WHOI-2007-01

Woods Hole Oceanographic Institution

Stratus Ocean Reference Station (20°S, 85°W)

Mooring Recovery and Deployment Cruise
R/V *Ronald H. Brown* Cruise 06-07,
October 9–October 27, 2006

by

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February 2007

Technical Report

Funding was provided by the National Oceanic and Atmospheric Administration
under Grant No. NA17RJ1223.

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Upper Ocean Processes Group
Woods Hole Oceanographic Institution
Woods Hole, MA 02543
UOP Technical Report 2007-01

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Approved for Distribution:

Robert A. Weller

Robert A. Weller, Chair

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Abstract

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

During the October 2006 cruise of NOAA's R/V *Ronald H. Brown* to the ORS Stratus site, the primary activities where recovery of the Stratus 6 WHOI surface mooring that had been deployed in October 2005, deployment of a new (Stratus 7) WHOI surface mooring at that site, in-situ calibration of the buoy meteorological sensors by comparison with instrumentation put on board by staff of the NOAA Earth System Research Laboratory (ESRL, formerly ETL), and observations of the stratus clouds and lower atmosphere by NOAA ESRL. A buoy for the Pacific tsunami warning system was also serviced in collaboration with the Hydrographic and Oceanographic Service of the Chilean Navy (SHOA). The old DART (Deep-Ocean Assessment and Reporting of Tsunami) buoy was recovered and a new one deployed which carried IMET sensors and subsurface oceanographic instruments. Argo floats and drifters were also launched and CTD casts carried out during the cruise.

The ORS Stratus buoys are equipped with two Improved Meteorological (IMET) systems, which provide surface wind speed and direction, air temperature, relative humidity, barometric pressure, incoming shortwave radiation, incoming longwave radiation, precipitation rate, and sea surface temperature. The IMET data are made available in near real time using satellite telemetry. The mooring line carries instruments to measure ocean salinity, temperature, and currents. The ESRL instrumentation used during the 2006 cruise included cloud radar, radiosonde balloons, and sensors for mean and turbulent surface meteorology.

Stratus 7 also received a new addition to its set of sensors: a partial CO2 detector from the Pacific Marine Environmental Laboratory (PMEL). Aerosol measurements were also carried out onboard RHB by personnel of the University of Hawaii. Finally, the cruise hosted a teacher participating in NOAA's Teacher at Sea Program.

TABLE OF CONTENTS

List of Figures

List of Tables

Abbreviations

ADCP	Acoustic Doppler Current Meter
CTD	Conductivity Temperature Depth
EPIC	Eastern Pacific Investigation of Climate
ETL	NOAA Environmental Technology Laboratory
ESRL	NOAA Earth System Research Laboratory (former ETL)
GPS	Global Positioning System
IMET	Improved Meteorological Systems
NOAA	National Oceanic and Atmospheric Administration
ORS	Ocean Reference Station
PMEL	Pacific Marine Environmental Laboratory
SBE	Sea Bird Electronics
SCS	Scientific Computer System
SHOA	Chilean Navy Hydrographic and Oceanographic Service
SST	Sea-Surface Temperature
UOP	Upper Ocean Processes Group
VMCM	Vector Measuring Current Meter
WHOI	Woods Hole Oceanographic Institution

I. INTRODUCTION

I.A. Background and Purpose

The presence of a persistent stratus deck in the subtropical eastern Pacific is the subject of active research in atmospheric and oceanographic science. Its origin and maintenance are still open to discussion. A better understanding of the processes responsible for it is desirable not only because the nature of air-sea interactions in this region could be of valuable and maybe unique interest, but also because the regional radiative budget, altered by the clouds, seems to introduce errors in the South Pacific SST field from current computer models. There is also a desire to monitor in-situ data because of the inability of satellites to cover the area under the stratus deck.

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

During the October 2006 cruise of NOAA's R/V *Ronald H. Brown* (RHB) to the ORS Stratus site, the primary activities were recovery of the WHOI surface mooring that had been deployed in October 2005, deployment of a new WHOI surface mooring at that site, in-situ calibration of the buoy meteorological sensors by comparison with instrumentation put on board by staff of the NOAA Earth System Research Laboratory (ESRL, formerly ETL), and observations of the stratus clouds and lower atmosphere by NOAA ESRL.

The ORS Stratus buoys are equipped with two Improved Meteorological (IMET) systems, which provide surface wind speed and direction, air temperature, relative humidity, barometric pressure, incoming shortwave radiation, incoming longwave radiation, precipitation rate, and sea surface temperature. The IMET data are made available in near real time using satellite telemetry. The mooring line carries instruments to measure ocean salinity, temperature, and currents. The ESRL instrumentation used during the 2006 cruise included cloud radar, radiosonde balloons, and sensors for mean and turbulent surface meteorology.

The Chief Scientist was Dr. Robert Weller, who is affiliated with the Woods Hole Oceanographic Institution. There were 15 people in the science party; whose list is given in the table below.

Table I.A.1. Stratus 2006 Science Party

	Name	Sex	Affiliation	Nationality
1	Robert Weller	M	WHOI	USA
2	Jeff Lord	M	WHOI	USA
3	Nan Galbraith	F	WHOI	USA
4	Sean Whelan	M	WHOI	USA
5	Sebastien Bigorre	M	WHOI	France
6	Brett Hoyt	M	NOAA TAS	USA
7	Dan Wolfe	M	NOAA ESRL	USA
8	Virende Ghate	M	U Miami	India
9	Byron Blomquist	M	U Hawaii	USA
10	Mingxi Yang	M	U Hawaii	PR China
11	Stacy Maenner	F	NOAA PMEL	USA
12	Alvaro Vera	M	SHOA	Chile
13	Jorge Araya	M	SHOA	Chile
14	Jorge Gaete	M	SHOA	Chile
15	Uriel Zajaczkovski	M	U. Buenos Aires	Argentina

I.B. Cruise Timeline

October 9, 2006. The science party boarded in Rodman, Panama. RHB refueled and departed from Rodman, steaming to the location of the WHOI buoy (Fig I.B.1).

