; (2) the suspended instrumentation attached to the buoy's bridle acts as a sea anchor to stabilize the buoy during deployment; and (3) the length of payed out mooring wire and instrumentation provides adequate scope for the buoy to clear the stern without capsizing or hitting the ship. The remainder of the mooring is deployed over the stern. The following narrative is the actual step-by-step procedure used for the Stratus 4 mooring deployed from the R/V *Revelle*.

The basic deck equipment and deck layout is illustrated in Figure 9. The mooring gear used in the deployment of the surface mooring included: the TSE winch, port crane, and the standard complement of cleats, chain grabs, stopper lines and slip lines. Personnel required for the first phase of the operation were: two instrument handlers, crane whip/stop line handler, four mooring wire handlers, winch operator, and a crane operator. Additional personnel assisted with positioning instruments for deployment. Figure 9 illustrates the positioning of personnel during the instrument-lowering phase.

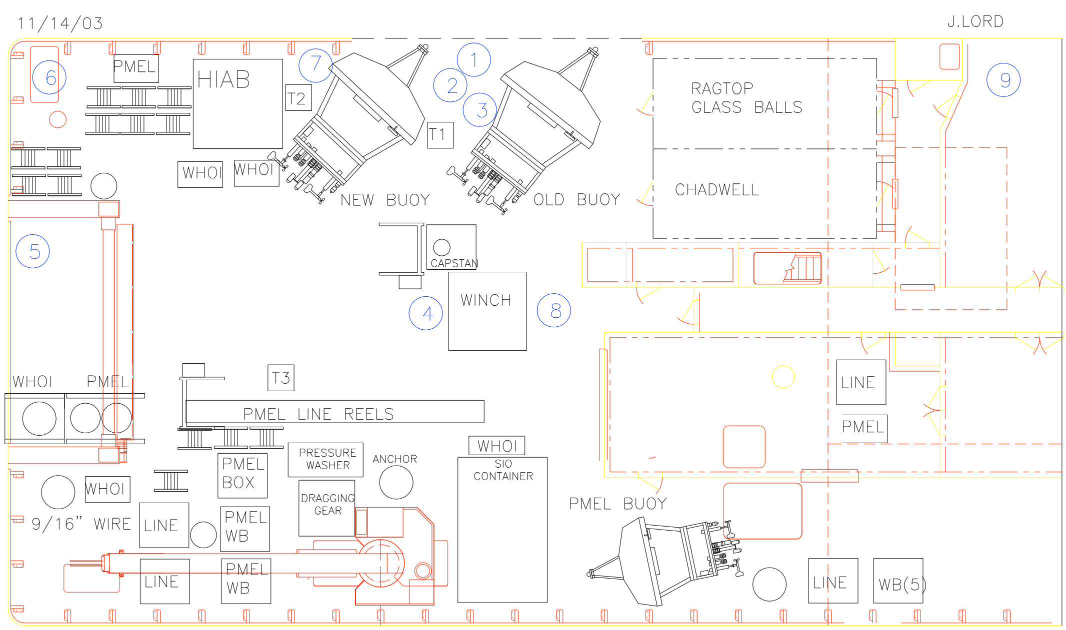


Figure 9. Deck Equipment and Layout.

The TSE winch drum was pre-wound with the following mooring components listed from deep to shallow:

500 m 7/8" nylon
500 m 7/8" nylon
150 m 7/8" nylon
200 m 7/8" nylon – nylon to wire shot
Canvas tarp barrier interface
100 m 3/8" wire - nylon to wire shot
500 m 3/8" wire
500 m 3/8" wire
500 m 3/8" wire
100 m 3/8" wire
58 m 3/8" wire
38 m 3/8" wire

A tarp was placed between the nylon and wire rope to prevent the wire from burying into the nylon line under tension. A tension cart was used to pretension the nylon and wire during the winding process.

The ship was positioned nine nautical miles downwind and down current from the desired anchor site. An earlier bottom survey indicated this track would take the ship over an area with consistent ocean depth. This allowed an acceptable margin of error for delays or drift off the desired track.

Prior to the deployment of the mooring, 100 meters of 3/8" diameter wire rope was payed out to allow its bitter end to be passed out through the center of the A-frame and around the aft port quarter and forward along the port rail to the instrument lowering area.

The four hauling wire handlers were stationed around the aft port rail. Their positions were; in front of the TSE winch, center of the A-frame, aft port quarter, and approximately 5 meters forward along the port rail. The wire handlers' job was to keep the hauling wire from fouling in the ship's propellers and pass the wire around the stern to the line handlers on the port rail.

To begin the mooring deployment, the ship hove to with the bow positioned with the wind slightly on the port bow. The crane was extended out so that there was a minimum of 10 meters of free whip hanging over the instrument lowering area. All subsurface instruments for this phase had been staged in order of deployment on the port side main deck. Instrumentation from 40 meters to the surface had a pre-connected shot of chain or wire shackled to the top of the instrument, plus a shackle and ring attached to the bottom of the load bar. Instrumentation 40 meters and deeper had their chain or wire shot secured to the bottom of the instrument. A shackle and ring was attached to the bottom of each shot of chain or wire. The 40-meter instrument was rigged with shots above and below.

The first instrument segment to be lowered was the 3.22 meter 3/4" proof coil chain, 40 meter depth SeaCat, 3.98 meter length of 3/4" chain. The instrument lowering began by shackling the bitter end of the hauling wire to the free end of the 3.22 meter length of 3/4" chain. The crane whip hook suspended over the instrument lowering area was lowered to approximately 1 meter off the deck. A 6-foot long "Lift All" sling, hitched through a 3/4" chain grab, was hooked onto the crane. The chain grab was hooked onto the 3.98 meter 3/4" chain approximately .5 meters from the free end.

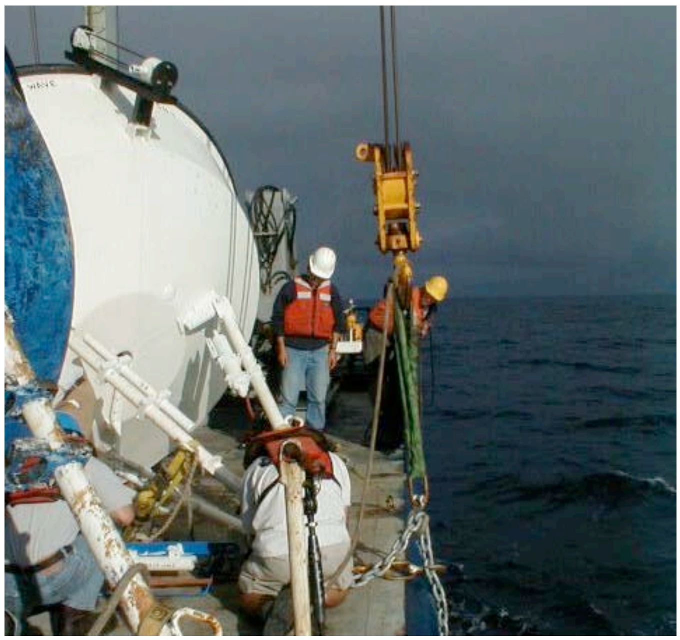


Figure 10. Lowering Stratus 4 Instruments Over the Side.

The crane whip was raised up so that the chain and instrument were lifted off the deck. The crane swung outboard to clear the ship's side, and slowly lowered the whip and attached mooring components down into the water. The TSE winch payed out the hauling wire simultaneously. The wire handlers positioned around the stern eased wire over the port side, paying out enough wire to keep the mooring segment vertical in the water. The shot of 3/4" chain was stopped off .5 meters above the ship's deck using a 3/4" chain grab and stopper line. The crane was then directed to swing slightly inboard and lower its 3/4" chain grab to the deck. The stopper line was hauled in enough to take the load from the crane and made fast to the deck. The hook on the crane was removed.

The next segment in the mooring to be lowered was the 35 meter T-Pod, and 1.5 m length of 3/4" chain. The instrument and chain were brought into the instrument lowering area with the instrument bottom end pointing outboard so that it could be shackled to the top of the stopped off chain shot. The loose end of the chain, fitted with a 3/4" chain shackle and 7/8" end link, was again hooked onto the crane whip using a chain grab on a sling. The crane whip was raised taking with it the chain and instrument into a vertical position, 0.5 m off the deck. Once the crane's whip had taken the load of the mooring components hanging over the side, the stopper line was slacked and removed. The crane swung outboard and the whip lowered. The TSE winch slowly payed out the hauling wire at a pay out rate similar to the descent rate of the crane whip.

The operation of lowering the upper mooring components was repeated up to the 0.52 meter shot of 3/4" chain shackled to the 3.9 meter depth SeaCat. The load from this instrument cluster was stopped off in the end link at the top of the instrument load bar. This allowed enough slack to connect the buoy bridle to the instrument cluster. The free end of 0.52 meter 3/4" chain was then shackled to the 1" end link attached to discus bridle universal joint.

The second phase of the operation was the launching of the buoy. There were three slip lines rigged on the discus to maintain control during the lift. Lines were rigged on the bridle, tower bail and a buoy deck bail. The 30 ft. bridle slip line was used to stabilize the bridle and allow the hull to pivot on the apex at the start of the lift. The 50 ft. tower slip line was rigged to check the tower as the hull swung outboard. A 75 ft. buoy deck bail slip line was rigged to prevent the buoy from spinning as the buoy settled in the water. This is used so the quick release hook, hanging from the crane's whip, could be released without fouling against the tower. The buoy deck bail slip line was removed just following the release of the buoy. An additional line was tied to the crane hook to help pull the crane block away from the tower's meteorological sensors once the quick release hook had been triggered and the buoy cast adrift.

Figure 11. Buoy Shown After Quick Release Tripped.

With three slip lines in place, the crane was directed to swing over the discus buoy. A four-foot sling hitched to through the quick release hook, was attached to the crane block. The quick release hook was attached directly to the main lifting bail. Slight tension was taken up on the whip to hold the buoy. The chain lashings, binding the discus to the deck, were removed. The stopper line holding the suspended 40 meters instrumentation was eased off to allow the discus to take the hanging load. The discus was raised up and swung outboard as the slip lines kept the hull in check. The tower slip line was removed first, followed by the bridle slip line. Once the discus had settled into the water (approximately 20 ft. from the side of the ship), and the release hook had gone slack, the quick release was tripped. The crane swung forward to keep the block away from the buoy. The slip line to the buoy deck bail was cleared at about the same time. The ship then maneuvered slowly ahead to allow the buoy to come around to the stern.

The TSE winch operator slowly hauled in the slack wire once the discus had drifted behind the ship. The ship's speed was increased to 1/2 knot through the water to maintain a safe distance between the buoy and the ship. The bottom end of the shot of chain shackled to the hauling wire was pulled in and stopped off at the transom. The next instrument, 45 meter depth VMCM and pre attached chain shot shackled to the end of the stopped off chain. The free end of chain, shackled to the bottom of the VMCM cage, was shackled to the free end of hauling wire. The hauling wire was pulled onto the TSE winch to take up the slack on the chain. The winch slowly took the mooring tension from the stopper line hooked onto the chain shot ahead of the VMCM.

A traveling snatch block was suspended from the A-frame using the heavy duty air tugger to adjust the height if the block. Two frapping lines were attached to the block to keep it from swinging out of control. The block was opened and installed over the chain on the bottom side of the VMCM. This block was hauled up to about 8 feet off the deck, lifting the VMCM off the deck as it was raised. By controlling the A-frame, block height, and winch speed, the VMCM was lifted clear of the deck and over the transom. The winch payed out to the next termination. The termination was stopped off using lines on cleats, and the hauling wire removed while the next instrument was attached to the mooring.

Figure 12. Using The Hanging Block To Control Deployment.

The next several instruments were deployed in a similar manner. Soon, short shots of chain, were replaced by longer shots of 7/16” jacketed wire rope. When pulling the slack on these longer shots, the terminations were covered with a canvas wrap before being wound onto the winch drum. The purpose of the canvas was to cover the shackles and wire rope termination and prevent damage from point loading the lower layers of wire rope and nylon already on the drum. The process of instrument insertion was repeated for the remaining instruments down to 354 meters.

All the wire and nylon on the TSE winch drum was payed out, and the end of the nylon was stopped off to a deck cleat. The mooring was set up for temporary towing. A 5-meter length of 1/2” trawler chain was secured to the stopped off nylon end. A second stopper line was hooked onto the chain. Both stoppers were eased out so that 1 to 2 meters of the chain shot was past the stern and secured to deck cleats.

A tension cart was secured on the fantail, aft of the winch. A 500-meter reel of 7/8” nylon line was mounted to the cart. The nylon was wound on to the winch. The free end of the nylon was shackled to the stopped off 1/2” chain and hauled in, pulling the deployed nylon termination back onto the deck. This termination was stopped off and the towing chain was removed. The nylon terminations were shackled together and pay out continued.

The long lengths of wire and nylon were payed out approximately 10% slower than the ship’s speed through the water. Payout speed was monitored using a digital tachometer, Ametek model #1726. The selected readout from the tachometer was in miles per hour. A table was created to compare ships speed and wire payout.

While the wire and nylon line was being payed out, the crane was used to lift the 96 glass balls out of the rag top container. These balls were staged fore and aft, in four ball segments, just aft of the container.

Once the nylon line was payed out, it was stopped off two meters from the transom, and the winch line removed. An H-bit cleat was positioned in front of the TSE winch and secured to the deck. The free end of the 2000 meter shot of nylon/polypropylene line, stowed in two wire baskets was bent around the H-bit and passed on to the stopped off mooring line. The shackle connection between the two nylon shots was made. The line handler at the H-bit pulled in all the residual slack and held the line tight against the H-bit. The stopper lines were then eased off and removed. The person handling the line on the H-Bit kept the mooring line parallel to the H-bit with moderate back tension. The H-bit line handler and one assistant eased the mooring line out of the wire basket and around the H-bit at the appropriate pay out speed relative to the ships speed.

Figure 13. H-Bit Rigged For Deploying 2000 Meters Of Line.

When the end of the polypropylene line was reached, pay out was stopped and a Yale grip was used to take tension off the polypropylene line. The winch tag line was shackled to the end of the polypropylene line. The polypropylene line was removed from the H-Bit. The winch line and mooring line were wound up taking the mooring tension away from the stopper line on the Yale grip. The stopper line was removed. The TSE winch payed out the mooring line until the thimble was approximately 1 meter from the ship's transom.

The deployment of 96 - 17" glass balls was accomplished using two 20 meter long stopper lines reeved through the two 10" snatch blocks secured to the front of the winch. This configuration of the deck stopper fair lead allowed for the maximum available distance between the TSE winch and the transom, while keeping the mooring components centered in the front of winch.

The 96 glass balls were bolted on 1/2" trawler chain in 4 ball (4 meter) increments. The 24 sections of chain and glass balls were laid out on the deck, and shackles together in pairs. The first string of glass balls was dragged aft and connected to the stopped off polypropylene line. The glass balls were stretched out up to the front of the winch. Two stopper lines with hooks were attached to the end of the section of glass balls closest to the front of the winch. The line was pulled tight and secured to deck cleats. The winch line was eased off, and the load transferred. The stoppers were payed out slowly as the balls went off the transom.

The stopper lines were payed out until one glass ball outboard of the stopper's hook remained on deck with a segment of 1/2" trawler chain bent over the transom. The stopper lines were secured to the deck. Another two segments of glass balls on chain was dragged into position and attached to the mooring. One of the stopper lines was removed and hooked into the end link closest to the TSE winch, then the second stopper was moved up as well. Tension was pulled up, and lines made fast to a cleat. This process of attaching balls and slipping over the transom continued until all 96 balls were on the mooring line.

The acoustic release and attached 1/2" trawler chain segments were deployed using an air tugger hauling line reeved through a block hung in the A-frame, and the TSE winch. Shackled to the end of tugger line was a 1/2" chain grab. The 20 meter 1" Samson anchor pennant was shackled to the TSE winch tag line and wound onto the winch. The acoustic release was positioned on the fantail 1 meter from the transom. The stopped off 5 meter length of 1/2" trawler chain was shackled to the top of the release. A 5-meter length of 1/2" chain was shackled to the bottom of release and the loose end of the chain secured to the anchor pennant. The A-frame was positioned so the hanging air tugger line and chain grab was over the top end of the release. The tugger line was lowered and hooked onto the 1/2" chain approximately 1 meter from the bottom end of the release. The anchor pennant was drawn up so that all available slack in the line was taken up on the winch drum. The tugger line was hauled in lifting the release off the deck. The A-frame was shifted outboard with the winch slowly paying out its line. The tugger line hauled in and payed out during this shift out board in order to keep the release off the deck as the instrument passed over the transom. Once the release had cleared the deck, the TSE winch payout was stopped and the tugger line was removed. The winch payed out the rest of the chain and the 20 Meter anchor pennant. The pennant was stopped off 2 meters from the transom.

The last 5 meter shot of 1/2" trawler chain was attached to the anchor and the anchor pennant. A 5/8" chain shackle and 5/8" pear link was attached to the chain approximately two meters from the anchor. A 20-meter length of 1" Samson line was passed through this link and secured to two cleats in the deck, just forward of the A-frame stop pedestal. The mooring load was transferred from the stopper line on the pennant to the slip line on the chain.

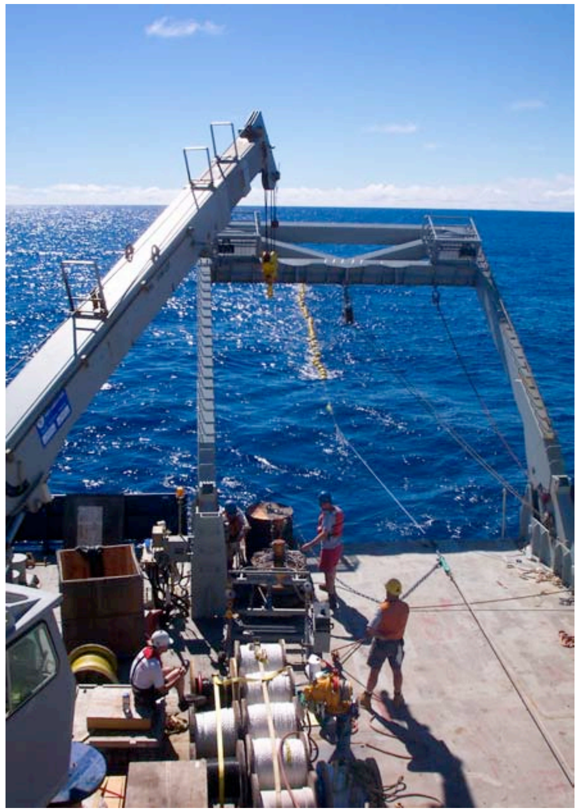


Figure 14. Anchor Rigged For Deployment.

Deck bolts were removed from the anchor tip plate. The Starboard crane was shifted so the crane whip would hang over, and slightly aft of the anchor. The whip was lowered and the whip hook secured to the tip plate chain bridle. A slight strain was applied to the bridle. The chain lashings were removed from the anchor. The Samson line was slipped off, transferring the mooring tension to the 1/2" chain and anchor. The line was pulled clear and the crane whip raised 0.5 meters lifting the forward side of the tip plate causing the anchor to slide over board.

5. Anchor Position Triangulation

After deployment, the exact position of the anchor was determined. At three points surrounding the anchor, the release was pinged and a distance determined. Through simple geometry, the anchor position was determined. Figure 15 shows the ranging pattern used to determine anchor position.

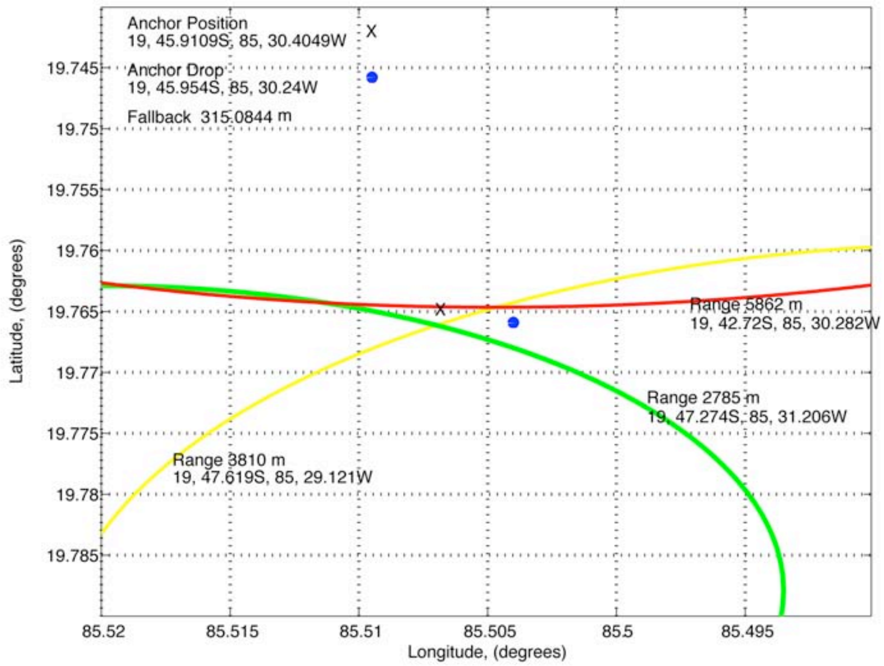


Figure 15. Acoustic Release Survey.

Prior to deployment, a bottom survey was completed to find a new mooring location approximately 30 nm away from the old site. This was done to shift the mooring from the location that has been occupied for the past three deployments and is known to fishermen.

The initial point for launching the buoy was 19° 42.7' S, 85° 37.6' W. The deployment track was along 115°, into the wind, and towards the nominal end point of 19° 49.1' S, 85° 23.0' W, which is 15 nm from the starting point. The target anchor site was at 20° 10.4' S, 85° 06.8' W (9 nm along deployment track).

When the mooring was ready for deployment, the ship was 7.7 nm along the deployment track. The anchor was dropped at 19° 45.954 S, 85° 30.240' W, where the water depth (corrected) was 4413 m.

