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Technical Report

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Woods Hole, MA 02543
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ABSTRACT

The Long Term Evolution and Coupling of the Boundary Layers Study (referred to as the Stratus Project) is an effort to obtain a reliable multi-year dataset of meteorological and subsurface measurements beneath the stratus cloud deck off the coast of Chile and Peru. This data will improve our understanding of the role of clouds in ocean-atmosphere coupling. This project is part of the Eastern Pacific Investigation of Climate (EPIC), a NOAA-funded Climate Variability (CLIVAR) study.

During the Stratus 2002 cruise, a surface mooring that had been deployed for one year off the coast of Chile was recovered, and a new surface mooring was deployed in the same location. The 2002 deployment starts the final year of a three-year occupation of the site by a Woods Hole Oceanographic Institution (WHOI) mooring as part of the Enhanced Monitoring element of EPIC. The occupation of the site will be continued under the NOAA Climate Observations Program, with the mooring serving as a Surface Reference Site.

The Stratus buoys were equipped with surface meteorological instrumentation, mainly two Improved METeorological (IMET) systems. The moorings also carried subsurface equipment attached to the mooring line, which measured conductivity, temperature, current direction and velocity, chlorophyll-a, and rainfall.

The moorings were recovered and deployed by the Upper Ocean Processes Group of WHOI from the Scripps Institution of Oceanography's R/V *Melville*. In collaboration with investigators from the Chilean Navy Hydrographic and Oceanographic Service (SHOA) and the University of Concepcion, Chile, conductivity, temperature, and depth (CTD) profiles were obtained at the mooring site and along 20°S while steaming east from the mooring site.

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ABBREVIATIONS

ADCP	Acoustic Doppler Current Meter
CLIVAR	Climate Variability
CTD	Conductivity Temperature Depth
EPIC	Eastern Pacific Investigation of Climate
IMET	Improved Meteorological Systems
NOAA	National Oceanic and Atmospheric Administration
SBE	Sea Bird Electronics
SCG	Shipboard Computer Group
SCR	Silicon Controlled Rectifiers
SHOA	Chilean Navy Hydrographic and Oceanographic Service
SIO	Scripps Institution of Oceanography
SST	Sea-Surface Temperature
UOP	Upper Ocean Processes Group
VMCM	Vector Measuring Current Meter
WHOI	Woods Hole Oceanographic Institution
XBT	Expendable Bathythermograph

I. PROJECT BACKGROUND AND PURPOSE

The purpose of this cruise was to recover and then deploy a new well-instrumented surface mooring under the stratocumulus clouds found off Chile and Peru in the vicinity of 20°S and 85°W. The mooring has been deployed for three years as a component of the Enhanced Monitoring element of the Eastern Pacific Investigation of Climate (EPIC) programs. The first deployment was in October 2000 (Stratus 1). The buoy was recovered and a new buoy (Stratus 2) deployed in October 2001. In October 2002, Stratus 2 was recovered and Stratus 3 deployed. Cruises for recovery and redeployment will follow each October.

The science objectives of the Stratus Project are to observe the surface meteorology and air-sea exchanges of heat, freshwater, and momentum, to observe the temporal evolution 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 how the clouds and air-sea interaction in this region are parameterized.

Work for Stratus 2002 was carried out aboard the R/V *Melville* of the Scripps Institution of Oceanography (SIO). The Stratus 2002 work constituted Leg 3 of the Vancouver cruise (Vanc03) for the *Melville*. Vanc03 began in Puntarenas, Costa Rica, and ended in Arica, Chile.

The first three deployments of the Stratus moorings are part of EPIC. EPIC is a Climate Variability (CLIVAR) study with the goal of investigating links between sea surface temperature variability in the eastern tropical Pacific and climate over the American continents. Important to that goal is an understanding of the role of clouds in the eastern Pacific in modulating atmosphere-ocean coupling. The Stratus moorings are to be maintained at that site as a long-term Surface Reference site, part of the Global Ocean Observing System. Stratus moorings have been maintained at this site by the Upper Ocean Processes (UOP) Group of Woods Hole Oceanographic Institution (WHOI).

The Stratus moorings carry two redundant sets of meteorological sensors and the mooring line also carries a set of oceanographic instruments (See Table 1). Acoustic rain gauges placed on the mooring were provided by Jeff Nyusten (University of Washington APL).

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)
Incoming shortwave radiation	Chlorophyll Absorption
Incoming longwave radiation	
Precipitation	

Data were also collected using the R/V *Melville's* equipment, including surface meteorology, sea surface temperature and salinity, upper ocean currents, and bottom topography.

II. STRATUS 2002 CRUISE

Two main tasks were completed during the Stratus 2002 Cruise aboard the R/V *Melville*:

1. Retrieval of Stratus 2 mooring
2. Deployment of Stratus 3 mooring

The cruise was designated Vancouver Leg 3, or Vanc03. The cruise began in Puntarenas, Costa Rica on October 13, 2002 and proceeded to the mooring site off the coast of Chile. The *Melville* then proceeded Arica, Chile where it docked on October 30, 2002. Figure 1 shows the cruise track of the Stratus 2002 cruise.

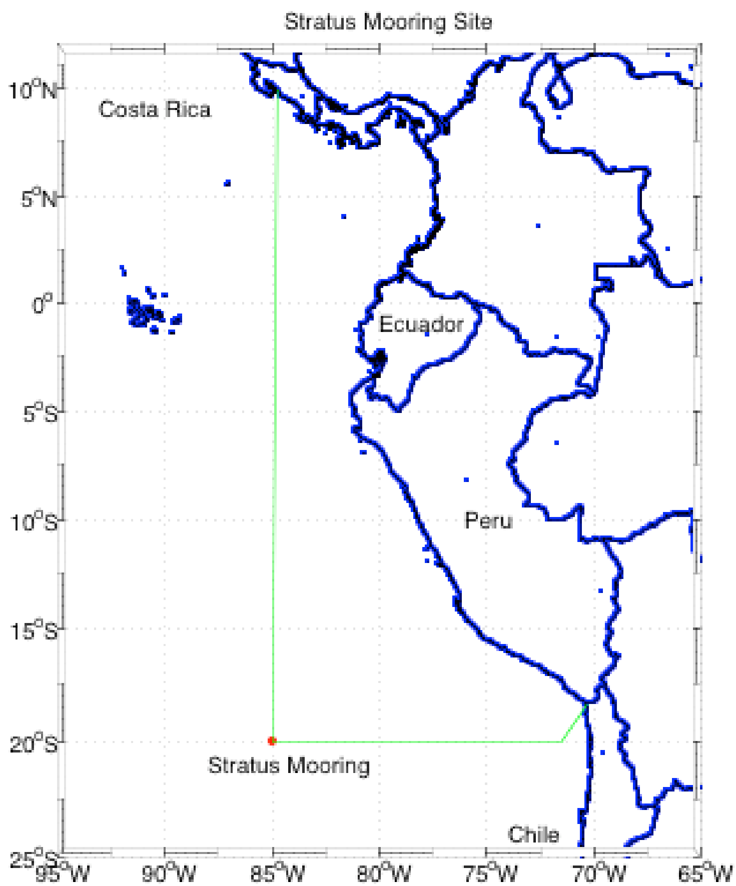


Figure 1. Track of R/V *Melville* during the Stratus 2002 Cruise (Vanc03).

Locations:

Puntarenas, Costa Rica: 9°58.13'N, 84°50.25'W
Mooring Anchor (buoy can be 4-5 km from anchor): 20°8.597'S, 85°4.351'W
Arica, Chile: 19°28'S, 70°20'W

Distances:

Puntarenas to Mooring: 1,789 nautical miles (nm)
Mooring to Arica: 835 nm

During the Stratus 2002 cruise, there was only one science party onboard the R/V *Melville*. The science group was given full use of scientific and rigging equipment onboard. Table 2 below lists the names of crew and science group members that participated in the Stratus 2002 cruise.

Table 2. Personnel aboard during Stratus 2002 cruise.

Crew	Title	Science Party	Organization
Chris Curl	Captain	Robert Weller, Chief Scientist	WHOI
John Manion	Chief Mate	Paul Bouchard	WHOI
Joe Ferris	Second Mate	Jeff Lord	WHOI
Alejo Alejo	Third Mate	Jim Ryder	WHOI
Paul Bueren	Chief Engineer	James Dunn	WHOI
Joel Rebelo	First A/E	Jason Smith	WHOI
Pat Fitzgerald	Second A/E	Nan Galbraith	WHOI
Em Juhasz	Third A/E	Lara Hutto	WHOI
Phil Brady	A/B	Alice Stuart-Menteth	Southampton Oceanography Center/WHOI
Allan Vacha	A/B	Jenny Maturana	Chilean Navy Hydrographic and Oceanographic Service
Dave Grimes	A/B	Oscar Pizzaro	University of Concepcion, Chile
Andrew Carter	Oiler	Jaime Letelier	University of Concepcion, Chile
Mike Hotchkiss	Oiler		
Joe Ramos	Oiler		
Bill Kamholz	Boatswain		
Paul Shute	Ordinary Seaman		
Bob Seely	Sr. Cook		
Ed Miller	Cook		
Jon Boing	Electrician		
Kelvin Wiley	Oiler		
Jason Kimbrell	Wiper		

Preparation for the Stratus 2002 cruise began in 2001. The buoy, meteorological sensors, anchors, mooring winch, and open-topped van holding glass balls were shipped to San Diego, California to take advantage of the opportunity to load the heaviest items on the R/V *Melville* before she left to begin the Vancouver Expedition. Space was made available at the SIO Marine Facility in Point Loma. The IMET systems were prepared, installed on the buoy, and tested. The tests in port included spinning the whole buoy, stopping every 90°, to calibrate the compasses of the IMET systems. Then the buoy, van, and heavy equipment were loaded on the ship. The R/V *Melville* sailed from San Diego on August 5, 2002 to begin the Vancouver Expedition.

Additional mooring equipment was shipped to Costa Rica and stored for loading immediately prior to the start of the cruise. Lab equipment, including computers, printers, card and tape readers, and other general office equipment were also shipped to Costa Rica.

The Upper Ocean Processes (UOP) Group joined the ship in Costa Rica. The *Melville* entered Puerto Caldera, Costa Rica on the morning of October 9, 2002. Permission from local authorities to unload and load equipment was granted in the early afternoon. UOP personnel helped unload equipment used in Vancouver Legs 1 and 2. Two forty-foot sea containers contained the UOP gear that needed to be loaded. Loading continued to 20:00 L (local time) on October 9, and began again at 06:30 L on October 10. At 10:00 L, with loading completed, R/V *Melville* left the pier at Puerto Caldera and moved to anchor off Puntarenas, Costa Rica (see Figure 2). UOP personnel commuted by water taxi and finished setting up in the lab and on deck on October 11 and 12. A sonic anemometer was installed on the jack staff of the ship, and antennas were mounted for GPS and Argos reception. On October 12, during a test of the ship's CTD, the CTD was lost overboard. UOP personnel moved on board on October 13 along with Oscar Pizarro and Jaime Letelier from the University of Concepcion, Chile, and Jenny Maturana from the Chilean Navy Hydrographic and Oceanographic Service. The CTD was recovered by divers and the R/V *Melville* departed Puntarenas, Costa Rica at about 16:00 L on October 13, 2002.

Figure 2. R/V *Melville* anchored offshore of Puntarenas, Costa Rica.

From Puntarenas, Costa Rica, the ship steamed south along 85°W. Underway data acquisition, including momentum flux data acquired with the WHOI sonic anemometer and the ship's instrumentation, began as we entered international waters. A safety briefing was held on October 13, and a Fire and Boat drill was held on October 14. On October 14 Bob Weller and Jeff Lord met with the Captain, the mates, and Ron Comer (SIO Resident Technician) to review mooring recovery and deployment procedures. Jeff Lord held several classes on deck to acquaint the science group with deck hardware during the transit south. Work in the lab focused on preparing instrumentation to be deployed on the new mooring and on getting ready to download data from recovered instrumentation. Computers were also set up for the 24-hour comparisons of the ship and buoy meteorological sensors to be carried out next to the Stratus 2 buoy before recovery and next to the Stratus 3 buoy after deployment. Concerns arose about the quality of the following *Melville* data sets: sea surface salinity (~0.7 psu too low), incoming shortwave (not installed, tried to install a spare WHOI shortwave radiation (SWR) module, failed to get communication, and mounted it on the ship's bow mast as an internally recording stand-alone module), ship's winds (relative wind direction unchanging, true wind direction changing as ship maneuvers).

On October 16, we stopped to lower and test the acoustic releases to be used on the mooring. They were lowered to 100, 500, 1000, and 1500 m depths. Paul Bouchard (WHOI) communicated with the releases at each depth. After the release test, a trial CTD was made to 1000 m depth to verify operation of the CTD, which worked well. R/V *Melville* continued on its steam south along 85°W toward 20°S. Equator crossing ceremonies were held on October 17. On the steam south, it was found that the new TSE mooring winch, which had been tested in port, would not run. This new winch differs from the older WHOI TSE winches by having a circuit installed that senses the phase of the 3-phase, 480 volt input lines and cuts the winch if it detects change in phase. At sea, noise from the ships Silicon Control Rectifiers (SCRs) is apparently sufficient to activate this circuit. After discussion with the Rigging Shop at WHOI, Jeff Lord asked the ship's chief engineer to bypass this circuit.

The transit south continued on October 18 through 20, with *Melville* arriving at the mooring site at 22:20 L on October 20. A radar target was acquired at approximately 6 nm range, and the light on the buoy was spotted at 4 nm range. The buoy was found approximately 1.5 nm downwind of the anchor position. It was approached and examined using the searchlight. While steaming toward the buoy, e-mail from WHOI indicated the possibility that meteorological data was no longer being transmitted. However, receivers on the *Melville* confirmed that one IMET system on the buoy was continuing to transmit. After this inspection, the ship moved away from the mooring about 10 nm and did two CTD casts. In the early morning of October 21 the ship was positioned roughly 1/4 mile downwind of the buoy, bow into the wind and a 24-hour comparison of the buoy meteorological sensors with shipboard sensors was begun. At 07:00 L, a 12 hour period of hand held meteorological and SST observations began, with observations made at the bow and on deck next to the Stratus 3 buoy.

The ship and buoy comparison ended at 07:00 L on October 22. The mooring recovery began at 08:00 L. Initially the ship was positioned ~100 m east of the anchor site, with the surface buoy located to the northwest of the anchor site. Upon release, as the balls began to rise the ship was moved another 100 m east and the small boat was launched. The balls rose to the surface after 45 minutes, and the small boat went over to fasten a recovery line to the glass balls. The line was passed to the fantail of the ship, and the glass balls were brought on board. Four glass balls shattered at depth, as indicated by the condition of their hardhats. After the balls were recovered, the small boat was retrieved and recovery of the mooring continued. The mooring was recovered up to the 40 m deep instrument. At that point the mooring was released, allowing the top 40 m of instrumentation to provide stability for the buoy hull. The small boat was used to attach a lifting line to the buoy. The buoy was brought on board over the port side and secured on deck. Then the remaining instrumentation was recovered using the ship's crane.

After recovery, the instrumentation was photographed. Then final timing marks (cold spikes, rotor spins, etc) were applied to the time series being recorded. After these two steps, cleaning of the biofouling began (see Figure 3). The biofouling was dominated by gooseneck barnacles. These were quite thick on the buoy hull and down to approximately 30 m; some goosenecks were found even at 135 m on the RDI Acoustic Doppler Current Profiler (ADCP). The floating SST on the buoy hull was stuck in the down position by the gooseneck barnacles. The buoy hull and meteorological instrumentation were in good condition, not showing as heavy a crust of salt spray as seen after year 1. There was rain in the vicinity during the recovery, with waterspouts spotted by Ron Comer. Most of the recovery day was clear and sunny. Details of the mooring recovery and specific notes about the instrumentation are provided in the Mooring Log (Appendix D).

Figure 3. Bio-fouling on buoy and bridle.

On October 23, cleaning of the recovered instrumentation continued. The fantail was set up in the morning for the deployment of the Stratus 3 buoy from the starboard side. This required removing bulwarks, replacing bulwarks on the port side, repositioning the buoy hull and other steps. This work was done while the ship was hove-to near the anchor site of the Stratus 2 mooring. In the afternoon, a survey of the bottom was made using the ship's SeaBeam, running along a trial course for the deployment, steaming 130°, into the wind. The presence of a large (several miles long by 1/2 mile wide) flat area within +/- 50 m of the desired 4440 m depth was confirmed. With this done, the ship was allowed to steam 10 nm to the west to dump trash and then returning before first light to the initial point.

The initial point (20°03.9'S, 85°14.9'W) was chosen to be 10 nm away from the target for anchor deployment (20°10.4'S, 85°06.8'W) along the course reciprocal to 130°. At the initial point the first 40 m of instrumentation was deployed starting around 08:00 L on October 24, 2002. Then the buoy was deployed, and the ship went ahead to bring the buoy aft. The rest of the mooring was payed out over the day as the ship proceeded along the planned track at speeds through the water of between 0.5 and 1.5 knots, adjusted to keep the tension in the mooring line appropriate. At the same time line payout rate was monitored on deck so that line was never deployed at a rate faster than the ship's progress through the water. All gear was in the water, with the mooring made into the anchor on the flip plate on the fantail by roughly 19:00 L. At that time the ship was approximately 300 m away from the target site. To allow for some fallback the ship was taken 400 m past the target site before dropping the anchor. The anchor went over at 19:16 L. The Mooring Log provides detailed information about timing and the deployment (Appendix D).

Following the anchor drop the ship positioned itself about 1/2 mile away from the anchor site to allow the mooring to settle out. Then an acoustic survey of the anchor position was carried out. This was done by steaming to three points, each about 2 nm away from the anchor site. At each site, the water depth was obtained by SeaBeam and a slant range to the anchor was obtained using the deck release hydrophone and gear. The three ranges were converted to horizontal ranges and the intersection of the three range circles gave a good estimate of the anchor position (20°10.48'S 85°06.73'W). This indicated a fallback (distance between anchor drop and anchor on bottom) of 212 m or 4.8% of the water depth. The acoustic survey was completed at roughly 23:00 L.

Following the acoustic anchor survey, the ship was positioned 1/4 mile downwind, bow into the wind for the ship-buoy comparison (with the Stratus 2 buoy on deck and recording). The comparison ran through October 25. Hand held observations were done for 11 hours starting at 08:00 L on October 25.

At 23:00 L on October 25, 2002 the *Melville* left the mooring and began to steam eastward to occupy a series of CTD stations along 20°S (roughly every 40' of longitude) until reaching 20°S, 70°40'W where the ship turned toward Arica. The first CTD cast was done 10 nm east of the mooring site. Oscar Pizarro, from the University of Concepcion, organized and supervised the CTD section and has provided more details in Section IV of this report. The CTD section continued until the morning of October 30, when the ship arrived off Arica, Chile. Data collection stopped outside of the three nautical mile range specified in the clearance obtained from Chile. The pilot was picked up and the ship docked in Arica at 08:00 L on October 30. WHOI gear, with the exception of the buoy hull and the spare mooring anchor, was unloaded and packed into two 40′containers waiting at the pier along with the open-topped 20′container that was on board. Because a flat-rack was not available in Arica, the hull and anchor stayed on board until Valparaiso, Chile.

III. STRATUS BUOYS

A. Overview

The three meter discus buoys used in the Stratus project were 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 PACS deployment.

The instrument systems recovered on the Stratus 2 mooring and deployed on the Stratus 3 mooring are described in detail below.

B. Surface Instruments

a. Improved Meteorological (IMET) Systems (Stratus 2 and 3)

There are two independent IMET systems on the Stratus buoys (as shown in Figure 4). 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.

Figure 4. Surface instrumentation on the Stratus 3 mooring.

The IMET data logger for Stratus 2 was based on an Onset Computer Corp. Model 7 Tattletale computer with hard drive, that was configured and programmed with power conservation in mind. An associated interface board ties the Model 7 via individual power and RS-485 communication lines to each of the nine IMET modules, including the PTT module.

For Stratus 3 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 uarts; 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 comms 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 & North Velocity, Wind Speed Average, Max, and Min, Last Wind Vane Direction, Last Compass Direction
BPR Barometric Pressure
HRH Relative Humidity and Air Temperature
SWR Short Wave Radiation
LWR Dome Temperature, Body Temperature, Thermopile Voltage, Long Wave Radiation
PRC Precipitation Level
SST SeaCat Sea Surface Temperature, SeaCat 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.

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

c. Stand-alone Wind Module (Stratus 2)
Wind speed and direction are measured with a modified R.M. Young model 05103 wind monitor. It uses a propeller to measure wind speed. The standard vane potentiometer is removed and the vane shaft extended down and coupled with an absolute angle encoder for a full 360 degrees of measurement. A magnetometer compass is used to provide the north reference for use on buoys. Data is recorded every two minutes and is stored on an eight mega-byte FLASH card.

d. 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 megabyte 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.

a. Floating SST Sensor (Stratus 2 and 3)

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, light weight, durable and reliable temperature logger that was set to record the sea surface temperature every 5 minutes.

b. Sub-surface Argos Transmitter (Stratus 2 and 3)

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.

c. SeaCat Conductivity and Temperature Recorders (Stratus 2 and 3)

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 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.

d. MicroCat Conductivity and Temperature Recorder (Stratus 2 and 3)

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.

e. Brancker Temperature Recorders (TPOD, Stratus 2 and 3)

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.

Figure 5. TPODs being prepared for deployment.

f. SBE-39 Temperature Recorder (Stratus 2 and 3)

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.

g. Vector Measuring Current Meters (Stratus 2 and 3)

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 was deployed at the 350m depth on the Stratus 1 and 2 discus buoys. 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 therefore the sampling rate was set to once per minute.

h. 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.

i. 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.

j. RDI Acoustic Doppler Current Profiler (Stratus 2 and 3)

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 horizontal current velocities. The data sampling rates and parameters are user-definable, and were set as follows: 12 velocity bins of 10 m each, starting 11.98 m from the transducers and ending at 131.98 m; 30 pings per ensemble with one ping per second; and a one hour interval between the start of ensembles. These settings should provide an approximately 400-day deployment lifetime on the internal battery. These particular settings are only available using the Windows version of the RDI deployment software (the DOS version limits you to 8 m bins). The time between pings must be set manually in the text-based deployment file before it is sent to the instrument.

k. 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.

l. Acoustic Rain Gauge (Stratus 2 and 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.

m. Acoustic Release (Stratus 2 and 3)

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 2 Recovery

The Stratus 2 mooring was deployed in October of 2001, and recovered approximately one year later. Table 3 below gives the details of deployment and recovery operations.

Table 3. Stratus 2 Mooring Information.

Stratus 2		
Deployment	Date	October 19, 2001
	Time	19:46:00 **UTC**
	Position at Anchor Drop	20° 08’45.1” S, 85° 08’18.0”W
	Deployed by	Ostrom, Bouchard, Lord, Weller
	Recorder	Charlotte Vallee
	Ship	R/V *Brown*
	Cruise No.	RB-01-08
	Depth	4454
	Anchor Position	20°8.597’S, 85°8.4351’W
Recovery	Date	October 22, 2002
	Time	12:59:43 **UTC**
	Position	20° 08.594’S, 85° 08.350’W
	Recovered by	Lord, Dunn, Ryder, Bouchard, Smith, Weller
	Recorder	Lara Hutto
	Ship	R/V *Melville*
	Cruise No.	Vanc03

a. Mooring Description

The Stratus 2 mooring was instrumented with meteorological instrumentation on the buoy, and subsurface oceanographic equipment on the mooring line. Tables 4 and 5 below detail the instrumentation. Figure 6 is a schematic representation of the Stratus 2 mooring.

Table 4. Stratus 2 Surface Instrumentation

Instrument	**ID Number**	**Height[5] (cm)**
System #1		
Data Logger	STR2-01	
Relative Humidity	HRH 223	250
Wind Module	WND 207	297
Barometric Pressure	BPR 106	238.5
Shortwave Radiation	SWR 102	315
Longwave Radiation	LWR 104	315
Precipitation	PRC 004	273.5
Argos Transmitter	PTT 09805 PTT 09807 PTT 09811	
System #2		
Data Logger	STR 2-02	
Relative Humidity	HRH 217	273
Wind Module	WND 212	297
Barometric Pressure	BPR 110	239.5
Shortwave Radiation	SWR 002	315
Longwave Radiation	LWR 103	315
Precipitation	PRC 109	273.5
Argos Transmitter	PTT 09819 PTT 09833 PTT 25078	
Stand Alone		
Wind Module	WND 213	257
Relative Humidity	HRH 218	273.5

[5] Heights given are measured from the buoy deck, which was 0.4 meters above the mean waterline.

Table 5. Stratus 2 Subsurface Instrumentation

Depth (m)	Instrument	Serial Number	Measurement
0	SBE 39	0477	Temperature
0.6	MicroCat (SBE 37)	1834	Conductivity and Temperature (Logged internally and through IMET System #1)
0.6	MicroCat (SBE 37)	1837	Conductivity and Temperature (Logged internally and through IMET System #2)
0.7	SeaCat (SBE 16)	1882	Conductivity and Temperature
1.1	Argos Transmitter	PTT 24576	Satellite transmission in case mooring is overturned.
3.71	SeaCat (SBE 16)	994	Conductivity and temperature
7	SeaCat (SBE 16)	2324	Conductivity and temperature
10	VMCM	031	Currents
13	TPOD	3305	Temperature
16	SeaCat (SBE 16)	2322	Conductivity and temperature
20	VMCM	023	Currents
25	TPOD	3761	Temperature
30	SeaCat (SBE 16)	2323	Conductivity and temperature
32.5	VMCM	027	Currents
35	TPOD	4489	Temperature
37.5	Acoustic Rain Gauge	Ibis	Precipitation
40	SeaCat (SBE 16)	0144	Conductivity and temperature
47.5	TPOD	3283	Temperature
55	TPOD	3833	Temperature
62.5	SeaCat (SBE 16)	0927	Conductivity and temperature
70	TPOD	4488	Temperature
77.5	TPOD	3667	Temperature
85	SeaCat (SBE 16)	0928	Conductivity and temperature
92.5	TPOD	4481	Temperature
100	TPOD	3309	Temperature
115	TPOD	3701	Temperature
130	SeaCat (SBE 16)	0993	Conductivity and temperature
135	ADCP	1220	Currents
145	TPOD	3704	Temperature
160	TPOD	4483	Temperature
190	SeaCat (SBE 16)	0146	Conductivity and temperature
220	TPOD	4493	Temperature
235	VMCM	Test cage	N/A
250	TPOD	3703	Temperature
349	SBE 39	0282	Temperature
350	VMCM	001	Currents
450	SBE 39	0276	Temperature

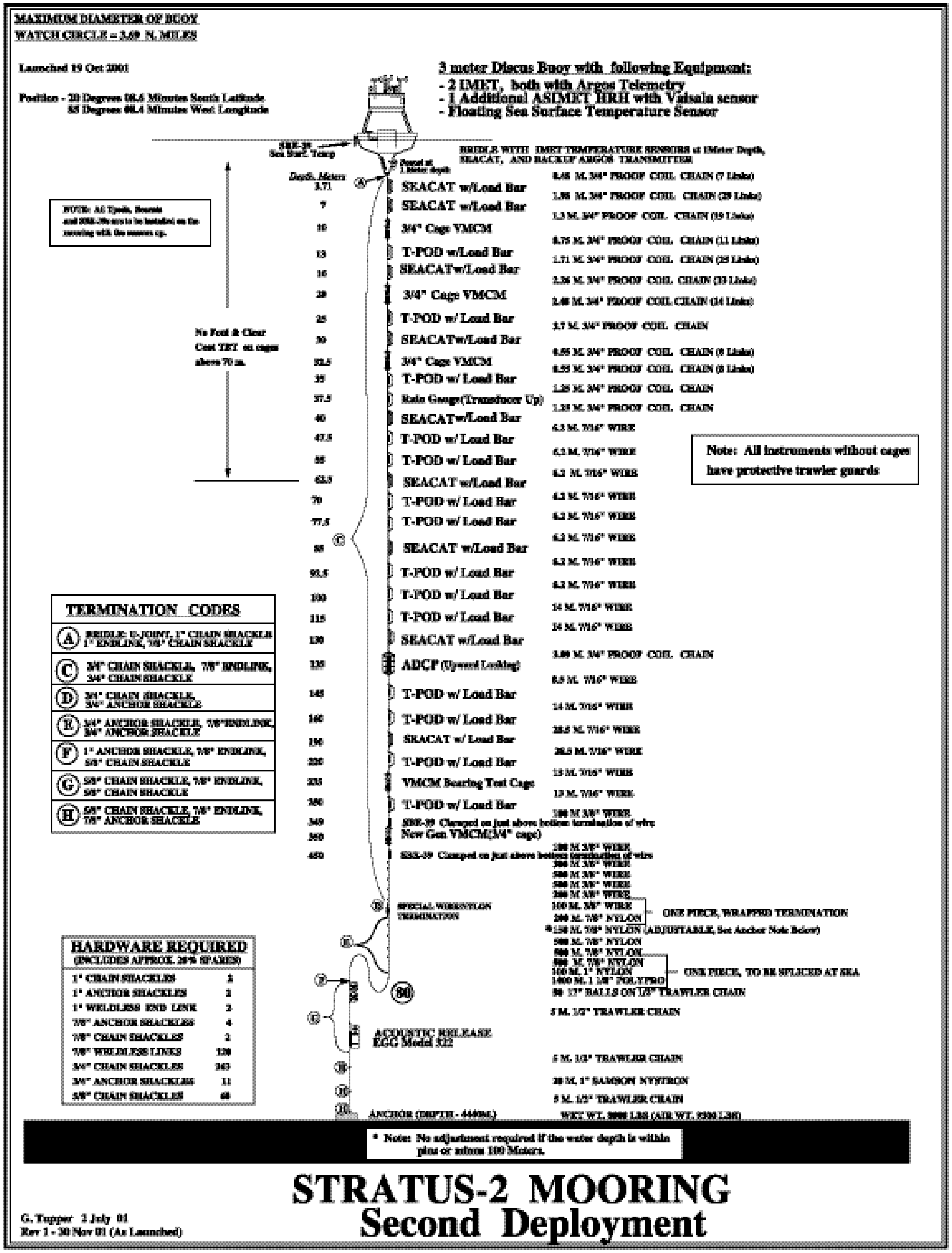


Figure 6. Stratus 2 Mooring Diagram.

b. Recovery Process

The R/V *Melville* was positioned roughly 100 meters upwind from the anchor position. The release was fired and it took approximately 40 minutes for the glass balls to come to the surface. Once the glass balls were on the surface, the small boat was deployed with 2 crewmembers and one mooring tech. The small boat hooked into the 1/2" trawler chain and towed the glass balls to the stern of the *Melville***.** A heaving line was thrown to the small boat which was attached to the winch leader. The winch leader was fair leaded through the ships block on the A-frame. The winch leader was shackled into an 8 foot "lift-all" sling and the small boat maneuvered away from the ship. The TSE winch hauled in the winch leader and glass balls over the stern. Two tuggers and a capstan were used in recovering the glass balls. The release was stopped off to the A-frame. Once all the glass balls were on deck, the winch leader was used to recover the release.

Figure 7. Retrieval of glass balls.

Two stopper lines were hooked into the bottom of the 1400 meters of the 1-1/8" polypropylene. The winch leader was then shackled to the polypropylene. The stopper lines were eased off and then cleared. The glass balls were disconnected and brought forward to the rag top container to be loaded. Once the fantail was cleared, hauling began. A Yale grip was placed on the polypropylene with roughly 15 meters of polypropylene to the 100 meters of 1" nylon splice. A stopper was hooked to the Yale grip and made fast to a deck cleat. The polypropylene was cut free from the winch, and a bowline was made at the cut end. The stopper line was hooked to the bowline and made fast to the other deck cleat. The polypropylene was then spooled off using a winding cart and 7 empty wooden spools.

The TSE winch leader was shackled to the bowline from the polypropylene and took up the remainder of the slack. Once the winch had the load, the stopper lines were eased off and then cleared. The Yale grip was removed and hauling began with remainder of the polypropylene, 100 meters of 1" nylon, and three 500 meter shots of 7/8" nylon. Hauling stopped at the end of the third 500 meter shot of nylon. Stopper lines were hooked to the 150 meter shot of 7/8” nylon and made fast to the deck cleats. The line on the winch was off loaded into a wire basket forward of the winch.

The TSE winch leader was shackled to the 150 meter shot of 7/8” nylon and took up the remainder of the slack. Once the winch had the load, the stopper lines were eased off and then cleared. Hauling began with the 150 meter shot of 7/8” nylon and the special wire/nylon termination, which consisted of 200 meters of 7/8” nylon and 100 meters of 3/8” jacketed wire rope. The winch continued to haul in the 200 meter shot of 3/8” wire rope, 2 each of the 500 meter shots of 3/8” wire rope, and 1 each shot of 300 meter 3/8” wire rope. Stopper lines were hooked to the 300 meter to 100 meter shot of wire rope and made fast to the deck cleats. The Gifford block was hung, using the big air tugger fair-leaded to the TSE winch and through the trawl block that was shackled to the A-frame. The 300 meter shot was disconnected from the 100 meter shot. The 300 meter shot was reeved through the Gifford block and re-connected to the 100 meter shot. The winch took up the slack and the stopper lines were eased off and cleared. 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 first instrument was the SBE-39, which was clamped on the wire rope. The A-frame was boomed in, and the SBE-39 was removed. The A-frame was boomed out over the stern of the ship and hauling continued until the next instrument. The procedure for recovering the instruments went as followed. The A-frame was boomed in and TSE winch operator payed out the wire. The air tugger operator lowered the Gifford block. Once the instrument was on deck a stopper line was hooked to the 7/8” end link at the top of the instrument. The instrument was disconnected from the hardware and moved to a staging area for pictures. The wire rope then was shackled back to the load. The A-frame boomed out, the Gifford block was raised, and TSE winch continued to haul in until the next instrument.

The above procedure was continued throughout the recovery operation until the TPOD at 47.5 meters was recovered. All the shots of wire between the instruments were taken off the winch as they were recovered, as the 100 meter shot was used as the hauling leader. A stopper line was hooked to the top of the last 6.2 meter shot of wire and disconnected the TPOD at 47.5 meters. A shackle and link was attached to the 7/8” link at the bottom of the 6.2 meter shot of wire. A slip line was secured to a cleat on one side of the A-frame and passed through the link and made fast to the cleat on the other side of the A-frame. The stopper line was eased off and then cleared. The slip line was eased out so the discus buoy and the remaining 40 meters of instruments went adrift. The ship went ahead slow to move away from the buoy.

The deck was rearranged for recovering the discus buoy and the last 40 meters of instruments. The three tuggers, the capstan, and the ship’s knuckle crane were used in this part of the operation. This all took place on the port side, just aft of the hanger. Two tuggers were placed on the port side, one just aft of the port hanger, next to the “tool room” and one just forward of the port lazarette. The big tugger was placed aft of the ship’s “Alaska Crane”. Prior to departure, the two forward sections of bulwarks were removed for recovery of the discus buoy.

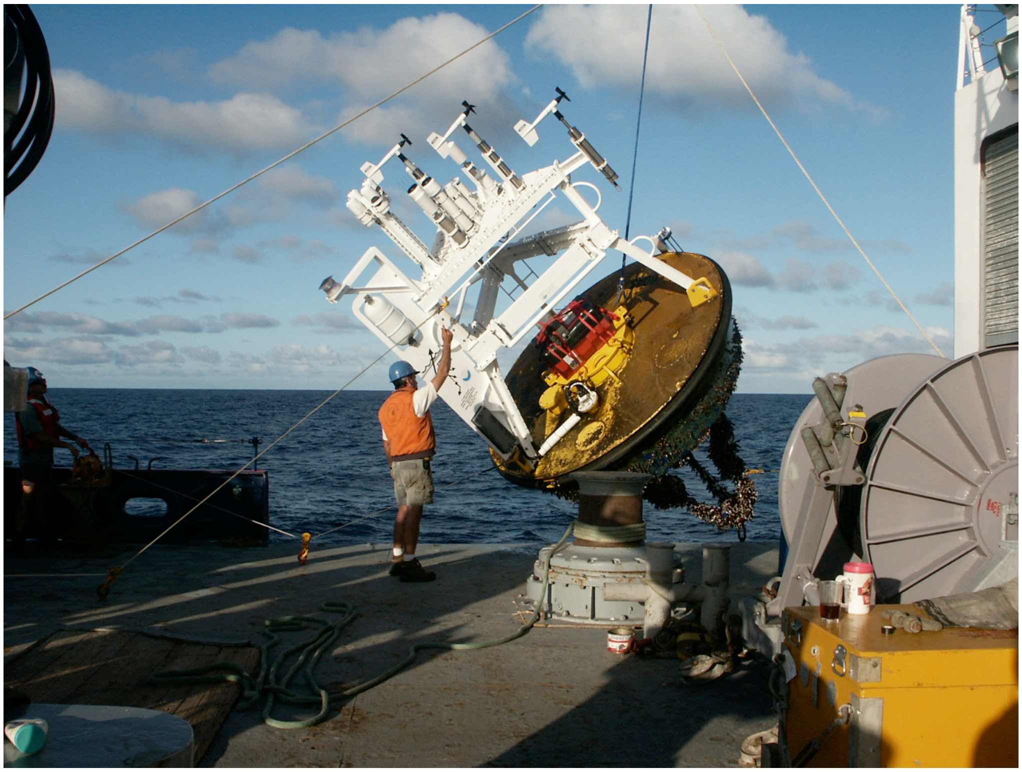


Figure 8. Retrieval of the Stratus 2 buoy.

The small boat was deployed with 2 crewmembers and one mooring tech. The small boat approached the buoy and hooked into the bail, opposite of the vane. The blue amstel pickup line was used. A red tag line was bent into the soft eye of the pendant. The small boat towed the buoy to port side of the ship. A heaving line was thrown to the small boat and tied to the red tag line. The line was hauled back to the ship with the ship's crane standing by. The pickup pendant was hooked to 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 lines from the tuggers were attached to the buoy. The buoy was hoisted up and then swung inboard while the tuggers kept tension on the buoy.

Once the buoy was set on deck, wooden wedges were placed under the buoy and aircraft straps were used to secure the buoy. The capstan was used with a 1" stopper line which was used to stop off on the 0.48 meters of 3/4" proof coil chain. The tugger aft of the hanger now had a 3/4" chain hook shackled to the thimble. It was also used to stop off on the 3/4" chain. The shackle was disconnected from the universal plate located at the bottom of the bridle legs.

A stopper line with a 3/4" chain hook was used, the deck cleat was bolted down outboard of forward tugger. The capstan eased off the line and then cleared. A 6 foot "lift-all" sling was placed through the 7/8" end link and to the crane's block. The crane took the load from the stopper line, and tugger lines were cleared. The crane hoisted the two SeaCat instruments then stopped while the tugger and stopper line were hooked into a bite of chain and made fast. The crane then lowered the instruments and chain to the deck. Then the crane was repositioned over the load and hooked into the chain using a 6 foot lift-all sling and a 3/4" chain hook. The crane took the load and the tugger and the stopper line were eased off and cleared. The crane lifted the next section of instruments and chain. The tugger and stopper line were made fast, and the crane lowered the load to the deck. This procedure was used until all instruments were on the deck. The height of the lifts depended on the length of chain between instruments. The highest pick was roughly 20 feet off the deck.

c. Time Spikes

Timing spikes were applied to some of the instruments recovered from Stratus 2. These spikes were performed so that responses in the data file could be checked against a known time. Black bags were placed on the long and shortwave radiation sensors to block as much light as possible. Instruments measuring temperature were placed in ice baths or in a large refrigerator. The VMCM rotors were spun and then blocked. Table 6 gives the details of the timing spikes for pre-deployment of Stratus 2 and Table 7 post-recovery.

Table 6. Stratus 2 Pre-Deployment Timing Marks.