October 10, 2006. One stop was made en route for lowering and testing of acoustic releases at 1500m depth; CTD test as well. Latitude 2 S.

October 11, 2006. Time spiking of subsurface temperature sensors.

October 12, 2006. Antifouling application. Spare SWR and LWR installed forward on O1 deck in front of ETL van, next to ship and ETL SWR and LWR sensors. Cross comparison desired for intercalibration.

October 13, 2006. Entered international waters. Measurements started. Launched first Argo float and drifter (A1/D1). Balloon radiosondes launches started, every 6 hours (11:00, 17:00, 23:00, 05:00 UTC). Lower part of mooring line assembled and reeled in.

October 14, 2006. Launched D2 at 12°S, A2/D3 at 14°S, D4 at 16°S. Balloons launched. Buoy hull painted with antifouling.

October 15, 2006. Float A3/Drifter D5, balloons launched. RHB steamed from A3/D5 to Initial point of bottom survey before deployment of Stratus 7 buoy. Bottom survey carried out to locate a target region for the deployment of Stratus 7. Brisk winds out of the SE; swell and waves. At end of survey park at Initial Point. Preparations for deployment.

October 16, 2006. Wind and waves down. Buoy Stratus 7 deployment started at 12:15 UTC, buoy in water at 12:45. Anchor over at 17:51. Depth of anchor 4416m. CTD casts to 4400m (1) and 500m (3) overnight. Ballon launches: 6 per day. Ship moves back to Stratus 6 buoy, taking position bow into the wind, ¼ mile downwind of buoy.

October 17, 2006. Ship stationed downwind of Stratus 6 for instrument intercomparison. DART II buoy prepared. CTDs to 500m.

October 18, 2006. Recovery of Stratus 6 buoy. Instruments cleanup. CTD to 4,200 m at Stratus 6 site. Move back to Stratus 7 site.

October 19, 2006. Ship stationed downwind of Stratus 7 buoy for data intercomparison, CTD casts to 500m. Data dumping from instruments started.

October 20, 2006. Left Stratus 7 buoy at 14:15 UTC, en route to the SHOA buoy. Launched Float A4, Drifter D6.

October 21, 2006. Launched Float A6, Drifters D7, D8, D9. Data dumping from Stratus 7 buoy continues. Ship's bearing 89° true. Underway to SHOA buoy.

October 22, 2006. Arrive at SHOA buoy site 15:30. Seabeam survey of 6 nm x 6 nm region around DART I buoy. Recovery DART I.

October 23, 2006. Deployed DART II buoy and BPR. Stand by DART II buoy for intercomparison and shallow CTD (500 m) series.

October 24, 2006. Depart DART II buoy for Valparaiso at 11:30. Radiosondes and underway sampling continues. Drifter and Argo float deployments continue.

October 25, 2006. Underway for Valparaiso. Radiosondes and underway sampling continues. Drifter and Argo float deployments continue.

October 26, 2006. Underway for Valparaiso. Radiosondes and underway sampling continues. Drifter and Argo float deployments continue.

October 27, 2006. Sampling stopped at 10:40. Entry intoValparaiso. Store gear and rearrange deck to make way for next leg.

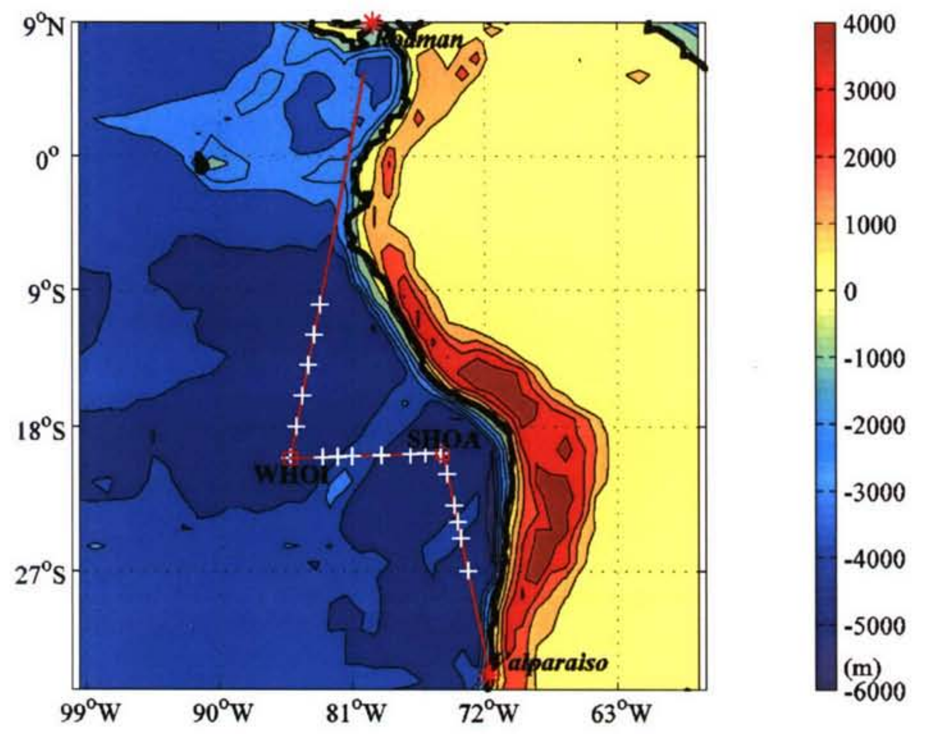


Figure I.B.1: R/V *Ron Brown* cruise 06-07 track. Color contour show bathymetry and white crosses the different float and drifter launches.