Latitude of Position 1:	19.79365° S
Longitude of Position 1:	85.48535° W
Range of Position 1:	3810 m
Latitude of Position 2:	19.7879° S
Longitude of Position 2:	85.5201° W
Range of Position 2:	2785 m
Latitude of Position 3:	19.7120° S
Longitude of Position 3:	85.5047° W
Range of Position 3:	5862 m

Position of Anchor drop: 19° 45.951' S, 85° 30.239' W
Position of Anchor on Bottom: 19° 45.9109' S, 85° 30.4049' W
Fallback: 315.1 m (7.1% of water depth)

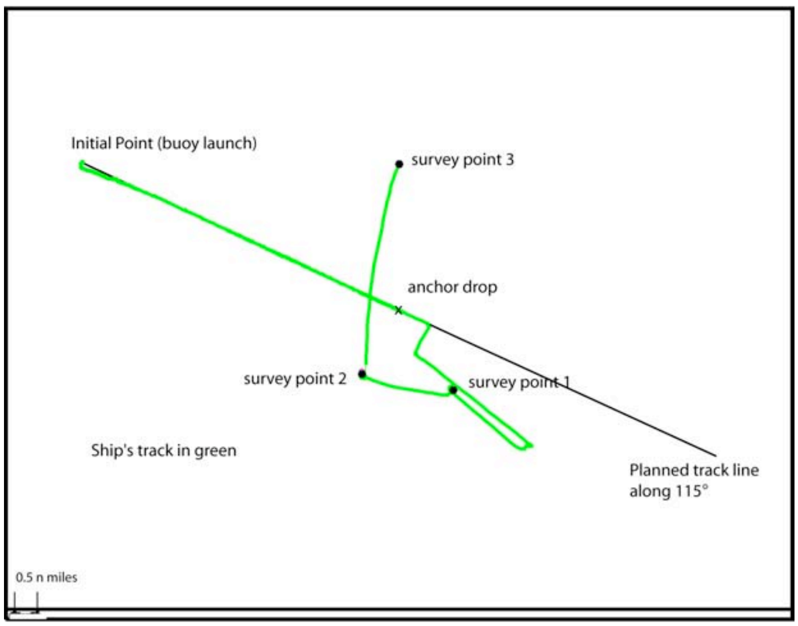


Figure 16. Stratus 4 Anchor Survey.

F. Comparison of buoy and ship IMET sensors

During the 2003 cruise, shipboard meteorological and seawater data systems were monitored for use in comparisons with data from the Stratus buoys. The primary source of underway shipboard data was via a serial feed sending data at a 5-second rate. This data was collected on a laptop computer using ProComm Plus running under Cygwin, subsampled to one minute with fields of interest and extracted in real-time using a shell script running in another Cygwin window on the same laptop.

Meteorological data from the buoy instruments was monitored using an Alpha Omega Satellite Uplink Receiver and a Matlab application called Argplot. Data from the buoys and the shipboard systems was then compared in real time using a third laptop with disks shared over the network. The data records supplied via serial feed were comma-separated ASCII fields containing value-name pairs. The following is a sample of this record.

$WICOR,131103,131024,20.32,AT2,1012.49,BP2,71.09,RH2,20.23,RT2,14.93,DP2,0.0,PR2,11.6,WS2,324.3,WD2,7.6,
TW2,113.2,TI2,12.6,WS2,325.7,WD2,8.2,TW2,118.3,TI2,296.18,LD2,294.55,LB2,-
238.1,LT2,345.1,LW2,100.3,SW2,294.72,LB1,-
99.0,LT9,416.4,LW1,1.2,SW2,196.07,PA2,20.934,TT2,49.117,TC2,35.199,SA2,24.664,SD2,1524.249,SV2,1.0,FI2,19.1
66,TT2,-
.001,TC2,0.010,SA2,0.000,SD7,1479.780,SV2,0.0,FI2,0.527,OC2,21.448,OT2,1.046,OX2,0.5274,OS2,21.59,WT2,0.352
,FL2,-99.000,FL9,-0.34,VP2,1.77,VR2,-0.03,VH2,0.05,VY2,1.48,VX2,-99.0,ZO9,-99.0,ZS9,-
99.0,ZT9,176.4,SH2,1.5,SM2,0.9,SR2,0.0,BT2,-9.22004,LA2,-
84.91667,LO2,47425,GT2,180.6,CR2,12.7,SP2,1037193025,ZD2,178.8,GY2*10

For our comparison, data was subsampled to 1 minute, the sample rate of the sensors, and fields of interest were extracted using a shell script:

```
awk -F, '(NF == 127 && NR %12 == 0 ){print $2,$3,$6,$8,$10,$24,$26,$28,$30,$38,$40,$52,$54,$56}'
```

This script produced an ASCII flat file containing date and time, barometric pressure, relative humidity, air temperature, relative wind speed and direction, true wind speed and direction, longwave and shortwave radiation, sea surface temperature, conductivity, and salinity. It was run using the shell command tail –f, to update the output as records were written by the ProComm logging program.

In real time, a Matlab program checked for new data from the script pre-processing shipboard data. When 60 points had been accumulated, an hourly average was calculated and the Argos data was reloaded from the laptop collecting that data. Data was then replotted and another accumulation cycle would begin. Wind direction were rotated from oceanographic to meteorological convention for comparison with the SCS wind data.

This system worked well except for a delay in the ProComm logging; this program is DOS-based and does not write to disk in a way that facilitates file sharing. This sometimes caused delays in updating the data.

Figures 17 and 18 show comparisons between the shipboard, buoy (noted as System 1 and 2), bucket temperatures, and data collected by the ETL group. Buoy data from November 15 – November 17 is for Stratus 3, and buoy data from November 19 – 21 is for Stratus 4.

The ship's thermosalinograph was known to have a temperature bias, so bucket temperatures were collected on a hourly basis by the watch standers to verify data from the buoys. In general, the ships sea temperature readings were higher than those collected by the other methods. It is also believed that the ship's longwave sensor was broken as it produced values very different from any of the other sensors.

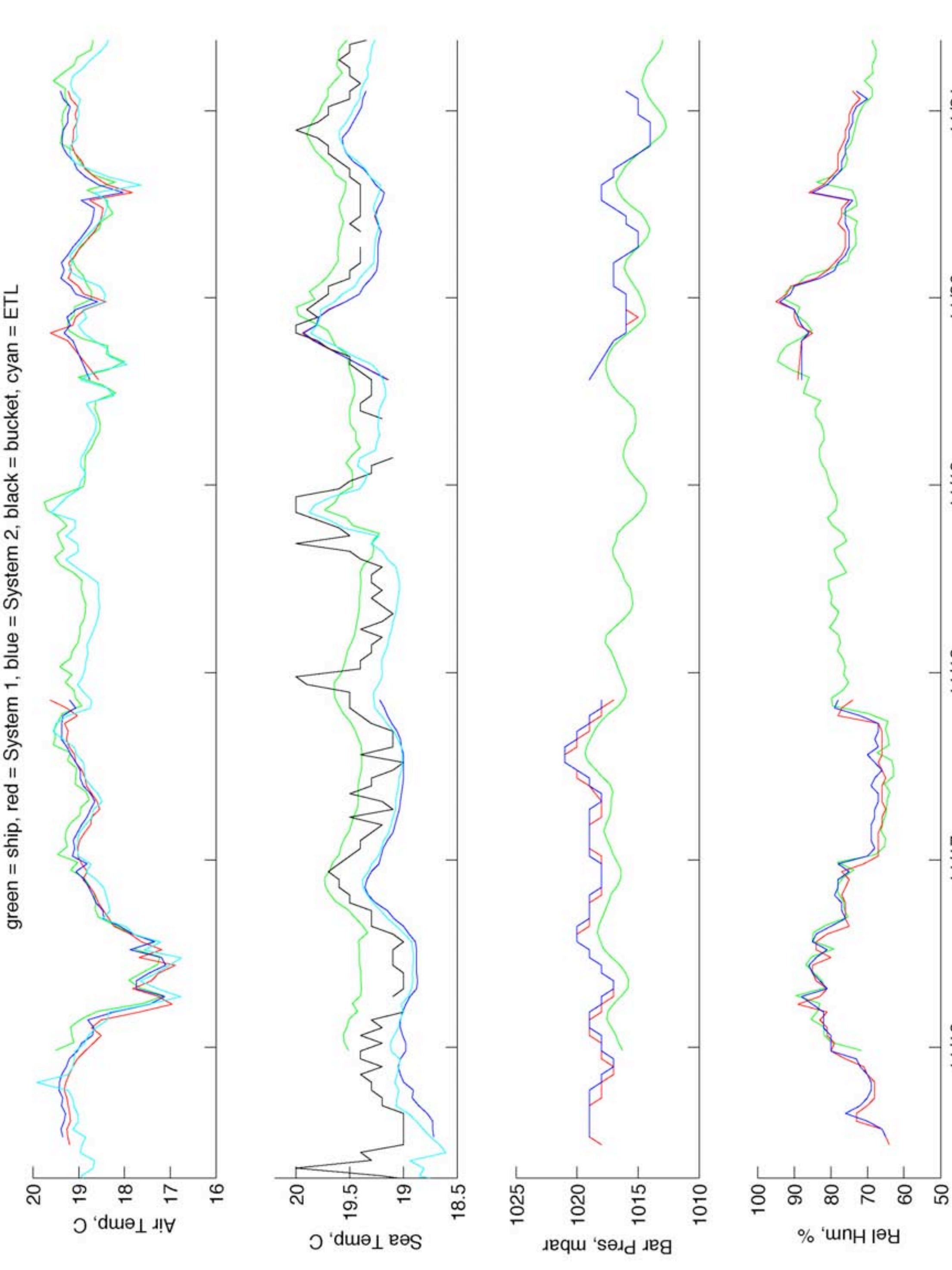


Figure 17. Meteorological Comparisons.

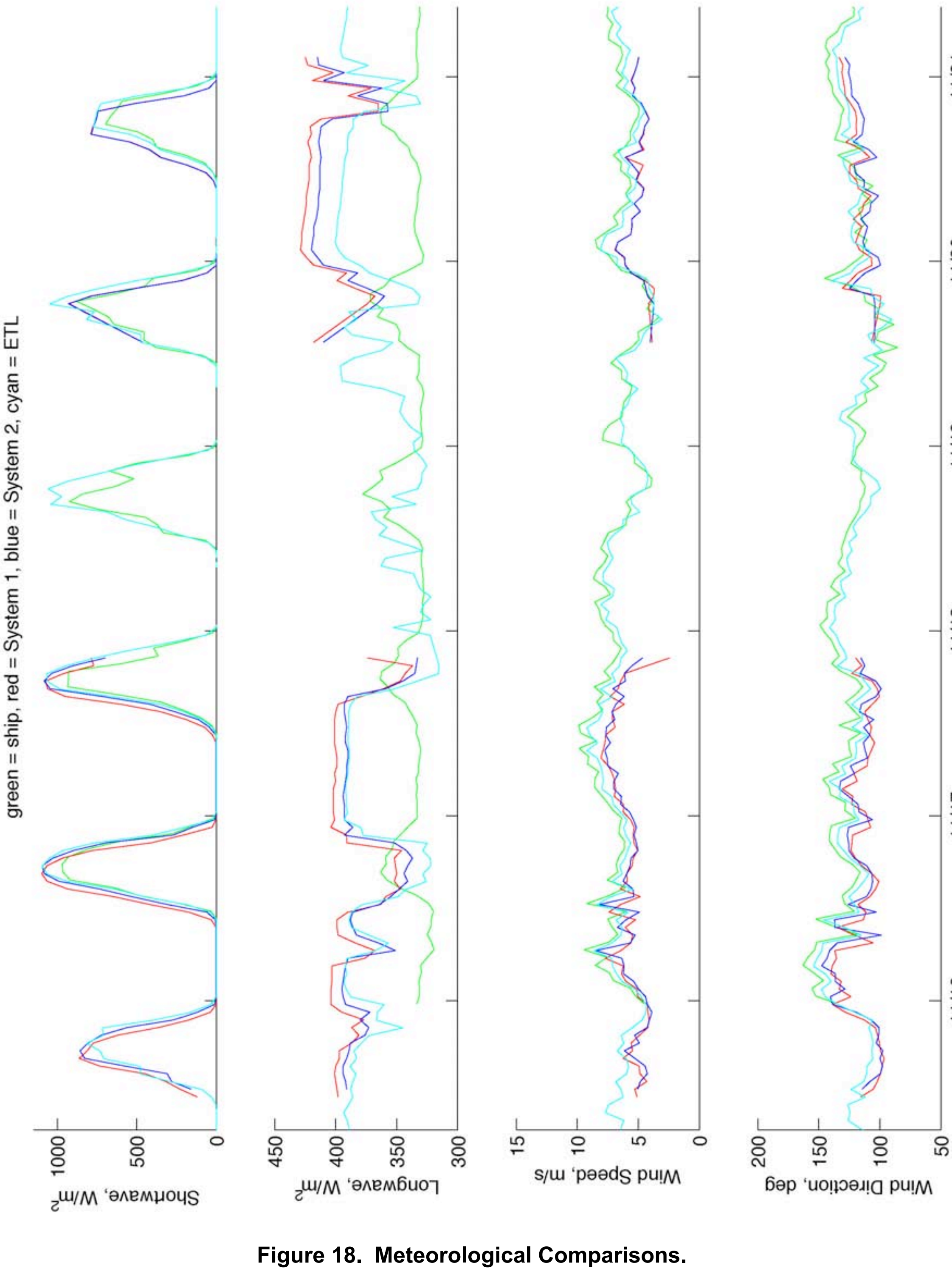


Figure 18. Meteorological Comparisons.

IV. SHIPBOARD MEASUREMENTS

The R/V *Revelle* was equipped with a variety of scientific and navigational equipment during the Stratus 2003 cruise. This section gives some basic data plots from the underway data. Figures 19 and 20 show echo sounder and bathymetry images produced by the shipboard computer technician. Table 15, and Figures 21 and 22 give information on and results from CTD casts performed at the Stratus site.

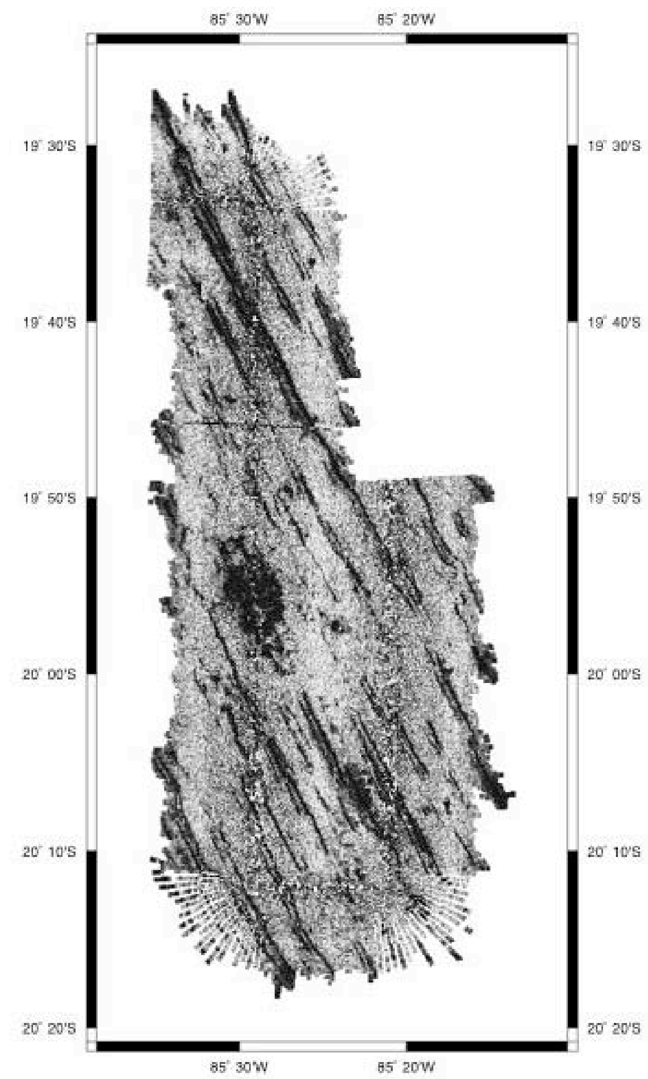


Figure 19. Multibeam Echo Sounder Image.

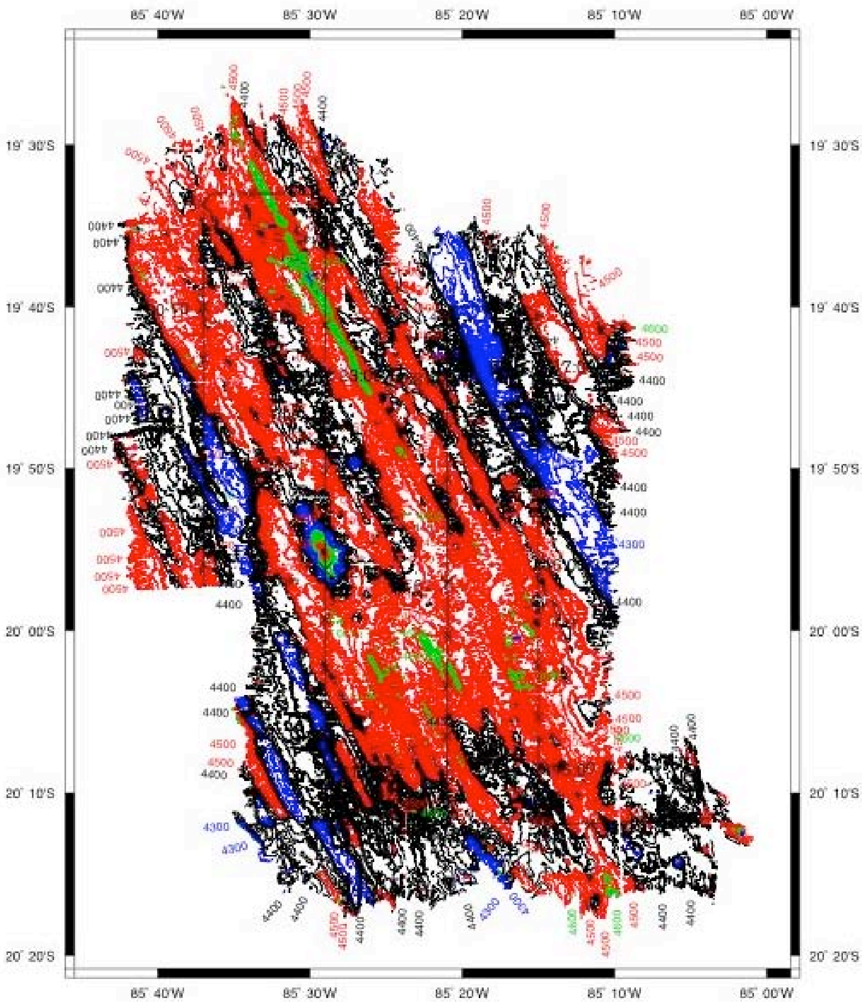


Figure 20. Bathymetry Map Used to Find New Stratus Location.

Table 15. CTD Casts

Cast #	Start Time (UTC)	Stop Time (UTC)	Start Position	Stop Position	Depth (m)
Test	11/15/03 20:02	11/16/03 21:20	20° 08.349' S 85° 12.769' W	20° 08.345' S 85° 12.765' W	1500
1	11/15/03 23:45:00	11/16/03 01:49:15	20° 03.749' S 85° 15.563' W	20° 03.746' S 85° 15.559' W	4000
2	11/16/03 01:52:00	11/16/03 03:44:00	20° 03.749' S 85° 15.558' W	20° 03.750' S 85° 15.559' W	4000
3	11/21/03 05:08:00	11/21/03 06:58:00	19° 47.531' S 85° 24.578' W	19° 47.555' S 85° 24.423' W	4000
4	11/21/03 06:59:00	11/21/03 08:50:00	19° 47.555' S 85° 24.423' W	19° 47.557' S 85°24.424' W	4000

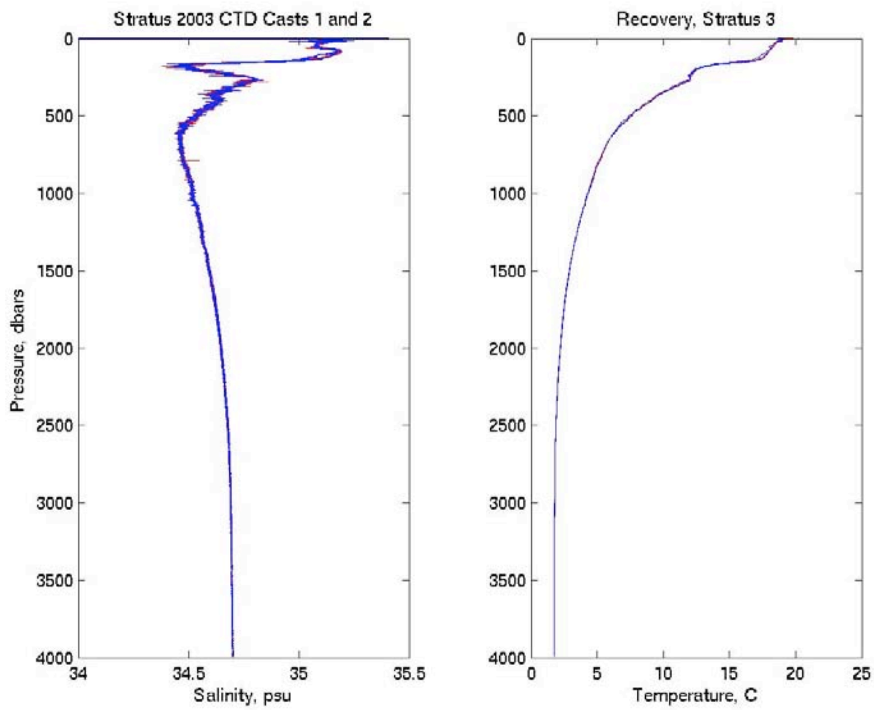


Figure 21. CTD Cast Prior to Stratus 3 Recovery.

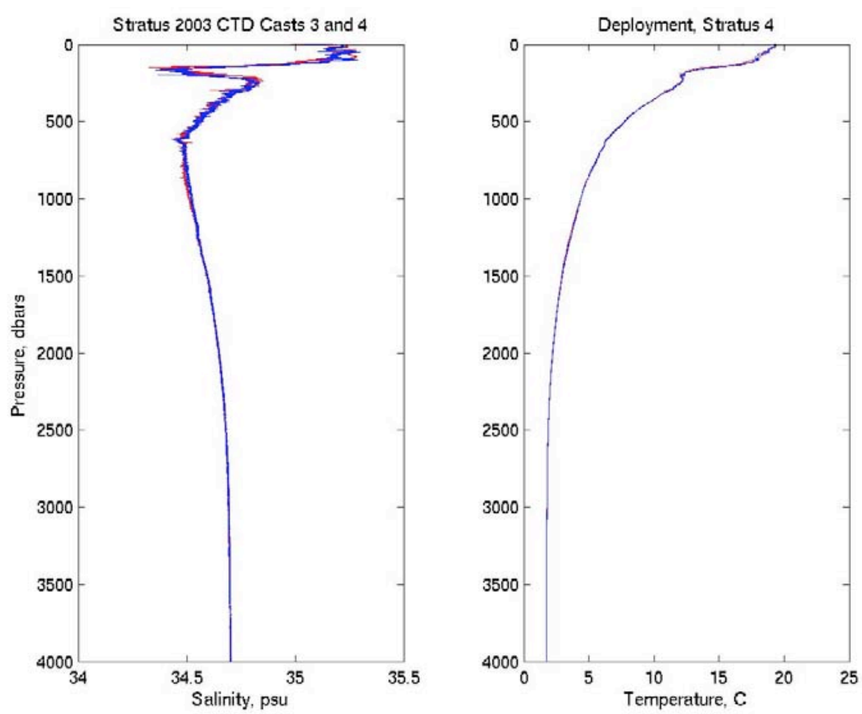


Figure 22. CTD Casts After Deployment of Stratus 4.