Instrument	Serial #	Pre-Spike On		Pre-Spike Off	
□	□	Date	Time	Date	Time
MicroCat (SBE37)	1834	11-Oct-01	0:12:00	11-Oct-01	1:12:00
MicroCat (SBE37)	1837	11-Oct-01	0:12:00	11-Oct-01	1:12:00
SeaCat (SBE16)	1882	10-Oct-01	18:38:00	10-Oct-01	19:36:00
SBE 39	0477	16-Oct-01	13:03:00	16-Oct-01	14:04:00
SeaCat (SBE16)	0994	18-Oct-01	17:49:00	18-Oct-01	19:01:00
SeaCat (SBE16)	2324	18-Oct-01	17:49:00	18-Oct-01	19:01:00
□	□	Clock Reset	1st Spin	2nd Spin	Bands Off
VMCM	031	8-Oct-01, 22:30:00	10-Oct-01, 11:35:00	10-Oct-01, 23:39:00	19-Oct-01, 13:01:30
TPOD	3305	18-Oct-01	17:35:00	18-Oct-01	18:52:00
SeaCat (SBE16)	2322	18-Oct-01	17:49:00	18-Oct-01	19:01:00
		Clock Reset	1st Spin	2nd Spin	Bands Off
VMCM	023	8-oct-01, 22:45:00	10-oct-01, 11:34:00	10-oct-01, 23:38:00	19-oct-01, 12:56:30
TPOD	3761	18-Oct-01	17:35:00	18-Oct-01	18:52:00
SeaCat (SBE16)	2323	18-Oct-01	17:49:00	18-Oct-01	19:01:00
		Clock Reset	1st Spin	2nd Spin	Bands Off
VMCM	027	8-oct-01, 22:15:00	10-Oct-01, 11:36:00	10-oct-01, 23:40:00	19-Oct-01, 12:50:20
TPOD	4489	18-Oct-01	17:35:00	18-Oct-01	18:52:00
SeaCat (SBE16)	0144	18-Oct-01	17:49:00	18-Oct-01	19:01:00
TPOD	3283	18-Oct-01	17:35:00	18-Oct-01	18:52:00
TPOD	3833	18-Oct-01	17:35:00	18-Oct-01	18:52:00
SeaCat (SBE16)	0927	18-Oct-01	17:49:00	18-Oct-01	19:01:00
TPOD	4488	18-Oct-01	17:35:00	18-Oct-01	18:52:00
TPOD	3667	18-Oct-01	17:35:00	18-Oct-01	18:52:00
SeaCat (SBE16)	0928	18-Oct-01	17:49:00	18-Oct-01	19:01:00
TPOD	4481	18-Oct-01	17:35:00	18-Oct-01	18:52:00
TPOD	3309	18-Oct-01	17:35:00	18-Oct-01	18:52:00
TPOD	3701	18-Oct-01	17:35:00	18-Oct-01	18:52:00
SeaCat (SBE16)	0993	18-Oct-01	17:49:00	18-Oct-01	19:01:00
ADCP	1220	N/A	N/A	N/A	N/A
TPOD	3704	18-Oct-01	17:35:00	18-Oct-01	18:52:00
TPOD	4483	18-Oct-01	17:35:00	18-Oct-01	18:52:00
SeaCat (SBE16)	0146	18-Oct-01	17:49:00	18-Oct-01	19:01:00
TPOD	4493	18-Oct-01	17:35:00	18-Oct-01	18:52:00
TPOD	3703	18-Oct-01	17:35:00	18-Oct-01	18:52:00
SBE39	0282	16-Oct-01	13:03:00	16-Oct-01	14:04:00
		Clock Reset	1st Spin	2nd Spin	Bands Off
VMCM	001-203	8-oct-01, 19:00:00	10-oct-01, 11:37:30	10-oct-01, 23:41:30	19-oct-01, 14:35:40
SBE39	0276	16-Oct-01	13:03:00	16-Oct-01	14:04:00

Table 7. Stratus 2 Post-Recovery Timing Marks

Instrument	Serial #	Post-Spike On		Post-Spike Off	
□	□	Date	Time	Date	Time
Shortwave	102	23-Oct-02	13:15:00	23-Oct-02	14:19:02
Longwave	104	23-Oct-02	13:15:00	23-Oct-02	14:19:02
Shortwave	002	23-Oct-02	13:15:00	23-Oct-02	14:19:02
Longwave	103	23-Oct-02	13:15:00	23-Oct-02	14:19:02
MicroCat (SBE37)	1834	23-Oct-02	13:20:30	23-Oct-02	14:22:00
MicroCat (SBE37)	1837	23-Oct-02	13:20:30	23-Oct-02	14:22:00
SeaCat (SBE16)	1882	23-Oct-02	13:01:00	23-Oct-02	14:06:00
SBE 39	0477	23-Oct-02	13:42:00	23-Oct-02	15:09:00
SeaCat (SBE16)	0994	23-Oct-02	13:01:00	23-Oct-02	14:06:00
SeaCat (SBE16)	2324	23-Oct-02	13:01:00	23-Oct-02	14:06:00
□	□	Bands On	1st Spin	2nd Spin	Bands On
VMCM	031	22-Oct-02, 23:11:26	23-oct-02, 14:28:00	23-oct-02, 19:41:00	23-oct-02, 19:41:15
TPOD	3305	23-Oct-02	11:33:00	23-Oct-02	12:55:00
SeaCat (SBE16)	2322	23-Oct-02	13:01:00	23-Oct-02	14:06:00
		Bands On	1st Spin	2nd Spin	Bands On
VMCM	023	22-Oct-02, 23:18:03	23-Oct-02, 14:31:00	23-Oct-02, 19:39:00	23-Oct-02, 19:39:15
TPOD	3761	23-Oct-02	11:33:00	23-Oct-02	12:55:00
SeaCat (SBE16)	2323	23-Oct-02	13:01:00	23-Oct-02	14:06:00
		Bands On	1st Spin	2nd Spin	Bands On
VMCM	027	22-oct-02, 23:27:25	23-oct-02, 14:26:00	23-oct-02, 19:40:00	23-oct-02, 19:40:15
TPOD	4489	23-Oct-02	11:33:00	23-Oct-02	12:55:00
SeaCat (SBE16)	0144	23-Oct-02	13:01:00	23-Oct-02	14:06:00
TPOD	3283	23-Oct-02	11:33:00	23-Oct-02	12:55:00
TPOD	3833	23-Oct-02	11:33:00	23-Oct-02	12:55:00
SeaCat (SBE16)	0927	23-Oct-02	13:01:00	23-Oct-02	14:06:00
TPOD	4488	23-Oct-02	11:33:00	23-Oct-02	12:55:00
TPOD	3667	23-Oct-02	11:33:00	23-Oct-02	12:55:00
SeaCat (SBE16)	0928	23-Oct-02	13:01:00	23-Oct-02	14:06:00
TPOD	4481	23-Oct-02	11:33:00	23-Oct-02	12:55:00
TPOD	3309	23-Oct-02	11:33:00	23-Oct-02	12:55:00
TPOD	3701	23-Oct-02	11:33:00	23-Oct-02	12:55:00
SeaCat (SBE16)	0993	23-Oct-02	13:01:00	23-Oct-02	14:06:00
ADCP	1220	23-Oct-02	12:02:00	23-Oct-02	13:08:00
TPOD	3704	23-Oct-02	11:33:00	23-Oct-02	12:55:00
TPOD	4483	23-Oct-02	11:33:00	23-Oct-02	12:55:00
SeaCat (SBE16)	0146	23-Oct-02	13:01:00	23-Oct-02	14:06:00
TPOD	4493	23-Oct-02	11:33:00	23-Oct-02	12:55:00
TPOD	3703	23-Oct-02	11:33:00	23-Oct-02	12:55:00
SBE39	0282	23-Oct-02	11:35:00	23-Oct-02	12:55:00
		Bands On	1st Spin	2nd Spin	Bands On
VMCM	001-203	22-oct-02, 20:50:25	23-oct-02, 12:03:30	23-oct-02, 19:42:00	23-oct-02, 19:42:15
SBE39	0276	23-Oct-02	11:35:00	23-Oct-02	12:55:00

d. Antifoulant performance

The Stratus 2 discus buoy and instruments were coated with antifoulant to prevent biofouling. Two different types of antifoulant were used: SN-1 and TBT. SN-1 is an antifoulant created by E Paint Company and uses 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, makes SN-1 an alternative to organotin antifouling paints which have been banned by the International Maritime Organization. TBT stands for tributyltin oxide which prevents the attachment and growth of barnacles, plankton, algae, and other organisms on ships or equipment in the marine environment.

Most of the instruments were only coated around the sensors. The Acoustic Rain Gauge had no protective coatings applied. VMCMs were treated with SN-1, but not TBT.

Observations of fouling were:

- Fouling on instruments appeared heavier, and at greater depths, than on instruments recovered from the Stratus 1 mooring. A heavy algae was present on instruments between 20-40 meters.
- VMCMs showed heavy fouling of goose neck barnacles on the instrument cage and propellers. Some of the propellers would not spin freely after recovery.
- SeaCats showed heavy fouling on the pressure case and inside the conductivity cell shield down to 40 meters.
- T-Pods on load bars had moderate fouling down to 45 meters.
- The RDI ADCP at 135 meters showed light fouling on the cage above the transducer heads.
- Small goose neck barnacles were observed on instruments down to 160 meters.

Figure 9. Stratus 2 VMCM, 20 meters

E. Stratus 3 Deployment

The Stratus 3 mooring was deployed in October of 2002, and is scheduled to be recovered approximately one year later. Table 8 below gives the details of deployment operations.

Table 8. Stratus 3 Mooring Information

Stratus 3		
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, Bouchard, Smith, Weller
	Recorder	Lara Hutto
	Ship	R/V *Melville*
	Cruise No.	Vanc03
	Depth	4440
	Anchor Position	20° 10.4816'S, 85° 6.7273W

a. Mooring Description

The Stratus 3 mooring was instrumented with meteorological instrumentation on the buoy, and subsurface oceanographic equipment on the mooring line. Tables 9 and 10 below detail the instrumentation. Figure 10 is a schematic representation of the Stratus 2 mooring.

Table 9. 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 0.4 meters above the mean waterline.

Table 10. 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
13	Aanderaa w/ temp	129	Currents and temperature
16	SeaCat	2325	Conductivity and temperature
20	VMCM	030	Currents
25	CHLAM w/ SBE 39	CHLAM #1 SB 0049	Chlorophyll-a and temperature
30	SeaCat	1880	Conductivity and temperature
32.5	VMCM	055	Currents
35	TPOD	4485	Temperature
40	MicroCat	1326	Conductivity and Temperature
45	VMCM	011	Currents
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
450	SBE 39	0050	Temperature

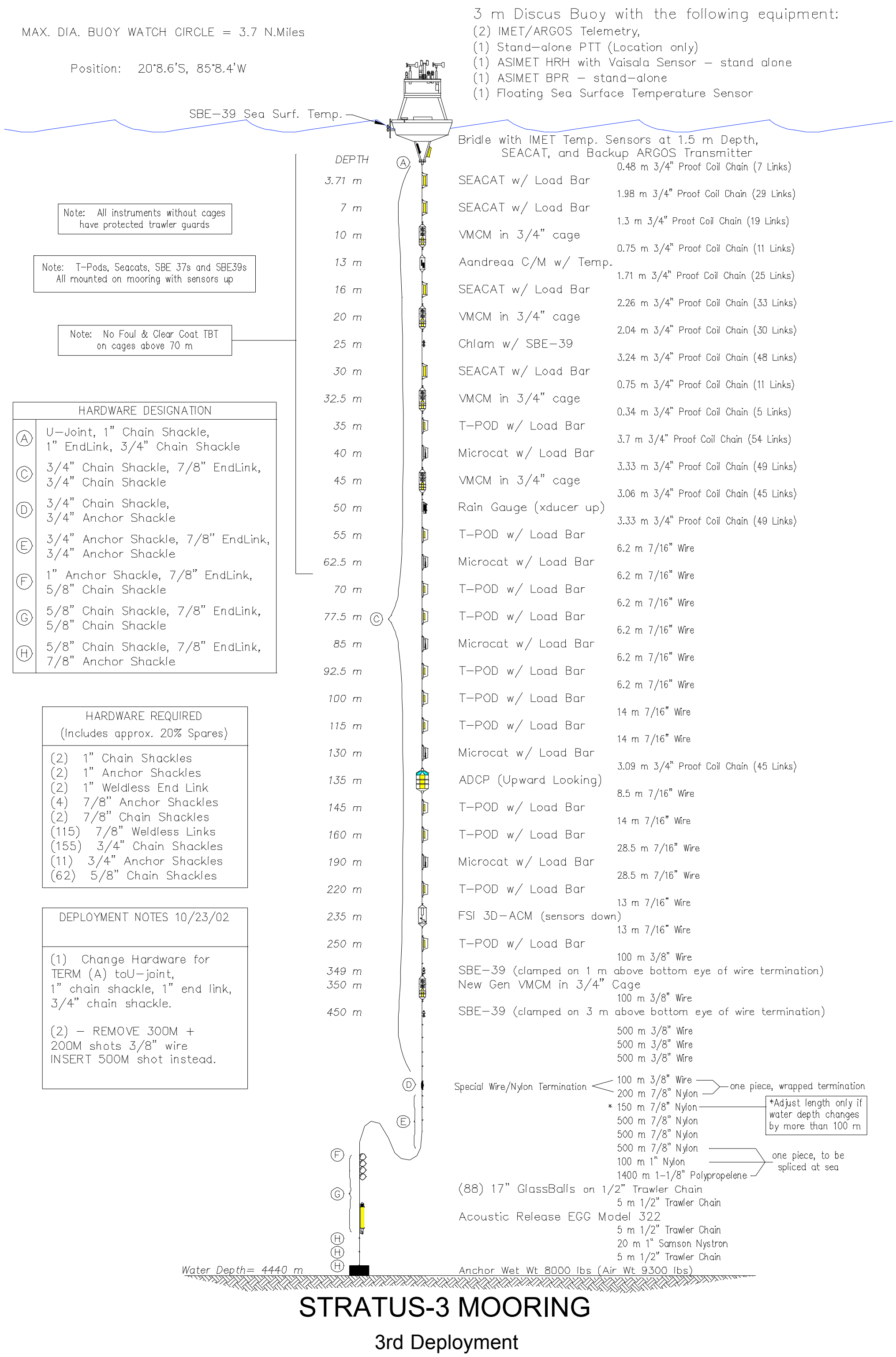


Figure 10. Stratus 3 Mooring Diagram.

b. Antifoulant Application

Previous discus moorings have been used to test 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 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 service life up to 8 months.

However, certain instruments are adversely affected by even the slightest fouling. To date, antifouling paint in addition to SN-1 must be used to insure the most protection on those instruments. TBT and Trilux with Biolux were used on the Stratus 3 mooring in addition to SN-1. TBT stands for tributyltin oxide which prevents the attachment and growth of barnacles, plankton, algae, and other organisms on ships or equipment in the marine environment. Trilux with Biolux is a hard antifoulant paint that contains two biocides. Trilux contains cuprous thiocyanate which reduces shellfouling. Biolux contains Teflon and prevents slime and algae growth.

Although no formal testing is being carried out on the Stratus 3 mooring, we continue to monitor the effectiveness of anti-fouling coatings used. The table below shows methods for coating the buoy hull and instrumentation for the Stratus 3 deployment.

Table 11. 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

c. Time Spikes

Timing spikes were applied to the Stratus 3 mooring instrumentation prior to deployment. These spikes will help with data processing by allowing for timing to be checked on the instruments. Table 12 below details the timing spike information.

Table 12. Stratus 3 Timing Spikes.

Instrument	Serial #	Pre-Spike On		Pre-Spike Off	
Data Logger	04	N/A	N/A	N/A	N/A
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
Data Logger	07	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
Clham 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

d. Deployment Process

The Stratus 3 surface mooring deployed from the R/V *Melville* was set using the UOP two phase mooring technique. Phase 1 involved the lowering of approximately 40 meters of instrumentation over the starboard side of the ship. Phase 2 was the deployment of the buoy into the sea. 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 the deployment of the buoy; and (3) the 80 meter 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 3 mooring deployed from the R/V *Melville*.

The basic deck equipment and deck layout is illustrated in Figure 11. The mooring gear used in the deployment of the surface mooring included: the TSE winch, main crane, and the standard complement of chain grabs, stopper and slip lines.

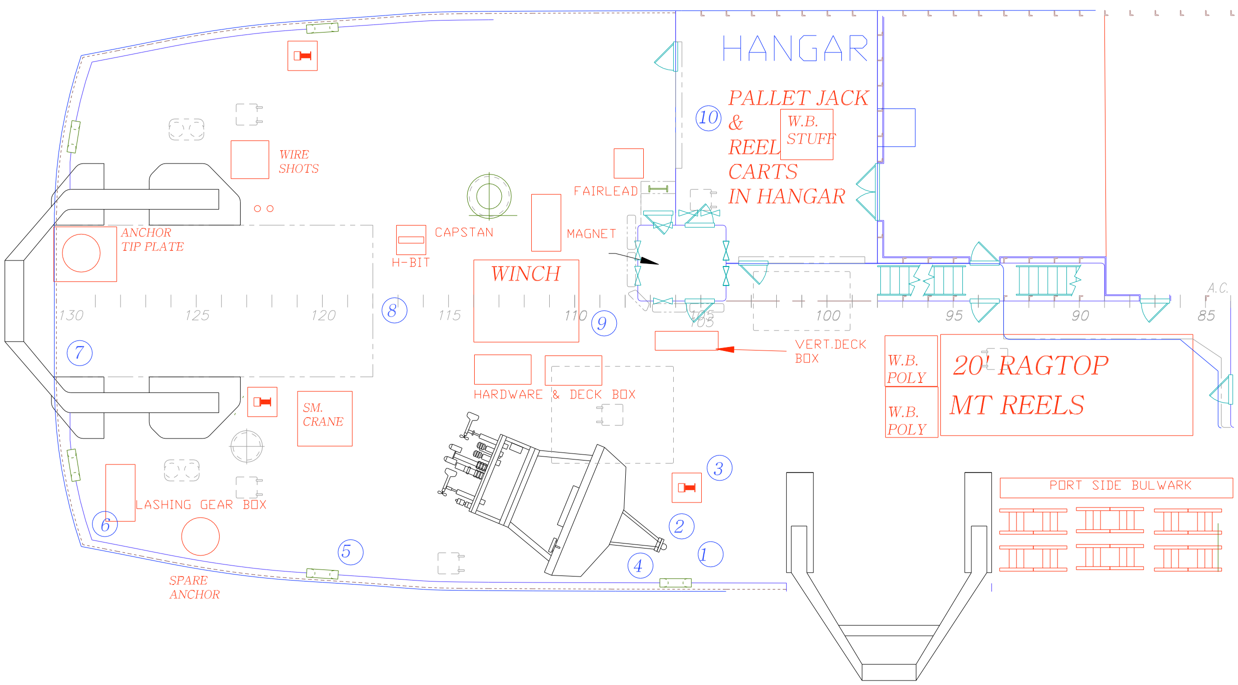


Figure 11: Basic deck equipment and deck layout.

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

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
200 m 3/8” wire
500 m 3/8” wire
500 m 3/8” wire
300 m 3/8” wire
100 m 3/8” wire
100 m 3/8” wire

A canvas 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 ten nautical miles down wind and down current from the desired anchor site. An earlier bottom survey indicated this track would take the ship over large area with consistent ocean depth. This would allow an acceptable margin of error for delays or drift off the desired track.

The personnel required for the first phase of the operation were: two instrument handlers, crane whip handler, tugger operator, 4 mooring wire handlers, winch operator, and crane operator.

Prior to the deployment of the mooring a 100-meter length 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 starboard quarter and up forward along the starboard rail to the instrument lowering area.

The four hauling wire handlers were stationed around the aft starboard rail. Their positions were in front of the TSE winch, center of the A-frame, aft starboard quarter, and approximately 5 meters forward along the starboard rail. The wire handler’s 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 starboard rail.

To begin the mooring deployment, the ship hove to with the bow positioned with the wind slightly on the starboard 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 had been staged in their order of deployment on the starboard 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. Instrumentation 47.5 meters and deeper had their chain or wire shot secured to the bottom of the instrument. The 40-meter instrument was rigged with shots above and below.

The first instrument segment to be lowered was the 3.3 meter 3/4" proof coil chain, 40 meter depth MicroCat, 3.7 meter length of 3/4" chain. The instrument lowering commenced by shackling the bitter end of the hauling wire to the free end of the 3.3 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 3.7 meter 3/4" chain approximately 0.5 meters from the free end.

Figure 12: Lowering subsurface instruments over the side.

The crane whip was raised up so that the chain and instrument were lifted off the deck approximately 0.5 meters. 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 it over the starboard 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 attached to an air tugger line. The crane was then directed to swing slightly inboard and lower its 3/4" chain grab to the deck. The air tugger's line hauled in enough to take the load from the crane. The hook on the crane was removed. A 3/4" nylon stopper line with a snap hook was hooked into the loose end link shackled to the end of the 3/4" chain and secured to a deck cleat as a backup to the air tugger.

The next segment in the mooring to be lowered was the 35 meter T-POD, and 0.34 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 0.48 meter shot of 3/4” chain shackled to the 3.71 meter depth SeaCat. The load from this instrument cluster was stopped with a chain hook on a stopper line below the 3.71 meter SeaCat. This allowed enough slack to connect the buoy bridle to the instrument cluster. The free end of 0.48 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 discus 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 (Figure 13). The 30 foot. 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 60 foot. tower slip line was rigged to check the tower as the hull swung outboard. A 75 foot. 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.

Personnel required for this phase of the operation included a deck supervisor, TSE winch operator, 4 hauling wire handlers, three slip line handlers, a crane operator, a crane whip tag line handler and quick release handler.

Figure 13: Slip lines rigged on the discus to maintain control during the lift.

With all three slip lines in place, the crane was directed to swing over the discus buoy. The crane's whip was lowered to the discus. A four-foot sling, hitched to 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 bridle slip line was removed first, followed by the tower bail slip line. Once the discus had settled into the water (approximately 15 foot. 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 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 3/4" 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 small quick release hook, attached to the heavy-duty tugger line and passed through a block on the A-frame, lifted the instrument off the deck. The TSE winch payed out allowing the VMCM to be eased over the stern. The tugger held the VMCM above the deck as it went over the transom. Once the VMCM was clear, the tugger line was slacked and the quick release tripped. The same procedure was used to connect and deploy the 50-meter Acoustic Rain Gauge.

The next several instruments were deployed in a similar manner. However, instead of short shots of chain, longer shots of 7/16" jacketed wire rope were used. 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. Once the winch carried the load of the mooring, the stopper line was removed, and the winch payed out the wire. As the bottom end of wire shot came off the TSE winch drum, the canvas wrap was removed. The termination was stopped off approximately 2 meters from the transom.

The hauling wire was unshackled, and the next instrument and wire shot were brought out to the stopped off wire. The quick release attached to the air tugger and reeved through the A-frame block was used to ease each instrument over the transom. The process of instrument insertion was repeated for the remaining instruments down to 250 meters. As the instrument load increased and the shots of wire became longer another method of easing wire and instruments over the transom was used. The quick release hook reeved through the A-Frame was replaced with a hanging Gifford block. The hanging block allowed wire to be payed out over the stern without chafing on the transom. The adjustable height made reaching terminations and easing instruments over the stern easy.

Figure 14: Using the hanging block to control instrument deployment.

Using the air tugger to adjust the height of the block, and using the winch payout and A-Frame, instruments could be lifted off the deck and eased over the stern without making any contact with the ship. After 1500 meters of wire rope were payed out, the Gifford block had to be changed to a snatch block to accommodate the nylon line. The line could be removed from the block without breaking terminations. This made it easy to get the bulky wire to nylon termination and all nylon line deployed.

All the mooring 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 were 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.

Once the 500-meter 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 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 payout speed relative to the ships speed. The H-bit and polypropylene were sprayed with water while being payed out to reduce friction and heat generated.

Figure 15: H-Bit rigged for deploying 2000 meters of line.

While the nylon/polypropylene line was being payed out, the crane was used to lift the 88 glass balls out of the rag top container. These balls were staged fore and aft, in four ball segments, just aft of the starboard A-frame.

When the end of the polypropylene line was reached, payout 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 88 - 17" glass balls was accomplished using two 20 meter long stopper lines reeved through the two 8" 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 88 glass balls were bolted on 1/2” trawler chain in 4 ball, 4 meter increments. The first string of glass balls was dragged aft and connected to the stopped off polypropylene line. Another four-meter section of glass balls was attached to the first section. The glass balls were stretched out up to the front of the winch. A stopper line with a 2-ton snap hook was hooked onto an end link closest to the front of the winch. The line was pulled tight and secured to a deck cleat. The winch line was eased off, and the load transferred. This stopper was payed out slowly as the balls went off the transom.

The stopper line was 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 deck edge. The stopper line was secured to the deck. Another two segments of glass balls on chain were dragged into position and attached to the mooring. The free stopper line was hooked into the end link closest to the TSE winch. Tension was pulled up, and the line made fast to a cleat. The aft stopper line was eased off and removed. This section of balls was eased over the transom. This process of attaching balls and slipping over the transom continued until all 88 balls were on the mooring line.

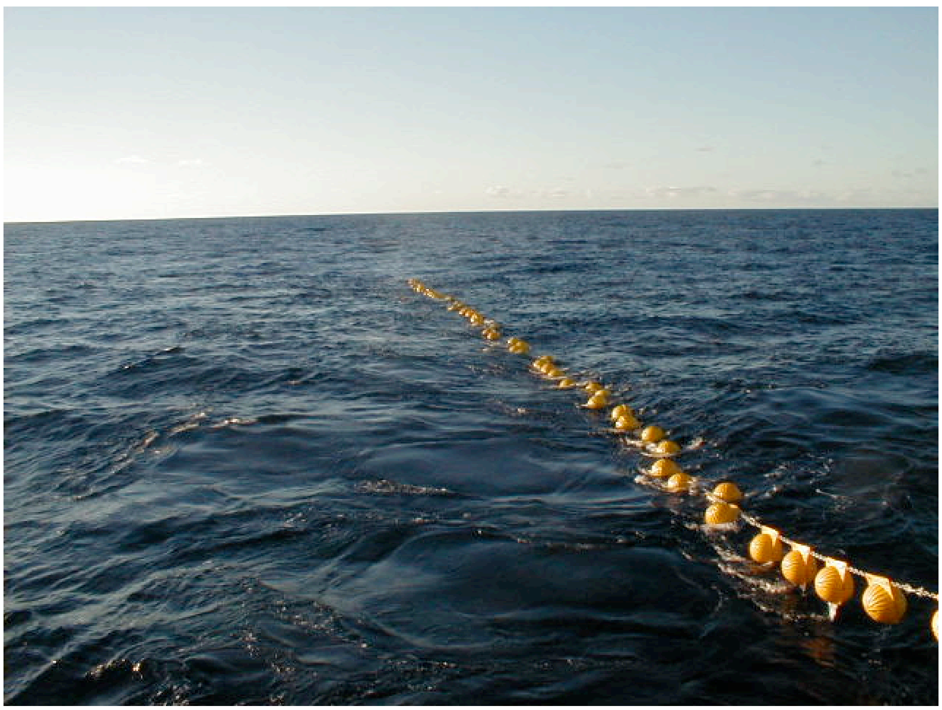


Figure 16: Glass balls in hard hats deployed on mooring line.

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 1.5 meters 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 outboard 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 1/2" screw pin shackle and 5/8" pear link was attached to the chain approximately two meters from the anchor. A 20-meter length of 3/4" Samson line was passed through this link and secured to two cleat on the A-frame stop pedestal. A stopper line with a chain hook was attached approximately 2 meters down from the anchor pennant. The mooring load was transferred from the stopper line on the pennant to the stopper line on the chain. The line on the pennant was removed. The stopper line on the chain was eased off. As the pennant and two meters of chain went over the transom, the load was transferred to the 3/4" Samson slip line, and the chain hook removed from the chain.

The 01 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. At this point, this ship was positioned three hundred meters short of the anchor target. It was necessary to tow the mooring past the anchor site another four hundred meters to compensate for anchor fallback. The mooring was towed, with the load on the Samson slip line, for approximately 30 minutes before the command the drop the anchor was given. 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.

e. 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. Details are given below, Figure 17 shows the ship's track during triangulation, and Figure 18 shows the distances determined to the anchor.

- Initial point for launching buoy: 20°03.9'S 85°14.9'W
- Deployment track 130°, into wind, toward nominal endpoint: 20°13.6'S 85°02.7'W
- Target for anchor site: 20°10.4'S 85°06.8'W (10 nm along deployment track)
- 3-point acoustic survey of anchor position
- Position of Anchor drop: 20°10.551'S 85°6.63'W
- Position of Anchor on Bottom: 20°10.4816'S 85°6.7273'W

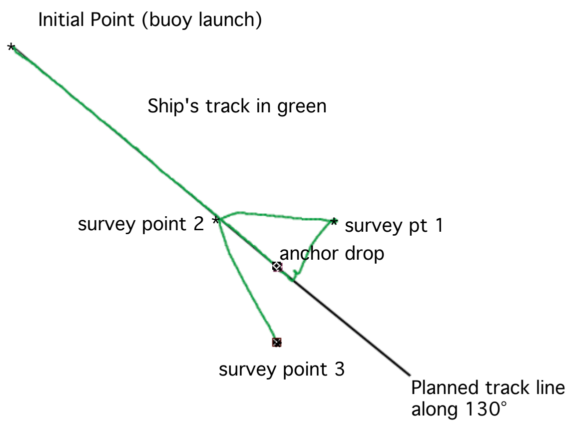


Figure 17. Cruise Track for deployment and anchor survey.

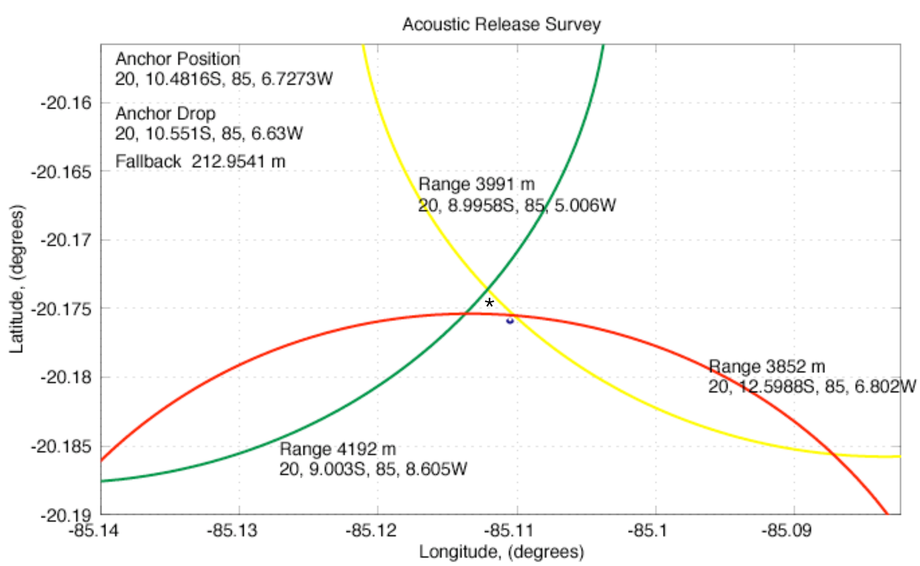


Figure 18. Acoustic Ranging to Locate Anchor.

F. Comparison of buoy and ship IMET sensors

The IMET buoy data is validated at the start and end of each yearly deployment using ship data. During this cruise, particular attention was focused on the ship's sea surface temperature (SST) and salinity as the mooring site was approached to ensure that the ship was positioned in the same water body as the mooring during the ship/buoy comparison. Data analysis from the Stratus 2 cruise on R/V *Ron Brown* revealed that moving the ship away from the buoy to obtain the CTD profiles during the final Stratus 1 buoy/ship comparison day (10/16/2001 - 289) compromised the success of the comparison. CTDs need to be deployed some distance away from the mooring to ensure that the wire does not become entangled with the mooring line. During the previous cruise, two CTDs had been deployed during the ship/buoy comparison day and by chance the ship crossed a small front as it moved away from the mooring. As a result the comparison was compromised because the ship was in a different water mass for a third of the comparison day (Figure 19).

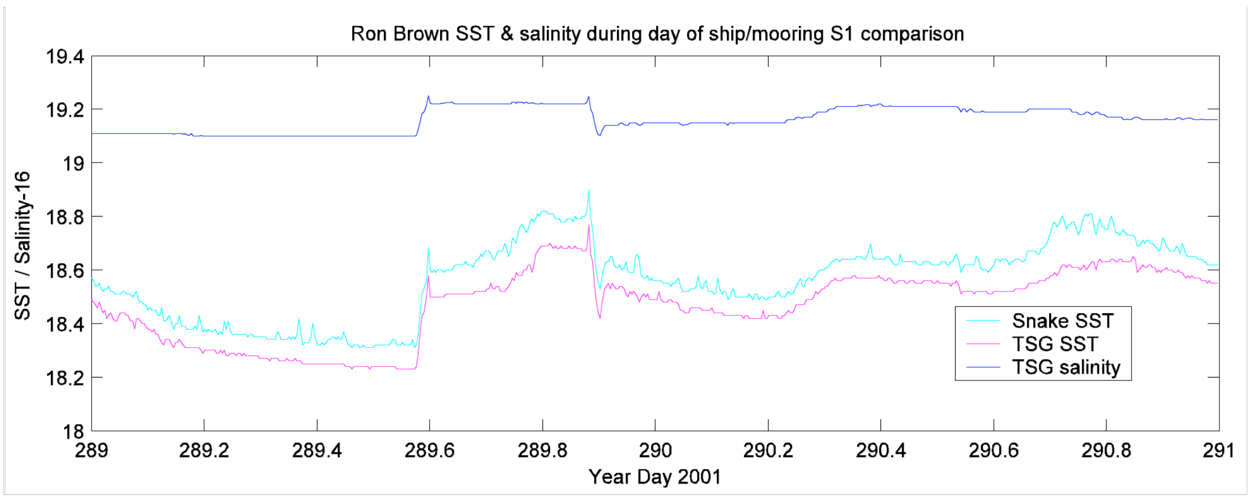


Figure 19: Ship data from the R/V *Ron Brown* during comparison for the Stratus 1 mooring.

Note the jump in SST and salinity caused by the front between time 289.5 and 290. (Snake SST = floating SST sensor deployed from the R/V *Ron Brown*)

To avoid a similar scenario from recurring during the Stratus 3 cruise, it was decided that during the days of the ship/mooring data comparisons, the ship would stay close to the moorings and no CTDs would be carried out. The ship arrived at the mooring location at 20:00 L (local time) on Sunday, October 20th. After the mooring was inspected, the ship moved away and two CTD casts were carried out during the night. By 07:00 L the next day, the ship was back at the mooring location and the buoy/ship 24-hour comparison began. The Stratus 3 mooring was deployed on 24th October. The following day another comparison period began. Again no CTDs were carried out during the comparison. Two CTDs were deployed downwind of the mooring site after the comparison period was over.

Figure 20 shows the SST and salinity variability around the mooring location during the Stratus 3 cruise. Although the ship's salinity was evidently too fresh, it's variability corresponded well with the SST so it was used to help identify fronts. A cooler, fresher front was present near the mooring site and so care was taken to ensure that the buoy/ship comparisons were carried out in the same water body. The Stratus 3 mooring was deployed just within the front and so the Stratus 3 comparison was carried out in the cooler water mass.

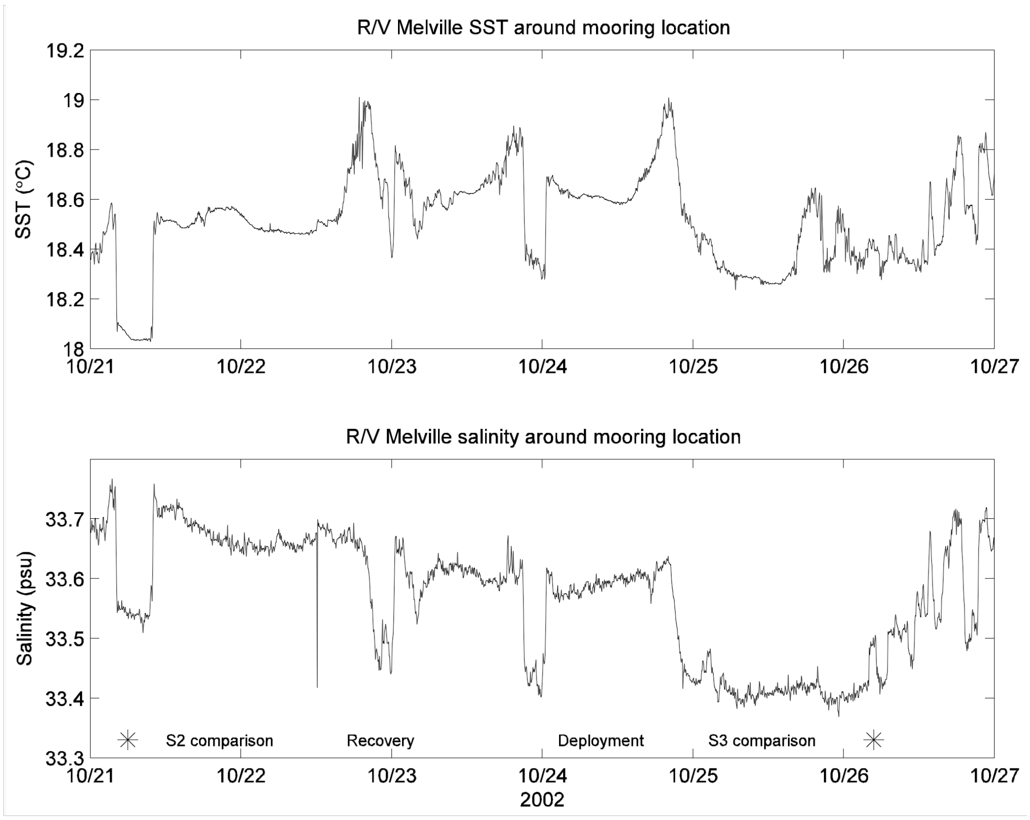


Figure 20: SST and salinity variability around the mooring location.
* marks the time of the CTD deployment.

During the comparison several different IMET systems and other instruments were used for the data comparison. During daylight hours meteorological measurements were taken with handheld instruments on the hour along with bucket SST measurements. The meteorological measurements were taken at the bow and near the fantail where the buoy on deck was tied down. The Kestrel 4000 measured air temperature, barometric pressure and wind speed and the Vaisala measured relative humidity. The list below describes the instruments used for the data comparisons:

Stratus 2 IMET (logger 1): hourly average data
Ship's IMET: 5 minute point measurements
Stratus 3 IMETs (logger 4 & 7): hourly average data
WHOI Sonic Anemometer: 15 minute average data
Handheld meteorological instruments: hourly point reading
Bucket thermometer: hourly point reading

The comparison was limited by some faults in the ship's IMET sensors: the barometric pressure was approximately 10 mbar too low and the wind direction on the anemometer appeared to be jammed at 240º. Consequently the ship's winds could not be corrected to true wind speed and direction. During the start of the cruise the ship's salinity was noted to be too fresh which was confirmed by a comparison with surface CTD data making it unusable. The ship's shortwave sensor was broken throughout the cruise and while it was replaced by a spare UOP sensor, the data was only logged internally and could not be analyzed until after the cruise. Additional measurements were used where possible to ensure that the in situ IMET variables were compared. Only salinity could not be compared because there was no other source of measurement.

a. Stratus 2 Comparison

A final ship-buoy data comparison was carried out over a 24 hour period just before the Stratus 2 mooring was recovered (10/21/02 12:00 UTC – 10/22/02 12:00 UTC). The aim of the comparison was to assess how well the sensors worked after a year at sea. The ship was positioned close to the mooring, a quarter of a degree downwind at 20º07'60 S, 85º10'10 W, heading 111.8º. This position was maintained over the 24 hour period. During the comparison the stratus clouds cleared during midday and there were long sunny periods (Figure 21).

Figure 21: Clouds during 10/21/02 10:30 LST, 12:00 LST & 18:00 LST

The comparison results generally show good agreement, with the largest deviation observed in the longwave radiation. This provides confidence that the sensors were still working well after a year at sea. Figure 22a shows the comparison for air temperature. The Stratus 2 buoy and the ship agree well while the other measurements show warmer air temperatures during the day. This difference can probably be explained by thermal air flow on the ship. The Stratus 3 buoy was positioned at an angle on the ship's deck so the sensors were close to the deck surface and subjected to thermal eddies and sheltering effects. The handheld measurements were also likely to have been affected by the ship's thermal 'effects'.

Figure 22b presents the SST comparison. The ship SST is measured by the TSG at approximately 4m depth and so the cooler ship sea temperatures may have been due to weak diurnal stratification in the water column. During the day the weather was quite sunny and a small diurnal cycle was evident in the SST data. The bucket SST (measured with a mercury thermometer) showed no variation in temperature and was generally cooler than the other measurements. The bucket SST could only be read off at an accuracy of 0.5 ºC and since it was lowered just over the edge of the ship the water was likely to have been well mixed due to the bow thrusters breaking down any diurnal stratification.

Figures 22c & 22d show good agreement for the relative humidity and barometric pressure sensors. Since the ship's IMET pressure was incorrect, the Stratus 2 data was compared against the handheld and Stratus 3 data. The ship showed generally smaller relative humidity values but this may have been explained by the sensor height difference as the ship's sensor was mounted on the foremast at 13.56m above mean sea level. The handheld measurements of relative humidity showed reasonably good agreement with the ship data. The Stratus 3 data should be reviewed with some caution at this point. The bridle legs had been placed on the buoy, leaving it tilted at approximately 60 degrees from vertical. This tilt affects data quality as does the heating and flow distortion associated with the ship itself.

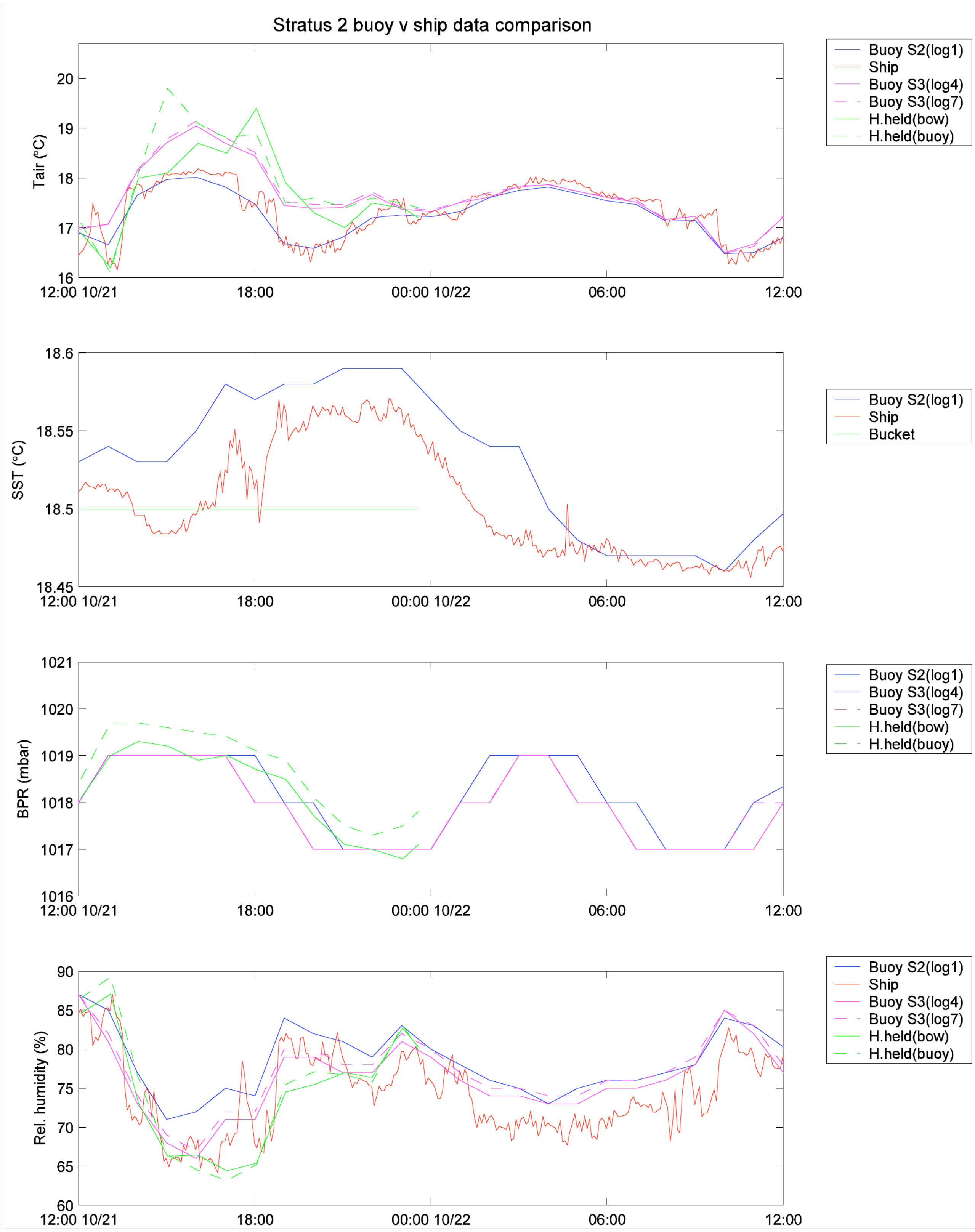


Figure 22: Stratus 2 buoy data comparison (times are given in UTC).