II. PRE-CRUISE

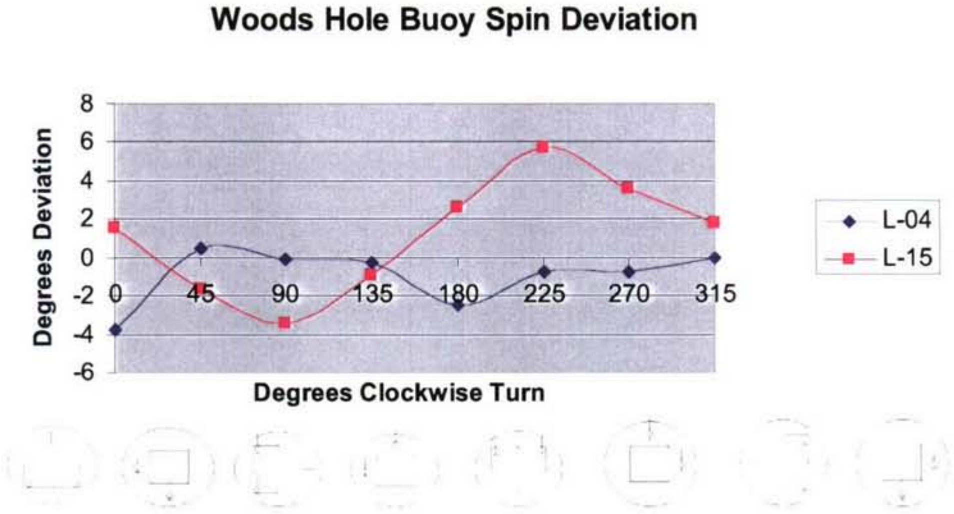
II.A. Ship Loading

On September 19, 2006, trucks left WHOI with all the equipment to Charleston, South Carolina, where R/V *Ron Brown* was stationed. During the period September 21-28 a group from WHOI went to Charleston to set up the buoy and load it on the RHB with all the equipment.

After the buoy spin the buoy was placed at the end of the pier where the wind was less disturbed. Transmissions from the instruments on the buoy were made with an Alpha Omega uplink receiver to check the validity of data as part of the final burn-in. The buoy was then boarded on the ship. RHB departed from Charleston on about October 2, 2006, and arrived in Rodman, Panama, on October 8, 2006. The science party boarded on the 9th and the ship left Rodman that same day, en route to the WHOI buoy site.

II.B. Buoy Spins

The buoy spin is a check procedure of the compass on the buoy. A visual reference direction is first set using an external compass. The buoy is then oriented successively at 8 different angles and the vanes of the anemometers visually oriented towards the reference direction and then blocked. Wind is then recorded for 15 minutes at the end of which the average compass and wind direction is read, the sum of which should correspond to the reference heading, within errors due to approximations in orientation, compass precision and any deformation of the magnetic field due to the buoy metallic structure. A first buoy spin was made in Woods Hole and a second one in Charleston. The second buoy spin was made on the parking lot near the pier on October 23rd. Figures (II.B.1a,b) show the deviation of the reading from the reference heading during the buoy spin, for both wind systems on the buoy.



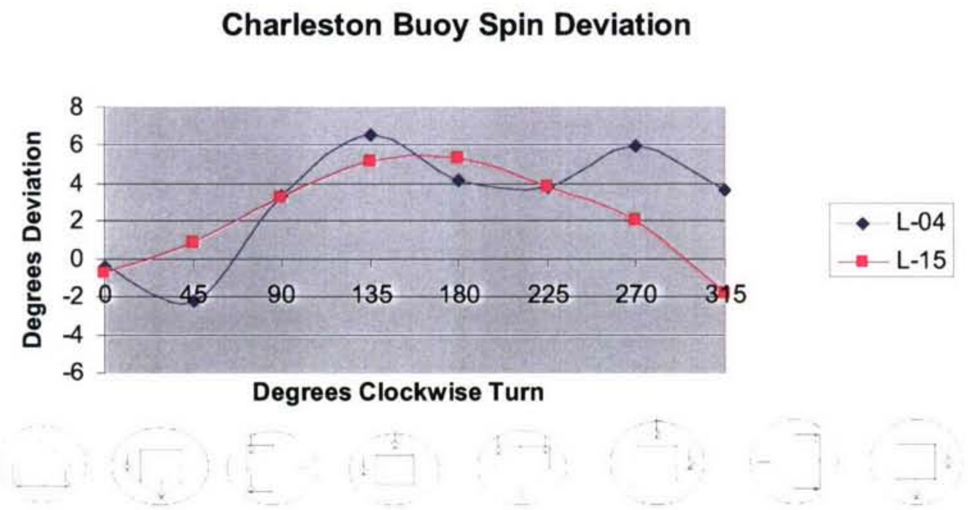


Fig II.B.1a,b Buoy spins for Climode 2. Deviation from reference heading for 8 different orientations of the buoy.

II.C. Telemetry

Each ASIMET module onboard the buoy samples data every minute and records it on a dedicated flashcard. The logger receives and stores this data. It also computes hourly averages for Argos transmissions. These Argos transmissions can be picked up as well by an Alpha Omega Uplink receiver directly from the Argos antenna on the buoy. The hourly averages help monitoring the status of instruments and quality of data they provide.

II.D. Burn-in

Before each deployment the sensors are calibrated and then tested in different conditions. A cold room is run and tests are done for instruments separately and in the deployment configuration. This last test ensures that the instruments work properly and transmit well in the presence of the Argos transmitters. These tests are run for several months to check the durability of the instruments. Appendix A provides the notes of this burn-in process.

III. ORS STRATUS MOORINGS

III.A. Overview

The buoys used in the Stratus project are equipped with surface meteorological instrumentation, including two Improved Meteorological (IMET) systems. The mooring line also carries subsurface instrumentation that measures conductivity and temperature and a selection of acoustic current meters and vector current meters.

The WHOI mooring is an inverse catenary design utilizing wire rope, chain, nylon and polypropylene line and has a scope of 1.25 (scope is defined as slack length/water depth). The Stratus 6 surface buoy is similar to the new Stratus 5 design and has a 2.7 meter diameter foam buoy with an aluminum tower and rigid bridle. Prior to Stratus 5, buoys had been similar but consisted of a single-piece aluminum hull. The design of these surface moorings took into consideration the predicted currents, winds, and sea-state conditions expected during the deployment duration.

The instrument systems recovered and deployed on the Stratus moorings are described in detail below.