V. ADDITIONAL CRUISE ACTIVITIES

A. Deployment of Drifters and Underway Watch

During the Stratus 2003 cruise, a 24-hour watch schedule was set up. Watch standers were responsible for updating the cruise log, deploying ARGO floats and surface drifters, assisting the ETL group with radiosonde deployments, and taking water temperature readings with a bucket thermometer.

The floats and drifters were deployed at specified locations. The ship was stopped for deployments of the ARGO floats, but was kept at the current speed for deployment of the surface drifters. Deployment details are given below in Tables 16 and 17.

Table 16. Deployment Times and Locations for Argo Floats.

Float #	Self Test Date and Time (UTC)	Deployment Date and Time (UTC)	Latitude	Longitude
239	11/11/03 15:40	11/11/03 20:58	01° 59.442'S	84° 00.664' W
252	11/12/03 11:53	11/12/03 12:03	04° 00.25' S	84° 54.988' W
241	11/13/03 06:10	11/13/03 07:10	07° 59.830' S	84° 55.003' W
249	11/14/03 02:27	11/14/03 02:39	12° 00.03' S	84° 55.00' W
240	11/14/03 22:10	11/14/03 22:27	16° 00.049' S	84° 54.992' W
247	11/15/03 22:03	11/15/03 22:26	20° 10.805' S	85° 08.290' W
250	Time not recorded	11/22/03 03:37	20° 00.1' S	81° 00.10' W
236	11/22/03 17:19	11/22/03 17:30	20° 00.00' S	78° 00.00' W
248	11/23/03 19:56	11/23/03 20:03	19° 44.778' S	74° 50.178' W

Table 17. Deployment Times and Locations for Surface Drifters.

Drifter #	Date and Time (UTC)	Latitude	Longitude
39608	11/13/03 16:55:55	10° 0.202' S	84° 55.00' W
41082	11/13/03 17:21:48	10° 05.40' S	84° 54.99' W
41083	11/13/03 17:48:20	10° 10.82' S	84° 54.99' W
39266	11/13/03 18:15:10	10° 16.298' S	84° 54.99' W
39303	11/13/03 18:41:40	10° 21.642' S	84° 55.00 W
39302	11/13/03 19:13:15	10° 28.085' S	84° 54.993' W
41049	11/13/03 19:35:10	10° 32.432' S	84° 54.995' W
39267	11/13/03 20:02:00	10° 37.87' S	84° 54.996' W
39304	11/13/03 20:30:00	10° 43.500' S	84° 55.002' W
39305	11/13/03 20:54:36	10° 48.690' S	84° 54.995' W
39301	11/14/03 17:26:36	15° 00.064' S	84° 54.997' W
39300	11/14/03 17:53:20	15° 05.483' S	84° 55.001' W
39299	11/14/03 18:47:00	15° 16.291' S	84° 55.001' W
39298	11/14/03 20:07:00	15° 32.514' S	84° 54.999' W
41048	11/14/03 21:54:56	15° 54.065' S	84° 55.002' W
41065	11/15/03 03:23	16° 59.874' S	84° 55.000' W
41068	11/15/03 03:48	17° 5.24' S	84° 55.00' W
41069	11/15/03 04:15	17° 10.79' S	84° 55.00' W
41067	11/15/03 04:41	17° 16.15' S	84° 55.00' W
41066	11/15/03 05:09	17° 22.003' S	84° 55.00' W
41060	11/15/03 05:29	17° 26.960' W	84° 55.00' W
41061	11/15/03 06:00	17° 32.041' S	84° 55.00' W
41062	11/15/03 06:26	17° 37.6' S	84° 55.00' W
41063	11/15/03 06:52	17° 43.21' S	84° 55.00' W
41064	11/15/03 07:19	17° 48.73' S	84° 55.00' W
41050	11/21/03 14:57	20° 00.00' S	84° 00.00' W
41051	11/21/03 15:19	20° 00.00' S	83° 54.61' W
41052	11/21/03 16:04	20° 00.00' S	83° 43.81' W
41053	11/21/03 17:10	20° 00.00' S	83° 27.61' W
41054	11/21/03 18:43	20° 00.00' S	83° 06.04' W
41055	11/22/03 07:56	20° 00.00' S	80° 00.04' W
41056	11/22/03 08:20	20° 00.00' S	79° 54.41' W
41057	11/22/03 08:42	20° 00.00' S	79° 49.16' W
41058	11/22/03 09:05	20° 00.00' S	79° 43.80' W
41059	11/22/03 09:30	20° 00.00' S	79° 38.40' W
41070	11/22/03 09:56	20° 00.00' S	79° 32.94' W
41071	11/22/03 10:21	20° 00.00' S	79° 27.62' W
41072	11/22/03 10:47	20° 00.00' S	79° 22.24' W
41073	11/22/03 11:12	20° 00.00' S	79° 16.84' W
41074	11/22/03 11:38	20° 00.00' S	79° 11.43' W
41075	11/23/03 03:14	19° 48.00' S	76° 00.00' W
41076	11/23/03 03:40	19° 48.00' S	75° 54.00' W
41077	11/23/03 04:30	19° 48.00' S	75° 43.87' W
41078	11/23/03 05:46	19° 48.00' S	75° 27.61' W
41079	11/23/03 07:29	19° 48.00' S	75° 05.98' W

B. Recovery of Ecuadorian Buoy

In response to a request from the Ecuadorian National Observer participating in the cruise, the WHOI Upper Ocean Processes Group agreed to assist the Ecuadorian Navy's Institute of Oceanography (INOCAR) in recovering equipment from their San Pedro buoy. The buoy, located at approximately 02˚ S, 84° W in 2100 meters of water had been vandalized.

The buoy hull was a 2.80 meter discus, approximately 1.8 meters tall. A suite of meteorological sensors was originally mounted to a single mast on the buoy. These instruments had all been vandalized prior to recovery. An array of Sea Bird SBE 37 MicroCat C/T recorders was clamped to the mooring wire. An inductive modem relayed data from these instruments to the surface.

The mooring configuration was an inverse catenary design with a scope of 1.5:1. A five-meter shot of 3/4" chain was attached to a 500 meter shot of 1/2" jacketed steel mooring wire. Below that was 1000 meters 16 mm nylon line attached to 1600 meters of 16 mm polypropylene line. An array of ten 10" trawl floats was connected at the termination of nylon and polypropylene. A 1500 kg clump weight with a 250 kg danforth anchor was used in the anchor system. No acoustic release was used on the mooring. Based on the breaking strength of the mooring line, and the size of the anchor, it was considered unsafe to try to haul the anchor up off the bottom.

Recovery of the buoy and C/T array commenced by launching a small boat from the *Revelle*. Personnel in the boat attached a lifting sling to the buoy and relayed a line to the ship. The ship maneuvered so the buoy was just aft of the A-frame. The buoy was lifted through the A-Frame and secured to the deck (18:55 GMT, 01° 59.56' S, 84° 00.6' W).

The mooring chain was disconnected from the buoy, and the cable from the inductive modem pickup was disconnected from the mooring wire. At this point the buoy was lifted over the starboard side and released back into the water. The small boat towed the buoy to the Ecuadorian Naval vessel, the B.A.E. *Calicuchima*, that was standing by to receive the recovered buoy and instruments.

Once the buoy was cleared from the deck recovery of the instruments and mooring wire continued. The *Revelle* steamed into the wind toward the estimated anchor location, effectively reducing the stress on the mooring wire as it was recovered. After recovering most of the instruments and almost 400 meters of wire, a big knot came up in the mooring wire. Paying the mooring out much faster than the ship is moving typically causes a knot in the mooring wire. Once the anchor is dropped from the vessel the mooring goes slack and is able to twist on itself, causing a knot that compresses on itself as tension is returned to the mooring.

To continue the recovery, a yale grip was attached to the wire below the knot, the knot, and the wire above the yale grip were cut away from the mooring. A second winch leader was wound onto the winch and connected to the yale grip to finish the recovery of instruments.

Once all instruments and mooring wire were recovered, a slip line was rigged at the termination of the wire and nylon. The mooring line was slipped off into to sea, as it was no longer safe to continue the recovery (20:32 GMT, 01° 59.82' S, 84° 0.43' W). Figure 23. shows the recovery of the Ecuadorian buoy from the *Revelle*.

Figure 23. Recovery Of Instruments From The Ecuadorian Mooring.

Mooring wire and instruments were transferred to the waiting B.A.E. *Calicuchima*. Edwin Pinto of INOCAR and Rob Palomares, an off-going Scripps electronics technician, returned to Guayaquil aboard the *Calicuchima*.

C. PMEL / SHOA / NDBC Tsunami Buoy

1. PMEL Report

The National Oceanic and Atmospheric Administration's (NOAA) Deep-ocean Assessment and Reporting of Tsunamis (DART) Project is an effort of the U.S. National Tsunami Hazard Mitigation Program (NTHMP) to develop an early tsunami detection and real-time reporting capability. Although seismic networks and coastal tide gauges are indispensable for assessing the hazard during an actual event, an improvement in the speed and accuracy of real-time forecasts of tsunami inundation for specific sites requires direct tsunami measurement between the source and a threatened community. Currently, only a network of real-time reporting, deep-ocean bottom pressure (BPR) stations can provide this capability. Numerous NOAA deployments of ever-improving prototype systems have culminated in the current operating network of DART stations in the North and South Pacific.

Network coverage is presently limited to known tsunamigenic zones that threaten U.S. coastal communities. Because tsunamis can be highly directional, DART stations must be properly spaced to provide reliable estimates of the primary direction and magnitude of the energy propagation. A method for detector siting will consider various tradeoffs between early tsunami detection, adequate source zone coverage, and DART system survivability. A proposed network will be designed to provide adequate coverage of tsunamis originating in source regions that threaten U.S. coastal communities: the Alaska Aleutian Subduction Zone, the Cascadia Subduction Zone, and the South American Seismic Zone.

The DART mooring system is illustrated in Figure 24. Each system consists of a seafloor BPR and a moored surface buoy with related electronics for real-time communications. The BPR uses a pressure transducer manufactured by Paroscientific, Inc., to make 15-second averaged measurements of the pressure exerted on it by the overlying water column. These transducers use a very thin quartz crystal beam, electrically induced to vibrate at its lowest resonant mode. In DART applications, the transducer is sensitive to changes in wave height of less than a millimeter. An acoustic link is used to transmit data from the BPR on the seafloor to the surface buoy. The data are then relayed via a NOAA Geostationary Operational Environmental Satellite (GOES) satellite link to ground stations, which demodulate the signals for immediate dissemination to NOAA's Tsunami Warning Centers in Alaska and Hawaii and the Pacific Marine Environmental Laboratory (PMEL).

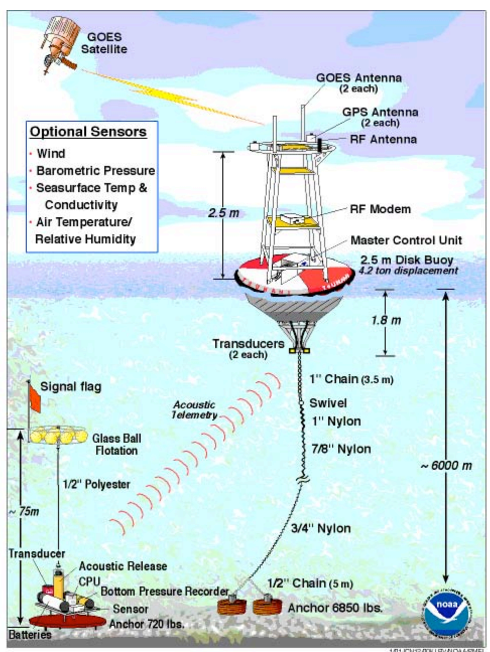


Figure 24. Schematic of the DART Mooring System.

2. SHOA Report

The DART (Deep-Ocean Assessment and Reporting of Tsunami) Project was created in order to efficiently and quickly confirm the generation of a potentially destructive tsunami, as well as to support the ongoing effort to develop and implement an early detection capability and real-time report of tsunamis in the deep ocean. This project was created as part of the National Tsunami Hazard Mitigation Program (NTHMP) of the United States.

The Hydrographic and Oceanographic Service of the Navy of Chile, in charge of the National Seaquake Warning System of Chile (SNAM), is making an effort to improve its capabilities to comply with responsibilities assigned by law; therefore as of November 2003, it will have installed a DART system off the north coast of Chile, near Iquique.

The DART system is composed of two main units, a bottom-pressure sensor and a transmitter buoy on the surface. The bottom-pressure measuring sensor is installed on the ocean floor, and it is capable of detecting tsunamis of minimal magnitude (1 cm).

The buoy, installed on the ocean's surface establishes real-time communication with the GOES satellite. The system has two ways of reporting the information, one standard system and one warning system. The standard is the normal way of working by which four assessments of the ocean level, averaged every 15 minutes, are received every hour. When the internal software detects the generation of an event, a variation of more than 4 cm, the system stops the standard mode of operation and switches to the warning mode. While in warning mode, it submits average assessments every 15 seconds; these are forwarded for a few minutes during the first messages, then following are one-minute average messages for at least three hours if no other event is detected.

Figure 25. DART Buoy After Deployment.

When the bottom pressure sensor perceives any significant variation in the sea level, it transmits the data to the surface buoy through an acoustic link; the buoy then forwards the data to the GOES satellite, which sends the information to the earth stations; these demodulate the signal for immediate release to the Tsunami Warning Centers of the International Tsunami Warning System. The DART system has been designed to function for at least two years without maintenance.

Figure 26. Bottom Pressure Sensor Platform.

On November 23, 2003, PMEL, NDBC, and SHOA staff initiated the preparation work for the installation of the buoy. The work started by anchoring the surface buoy, which was tied on the starboard, on the ship's deck. Once the buoy was in the ocean its gear was deployed. First, a 7/16" steel covered cable was dropped, then nylon cable followed, to achieve an approximate depth of 4284 m; these were tied to 6850 kg of dead weight.

Once the anchoring of the buoy was finished by dropping the dead weight, at approximately 14:00, the preparation work for the anchoring of the bottom-pressure sensor (BPR) started.

The work followed a certain order, starting with the high depth glass spheres that will allow the recovery of the instrument; these were connected to nylon and finally to a 50 m nylon rope that is then tied to the BPR, which contains dead weight in its base. Once the mooring was checked, the BPR anchoring maneuver started, and was completed at 15:18.

The DART system's technology will allow the National Seaquake Warning System to improve its capability to evaluate and disseminate warnings in an efficient and timely manner and will avoid false alarms and possible losses as a consequence.

The anchoring of this first DART buoy in Chile (19°40.31'S,074°50.29'W) and in South America, is a big step towards mitigation efforts against tsunamigenic events in close and long range sites. This is not only a great contribution to the Chilean coastal communities, but also to the coastal communities in the Pacific Basin and to the International Tsunami Warning System.

D. ETL Measurements

1. Background on Measurement Systems

The Environmental Technology Laboratory (ETL) air-sea flux and cloud group conducted measurements of fluxes and near-surface bulk meteorology during the fall field program to recover the WHOI Ocean Reference Station buoy at 20 S Latitude 85 W Longitude. The ETL flux system was installed initially in San Diego in September 2003 and brought back into full operation in Manta, Ecuador, in early November 2003. The air-sea flux system consists of six components:

1. A fast turbulence system with ship motion corrections mounted on the jackstaff. The jackstaff sensors are: INUSA Sonic anemometer, OPHIR IR-2000 IR-hygrometer, LiCor LI-7500 fast CO2/hygrometer, and a Systron-Donner motion-pak.
2. A mean T/RH sensor in an aspirator on the jackstaff.
3. Solar and IR radiometers (Eppley pyranometers and pyrgeometer) mounted on top of a seatainer on the 02 deck.
4. A near surface sea surface temperature sensor consisting of a floating thermistor deployed off port side with outrigger.
5. A Particle Measurement Systems (PMS) Lasair-II aerosol spectrometer mounted in the same seatainer.
6. An optical rain gauge mounted on the bow tower. Slow mean data (T/RH, PIR/PSP, etc) are digitized on Campbell 21x data logger and transmitted via RS-232 as 1-minute averages.

A central data acquisition computer logs all sources of data via RS-232 digital transmission:

Sonic Anemometer
LiCor CO2/H2O
Slow means (Campbell 21x)
Unused
OPHIR hygrometer
Systron-Donner Motion-Pak
Ship's SCS
ETL GPS

The data sources are archived at full time resolution. At sea a set of programs is run each day for preliminary data analysis and quality control. As part of this process, a quick-look ASCII file is produced that is a summary of fluxes and means. The data in this file comes from three sources: The ETL sonic anemometer (acquired at 20 Hz), the ships SCS system (acquired at 5 sec intervals), and the ETL mean measurement systems (sampled at 10 sec and averaged to 1 min). The sonic is 5 channels of data; the SCS file is 66 channels, and the ETL mean system is 42 channels. A series of programs are run that read these data files, decode them, and write daily text files at 1 min time resolution.

A second set of programs reads the daily 1-min text files, time matches the three data sources, averages them to 5 or 30 minutes, computes fluxes, and writes new daily flux files. The 5-min daily flux files have been combined and rewritten as a single file to form the file *flux_5hf_weller03.txt*. The 1-min daily ASCII files are stored as *proc_nam_dayDDD.txt* (nam='pc', 'scs', or 'son'; DDD=yearday where 000 GMT January 1, 2001 =1.00). File structure is described in the original Matlab files that write the data, *prt_nam_03.m*.

ETL also operated three remote systems: a Vaisala CT-25K cloud base ceilometer, a 35 GHz vertically pointed Doppler cloud radar, and a 20.6 - 31.65 GHz microwave radiometer. The ceilometer is a vertically pointing lidar that determines the height of cloud bottoms from time-of-flight of the backscatter return from the cloud. The time resolution is 30 seconds and the vertical resolution is 15 m. The raw backscatter profile and cloud base height information deduced from the instrument's internal algorithm are stored in daily files with the naming convention *CRVYYDDD.raw* where YY=03 and DDD=julian day. File structure is described in *ceilo_readme.txt*.

ETL has an integrated system in a seatainer that includes a Doppler Ka-band cloud radar (MMCR) and a microwave radiometer. The system can be used to deduce profiles of cloud droplet size, number concentration, liquid water concentration etc. in stratus clouds. If drizzle (i.e., droplets of radius greater than about 50 μm) are present in significant amounts, then the microphysical properties of the drizzle can be obtained from the first three moments of the Doppler spectrum. The radar is extremely sensitive and can detect most tropical cirrus and fair weather cumulus clouds. The Doppler capability can also be used to measure in-cloud vertical velocity statistics.

2. Flux Data

Preliminary flux data is shown for yearday=322 (November 18, 2003). The time series of ocean and air temperature is given in Figure 27. The water temperature is about 19.2 C and the air temperature is about 18.8 C until it increases abruptly at 1230 pm GMT (730 am local) to about 19.1 C.

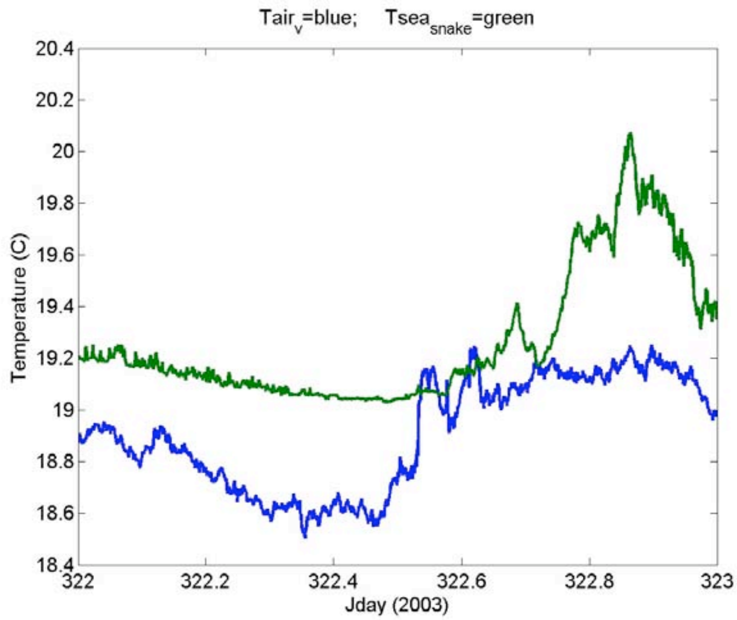


Figure 27. Time Series of Near-Surface Ocean Temperature and 18m Air Temperature.

The effect of clouds on the downward solar flux is shown in Figure 28 and on the IR flux in Figure 29. For the solar flux, broken clouds are apparent in the jagged form of the curve during the morning and the sharp drops in the afternoon. For IR flux, clear skies have values of about 320 Wm^{-2} and cloudy skies values around 390 Wm^{-2}.

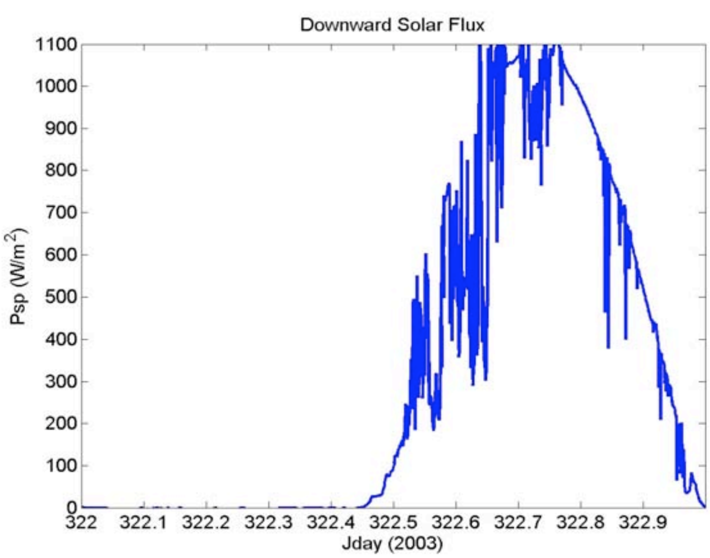


Figure 28. Time Series of Downward Solar Flux.

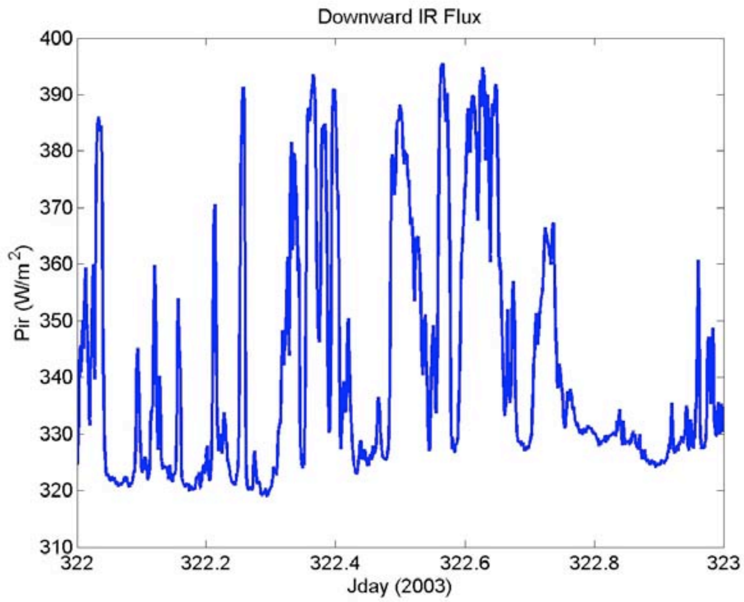


Figure 29. Time Series of Downward IR Flux.