The longwave radiation showed an offset in the Stratus 2 sensor (Figure 23b). The Stratus 2 radiation was approximately $30Wm^{-2}$ lower than the other measurements, although the Stratus 3 sensors may have received additional longwave from the ship's surfaces. The two Stratus 3 sensors showed a small difference of approximately $10Wm^{-2}$. The Stratus 2 downwelling shortwave radiation was compared against the ship's shortwave sensor and the Stratus 3 IMET sensors onboard the ship (Figure 23a). The Stratus 3 sensors did not provide an ideal comparison as they were affected by the angle of the buoy on deck and were shaded. Comparison with the ship data revealed good agreement. The higher resolution ship data revealed the high temporal variability of the shortwave due to the breaking up of the stratus clouds during the day.

Figures 23c & 23d show the anemometer comparison results. While the ship's wind direction was broken, the wind speed was accurate and it was used, along with the sonic anemometer data and handheld wind speeds, for the comparison. The results show good agreement between the ship's IMET and sonic wind speeds and the Stratus 2 buoy data (Figure 23c). The Stratus 3 data and the handheld data reveal lower wind speeds caused by air-flow effects around the ship. The results show the relative wind speed since the buoy data could not be corrected without a surface current velocity and the ship data could not be corrected due to the fault in the anemometer. During the cruise, true wind speed and direction were only available for the sonic system. Figure 23d shows the relative wind directions which varies between the sensors as would be expected. The table below (Table 13) summarizes the results of the comparison.

Table 13: Stratus 2 buoy v ship data comparison (10/21/02)

	Comparison	Mean Bias	Std. Deviation	Correlation
Tair (ºC)	S2 – ship	-0.07	0.1	0.98
SST (ºC)	S2 - ship	0.03	0.02	0.92
BPR (mbar)	S2 – S3	0.25	0.44	0.86
Rel. humidity (%)	S2 - ship	4.17	0.97	0.94
Incoming Shortwave (Wm^{-2})	S2 - ship	-0.93	28.83	0.99
Incoming Longwave (Wm^{-2})	S2 – S3	-39.04	5.48	0.62
Rel. wind speed (m/s)	S2 - ship	-0.30	0.27	0.97

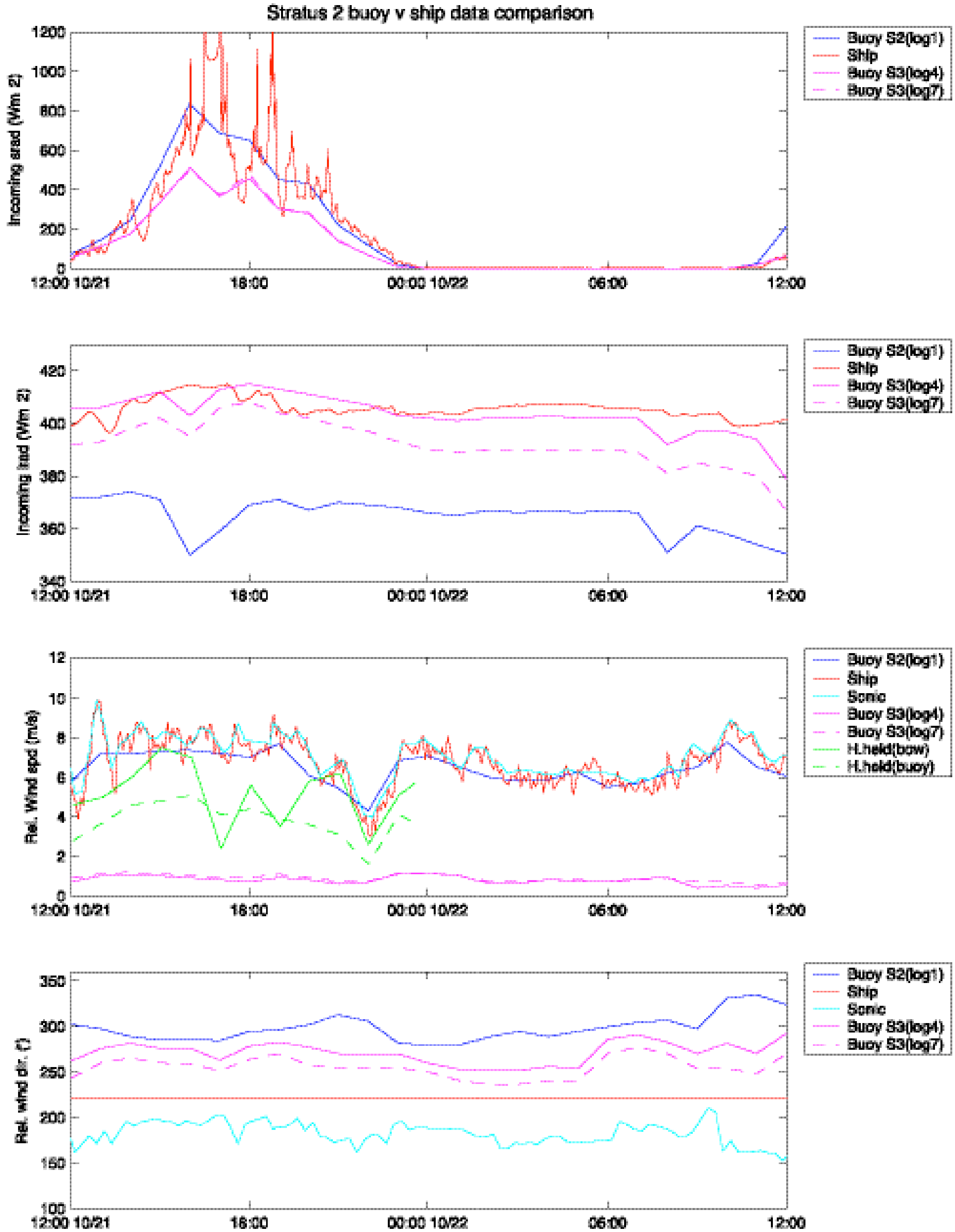


Figure 23: Stratus 2 buoy data comparison (times are given in UTC).
Figure 23 shows incoming shortwave radiation, incoming longwave radiation, relative wind speed, and relative wind direction (to direction).

b. Stratus 3 Comparison

The new Stratus 3 mooring was deployed on 24th October. After an anchor survey had been carried out to find the exact location of the anchor, the ship/buoy comparison period began. The comparison was carried out over a 24 hour period (10/25/02 04:00 UTC – 10/26/02 04:00 UTC) and the ship was positioned in the same way as before with it's position maintained at 20º09'4958 S, 85º08'0305 W, heading 137.3º, just downwind of the new mooring location. During the day, clear patches appeared in the clouds and the sun broke though. The same instruments, as used in the Stratus 2 comparison, were used for this data comparison. The IMET data from the recovered Stratus 2 buoy could be used in the comparison since the instrument logging was not shut down until the day after the Stratus 3 comparison. The Stratus 2 bridle legs were removed on October 23, and the buoy was set upright. Therefore buoy tilt is not a source of error for the Stratus 3 comparison as it was for the Stratus 2 comparison.

Figure 24a shows the air temperature comparison. There is reasonable agreement between the Stratus 3 buoy and ship data. The Stratus 2 data and the handheld measurements were biased high due to the thermal air flow effects on the ship's deck. The two sensors on the Stratus 3 buoy show almost identical results, which are also seen in the SST (Figure 24b). The Stratus 3 buoy also shows good agreement with the ship SST. The buoy misses a sudden drop in SST at around 21:00 but it may be that the ship passed through a small scale feature which did not go past the buoy.

There is good agreement between all the sensors for the barometric pressure (with exception to the ship which is ignored for the comparison) (Figure 24c). There are some differences between the sensors for relative humidity (Figure 24d) which are most likely due to natural variability and do not reflect biases. The Stratus 3 buoy data shows the same variability as the ship but has slightly higher values which again may be explained by the difference in the height of the sensors. The handheld measurements do not show the same good agreement as they did during the earlier Stratus 2 comparison.

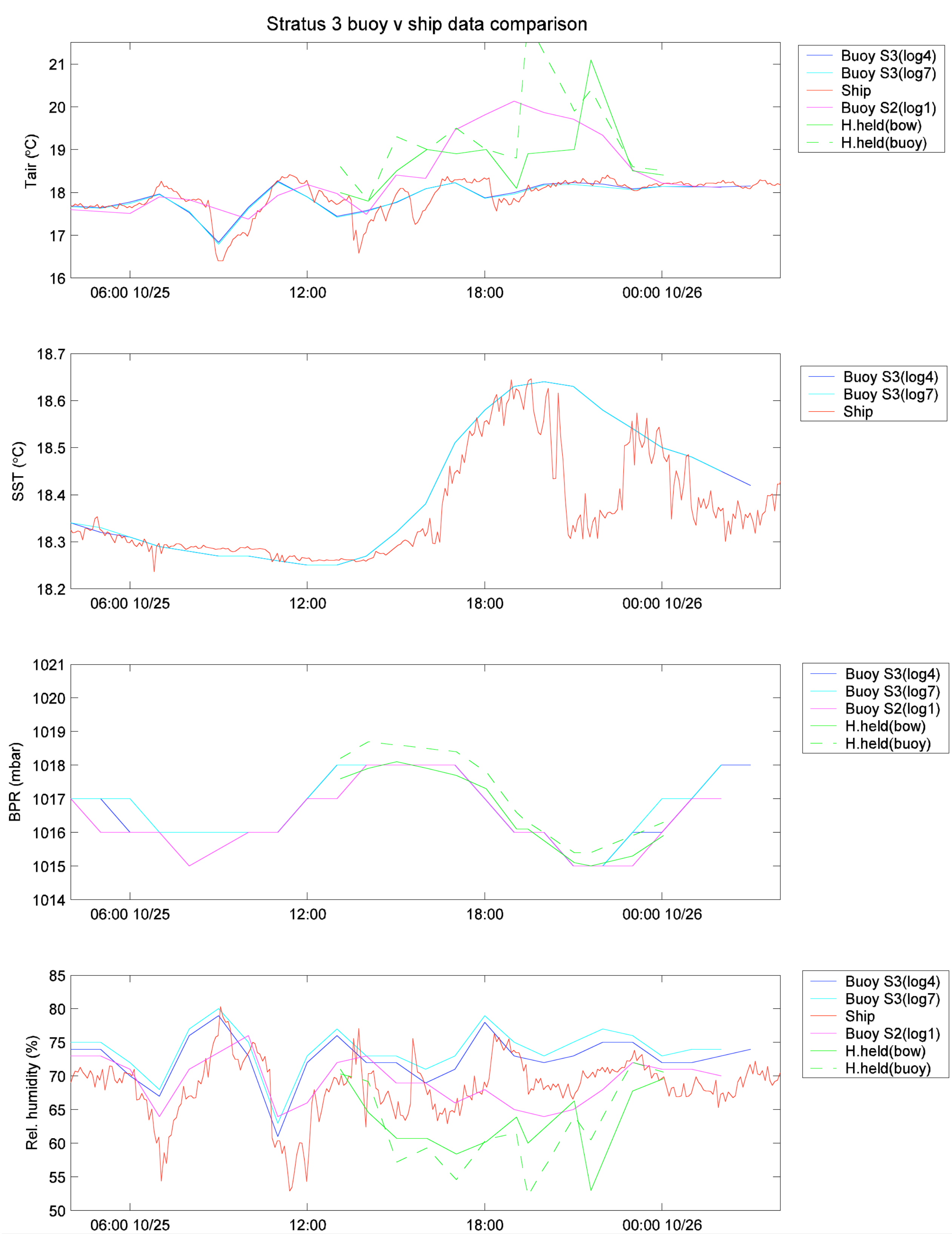


Figure 24: Stratus 3 buoy data comparison (times are given in UTC).

The results are excellent for the downwelling shortwave radiation comparison (Figure 25a). The recently recovered Stratus 2 buoy was positioned upright on the deck so it was not susceptible to any shading effects. The three sensors agree well with the ship's shortwave and the two Stratus 3 measurements are identical. Again the ship data reveals the high temporal variability in this region. The results are less promising for longwave radiation (Figure 25b). All three IMET systems show lower readings than the ship sensor. The Stratus 2 and 3 measurements capture the same temporal variability which is not detected in the ship's longwave despite it being higher frequency data. The failure of the ship to detect the longwave variability indicates a failure of this system. The Stratus 2 data is slightly lower than the Stratus 3 sensors by approximately 12-22 Wm^{-2} and a smaller difference of around $10Wm^{-2}$ is evident between the two Stratus 3 instruments. The 12 Wm^{-2} difference is probably the best estimate possible of the Stratus 2 longwave offset.

The anemometers are compared in Figure 25c & 25d. The two Stratus 3 anemometers show excellent agreement with each other (Figure 25c) and they compare reasonably well with the ship's anemometer and the sonic wind data. The ship's IMET and sonic systems also show excellent agreement and capture the same magnitude and temporal variability. The generally weaker Stratus 3 winds can most likely be attributed to the different sampling times since hourly averaged buoy data are compared against 15 minute averaged sonic data and 5 minute point observations from the ship's IMET system. The Stratus 2 buoy wind is much weaker and is presumably sheltered by the ship. The handheld measurements also show lower readings than the ship and Stratus 3 buoy winds. The three buoy anemometers show similar relative wind directions which differ from the sonic anemometer (Figure 25d). True wind directions are required to comment on the direction accuracy of the sensors.

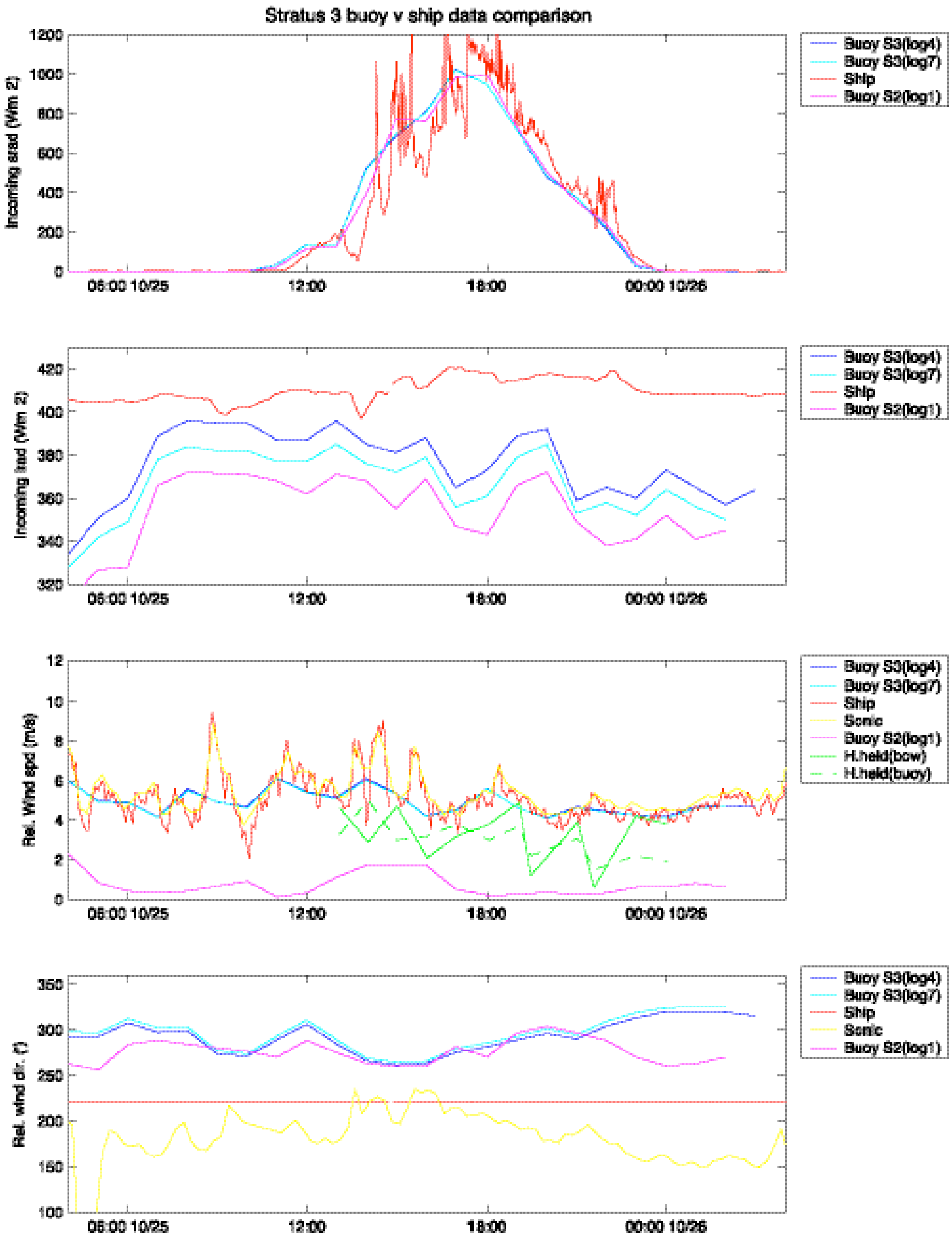


Figure 25: Stratus 3 buoy data comparison.

Figure 25 shows incoming shortwave radiation, incoming longwave radiation, relative wind speed, and relative wind direction.

Table 14 summarizes the results of the data comparison and Table 15 presents comparison results between the two Stratus 3 IMET systems (logger 4 and logger 7).

Table 14: Stratus 3 buoy vs. ship data comparison (10/25/02)

	Comparison	Mean bias	Std. deviation	Correlation
Tair (ºC)	S3 – ship	-0.02	0.10	0.97
SST (ºC)	S3 - ship	0.04	0.08	0.85
BPR (mbar)	S3 – S2	0.23	0.43	0.91
Rel. humidity (%)	S3 - ship	4.09	1.62	0.91
Incoming Shortwave (Wm^{-2})	S3 – S2	3.00	40.47	0.99
Incoming Longwave (Wm^{-2})	S3 – S2	22.00	5.15	0.95
Rel. wind speed (m/s)	S3 - ship	-0.14	0.36	0.90

Table 15: Stratus 3 buoy logger 4 vs. logger 7 data comparison (10/25/02)

	Comparison	Mean bias	Std. deviation	Correlation
Tair (ºC)	log4 - log7	0.0157	0.020	0.99
SST (ºC)	log4 - log7	0.0004	0.002	0.99
BPR (mbar)	log4 - log7	-0.087	0.288	0.96
Rel. humidity (%)	log4 - log7	-1.391	0.499	0.99
Incoming Shortwave (Wm^{-2})	log4 - log7	-0.826	4.519	0.99
Incoming Longwave (Wm^{-2})	log4 - log7	9.434	2.041	0.99
Rel. wind speed (m/s)	log4 - log7	0.043	0.042	0.99
Rel. wind direction (º)	log4 - log7	-4.342	0.962	0.99

IV. CTD STATIONS

Twenty CTD casts were completed during the Stratus 2002 cruise along 20°S (Figure 26). The upper panel of Figure 26 shows the locations of the stations. The lower panel shows bottom depth and vertical lines show the depth and location of the CTD stations. Most of the casts went to 1000 m and water samples for salinity analysis were collected at six different levels for some of the stations. Table 16 presents relevant information from each station, including date, time, position, and nominal depth of salinity samples.□

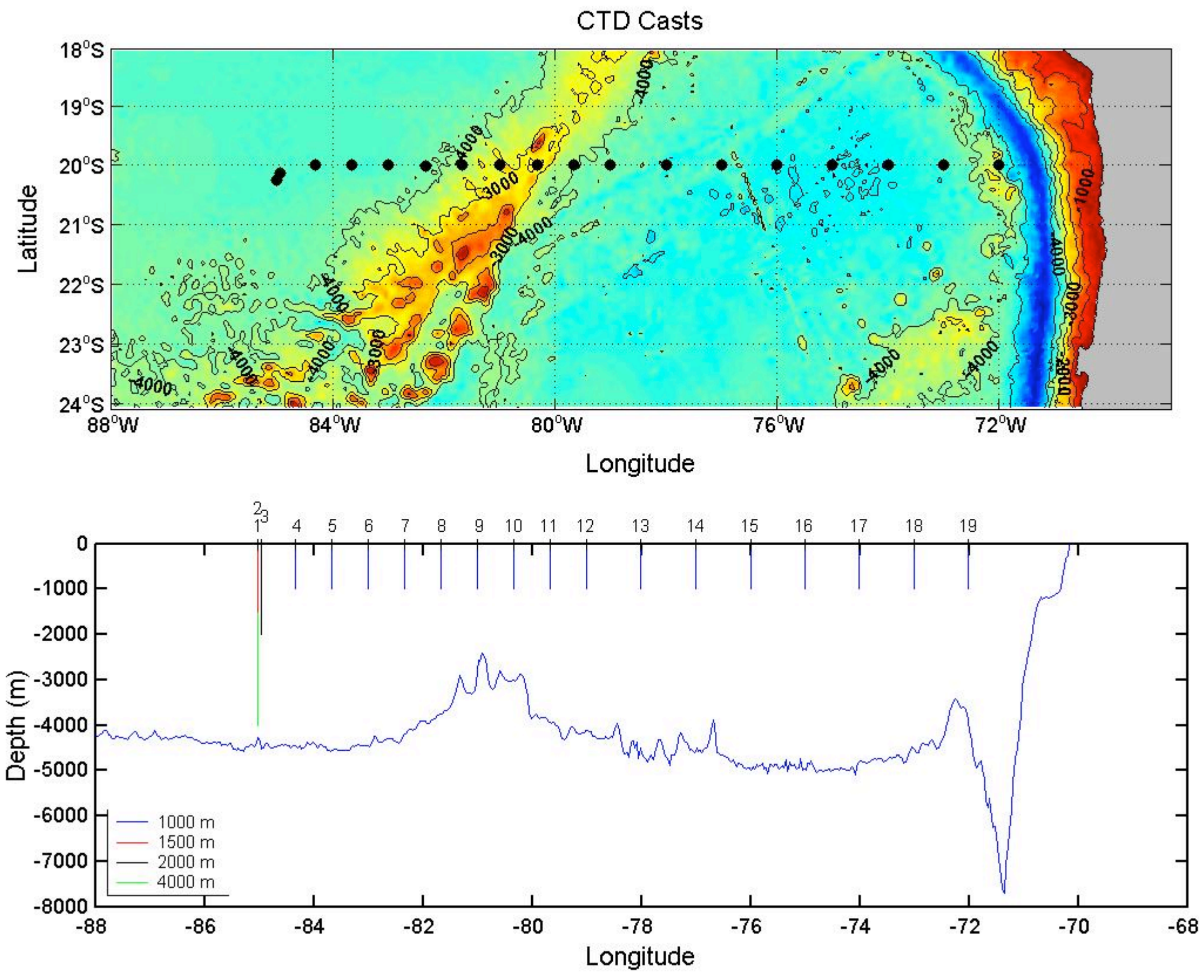


Figure 26. CTD stations accomplished during the Stratus 2002 cruise.

Table 16. CTD Summary Information.

Cast Name	Date	Hour UTC	Latitude (°S)	Longitude (°W)	Depth Cast (m)	Depth Bottom (m)	Water Samples
Stratus00	021016	21:05	2° 1.624'S	84° 59.99'W	1000	2669	----
Stratus01	021021	04:43	20° 14.60'S	85° 01.05'W	4000	4416	4000, 3000, 2000, 1000, 700, 600, 300, 100, 50, 30, 15, 10
Stratus02	021021	08:05	20° 14.61'S	85° 01.05'W	1500	4416	----
Stratus03	021026	05:20	20° 07.65'S	84° 57.58'W	2000	4400	----
Stratus04	021026	10:18	20° 00.05'S	84° 19.99'W	1000	----	----
Stratus05	021026	14:40	20° 00.00'S	83° 40.43'W	1000	----	----
Stratus06	021026	19:18	20° 00.00'S	83° 00.23'W	1000	4370	1000, 500, 300, 200, 100, 50
Stratus07	021027	00:05	20° 00.03'S	82° 20.08'W	1000	4197	----
Stratus08	021027	04:45	19° 59.97'S	81° 40.07'W	1000	3804	----
Stratus09	021027	09:23	20° 00.01'S	81° 00.02'W	1000	3272	1000, 500, 300, 200, 100, 50
Stratus10	021027	14:14	19° 59.99'S	80° 20.00'W	1000	3045	----
Stratus11	021027	18:43	20° 00.00'S	79° 40.05'W	1000	3912	----
Stratus12	021027	23:30	20° 00.02'S	79° 00.06'W	1000	4116	1000, 500, 300, 200, 100, 50
Stratus13	021028	06:09	20° 00.00'S	78° 00.30'W	1000	4776	----
Stratus14	021028	12:49	19° 59.99'S	77° 00.04'W	1000	4638	1000, 500, 300, 200, 100, 50
Stratus15	021028	19:17	20° 00.00'S	76° 00.01'W	1000	4978	----
Stratus16	021029	01:25	19° 59.95'S	75° 00.09'W	1000	5089	1000, 500, 300, 200, 100, 50
Stratus17	021029	07:55	19° 59.99'S	74° 00.04'W	1000	4726	----
Stratus18	021029	14:20	19° 59.98'S	73° 00.01'W	1000	4588	1000, 500, 300, 200, 100, 50
Stratus19	021029	20:48	19° 59.96'S	72° 00.05'W	1000	4067	----

An *SBE 911-plus* system, which was provided by SIO as ship's equipment, was used in all casts as the main instrument. Additionally, after some problems with the main CTD a self-contained SBE-19 CTD belonging to the WHOI UOP group was mounted on the frame together with the main CTD in stations Stratus 11 to Stratus 19. That instrument provided a completely independent data set.□Data from both CTDs are included in the present report.□Figures for each station, including vertical profiles of temperature, salinity, oxygen and sigma-theta, and a T-S diagram were generated. Figures from the SBE 19 are specified in the title as CTD-19. For the SBE 911 plus data from the primary and secondary sensor were plotted. Note that data from the main CTD at station Stratus18 (corresponding to file stratus18.dat) were corrupted.

An *SBE 911plus* CTD with oxygen sensor (SB43) was used in all the casts. The CTD has a double set of temperature and salinity sensors and two independent pumps, and an altimeter. The scan rate for the CTD was 24 scans per second. Temperature and conductivity sensors were calibrated by the manufacturer on September 2002.

Four different types of files were generated. Each type can be identified by a different extension:

- Files **.dat** are binary raw data files generated by the SBE 911 plus CTD.
- Files **.hex** are binary raw data files generated by the SBE 19 CTD.
- Files **.cnv** are ASCII data files. Those files contain the raw data in engineering units. They were generated by the software SEASOFT-Win32 (SBE Data processing) based on the raw data (.dat or .hex depending on the CTD) and the calibration constants (.con files).
- Files **.avg** contain pre-processed data. During processing, evidently erroneous and large spikes were removed.

Files ".cnv" have the standard format generated by the SEASOFT-Win32 (SBE Data processing) software. Each file contains a variable length header with information about the cast (ship name, cruise, cast name, position, etc.), and information about the instrument, software used in the processing, type of sensors and calibration date, variables in the file and the observed range of each variable. Variables are written in float format using 11 characters by column corresponding to:

- CTD SBE 911 plus - pressure, temperature-primary, temperature-secondary, salinity-primary, salinity-secondary, conductivity-primary, conductivity-secondary, oxygen, density, altimeter and a last flag column.
- CTD SBE 19 - pressure, temperature, salinity, conductivity, density and a flag column.

Spikes in all the sensors, much larger than that usually produced in salinity due to changes in temperature, were observed in several casts in both the SBE 911 and the SBE 19 CTDs.

A test cast down to 1000 m was accomplished during the transit to the Stratus position to check the CTD SBE 911 plus. During that cast all the sensors apparently worked well. Differences between both sets of temperature and conductivity were, in general, in the accepted range (+/- 0.002 C and +/- 0.0006 S/m for temperature and conductivity respectively). The same results were obtained in the following cast, which was accomplished near the Stratus site (station Startus01).

During the cast Stratus03 the CTD data showed evident errors. A number of spikes in most sensors were observed (Figure 27). After the Stratus03 cast, the CTD connections, and the connection with the wire were visually checked. Problems with the data continued during the following stations. To try to solve this problem the following actions were taken:

- Visual check and cleaning of the connections between sensors, main CTD body and Rosette pylon.
- New connection between main conductive cable and CTD (winch wire-CTD).
- Cleaning of the sensors using Triton X-100 (special detergent provide by SBE).

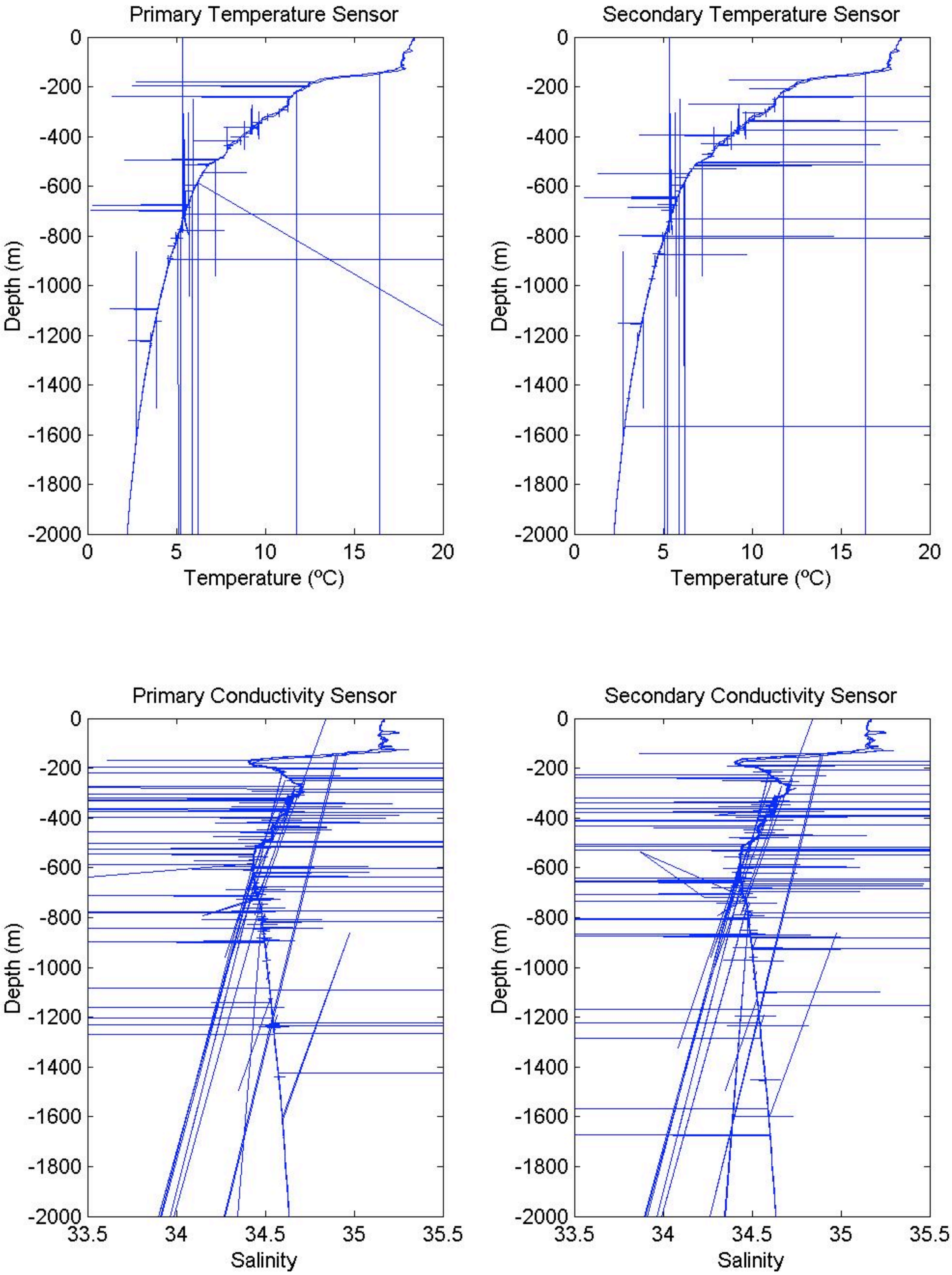


Figure 27. Raw CTD data with spikes.

The different actions were performed before different CTD casts, so it was possible to evaluate the effect of each action separately. The next cast after the cleaning of the sensors (Stratus15) was relatively good, with only minor spikes. Nevertheless the following casts (Stratus16 to Stratus18) were as bad as those previous to the cleaning. A second cleaning was performed before the last cast (Stratus19), with excellent results, no spikes were observed in this last cast. Maintenance and cleaning of the CTD were done by Paul Bouchard and Ron Comer.

As mentioned above data from the main CTD at station Stratus18 were corrupted. During the acquisition the data was fine (with the usual errors mentioned above), but after converting the binary file (.dat) to ASCII (.cnv) the file was corrupted.

Starting from station 11 we included a SBE 19 in the frame together with the main CTD. The data set corresponding to the stations Stratus11 and Stratus12 were spiky, in a similar way as the data obtained with the 911 CTD, while data from stations Stratus 13 and 14 were apparently in good condition. After station Stratus14 the CTD memory was erased. Of the new set of CTD casts, Stratus 15 to 19 were also spiky.

A preliminary processing of the CTD data was performed on board using a set of simple Matlab functions. Based on the ASCII raw data, we apply several criteria to eliminate spikes in the different variables. Pre-processed ASCII files were created averaging the data every one meter, we include in those files the same header presents in the ".cnv" files.

The preliminary processing for the 911 plus CTD consisted in the following steps:

- Remove all out-of-range values. The valid ranges used for the different variables were:

  0 db < pressure < 5000 db
  0 °C < temperature < 25 °C
  33 psu < salinity < 36 psu
  0 ml/L < oxygen < 6 ml/L
  Note that chosen values were selected based on the observations.

- Align oxygen sensor: Oxygen values were delayed 3.5 seconds (84 scans after the pressure sensor).

- Eliminate data with first difference between consecutive scans larger than a given value. The selected values for the different variables were:

  Pressure 0.25 db
  Salinity 0.001 psu
  Oxygen 0.005 ml/L
  Note that after we eliminated records with spikes in pressure no spike in temperature appear.

- Eliminate reversal. Records related to decreasing values in pressure were eliminated.

- The modal value every one db was estimated using ten intervals.

The preliminary processing for the SBE 19 CTD consisted in the following steps:

- Remove all out-of-range values. The valid ranges used for the different variables were:

  0 db < pressure < 5000 db
  0 °C < temperature < 25 °C
  33 < salinity < 36
  Note that chosen values were selected based on the observations.

- Eliminate data with first difference between consecutive scans larger than a given value. The selected values for the different variables were:

  Pressure 2 db
  Salinity 0.05 psu
  Note that after we eliminate records with spike in pressure no spike in temperature appear.

- Eliminate reversal. Records related to decreasing values in pressure were eliminated.

- The mean value every one db was calculated.

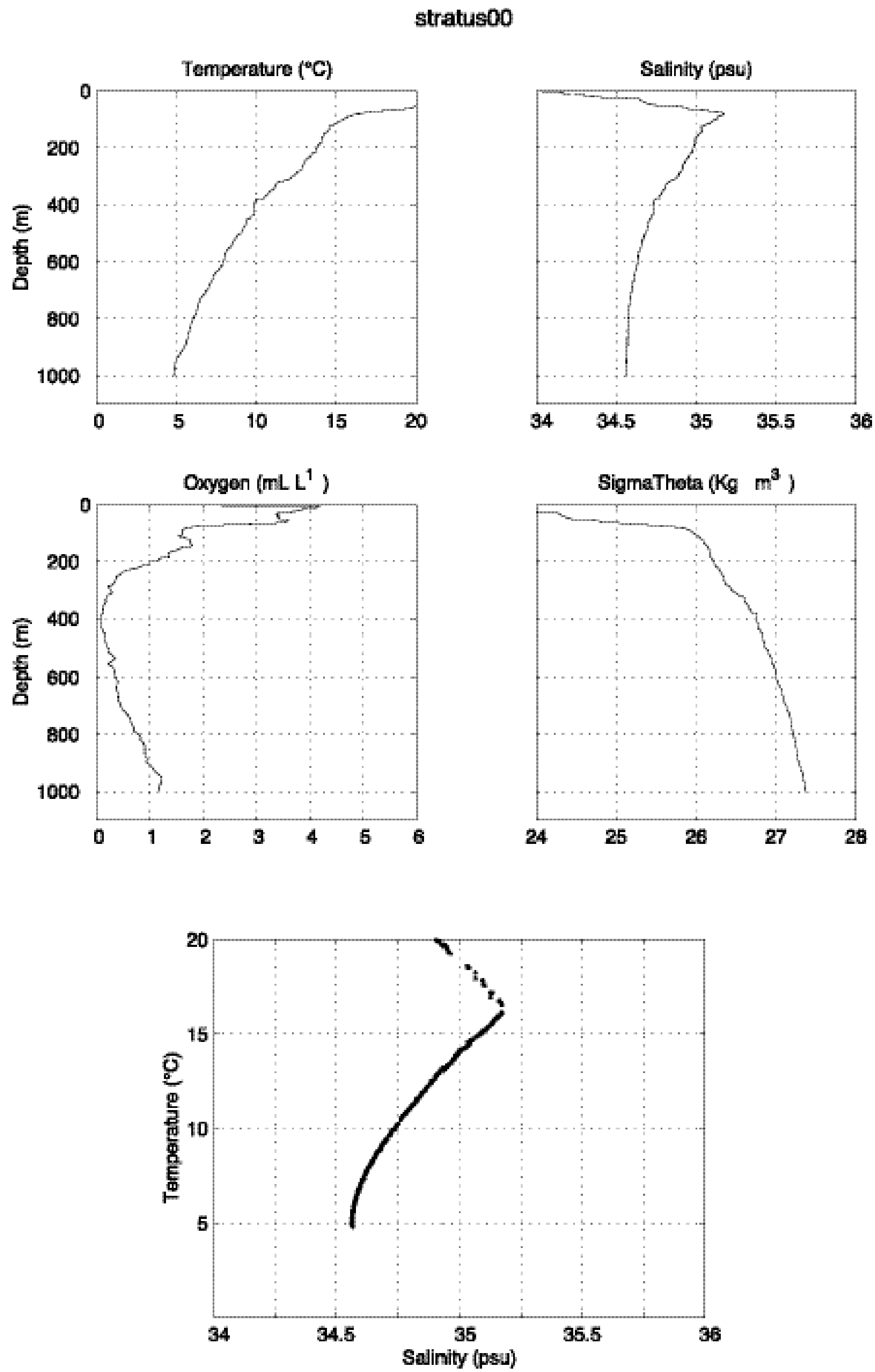


Figure 28. Stratus 00 CTD Cast.

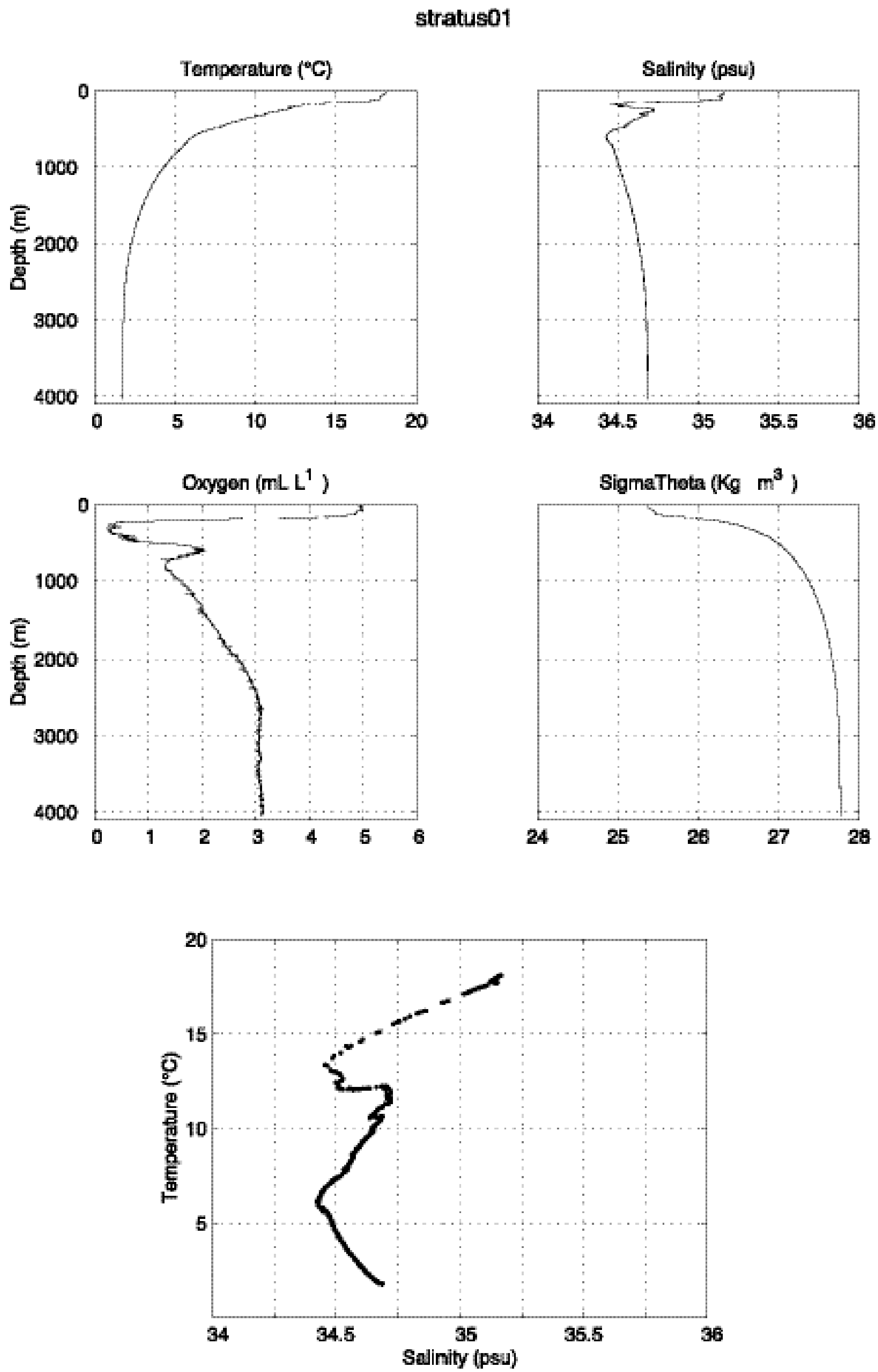


Figure 29. Stratus 00 CTD Cast.