III.B. Surface Instruments

There are two independent IMET systems on the Stratus buoys. These systems measure different meteorological parameters once per minute, and transmit hourly averages via satellite. These parameters are:

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

A partial CO2 sensor was also installed for the first time on the Stratus 7 buoy. This sensor was set up by PMEL.

All IMET modules for the Stratus experiment are designed for low power consumption so that a non-rechargeable alkaline battery pack could be used. Near-surface temperature and conductivity are measured with a SeaBird MicroCat with an RS-485 interface.

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

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

The LOGR53IF Interface board handles power and communications distribution to the IMET modules as well as interface to various options such as PTT or A/D modules. Connector P12 is the main RS232 "console" interface to the LOGR53 and can also be used to apply external power (up to about 100 MA) to the system during test. The main +12-15V battery stack (for the base logger with FLASH card) is connected to P13; the "sensor" +12-15V battery stack (which typically powers the IMET modules) is connected to P14; the "aux" battery stack (which typically powers the optional PTT) is connected to P19. Regulated +5V power for the system is produced on this board.

Parameters recorded on a FLASH card are:

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

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

III.C. Subsurface Instruments

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

1. Floating SST Sensor
A Sea-Bird SBE-39 was placed in a floating holder (a buoyant block of synthetic foam sliding up and down along 3 stainless steel guide rods) in order to sample the sea temperature as close as possible to the sea surface. The Sea-Bird model SBE-39 is a small, lightweight, durable and reliable temperature logger. A TR-1050 was also added on the float for Stratus 7.

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

3. SeaCat Conductivity and Temperature Recorders
The model SBE 16 SeaCat was designed to measure and record temperature and conductivity at high levels of accuracy. 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 others were mounted on in-line tension bars and deployed at various depths throughout the moorings. The conductivity cell is protected from bio-fouling by the placement of antifoulant cylinders at each end of the conductivity cell tube.

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

5. Brancker Temperature Recorders (TPOD)
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.

6. Brancker XR-420 Temperature and Conductivity Recorder
The Brancker XR-420 CT is a self-recording temperature and conductivity logger. The operating temperature range for this instrument is -5° to 35°C. It has internal battery and logging, with the capability of storing 1,200,000 samples in one deployment. A PC is used to communicate with the Brancker via serial cable for instrument set-up and data download.

7. SBE-39 Temperature Recorder

The Sea-Bird model SBE-39 is a small, light weight, durable and reliable temperature logger. It is a high-accuracy temperature (pressure optional) recorder with internal battery and non-volatile memory for deployment at depths up to 10,500 meters (34,400 feet).

8. Vector Measuring Current Meters (VMCMs)

The VMCM has two orthogonal cosine response propeller sensors that measure the components of horizontal current velocity parallel to the axles of the two-propeller sensors. The orientation of the instrument relative to magnetic north is determined by a flux gate compass. East and north components of velocity are computed continuously, averaged and then stored. All the VMCMs deployed from Stratus 4 onward have been next generation models that have newer circuit boards and record on flash memory cards instead of cassette 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.

9. Aanderaa Current Meter (Stratus 7 only)

The Aanderaa Recording Current Meter, Model RCM 11, features the Mk II Doppler Current Sensor DCS 3820. The RCM comes equipped with an eight ton mooring frame and is used in-line with the mooring line.

10. RDI Acoustic Doppler Current Profiler

The RD Instruments (RDI) Workhorse Acoustic Doppler Current Profiler (ADCP, Model WHS300-1) is mounted looking upwards on the mooring line. The RDI ADCP measures a profile of current velocities.

11. SonTek Argonaut MD Current Meter

SonTek Argonaut MD current meters have been used in the upper portion of the mooring line. The three-beam 1.5Mhz single point current meter is designed for long term mooring deployments, and can store over 90,000 samples.

12. Nortek

The Nortek Aquadopp current profiler uses Doppler technology to measure currents. It has 3 beams tilted at 25 degrees and has a transmit frequency of 1 MHz. The internal tilt and compass sensors give current direction.

13. Acoustic Release

The acoustic release used on the Stratus 6 mooring is an EG&G Model 8242. This release can be triggered by an acoustic signal and will release the mooring from the anchor. Releases are tested at depth prior to deployment to ensure that they are in proper working order.

III.D. Stratus 7 Deployment

III.D.1. Mooring Description

The mooring design is shown in Figure III.D.1. Instruments deployed on the mooring are described in Table III.D.1a (surface) and III.D.1b (subsurface).