Figure 30 shows the time series of four of the five primary components of the surface heat balance of the ocean (solar flux is left out). The largest term is the latent heat (evaporation) flux, followed by the net IR flux (downward minus upward), the sensible heat flux, and the flux carried by precipitation. We are using the meteorological sign convention for the turbulent fluxes so all three fluxes actually cool the interface in this case. The time series of net heat flux to the ocean is shown in Figure 31 (the values at the top of the graph are the average for the day). The sum of the components in Figure 30 is about -130 Wm^{-2}, which can be seen in the night time values; the large positive peak during the day is due to the solar flux. The integral over the entire day gives an average flux of 166 Wm^{-2}, indicating strong warming of the ocean mixed layer.

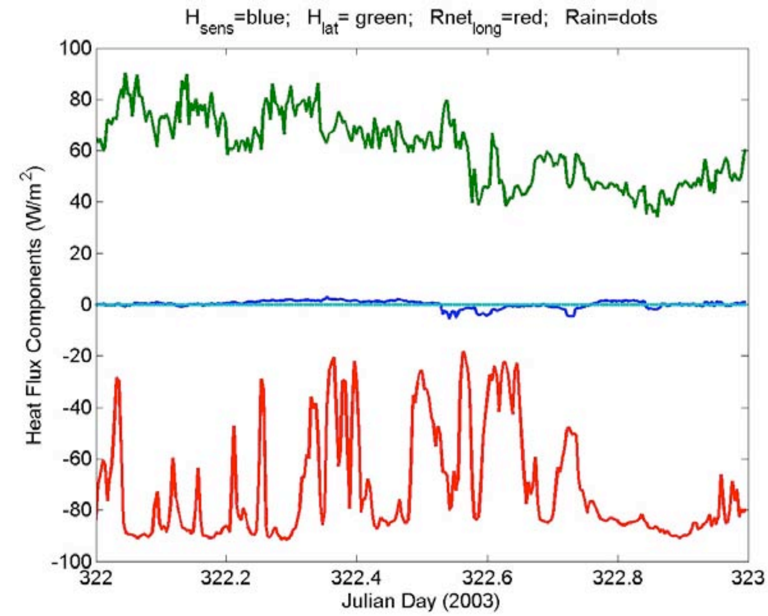


Figure 30. Time Series Of Surface Heat Flux Components

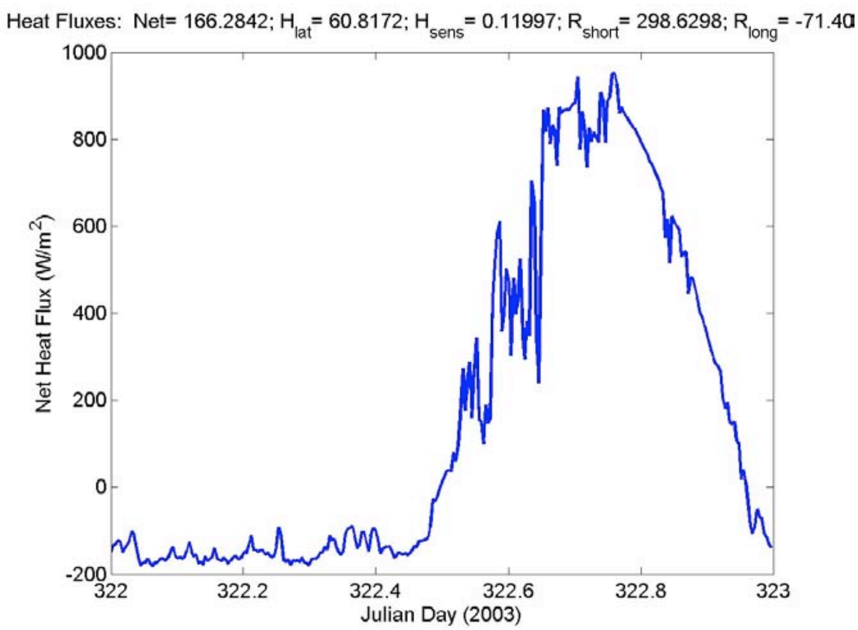


Figure 31. Time Series Of Net Heat Flux To The Ocean Surface.

3. Remote Sensing Data

A sample ceilometer 24-hr time-height cross section for November 18 is shown in Figure 32. The colors denote the intensity of the lidar return; the black dots are the cloud base height at that time. The speckled color regions above the clouds are noise caused by diffuse sunlight. This day had 35% cloud cover and two sets of cloud base heights: the dominant stratocumulus layer with cloud bases 1000 to 1200 m and occasional lower level 'scud' clouds with bases about 500 m. Small amounts of drizzle can be seen as the light blue color right below cloud base (e.g., 1430 GMT at 500 m). A sample time-height cross section (Figure 33) from the cloud radar is shown for a 24-hr period on November 18. The panels indicated the intensity of the return (upper), the mean fall velocity of the scattering droplets (middle panel), and the Doppler width of the return. This happens to be a day with low cloud cover; clouds are fairly thin with tops at 1.0 - 1.2 km. Light drizzle events are apparent as the 0830 and 1430; the radar is much more sensitive to drizzle than the ceilometer.

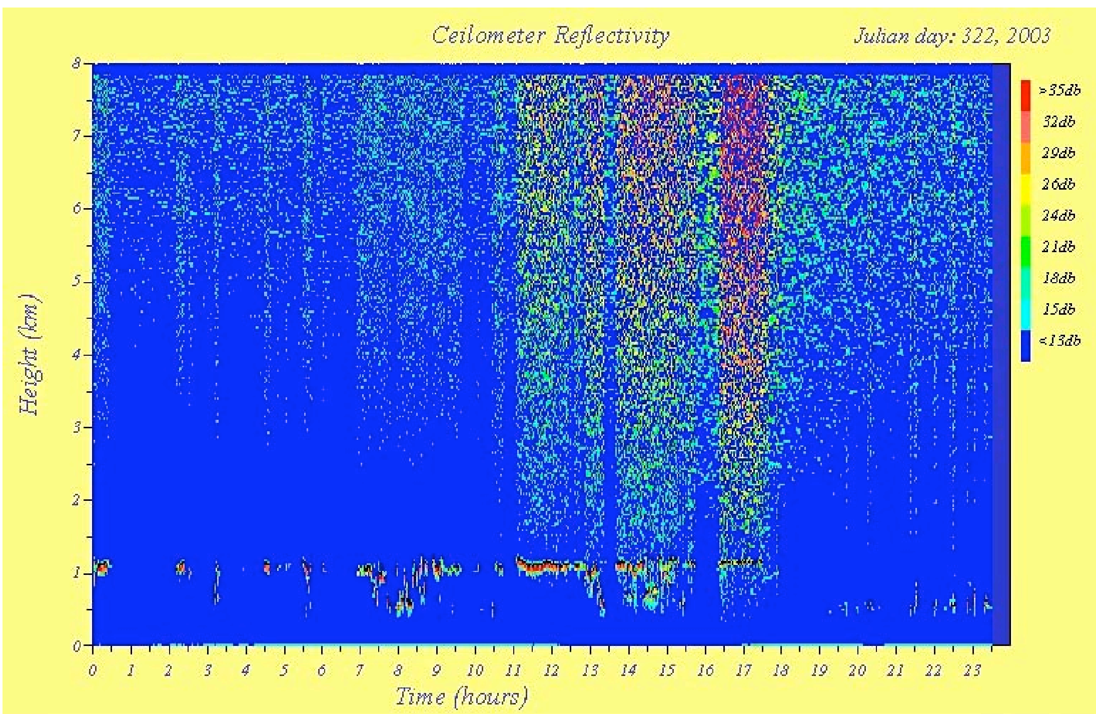


Figure 32. Time Height Cross-Section Of Low Cloud Base Data For Day 322 (November 18, 2003).

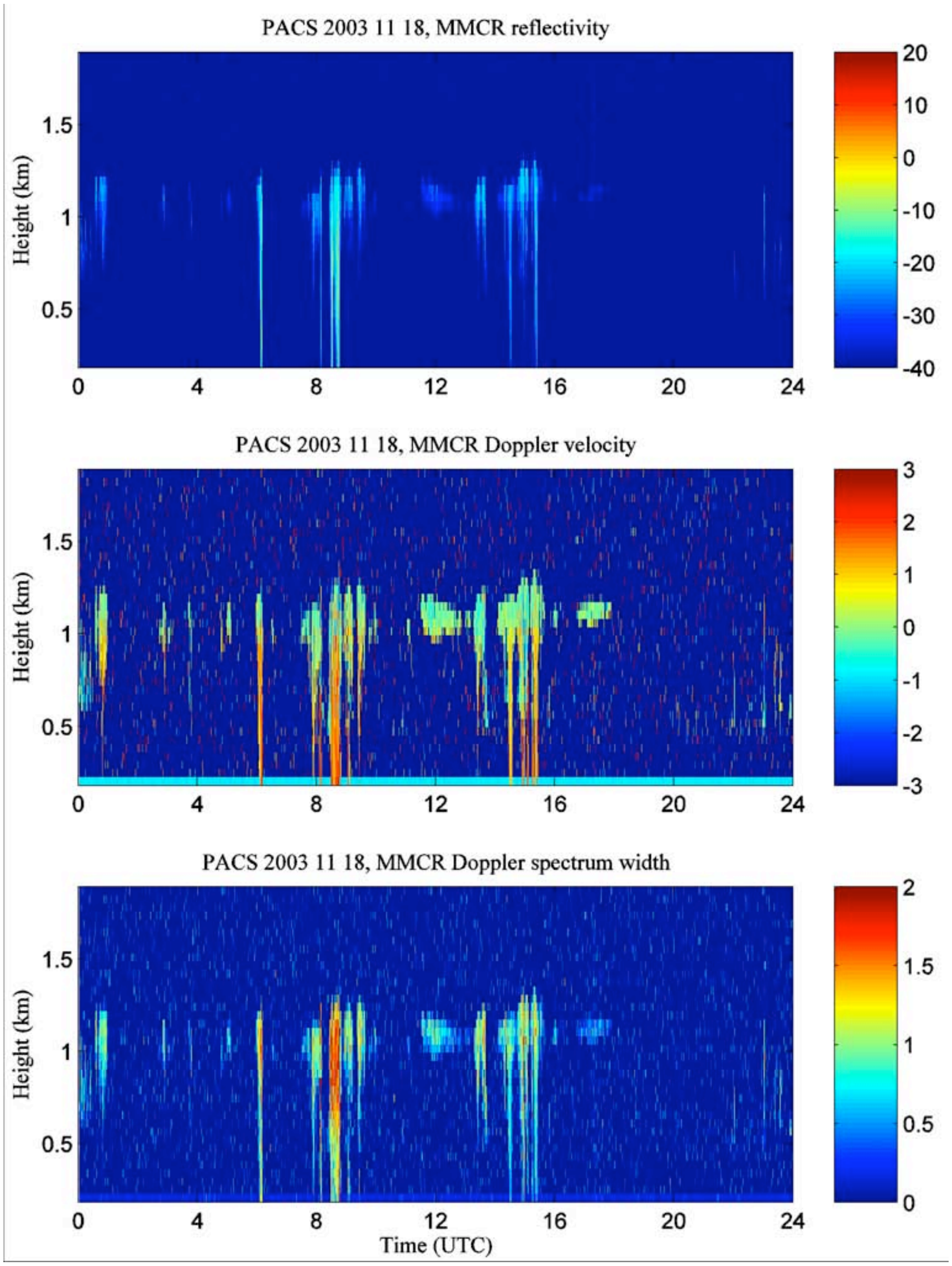


Figure 33. Time-Height Cross Section Data From 35 Ghz Cloud Radar.

4. **Cruise Summary Results**

The 5-min time resolution time series for sea/air temperature are shown in Figure 34 and for wind speed and N/E components in Figure 35. The change in conditions for the first three days of the record is associated with the run south from Manta, Ecuador, to the WHOI buoy at 20 S. Time series for flux quantities are shown as daily averages.

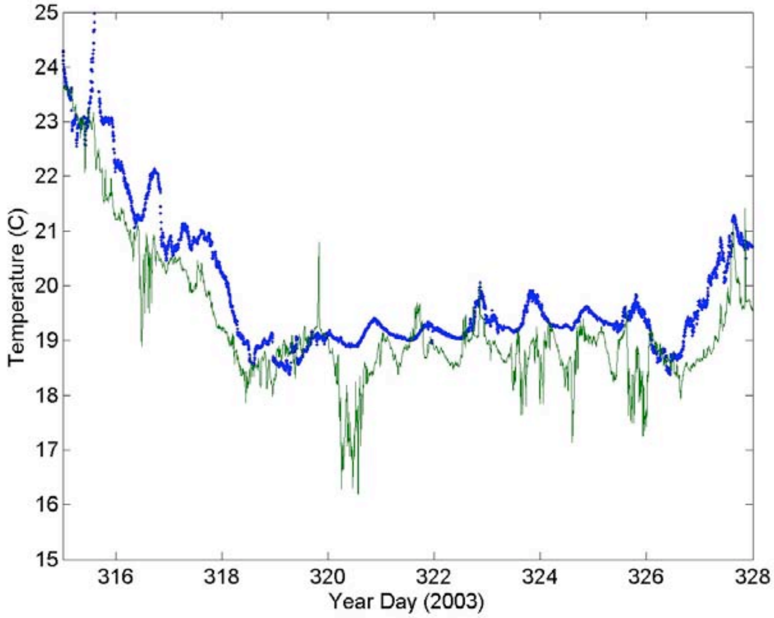


Figure 34. Time Series Of Near-Surface Ocean Temperature And 18-M Air Temperature For The 2003 *Revelle* Cruise.

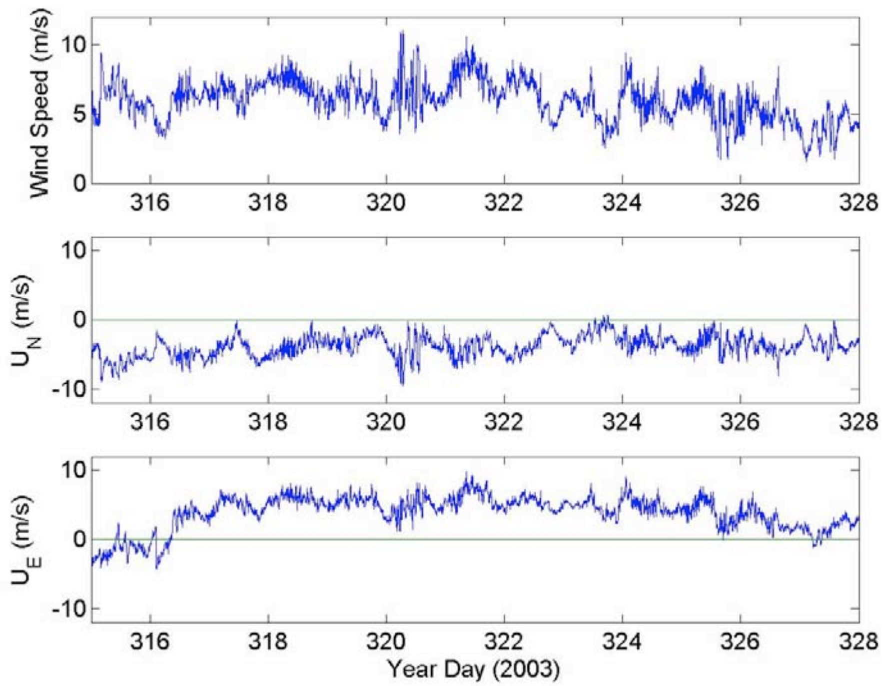


Figure 35. Time Series Of Wind Speed, and Northerly (Middle Panel) and Easterly Component (Lower Panel).

Figure 36 gives the flux components (solar flux – circles, latent heat flux – triangles, sensible heat flux – diamonds, net IR flux x's) and Figure 37 the net heat flux to the ocean. The diurnal cycle of cloudiness at 20 S shows up as the larger values of net heat flux and solar flux at 20 S where afternoon clearing leads to much greater 24-hr average solar flux. Just for amusement, the transect from 85 W to 75 W along 85 S is shown in Figure 38 (upper panel - wind speed, middle panel ocean near-surface temperature (circles) and air 18-m temperature (x's), lower panel sensible heat flux (circles) and latent heat flux (x's)). The diurnal cycle appears to be much stronger than longitudinal variations; this is in contrast to the noticeable spatial variations in the run from 1 S to 20 S down 85 W longitude from Manta.

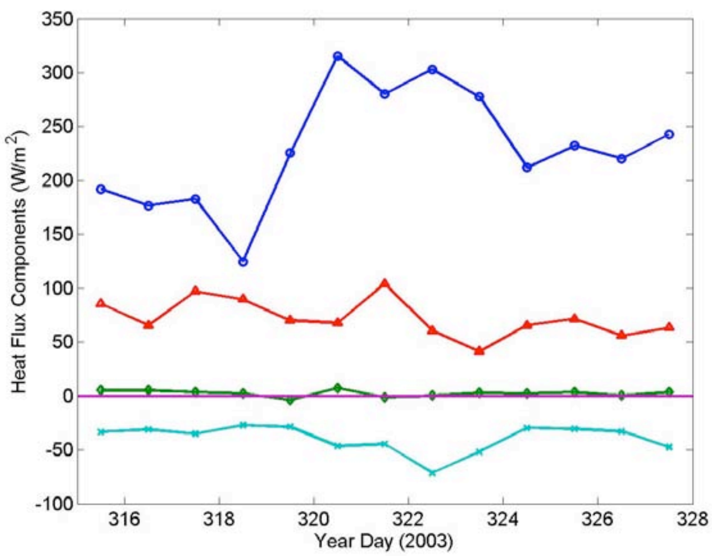


Figure 36. Time Series Of 24-Hr Average Heat Flux Components.

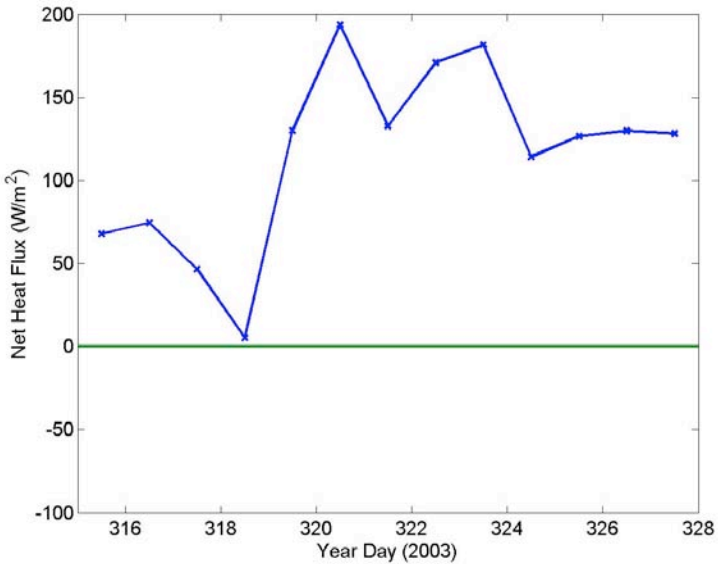


Figure 37. Time Series Of 24-Hr Average Net Heat Flux To The Ocean.

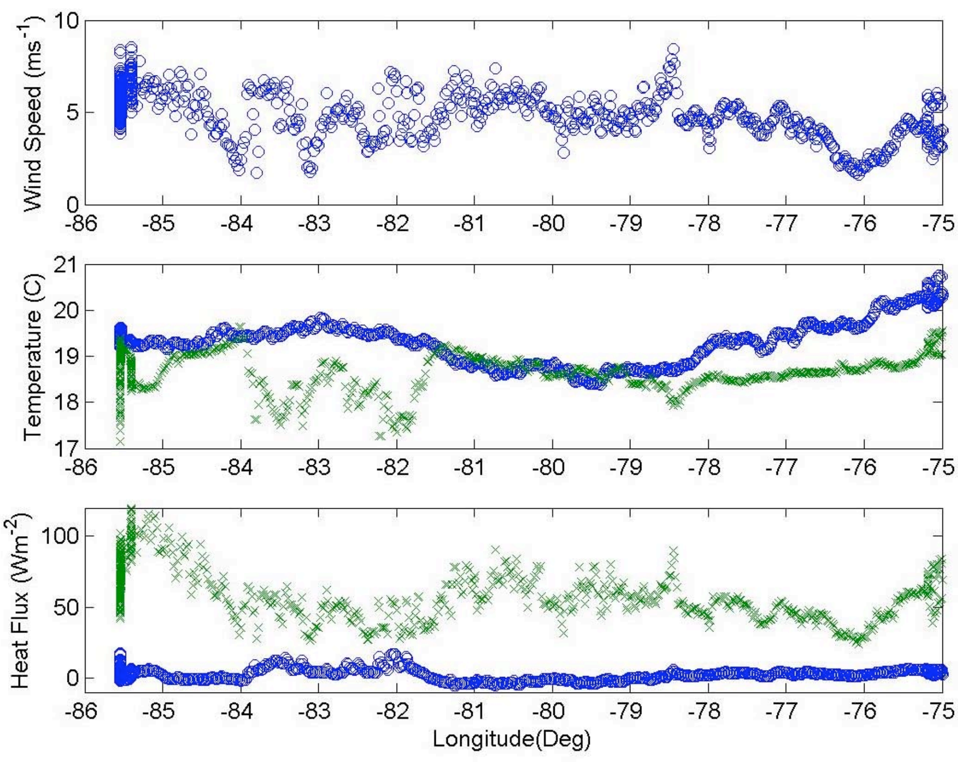


Figure 38. Meteorological Variables as a Function Of Longitude From WHOI Buoy (85 W) To The DART Buoy (75 W).

Beginning on November 14 and ending on November 24, 45 successful rawinsonde launches (4 times daily at 0, 6, 12, and 18 UTC) were completed. A time-height color contour plot of temperature is shown in the upper panel of Figure 39; the middle panel shows the relative humidity and winds (zonal and meridional - these use the meteorological convention, with northerly, easterly, southerly, and westerly winds shown as arrows pointing 0, 90, 180, and 270 degrees counterclockwise from north); the bottom panel is virtual potential temperature with the black dots representing the lifting condensation level computed from the lower part of the profile. The boat was in transit from Manta from Julian day (JD) 318 until 319.5, and stationary thereafter at the WHOI buoy from JD 319.5 until JD 325.5.