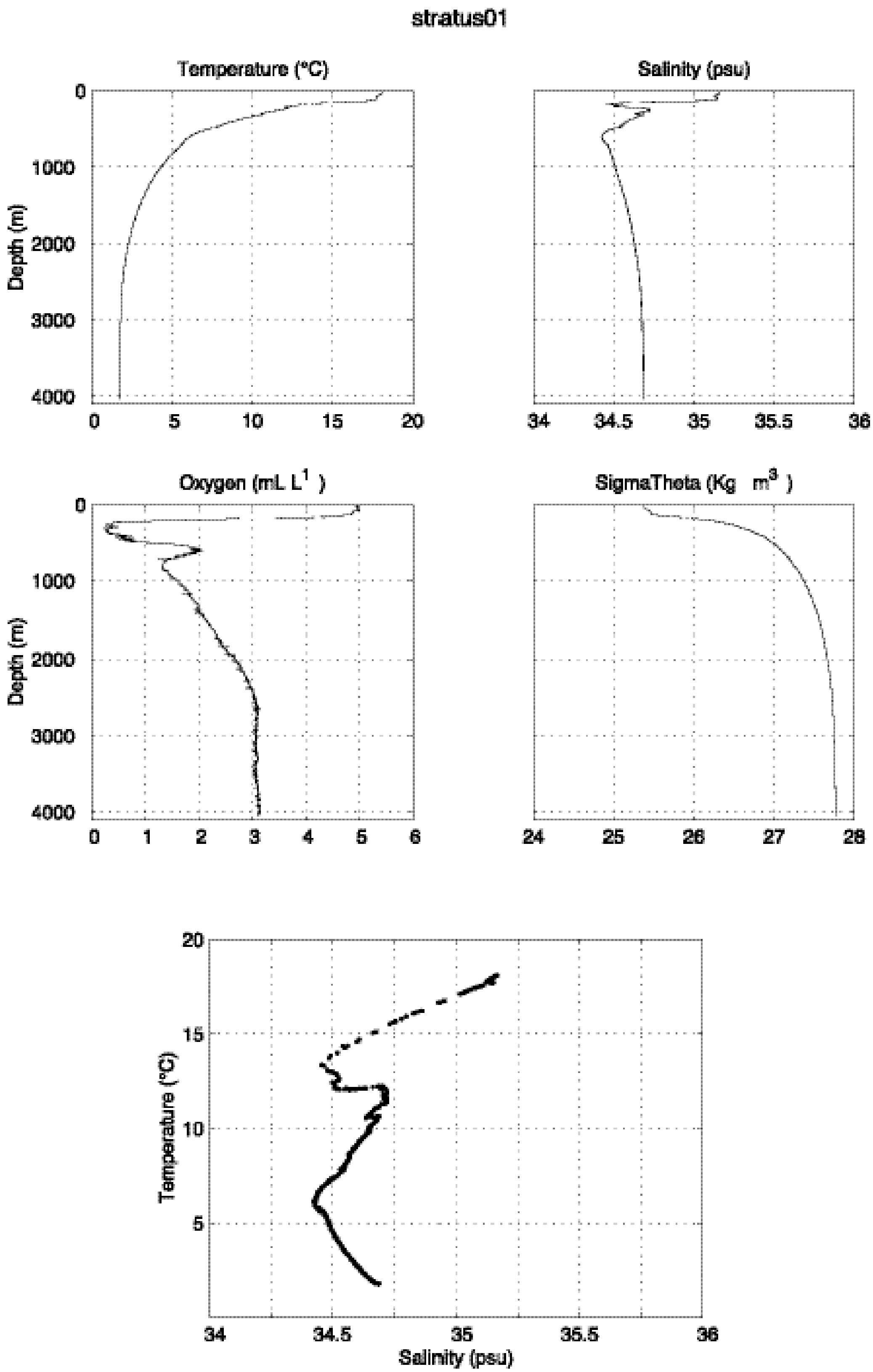


Figure 30. Stratus 01 CTD Cast.

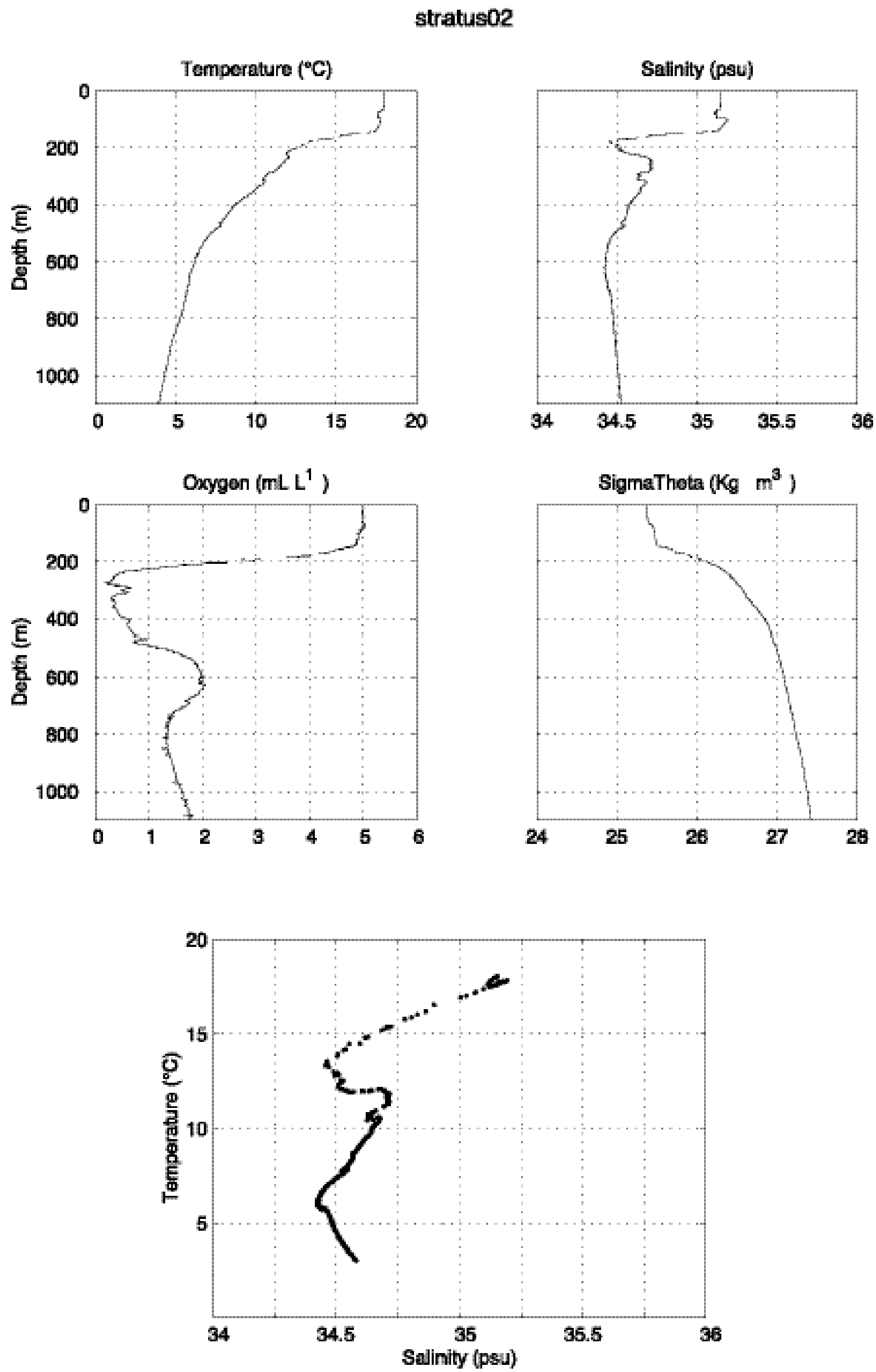


Figure 31. Stratus 02 CTD Cast.

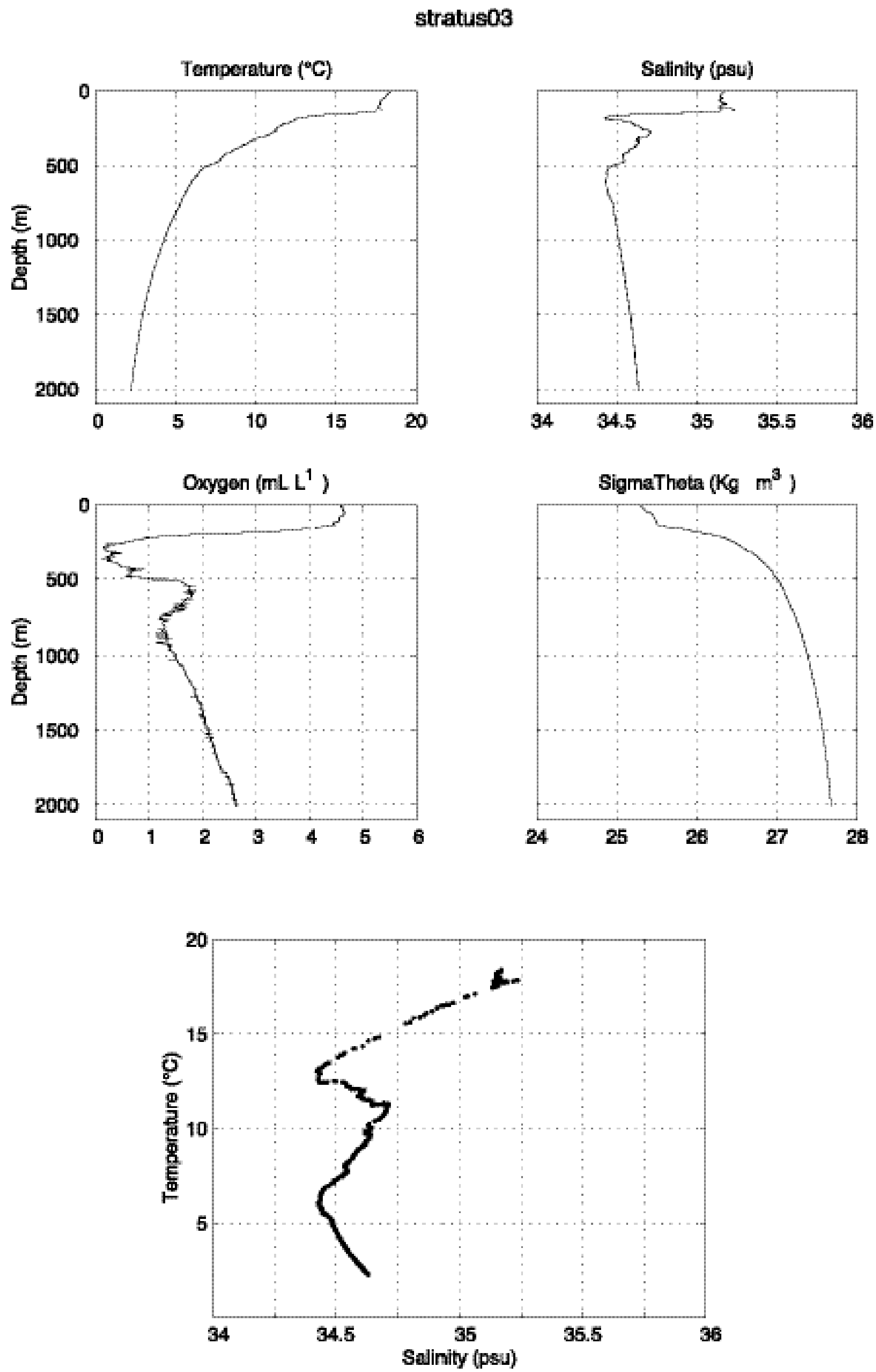


Figure 32. Stratus 03 CTD Cast.

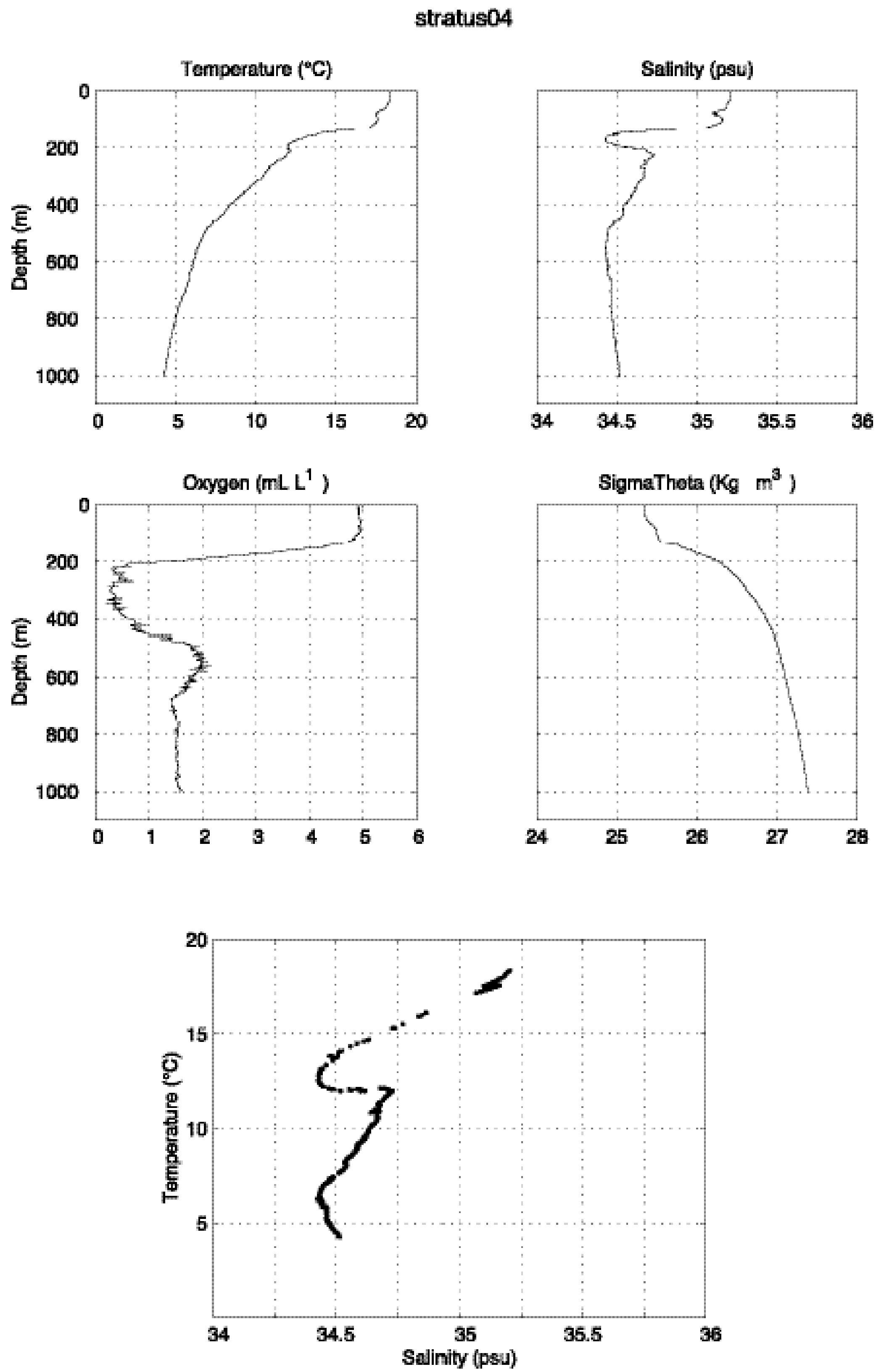


Figure 33. Stratus 04 CTD Cast.

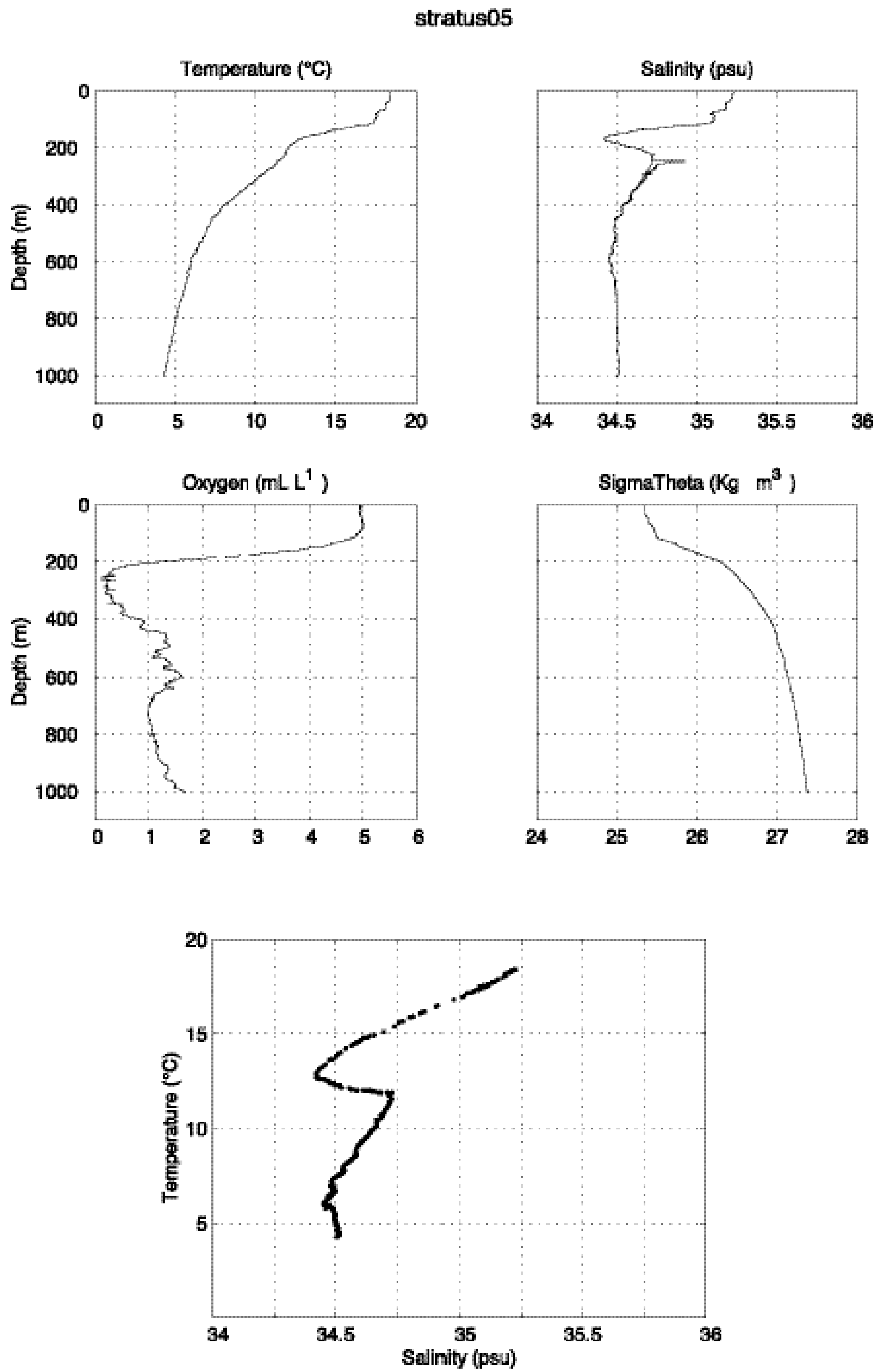


Figure 34. Stratus 05 CTD Cast.

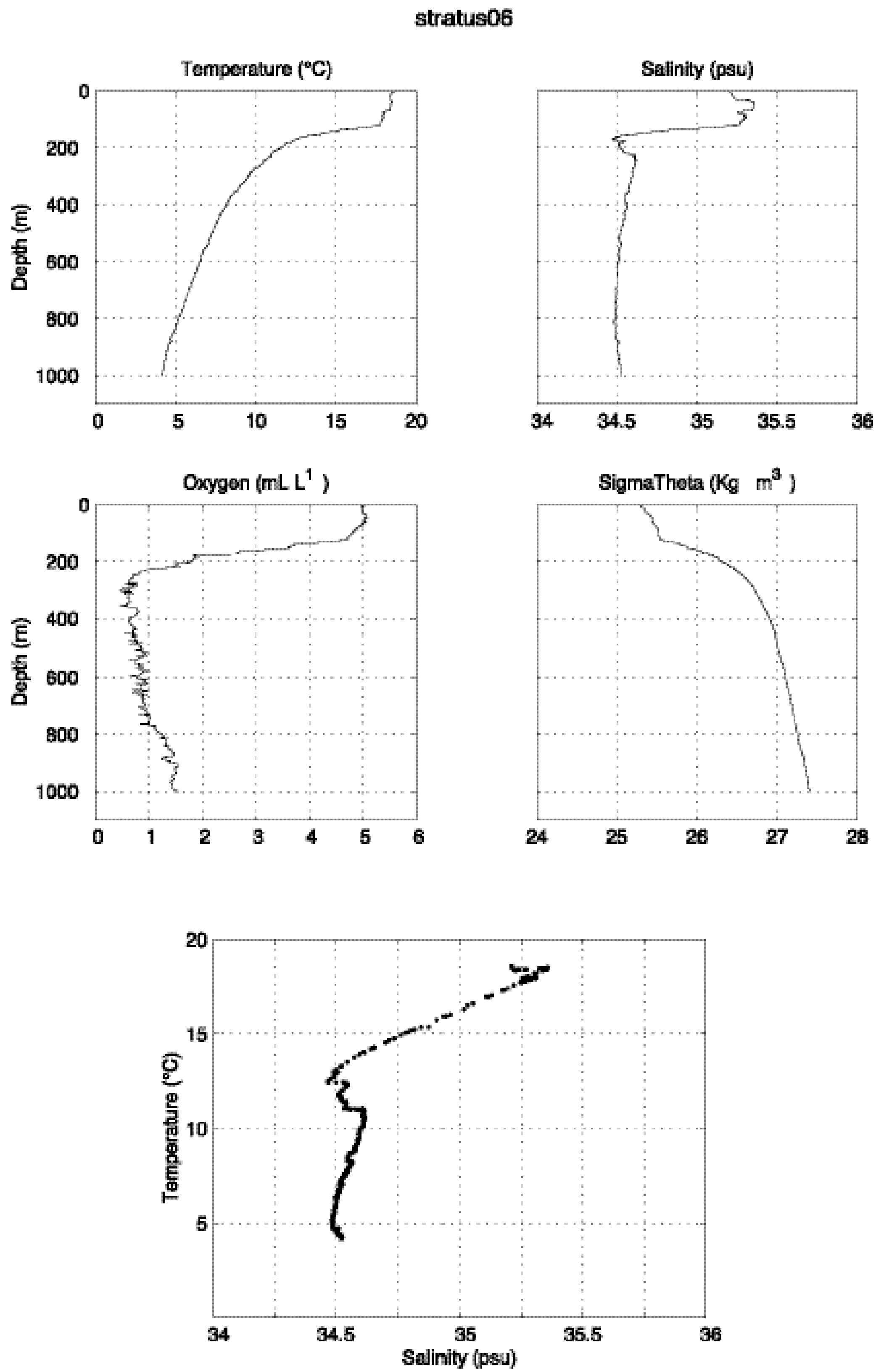


Figure 35. Stratus 06 CTD Cast.

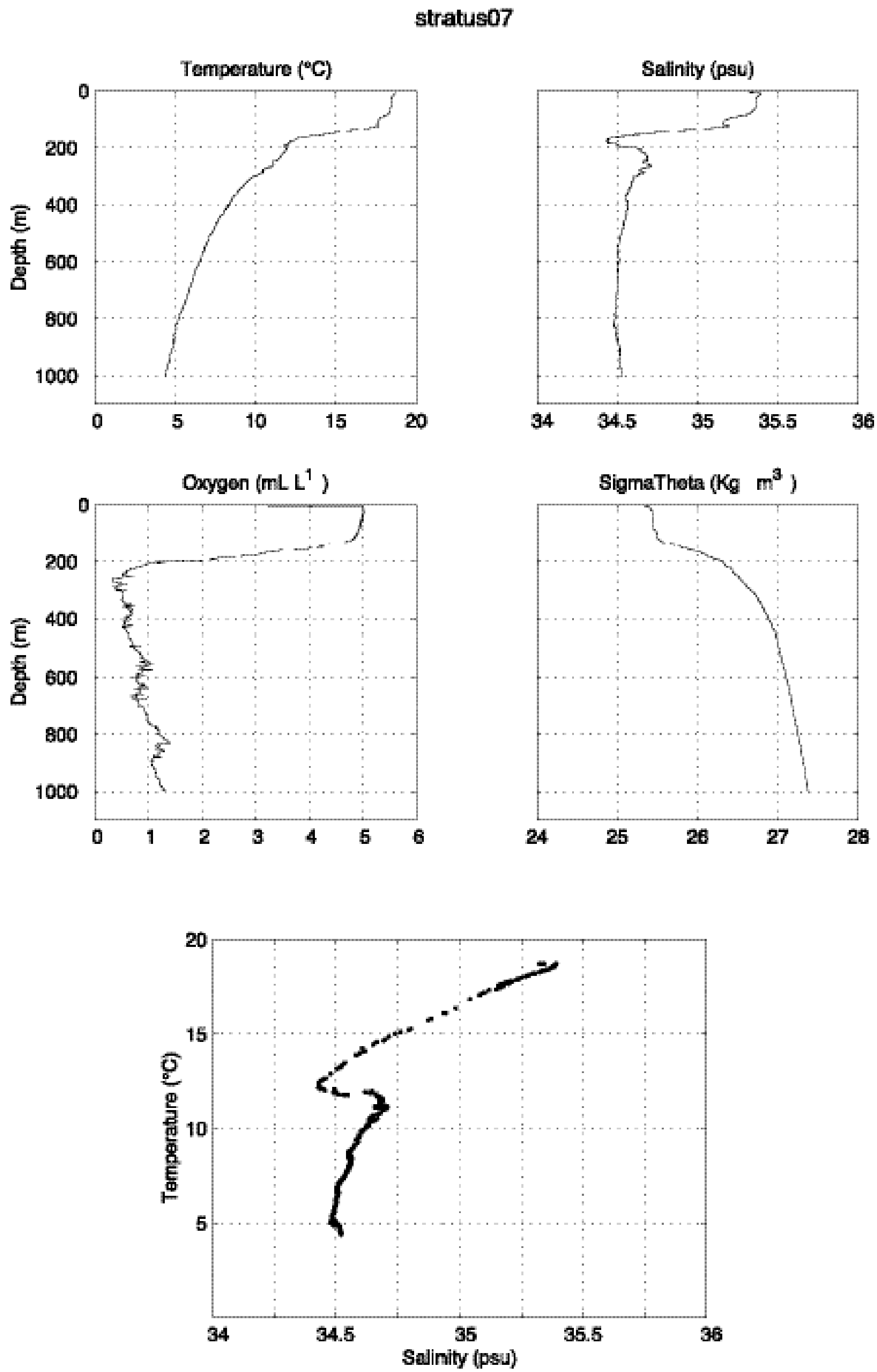


Figure 36. Stratus 07 CTD Cast.

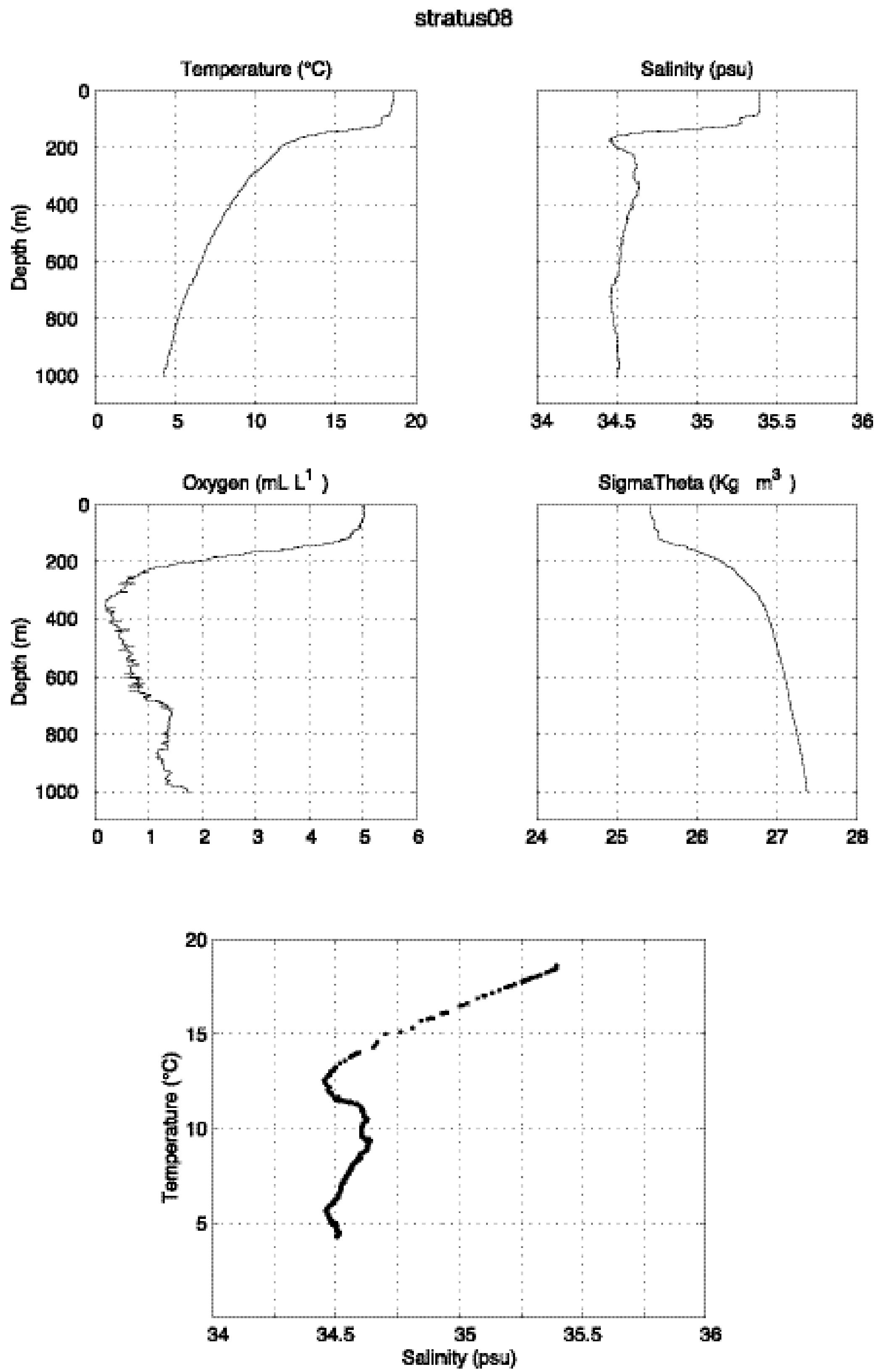


Figure 37. Stratus 08 CTD Cast.

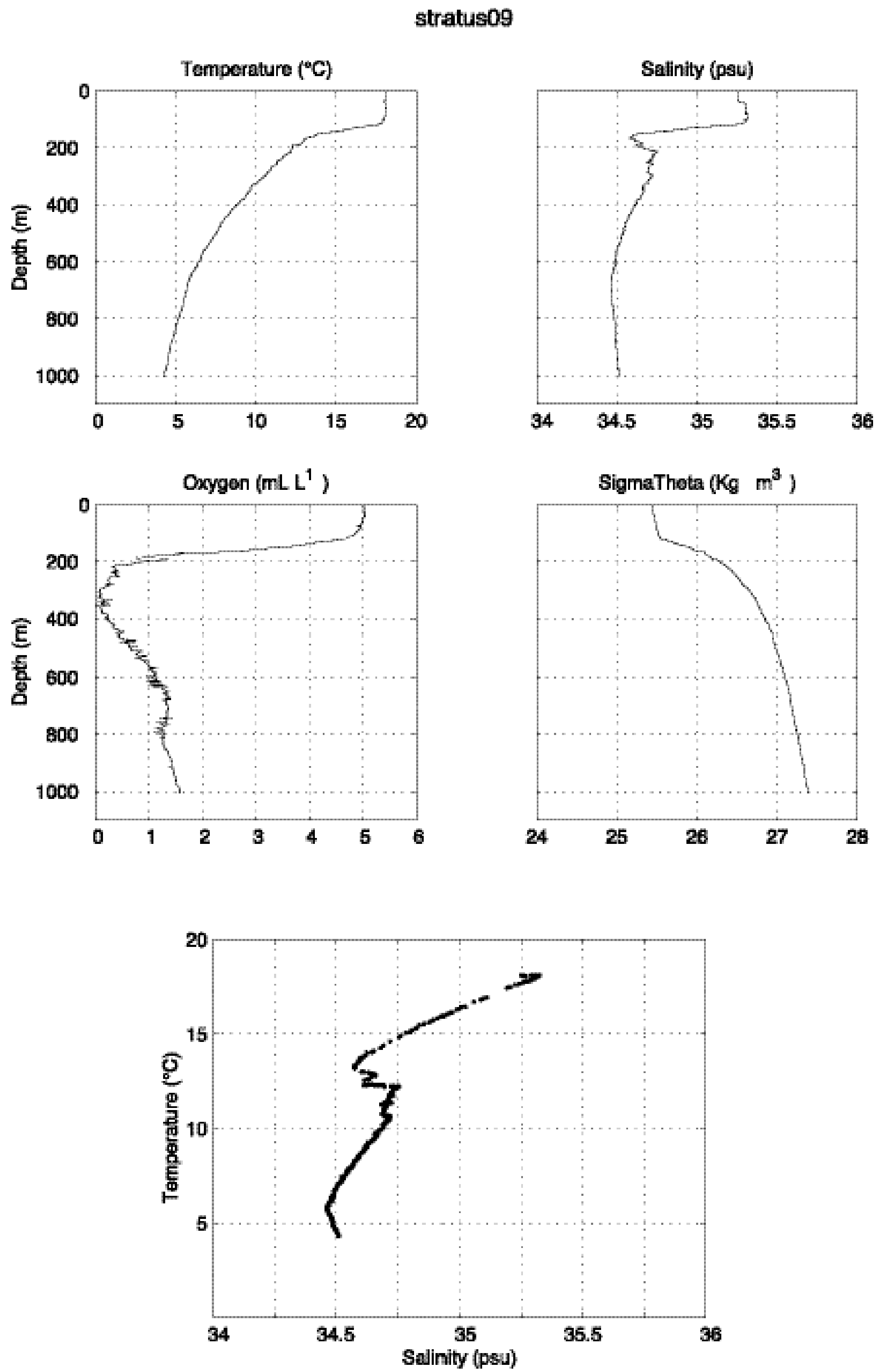


Figure 38. Stratus 09 CTD Cast.

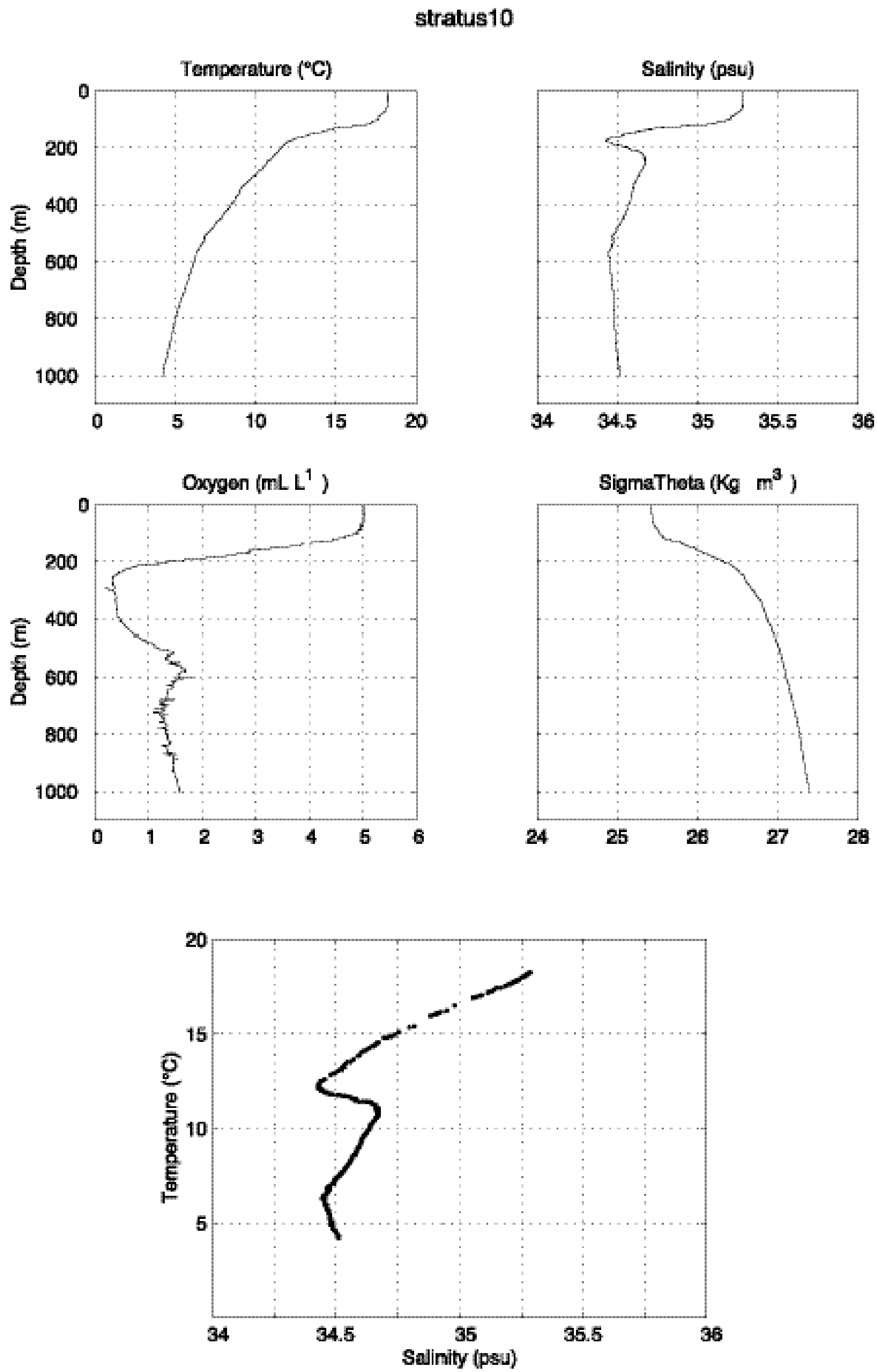


Figure 39. Stratus 10 CTD Cast.

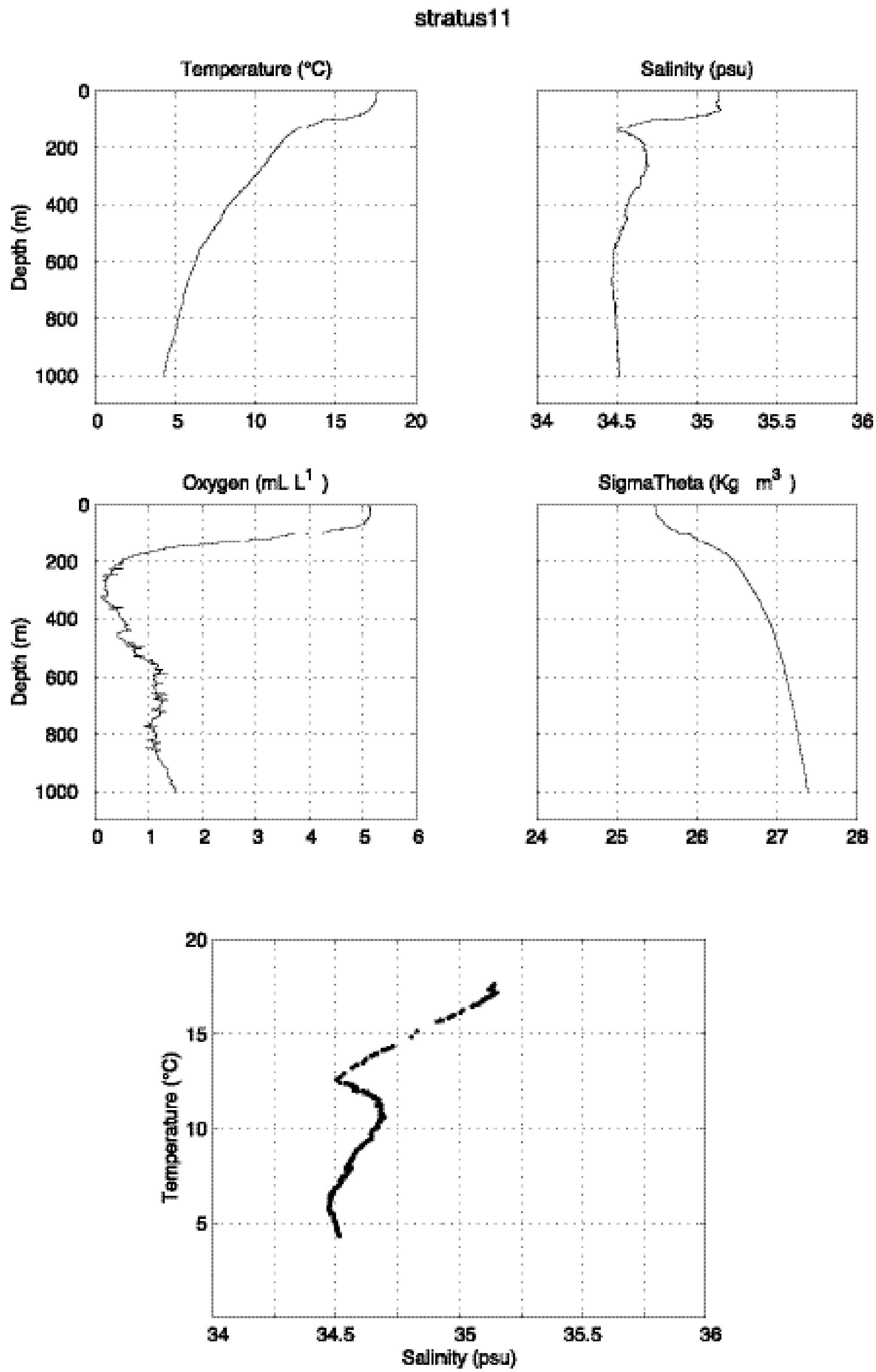


Figure 40. Stratus 11 CTD Cast.