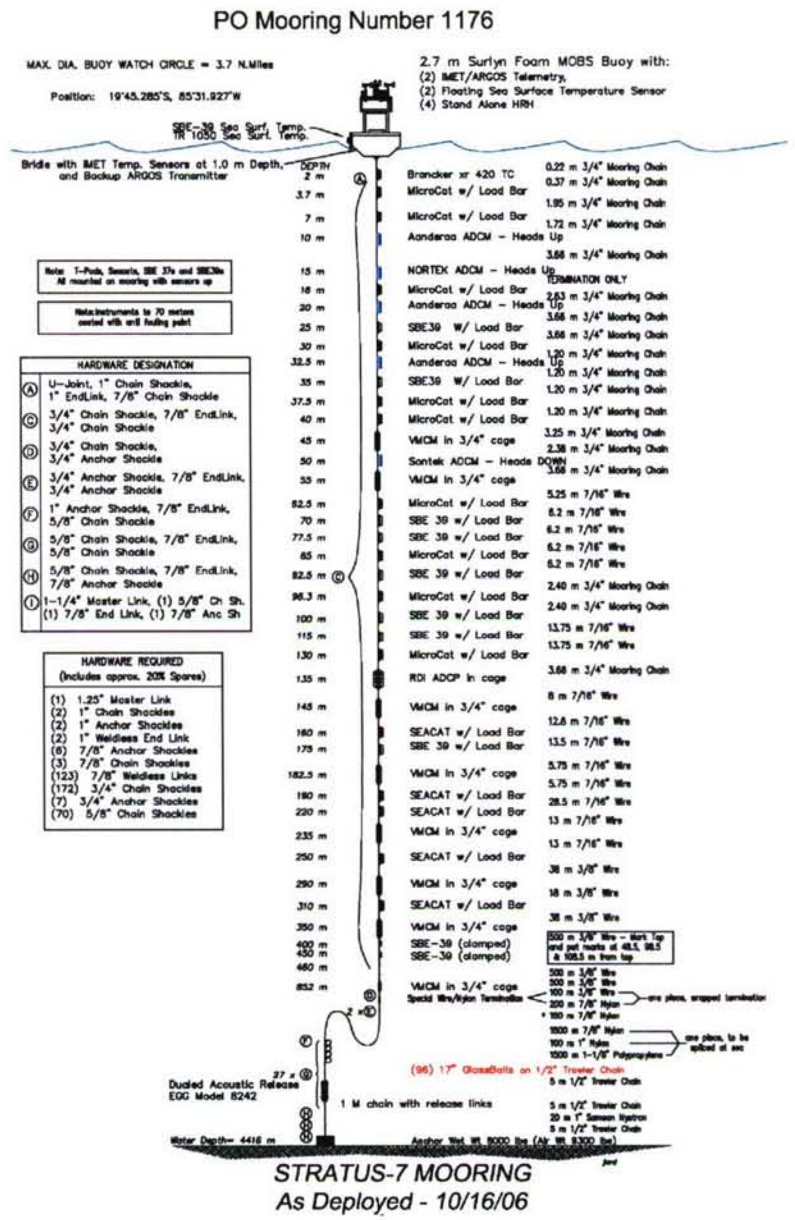


Figure III.D.1. Stratus 7 mooring design.

Table III.D.1a. Stratus 7 surface instrumentation.

Module	Serial	Firmware Version	Height Cm
System 1			
Logger	L-04	LOGR53 V2.70	
HRH	232	VOS HRH53 V3.2	223
BPR	207	VOS BPR53 V3.3 (Heise)	237.5
WND	222	VOS WND53 V3.5	273
PRC	205	VOS PRC53 V3.4	241
LWR	214	VOS LWR53 V3.5	283
SWR	219	VOS SWR53 V3.3	282
SST	1727	SBE 37 SM	-151
PTT	18171	27919, 27920, 27921	
System 2			
Logger	L-15	LOGR53 V2.70	
HRH	231	VOS HRH53 V3.2	223
BPR	217	VOS BPR53 V3.3 (Heise)	237
WND	215	VOS WND53 V3.5	271
PRC	208	VOS PRC53 V3.4	241
LWR	218	VOS LWR53 V3.5	283
SWR	212	VOS SWR53 V3.3	282
SST	1835	SBE 37 SM	-151
PTT	12789	27916, 27917, 27918	
Stand-Alone Modules			
HRH	216	VOSHRH53 V3.2	208
LASCAR	3	1hr Samples for 1.8 yrs	219
LASCAR	4	1hr Samples for 1.8 yrs	190
BEACON	104	ID 24576	
PC02	11		
Float SST	12707	TR-1050	-12.5 *
Float SST	72	SBE 39	-5.5 *
* distance from top of float			

Table III.D.1b. Stratus 7 subsurface instrumentation

Instrument	Serial	Depth Meters		Sample Rate (mn)
TR-1050	12707	Float (-12.5*)		1
SBE39	72	Float (-5.5*)		5
pCO2	11			
SBE37SM	1727	Bridle		
SBE37SM	1835	Bridle		
XR 420 TC	10514	2	Load Bar	5
VMCM	003	45	Cage	
VMCM	004	55	Cage	
VMCM	009	145	Cage	
VMCM	013	182.5	Cage	
VMCM	016	235	Cage	
VMCM	061	290	Cage	
VMCM	062	350	Cage	
VMCM	083	852	Cage	
SBE16	146	160	Load Bar	5
SBE16	991	190	Load Bar	5
SBE16	1873	220	Load Bar	5
SBE16	1875	250	Load Bar	5
SBE16	1881	310	Load Bar	5
SBE37	1325	3.7	Load Bar-T	5
SBE37	1326	7	Load Bar-T	5
SBE37	1328	16	Load Bar-T	5
SBE37	1329	30	Load Bar-T	5
SBE37	1330	37.5	Load Bar-T	5
SBE37	1906	40	Load Bar	5
SBE37	1908	62.5	Load Bar	5
SBE37	1909	85	Load Bar	5
SBE37	2012	96.3	Load Bar	5
SBE37	2015	130	Load Bar	5
SBE39	476	25	Load Bar	
SBE39	477	35	Load Bar	
SBE39	48	70	Load Bar	5
SBE39	49	77.5	Load Bar	5

SBE39	102	92.5	Load Bar	5
SBE39	103	100	Load Bar	5
SBE39	276	115	Load Bar	5
SBE39	284	175	Load Bar	5
SBE39	719	400	Clamped	5
SBE39	720	450	Clamped	5
Aanderaa	13	10	Load Bar/ Plastic	30
Aanderaa	78	20	Load Bar/ Plastic	30
Aanderaa	79	32.5	Load Bar/ Plastic	30
Nortek ADCM	2128	15	Load Bar	
Sontek ADCM	D208	50	Load Bar	1Mhz
RDI ADCP	1281	135	Ti Cage	
Beacon	104	ID 24576		

* distance in cm down from top of float

III.D.2. Time Spikes

Before a buoy launch and after its recovery, different physical signals are imprinted in the instruments records at determined time. This reveals the possible presence of a drift in the internal clock of instruments. Temperature and salinity sensors are plunged into a large bucket filled with ice and fresh water for about an hour. Radiation sensors are covered with black plastic bags. VMCM rotors are spun and then blocked. Table (III.D.2) lists the time spikes for Stratus 7 instruments.

Table III.D.2. Time spikes for Stratus 7 instruments.