A pronounced temperature inversion is evident at approximately 1.0-1.5 km. On JD 323 the inversion is less pronounced. The boundary layer below the temperature inversion has relative humidity consistently above 65%, and drizzling episodes are marked by relative humidity above 90 %. Two time periods with relative humidity above 90% occur at the surface; these correspond with drizzle detectable by surface observers on the *Revelle*. The winds are consistent with climatology, with southeasterlies prevailing within the boundary layer and westerlies aloft.

An interesting aspect of Figure 39 is two episodes of higher relative humidity subsiding from aloft into the boundary layer. The more pronounced case occurs on JD 322-324 (Nov. 18-20), and another, drier, example occurs from JD 318-321 (Nov. 14-17). In both cases the depth of the boundary layer moisture increases when the subsiding moisture slug reaches the boundary layer, and corresponds with drizzling time periods evident within the cloud radar data. For the second case, cloud tops appear to reach 1.4 km on Nov. 19, coinciding with the weakest temperature inversion measured during the cruise.

The bottom panel of Figure 39 shows the virtual potential temperature (θ_v)as calculated from the rawinsonde data, along with the lifting condensation level (LCL) of an air parcel with the mean temperature and relative humidity of the 1000-1010 mb layer (an approximately 100 m thick air layer slightly above the ocean surface). θ_v provides a measure of the air buoyancy; lower values indicate air that is less able to rise. A strong variability is evident within the boundary layer. Low values often correspond to the cooling associated with the evaporation of drizzle. This cooling will tend to inhibit further stratus/stratocumulus cloud development, by discouraging the moisture flux from the surface necessary for the cloud maintenance.

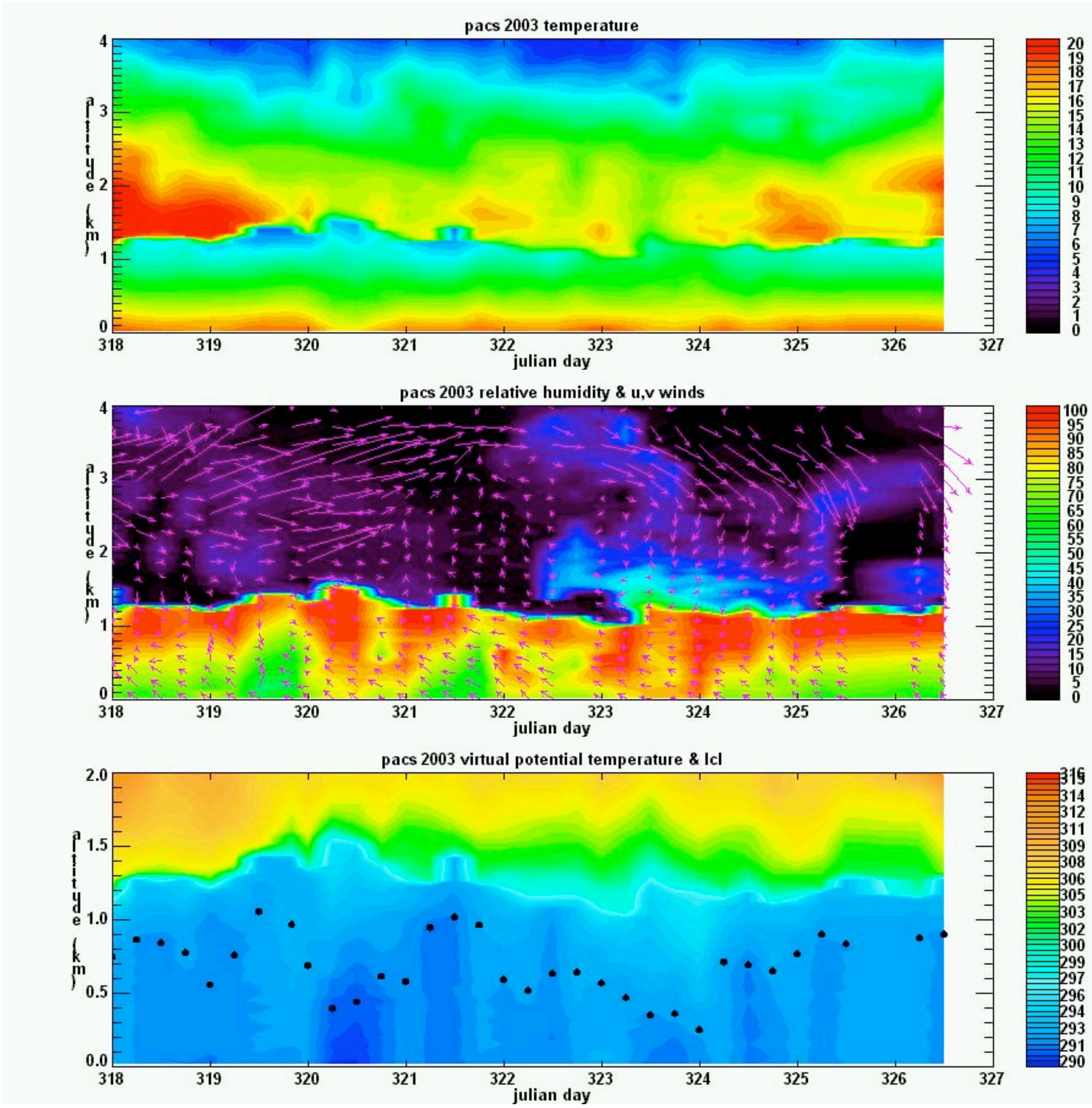


Figure 39. Time-height color contour plots from rawinsondes launched during the 2003 Revelle cruise.

The lifting condensation level corresponds well with the ceilometer-derived cloud base (Figure 40) and also demonstrates a strong variability. During drizzling episodes, the LCL is lowered by the high moisture content of the lower boundary layer, for example towards the end of JD 323. The time series of data from the microwave radiometer is shown in Figure 40; column water vapor (upper panel), column liquid water path (middle path), and microwave brightness temperature (bottom panel) at 20.6 GHz (blue) and 31.65 GHz (red). The period from 318-322 was clearly drier (vapor = 1 cm) than 323-328 (vapor = 2 cm). There does not to be any correlation with total column vapor and liquid water. Days 322-323 (November 18-29) were the most cloud free.

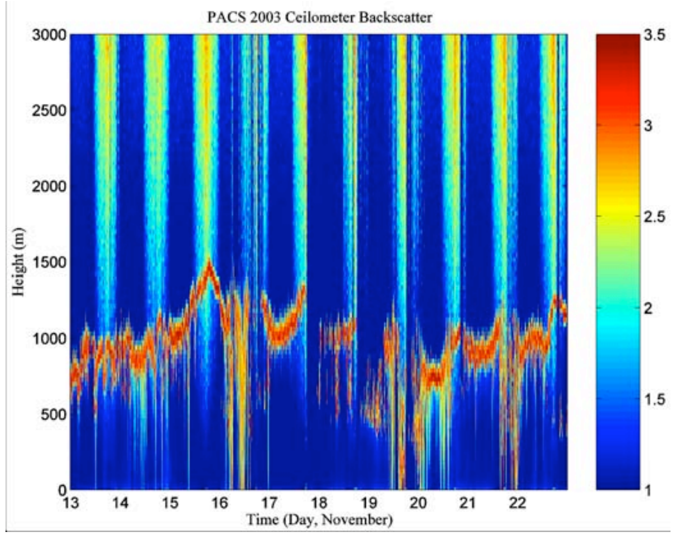


Figure 40. Time-Height Cross Section For The Ceilometer Backscatter Intensity For The Entire Experiment. Cloud Base Is Near The Maximum Intensity Region (Red Color).

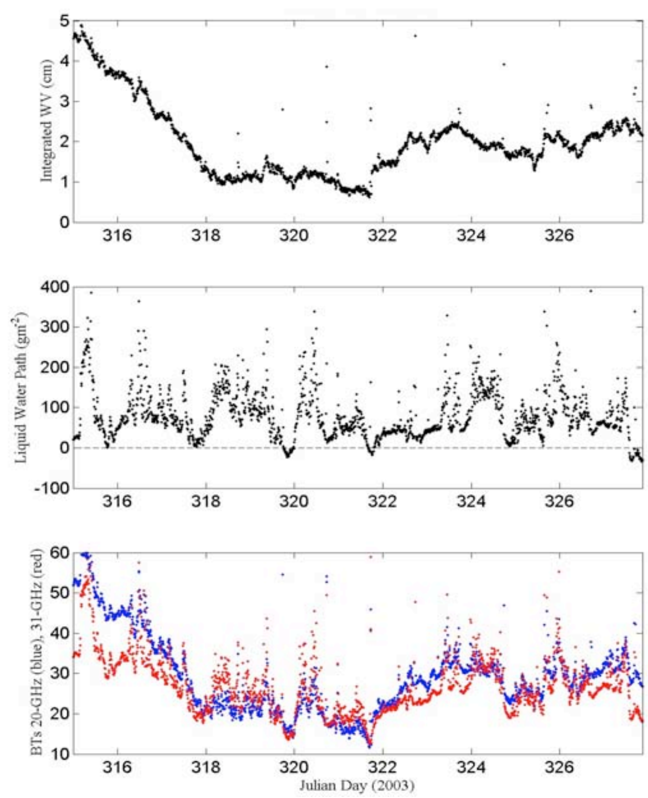


Figure 41. Time series of data from the 21-31 GHz microwave radiometer at 10-min resolution.

Data from the PMS Lasair-II aerosol spectrometer is shown in Figure 42. The upper panel shows concentration for sizes greater than 0.1 _m diameter. The lower panel shows concentrations for channels 0 (0.1 – 0.2 _m) , channel 2 (0.3 – 0.4 _m), and channel 4 (1 – 5 _m). The large positive spikes are caused by encounters with the ship's exhaust plume. This instrument counts particles in size ranges from 0.1 to 5 _m diameter based on scattering of light from a laser beam. This size range includes most of the so-called accumulation-mode aerosols that represent most of the particles activated to form droplets in clouds. Thus, the total number of aerosols counted by this device is expected to correlate with cloud condensation nuclei and the number of cloud drops. More detailed aerosol information was obtained by Jason Tomlison (Texas A&M University). The Lasair-II time series shows periods of significant reductions in particles (from 200-300 to 20-30) on days 320 (November 16), 323 (November 19), and late 325 – early 326 ((November 21-22). These were also the days with decoupled boundary layers (as indicated by scattered clouds below the main stratus deck) and significant drizzle.

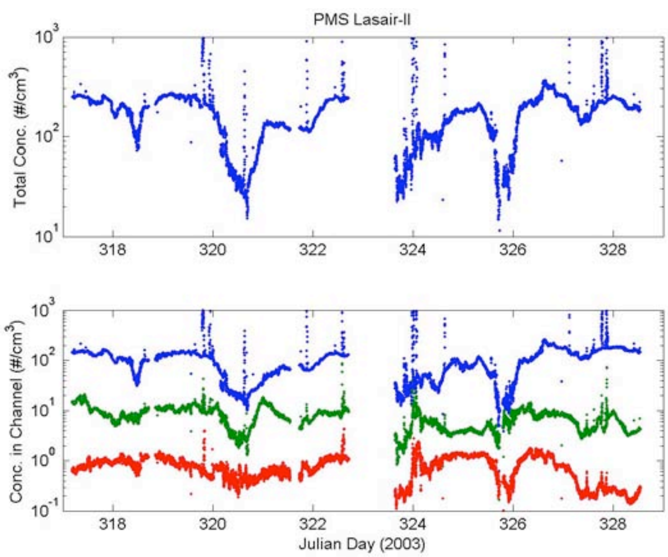


Figure 42. Aerosol data from the ETL PMS Lasair-II size spectrometer.

Data from the cloud radar, ceilometer, and rawinsonde system have been processed and combined in Figure 43 to display cloud boundaries. Cloud top is determined from an intensity threshold on the radar backscatter signal. Cloud base is directly from the ceilometer algorithm. Lifting condensation level (LCL) is computed from the lower part of the sounding (as in Figure 39); LCL is a thermodynamic estimate of cloud base for a well mixed boundary layer. Co-location of the LCL and ceilometer cloud base implies a well mixed atmospheric boundary layer.

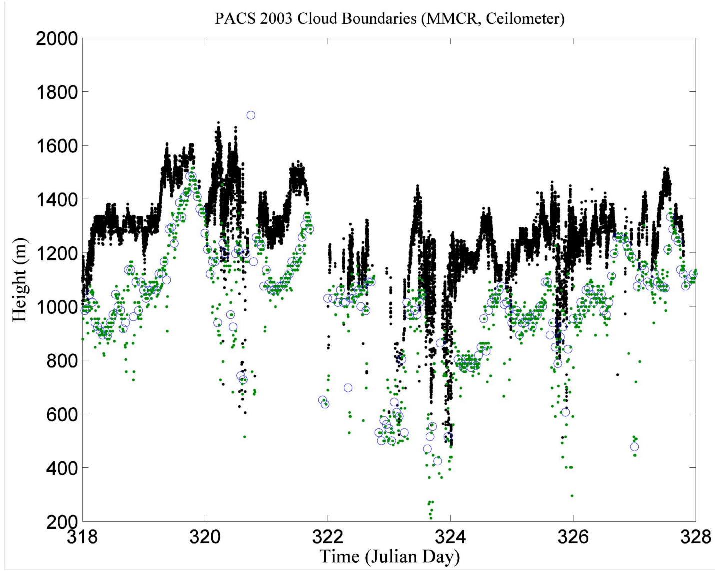


Figure 43. Time series of cloud top height (black dots) from the radar; cloud base height (green dots) from the ceilometer; lifting condensation level (LCL, blue dots) from the rawinsonde temperature and humidity data.

5. ETL Data Cruise Archive

Selected data products and some raw data were made available at the end of the cruise for the joint cruise archive. Some systems (radar, turbulence, microwave radiometer) generate too extravagantly to be practical to share. Compared to processed information, the raw data is of little use for most people. For the radar only image files are available; full digital data will be available later from the ETL website. For the microwave radiometer, the time series after some processing and averaging. No direct turbulent flux information is provided; that will be available after processing is done back in Boulder. However, bulk fluxes are available in the flux summary file.

Data Archive Directories:

Ceilo	Ceilometer files (processed file, images)
Flux	Air-sea flux files (processed flux files: daily files, cruise file, some m-files)
Rawship	The entire Revelle ship data file at 5 s resolution as logged by ETL
Ship	ETL processed files from the Revelle system
Ballones	Rawinsondes files (.PTU and .WIND)
Microwv	Microwave radiometer files (processed files; graphic display)
Radar	Image files from cloud radar
Aerosol	Lasair II (particle count file; graphic file)
Reports	Documentation (cruise report, school write up, summary image files)

E. TAMU Measurements

Marine aerosol concentrations and the processes that produce and remove the aerosols in the southeast Pacific have rarely been studied. During the Stratus 2003 research mission, the Texas A&M University (TAMU) Aerosol Research Group was given a unique opportunity to deploy two instruments to study a large spectrum of aerosol diameters from 12-nm to 15-μm. A Tandem Differential Mobility Analyzer (TDMA) investigated aerosols diameters up to 800-nm, while an Aerodynamic Particle Sizer (APS) model 3321 produced by TSI looked at the remaining aerosols up to 15-μm. The data collected will allow for a better understanding of the marine aerosol's chemical composition and distribution in this region of the world.

The TDMA was constructed at TAMU by Dr. Don Collins (Figure 44) and measures the concentration of aerosols and for a specific diameter aerosol, its hygroscopic and volatilization properties. The DMA works through an application of basic electrostatics. The sample air is given a positive charge through the use of Plomonium-210, an alpha emitting source. Through the use of the fact that it will take more charge to move an increasingly massive particle, the charge air stream is moved into a long cylindrical chamber with a known negative charge on the outer wall. For a given charge, their will be a certain size that is able to move the right distance to escape out of a narrow slit at the bottom of the chamber and into the instrument for further sampling. The particles that are too small will crash into the outer wall, while the particles that are too large will fall into the bottom of the instrument. A filtered sheath flow moves the particles through the DMA chamber at a known flow rate.

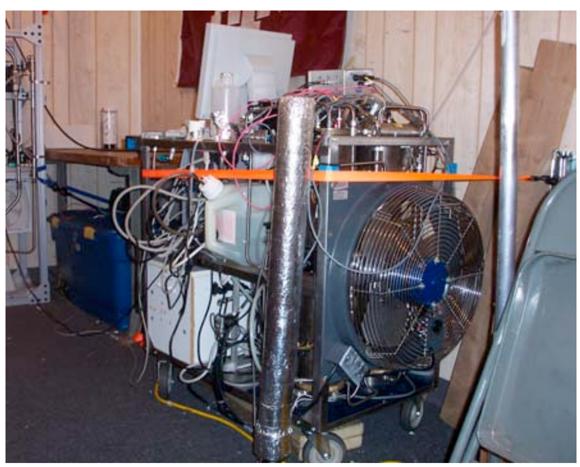


Figure 44. The Aerosol Research Group's Tandem Differential Mobility Analyzer.

Distributions are created through the variation of the voltage of the DMA and counting the amount of particles at a given size using a Met One Condensation Nucleus Counter (CNC). The hygroscopic properties are investigated by first experiencing the particles to a high relative humidity (85%) using a Nafion tube. As a result, the aerosol will grow and their size distribution is measured by the second DMA. Each chemical composition will grow by a unique factor know as the growth factor. By determining the growth factor of a particle, one can determine the chemical make up of the aerosol. This is plotted using a value Dp/Dp*, where Dp is the new diameter and Dp* is the original diameter. Finally, the volatilization properties are investigated by experiencing a known aerosol diameter to a varying temperature between 45^0C to 300^0C and then to a high RH. The remaining aerosols are sampled by the second DMA to determine their growth factor and concentration. Theoretically most sulfur-based aerosols will be volatilized by 250^0C, while sea-salt will not be volatilized till 820^0C.

The APS works on the principle of inertia. For a know acceleration, a large particle will accelerate slower than a smaller particle. By calculating the time it takes a particle to pass between two lasers at a certain distance apart, the size of the particle can be determined. For sizes between 800-nm and 15-μm, the aerosols should consist primarily of sea salt and possibly some carbonaceous component from the mainland of Chile. To investigate the concentration of dust, the flow will alternate between a furnace set at 920^0C and no furnace (see Figure 45). The flow enters in at the top of the frame and passes through a diffusion drier. The flow then either passes through the furnace or the no furnace tube, depending in which valve is open. The APS is located at the bottom of the frame. By burning off the sea salt, the concentration of dust was determined. The following sections will give an overview of the data files.

Figure 45. The APS and furnace set up used in the data collection.

The data can be found in the directory ***\Sea Salt***. The data files are organized by date and the time that the measurement was started. Each loop first begins with a DMA scan (scan set 0) where the voltage is first ramped for the entered scan time to collect the range requested and then is ramped back down to near zero. Theoretically if the instrument is running optimally the up and down scans will align. After the DMA scan, the TDMA scan is begun for each size requested. At the completion of the TDMA scans, the instrument begins a new loop with a DMA scan. The following paragraphs will use ***\Sea salt\19Nov03 17.37.13*** as an example. The first two files, “scan sequence.txt” gives the sizes in μm the TDMA investigated and “input parameters.txt” gives the initialization values of the instrument (see below example).

Table 18. Example Initialization Values for the TDMA.

The APS Range (μm)	0.65 20
The DMA Range (μm)	0.01 0.8
Direct Sample Time (s)	0
DMA Scan Time (s)	300
TDMA Scan Time (s)	90
Number of Bins for DMA scan	90
Number of Bins for TDMA scan	60
Plumbing time (s)	1.7
Optical Particle Counter Bins	0
Qsh/Qs	10
Max Voltage (V)	9000
Qsh Range (L/min)	27 10
HV Zero Downstream (V)	-0.002
Maximum Scan per Size	4
Minimum Counts per size	400
RH Range	85 40
Plumbing Time Slope (s)	2.75
HV Zero Upstream (V)	-0.002
Upstream Temp (0C)	0
Temp Range (^{0}C)	45 300
Smearing Time Slope (s-L/min)	0
Smearing Time Offset (s)	0
Particle Density (g/cm^3)	2.1

The actual data can be found in the folder with the date, i.e. ***Nov 19***. All files are in ASCII and will need to be transposed to be viewed correctly. The ***APS*** contains values measured by the instrument in three files. The "aerodynamic record.txt" contains the number of counts while "AP Dp and Inv.txt" contains the sizes sampled. The ***APS RH*** folder is not used.

The ***copy*** and ***for_plot*** folders contain the data for the TDMA. Within the ***copy*** folder there are individual folders for each DMA and TDMA scan set. In this case the 8 scans conducted are contained in the folders numbered zero though eight. Folder zero contains data for the DMA scan while folder one through eight contains data for the TDMA scans. Within each scan folder there are six files. The "avg_conc.txt" contains the number concentration for the up and down scan. The "counts.txt" contains the raw counts from the CNC. The "fractional_error.txt", "measured.txt", and "setpoint.txt" contains information concerning the sample flow (Qs), the up stream sheath flow (Qsh), the down stream sheath flow, the up stream voltage, the down stream voltage, the upstream RH, the downstream RH, and the RH of the flow coming into the instrument, respectively by column.

In the ***for_plot*** folder, the same information is present in the "counts.txt", "fractional_error.txt", "measured.txt", and "setpoint.txt" as stated in the above paragraph. The "set_0.txt" through "set_8.txt" contains the same data as the "avg_conc.txt" file found in each individual folder under the ***copy*** folder. The entire scan set data can also be found in the "loop_1.txt" file. The "legend_set_0.txt" through "legend_set_8.txt" give the times that each scan was ran for.

The last folder ***panel*** contains a screen capture of the front panel as a jpeg image. At the end of every loop, one of these images is placed in the folder.

F. Teacher-at-Sea Program

During the 2003 Cruise, there were two teachers onboard who were sponsored by the National Oceanic and Atmospheric Administration (NOAA) Teacher at Sea Program and NOAA's Office of Global Programs (OGP).

Debra Brice is a middle school science teacher in San Diego at San Marcos Middle School, and Viviana Zamorano is also a middle school science teacher at Escuela America in Arica, Chile. During the cruise, the teachers assisted with science operations including mooring deployments and recoveries. The teachers also hosted web broadcasts, wrote daily logs, took photos, and interviewed science members and crew. This information was used to communicate with their own classrooms as well as those of other land-based teachers. They were assisted with the video and web-based communications by John Kermond, also of NOAA. All of their video, pictures, and logs are available at http://www.ogp.noaa.gov/ootas/index.html.

ACKNOWLEDGEMENTS

This project was funded through grants from the Office of Global Programs of the National Oceanic and Atmospheric Administration (NOAA Grant NA17RJ1223). The UOP Group would like to thank the crew of the R/V *Revelle,* ETL, PMEL, NDBC, SHOA, INOCAR, and the Teacher's at Sea for all of their help during the Stratus 2003 cruise.