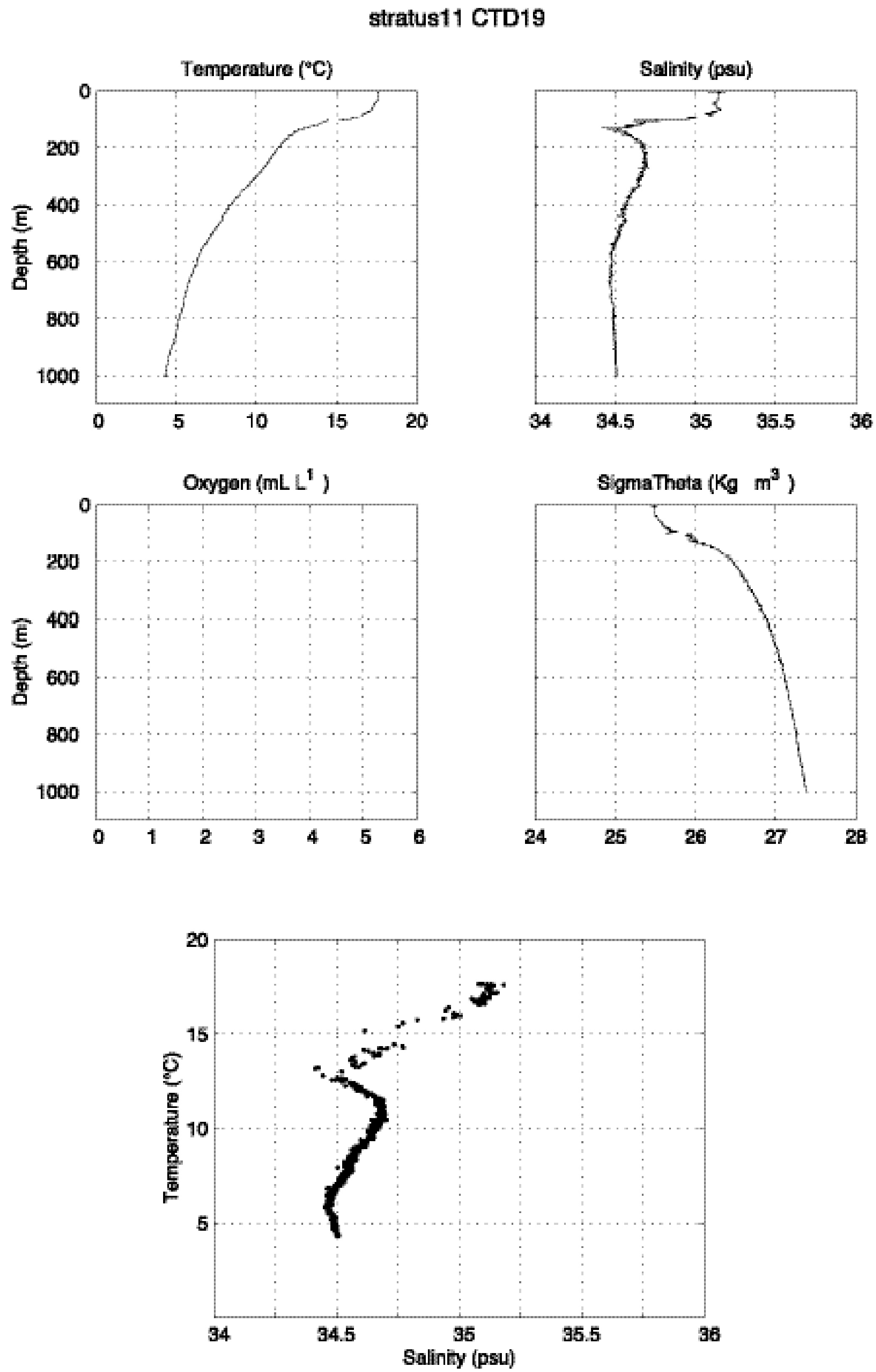


Figure 41. Stratus 11 CTD Cast, SBE 19 Data.

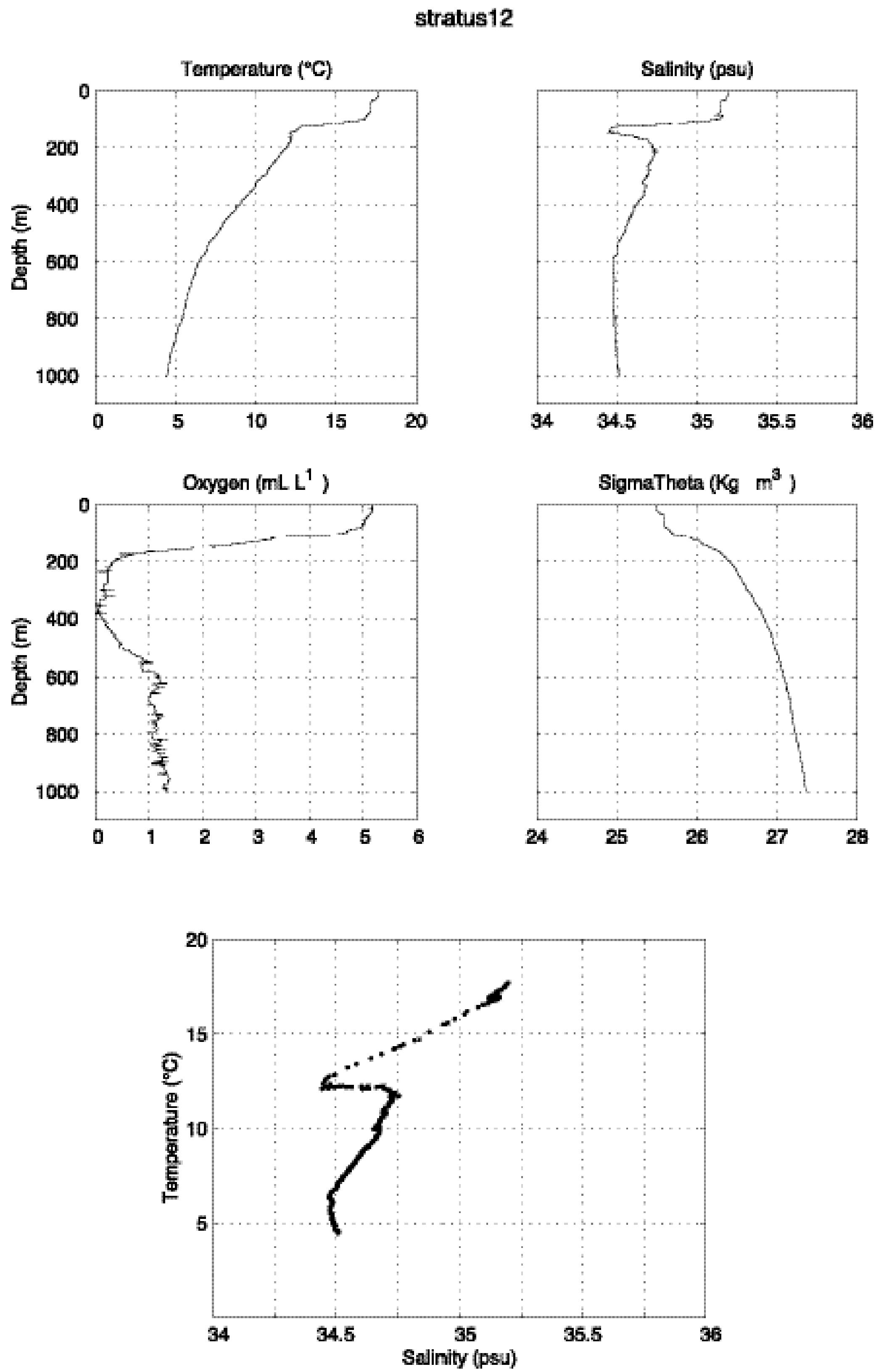


Figure 42. Stratus 12 CTD Cast.

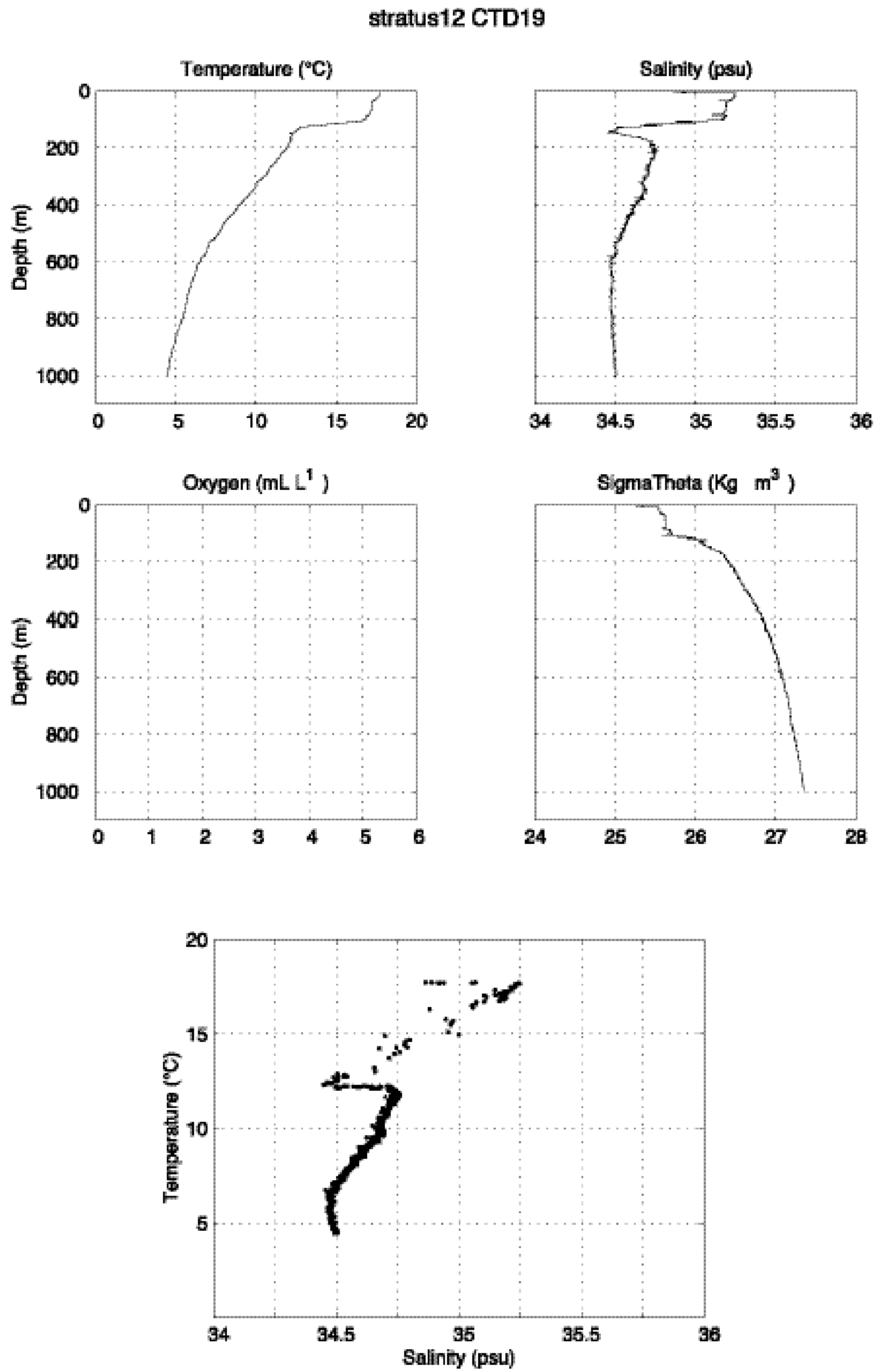


Figure 43. Stratus 12 CTD Cast, SBE 19 Data.

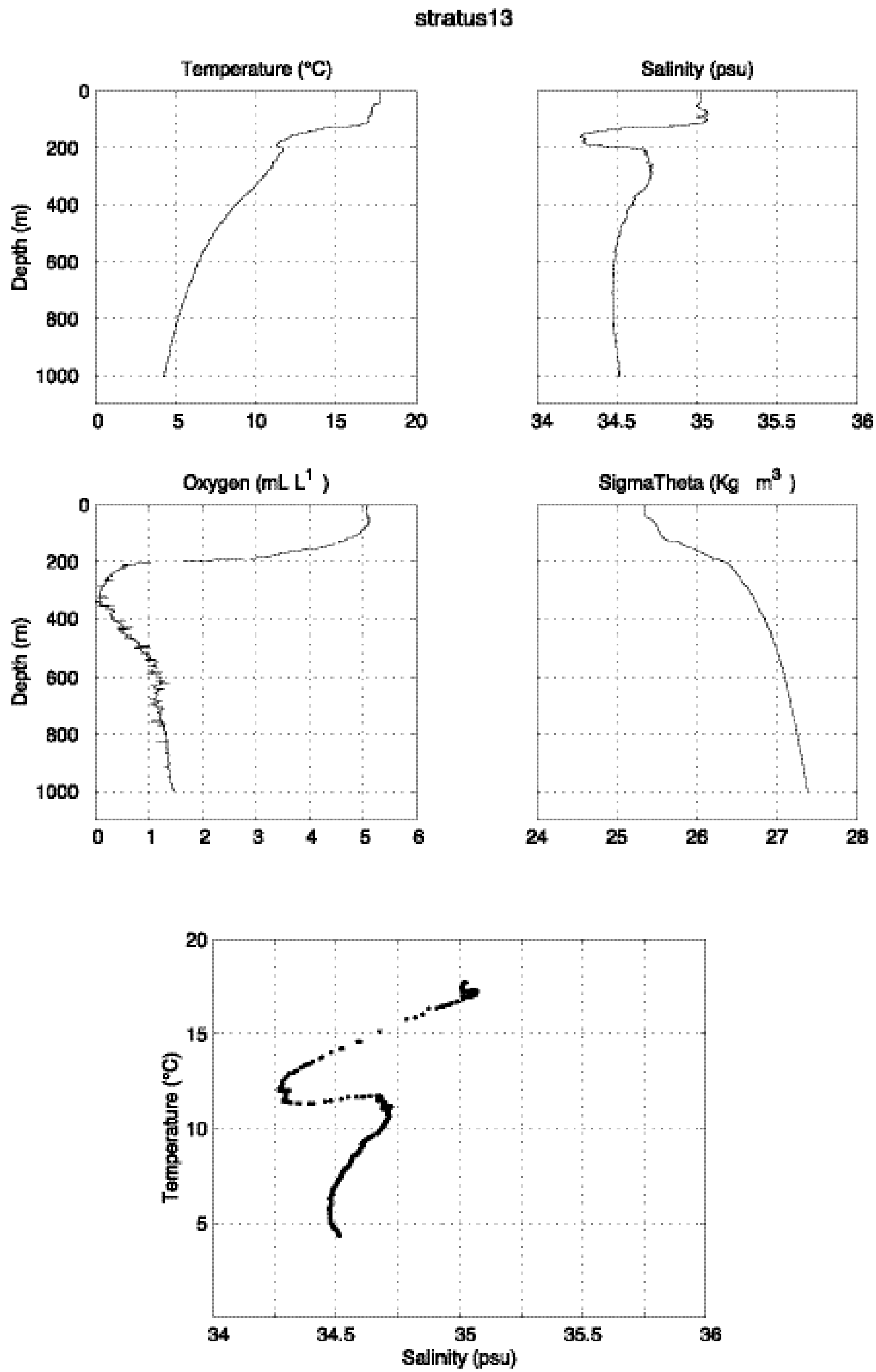


Figure 44. Stratus 13 CTD Cast.

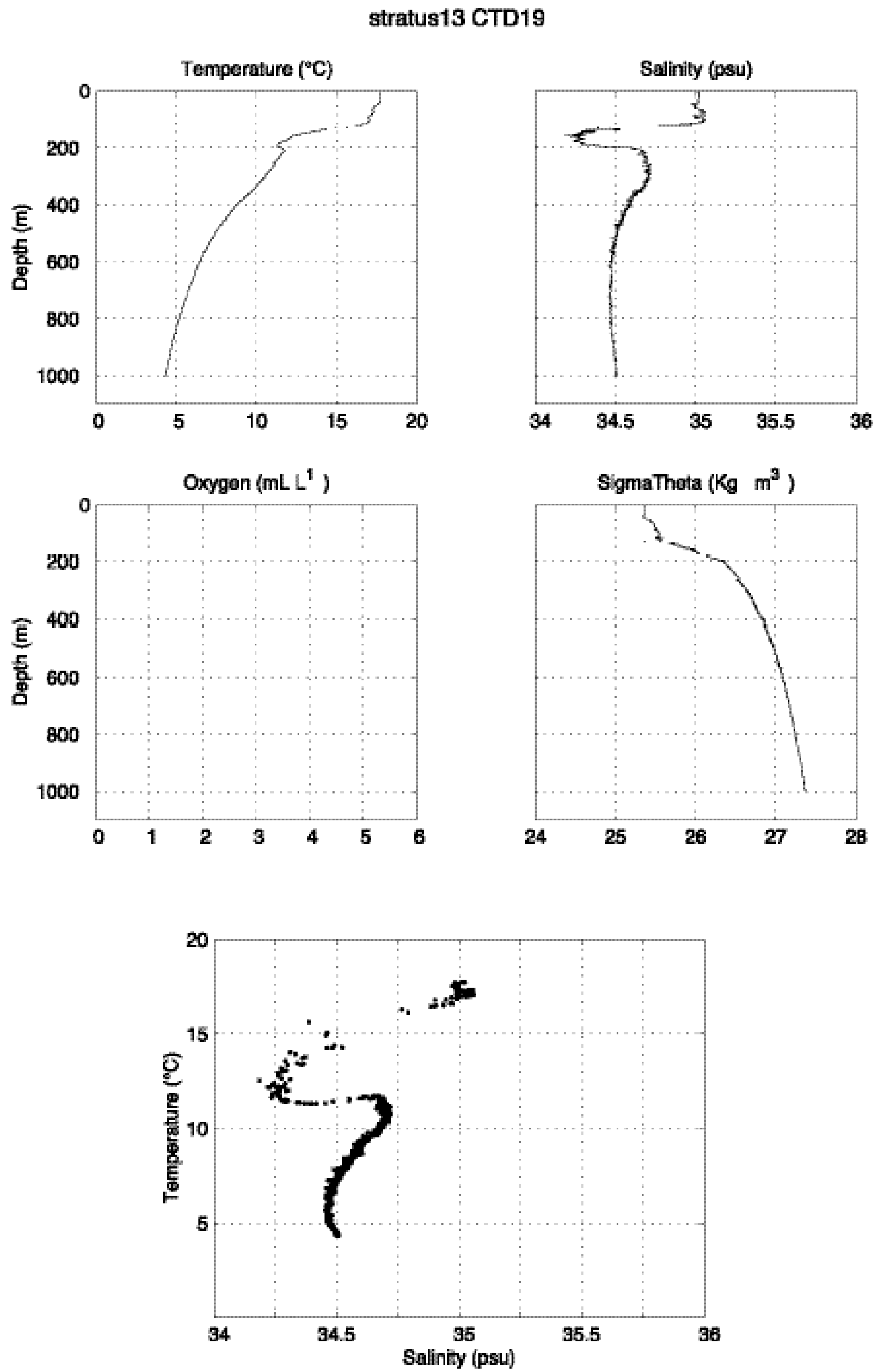


Figure 45. Stratus 13 CTD Cast, SBE 19 Data.

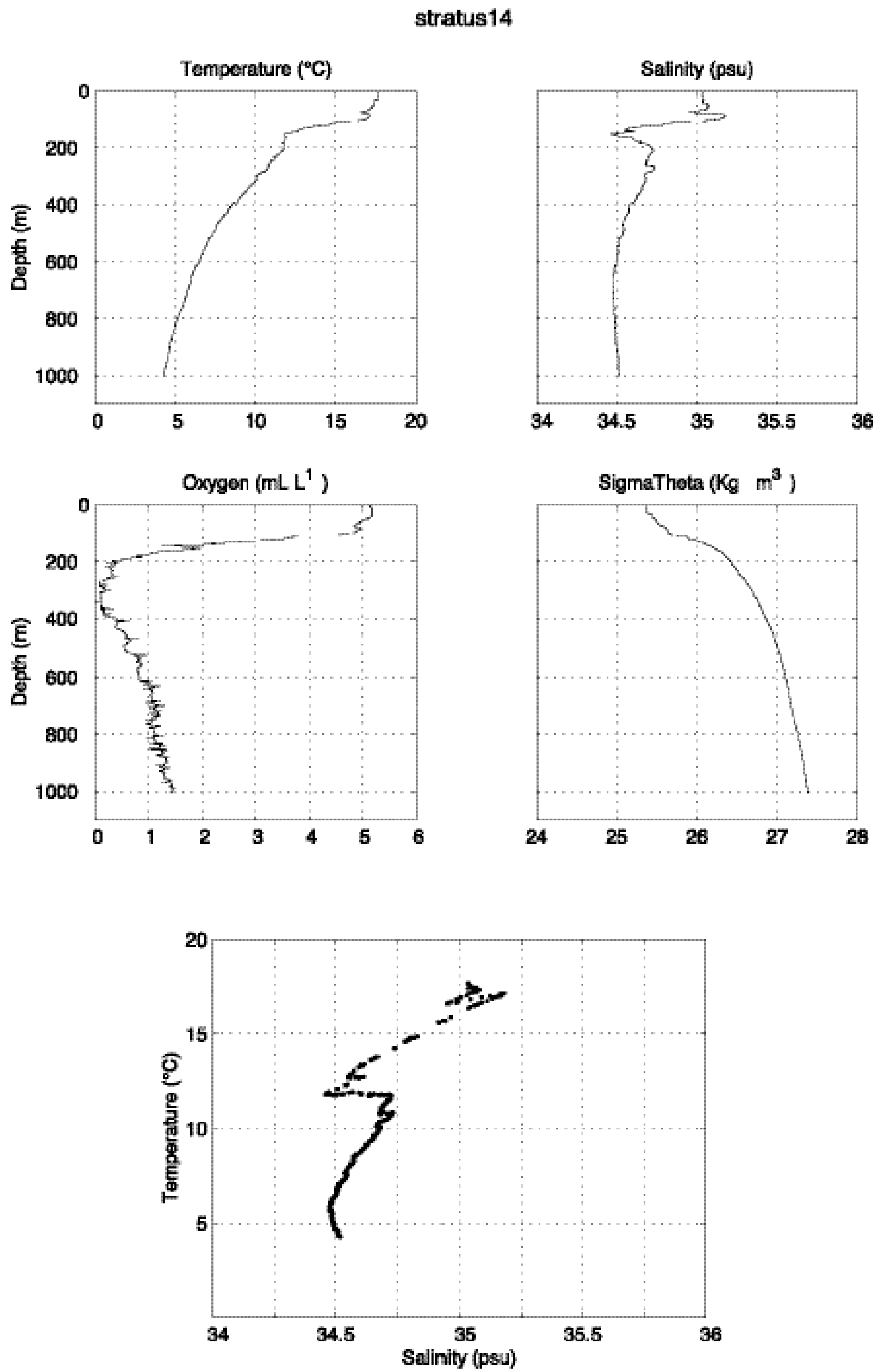


Figure 46. Stratus 14 CTD Cast.

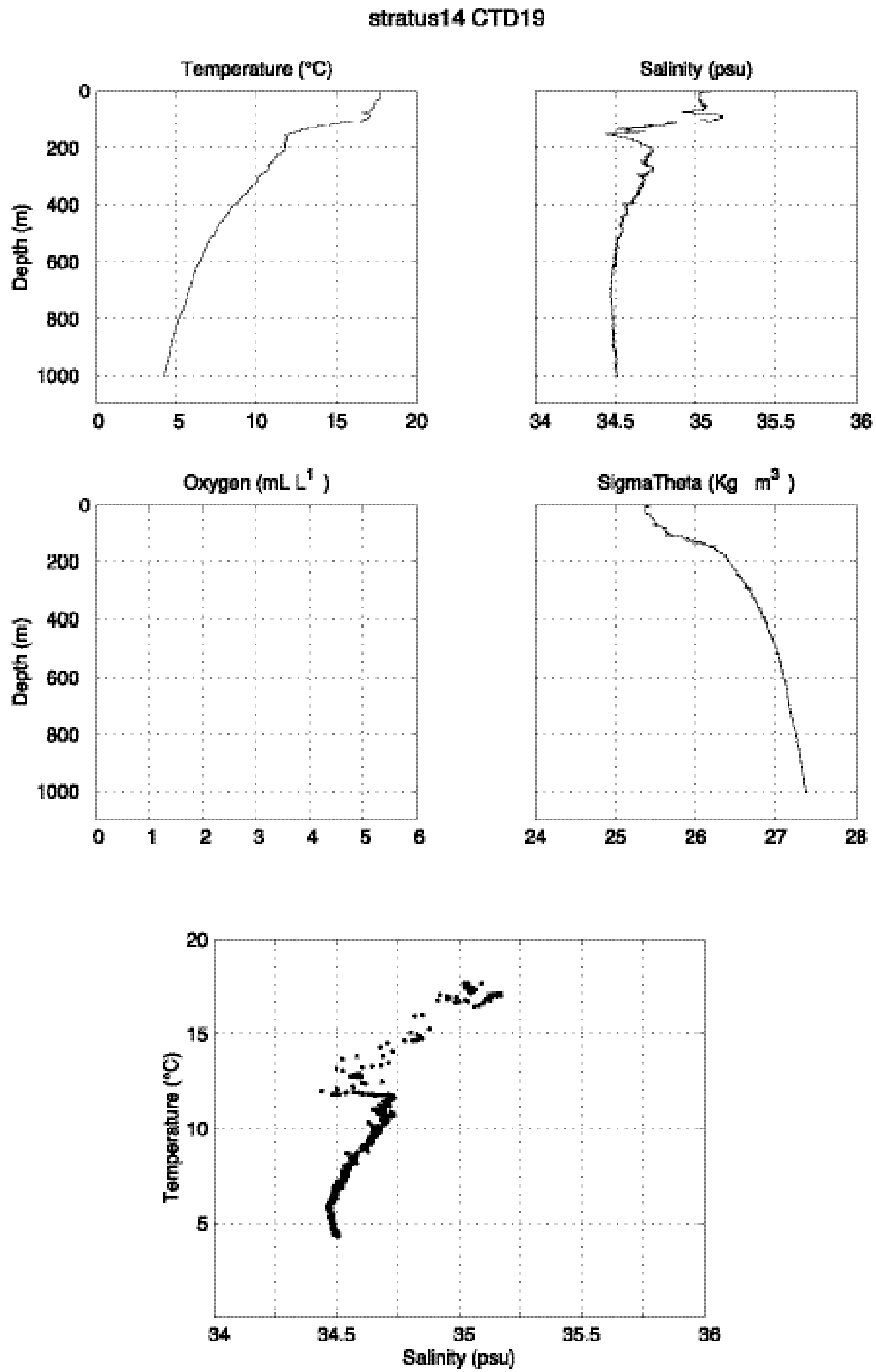


Figure 47. Stratus 14 CTD Cast, SBE 19 Data.

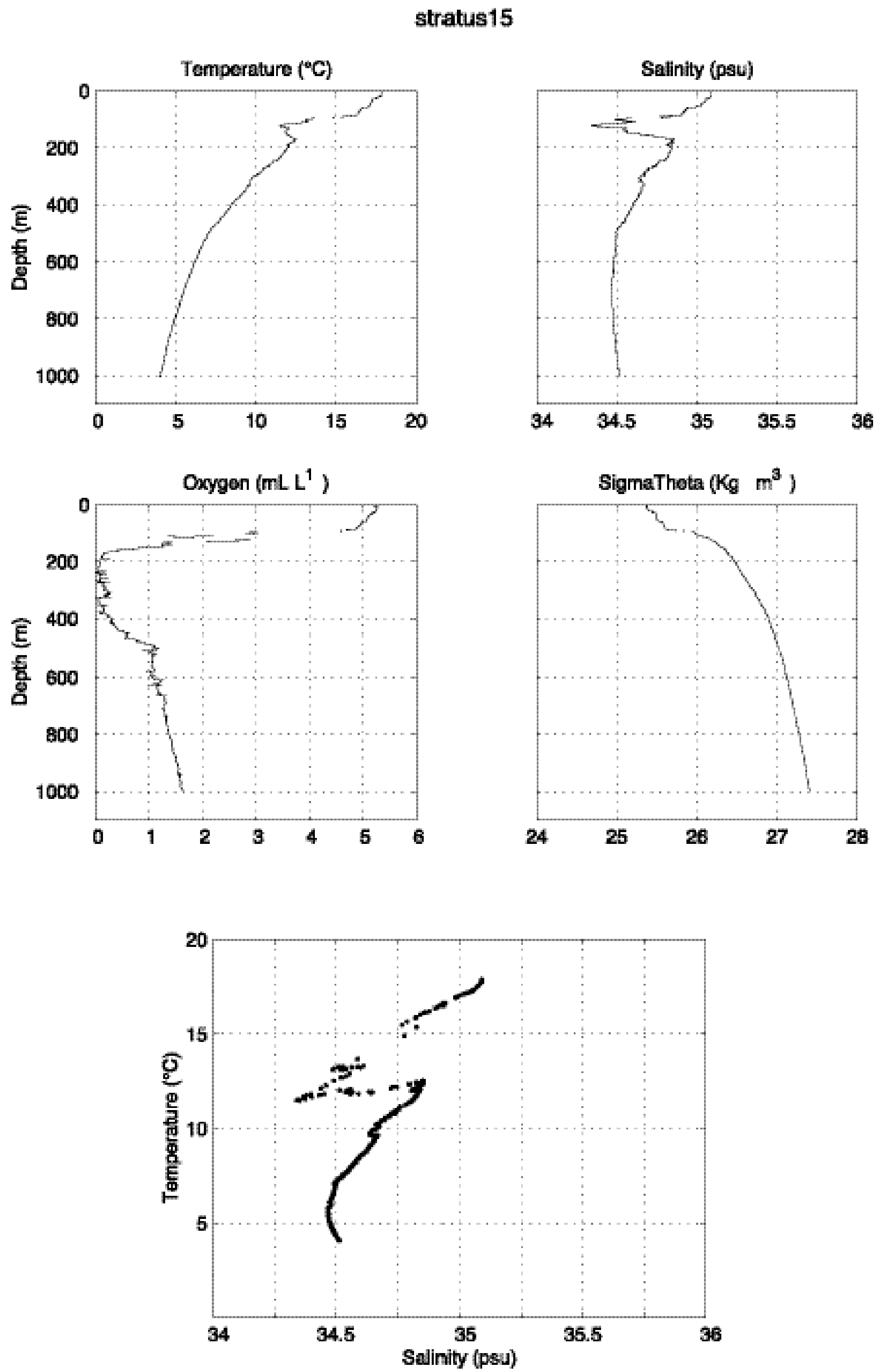


Figure 48. Stratus 15 CTD Cast.

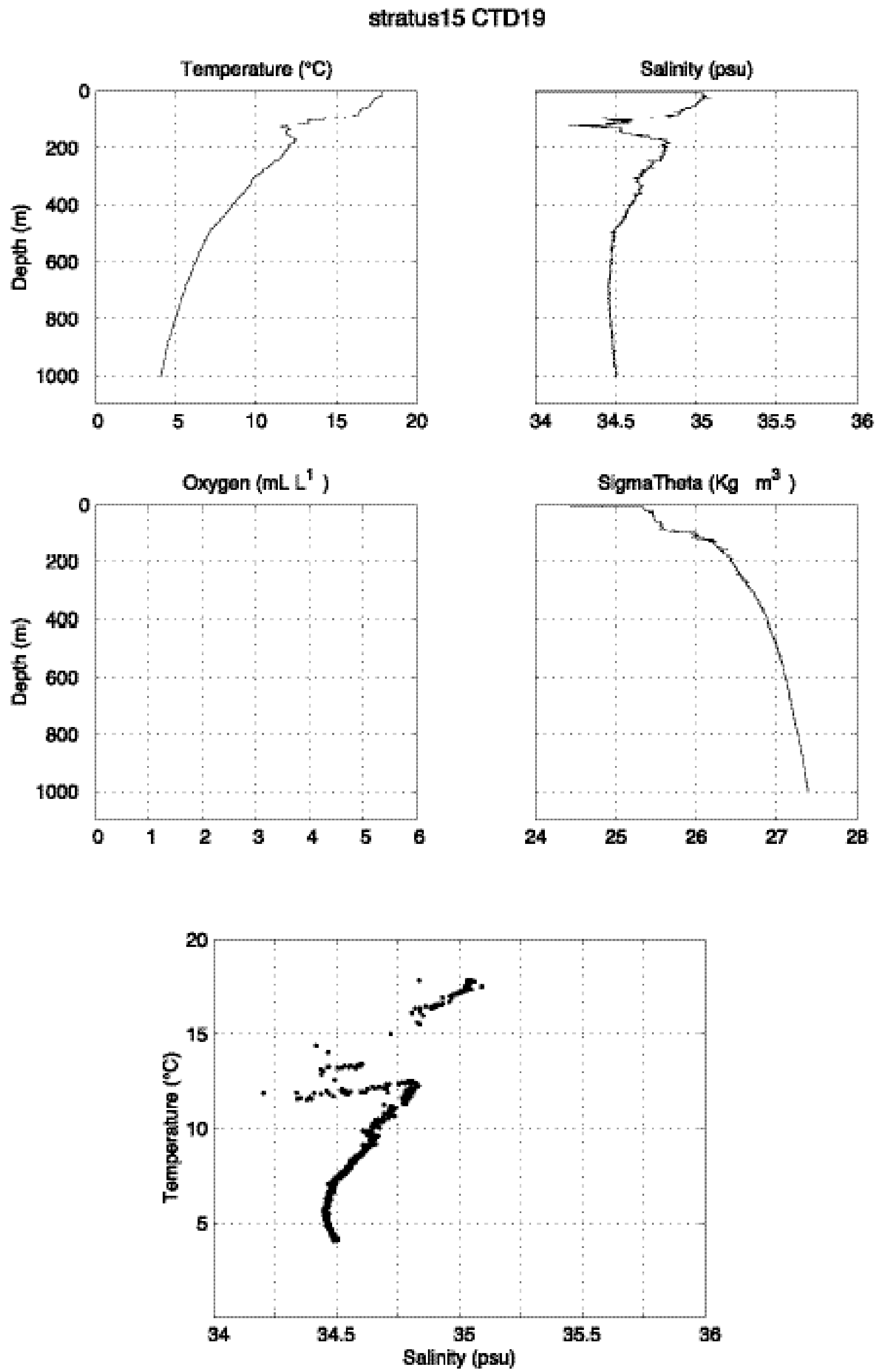


Figure 49. Stratus 15 CTD Cast, SBE 19 Data.

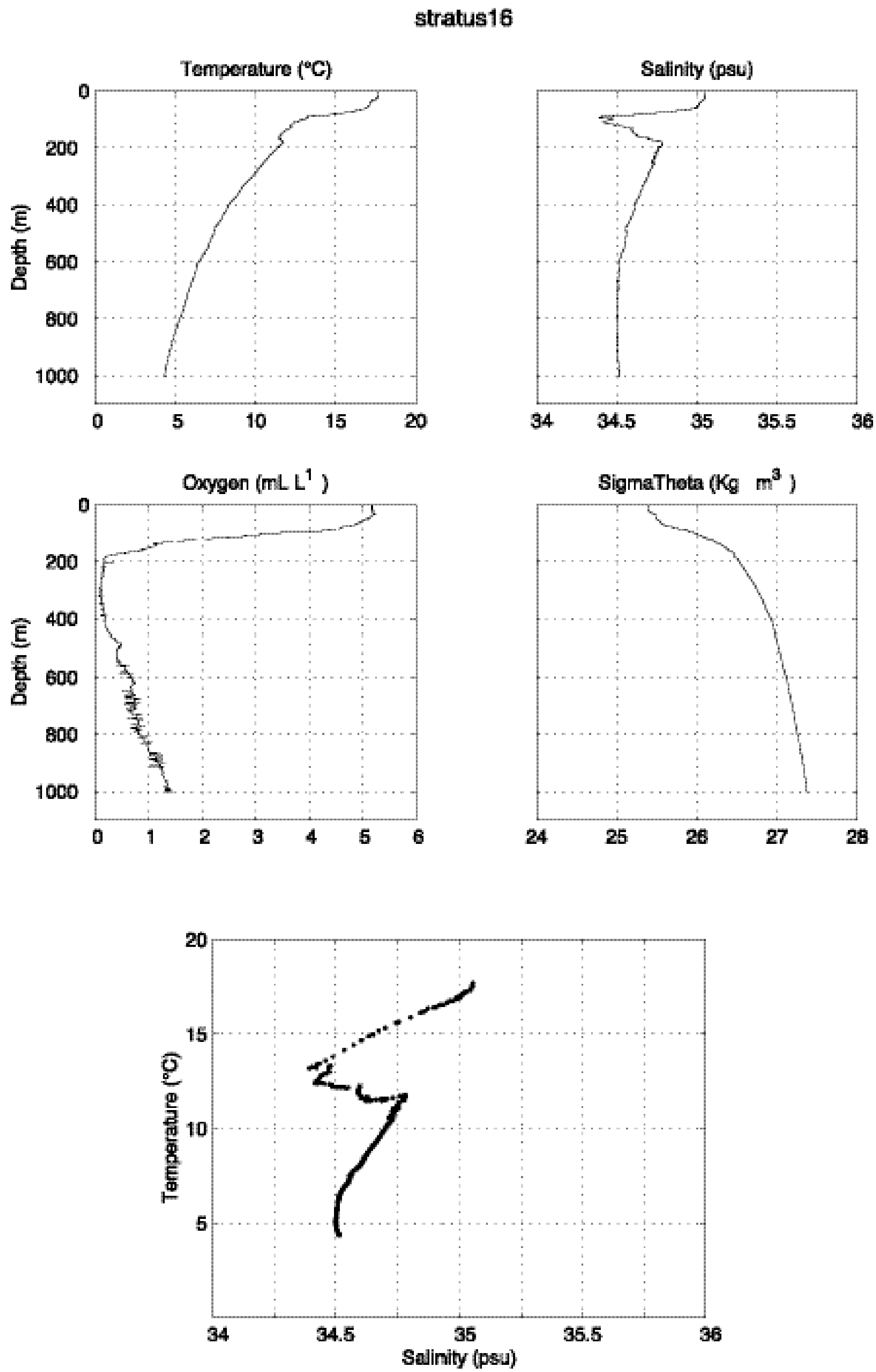


Figure 50. Stratus 16 CTD Cast.