Instrument	Serial	Date	Spike Start	Spike End
SWR	212,219	10/13/2006	17:01:30	18:07:30
LWR	214,218	10/13/2006	17:01:30	18:07:30
SST (SBE39)	1727,1835	10/13/2006	16:48:00	18:06:30
PRC				
TR-1050	12707	10/10/2006	17:46:30	18:54:00
SBE39	72	10/10/2006	17:46:30	18:54:00
SBE39	717			
XR 420	10514	10/11/2006	13:13:00	14:40:30
SBE16	146,991,1873,1875, 1881	10/11/2006	13:12:00	14:40:30
SBE37	1325,1326,1328,1329, 1330,1906,1908,1909, 2012,2015	10/11/2006	17:33:30	19:21:30
SBE37	1900			
SBE39	48,49,102,103,276,28 4,719,720,476,477	10/11/2006	13:14:00	14:40:30
SBE39	721			
Aanderaa	13,78,79	10/11/2006	15:07:30	16:37:30
Nortek ADCP	2128	10/11/2006	13:13:00	14:40:30
Sontek ADCM	D208	10/11/2006	13:13:00	14:40:30
RDI	1281	10/11/2006	15:07:30	16:37:30
VMCM	003	10/16/2006	12:05:30	
VMCM	004	10/16/2006	12:58:50	
VMCM	009	10/16/2006	13:35:36	
VMCM	013	10/16/2006	13:41:40	
VMCM	016	10/16/2006	13:51:00	
VMCM	061	10/16/2006	13:58:51	
VMCM	062	10/16/2006	14:05:10	
VMCM	083	10/16/2006	14:15:00	

III.D.3. Antifouling

Previous moorings have been used as test beds for a number of different antifouling coatings. The desire has been to move from organotin-based antifouling paints to a product that is less toxic to the user and more environmentally friendly. These tests have led the Upper Ocean Process group to rely on E Paint Company's SUNWAVE as the antifouling coating used on the buoy hull, and EPaint ZO for most of the instruments at 70 meters depth or above. A proprietary formula, called Bio-Grease, was developed for use on the ADCP/ADCM transducers.

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

SUNWAVE is a two-part, water-based, antifouling coating that offers a truly eco-friendly approach to controlling biofouling. The product claims superior adhesion and durability. Results from this study will validate SUNWAVE as a viable alternative to organotin, copper, and other more toxic coatings.

The Table III.D.3 below shows methods used for coating the buoy hull and instrumentation for the Stratus 7 deployment

Table III.D.3. Antifouling applications on Stratus 7 instruments.

Description	Coating	Color	Coats	Method
Buoy Hull	E-Prime 1000 SUNWAVE	Gray Blue White	1 2 3+	Roller Roller Roller
Floating SST SST Frame	SN-1 ZO	White White	2 2	Brush Spray
SBE 37s on hull bottom	ZO	White	2	Brush
Load Bars Trawl guards not treated	ZO & SN-1	WHITE	Brushed in area of sensors. Some bars had residual coatings	
**All instruments to 70 Meters	ZO & SN-1	White	2	Brush – applied only in area of sensors
Seacat/Microcat shields and conductivity cells	ZO	White	2	Brush
RDI ADCP heads (135 M) Residual trilux on heads	BIO-GREASE	Clr	1	Grease applied with gloves
VMCMs Props Sting ** ** stings on 45m & 55m only	Epaint "p" - ZO	Gray White	2 2	Spray Brush/Spray
ADCM/ADCP transducers Housings	Epaint – Bio Grease SN-1		1 2	Grease applied with gloves

** In Table III.D.3 the Microcats indicated were painted with ZO, all other instruments were coated with SN-1. Instruments closer to the surface had more area of the housing and load bar painted than those below 50 meters.

III.D.4. Mooring Deployment

The new Stratus 7 mooring was deployed before the recovery of the Stratus 6 mooring due to the lack of space on the fantail, which was loaded with Stratus mooring gear, the Chilean DART buoy gear, and mooring gear for the cruise to follow, which would service the TAO array. In previous years, Stratus mooring deployments had been done in the vicinity of 19°45'S, 85°32'W as well as near the present site of Stratus 6 (20°02'S, 85°11'W). When a buoy was recovered at one site with fishing line entangled, the subsequent deployment was done at the other site in an attempt to make it less easy for fishing boats to return to the same site and fish around the buoy. This year, the lack of space on the fantail drove the decision to deploy first. The choice of the alternate site was based on our prior experience there and resulting knowledge that good bottom topography (depth and a relatively flat area to select as an anchor target) was available.

III.D.4.i. Bottom survey

On October 15 we arrived in the vicinity of the alternate site. The wind was strong and out of the SE, between 115° and 130° true. A Seabeam survey was begun on the track line to the area and then completed along a track toward the SE along 115°. A final leg along a reciprocal course was run to the NW with an offset of 3.5 nm to complete the survey shown in Fig III.D.2.

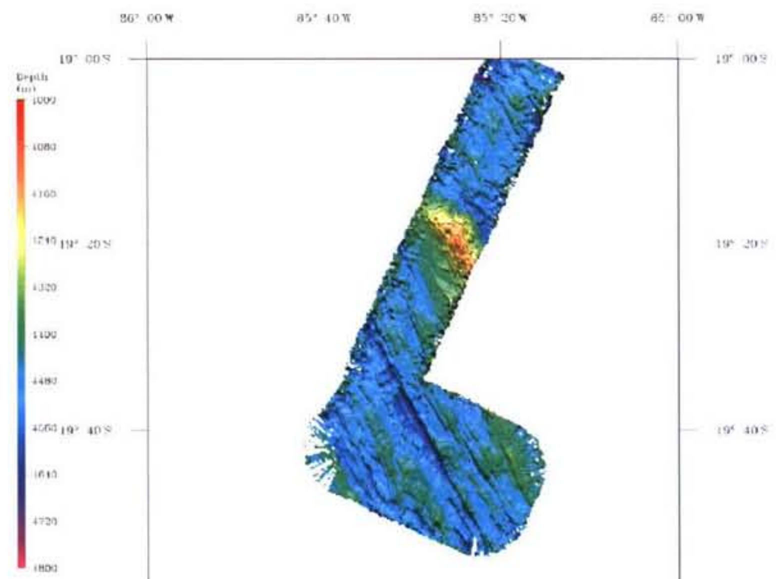


Figure III.D.2. Bottom bathymetry from Seabeam survey done along approach to and at site chosen for deployment of Stratus 7. Depth contours are 50 m.