APPENDIX A – CRUISE LOGISTICS

Hotel in Manta Ecuador

Oro Verde Hotel
Malecon Avenue and 23rd Street
Manta, 1305135, Ecuador
http://www.oroverdehotels.com/manta/,
http://www.oroverdehotels.com/ingles/manta
Phone 593-5-629200 or 593-5-629209, fax 593-5-629210

Hotel in Arica

Arica Hotel
Av. Commandante San Martin 599
Arica, Chile
56-58 254 540 fax 56-58 231 133 e-mail: resarica@panamericanahoteles.cl
more info at http://www.panamericanahoteles.cl
note country code for Chile is 56, so from U.S., dial 011 56 58 254 540

R/V *Revelle*

INMARSAT: (Use the Pacific numbers first (872), if no success try Atlantic –West (874)) (Inmarsat-B), as dialed from the U.S.:

(Pacific) 011-872-336780020 (voice)
(Pacific) 011-872-336780021 (fax)
If 872 does not work, try 874
(Atlantic-West) 011-874-1503656

More information about ship:
http://www.sio.ucsd.edu/shipsked/ships/revelle/index.html

SIO Marine Operations:

General contact: 858-534-1641 (in San Diego)

Dr. Robert A. Knox- Associate Director
(858) 534-4729
(858) 535-1817 (fax)
rknox@ucsd.edu

Mrs. Rose Dufour/ Mrs. Elizabeth Brenner
Scheduler & Foreign Clearances
(858) 534-2841
(858) 535-1817 (fax)
shipsked@ucsd.edu

Capt. Thomas Althouse-Marine Superintendent
Nimitz Marine Facility
(858) 534-1643
(858) 534-1635 (fax)
capt@mpl.ucsd.edu

Agent in Ecuador:
Jose Pulley
jpulley@remar.com.ec
Phone: 011 593-4-2322111
Fax: 011 593-4-2531541
REMAR S.A.
Edificio Valra Piso 9
Guayaquil, Ecuador

Agent in Chile
Mr. Renzo Caprile
Phone: 011 56 58 250238 fax: 011 56 58 269229
(56 in country code for Chile)
Email arica@ajbroom.cl
Copy email to Jean Aguila
operations@ajbroom.cl
011 56-32-268200 fax 011 56-32-213308

Ag Maritimas Broom Arica, Ltda
Artruro Prat 391
Floor 10 Off 106
ARICA – CHILE

Mail could be sent to:
MASTER
RV Melville
%Ag Maritimas Broom Arica, Ltda.
Artruro Prat 391 Floor 10
Off 76
Arica, Chile

APPENDIX B – MOORING LOGS

Moored Station Log

PAGE 1

(fill out log with black ball point pen only)

ARRAY NAME AND NO. Stratus III **MOORED STATION NO.** 1108

Launch (anchor over)

Date 25 October 2002 (day-mon-year) **Time** 0:16:26 **UTC**

Latitude 20° 10.551' (deg-min) **N or (S)** **Longitude** 85° 6.63' (deg-min) **E or (W)**

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

Deployed by: Lord, Dunn, Ryder, Weller, Smith **Recorder/Observer:** Lara Hutto

Ship and Cruise No Melville Vanc03 **Intended duration:** 365 **days**

Depth Recorder Reading 4444 **m** **Correction Source:** Matthew's Table Correction to Seabeam

Depth Correction -4 **m**

Corrected Water Depth 4440 **m** **Magnetic Variation:** 7.9166 **E or W**

Anchor Position: Lat. 20°10.482' **N or (S)** **Long.** 85° 6.727' **E or (W)**

Argos Platform ID No. See page 2. **Additional Argos Info may be found on pages 2 and 3.**

Acoustic Release Information

Release No. 503121 **Tested to** 1500 **meters**

Receiver No. 3 **Release Command** 33

Enable Command 32

Interrogate Freq. 11 KHz **Reply Freq.** 10 KHz

Recovery (release fired)

Date 17 November 2003 (day-mon-year) **Time** 12:32 **UTC**

Latitude 20° 10.117' (deg-min) **N or (S)** **Longitude** 85° 06.358' (deg-min) **E or (W)**

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

Recovered by: Lord, Ryder **Recorder/Observer:** Hutto

Ship and Cruise No. Revelle, Dana 03 **Actual duration:** 389 **days**

Distance from actual waterline to buoy deck 0.3 **meters**

Surface Components

Buoy Type 3m Discus **Color(s) Hull** Blue Deck Yellow **Tower** White

Buoy Markings If found adrift contact Woods Hole Oceanographic, Woods Hole, MA 02543 USA, 508-548-1401

Surface Instrumentation

Item	ID	Height *	Comments
Data Logger	L04		System #1
Rel. Humidity	HRH 219	257.2 top of shield	ASIMET
Wind Module	WND 217	303.7 rotor axis	ASIMET
Precipitation	PRC 206	275.3 top of funnel	ASIMET
LongWave Rad.	LWR 101	316.5 Base of dome	IMET
ShortWave Rad.	SWR 109	316.5 base of dome	IMET
Argos PTT	ID 27916		Wildcat PTT #12789
	ID 27917		
	ID 27918		
Barom. Press.	BPR 106	241.8 Center of Port	IMET
Data Logger	L07		System #2
Rel. Humidity	HRH 216	255.3 top of shield	ASIMET
Wind Module	WND 219	303.0 rotor axis	ASIMET
Precipitation	PRC 205	275.3 top of funnel	ASIMET
LongWave Rad	LWR 006	316.5 base of dome	IMET
Short Wave Rad	SWR 111	316.5 base of dome	IMET
Argos PTT	ID 27919		Wildcat PTT #18171
	ID 27920		
	ID 27921		
Barom ~~B~~Press	BPR 112	241.8 Center of Port	IMET
Barom. Press.	BPR 204	219.7 Center of Port	Stand alone, ASIMET
Rel. Humidity	HRH 222	269.6 top of shield	Stand alone, ASIMET
Argos PTT	ID 20060		Stand alone, #18231

*** Height above buoy deck** in centimeters

Sub-Surface Instrumentation on Buoy and Bridle

Item	ID	Depth†	Comments
IMET SB37	1836	127 mid-cell	Attached to bridle, System #1
IMET SB37	1305	132.1 mid-cell	Attached to bridle, System #2
Seacat	1881	132.1 mid-cell	Attached to bridle, Stand Alone
Argos SIS	ID 24337	200.1 bottom	SN # 102
SBE 39	0072	θ	Floating SST
Bridle	–	–	New U-joint assembly
			3m discus universal joint
			1" chain shackle

† **Depth below buoy deck** in centimeters

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 1108

Depth from drawing (m)	Item No.	Lgth [m]	Item	Inst No.	Time Over	Notes	Data No.	Calc Dpth	Time Back	Notes
	1	0.48	3/4" Proof Coil Chain							
3.71	2		Seacat	1873	14:31:00	Wogs Live!			21:41	
	3	1.98	3/4" PCC							
7	4		Seacat	1875	14:06:54				21:41	
	5	1.3	3/4" PCC							
10	6		3/4" Cage VMCM	009	13:57:48	13:53:26 Bands off			21:42	fishing line in rotors
	7	0.75	3/4" PCC							
13	8		Aandera w/ temp	129	13:54:21				21:45	
	9	1.71	3/4" PCC							
16	10		Seacat	2325	13:51:30				21:46	fishing line on inst.
	11	2.26	3/4" PCC							
20	12		3/4" Cage VMCM	030	13:46:15	13:43:47 bands off			21:46	
	13	2.04	3/4" PCC							
25	14		Chlam w/ SBE-39	Ch #1 SB 0049	13:43:32				21:50	
	15	3.24	3/4" PCC							
30	16		Seacat	1880	13:40:38				21:50	fishing line
	17	0.75	3/4" PCC							
32.5	18		3/4" Cage VMCM	055	13:40:28	13:28:35 bands off			21:55	fishing line
	19	0.34	3/4" PCC							
35	20		T-POD	4485	13:37:28				21:56	Fishing line

Date/Time	Comments
~ 14:31 (10/24/02)	Buoy in water (10/24/02)

MOORED STATION NUMBER 1108

depth from drawing (m)	Item No.	Lgth [m]	Item	Inst No.	Time Over	Notes	Data No.	Calc Dpth	Time Back	Notes
	21	3.7	3/4" PCC							
40	22		Microcat	1326	13:25:09	Back out of water 15:07:0[illegible]			21:57	fishing line
	23	3.33	3/4" PCC							
45	24		3/4" Cage VMCM	011	15:14:39	Bands off 15:12:50			21:57	fishing line
	25	3.06	3/4" PCC							
50	26		RainG.	Ibis	15:19:24				20:38	
	27	3.33	3/4" PCC							
55	28		T-POD	3836	15:23:51				20:34	
	29	6.2	7/16" Wire						2	
62.5 ~~70~~	30		~~T-POD~~ Microcat	1330 ~~3830~~	15:28:57 ~~15:31:46~~				20:30	
	31	6.2	7/16" Wire							
70	32		T-POD	3830	15:31:46				20:25	
	33	6.2	7/16" Wire							
77.5	34		T-POD	3259	15:35:17				20:20	
	35	6.2	7/16" Wire							
85	36		Microcat	1329	15:38:18				20:15	fishing line
	37	6.2	7/16" Wire							
92.5	38		T-POD	4495	15:40:53				20:10	fishing line
	39	6.2	7/16" Wire							
100	40		T-POD	4228	15:43:52				20:05	fishing line

Date/Time	Comments
11/17/03, 20:43 UTC	Upper mooring set free

MOORED STATION NUMBER 1108

depth from drawing (m)	Item No.	Lgth [m]	Item	Inst No.	Time Over	Notes	Data No.	Calc Dpth	Time Back	Notes
	41	14	7/16" Wire							
115	42		T-POD	3831	15:46:47				20:00	
	43	14	7/16" wire							
130	44		Microcat	2012	15:49:11				19:56	
	45	3.09	3/4" PCC							
135	46		ADCP	1218	15:52:46				19:51	
	47	8.5	7/16" wire							
145	48		T-POD	3764	15:55:50	1st goose neck on inst.			19:49	
	49	14	7/16" wire							
160	50		T-POD	3762	16:01:22				19:44	
	51	28.5	7/16" wire							
190	52		Microcat	1328	16:06:50				19:39	
	53	28.5	7/16" wire			1st goose neck on wire				
220	54		T-POD	3258	16:10:20				19:33	
	55	13	7/16" wire							
235	56		FSI 3-D ACM	1469	16:15:50	Sensors down			19:28	
	57	13	7/16" wire							
250	58		T-POD	4494	16:24:30				19:22	
	59	100	3/8" wire							
349	60		SBE39	0048	16:35:30	Clamped on wire			19:10	

Date/Time	Comments

MOORED STATION NUMBER 1108

depth from drawing (m)	Item No.	Lgth [m]	Item	Inst No.	Time Over	Notes	Data No.	Calc Dpth	Time Back	Notes
350	61		New Gen MCM Cage	001	16:35:30	bands off 16:30:24			19:07	Bands on 20:55:30
	62	100	3/8" wire							
450	63		SBE 39	0050	16:40:24	Clamped on wire			18:52	
	64	500	3/8" wire		16:40:24				18:52	
	65	500	3/8" wire		17:02:25				18:33	
	66	500	3/8" wire		17:38				18:16	
	67	100	3/8" wire		18:03:30	one piece wrapped termination (67–68)			17:56	
	68	200	7/8" nylon		18:21:50				17:48	
	69	150	7/8" nylon		18:36:27				17:37	
	70	500	7/8" nylon		18:48:27				17:22	
	71	500	7/8" nylon		20:09:49				15:56	
	72	500	7/8" nylon		20:58:52	one piece to be spliced at sea (72–74)			15:43	
	73	100	1" nylon		21:17:23				15:29	
	74	1400	1 1/8" polypro		21:21:15				15:25	
	75		88 - 17" glass balls		22:40	on 1/2" trawler chain			14:00	
	76	5	1/2" trawler chain		23:19:31				14:00	
	77		Acoustic Release	503121	23:32:46	Pin Out 23:31:51			14:00	
	78	5	1/2" trawler chain		23:32:46				14:00	
	79	20	1" Samson Nystron		23:42:14				14:00	
	80	5	1/2" trawler chain						14:00	

Date/Time	Comments
10/24/02	Stopped winch to wind nylon between items #71 and #72.
	Acoustic Release Model EGG 322
11/17/03	~5 broken glass balls.
11/17/03	14:38 Stopping off to spool off winch.
11/17/03	~15:56 Stopping off to spool off winch.

MOORED STATION NUMBER 1108

Item No.	Lgth [m]	Item	Inst No.	Time Over	Notes	Data No.	Calc Dpth	Time Back	Notes
81		Anchor		0:16:26	Air wt 9300 lb Wet wt 8000 lb				
82									
83									
84									
85									
86									
87									
88									
89									
90									
91									
92									
93									
94									
95									
96									
97									
98									
99									
100									

Date/Time	Comments

MOORED STATION NUMBER 1108

Date/Time	Comments
	All times recorded in GMT.
11/17/2003	Light inoperative on recovered buoy.
11/17/2003	Glass balls sighted ~13:10
	1st ball on deck 13:52
	Last ball on deck 14:00
11/17/2003	Buoy on deck 21:27
	20° 11.67' S, 085° 3.71' W
11/17/2003	Buoy disconnected 20:44
	20° 11.64' S, 085° 3.65' W
11/17/2003	Glass balls hooked 13:50
	20° 10.52' S, 085° 06.82' W

Moored Station Log

PAGE 1

(fill out log with black ball point pen only)

4413 read at anchor site

ARRAY NAME AND NO. Stratus 4 MOORED STATION NO. 1119

Launch (anchor over)

Date 11/19/2003 ~~day-mon-year~~ Time 20:31:30 UTC

Latitude 19° 45.951' deg-min N or (S) Longitude 85° 30.239' deg-min E or (W)

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

Deployed by: Lord, Ryder Recorder/Observer: Hutto

Ship and Cruise No Revelle, Dana 03 Intended duration: 365 days

Depth Recorder Reading 4441 m Correction Source: Already applied

Depth Correction N/A m

Corrected Water Depth N/A m Magnetic Variation: ____ E or W

Anchor Position: Lat. 19° 45.931' N or (S) Long. 85° 30.405' E or (W)

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

Acoustic Release Information

Release No. 339 Tested to 1500 meters

Receiver No. 6 Release Command 63

Interrogate Freq. 11 KHz Reply Freq. 10 KHz

Recovery (release fired)

Date ____ day-mon-year Time ____ UTC

Latitude ____ deg-min N or S Longitude ____ deg-min E or W

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

Recovered by: ____ Recorder/Observer: ____

Ship and Cruise No. ____ Actual duration: ____ days

Distance from actual waterline to buoy deck ____ meters

Surface Components

Buoy Type 3m discus **Color(s) Hull** yellow/white **Tower** white

Buoy Markings If found contact Woods Hole Oceanographic Woods Hole, MA 02543 USA, WHOI 508-548-1401

Surface Instrumentation

Item	ID	Height *	Comments
Data Logger	L01		System #1
Rel. Humidity	HRH 223	257.2 Top of Sheild	ASIMET
Wind	WND 212	297.2 Rotor axis	ASIMET
Precip.	PRC 004	273.1 Top of funnel	IMET
Longwave	LWR 204	316.5 Base of dome	ASIMET
Shortwave	SWR 102	316.0 Base of dome	IMET
Bar. Pressure	BPR 006	236.5 Center of Port	IMET
Argos PTT	ID 9805		Wildcat #14709
	ID 9807		
	ID 9811		
Data Logger	L02		System #2
Rel. Humidity	HRH 221	257.2 Top of Shield	ASIMET
Wind	WND 206	297.0 Rotor Axis	ASIMET
Precip.	PRC 109	275.3 Top of funnel	IMET
Longwave	LWR 104	316.6 Base of dome	IMET
Shortwave	SWR 104	376.0 Base of dome	IMET
Bar. Pressure	BPR 110	236.0 Center of port	IMET
Argos PTT	ID 24337		Wildcat #14612
	ID 27970		
	ID 27971		
Rel. Humidity	HRH 227	273.0 Top of Sheild	ASIMET / Stand Alone
Argos SIS	ID 11427		SN #22

*** Height above buoy deck** in centimeters

Sub-Surface Instrumentation on Buoy and Bridle

Item	ID	Depth†	Comments
SBE 39	0717	θ	Floating SST
SBE 16	1877	141	Attached to bridle, stand alone
SBE 37	1834	148	System #1, attached to bridle
SBE 37	1837	145	System #2, attached to bridle

† Depth below buoy deck ~ in 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 1119

Depth From drawing (m)	Item No.	Lgth [m]	Item	Inst No.	Time Over	Notes	Data No.	Calc Dpth	Time Back	Notes
	1	0.52	3/4" chain							
3.9	2		SBE16	1882	13:13					
	3	1.8	3/4" chain							
7	4		SBE 16	0146	12:58					
	5	1.2	3/4" chain							
10	6		VMCM	033	12:55	12:52:33 bands off				
	7	0.97	3/4" chain							
13	8		Sontek	D171	12:53					
	9	1.50	3/4" chain							
16	10		SBE16	1879	12:50					
	11	2.25	3/4" chain							
20	12		VMCM	066	12:46	12:44:50 bands off				
	13	2.85	3/4" chain							
25	14		TPOD	3667	12:46					
	15	3.66	3/4" chain							
30	16		SBE16	2324	12:39					
	17	0.75	3/4" chain							
32.5	18		Sontek	D197	12:39					
	19	1.5	3/4" chain							
35	20		TPOD	3839	12:36					

Date/Time	Comments
11/19/2003	Buoy in water 13:13

MOORED STATION NUMBER 1119

Depth from Drawing (m)	Item No.	Lgth [m]	Item	Inst No.	Time Over	Notes	Data No.	Calc Dpth	Time Back	Notes
	21	3.98	3/4" chain							
40	22		SBE16	0927	12:33					
	23	3.22	3/4" chain							
45	24		VMCM	053	13:30					
	25	2.75	3/4" chain							
50	26		SBE16	0994	13:34					
	27	3.15	3/4" chain							
55	28		Sontek	D193	13:36					
	29	5.3	7/16" wire							
62.5	30		SBE16	1878	13:39					
	31	6.2	7/16" wire							
70	32		TPOD	4483	13:44					
	33	6.2	7/16" wire							
77.5	34		TPOD	3703	13:47					
	35	6.2	7/16" wire							
85	36		SBE16	0993	13:49					
	37	1.85	3/4" chain							
88.5	38		VMCM bearing test	Test	13:53					
	39	1.85	3/4" chain							
92.5	40		TPOD	3701	13:55					

Date/Time	Comments

MOORED STATION NUMBER 1119

Depth from drawing (m)	Item No.	Lgth [m]	Item	Inst No.	Time Over	Notes	Data No.	Calc Dpth	Time Back	Notes
	41	6.2	7/16" wire							
100	42		TPOD	4481	13:58					
	43	14	7/16" wire							
115	44		TPOD	4493	14:03					
	45	14	7/16" wire							
130	46		SBE16	0928	14:05					
	47	3.43	3/4" chain							
135	48		RDI	1220	14:10	looking up				
	49	8	7/16" wire							
145	50		TPOD	3309	14:12					
	51	14	7/16" wire							
160	52		SBE37	2011	14:21					
	53	28.5	7/16" wire							
175	54		TPOD	4488	14:23	on wire				
	55									
190	56		VMCM	030	14:29					
	57									
192	58		SBE16	2322	14:29					
	59	28.5	7/16" wire							
222	60		SBE37	1899	14:34					

Date/Time	Comments

MOORED STATION NUMBER 1119

	Item No.	Lgth [m]	Item	Inst No.	Time Over	Notes	Data No.	Calc Dpth	Time Back	Notes
	61	14	7/16" wire							
238	62		VMCM	073	14:39	14:55:30 bands off				
	63	14	7/16" wire							
254	64		TPOD	4489	14:43					
	65	38	3/8" wire							
280	66		TPOD	3305	14:50					
	67	~	~	~	~	~	~	~	~	~
294	68		VMCM	068	14:54	14:52:10 bands off				
	69	58	3/8" wire			red term came loose				
354	70		VMCM	057	15:08	15:03:15 bands off				
	71	100	3/8" wire							
400	72		SBE39	0282	15:11					
	73	~	~	~	~	~	~	~	~	~
450	74		SBE39	0203	15:13					
	75	500	3/8" wire		15:33					
	76	500	3/8" wire		15:51					
	77	500	3/8" wire		16:04					
	78	100	3/8" wire		16:08					
	79	200	7/8" nylon		16:16					
	80	150	7/8" nylon		16:23					

Date/Time	Comments
11/19/03	14:56 Stop to work on block.

MOORED STATION NUMBER 1119

Item No.	Lgth [m]	Item	Inst No.	Time Over	Notes	Data No.	Calc Dpth	Time Back	Notes
81	500	7/8" nylon		16:38					
82	500	7/8" nylon		17:24					
83	500	7/8" nylon		17:53					
84	100	1" nylon		18:14					
85	1400	1 1/8" poly		19:09					
86		96 glass balls (17")		1 - 19:15 96 - 19:49					
87	5	chain		19:53					
88		release	339	20:04	pin out				
89	5	Chain		20:16					
90	20	nystron		20:22					
91	5	chain		20:31:30					
92		anchor		20:31:30					
93									
94									
95									
96									
97									
98									
99									
100									

Date/Time	Comments
11/19/03	16:58 tied off for spooling
11/19/03	17:49 tied off for h-bit

MOORED STATION NUMBER 1119

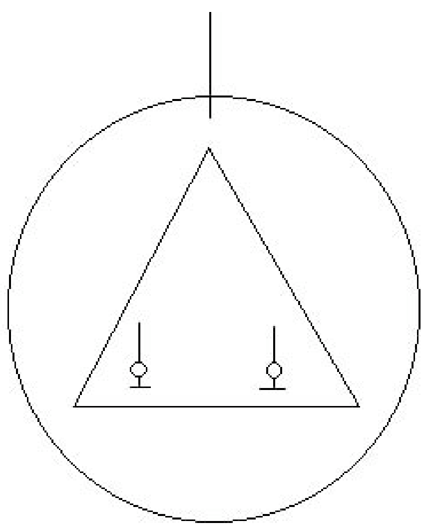
Date/Time	Comments
11/19/2003	Position at beginning of deployment
	19° 42.70' S , 085° 37.60' S

APPENDIX C – BUOY SPINS

Prior to the launch of the Stratus buoys, the compass and wind vane directions are checked on the IMET systems. A stationary point at some distance from the buoy is surveyed to provide a reference point. The vanes are locked in position pointing towards the reference point. Then readings from the vane and compass are noted. The entire buoy is rotated approximately 60° and the vanes locked in position towards the reference point. Readings are again taken from the vane and compass. This process is done at six positions to complete a 360° rotation. To find the true direction of the vane, the vane reading is added to the compass reading, and 360° are subtracted if needed.

The following pages show the results of buoy spins performed in San Diego, CA for the Stratus 4 buoy.