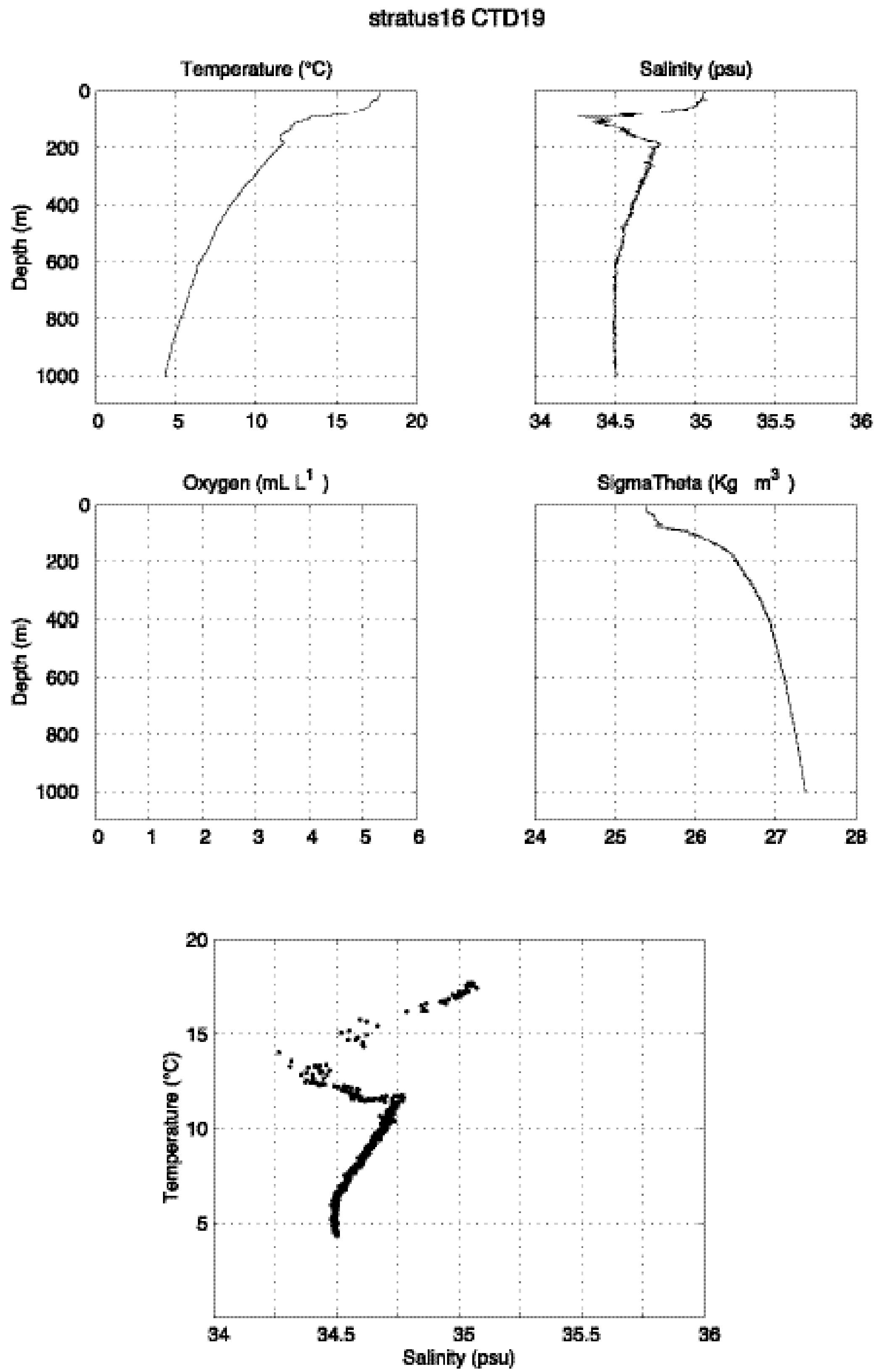


Figure 51. Stratus 16 CTD Cast, SBE 19 Data.

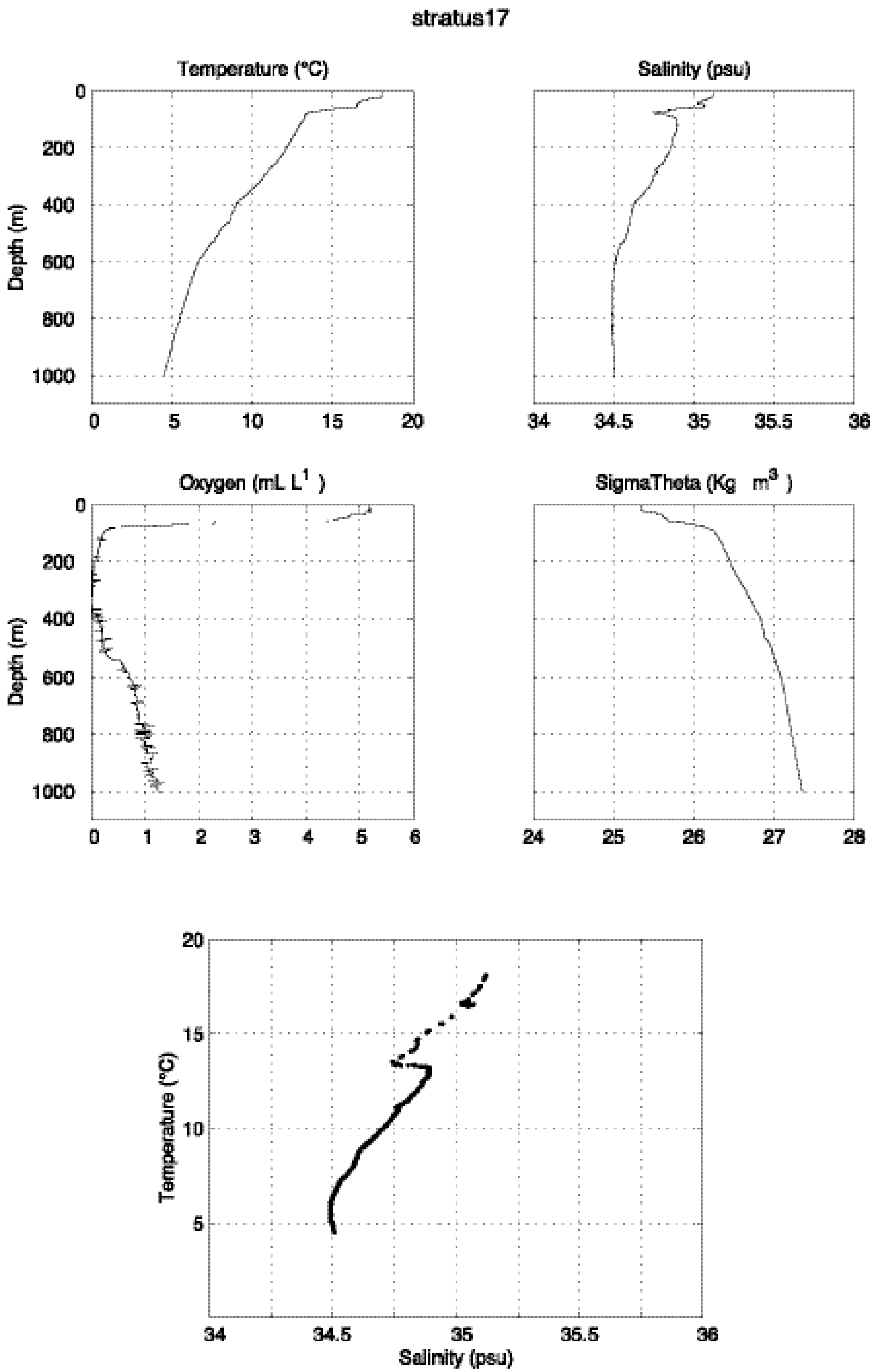


Figure 52. Stratus 17 CTD Cast.

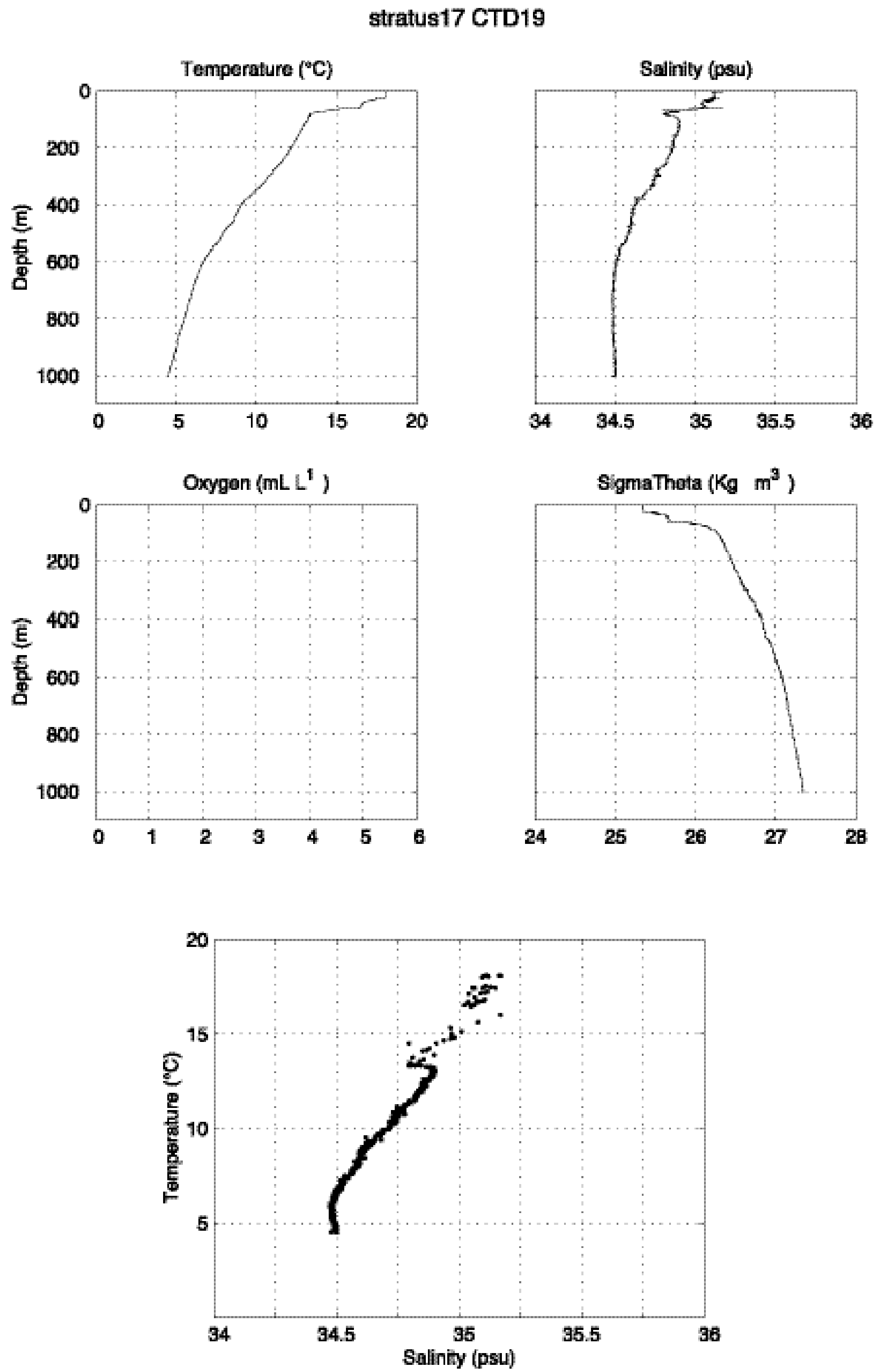


Figure 53. Stratus 17 CTD Cast, SBE 19 Data.

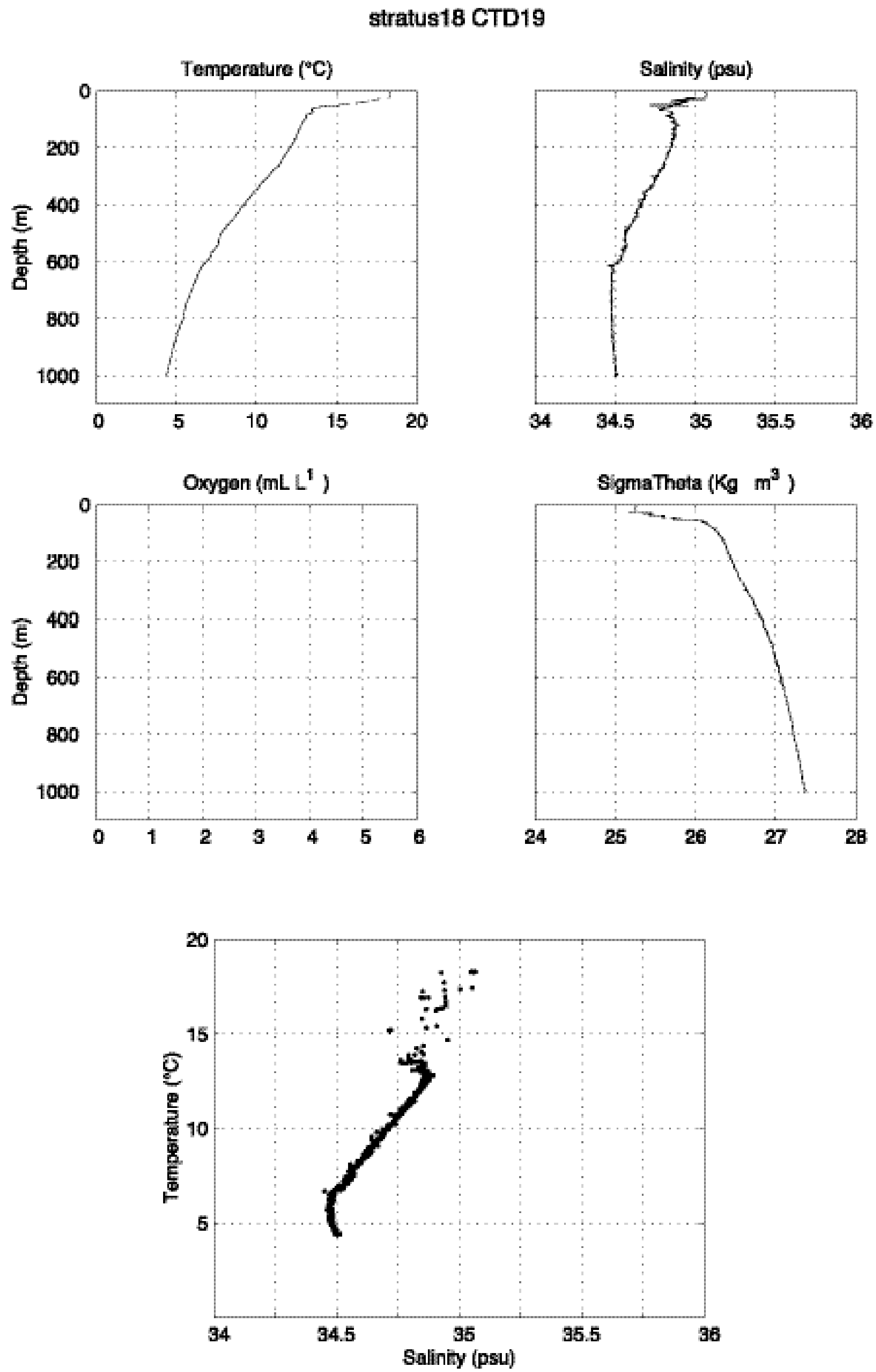


Figure 54. Stratus 18 CTD Cast, SBE 19 Data.

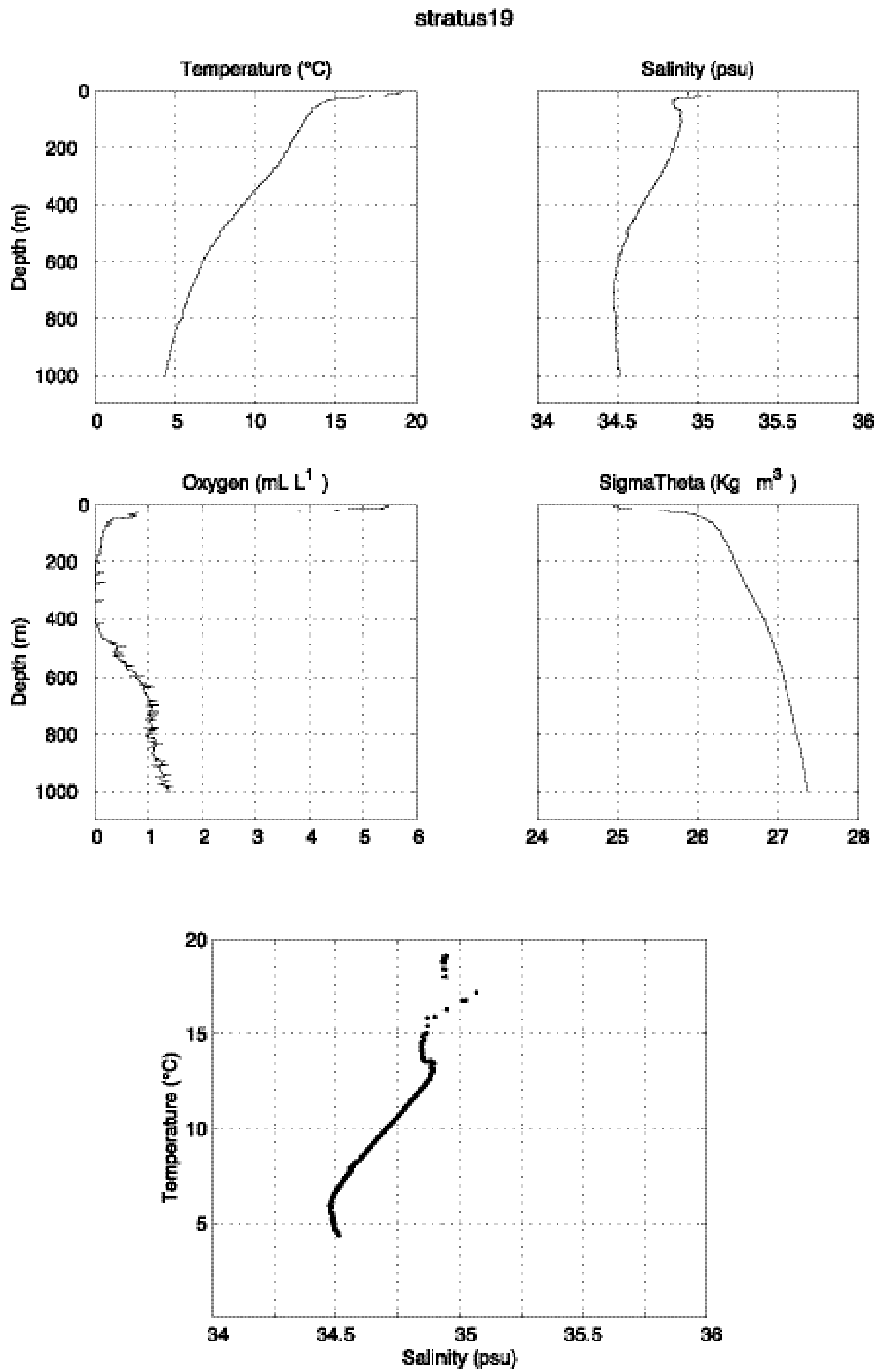


Figure 55. Stratus 19 CTD Cast.

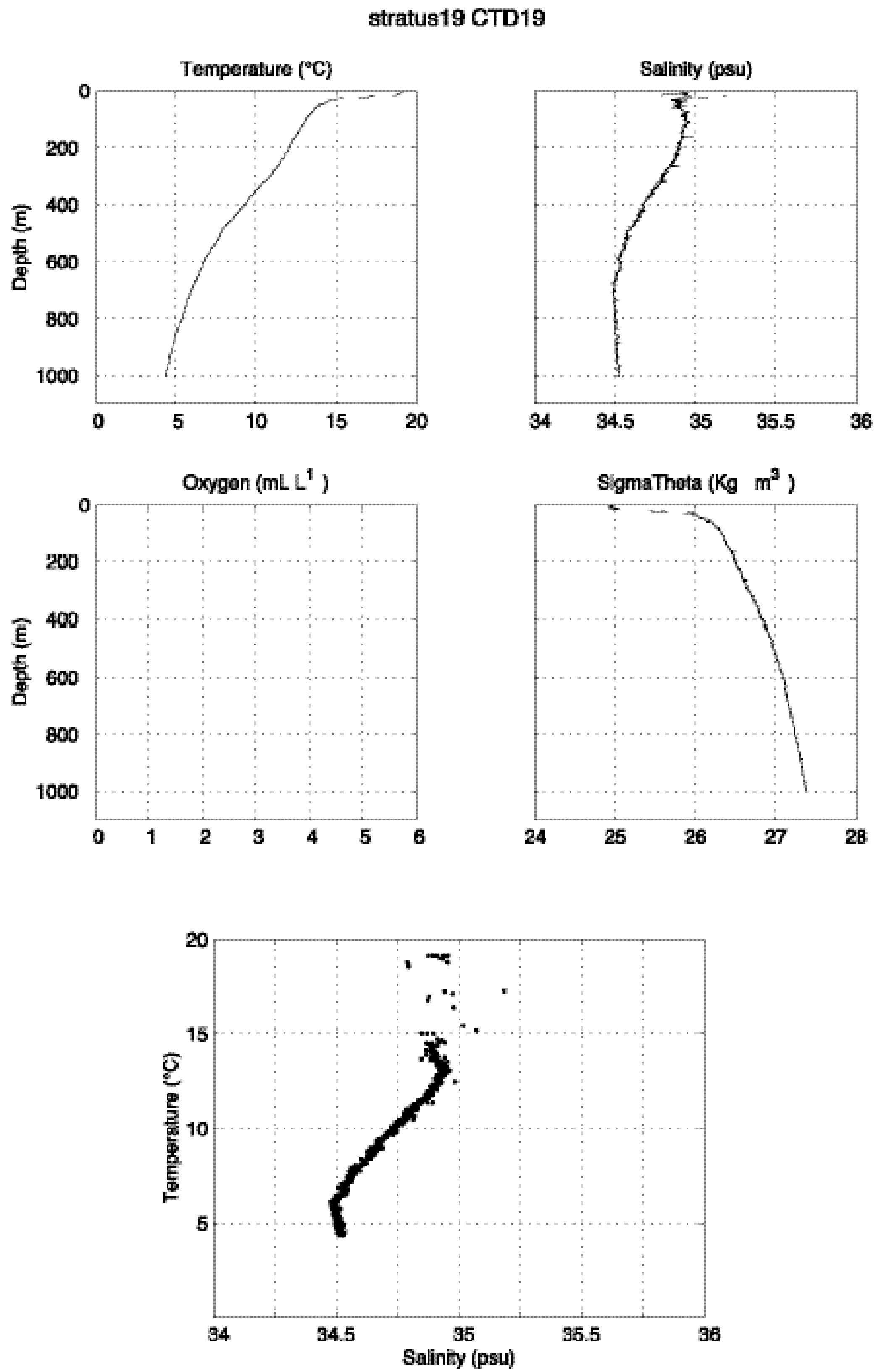


Figure 56. Stratus 19 CTD Cast, SBE 19 Data.

V. SHIPBOARD MEASUREMENTS

The R/V *Melville* was equipped with a variety of scientific and navigational equipment during the Stratus 2002 cruise. As mentioned earlier in the report, some of this equipment was used to verify meteorological instrumentation on the buoys. This section will give information on the shipboard equipment and some basic data plots. Table 17 outlines the equipment onboard the *Melville*.

Table 17. Scientific Equipment onboard the R/V *Melville*

Equipment	Manufacturer / Model	Additional Information
Multiyear Echo sounder	Sea beam 2000	12 kHz frequency, 120° swath, bathymetry, and sides can
Sub-bottom Profiler[7]	Knudsen 320 B	3.5 and 12 kHz frequency
Magnetometer	Geometric G-886	Towed behind ship
Gravity Meter	Bell BGM-3	
Acoustic Doppler Current Profiler (ADCP)	RDI Narrowband	150 kHz
Underway Meteorological and Sea Surface Data System		

[7] The Knudsen sub-bottom profiler was not in use during the Stratus 2002 cruise.

A. Navigation

The R/V *Melville* provided GPS-based navigation information. This data provided time series of position, ship's course, and ship's speed. The navigation data helped the UOP group place the moorings in the correct locations, and also gave the locations of the CTD casts. Figure 57 shows the cruise track for Vanc03.

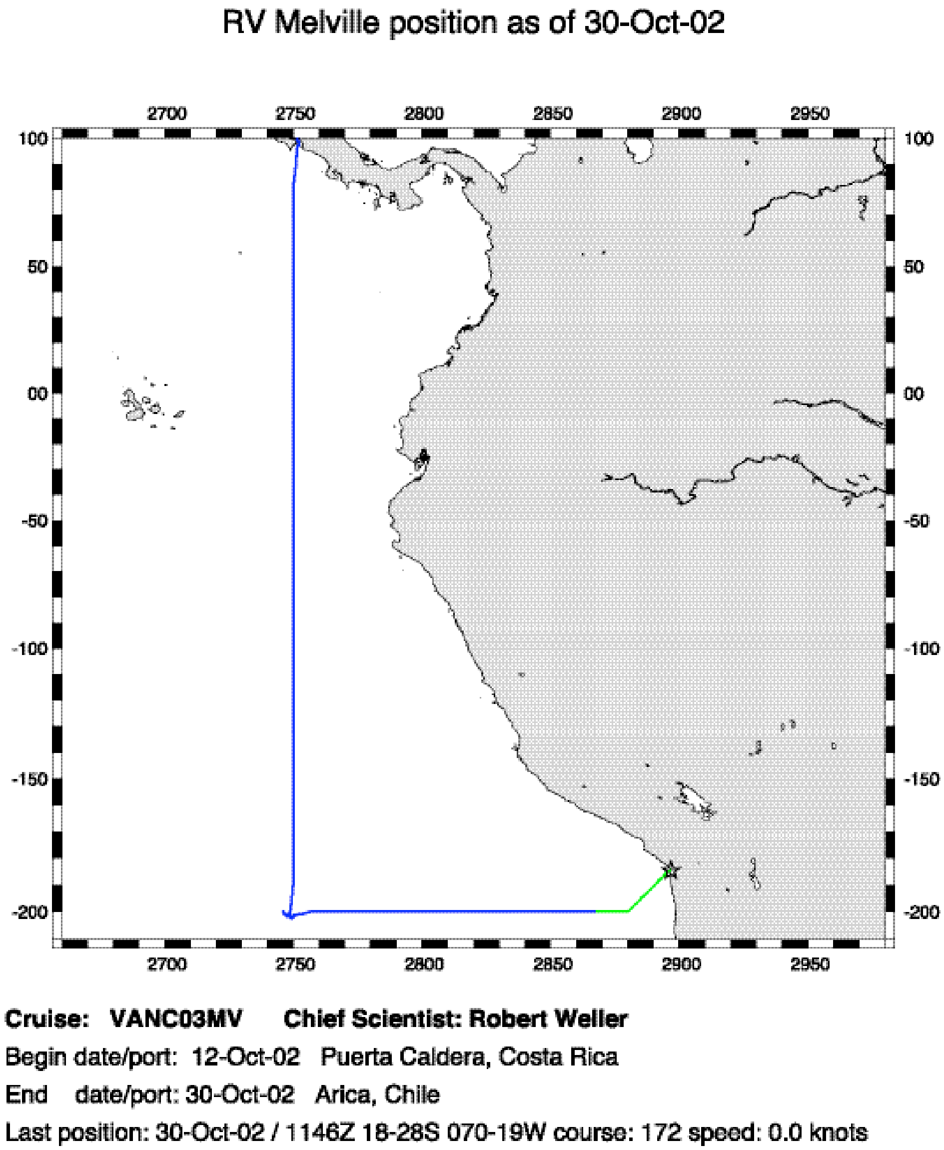


Figure 57. Cruise track for Vance 03.

B. IMET

The *Melville* was equipped with an Improved Meteorological (IMET) system during the Stratus 2002 cruise. There was, however, no incoming shortwave sensor on the ship's IMET system. UOP personnel added a spare shortwave module to the ship's mast, but were unable to retrieve real-time data from this module. This data was retrieved at the end of the cruise. *Melville's* onboard IMET system was used to compare the IMET systems on the Stratus buoys. Figure 58 shows the data collected from the *Melville's* IMET system.

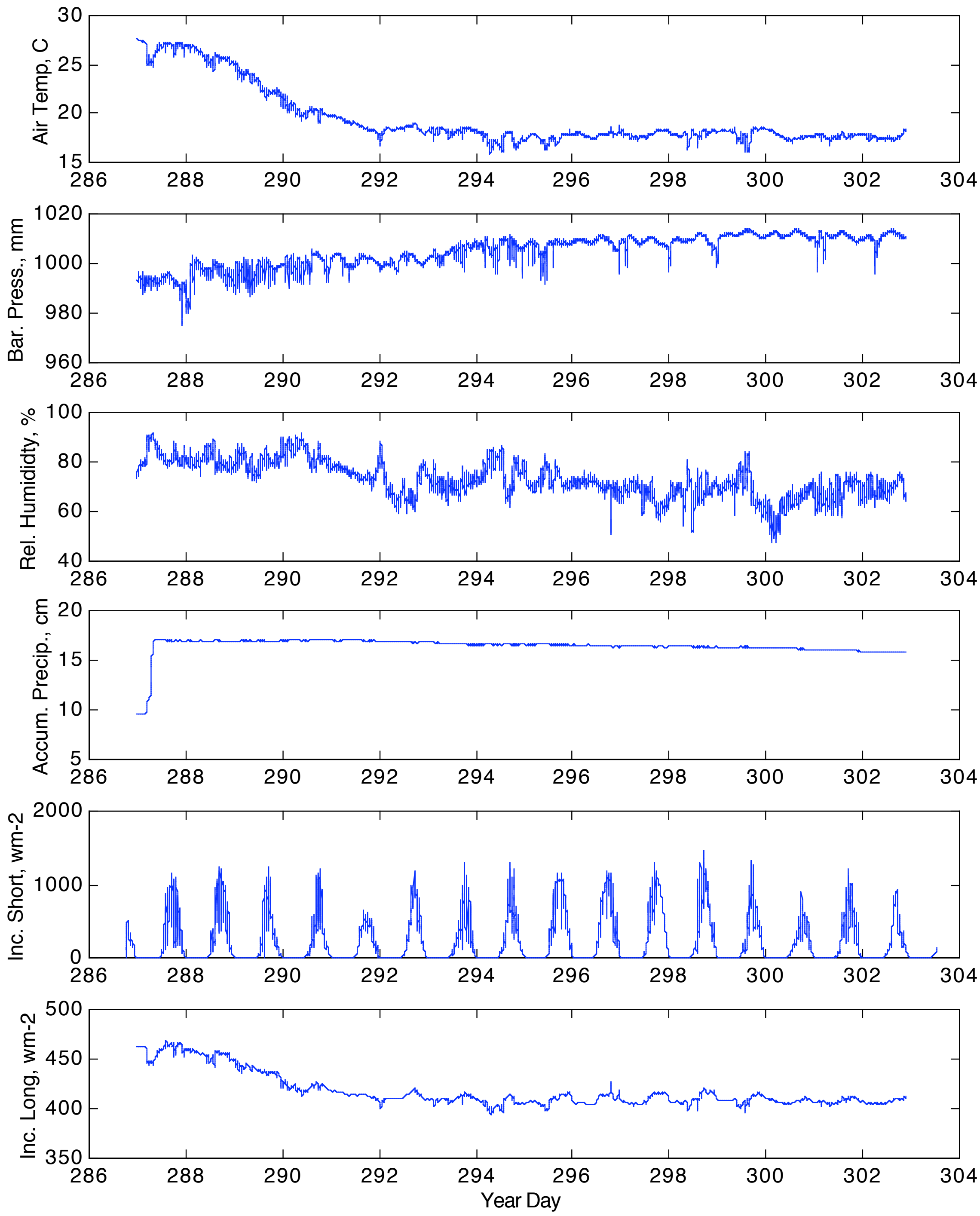


Figure 58. Shipboard IMET data collected during the Stratus 2002 cruise.

C. Acoustic Doppler Current Profiler (ADCP)

ADCP data was collected while underway during the Stratus 2002 cruise. This data can be processed with software available from RDI who manufactured the ADCP onboard the *R/V Melville*.

D. Magnetometer

The ship's magnetometer was deployed while underway. Figure 59 is an example plot showing ship's heading, speed, water depth, magnetic field, and magnetic anomaly.

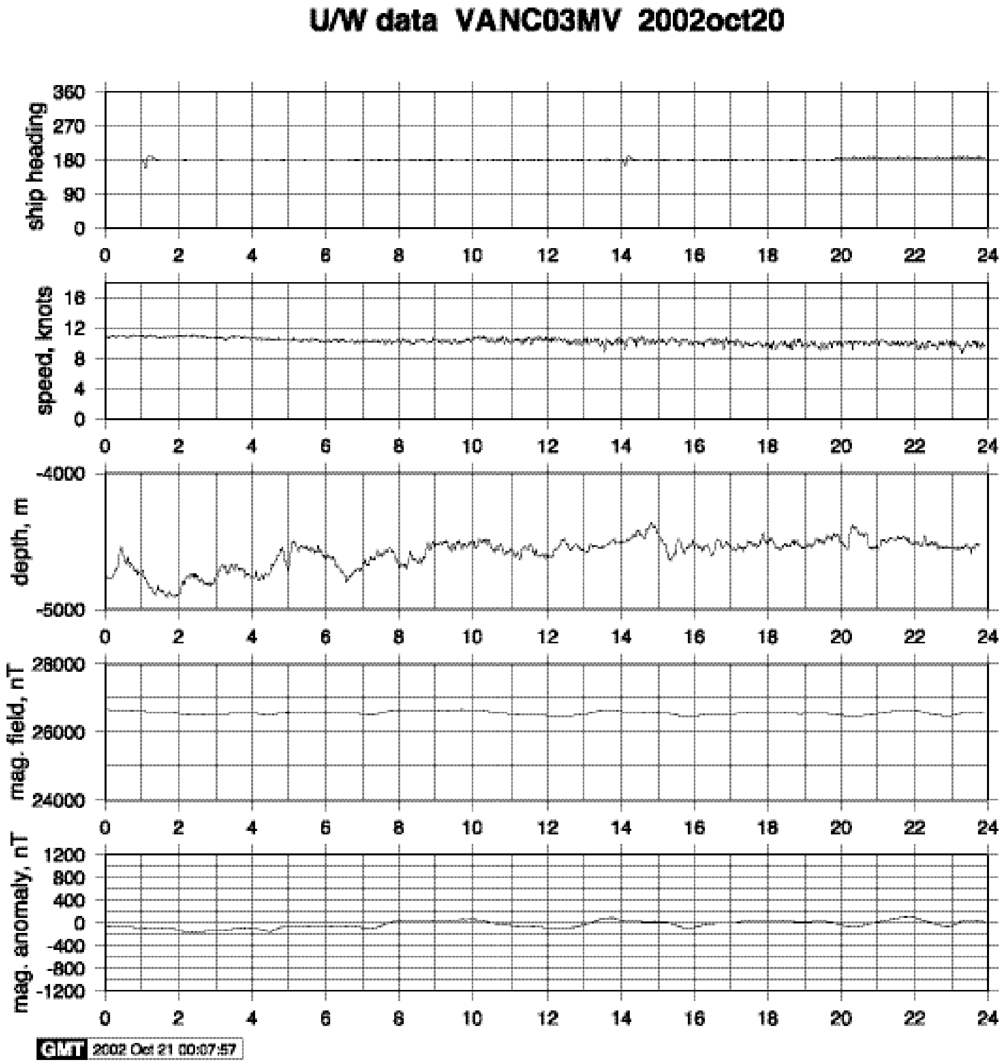


Figure 59. An example plot showing ship's true heading, speed, water depth, magnetic field, and magnetic anomaly.

E. SeaBeam

The SeaBeam was operated on various days throughout the Stratus 2002 cruise. This data was processed onboard to produce several figures. Figure 60 below is a graphic representation of the SeaBeam data in the vicinity of the Stratus 3 mooring site and Figure 61 shows sidescan sonar taken in the same general location.

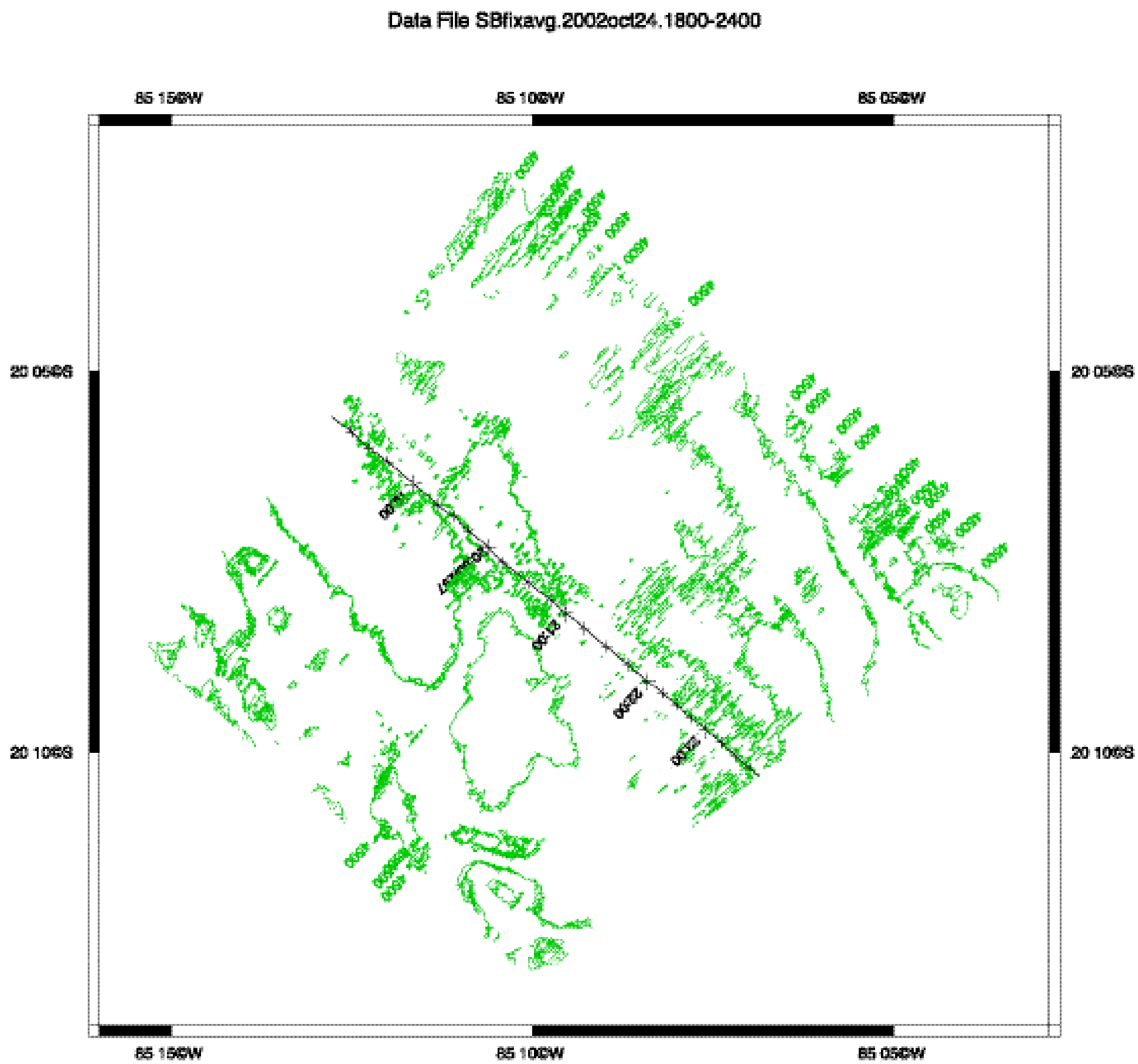


Figure 60. Graphic representation of SeaBeam data taken on October 24, 2002.

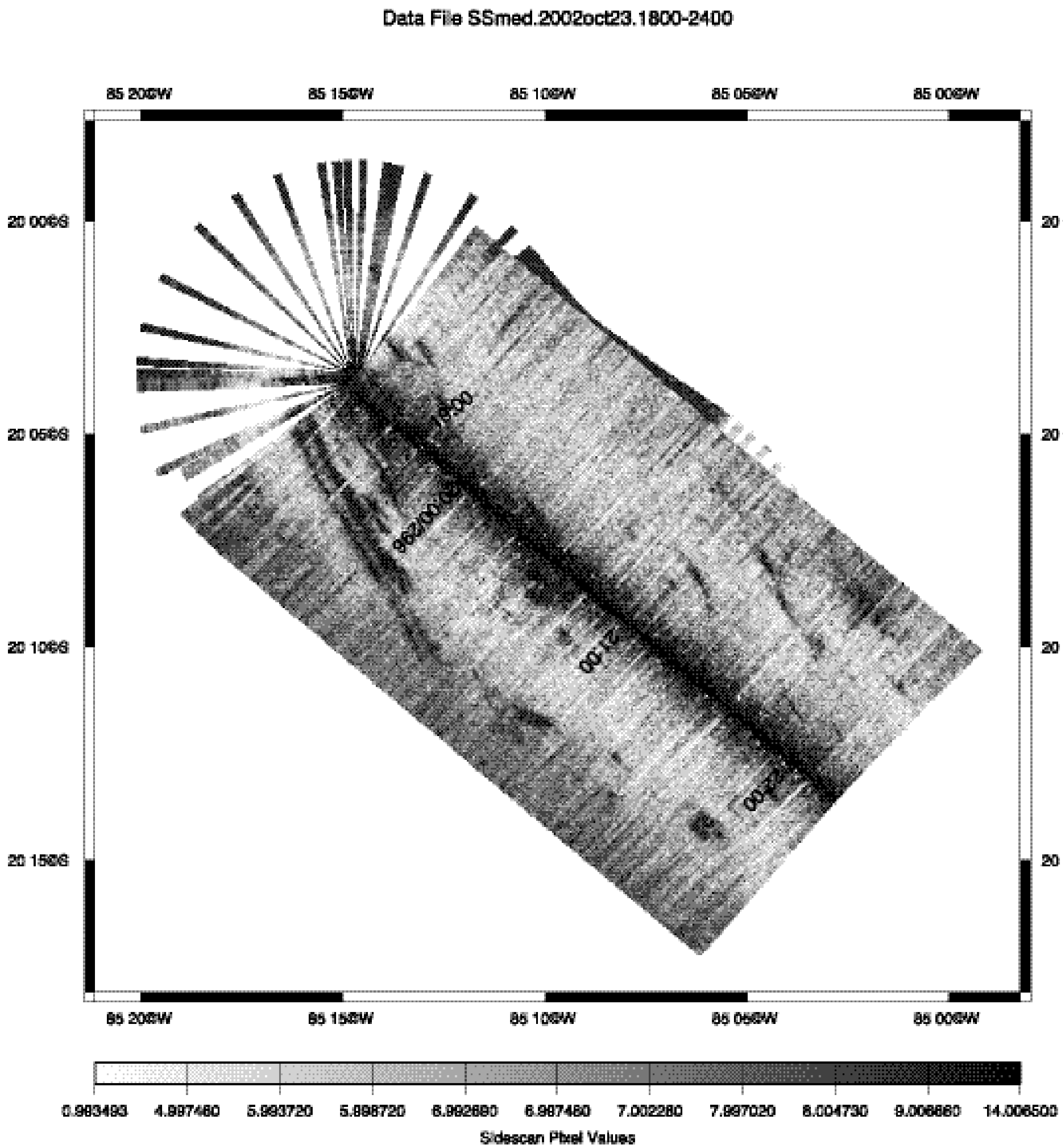


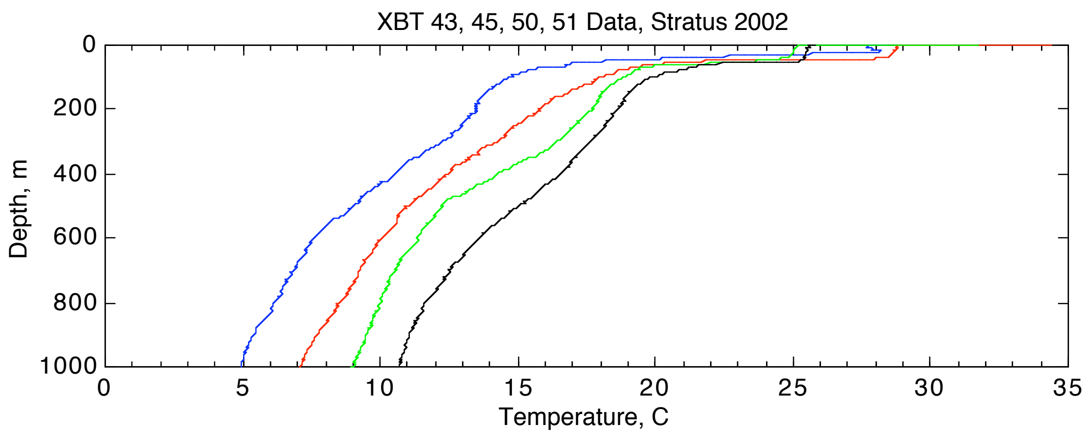
Figure 61. Sidescan sonar taken on October 23, 2002.