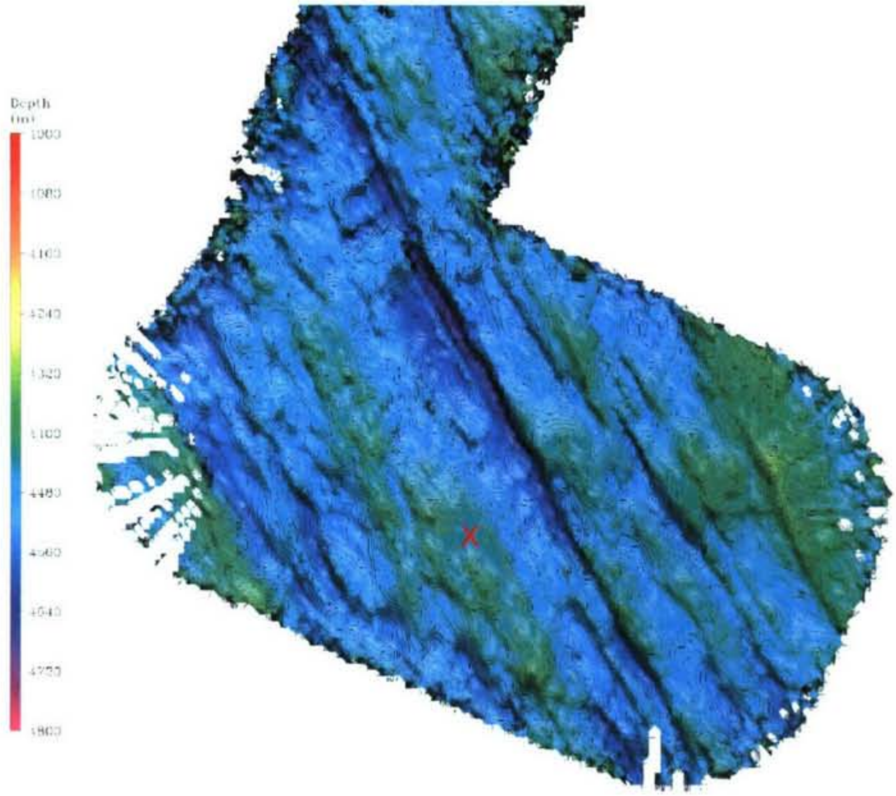


Figure III.D.3. Blow up of Seabeam survey. The plateau marked with a red X was selected as the target region.

The survey located a good region, a plateau at depths of 4400-4450 m, which is marked by an X in Figure III.D.3. The wind continued out of the SE and a course to the SE was planned that cut through the region and provided a zone of several miles width. Through the next morning, the wind continued to blow out of the SE, but the wind and seas did moderate. A deployment track (Fig III.D.4) was chosen, with the target site for the anchor drop (19°46.3192'S, 85°29.5755'W) 9.99 nm from the initial point (19°41.9265'S, 85°39.1187'W) along a course of 116°.

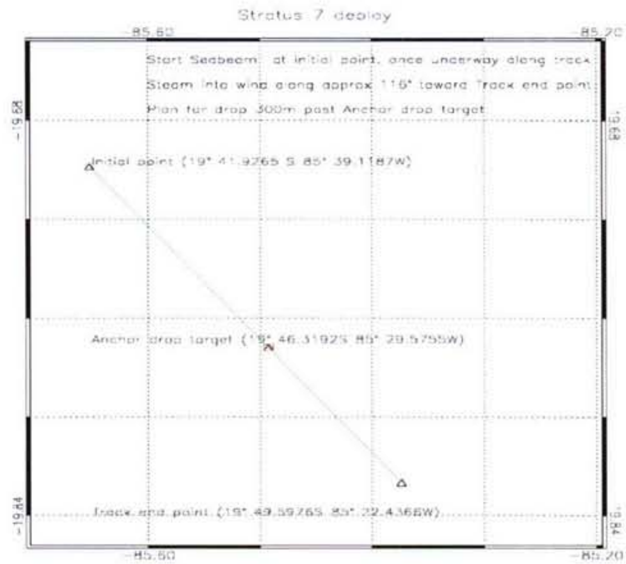


Figure III.D.4. Track used for the deployment of Stratus 7.
The R/V *Ronald H. Brown* was stationed at the Initial Point when the deployment started.

III.D.4.ii. Deployment

The Stratus 7 surface mooring was set using the UOP two-phase mooring technique. Phase 1 involves the lowering of approximately 50 meters of instrumentation followed by the buoy, over the port side of the ship. Phase 2 is the deployment of the remaining mooring components through the A-frame on the stern.

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

- 150 m 7/8" nylon
- 200 m 7/8" nylon – nylon to wire shot
- 100 m 3/8" wire - nylon to wire shot
- 500 m 3/8" wire
- 500 m 3/8" wire
- 500 m 3/8" wire
- 38 m 7/16" wire
- 18 m 7/16" wire
- 38 m 7/16 wire
- 50 m 7/16" wire

A tension cart was used to pretension the nylon and wire during the winding process.

The ship was positioned 8 nautical miles downwind and downcurrent from the desired anchor site. An earlier bottom survey indicated this track would take the ship over an area with consistent ocean depth.

Prior to the deployment of the mooring, approximately 80 meters of 3/8" diameter wire rope was payed out to allow the end to be passed out through the center of the A-frame, around the aft port quarter and forward along the port rail to the instrument lowering area.

Four wire handlers were stationed around the aft port rail. The wire handlers' job was to keep the hauling wire from fouling in the ship's propellers and to pass the wire around the stern to the line handlers on the port rail.

To begin the mooring deployment, the ship hove to with the bow positioned with the wind slightly on the port bow. The crane was extended out so that there was a minimum of 6 meters of free whip hanging over the instrument lowering area. All subsurface instruments for this phase had been staged in order of deployment on the port side main deck. All instrumentation had their chain or wire shot pre-rigged to the top of the instrument. A shackle and ring was attached to the top of each shot of chain or wire.