161 Deg.

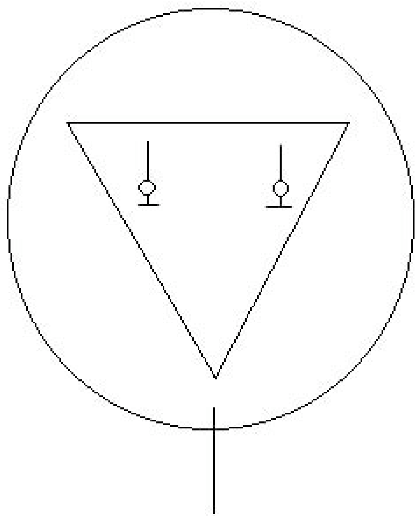


Vanes Secured Time/Date UTC: 16:05:30, 19 SEP 03

System 1	Compass	Vane	Direction	Time UTC
Logger #: L01				
Stop Sampling: 16:11:30				
Wind #: WND 212	337.8	182.1	159.9	16:13:00
Restart Sampling: 16:13:30				

System 2	Compass	Vane	Direction	Time UTC
Logger #: L02				
Stop Sampling: 16:14:30				
Wind #: WND 206	321.4	196.4	157.8	16:16:00
Restart Sampling: 16:16:30				

161 Deg.

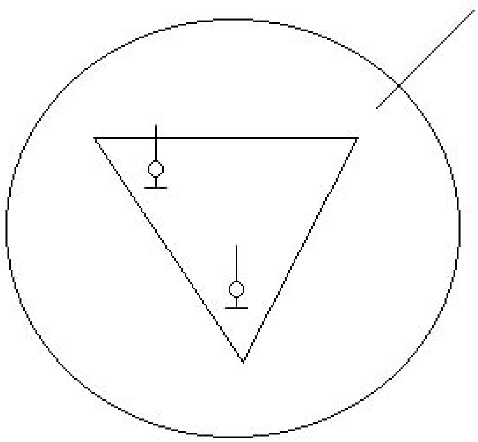


Vanes Secured Time/Date UTC: 16:51:30, 19 SEP 03

System 1	Compass	Vane	Direction	Time UTC
Logger #: L01				
Stop Sampling: 17:01:30				
Wind #: WND212	4.5	157.3	161.8	17:02:00
Restart Sampling: 17:02:30				

System 2	Compass	Vane	Direction	Time UTC
Logger #: L02				
Stop Sampling: 16:59:30				
Wind #: WND206	17.4	143.5	161.9	17:00:00
Restart Sampling: 17:00:30				

161 Deg.

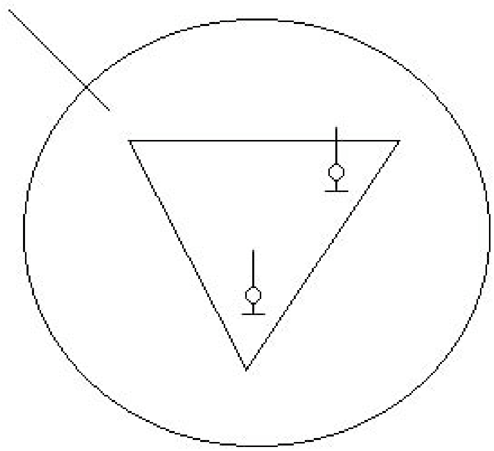


Vanes Secured Time/Date UTC: 16:21:45, 19 SEP 03

System 1	Compass	Vane	Direction	Time UTC
Logger #: L01				
Stop Sampling: 16:29:45				
Wind #: WND212	43.3	122.2	165.5	16:30:00
Restart Sampling: 16:30:30				

System 2	Compass	Vane	Direction	Time UTC
Logger #: L02				
Stop Sampling: 16:28:30				
Wind #: WND206	23.8	135.3	159.1	16:29:00
Restart Sampling: 16:29:30				

161 Deg.

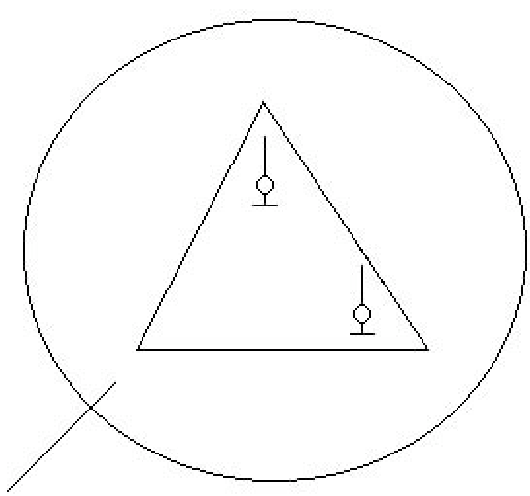


Vanes Secured Time/Date UTC: 17:27:30, 19 SEP 03

System 1	Compass	Vane	Direction	Time UTC
Logger #: L01				
Stop Sampling: 17:36:30				
Wind #: WND212	281.5	241.6	163.1	17:37:00
Restart Sampling: 17:37:30				

System 2	Compass	Vane	Direction	Time UTC
Logger #: L02				
Stop Sampling: 17:39:30				
Wind #: WND206	264.5	254.5	159.0	17:40:00
Restart Sampling: 17:40:30				

161 Deg.

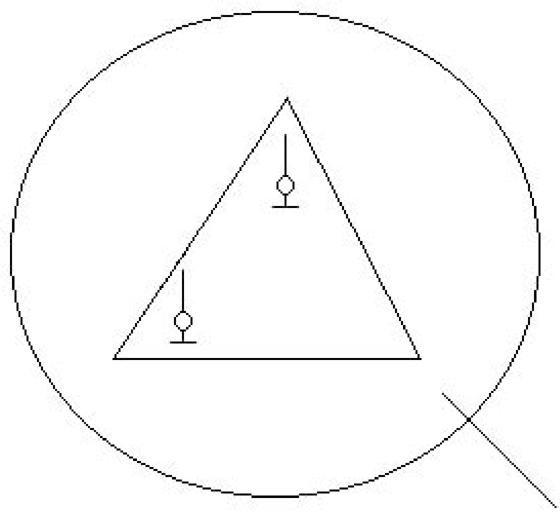


Vanes Secured Time/Date UTC: 17:08:00, 19 SEP 03

System 1	Compass	Vane	Direction	Time UTC
Logger #: L01				
Stop Sampling: 17:20:30				
Wind #: WND212	223.8	300.8	164.6	17:22:00
Restart Sampling: 17:22:30				

System 2	Compass	Vane	Direction	Time UTC
Logger #: L02				
Stop Sampling: 17:15:30				
Wind #: WND206	204.0	315.6	159.6	17:16:30
Restart Sampling: 17:18:30				

161 Deg.



Vanes Secured Time/Date UTC: 16:36:15, 19 SEP 03

System 1	Compass	Vane	Direction	Time UTC
Logger #: L01				
Stop Sampling: 16:44:30				
Wind #: WND212	101.7	60.9	161.9	16:45:00
Restart Sampling: 16:45:30				

System 2	Compass	Vane	Direction	Time UTC
Logger #: L02				
Stop Sampling: 16:46:30				
Wind #: WND206	86.3	72.8	159.1	16:47:00
Restart Sampling: 16:47:30				

APPENDIX D – INSTRUMENT NOTES

The following pages include notes from Smith on instrument set, clock checks, and timing spikes.

Stratus IV Notes (San Diego)

note: all times UTC

17Sep03
Initial Instrument Setups

HRH S/N: HRH223
Address: HRH01
Logger: L01
Flash card: 8Mb Flash - erased
C530 card FW: VosHRH53 v3.2
HPS card FW: HPS-HRH v1.6
Clock set: 17Sep03 18:10:08
Sanity check: Viewed test and calculated strings

WND S/N: WND213
Address: WND01
Logger: Spare
Flash card: 4Mb Flash - erased
note: Must be changed if deployed
C530 card FW: VosWND53 v3.4
Pic FW: PicWND v1.5
Clock set: 17Sep03 18:19:30
Sanity check: Viewed test and calculated strings

HRH S/N: HRH221
Address: HRH01
Logger: L02
Flash card: 8Mb Flash - erased
C530 card FW: VosHRH53 v3.2
HPS card FW: HPS-HRH v1.6
Clock set: 17Sep03 18:32:30
Sanity check: Viewed test and calculated strings

HRH S/N: HRH227
Address: HRH01
Logger: Spare/Stand alone
Flash card: No Flash Card
note: Needs flash card from another spare for stand alone
C530 card FW: VosHRH53 v3.1
HPS card FW: HPS-HRH v1.6
Clock set: 17Sep03 18:41:07
Sanity check: Viewed test and calculated strings

WND S/N: WND206
Address: WND01
Logger: L02
Flash card: 8Mb Flash - erased
note: Check clock for onboard battery performance
C530 card FW: VosWND53 v3.4
Pic FW: PicWND v1.5
Clock set: 17Sep03 20:41:15
Sanity check: Viewed test and calculated strings

BPR S/N: BPR110
Address: BPR01
Logger: L02
Flash card: No Flash - Old IMET
FirmWare: IMETBPR v2.1
Clock set: No clock - Old IMET
Sanity check: Viewed test and calculated strings

BPR S/N: BPR006
Address: BPR01
Logger: L01
Flash card: No Flash - Old IMET
Firmware: IMETBPR v2.1
Clock set: No clock - Old IMET
Sanity check: Viewed test and calculated strings

WND S/N: WND212
Address: WND01
Logger: L01
Flash card: 8Mb Flash - erased
C530 card FW: VosWND53 v3.4
Pic FW: PicWND v1.5
Clock set: 17Sep03 20:54:20
Sanity check: Viewed test and calculated strings

LWR S/N: LWR104
Address: LWR01
Logger: L02
Flash card: No Flash - Old IMET
Firmware: IMETLWR v2.3
Clock set: No clock - Old IMET
Sanity check: Viewed test and calculated strings

LWR S/N: LWR204
Address: LWR01
Logger: L01
Flash card: 8Mb Flash - erased
C530 card FW: VosLWR53 v3.5
HPS card FW: HPSLWRF v1.4
Clock set: 17Sep03 21:11:44
Sanity check: Viewed test and calculated strings

PRC S/N: PRC109
Address: PRC01
Logger: L02
Flash card: No Flash - Old IMET
Firmware: IMETPRC v2.4
Clock set: No clock - Old IMET
Sanity check: Viewed test and calculated strings

PRC S/N: PRC004
Address: PRC01
Logger: L01
Flash card: No flash - Old IMET
Firmware: IMETPRC v2.4
Clock set: No clock - Old IMET
Sanity check: Viewed test and calculated strings

SWR S/N: SWR104
Address: SWR01
Logger: L02
Flash card: No flash - Old IMET
Firmware: IMETSWR v2.1
Clock set: No clock - Old IMET
Sanity check: Viewed test and calculated strings

SWR S/N: SWR102
Address: SWR01
Logger: L01
Flash card: No flash - Old IMET
Firmware: IMETSWR v2.1
Clock set: No clock - Old IMET
Sanity check: Viewed test and calculated strings

SST S/N: SBE37 - 1834
Comms: RS-485 9600 Baud
note: 3 fresh batteries
Firmware: v2.2
Clock set: 18Sep03 16:04:20
Format: 1
Storetime: Yes
Output Sal: No
Output SV: No
Refpress: Zero
Interval: 300 seconds
Samplenum: Zeroed
Total Samples: 233016
StartMMDDYY: 110103
StartHHMMSS: 010000 Ok
Startlater: Waiting to start

SST S/N: SBE37 - 1837
Comms: RS-485 9600 Baud
note: 3 fresh batteries
Firmware: v2.2
Clock set: 18Sep03 15:56:20
Format: 1
Storetime: Yes
Output sal: No
Output SV: No
Refpress: Zero
Interval: 300 seconds
Samplenum: Zeroed
Total Samples: 233016
StartMMDDYY: 110103
StartHHMMSS: 010000 Ok
Startlater: Waiting to start

SBE37 S/N: 1899
Comms: RS-232 9600 Baud
note: All 6 fresh batteries
Firmware: v2.3
Clock set: 18Sep03 16:37:48
Format: 1
Storetime: Yes
Interval: 300 seconds
Samplenum: Zeroed
Total Samples: 233016
StartMMDDYY: 110103
StartHHMMSS: 010000 Ok
Startlater: Waiting to start

SBE37 S/N: 2011
Comms: RS-232 9600 Baud
note: All 6 fresh batteries
Firmware: v2.3
Clock set: 18Sep03 17:27:36
Format: 1
Storetime: Yes
Interval: 300 seconds
Samplenum: Zeroed
Total samples: 233016
StartMMDDYY: 110103
StartHHMMSS: 010000 Ok
Startlater: Waiting to start

SBE39 S/N: 102
Case: Titanium
Comms: RS-232 2400 Baud
note: Fresh lithium 9volt
Firmware: v1.1
Clock set: 18Sep03 18:23:16
Interval: 300 seconds
Samplenum: Zeroed
Total samples: 299593
StartMMDDYY: 110103
StartHHMMSS: 010000 Ok
Startlater: Waiting to start

SBE39 S/N: 203
Case: Titanium
Comms: RS-232 2400 Baud
note: Fresh lithium 9volt
Firmware: v1.6
Clock set: 18Sep03 18:26:13
Interval: 300 seconds
Samplenum: Zeroed
Total samples: 299593
StartMMDDYY: 110103
StartHHMMSS: 010000 Ok
Startlater: Waiting to start

SBE39 S/N: 282
Case: Titanium
Comms: RS-232 2400 Baud
note: Fresh lithium 9volt
Firmware: v1.6
Clock set: 18Sep03 18:33:42
Interval: 300 seconds
Samplenum: Zeroed
Total samples: 299593
StartMMDDYY: 110103
StartHHMMSS: 010000 Ok
Startlater: Waiting to start

SBE39 S/N: 476
Case: Plastic
Comms: RS-232 2400 Baud
note: Fresh lithium 9volt
Firmware: v1.6
Clock set: 18Sep03 18:41:26
Interval: 300 seconds
Samplenum: Zeroed
Total samples: 299593
StartMMDDYY: 110103
StartHHMMSS: 010000 Ok
Startlater: Waiting to start

SBE39 S/N: 716
Case: Plastic
Comms: RS-232 2400 Baud
note: Fresh lithium 9volt
Firmware: v1.6
Clock set: 18Sep03 18:50:02
Interval: 300 seconds
Samplenum: Zeroed
Total samples: 299593
StartMMDDYY: 110103
StartHHMMSS: 010000 Ok
Startlater: Waiting to start

SBE39 S/N: 717
Case: Plastic
Comms: RS-232 2400 Baud
note: Fresh lithium 9volt
Firmware: v1.6
Clock set: 18Sep03 18:58:50
Interval: 300 seconds
Samplenum: Zeroed
Total samples: 299593
StartMMDDYY: 110103
StartHHMMSS: 010000 Ok
Startlater: Waiting to start

SWR S/N: SWR202
Address: SWR01
Logger: Spare
Flash card: 8Mb Flash - erased
C530 card FW: VosSWR53 v3.3
HPS card FW: HPS-HRH v1.6
Clock set: 19Sep03 20:23:18
Sanity check: Viewed test and calculated strings

LWR S/N: LWR206
Address: LWR01
Logger: Spare
Flash card: 8Mb Flash - erased
C530 card FW: VosLWR53 v3.5
LWRF card FW: HPS-HRH v1.4
Clock set: 19Sep03 20:27:30
Sanity check: Viewed test and calculated strings

BPR S/N: BPR107
Address: BPR01
Logger: Spare
Flash card: None - Old IMET
FW: IMET BPR v2.0
Clock set: No Clock
Sanity check: Viewed test and calculated strings

LWR S/N: LWR103
Address: LWR01
Logger: Spare
Flash card: None - Old IMET
FW: IMET LWR v2.3
Clock set: No Clock
Sanity check: Viewed test and calculated strings

PRC S/N: PRC108
Address: PRC01
Logger: Spare
Flash card: None - Old IMET
FW: IMET PRC v2.4
Clock set: No Clock
Sanity check: Viewed test and calculated strings

SBE16 S/N: 927
note: Fresh battery pack
Battery V: 10.6 volts
Lithium V: 5.5 volts
Firmware: v4.1b
Interval: 300 seconds
Samplenum: Zeroed
Total Samples: 260821
Setup CMDS: DS, TM, IR, ST, SI, TI, IL, GL, DS
StartMMDDYY: 110103
StartHHMMSS: 010000 Ok
Startlater: Waiting to start

SBE16 S/N: 2324
note: Fresh battery pack
Battery V: 10.3 volts
Lithium V: 5.4 volts
Firmware: v4.1a
Interval: 300 seconds
Samplenum: Zeroed
Total Samples: 260821
Setup CMDS: DS, TM, IR, ST, SI, TI, IL, GL, DS
StartMMDDYY: 110103
StartHHMMSS: 010000 Ok
Startlater: Waiting to start

SBE16 S/N: 1879
note: Fresh battery pack
Battery V: 10.4 volts
Lithium V: 5.6 volts
Firmware: v4.1b
Interval: 300 seconds
Samplenum: Zeroed
Total Samples: 260821
Setup CMDS: DS, TM, IR, ST, SI, TI, IL, GL, DS
StartMMDDYY: 110103
StartHHMMSS: 010000 Ok
Startlater: Waiting to start

SBE16 S/N: 994
note: Fresh battery pack
Battery V: 10.0 volts
Lithium V: 5.3 volts
Firmware: v4.1b
Interval: 300 seconds
Samplenum: Zeroed
Total Samples: 260821
Setup CMDS: DS, TM, IR, ST, SI, TI, IL, GL, DS
StartMMDDYY: 110103
StartHHMMSS: 010000 Ok
Startlater: Waiting to start

SBE16 S/N: 1878
note: Fresh battery pack
Battery V: 11.0 volts
Lithium V: 5.4 volts
Firmware: v4.1b
Interval: 300 seconds
Samplenum: Zeroed
Total Samples: 260821
Setup CMDS: DS, TM, IR, ST, SI, TI, IL, GL, DS
StartMMDDYY: 110103
StartHHMMSS: 010000 Ok
Startlater: Waiting to start

SBE16 S/N: 1882
note: Fresh battery pack
Battery V: 10.4 volts
Lithium V: 5.5 volts
Firmware: v4.1
Interval: 300 seconds
Samplenum: Zeroed
Total Samples: 260821
Setup CMDS: DS, TM, IR, ST, SI, TI, IL, GL, DS
StartMMDDYY: 110103
StartHHMMSS: 010000 Ok
Startlater: Waiting to start

SBE16 S/N: 146
note: Fresh battery pack
Battery V: 10.9 volts
Lithium V: 5.6 volts
Firmware: v4.1b
Interval: 300 seconds
Samplenum: Zeroed
Total Samples: 260821
Setup CMDS: DS, TM, IR, ST, SI, TI, IL, GL, DS
StartMMDDYY: 110103
StartHHMMSS: 010000 Ok
Startlater: Waiting to start

During burn-in ops in San Diego, LWR104 experienced 2 eeprom failures. As the calibrated set for this modules was better than the set in the spare (LWR103), a switch was made. The PWRCom and SCM51 cards from LWR103, were put into module LWR104, which retained it's ADC1216, Preamp, and Pir set. After assembly of the 'new' module, LWR104 appeared to have retained it's calibration with respect to the other LWR on the buoy.
Radiometer Note:
Once all radiometers were mounted onto the buoy, all 4 of them were leveled to within 1 degree with respect to the buoy deck. Further, after placement of the buoy on the ship, the deck was levelled to within 1 degree with the ship sitting at the dock.

Ecuador
Thursday 6Nov03
Note: Any time marked UTC was read from a radio controlled / GPS clock.
Popped Buoy well.
Logger 1
Status Message: Saved as Logger1.sta
Clock: 2003/11/06 18:49:02 UTC
Logger: 2003/11/06 18:50:02
Records Used: 70308
Battery V: 12.5 volts
Logger Stop: 2003/11/06 18:50:20 UTC

Logger 2
Status Message: Saved as Logger2.sta
Clock: 2003/11/06 20:00:00 UTC
Logger: 2003/11/06 20:01:09
Records Used: 70405
Battery V: 12.5 volts
Logger Stop: 2003/11/06 20:00:45 UTC

Logger1 restarted for the night at 2003/11/07 22:07:15 UTC.
Logger2 restarted for the night at 2003/11/07 22:09:30 UTC.

Friday 7Nov03
Individual Module Dumps
Note: Most modules for Stratus4 are still of the older IMET variety and do not have flash cards or internal clocks.

HRH223, Logger1
Clock: 2003/11/07 13:20:02 UTC
Module: 2003/11/07 13:21:37
Records used: 1190
Dumped to: HRH223.met
Time set & ck: 2003/11/07 13:37:01 UTC
Flash: Erased

WND212, Logger1
Clock: 2003/11/07 13:48:40 UTC
Module: 2003/11/07 13:50:23
Records used: 1187
Dumped to: WND212.met
Time set & ck: 2003/11/07 14:01:21 UTC
Flash: Erased

HRH221, Logger2
Clock: 2003/11/07 15:25:22 UTC
Module: 2003/11/07 15:26:32
Records used: 1193
Dumped to: HRH221.met
Time set & ck: 2003/11/07 15:36:33 UTC
Flash: Erased
WND206, Logger2
Clock: 2003/11/07 15:49:08 UTC
Module: 2003/11/07 15:50:41
Records used: 1193
Dumped to: WND206.met
Time set & ck: 2003/11/07 16:02:33 UTC
Flash: Erased

LWR204, Logger1
Clock: 2003/11/07 16:16:20 UTC
Module: 2003/11/07 16:21:53
Records used: 1193
Dumped to: LWR204.met
Time set & ck: 2003/11/07 16:27:37 UTC
Flash: Erased

SBE37 s/n 1834, Logger1
Connected to bulkhead #1
Clock: 2003/11/07 16:55:35 UTC
37: 2003/11/07 16:55:34
As set capture: S4L01_37.cap
Dumped to: SBE37_1834.asc
Cleared: Yes
New setup capt: S4L01_37set.cap
Will start: 08Nov03 010000

SBE37 s/n 1837, Logger2
Connected to bulkhead #2
Clock: 2003/11/07 17:35:05 UTC
37: 2003/11/07 17:35:06
As set capture: S4L02_37.cap
Dumped to: SBE37_1837.asc
Cleared: Yes
New setup capt: S4L02_37set.cap
Will start: 08Nov03 010000

Logger 2 Kickoff
Clock set and check: 2003/11/07 18:16:54 UTC
Flash card cleared
GO at: 2003/11/07 18:29:00 UTC

Logger 1 Kickoff
Clock set and check: 2003/11/07 18:34:21 UTC
Flahs card cleared
GO at: 2003/11/07 18:41:00 UTC

Both precips cycled: 2003/11/07 19:00:00 UTC

L01 prc water added: 2003/11/07 20:14:00 UTC
L02 prc water added: 2003/11/07 20:15:00 UTC

Solar bagging: 2003/11/07 20:55:00 to 21:00:00 UTC

PRCs full cycle: 2003/11/07 22:03:00 UTC
Unbag solars: 2003/11/07 22:04:00 UTC

08Nov03

HRH standalone
Serial number: HRH227
Address: HRH01
C530 logger FW: v3.1
Front end FW: v1.6
Time set & ck: 2003/11/08 13:01:17 UTC
Flash card: Installed and erased 8Mb
Batteried and mounted on buoy 2003/11/08 13:45:00 UTC

L01 SST SBE37 s/n 1834 on buoy 2003/11/08 16:13:00 UTC
L02 SST SBE37 s/n 1837 on buoy 2003/11/08 16:17:00 UTC

Bridle seacat s/n ???? in cold salt bath 2003/11/08 16:51:00 UTC
Bridle seacat s/n ???? out of cold salt bath 2003/11/08 19:13:30 UTC

2 SSTs (1834 & 1837) in cold salt bath 2003/11/08 17:11:00 UTC

Floating SST (SBE39 s/n 717) in cold salt bath 2003/11/08 17:35:00 UTC
Floating SST (SBE39 s/n 717) out of cold salt bath 2003/11/08 19:13:45 UTC

After making the final cable connections between the loggers and the SBE37 sea surface temperature units, the argos plotting setup told us that one logger (L01) stopped responding and that the other logger (L02) was reporting zero values for sst. The second logger (L02) failed soon after. Not understanding the problem yet, but trying to get a logger back up, a new logger card set was installed that had previously worked on the bench. It failed immediately. Next, we took a step back and tried to establish a definate sequence of events before taking a chance on damaging our last functioning spare. Additionally, careful testing on the bench showed that the only damaged part of the logger card set was the C512 eprom. A new eprom resurrected the logger set. The wiring for the SSTs was carefully inspected after it was determined that the problems started following the addition of the SBE37 hookup cables. The way the cables were wired put 12+ volts on one of the communication lines. The cables were re-wired for proper power, ground, and comms. The repaired logger set was installed in the buoy well, and sensors were carefully reintroduced one at a time. Logger L02 was back up and running as a complete system by 7pm EST on 8Nov03. Logger L01 was repaired and back up by 11am EST on 9Nov03.