F. XBTs

Expendable bathythermographs (XBTs) were deployed throughout the Stratus 2002 cruise. These instruments measure temperature at varying depths to create sound velocity profiles which are used to process SeaBeam data.

Table 18. Summary of XBT launch times and locations.

XBT #	Date	Time (UTC)	Latitude	Longitude
43	10/14/02	16:18:23	6° 57.71301 N	84° 59.99902 W
45	10/15/02	18:41:57	2° 13.78059 N	85° 0.00195 W
50	10/17/02	20:07:10	6° 5.67133 S	85° 0.000W
51	10/18/02	19:06:40	10° 19.35388 S	84° 59.99902 W
52	10/19/02	19:50:10	14° 49.8291 S	84° 59.99805 W
54	10/23/02	19:38:45	20° 4.94666 S	85° 13.58594 W
55	10/27/02	13:11:35	19° 59.99976 S	80° 29.85107 W
56	10/28/02	11:03:56	19° 59.99964 S	77° 15.4292 W
57	10/29/02	11:26:44	20° 0.000 S	73° 31.27539 W



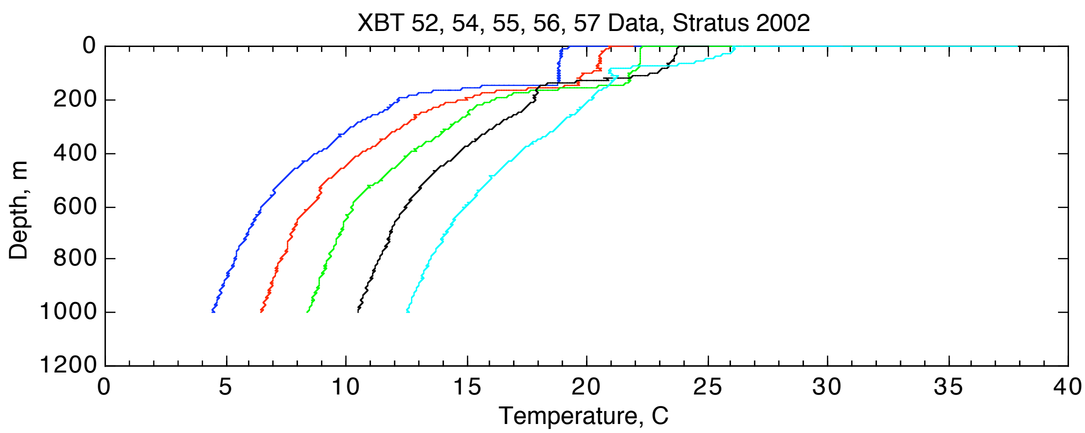


Figure 62. Temperature profiles from XBTs.
Profiles are in order from left to right as noted in the title, with each successive profile offset by two degrees.

G. Flux System

The WHOI Direct Covariance Flux System (DCFS) consists of a Solent three-axis sonic anemometer-thermometer and a Systron Donner MotionPAK. The sonic anemometer records the three components of wind velocity used to derive direct estimates of the wind vector stress (τ) using the eddy correlation technique. The MotionPAK, attached below the sonic anemometer, contains three-axis accelerometers and rate sensors which are used to help correct for the effects of platform motion. The DCFS was mounted on the fore bow mast of the R/V *Melville* at height of 11.96m above the mean sea surface. Since no relative humidity sensor was available only the momentum stress can be derived from the system.

The system was connected to a pre-designated DCFS laptop in the scientist's plot room via the sonic flux interface. Before starting data acquisition, the laptop time was set to the ship's UTC time. The sonic flux program (son_flux(2)) was then opened and data acquisition started at 10/14/02 19:00 UTC. Data was stored in hourly files, with the filename format: dddsssss.c1 (ddd – year day, sssss – time in seconds). Each day the flux laptop was checked to verify that the system was still working and that the computer was still recording and saving the data. The laptop's clock time was also noted regularly and any drift was recorded. Regular visual checks were also made of the mounted system to check for birds sitting on the mast or sensor.

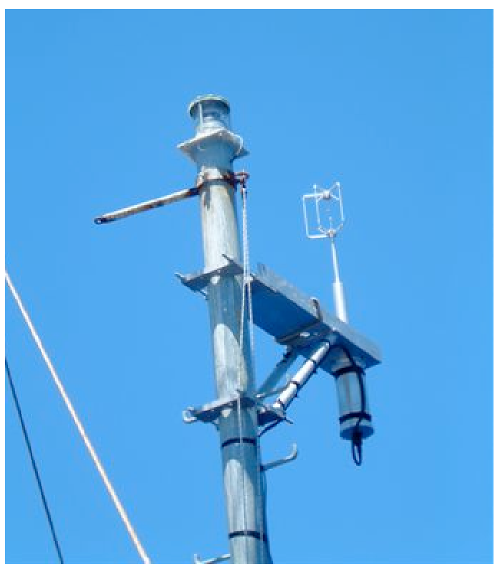


Figure 63: WHOI DCFS on R/V Melville

The wind velocity data was processed using Matlab routines provided by Jim Edson (WHOI). The ship's navigation and heading were required to fully correct for platform motion effects and these were obtained from the ship's GPS and gyro system. Daily one second navigation ASCII files (provided by the ship's computer technician) were converted to mat-files using *readepic.m*. These files were then used in the main *epic01.m* routine to compute the wind velocity fluctuations, true wind speed and direction and various other wind-related parameters. Some problems were encountered during the data processing. Several raw data files had large spikes in them which caused errors in the processing. For ease, these files were excluded from the processing.

The wind speed from the DCF system was compared with the ship’s IMET anemometer to confirm that the data was good. The accuracy of the ship’s anemometer was itself under question since it had been noted that the relative wind direction recorded by the ship did not change. A comparison with the sonic flux data confirmed that the relative wind direction was wrong but revealed that the relative wind speed was correct (see Data Comparison section for results).

Figure 64 below shows the overall results from the sonic system during the cruise. Winds were generally moderate (with the exception of 20th-22nd October) and the wind direction changed from southwesterly to southeasterly as the ship progressed south. Wind stress was calculated as:

$$\tau = \rho(<u'w'>+<v'w'>)$$

where *<u’w’>* and *<v’w’>*, the fluctuating velocity components, were outputs from the data processing. In this instance, <v’w’> was neglected because it is strongly affected by flow distortion and incomplete motion correction. Air density, ρ, was computed using the *air_dens.m* Matlab routine.

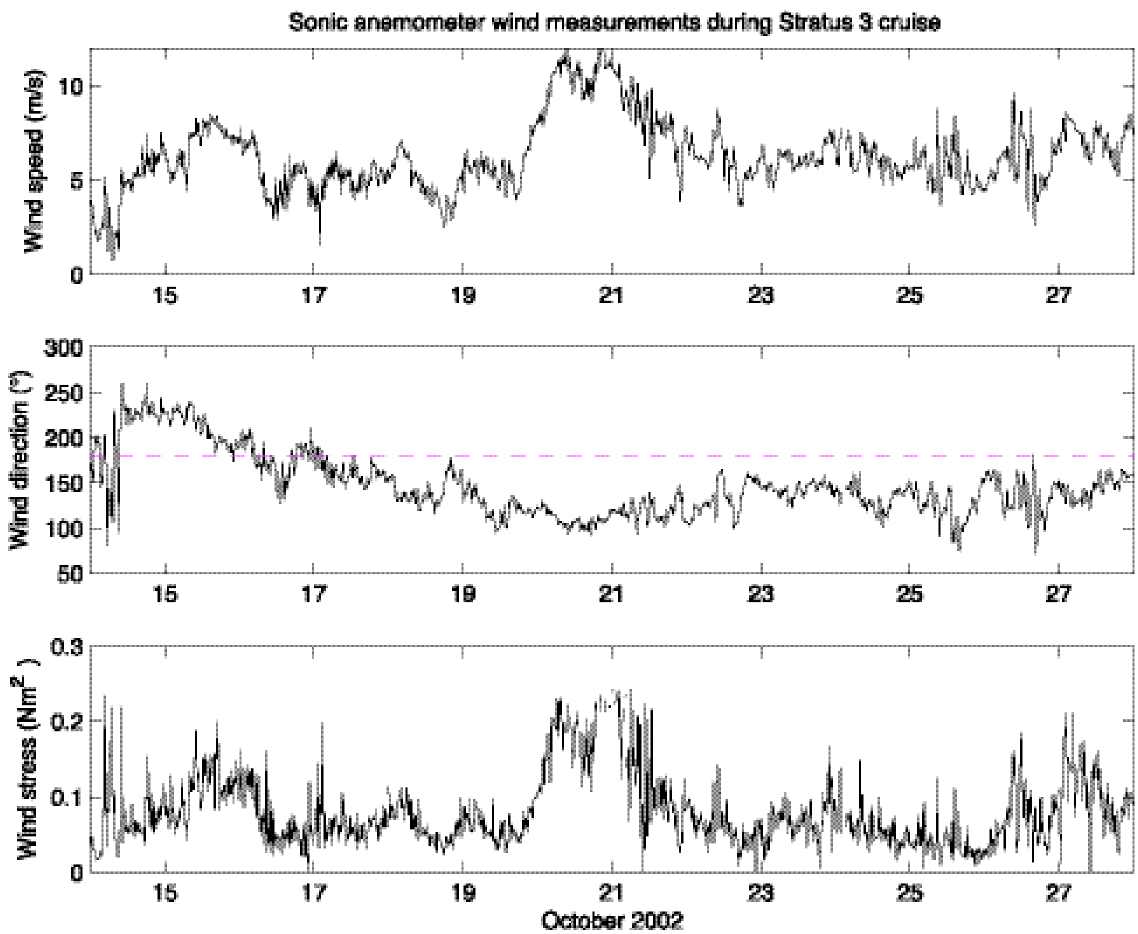


Figure 64: DCFS wind measurements during Stratus 3 cruise.
a) wind speed (m/s), b) wind direction from (°), c) wind stress (Nm^{-2}).

ACKNOWLEDGEMENTS

The Stratus team would like to thank the crew of the R/V *Melville* for welcoming us into their home, their tireless help in pursuing our science mission, an endless supply of useful information, and of course for sharing some fun times fishing and crossing the equator. We are also grateful to Jenny Maturana, Oscar Pizarro, and Jaime Letelier for their help in all endeavors during the Stratus cruise. We appreciate their willingness to jump in and get dirty. Last but not least, we are grateful for all of the WHOI staff who have helped with the never ending cruise logistics, data analysis, and instrument preparations.

This project was funded through grants from the Office of Global Programs of the National Oceanic and Atmospheric Administration (NOAA Grants NA96GP0429 and NA17RJ1223).

APPENDIX A – TIMING SPIKES AND CHECKLISTS

Post-cruise Recovery Check List - Stratus 2

Bag the Solars (ON) Note Time/Date UTC: 13:15:00, 23 OCT 02
Unbag Solars (OFF) Note Time/Date UTC: 14:19:30, 23 OCT 02

Temperature Spike SST's (IN) Note Time/Date UTC: 13:20:30, 23 OCT 02
Temperature Spike SST's (OUT) Note Time/Date UTC: 14:22:00, 23 OCT 02

Primary 1 Logger clock check (#STAT) Note Time/Date UTC: 13:59:00, 23 OCT 02
Primary 1 Logger clock check Note Time/Date from Logger: 14:09:32, 23 OCT 02

Primary 2 Logger clock check (#STAT) Note Time/Date UTC: 13:57:00, 23 OCT 02
Primary 2 Logger clock check Note Time/Date from Logger: 14:08:10, 23 OCT 02

Primary 1 Logger Stop Sampling Note Time/Date UTC: 13:35:00, 26 OCT 02
Primary 2 Logger Stop Sampling Note Time/Date UTC: 13:35:00, 26 OCT 02

Dump Data/Remove FLASH Card Primary 1 Logger: DONE
Dump Data/Remove FLASH Card Primary 2 Logger: DONE

Clock check Modules (attach form): DONE

Dump Data/Remove FLASH Card Primary 1 Modules: DONE
Dump Data/Remove FLASH Card Primary 2 Modules: DONE
Dump Data SBE-37's (SST's): N/A(No data due to no batteries)

Record Battery Power System 1: Logger=13.59v, modules=13.50v, and PTT=15.98v
Record Battery Power System 2: Logger=13.90v, modules=13.48v, and Ptt=15.98v
Power Down Systems: DONE

Temperature Spike Under water Inst.'s Note Time/Date UTC (approx. 1 hr.)

SeaCats: 13:01:00, 23 OCT 02(IN) 14:06:00, 23 OCT 02(OUT)	Ser. Num.'s: 0927, 0146, 2322, 0144, 1882, 0993, 2323, 0928, 0994, 2324
SBE-39(FLOATER): 13:42:00, 23 OCT 02(IN) 15:09:00, 23 OCT 02(OUT)	Ser. Num.'s: 0477
SBE-39'S: 11:35:00, 23 OCT 02(IN) 12:55:00, 23 OCT 02(OUT)	Ser. Num.'s:0276, 0282
Branckers: 11:33:00, 23 OCT 02(IN) 12:55:00, 23 OCT 02(OUT)	Ser. Num.'s:4488, 3305, 3761, 3667, 3283, 3701, 4489, 3703, 4483, 3704, 4481, 3309, 4493, 3833
ADCP: 12:02:00, 23 OCT 02(IN) 13:08:00, 23 OCT 02(OUT)	Ser. Num.'s: 1220

VMCM Checks(Attach CMOI): Done

Logger/Module Serial Numbers - Stratus 3

Primary MET System 1

Logger #: L04	Firmware Version: LGR53 2.50	
HRH #: 219	HPS v1.6/530 v3.1	Height From Deck: 257.2 cm
BPR #: 106	v2.0	242.4 cm
WND #: 217	530 v3.3	303.7 cm
PRC #: 206	HPS v1.6/530 v2.5	275.3 cm
LWR #: 101	v2.3	316.5 cm
SWR #: 109	v2.1	316.5 cm
SST# : 1836	Type: SBE-37	Depth from water line: 127.0 cm
PTT #: 12789	I.D. #: 27916	
	27917	
	27918	

Primary MET System 2

Logger #: L07	Firmware Version: LGR53 2.50	
HRH #: 216	HPS v1.6/530 v3.1	Height From Deck: 255.3 cm
BPR #: 112	v2.0	241.8 cm
WND #: 219	530 v3.3	303.0 cm
PRC #: 205	HPS v1.6/530 v2.5	275.3 cm
LWR #: 006	v2.3	316.5 cm
SWR #: 111	v2.1	316.5 cm
SST# : 1305	Type: SBE-37	Depth from water line: 132.1 cm
PTT #: 18171	I.D. #: 27919	
	27920	
	27921	

Stand-alone modules:

BPR#: 204		Height from Deck: 219.7 cm
HRH#: 222		269.6 cm
PTT#: 18231	I.D.#: 20060	

Pre-Cruise In Port Check List – Stratus 3

TASK

Note Primary 1 Logger Number: L04
Note Primary 2 Logger Number: L07

Note Primary 1 Module Numbers (Attach Form): Done
Note Primary 2 Module Numbers (Attach Form): Done

Start SST's (SBE-37's) to Internal Record, Note start time/date UTC: 01:00:00, 13 OCT 02

Power Up Logger Primary 1 Note time/date UTC: 18:24:30, 12 OCT 02
Power Up Logger Primary 2 Note time/date UTC: 18:35:00, 12 OCT 02

Test Modules Primary 1: Done
Test Modules Primary 2: Done

Check/Set Logger Clock Primary 1 Note time/date UTC: 18:28:00, 12 OCT 02
Check/Set Logger Clock Primary 2 Note time/date UTC: 18:37:30, 12 OCT 02

Zero Logger FLASH Card Primary 1: Done
Zero Logger FLASH Card Primary 2: Done

Buoy Spin (Attach Sheets): Done

Record interval of Module Primary 1 & 2: 1 Min.
Record interval of Loggers Primary 1 & 2: 1 min.
Record interval of SST's (SBE-37's): 5 Min.

Start Logger 1 sampling UTC: 18:34:00, 12 OCT 02
Start Logger 2 sampling UTC: 18:46:00, 12 OCT 02

SST's Temperature spike (IN) Note Time/Date UTC: 15:35:00, 15 OCT 02
SST's Temperature spike (OUT) Note Time/Date UTC: 16:33:30, 15 OCT 02

Bag the Solars (ON) Note Time/Date UTC: 15:39:00, 15 OCT 02
Unbag the Solars (OFF) Note Time/Date UTC : 16:34:00, 15 OCT 02
Wash Domes and Final Check: Done

Temperature Spike Under water Inst.'s Note Time/Date UTC:

SBE-37'S: 11:28:30, 16 OCT 02 (IN) 12:31:30, 16 OCT 02 (OUT)	Ser. Num.'s : 1330, 1329, 1328, 1326, 1910 2012, 1306
SBE-39'S: 11:28:30, 16 OCT 02 (IN) 12:31:00, 16 OCT 02 (OUT)	Ser. Num.'s : 0048, 0369, 0284, 0072, 0050, 0049, 0370
SBE-16'S: 11:29:00, 16 OCT 02 (IN) 12:32:00, 16 OCT 02 (OUT)	Ser. Num.'s: 1880, 1875, 2325, 1873
SBE-16(Bridle): 15:37:00, 15 OCT 02 (IN) 16:33:00, 15 OCT 02 (OUT)	Ser. Num.: 1881
Branckers: 13:16:00, 19 OCT 02 (IN) 14:39:00, 19 OCT 02 (OUT)	Ser. Num.'s: 4495, 4494, 3839, 3837, 4228, 4485, 3258, 3762, 3830, 3831, 3836, 3259, 3764

Aanderaa: 13:47:00, 16 OCT 02 (IN) Ser. Num.: 129
14:51:00, 16 OCT 02 (OUT)
FSI/ACM: 13:45:00 17 OCT 02 (IN) Ser. Num.: 1469
14:54:00, 17 OCT 02 (OUT)
RDI/ADCP: 13:33:00, 19 OCT 02 (IN) Ser. Num.: 1218
14:43:00, 19 OCT 02 (OUT)

VMCM Check & Rotor spins Note on CMOI : Done

Stratus 2 Instrument Clock Checks

Instrument	Serial Number	Clock Time	Date	Actual Time	Time Difference
SBE-39	276	18:35:51	23-Oct-02	18:37:00	-0:01:09
	282	18:43:33	23-Oct-02	18:44:00	-0:00:27
	477	18:47:06	23-Oct-02	18:48:00	-0:00:54
SBE-16	927	14:46:45	23-Oct-02	14:42:00	0:04:45
	146	14:51:38	23-Oct-02	14:50:00	0:01:38
	2322	15:01:21	23-Oct-02	14:59:00	0:02:21
	144	17:10:05	23-Oct-02	17:09:30	0:00:35
	1882	18:57:31	23-Oct-02	18:56:00	0:01:31
	993	20:06:57	23-Oct-02	20:06:30	0:00:27
	2323	22:45:48	23-Oct-02	22:45:30	0:00:18
	928	22:47:40	23-Oct-02	22:47:00	0:00:40
	994	10:01:21	24-Oct-02	10:01:00	0:00:21
	2324	10:02:44	24-Oct-02	10:02:00	0:00:44
TPOD	4488	18:47:10	23-Oct-02	18:50:00	-0:02:50
	3305	18:24:19	23-Oct-02	18:28:30	-0:04:11
	3761	18:13:09	23-Oct-02	18:03:00	0:10:09
	3667	18:04:01	23-Oct-02	17:56:00	0:08:01
	3283	17:54:46	23-Oct-02	17:49:00	0:05:46
	3701	17:33:57	23-Oct-02	17:27:30	0:06:27
	4489	17:22:03	23-Oct-02	17:20:00	0:02:03
	3703	17:09:01	23-Oct-02	17:04:30	0:04:31
	4483	16:34:07	23-Oct-02	16:34:00	0:00:07
	3704	15:32:16	23-Oct-02	16:26:30	-0:54:14
	4481	16:16:49	23-Oct-02	16:19:00	-0:02:11
	3309	16:16:06	23-Oct-02	16:12:00	0:04:06
	4493	15:57:39	23-Oct-02	16:01:00	-0:03:21
	3833	15:41:51	23-Oct-02	15:46:30	-0:04:39
Logger	01	14:09:32	23-Oct-02	13:59:00	0:10:32
	02	14:08:10	23-Oct-02	13:57:00	0:11:10
Wind	213	14:15:00	26-Oct-02	14:10:45	0:04:15
	207	16:06:46	26-Oct-02	16:00:00	0:06:46
	212	14:28:14	26-Oct-02	14:25:00	0:03:14
	223	10:03:40	26-Oct-02	14:32:45	-4:29:05
	218	15:49:53	26-Oct-02	15:36:30	0:13:23
	217	16:15:23	26-Oct-02	15:52:30	0:22:53

Instrument	Serial Number	VMCM Hex Value	Time Checked	Date Checked	Instrument Time
VMCM □ □	023	1E4A	15:53:08	25-Oct-02	381 D, 17 H, 7 M, 30 S
	027	1E4F	15:59:42	25-Oct-02	381 D, 17 H, 45 M, 0 S
	031	No Comms	N/A	25-Oct-02	N/A
New Gen VMCM	002/203	15:07:49	15:00:30	25-Oct-02	N/A

APPENDIX B - CRUISE LOG

*All times are given in UTC unless otherwise noted.

October 12, 2002
Module flash cards dumped.

October 13, 2002

1540	Buoy moved on deck, vane down towards deck, may not get Argos via satellite.
1550	24337 SIS (subsurface Argos) on, outside for testing.
1716	SST's plugged in.
1507 L	Sonic flux system started – looks fine.
1848 L	Sonic flux clock changed and logging started. Good files from 28668400.C1 onwards.
1900 L	Mast (SIO IMET) up again.

October 14, 2002

1706	Ship barometer is not correct. Reading 990 mb instead of 1010. Double checked with handheld barometer (1010.8). (Dan said barometer was checked and was fine just before we got on ship.)

October 15, 2002

October 16, 2002

1300	WDIR as reported in 1-minute SCS file looks frozen. Display "stuck" at 239.8°.
1830	Stopping for CTD and release test. Our heading 180° into wind.
2104	CTD Deployed IMET Sal = 33.414 = CTD@2m = 34.16 CTD saved to shiptest1.dat *SALINITY IS BAD
1245 L	Copying sonic flux data to CD.
1302 L	Have not stopped logging – but check in case data logging was affected. (Would affect file 2900001.C1 and 29003604.C1) Noticed that flux cable to sensor was being tugged – caused by someone in weights exercise room.

October 17, 2002

October 18, 2002 Sonic flux HP laptop drift, laptop is 19 seconds fast

1716	Stopped logging sonic data to install some software for external hard drive. Logging paused 17h16m20s Quit 17h20m40s 29161200.C1 will be shorter file Started logging again 17h29m10s (29162972.C1)
1044	Clear break in Stratus deck. (Medium-high dotted small clouds)

October 19, 2002

1726	Took photos of Stratus breaking up at mid-day.
1830	More photos taken.

October 20, 2002

1830	Took photos of Stratus clearing (1330 L)

October 21, 2002

0230 Nearing St2 anchor location, watching from bridge and via Argos receiver for signs of buoy
0431 Setting up for 1st CTD
0451 Stratus01 CTD deployed, 4000 m, bottle 4 did not close, bottle 6 leaks badly.
0741 Stratus01 CTD recovered
0808 Stratus02 CTD deployed, 1500 m
0915 Stratus02 CTD recovered
1200 Ship v. IMET2 comparison begins
1530 Photos taken of Stratus (1030 L)
1630 Photos taken of Stratus (1130 L)
1720 Photos taken of Stratus (1220 L)
1817 HP flux laptop has crashed. (1317 L) 29464803.C1 file was affected.
1824 Rebooted flux laptop. 1) Check time, HP laptop 23 seconds fast. 2) copy files (1827 **UTC**). 3) Restart son_flux2 18:29:34 **UTC**. 29466596.C1
1920 Photos taken of Stratus (14:20 L) Clouds thickening again. Possible rain behind ship.
2040 Photos taken of stratus (17:40 L)
2355 Photos of stratus (19:00 L)

October 22, 2002

1259 Release command seat confirmation received.
Weather: large clear patches, sunny.

October 23, 2002

1438 HP laptop flux (29650403.C1) (My watch has been reset to UTC seconds) 14:40:00 watch = 14:40:35 laptop. 35 seconds fast. Stratus 2 buoy placed upright on deck before lunch sometime. Weather: large breaks in cloud, sunny.

October 24, 2002
Pre launch – pillows off! Water into precips.
Weather – sunny, very clear after ~1030 L (1530 UTC)

October 25, 2002

1325 Sonic flux HP laptop 44 sec fast.
Weather – cloudy some breaks, clear patches, sunny at midday.
1730 UTC Photos taken at clouds (1230 L)
2230 Photos taken at clouds (1734 L)

October 26, 2002

0520 CTD 003 85°W, 20°S
1020 CTD 004 84°20'W, 20°S
1450 CTD 005 83°40'W 20°S
1504 HP laptop 49 seconds fast

October 27, 2002

1905 HP flux laptop 53 seconds fast

October 28, 2002

1106 HP flux laptop 56 seconds fast

October 29, 2002

Sonic flux system, HP laptop 61 seconds fast, data logging stopped on file 30268403.C1 (19:03)

Several instruments were checked daily to insure that they were working properly. These instruments included the shipboard IMET system, ADCP, thermosalinograph, Argos, and the sonic flux system. The mast where shipboard IMET and flux instruments was also monitored to insure that no birds were lighting on the mast and interfering with measurements. The table below gives the results of this daily monitoring.

Stratus 3 Check Log

Jday	UTC	Lat	Lon	IMET Screen	ADCP	TSG SST	TSG Cond	Bird On Mast?	ARGOS Transm	Ship Met Plots	S3 Met Plots	Sonic Flux
287[A]	1632	6.55N	84°59W			27.56	50.256	No				
287	2018	6.15N	85W			27.8	51.3	No				
288	1305	3.15N	85W			27.09	52.1	No				
288	1817	2°18N	85W			26.73	52.3	No				
288[B]	2351	1°17N	85W			26.49	33.26	No				
289	1315	1°05S	85W			25.21	33.16	No				
289[C]	1810	1°58S	85W			24.23	33.99	No				
291	1256	9°12S	85W			19.89	33.96	No				
291	2016	10°32S	85W			19.47	33.95	No				
292	1214	13°20S	85W			18.88	34.04	No				
293	0015	15°35S	85W			18.58	33.94	No				
293	1447	18°09S	85W			18.11	33.76	No				
295	1118	20°07S	85°10W			18.49	33.66					
296[D]	1448	20°08S	85°08W			18.67	33.59	No				
298	1347	20°09S	85°08W			18.26	33.61					
300	1908	19°59S	79°40W			17.66	33.37	No				

[A] Bad ship pressure, ~990.
[B] Salinity very fresh.
[C] Wind stuck (not changing), pressure = 1003
[D] Pressure now 1010.44, wind dir = 221.5

APPENDIX C – CRUISE LOGISTICS

Logistics for the Stratus 3 buoy turn around included shipping all surface buoy components and instrumentation to San Diego, assembling and testing the IMET system at the Scripps Marine Facility, and loading the assembled and running buoy on the R/V *Melville* in early August.

This avoided shipping the oversized buoy hull to Costa Rica. It also allowed us to work in a "user-friendly" environment for the assembly and test, reduced port time required in Costa Rica. Puerto Caldera, Costa Rica has absolutely no facilities to support our operation, and the prospect of daily downpours was a reality.

Cruise planning started with a meeting in at the Scripps Marine Facility on March 21, 2002. Ship schedules, load planning, and special needs were discussed at this meeting. We were given permission to load our buoy, 20-foot container, anchors, and mooring winch on the *Melville* before its departure on 05 August.

On 22 July, a forty foot flatbed truck carrying the above cargo (45,000 pounds) left Woods Hole for the Scripps Marine Facility in San Diego. On 28, WHOI personnel arrived in San Diego to begin buoy build up and test.

During July 29 - August 3 Robert Weller, Paul Bouchard, Nan Galbraith, Jeff Lord, and Jason Smith assembled the Stratus 3 surface buoy and surface instrumentation, and loaded WHOI cargo onto the *Melville*.

Final preparation of mooring hardware and subsurface instrumentation was done between August 5 and September 6. Two forty foot containers containing 30,000 pounds of gear were shipped from WHOI on September 10-11. These containers were shipped to Puerto Caldera, Costa Rica to be loaded onto the *Melville* on October 9-10.

The first cruise participants arrived in San Jose Costa Rica on October 6. On October 7, participants met with the Agent hired to assist with port services, and drove to Puntarenas. In Puntarenas we met with the sub agent who assured us our cargo had arrived and there were no customs issues with it.

On October 9, the *Melville* arrived at Puerto Caldera, and the remaining personnel arrived in Puntarenas. Offloading the previous cruises' gear was delayed, and unloading of WHOI cargo did not commence until 3:00 pm. It required a late night of loading, and an early start on October 10 to get all the WHOI cargo on the ship.

At 10:00 am on October 10, the *Melville* was moved to anchorage off Puntarenas. Worked commenced staging deck gear and setting up the labs. The next three days were spent preparing for the cruise and getting all gear lashed down. The *Melville* got under way at 16:00 on October 13.

Cruise details are discussed elsewhere in this report.
The *Melville* arrived in Arica Chile at 0800 on October 30. After the ship and personnel were cleared from customs unloading of the cargo began. Our agent in Chile, AJ Broom, had arranged for stevedores, forklift operators, and the two 40 foot-shipping containers to be used for the return shipment.

Unloading the ship was quick and efficient. By the time the lines were tied on the *Melville*, most of the lab gear had been packed up and put on pallets. The deck gear was unlashed and prepared for offloading.

By 2:00 pm all WHOI gear was loaded and tied down in the two containers. The 20-foot ragtop container had been unloaded, and the cover secured. On 31 October five WHOI personnel departed for home. The remaining four personnel departed Arica on 02 November after making sure all customs/shipping issues were in order.

One unexpected problem was that we could not ship a flat rack out of Arica. That meant shipping the buoy hull and 9300 pound anchor out of a different port. After exploring our options, we decided to leave the buoy and anchor on board the *Melville* until its stop in Valparaiso, Chile on December 5.

AJ Broom was the ships agent in Valparaiso. Arrangements were made to get the buoy and anchor unloaded and secured on a flat rack in Valparaiso, for further transit to WHOI.

The two 40 foot containers and the 20-foot rag top arrived in Woods Hole during the week of 2-6 December 2002.

Ship Information

R/V *Melville* from University of California, Scripps Institution of Oceanography (SIO)
http://shipsked.ucsd.edu/ships/melville/index.html

SIO Marine Operations:

Dr. Robert A. Knox – Associate Director
Phone: 858-534-4729
Fax: 858-535-1817
rknox@ucsd.edu

Rose Dufour / Elizabeth Brenner
Scheduler and Foreign Clearances
Phone: 858-534-2841
Fax: 858-822-5811
shipsked@uscd.edu

Capt. Thomas Althouse
Marine Superintendent
Nimitz Marine Facility
Phone: 858-534-1643
Fax: 858-534-1635

INMARSAT onboard ship:

Atlantic-East 011-871-1503656
Pacific 011-872-1503656
Indian 011-873-1503656
Atlantic-West 011-873-1503656
Note: When faxing the *Melville*, insert 81 between the dialing satellite area code and the Inmarsat number (i.e. 011-871-81-1503656). If the ship is in Pacific try Pacific area code (872) first, and if you can't get through then try Atlantic West (874). For operator assistance, dial 1-800-826-8680.

Hotel Information

Hampton Inn San Jose – Airport
Panamerican Highway
San Jose, Costa Rica
Phone: 506-443-0043
Fax: 506-442-9532
http://www.hamptonhotel.co.cr/default.htm

Hotel Beach Resort Yadran
Paseo de los Turustas
P.O. Box 14-5400
Puntarenas, Costa Rica
Phone: 506-661-2662
Fax: 506-661-1944
http://www.puntarenas.com/yadran

Arica Hotel
Av. Commandante San Martin 599
Arica, Chile
Phone: 56-58-254-540
Fax: 56-58-231-133
http://www.panamericanahoteles.cl
resarica@panamericanahoteles.cl

Agent Information

For Costa Rica:
Vasile Tudoran
Tudoran Transport
835 Ohio Avenue
Long Beach, CA 90804
Phone: 562-882-5590
Fax: 562-434-9800
vtudoran@aol.com

Subagent for Costa Rica:
Servicios Maritimo del Pacifico SA (SERMAR)
Phone: 011-506-661-1529
Fax: 011-506-661-2770

For Chile:
Renzon Caprile
Maritimas Broom Arica, Ltda.
Artruro Prat 391 of 76
Arica, Chile
Phone: 011-56-58-250238
Fax: 011-56-58-269229
arica@ajbroom.cl and copy to operations@ajbroom.cl

APPENDIX D - MOORING LOGS

Moored Station Log

PAGE 1

(fill out log with black ball point pen only)

ARRAY NAME AND NO. STRATUS II MOORED STATION NO. 1080

Launch (anchor over)

Date 19 October 2001 (day-mon-year) Time 19:46:00 UTC

Latitude 20°08'45.1" (deg-min) N or (S) Longitude 85°08'18.0" (deg-min) E or (W)

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

Deployed by: Ostrom, Bouchard, Lord, Weller Recorder/Observer: Charlotte Vallée

Ship and Cruise No Brown - RB-01-08 Intended duration: 365 days

Depth Recorder Reading 4459 m Correction Source:

Depth Correction -4 m

Corrected Water Depth 4454 m Magnetic Variation: ______ E or W

Anchor Position: Lat. 20°8.597 N or (S) Long. 85°8.4351 E or (W)

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

Acoustic Release Information

Release No. 701740 Tested to 1000 meters

Receiver No. 1 Release Command 13

Interrogate Freq. 11 KHz Reply Freq. 10 KHz

Recovery (release fired)

Date 22 October 2002 (day-mon-year) Time ~~[illegible]~~ 12:59:43 UTC

Latitude 20° 8.594' (deg-min) N or (S) Longitude 85° 8.350' (deg-min) E or (W)

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

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

Ship and Cruise No. Melville Vanc03 Actual duration: 367.7 days

Distance from actual waterline to buoy deck ~0.406 meters

Surface Components

Buoy Type 3m. Discus buoy **Color(s) Hull** deck yellow ~~Blue in water~~ **Tower** white

Buoy Markings

Surface Instrumentation

Item	ID	Height *	Comments
Data logger	STR 2-01		In well logger #1
Relative humidity	HRH 223	250cm	(tip of sensor) Relative to buoy deck
wind module	WND 207	297cm 256	(prop. axis)
Barom. pressure	BPR 106	238.5 cm	(center of Port)
Short wave Rad.	SWR 102	315 cm	(Base of dome)
long wave Rad.	LWR 104	315 cm	(Base of dome)
Precipitation	PRC 004	273.5 cm	(top of Funnel)
ARGOS trans	PTT 09805		
	09807		
	09811		
Data logger	STR 2-02		In well logger #2
Rel. Humidity	HRH 217	273 cm	(tip of sensor)
wind module	WND 212	297 cm	(prop. axis)
Barom. pressure	BPR 110	239.5 cm	(center of Port)
Short wave Rad.	SWR 002	315 cm	(base of dome)
long wave Rad.	LWR 103	315 cm	(base of dome)
Precipitation	PRC 109	273.5 cm	(top of Funnel)
ARGOS trans	PTT 09819		
	09833		
	25 078		
wind module	213	257 cm	Stand alone
Rel. humidity	HRH 218	273.5 cm	Stand alone

*** Height above buoy deck**

Depth from deck

Sub-Surface Instrumentation on Buoy and Bridle

Item	ID	Depth†	Comments
INET SB37	1834	1 m	System # 1
INET SB 37	1837	1 m	System # 2
SEA CAT	1882	1.1 m	
ARGOS xmtr	24 576	1.5 m	clamped to bridle (to the center)
SBE 39	0477	∅	Floating SST
Bridle	—	—	No tension logged
			Termination of bridle to...
			0.48 m 3/4" proof coil chain is:
			U joint - 1" chain shakle - 1" end link
			- 7/8

† Depth below buoy deck

Sub-Surface Components

	Type	Size(s)	Manufacturer
Chain			
Wire Rope			
Synthetics			
Hardware			

Flotation	Type (G.B.s, Spheres, etc)	Size	Quantity	Color
	GB's w/ hard hats	17"	80	yellow

No. of Flotation Clusters ________

Anchor Dry Weight 9300 lbs

MOORED STATION NUMBER 1080

pth from swivel	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							
.71m	2		seacat	994					23:02:00	
	3	1.98	3/4" P.C.C							
7	4		Seacat	2324	13:05:30				23:02:54	
	5	1.3	3/4" P.C.C							
10	6		VMCM	031	13:01:30	when rotors started			23:09:32	bands on 23:11:26
	7	0.75	3/4" P.C.C							
13	8		TPOD	3305	13:01:30				23:12:57	
	9	1.71	3/4" P.C.C							
16	10		Seacat	2322	13:00:00				23:12:59	
	11	2.26	3/4" P.C.C							
20	12		VMCM	023	12:56:30	Time when rotors started			23:17:11	bands on 23:18:23
	13	2.48	3/4" P.C.C							
25	14		TPOD	3761	12:55:50				23:20:40	
	15	3.7	3/4" P.C.C							
30	16		Seacat	2323	12:54:00				23:23:32	
	17	0.55	3/4" P.C.C							
32.5	18		VMCM	VM-027	12:50:20	when rotors started			23:25:59	bands on 23:27:25
	19	0.55	3/4" P.C.C							
35	20		TPOD	4489	12:48				23:25:59	

Date/Time	Comments
	P.C.C = Proof Coil Chain
	All TPOD's are brankers
	All Seacat's are SBE 1621

MOORED STATION NUMBER 1080

depth from drawing	Item No.	Lgth [m]	Item	Inst No.	Time Over	Notes	Data No.	Calc Dpth	Time Back	Notes
	21	1.25	3/4" P.C.C							
37.5	22		Acoustic Rain gauge	IBIS	12:47				23:28:56	
	23	1.25	3/4" P.C.C							
40	24		Seacat	0144	12:45:00				23:28:56	
	25	6.2	7/16" wire						22:02:41	
47.5	26		TPOD	3283	13:36:19				21:59:27	
	27	6.2	7/16" wire						21:58:54	
55	28		TPOD	3833	13:39:28				21:56:44	
	29	6.2	7/16" wire						21:56:23	
625	30		Seacat	0927	13:41:25				21:53:18	
	31	6.2	7/16" wire						21:53:10	
70	32		TPOD	4488	13:43:53				21:50:14	
	33	6.2	7/16" wire						21:49:55	
77.5	34		TPOD	3667	13:46:07				21:47:44	
	35	6.2	7/16" wire						21:47:05	
85	36		Seacat	0928	13:47:40				21:44:29	
	37	6.2	7/16" wire						21:44:03	
92.5	38		TPOD	4481					21:41:00	
	39	6.2	7/16" wire						21:40:24	
100	40		TPOD	3309	13:54:15				21:38:27	

Date/Time	Comments

MOORED STATION NUMBER 1080

	Item No.	Lgth [m]	Item	Inst No.	Time Over	Notes	Data No.	Calc Dpth	Time Back	Notes
	41	14	7/16" wire						21:37:37	
115	42		TPOD	3701	13:57:44				21:34:15	
	43	14	7/16" wire						21:33:23	
130	44		seacat	0993	13:59:50				21:29:43	
	45	3.09	3/4" P.C.C						21:30:04	
135	46		ADCP	TSN 1220	14:03 49	upward looking			21:27:05	
	47	8.5	7/16" wire						21:26:36	
145	48		TPOD	3704	14:07:20				21:23:47	
	49	14	7/16" wire						21:22:03	
160	50		TPOD	4483	14:12:35				21:19:24	
	51	28.5	7/16" wire						21:17:14	
190	52		seacat	0146	14:16:41				21:14:19	
	53	28.5	7/16" wire						21:10:55	
220	54		TPOD	4493	14:20:43				21:07:36	
	55	13	7/16" wire						21:06:53	
235	56		VMCM	NA	14:22:40	bearing test cage 14:24:26 in water			21:03:09	
	57	13	7/16" wire							
250	58		TPOD	3703	14:27:49				20:58:51	
	59	100	3/8" wire						20:52:02	
349	60		SBE 39	0282	14:38:32	clamped on wire			20:45:20	

Date/Time	Comments

MOORED STATION NUMBER 1080

depth from drawing	Item No.	Lgth [m]	Item	Inst No.	Time Over	Notes	Data No.	Calc Dpth	Time Back	Notes
350	61		VMCM	VM-001 203	14:35:40	New gen when rotors turned			20:45:20	bands on 20:50:25
	62	100	3/8" wire						20:32:55	
450	63		SBE 39	0276	14:50:47	clamped on wire			20:22:12	
	64	300	3/8" wire		14:51:00				20:09:54	
	65	500	3/8" wire		15:02:25				19:52:20	
	66	500	3/8" wire		15:22:13				19:30:22	
	67	200	3/8" wire		15:37:27				19:21:05	
	68	100	3/8" wire		15:44:42	one piece wrapped term			19:16:20	
	69	200	7/8" Nylon		15:48:42				19:05:17	
	70	150	7/8" Nylon		15:56:05				18:59:32	
	71	500	7/8" Nylon		17:33:08				17:51:49	
	72	500	7/8" Nylon		18:00:22				17:32:58	
	73	500	7/8" Nylon		18:13:00	one piece to be spliced at sea			17:15:56	
	74	100	1" Nylon		18:15:35				17:12:10	Time on spool
	75	1400	1 1/8" Polypro		18:36:35					
	76	80	17" glass balls		19:05:00 19:22:00	start & end time			14:02:45	
	77	5	1/2" Trawler chain		19:23					
	78		Acoustic release Egg model 322	701 740	19:39.50					
	79	5	1/2" Trawler chain		19:40					
	80	20	1" Samson Nystron		19:44:40					

Date/Time	Comments
line 76	Pin removed (cordon détaché de l'Acoustic. R) 19:27:00
line 80	Anchor drop position: 20°08'45.1"S // 85°08'18.0"W
line 70 + 71	Unwound winch in between sections 70 and 71
line 74 + 75	Unwound winch in between sections 75 and 74
15:40:42	1" Nylon (74) seen and held while winch unwound

MOORED STATION NUMBER 1080

Date/Time	Comments
Oct 19 2001	Time deployment for each instruments → took at the beginning
	in water
" " "	{Start deployment time : 12:45:30 UTC
	{End deployment time : 19:46:00 UTC
	↳ ≃ 7 hours
Oct 22, 2002	Release enabled at 12:57
	released at 12:59:43
	Glass balls surfaced 13:43:47
	Buoy onboard at ~ 23:00
	Wind module hit side of ship during recovery;
	there appears to be no damage.