9Nov03

SBE37's back out of salt bath for checkout.

SBE37 s/n 1834
Memory zeroed
Starttime date to 110903
Starttime set to 13:30:00 UTC
Started
Setup file captured to SBE-37-1834.cap

SBE37 s/n 1837
Memory zeroed
Starttime date to 110903
Starttime set to 13:30:00 UTC
Started
Setup file captured to SBE-37-1837.cap

Logger flash cards erased on both loggers
FW revision for loggers Logr53 v2.7

Logger L02 started at 09Nov03 14:27:00 UTC
Logger L01 started at 09Nov03 14:31:00 UTC

Flash cards in asimet modules erased from 14:45:00 to 15:00:00 09Nov03 UTC

SBE37 SST's back in cold salt bath at 09Nov03 17:04:30 UTC

LWR204 bagged at 18:05:00 09Nov03 UTC
LWR104 bagged at 18:07:00 09Nov03 UTC
SBE37 SST's out of cold salt bath at 18:10:00 09Nov03 UTC
SWR104 bagged at 18:14:00 09Nov03 UTC
SWR102 bagged at 18:16:30 09Nov03 UTC
HRH223 bagged at 18:19:00 09Nov03 UTC
Standalone HRH227 bagged at 18:21:00 UTC
HRH221 bagged at 18:22:45 09Nov03 UTC

LWR204 unbagged at 20:10:30 09Nov03 UTC
LWR104 unbagged at 20:11:00 09Nov03 UTC
SWR102 unbagged at 20:12:00 09Nov03 UTC
SWR104 unbagged at 20:13:00 09Nov03 UTC
HRH221 unbagged at 20:14:30 09Nov03 UTC
HRH227 unbagged at 20:16:00 09Nov03 UTC
HRH223 unbagged at 20:17:30 09Nov03 UTC

10Nov03

Setup and check out SBE19 ctd s/n 2361
600 baud
1Meg of ram

Setup and checkout release
Model # 322
Serial number 600986
Interrogate frequency 11KHz
Reply frequency 10KHz
Receiver # 9
Air test ok

11Nov03
Setup and checkout release
Model # 322
Serial number 339
Interrogate frequency 11KHz
Reply frequency 10 KHz
Receiver # 6
Air test ok

RDI Cold Salt spike
In cold bucket at 22:57:00 11Nov03 UTC
Out of cold bucket at 00:35:00 12Nov03 UTC

12Nov03

Sontek cold water spikes
Sontek s/n D197
in cold 12Nov03 13:51:30 UTC
out of cold 12Nov03 15:08:00 UTC

Sontek s/n D171
in cold 12Nov03 13:55:30 UTC
out of cold 12Nov03 15:11:00 UTC

Sontek s/n D193
in cold 12Nov03 14:01:00 approx
out of cold 12Nov03 15:13:00 approx

13Nov03

Tied down WND vanes for a while to get a steady reading.

Cold salt spikes

Seacat s/n 1882 (3.9m)
In cold salt at 13Nov03 13:39:30 UTC
Out of cold 13Nov03 15:15:45 UTC

Seacat s/n 0146 (7m)
In cold salt at 13Nov03 13:42:30 UTC
Out of cold 13Nov03 15:18:15 UTC

Tpod s/n 4489 (250m)
In cold salt at 13Nov03 13:46:00 UTC
Out of cold 13Nov03 15:12:45 UTC

Seacat s/n 928
In cold salt at 13Nov03 15:36:10 UTC
Out of cold 13Nov03 17:40:20 UTC

Seacat s/n 1879
In cold salt at 13Nov03 15:40:00 UTC
Out of cold 13Nov03 17:43:00 UTC

TPod s/n 3701
In cold salt at 13Nov03 15:41:45 UTC
Out of cold 13Nov03 17:45:45 UTC
Seacat s/n 927
In cold salt at 13Nov03 17:55:00 UTC
Out of cold 13Nov03 19:22:45 UTC

Seacat s/n 993
In cold salt at 13Nov03 17:58:00 UTC
Out of cold 13Nov03 19:24:15 UTC

TPod s/n 4493
In cold salt at 13Nov03 18:00:15 UTC
Out of cold 13Nov03 19:20:15 UTC

TPod s/n 3305
In cold salt at 13Nov03 18:03:00 UTC
Out of cold 13Nov03 19:27:00 UTC

TPod s/n 4488
In cold salt at 13Nov03 18:03:00 UTC
Out of cold 13Nov03 19:25:45 UTC

SBE39 s/n 282
In cold salt at 13Nov03 18:07:00 UTC
Out of cold 13Nov03 19:29:45 UTC

SBE39 s/n 203
In cold salt at 13Nov03 18:07:00 UTC
Out of cold at 13Nov03 19:28:30 UTC

Seacat s/n 1878
In cold salt at 13Nov03 19:52:45 UTC
Out of cold at 13Nov03 21:37:00 UTC

Seacat s/n 2324
In cold salt at 13Nov03 19:55:45 UTC
Out of cold at 13Nov03 21:35:00 UTC

TPod s/n 3667
In cold salt at 13Nov03 19:58:45 UTC
Out of cold at 13Nov03 21:33:30 UTC

TPod s/n 4481
In cold salt at 13Nov03 20:06:15 UTC
Out of cold at 13Nov03 21:31:30 UTC

14Nov03

Seacat s/n 0994
In cold salt at 14Nov03 13:25:45 UTC
Out of cold at 14Nov03 15:41:45 UTC

TPod s/n 3839
In cold salt at 14Nov03 13:29:00 UTC
Out of cold at 14Nov03 15:40:30 UTC

TPod s/n 4483
In cold salt at 14Nov03 13:28:10 UTC
Out of cold at 14Nov03 15:39:15 UTC

TPod s/n 3703
In cold salt at 14Nov03 13:30:00 UTC
Out of cold at 14Nov03 15:37:50 UTC

Win vanes were untied and locked on another position
at 14Nov03 14:23:00 approx.

15Nov03

12:30:00 approx. vanes unlocked
TPod s/n 3309
In cold salt at 15Nov03 13:41:30 UTC
Out of cold at 15Nov03 15:20:30 UTC

SBE37 s/n 2011
In cold salt at 15Nov03 13:41:00 UTC
Out of cold at 15Nov03 15:20:45 UTC

Seacat s/n 2322
In cold salt at 15Nov03 13:39:15 UTC
Out of salt at 15Nov03 15:21:15 UTC

SBE37 s/n 1899
In cold salt at 15Nov03 13:40:00 UTC
Out of salt at 15Nov03 15:21:00 UTC

Release test

Release s/n 339
Receiver #6
at 500m 20:10:00 UTC
Enabled 1st try low power
range 501m
Disabled 1st try low power
at 1500m 20:43:00 UTC
Enabled 1st try
range 1518m
Disabled 1st try
Primary unit

Release s/n 986
Receiver #9
at 500m 20:10:00 UTC
Enabled 1st try low power
range 501m
Diasbaled 4th try higher power
at 1500m 20:43:00 UTC
Enabled 1st try
range 1519m
Disabled 2nd try
Spare unit
CTD s/n 2361 test to 1500m
Tested CTD on release wire to check operations and look for spiking in data.
Vmain at 8.3v dc
cast started at 15Nov03 20:02:00 UTC
20.08.349 S 85.12.769 W
500m wire at 15Nov03 20:10:00 UTC
20.08.348 S 85.12.769 W
1500m wire at 15Nov03 20:42:00 UTC
20.08.353 S 85.12.765 W
Up cast finished and stop at 15Nov03 21:20:00 UTC
20.08.345 S 85.12.765 W
Vmain at 7.9v dc

CTD s/n 2361 Cast One on standby station pre-recovery
Vmain at 8.0v dc
cast started at 15Nov03 23:45:00 UTC
20.03.749 S 85.15.563 W
Final wire 4000m at 16Nov03 00:47:00 UTC
20.03.749 S 85.15.560 W
Up cast finished and stop at 16Nov03 01:49:15 UTC
20.03.746 S 85.15.559 W
Vmain at 7.3v dc

CTD s/n 2361 Cast Two on standby station pre-recovery
cast started at 16Nov03 01:52:00 UTC
20.03.749 S 85.15.558 W
Final wire 4000m at 16Nov03 02:50:00 UTC
20.03.751 S 85.15.559 W
Up cast finished and stop at 16Nov03 03:44:00 UTC
20.03.750 S 85.15.559 W
Vmain at 7.3v dc

16Nov03

NGVM setups

VM2-066
FW v3.02
Flash card erased
Set clock
VMTPOD
FW VMTPOD53 v3.00
VMT066 04Sep03 Therm813A
Jumper installed
Sanity check of values
Started 16Nov03 21:15:00 UTC

VM2-053
FW v3.02
Flash card erased
Set clock
VMTPOD
FW VMTPOD53 v3.00
VMT053 04Sep03 Therm505
Jumper installed
Sanity check of values
Started 16Nov03 23:49:00 UTC

VM2-068
FW v3.02
Flash card erased
Set clock
VMTPOD
FW VMTPOD53 v3.00
VMT068 04Sep03 Therm809A
Jumper installed
Sanity check of values
Started 16Nov03 23:40:00 UTC
Note: Felt small amount of grittiness felt in lower bearings

VM2-052
Note: Case says it is 057
FW v3.02
Flash card erased
Set clock
VMTPOD
FW VMTPOD53 v3.00
VMT057 04Sep03 Therm418
Jumper installed
Sanity check of values
Started 17Nov03 00:19:00 UTC

VM2-057
Note: Case says it is 073
FW v3.02
Flash card erased
Set clock
VMTPOD
FW VMTPOD53 v3.00
VMT073 04Sep03 Therm154
Jumper installed
Sanity check of values
Started 17Nov03 01:11:00 UTC

VM2-033
FW v3.02
Flash card erased
Set clock
VMTPOD
FW VMTPOD53 v3.00
VMT033 04Sep03 Therm444
Jumper installed
Sanity check of values
Started 17Nov03 23:07:15 UTC

VM2-030
FW v3.02
Flash card erased
Set clock
VMTPOD
FW VMTPOD53 v3.00
VMT030 04Sep03 Therm032
Jumper installed
Sanity check of values
Started 17Nov03 23:38:55 UTC

18Nov03

Installed arming plug in realease number 339

Bagged Stratus III solar radiometers 12:57:00 UTC
Unbagged at 15:07:00 UTC

Bagged HRH219 13:01:00 UTC
Unbagged at 15:09:00 UTC
Note: this is the HRH that was hit on the haul out of the water

Bagged HRH222 13:04:00 UTC
Unbagged at 15:11:00 UTC

Bagged HRH210 13:06:00 UTC
Unbagged at 15:12:00 UTC

Subsurface SBE37 cold salt spikes 13:58:30 to 13:59:30 UTC
s/n 1328 out at 15:13:45 utc
s/n 1329 out at 15:16:30 utc
s/n 1330 out at 15:17:00 utc
s/n 2012 out at 15:17:30 utc
s/n 1326 out at 15:17:54 utc

Buoy SBE37 SSTs in cold salt 15:30:33 UTC
Out of cold salt at 18:02:00 utc

Bridle seacat SBE16 s/n 1881
In cold salt at 15:37:00 utc
Out at 18:01:30 utc

Seacat s/n 1880 in cold salt at 15:44:30 utc
Out at 18:00:30 utc

Seacat s/n 2325 in cold salt at 15:47:00 utc
Out at 17:47:00 utc

Seacat s/n 1873 in cold salt at 15:49:30 utc
Out at 18:00:00 utc

Seacat s/n 1875 in cold salt at 15:53:00 utc
Out at 17:58:30 utc

SBE37 s/n 1328 190 meters
Time check
SBE37 18Nov03 17:12:38
UTC   18Nov03 17:11:20
Logging stopped at 17:12:15 utc
Dumped, no errors

SBE37 s/n 1326 40 meters
Time check
SBE37 18Nov03 17:38:46
UTC   18Nov03 17:38:00
Logging stopped at 17:39:00 utc
Dumped, 2+ transmission errors

Brancker and SBE39 cold salt temp spikes
In 18Nov03 utc Out 19Nov03 utc
Brancker s/n 3259 in 18:42:15 out 00:22:15
Brancker s/n 3762 in 18:42:45 out 00:22:30
Brancker s/n 3258 in 18:43:15 out 00:23:00
Brancker s/n 4485 in 18:43:45 out 00:22:00
Brancker s/n 4495 in 18:44:15 out 00:21:30
Brancker s/n 3831 in 18:44:45 out 00:21:00
Brancker s/n 4494 in 18:45:00 out 00:20:45
Brancker s/n 3836 in 18:45:30 out 00:21:15
Brancker s/n 3764 in 18:46:00 out 00:20:00
Brancker s/n 4228 in 18:46:30 out 00:20:00
Brancker s/n 3830 in 18:46:45 out 00:20:30
SBE39 s/n 0048 in 18:49:30 out 00:19:45
SBE39 s/n 0049 in 18:49:30 out 00:19:00
SBE39 s/n 0050 in 18:49:30 out 00:19:30

Buoy data logger systems
Opened hatch and heard outgas. Positive pressure in buoy well.

First (top) logger
LOG01 logr53
Logger L04
FW v2.50
Logger clock 18Nov03 19:32:37
UTC clock 18Nov03 19:32:00
Logger stopped at 18Nov03 19:32:40 utc
Battery voltages
P13 12.94 vdc
P14 14.41 vdc
P19 13.38 vdc
Records used 578939
Records avail 74373

Second (bottom) logger
LOG01 logr53
Logger L07
FW v2.50
Logger clock 18Nov03 20:13:45
UTC clock 18Nov03 19:35:45
Note: Big clock difference not a typo
Logger stopped at 18Nov03 19:37:15 utc
Battery voltages
P13 12.64 vdc
P14 14.19 vdc
P19 13.54 vdc
Records used 578969
Records avail 74343

Note: Indicating dessicant bottle fully pink

SBE39 s/n 0072 in cold salt 18Nov03 19:59:49 utc
Out of cold salt 18Nov03 20:40:00 utc
Note: This was the Stratus III floater and it will not talk

Cards removed from all loggers and Asimet instruments, then dumped
L01, L02, HRH222, HRH219, HRH216, WND219, WND217, BPR204, PRC206, PRC205

SBE39 s/n 0050
Time check
Instrument clock 19Nov03 01:46:37
UTC clock 19Nov03 01:47:45
Stopped logging at 19Nov03 01:48:30 utc

SBE39 s/n 0048
Time check
Instrument clock 19Nov03 10:54:47
UTC clock 19Nov03 10:55:45
Stopped logging at 19Nov03 10:56:15 utc

SBE37 s/n 1330
Time check
Instrument clock 19Nov03 11:05:45
UTC clock 19Nov03 11:05:00
Stopped logging at 19Nov03 11:05:30 utc

SBE37 s/n 1329
Time check
Instrument clock 19Nov03 11:19:47
UTC clock 19Nov03 11:18:45
Stopped (for some reason I didn't write this down)

SBE39 s/n 0049
Time check
Instrument clock 19Nov03 18:11:21
UTC clock 19Nov03 10:12:30
Stopped logging at 19Nov03 18:13:10 utc

Floating SST
SBE39 s/n 0072
Could not communicate
sent to Sea-Bird
No data in instrument

Anchor Drop Survey notes
Speed of Sound 1500 meters per second
5 meter transducer depth
4413 transponder depth

SBE37 s/n 2012
Time check
Instrument clock 20Nov03 00:12:59
UTC clock 20Nov03 00:12:00
Stopped logging at 20Nov03 00:12:30 utc

SBE37 s/n 1305
SST
Time check
Instrument clock 20Nov03 00:18:30
UTC clock 20Nov03 00:20:30
Stopped logging at 20Nov03 00:21:07 utc

SBE16 s/n 1875 7 meters
FW version 4.1b
Instrument clock 20Nov03 12:47:01
UTC clock 20Nov03 12:46:45
Stopped logging at 20Nov03 12:48:50 utc

SBE16 s/n 2325 16 meters
FW version 4.1a
Instrument clock 20Nov03 14:01:21
UTC clock 20Nov03 14:01:00
Stopped logging at 20Nov03 14:01:45 utc

WND217
Time check
Instrument clock 20Nov03 13:42:35
UTC clock 20Nov03 13:40:30

HRH222
Time check
Instrument clock 20Nov03 14:22:18
UTC clock 20Nov03 14:08:05

WND219
Time check
Instrument clock 20Nov03 14:42:00
UTC clock 20Nov03 14:25:25

BPR204
Time check
Instrument clock 20Nov03 14:53:15
UTC clock 20Nov03 14:42:40

SBE16 s/n 1873
Will not communicate
Send to SBE when received

SBE16 s/n 1881
Will not communicate
Send to SBE when received

SBE16 s/n 1880 30 meters
FW version 4.1b
Instrument clock 20Nov03 15:00:10
UTC clock 20Nov03 15:00:10
Stopped logging at 20Nov03 15:00:45 utc

PRC206
Time check
Instrument clock 20Nov03 16:10:25
UTC clock 20Nov03 16:01:40

PRC205
Time check
Instrument clock 20Nov03 16:15:08
UTC clock 20Nov03 16:11:08

HRH216
Time check
Instrument clock 20Nov03 16:31:13
UTC clock 20Nov03 16:18:30

HRH219
Time check
Instrument clock 20Nov03 16:35:28
UTC clock 20Nov03 16:21:10

Branckers
4485 Will not communicate

4494	Instrument clock	17:25:05
	UTC clock	17:30:24
4495	Instrument clock	17:42:19
	UTC clock	17:41:20
3764	Instrument clock	17:46:21
	UTC clock	17:51:28
3836	Instrument clock	18:07:50
	UTC clock	17:59:04
4228	Instrument clock	18:05:56
	UTC clock	18:06:20
3830	Instrument clock	18:18:04
	UTC clock	18:20:15
3762	Instrument clock	18:38:28
	UTC clock	18:29:50
3259	Instrument clock	18:43:49
	UTC clock	18:42:34
3831	Instrument clock	19:14:29
	UTC clock	19:04:28
3258	Instrument clock	19:08:09
	UTC clock	19:16:24

RDI cold salt water spike
In at 20Nov03 19:43:30 utc

VM-030 Rotor spins
21Nov03
Spinning from 16:53:00
to 16:54:00 utc
Spinning from 17:10:00
to 17:11:00 utc
Write at 17:22:23 21Nov03 utc
Unpowered at 17:24:00 21Nov03 utc

VM-009
21Nov03
Write at 18:04:30 21Nov03 utc
Spinning from 18:06:00
to 18:07:00 utc
Write at 18:12:00 21Nov03 utc
Spinning from 18:20:00
to 18:21:00 utc
Unpowered at 18:38:00 21Nov03 utc

VM001
New Gen unit with flash
Spinning from 19:09:00
to 19:10:00 utc
Instrument time 19:13:06 21Nov03
UTC clock 19:16:05 21Nov03
Stopped logging at 19:17:30 21nov03
Battery checks:
Bottom battery
pins 1 - 2 10.1 vdc
pins 3 - 4 14.3 vdc
Top battery (this battery leaked)
pins 1 - 2 10.1 vdc
pins 3 - 4 14.3 vdc

VM-011
Spinning from 20:22:00
to 20:23:00 utc
Write at 20:25:22 21Nov03 utc
Write at 20:32:52 21Nov03 utc
Spinning from 20:33:30
to 20:34:30 utc
Write at 20:40:22 21Nov03 utc
Powered down at 20:46:00 21Nov03 utc

VM-055
Spinning from 22:01:30
to 22:02:30 utc
Write at 22:07:30 21Nov03 utc
Write at 22:15:00 21Nov03 utc
Spinning from 22:17:30
to 22:18:30 utc
Powered down at 22:30:00 21Nov03 utc

FSI
Battery low - not logging
Cold water temp spike in at 14:09:00 22Nov03

Bowmast heights:
This was done in conjunction with Chris Fairall and was somewhat confusing.
Total height from water line to WHOI sonic was 14.2 meters
Total height from water line to ETL sonic was 18.6 meters
Total height from water line to ship sonic was 21.9 meters

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16. Abstract (Limit: 200 words)

The Ocean Reference Station at 20° S, 85° W under the stratus clouds west of northern Chile and Peru is being maintained to provide ongoing, climate-quality records of surface meteorology, of air-sea fluxes of heat, freshwater, and momentum, and of upper ocean temperature, salinity, and velocity variability. The Stratus Ocean Reference Station, hereafter ORS Stratus, is supported by the National Oceanic and Atmospheric Administrations (NOAA) Climate Observation Program. It is recovered and redeployed annually, with cruises that have come in October or November. During the November 2003 cruise of Scripps Institution of Oceanography's R/V Roger *Revelle* to the ORS Stratus site, the primary activities where the recovery of the WHOI surface mooring that had been deployed in October 2002, the deployment of a new WHOI surface mooring at that site, the in-situ calibration of the buoy meteorological sensors by comparison with instrumentation put on board by Chris Fairall of the NOAA Environmental Technology Laboratory (ETL), and observations of the stratus clouds and lower atmosphere by NOAA ETL and Jason Tomlinson from Texas A&M.

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