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 24 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

Depth Correction -4 m Table Correction to Seabeam

Corrected Water Depth 4440 m Magnetic Variation: ______ 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 ______ (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 Deck Yellow Blue 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	0	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

epth om awing 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							
71	2		Seacat	1873	14:31:00	Wogs Live!				
	3	1.98	3/4" PCC							
7	4		Seacat	1875	14:06:54					
	5	1.3	3/4" PCC							
10	6		3/4" Cage VMCM	009	13:57:48	13:53:26 Bands off				
	7	0.75	3/4" PCC							
3	8		Aandera w/ temp	129	13:54:21					
	9	1.71	3/4" PCC							
16	10		Seacat	2325	13:51:30					
	11	2.26	3/4" PCC							
20	12		3/4" Cage VMCM	030	13:46:15	13:43:47 bands off				
	13	2.04	3/4" PCC							
25	14		Chlam w/ SBE-39	Ch #1 SB 0049	13:43:32					
	15	3.24	3/4" PCC							
30	16		Seacat	1880	13:40:38					
	17	0.75	3/4" PCC							
32.5	18		3/4" Cage VMCM	055	13:40:28	13:28:35 bands off				
	19	0.34	3/4" PCC							
35	20		T-POD	4485	13:37:28					

Date/Time	Comments
~ 14:31	Buoy in water

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 15:07:01				
	23	3.33	3/4" PCC							
45	24		3/4" Cage VMCM	011	15:14:39	Bands off 15:12:50				
	25	3.06	3/4" PCC							
50	26		RainG.	Ibis	15:19:24					
	27	3.33	3/4" PCC							
55	28		T-POD	3836	15:23:51					
	29	6.2	7/16" Wire							
62.5 ~~70~~	30		~~T-POD~~ Microcat	1330 ~~3830~~	15:28:57 ~~15:31:46~~					
	31	6.2	7/16" Wire							
70	32		T-POD	3830	15:31:46					
	33	6.2	7/16" Wire							
77.5	34		T-POD	3259	15:35:17					
	35	6.2	7/16" Wire							
85	36		Microcat	1329	15:38:18					
	37	6.2	7/16" Wire							
92.5	38		T-POD	4495	15:40:53					
	39	6.2	7/16" Wire							
100	40		T-POD	4228	15:43:52					

Date/Time	Comments

MOORED STATION NUMBER 1108

epth rom rawing (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					
	43	14	7/16" wire							
130	44		Microcat	2012	15:49:11					
	45	3.09	3/4" PCC							
35	46		ADCP	1218	15:52:46					
	47	8.5	7/16" wire							
145	48		T-POD	3764	15:55:50					
	49	14	7/16" wire							
160	50		T-POD	3762	16:01:22					
	51	28.5	7/16" wire							
190	52		Microcat	1328	16:06:50					
	53	28.5	7/16" wire							
220	54		T-POD	3258	16:10:20					
	55	13	7/16" wire							
235	56		FSI 3-D ACM	1469	16:15:50	Sensors down				
	57	13	7/16" wire							
250	58		T-POD	4494	16:24:30					
	59	100	3/8" wire							
349	60		SBE39	0048	16:35:30	Clamped on wire				

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				
	62	100	3/8" wire							
450	63		SBE 39	0050	16:40:24	Clamped on wire				
	64	500	3/8" wire		16:40:24					
	65	500	3/8" wire		17:02:25					
	66	500	3/8" wire		17:38					
	67	100	3/8" wire		18:03:30	one piece wrapped				
	68	200	7/8" nylon		18:21:50	termination				
	69	150	7/8" nylon		18:36:27					
	70	500	7/8" nylon		18:48:27					
	71	500	7/8" nylon		20:09:49					
	72	500	7/8" nylon		20:58:52	one piece to be				
	73	100	1" nylon		21:17:23	spliced at sea				
	74	1400	1 1/8" polypro		21:21:15					
	75		88 - 17" glass balls		22:40	on 1/2" trawler chain				
	76	5	1/2" trawler chain		23:19:31					
	77		Acoustic Release	503121	23:32:46	Pin Out 23:31:51				
	78	5	1/2" trawler chain		23:32:46					
	79	20	1" Samson Nystron		23:42:14					
	80	5	1/2" trawler chain							

Date/Time	Comments
	Stopped winch to wind nylon between items
	#71 and #72.
	Acoustic Release Model EGG 322

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

APPENDIX E – INSTRUCTIONAL GUIDES

CTD Usage

SET UP CTD ON DECK
Check all white knobs at top and bottom of each water bottle are closed
Open top of water bottles – make sure the number on the water bottle corresponds with the firing numbers on metal in center of CTD as you click them open
Open bottom of bottles. Push all the bottom lids in the same direction so there is no obstruction when the bottles are closed.
At last minute, remove fresh water pump.
Lower into water

SET UP CTD SOFTWARE IN MAIN LAB
Press power button on gray SBE unit
Double click on Win32 SBE
Go to *Real Time Data _ Data Acquisition*
Under *Output Data Options*, tick box for Store On Disc
Under *Header Information*, fill in and hit OK
Waiting ….. then system is running
To close a bottle, press CTRL F3.
It is best to go to the required depth and wait for one minute so the water can flush through and then close the bottle so bottle captures water true of that depth. (If bottles are pre-configured you can not do this.)

DURING CTD
Check depth of altimeter on output screen so CTD does not hit bottom
Check distance from mooring (on GPS screen) to ensure we won't get caught in mooring line
Close water bottles only on way up

END OF CTD
End data acquisition (*Real Time Data _ Stop Acquisition*) and close down software and switch off SBE gray unit
Open the white knobs at top of the water bottles and use bottom white knob to release water for water samples.
To fill water bottles, rinse through 3 times and then fill the bottle to the top and replace plastic lid (to prevent evaporation) and then screw on main lid. Ideally four water samples/water bottle.
Clean CTD sensors with fresh water/put fresh water pump back on.

Argos Processing at Sea for Stratus-3 Cruise

Introduction

The UOP ASIMET systems are equipped with Seimac Wildcat transmitters, which send hourly averaged data through a satellite system operated by Service Argos for monitoring at WHOI. Onboard ship, we monitor these transmissions using Alpha Omega Satellite Uplink Receivers and a Matlab application called Argplot.

Each Asimet logger has a single transmitter. Each transmitter holds three 2-hour buffers, each buffer having its own identification number, assigned by Service Argos and programmed into the transmitters at WHOI. The Wildcats automatically encode these id numbers into the start of each transmission. The ASIMET logger sends an average of the past hour's data to the transmitter every hour, where it is put into the first buffer. Older data is rotated back into the other buffers, and all three buffers transmit in sequence, newest data first.

Collecting Argos Messages

On the Stratus 3 deployment cruise we placed whip antennae on the forward port and starboard rails on the *Melville's* 02 deck, and ran normal BNC cable to the receivers in the lab. We had adequate signal strength to about one km from the buoy with this set-up.

A Windows program called Uplinkw is provided with the AO receivers. This program can be configured to listen to specific Argos ids and to log messages continuously to a user-specified disk file via a serial port on a laptop. Uplinkw can load a configuration file in the *File* menu, and the configuration file will specify the name of the output log file, the com port to use, and the selected ids to monitor. While it is sometimes useful to monitor all ids, the default configuration for this program, the files can become very large. If reception of signals from a buoy are established and clear it may be better to log only the first id from each logger, which gives the most recent two hours of data.

It is also useful to specify that the output log file be written in the Argplot subdirectory, usually in the Matlab/work directory. If an existing output log file is found, Uplinkw prompts to see if the file should be appended; if the monitoring period isn't too long it is usually best to keep all the Argos data in one file, so the user should choose to append when prompted. For longer monitoring periods, a series of Uplinkw log files can be made, and mat files from previous Matlab runs can be loaded after Argplot begins.

Uplinkw does not hold data in a buffer; the log file is updated as records are received. Records that don't have a decodable id are rejected. Short records are included with the notation "<Out of data>" and Argplot ignores them. Short records can be generated by position-only transmitters, or by interference disrupting a data transmission.

Processing Collected Argos Messages

While Uplinkw is appending the output log file, we are able to access the data with Matlab using the m-files collectively called Argplot. At startup, Argplot reads the Uplinkw file from the beginning; when it reaches an end of file it simply waits for a minute and tries again until a new record is read. This simple file-sharing scheme works well on Windows 98, with no need for programmed inter-process communication.

Argplot reads configuration information from a Matlab mat file, also called a table file, that specifies the Argos id numbers associated with each instrument to be monitored. The three buffers in each transmitter are broadcast at rates between 90 and 200 seconds, so there is very high redundancy rate in the messages, and a six-hour window to acquire each data point.

When a new record is detected in the Uplinkw file, Argplot checks to see if the id is one of interest. If so, it identifies the instrument associated with the id, and then decodes the record time to see if this is a new record. If the record is new, it is decoded, printed, and plotted.

The program is interrupt driven, and a user interface is provided on the active plot window header. Various standard processes can be initiated using these plot buttons: the *Xlimits* button sets time axis limits for all plot panels, the *Save* button stores processed data to disk. The *Load* button allows a previously processed mat file to be added to the display. The *Stop* button calls a routine that saves data and exits Matlab. The *ShowHead* button prints a header line to the Matlab window, identifying the columns of ASIMET data being displayed there. The *NetSave* button writes a mat file to a remote system disk, which must be mounted to the local system and specified in the routine Netsave. A button next to each plot panel allows setting y limits for the ASIMET data variable in that panel. Any functionality not found in these buttons can be accessed using the *Kbd* button, which returns control to the keyboard. Processing resumes after the user inputs the word "return" at the *K*> prompt.

Argplot can be run for days without restarting although it is updating a 6-panel plot every hour for each ASIMET system that is being recorded. This is accomplished by creating the lines in each of the 6 panels plotted, and then modifying the lines as data accumulates. Since each line is an object with associated memory overhead, we bypass Matlab's memory accumulation problem by not creating new lines or plots after the startup plot is launched. This code is contained in the files Argosfig.m and Plotimet.m.

Uplinkw Usage

Double click on the Uplinkw icon. When the window opens, chose *Open* under the *File* menu and specify a configuration file. Edit the name of the output log file under the *Log* menu, checking that the directory is as expected. Add Argos ids using the *Add* button next to the *PTTs watched* sub-window. Remove ids by clicking on them in the list; a window opens showing the selected id, hit the *Delete* button in that window. When all desired changes have been made, go back to the *File* menu and select *Save*.

It is not normally necessary to specify the Com Port number in Uplink's window, but if no messages are seen and neither button is highlighted, try clicking on *Com 1*.

Argplot usage

Normally, the Matlab icon on the desktop open a Matlab session with mathome/work as the working directory. This can be modified if needed by left-clicking the icon. We create an m-file in the work directory called doao.m, which changes to the Argplot directory and runs go.m. Go sets up input file information and runs Argplot. After data accumulated in the Uplink log file is processed, previously processed data can be loaded from a mat file using the Load button on the active plot window.

Argplot saves all data in a mat file whenever new system 1 data is found. The mat file contains data from each system being monitored, as well as a string listing the fields in the array and one mapping the instruments in each system array. These last two items can be used to help use the array data.

For new implementations, the files that may need to be edited are doao.m, go.m, and netsave.m. Argosfig.m contains y-axis limits, and may also be edited for ease of use where different ranges of values are expected.

Argplot was originally written by Jonathan Ware, and has been updated and adapted for Alpha Omega use by Nan Galbraith.

Sample files

Sample Uplinkw configuration file, which can be created or edited in the Uplinkw program.

```
Port=COM1
Logfile=st3.log
        PTT=* B d t p 32x 32x 32x 32x 32x 32x 32x 32x
```

Sample Uplinkw log file:

```
07/31/2002 19:21:36 27921 6a29ca3d 3b51ff7f 6b801629  7d1f46a 25ca2b7b 51ff7fac 8015d107 d1f4a81c
07/31/2002 19:22:57 27916 6a39ce4a bb52017c 2b82866c b7d1f46a 35ca463b 52027b2b 80b66cb7 d1f4a6f0
07/31/2002 19:23:00 27917 6a31ca45 3b52017c ab001660 b7d1f46a 2dca467b 52017e6a 801658b7 d1f443b9
07/31/2002 19:23:03 27918 6a29ca3e fb52007f 2b00164c b7d1f46a 25ca2c3b 51ff7fac   15f4b7 d1f4d9ef
07/31/2002 19:23:21 27919 6a39ce48 fb52017c 2c029650 f7d1f46a 35ca447b 52027b2b 80c64cf7 d1f44be0
07/31/2002 19:23:24 27920 6a31ca43 7b52017c ab801640 f7d1f46a 2dca44fb 52007e6b   1638f7 d1f45030
07/31/2002 19:23:27 27921 6a29ca3d 3b51ff7f 6b801629  7d1f46a 25ca2b7b 51ff7fac 8015d107 d1f4a81c
```

Sample Matlab Configuration Table File

This is not a printable file, but can be created and saved in the startup user interface window in Argplot, or in Matlab using normal commands.

```
 instname:   [4x8    char]    4     7      1      2
    logfile:    [4x50  char]    s3_l4 s3_l7 s2_l1 s2_l2
    instcol:   [4x1    char]    r b g c
  id_num:   [4x3 double]
27916     27917     27918
27919     27920     27921
09805     09807     09811
09819     09833     25078
```

Sample Argplot Data Listing

The first column is the color of the instrument's plot lines.

sys	id	yearday	bp	at	sst	wnde	wndn	rh	swr	lw	prc	cnd	wnds	wndd
b	2	27919 290.46	1012.0	19.93	19.65	0.10	1.50	89.0	7.0	393.0	0.0	0.00	1.50	3.8
b	2	27919 290.50	1012.0	20.11	19.58	0.00	1.30	88.0	32.0	405.0	0.0	0.00	1.30	0.0

r 1 27916 290.50 1012.0 20.08 19.66 0.00 1.20   87.0 31.0 419.0 0.0   0.00 1.20   0.0
r 1 27916 290.54 1013.0 20.56 20.39 -0.10 1.20   82.0 66.0 425.0 0.0   0.00 1.20 355.2
b 2 27919 290.54 1013.0 20.55 20.36 -0.10 1.20   83.0 67.0 414.0 0.0   0.00 1.20 355.2

Stratus 2 Flash Cards

ASIMET loggers, relative humidity and air temperature modules, wind modules, and a new-generation current meter wrote to Intel-compatible type 2 flash memory cards during the Stratus 2 mooring.

Flash cards were read under Linux using the PC card slot on a Dell Latitude laptop computer. These cards were all recognized by the card manager, because they were already described in the configuration file for that utility. They were dumped using the command *cp /dev/mem0c0c card.dat* to extract data from the card onto disk. The different cards were then handled slightly differently because of variations in the software used to decode the binary files.

ASIMET Cards

The ASIMET processing programs, which run under DOS, do not expect to read the flash header, so ASIMET flash headers were removed using the command *dd if=card.dat of=st2lgrN.dat ibs=1024 obs=1024 skip=128* where N was the logger serial number, 1 or 2. The binary data files were then copied to a Windows disk and converted using *proclogr.bat*, which calls C programs logrswab and lograsc and writes out ASCII files. This batch file runs in an MS-DOS window. It expects the input file to have an extension of .dat. The syntax is *proclogr.bat st2imetN* and the batch file provides the extensions to the filenames.

The ASCII files were loaded into Matlab using logrload.m after specifying input filenames. stratus2_imet.mat contains both IMET systems' data, stored in Matlab structures. Matfiles st2_imet1.mat and st2_imet2.mat contain individual system records, with data stored as vectors.

The ASCII file that is generated by lograsc.c has lines containing 33 blank-separated fields, but not all are used:
hour, minute, day, month, year, rec_numb, mux_parm, east, north, WSpdavg, Wmax, Wmin, last vane, compass, BPR, HRH, atmp, SWR, LWR dome, body, thermopile, flux, PRC level, SST, Cond, bv1,bv2,bv3,bv4, PARM, SPARE1,2,3

Sample record with some whitespace removed and breaks added:
16 02 09 10 2001 02531 001
-0.13 -0.02 0.20 0.70 0.00 273.60 173.50
1013.77 82.430 21.300
315.4 300.470 300.480 -224.2 404.9
45.50 21.668 0.0000
12.50 12.60 12.70 12.80 123456789 1 0 0

New Generation VMCM Cards

The flash header was removed from the card.dat file as for the ASIMET cards:
dd if=nvm203.dat of=nvm203s.dat ibs=1024 obs=1024 skip=128
The resulting file was processed under Linux using vm2swab to swap bytes for PC usage and vm2asc to create an ASCII output file.
/usr/local/bin/uop/vm2swab nvm203s.dat nvm203.swb
/usr/local/bin/uop/vm2asc nvm203.swb nvm203.asc

Perl was used to convert dates to yearday and to make an ASCII “flatfile” that would be easily read into Matlab.
cat nvm203.asc | ./vmcnv.pl > nvm203c.asc
The output file was placed in a Windows directory for use
cp nvm203c.asc nvm203.dat /windows/stratus/stratus2/vmcm
Under windows, Matlab script loadnvm.m created a mat file with yearday, start_year, instrument name, deployment information, east, north, rotor1, rotor2, compass, tiltx, tilty.

Wind Cards

The wind module flash cards, complete with flash header, were processed under Linux using the C program voswnd to create ASCII files.

voswnd st2w212.dat st2w212.asc
cp st2w212.asc /windows/stratus/stratus2/wind

The voswind output is a Matlab-ready, space-delimited flat file with scaled data; no magnetic correction is applied. The output statement generates a minute field, since the ASIMET software provides only the value of the last minute in the hourly recording period, always 59.

("%2d %2d %2d %2d %4d %6.2f %6.2f %5.2f %5.2f %5.1f %5.1f %6.2f %6.2f\n",
hour, min - 59 + i, day, mon, year, Ve/100.0, Vn/100.0, WSpeed/5.0, WSMax/5.0, LastVane/10.0, LastCompass/10.0, TiltX/5.0, TiltY/5.0)

Windload.m was used to convert the ASCII files to Matlab under Windows.

RH Cards

After being copied from the flash card, the relative humidity module data files were converted under Linux using C program hrh2asc, which skips the flash header, swaps the bytes for PC use and decodes the data.
Hrh2asc st2rhNNN.dat s2rhNNN.asc
A time word is generated for each one-minute record, as for the wind files. The output statement is:
("%2d %2d %2d %2d %4d %6.2f %6.2f", hour, min - 59 + i, day, mon, year, rh, temp)
Files were then run through hrhcnv.pl
cat infile | ./hrhcnv.pls > outfile

This script is set up to generate continuous yeardays relative to 2001. On HRH223, which began recording to flash before 01/01/2001, old data was stripped off:
cat s2hr223.orig.asc | awk '($1 > 0){print}' > s2rh223.asc

The output could then just be read into Matlab under Windows as simply as:
load s2rhNNN.asc

Problems

There seems to be a discrepancy between yearday values generated by the Perl routines, which used the Perl module Time::JulianDay; and yeardays generated by Matlab, which use the datenum routine. This became apparent in comparing flash card winds to logger winds, where spikes were slightly offset in time. The problem might also be caused by a misuse of the "minute" field in the binary files; it is always 59 and refers to the minute of the last point in the physical record.

The current system of processing different types of flash files under different operating systems should be addressed in the near future. Since the cards must be read under Linux, there should be a complete set of programs to read them under Linux. These should generate Matlab-ready ASCII files with Julian date calculations.

NRG, RV *Melville*, 021029

R.V. *Melville* Shipboard Systems Data Processing for Stratus 3 Deployment Cruise

Data is collected by several systems on the *Melville* under the control of the Scripps Shipboard Computer Group. We monitored meteorological, navigational and seawater systems during the Stratus-3 deployment cruise for use in comparisons with ASIMET data from our buoys.

The primary source of underway shipboard data was an ASCII text file that was accumulated by our Shipboard Computer Group (SCG) technician on one of the *Melville's* Sun workstations. Updated every 5 minutes, it contained the last value of each parameter of interest from the ship's 1-minte data files. We also accessed 1-minute data, though not in real-time. The 1-minute data was contained in a series of single-day files available for download from a networked PC.

Accessing shipboard data

The 5-minute data file was preprocessed on the workstation using an automated shell script run by cron, the Unix scheduling utility, to remove non-numeric characters. It was continuously plotted using a Matlab script on a laptop, which also over-plotted hourly Argos ASIMET data and, when available, data collected on board the ship using hand-held instruments.

The 1-minute data was read at the end of the **UTC** day, and each day's data was archived in a Matlab mat file along with earlier data. Each file on the server contained all the data for a single day from all of the data collection systems. The meteorological data were written once a minute. The other fields, navigation and seawater properties, were written every thirty seconds. Because each record was independent of the time records, at every instance of a time record the previous array for corresponding data was checked and filled if needed.

Melville Shipboard Data Details

The 5-minute file contained the following parameters: month, day, hour, minute, latitude (degrees, minutes, hemisphere), longitude (degrees, minutes, hemisphere), ship's speed , heading, water depth, air temperature, barometric pressure, relative humidity, sea surface temperature, salinity, surface sound velocity, conductivity, longwave radiation, shortwave radiation, precipitation level. Water depth was available only when the Sea-Beam system was running. SST was taken from the INSSV system, which did not have a pump running, but comparisons between it and the INSCTS sst was reasonably good for our comparisons.

Sample 5-minute file:
10 11 21 44 9 58.1237N 84 50.2522W .0 265.7 DNV 27.133 1008.5 71.4 28.630 30.446 1537.8 50.250 464.0 -99.0 15.93
10 11 21 49 9 58.1302N 84 50.2530W .0 265.7 DNV 26.423 1008.4 75.6 28.638 30.449 1537.8 50.262 462.5 -99.0 15.92
10 11 21 55 9 58.1315N 84 50.2526W .0 265.7 DNV 26.343 1008.4 74.0 28.641 30.452 1537.8 50.269 460.6 -99.0 15.92

Data record samples from the 1-minute files and explanations follow, along with notes on variable names and fields that were not available.

INSTIM 1999,01,28,04,03,00
year, month, day, hour, minute, second
GPSTIM 1999,01,28,04,03,01
Year, month, day, hour, minute, second
GPSPOS 3,55.0280,N,172,56.6544,E,8,3,1.0
latitude degrees, latitude minutes, latitude hemisphere, longitude degrees, longitude minutes, longitude hemisphere, number of satellites, quality of fix reported by receiver, Horizontal DOP all reported but quality was always 1
GPSNAV 278.0,267.9,0.5,1.0
True heading, Magnetic heading, Speed (knots), Speed (km/hour)
INSNAV 110.5,-99.0,0.3,-99.0,-99.0,-99.0
Last gyro heading (degrees), Last speed forward/aft (knots), Last speed port/starboard (knots), Gyro average of log period (degrees) (not correctly averaged), Speed forward/aft across log period (knots), Speed port/starboard across log period (knots)
INSCTS 27.188,51.865,32.524,-99.000,-99.000,-99.000,0,0,0,0
From CTS sensor 1, uncorrected values: Sea temperature (degrees C), Conductivity (mmho), Salinity (PSU). From CTS sensor 2, uncorrected values: Sea temperature (degrees C), Conductivity (mmho), Salinity (PSU), Timeout errors: temp_1, cond_1, temp_2, cond_2
Only sensor 1 data available
INSSSV 1539.4,35.002,27.179,55.355
Surface sound velocity (meters/second), Salinity (parts/million), Corrected temperature (degrees C), Conductivity (mmho)
All sensors reported. These are sst3, cond3, sal3, and sssv

INSTRM 28.0,28.0
Thermistor 1 Sea temperature (degrees C), Thermistor #2 Sea temperature, (degrees C)
METDTA 1006.9,12.000,57.7,25.1,-99.000,23.36,-99.0
Barometric Pressure (millibars), Air temp (degrees C), Relative Humidity (percent), Air temperature from Relative Humidity module (degrees C), Sea Temp (degrees C), Precipitation (mm), Battery voltage from the WeatherPak (volts)
The sea temperature was not available from this system.
METRAD 447.3,341.2,24.9,25.1,1.2,4.0000
Shortwave radiation (watts/meter**2), Longwave radiation (watts/meter**2), Case temperature of longwave unit (degrees C), Dome temperature of longwave unit (degrees C), Thermopile voltage, Longwave wave calibration factor.
The shortwave radiation sensor was not operational, and was replaced on the mast by an ASIMET spare, which recorded internally.

METWND 6.4,7.1,310.9,-99.0,-99.0,-99.0
Wind speed averaged over 1 minute (Meters/second), Wind peak (Meters/second), Wind_dir (degrees), Wind_avg_2, Wind_peak_2 Wind_dir_2
Only wind sensor 1 was installed, and the direction readings were incorrect. Wind speed peak appeared to be identical to wind speed.

Melville Instrumentation

Information about the instrumentation was provided by the SCG.

The barometers are Atmospheric Instrumentation Research (AIR) Inc. strain gauge mounted on diaphragm instruments. AIR was bought by Vaisala in 1999. The barometric pressure is the value measured at the barometer height. The humidity sensors are Rotronics capacitance detectors with integral RTD temperature sensors. The precipitation gauge is an R.M. Young capacitance level-measuring sensor. The air temperature sensors are R.M. Young RTDs.

The LWR is a PIR sensor from Eppley. The SWR is normally a PSP sensor from Eppley, but for this cruise we supplied a replacement from ASIMET spares.

The wind sensors are R.M. Young pulse modules for speed with BEI 9-bit position encoders for direction. The total wind measurement cycle is 55 seconds. Wind speed is averaged in a 55 second cycle. Wind direction is calculated every 0.33 seconds. The recorded data shows the direction the wind is blowing from.

We made the following height measurements for the ship's IMET sensors on the bow mast (plus our stand-alone SWR mounted there):

Module	Measurement from	Height above water
PRC	bottom of funnel	13.74 meters
ATMP	mid shield	13.70 meters
SWR	top of dome	14.56 meters
LWR	top of dome	14.61 meters
HRH	mid-shield	13.56 meters
BPR	mid port	14.30 meters
WND	mid-vane	14.70 meters

APPENDIX F – BUOY SPINS

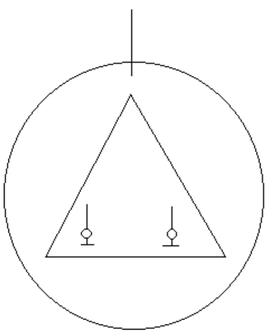
Prior to the launch of the Stratus buoys, the compass and wind vane directions are checked on the IMET systems. A stationary point at some distance from the buoy is surveyed to provide a reference point. The vanes are locked in position pointing towards the reference point. Then readings from the vane 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° is subtracted if needed.

The following pages show the results of buoy spins performed in San Diego, CA and Woods Hole, MA for the Stratus 3 buoy.

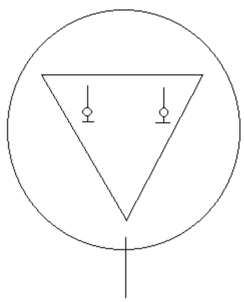
Stratus 3 Primary Buoy Spin, San Diego, CA

Bearing = 162 Degrees

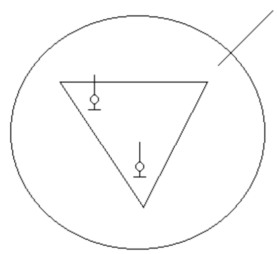
Position #	System #	Direction	Vane	Compass
1	1	163.5	178.4	345.1
1	2	161.3	185.4	335.9
2	1	162.5	04.6	157.9
2	2	164.7	012.5	152.2
3	1	166.9	127.0	039.9
3	2	162.7	131.7	031.0
4	1	160.7	239.3	281.4
4	2	161.2	246.5	274.7
5	1	161.5	300.0	221.5
5	2	163.9	308.3	215.6
6	1	164.3	060.0	104.3
6	2	164. 5	067.5	097.0



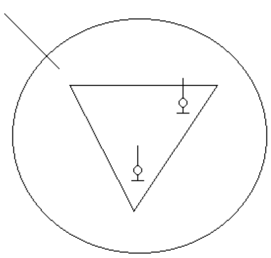
Position 1



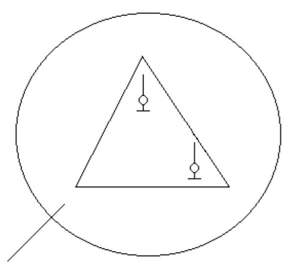
Position 2



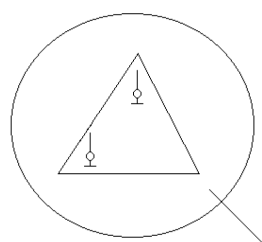
Position 3



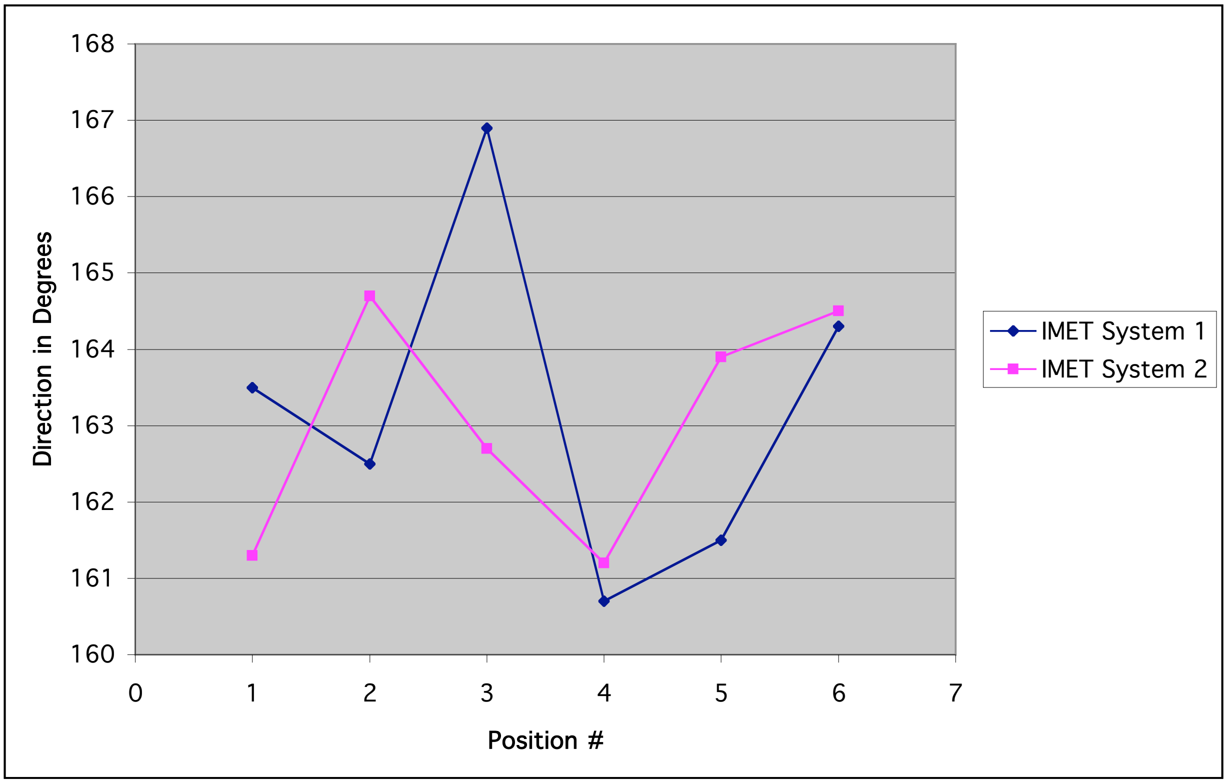
Position 4



Position 5

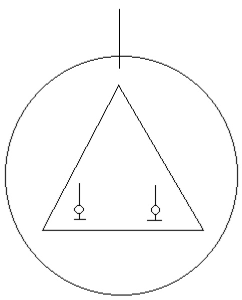


Position 6

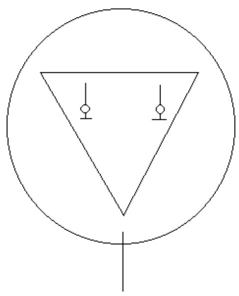

168
167
166
165
164
163
162
161
160
Direction in Degrees
0
1
2
3
4
5
6
7
Position #
IMET System 1
IMET System 2

Stratus 3 Primary Buoy Spin, Woods Hole , MA

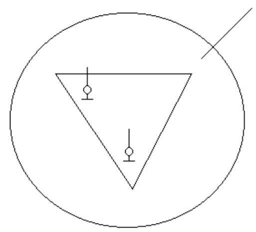
Position #	System #	Direction	Vane	Compass
1	1	310.9	177.6	133.3
1	2	311.1	185.3	125.8
2	1	304.2	354.6	309.6
2	2	308.6	06.8	301.8
3	1	309.7	122.2	187.5
3	2	309.5	128.7	180.8
4	1	307.8	236.9	070.9
4	2	311.5	248.0	064.5
5	1	307.1	306.3	00.8
5	2	310.3	317.5	352.8
6	1	306.3	058.8	247.5
6	2	310.1	069.4	240.7



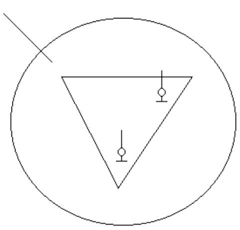
Position 1



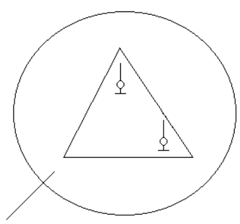
Position 2



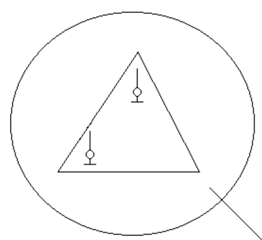
Position 3



Position 4



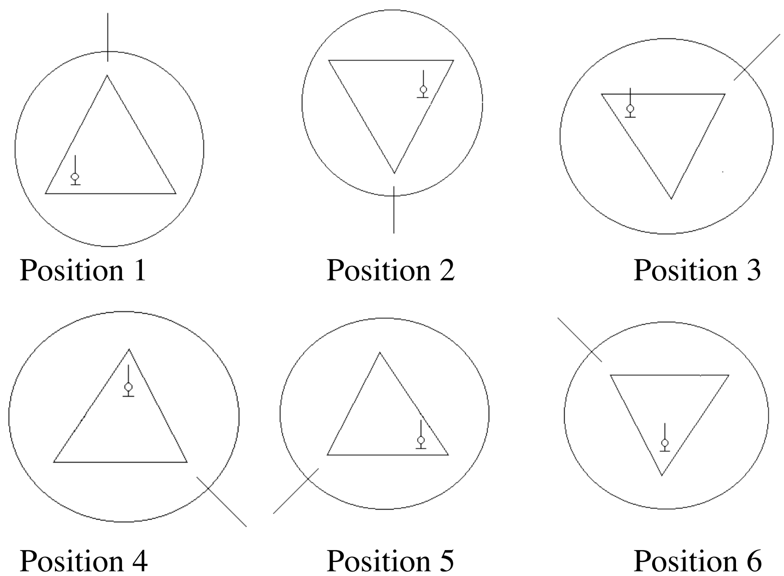
Position 5

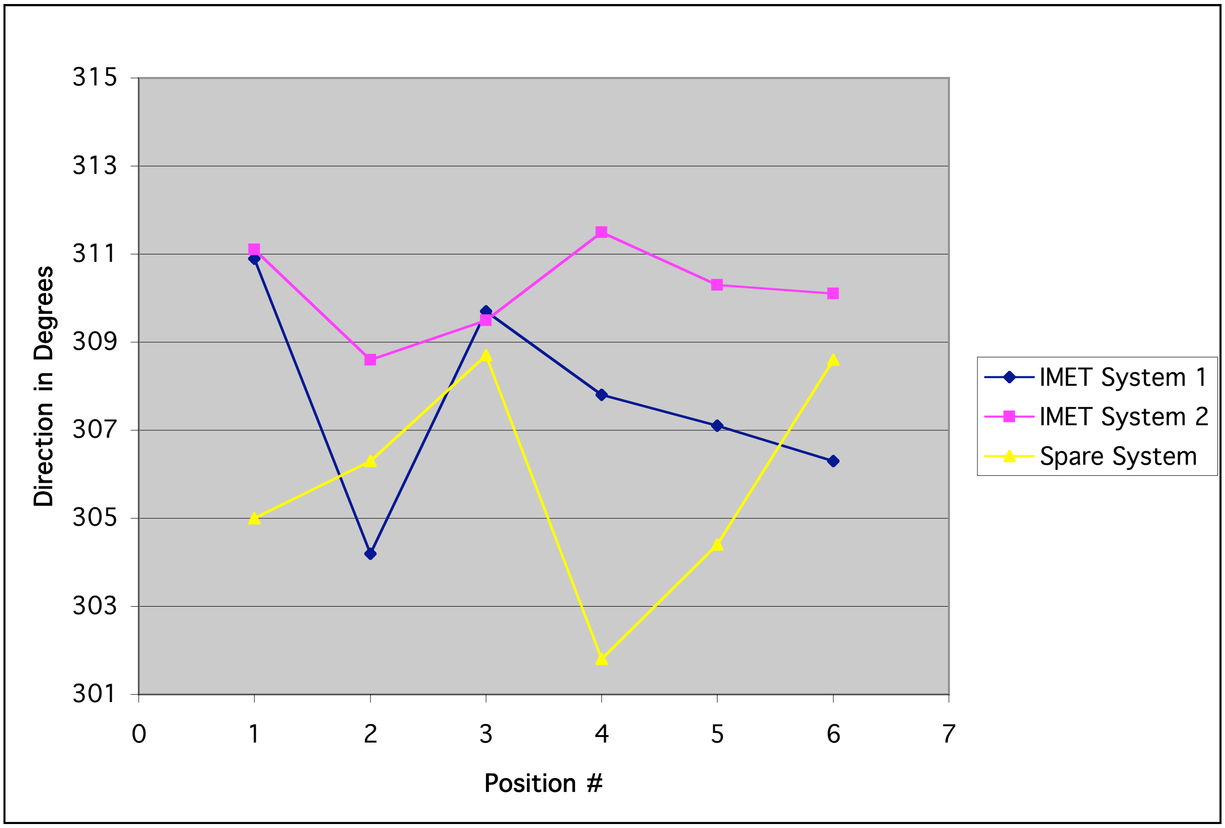


Position 6

Stratus 3 Spare Tower Spin, Woods Hole, MA

Position #	System #	Direction	Vane	Compass
1	Spare	305.0	060.3	244.7
2	Spare	306.3	239.7	066.6
3	Spare	308.7	00.8	307.9
4	Spare	301.8	115.6	186.2
5	Spare	304.4	179.1	125.3
6	Spare	308.6	302.1	06.5




315
313
311
309
307
305
303
301
Direction in Degrees
0
1
2
3
4
5
6
7
Position #
IMET System 1
IMET System 2
Spare System

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16. Abstract (Limit: 200 words)

The Long Term Evolution and Coupling of the Boundary Layers Study (referred to as the Stratus Project) is an effort to obtain a reliable multi-year dataset of meteorological and subsurface measurements beneath the stratus cloud deck off the coast of Chile and Peru. These data will improve the understanding of the role of clouds in ocean-atmosphere coupling. This project is part of the Eastern Pacific Investigation of Climate (EPIC), a NOAA-funded Climate Variability (CLIVAR) study.

During the Stratus 2002 cruise, a surface mooring was recovered and another deployed in the same location, as part of the Enhanced Monitoring element of EPIC.

The Stratus buoys were equipped with surface meteorological instrumentation, mainly two Improved METeorological (IMET) systems. The moorings also carried subsurface equipment attached to the mooring line, which measured conductivity, temperature, current direction and velocity, chlorophyll-a, and rainfall.

The moorings were recovered and deployed by the Upper Ocean Processes Group of WHOI from the Scripps Institution of Oceanography's R/V *Melville*. In collaboration with investigators from the Chilean Navy Hydrographic and Oceanographic Service (SHOA) and the University of Concepcion, Chile, conductivity, temperature, and depth (CTD) profiles were obtained at the site and along 20°S while steaming east from the mooring site.

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moored data

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