The first instrument segment to be lowered was the VMCM at 45m. The instrument lowering began by shackling the end of the hauling wire to the 2.4-meter shot of wire attached to the bottom end of the VMCM. The crane hook suspended over the instrument lowering area was lowered to approximately 1 meter off the deck. A sling was hooked onto the crane and passed through a ring to the top of the 3.25 meter shot of chain shackled to the top of the VMCM cage.

The crane was raised up so that the chain and instrument were lifted off the deck. The crane slowly lowered the wire and attached mooring components into the water. The wire handlers positioned around the stern eased wire over the port side, paying out enough wire to keep the mooring segment vertical in the water. The stopper line was hauled in enough to take the load from the crane and made fast to the deck. A stopper was attached to the top link of the instrument array as a back up. The hook on the crane was removed. Lowering continued with 12 more instruments and chain segments being picked up and placed over the side.

The operation of lowering the upper mooring components was repeated up to the 3.7 meter MicroCat T/C. The load from this instrument array was stopped off using a slip line passed through a shackle in the link above the MicroCat load bar. This allowed enough slack to connect the chain to the bottom of the XR 420 TC load bar, which had been shackled to the buoy universal joint earlier.

The second phase of the operation was launching the buoy. Three slip lines were rigged on the buoy to maintain control during the lift. Lines were rigged on the bridle, tower bail and a buoy deck bail. The 30 ft. slip line was used to stabilize the bottom of the buoy and allow the hull to pivot on the apex at the start of the lift. The 50 ft. tower slip line was rigged to check the tower as the hull swung outboard. A 75 ft. buoy deck bail slip line was rigged to prevent the buoy from spinning as the buoy settled in the water. This is used so the quick release hook, hanging from the crane's whip, could be released without fouling against the tower. The buoy deck 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.

With three slip lines in place, the crane swung over the buoy. The quick release hook, with a 1" sling link, was attached to the crane block. Slight tension was taken up on the whip to hold the buoy. The ratchet straps securing the buoy to the deck were removed. The buoy was raised up and swung outboard as the slip lines kept the hull in check. The stopper line holding the suspended 45 meters instrumentation was eased off to allow the buoy to take the hanging load. The lower slip line was removed first, followed by the tower slip line. Once the discus had settled into the water (approximately 20 ft. from the side of the ship), and the release hook had gone slack, the quick release was tripped. The crane swung forward to keep the block away from the buoy. The slip line to the buoy deck bail was cleared at about the same time. The ship then maneuvered slowly ahead to allow the buoy to come around to the stern.

The winch operator slowly hauled in the slack wire once the buoy had drifted behind the ship. The ship's speed was increased to 1/2 knot through the water to maintain a safe distance between the buoy and the ship. The bottom end of the shot of chain shackled to the hauling wire was pulled in and stopped off at the transom.

A traveling block was suspended from the A-frame using the heavy-duty air tugger to adjust the height of the block. The next instrument, 50 meter depth Sontek ADCM and pre-attached chain shot was shackled to the end of the stopped off mooring. The free end of the hauling wire was passed through the block and shackled to the free end of chain on the Sontek. The hauling wire was pulled onto the TSE winch to take up the slack. The winch slowly took the mooring tension from the stopper lines.

The block was hauled up to about 8 feet off the deck, lifting the Sontek off the deck as it was raised. By controlling the A-frame, block height, and winch speed, the instrument was lifted clear of the deck and over the transom. The winch was payed out to the next termination. The termination was stopped off using lines on cleats, and the hauling wire removed while the next instrument was attached to the mooring.

The next several instruments were deployed in a similar manner. When pulling the slack on the longer shots of wire, the terminations were covered with a canvas wrap before being wound onto the winch drum. The canvas covered the shackles and wire rope termination to prevent damage from point loading the lower layers of wire rope and nylon on the drum. This process of instrument insertion was repeated for the remaining instruments down to 350 meters.

While the wire and nylon line were being payed out, the crane was used to lift the 96 glass balls out of the rag top container. These balls were staged fore and aft, in four ball segments, on the port side of the deck. When all the wire and nylon on the winch drum were payed out, the end of the nylon was stopped off to a deck cleat.

An H-bit cleat was positioned in front of the TSE winch and secured to the deck. The free end of the 3000 meter shot of nylon/polypropylene line, stowed in three wood-lined wire baskets was dressed onto the H-bit and passed to the stopped off mooring line. The shackle connection between the two nylon shots was made. The line handler at the H-bit pulled in all the residual slack and held the line tight against the H-bit. The stopper lines were then eased off and removed.

The person handling the line on the H-Bit kept the mooring line parallel to the H-bit with moderate back tension. The H-bit line handler and one assistant eased the mooring line out of the wire basket and around the H-bit at the appropriate pay-out speed relative to the ship's speed.

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

The 96 glass balls were bolted on 1/2" trawler chain in 4 ball (4 meter) increments. The first two sets of glass balls were dragged into position and shackled together. One end was attached to the mooring at the transom. The other end was shackled to the winch leader. The winch pulled the mooring line tight, stopper lines were removed, and the winch payed out until 7 of the eight balls were off the stern. Stopper lines were attached, the winch leader was removed, and the process repeated until all 96 balls were deployed.

A 5-meter shot of chain was shackled to the last glass ball segment. The acoustic releases were shackled to the chain. Another 5-meter chain section was shackled to the releases. A 20 meter Nystron anchor pendant was shackled to that chain, and another 5 meter section of ½" chain was shackled to the anchor pendant. The mooring winch wound up these components until it had the tension of the mooring. The acoustic releases were laying flat on the deck.

The air tugger hauling line was passed through a block hung in the A-frame. A ½" chain hook was shackled to the end of the tugger line. The chain hook was attached to the mooring about two meters below the acoustic releases. The A-frame was positioned all the way in. The tugger line was pulled in and the releases were raised from the deck. As the winch payed out, the A-frame moved out and eased the release over the transom without touching the deck. The tugger payed out and the chain hook was removed.

The winch continued to pay out until the final 5-meter shot of chain was just going over the transom. A shackle and link was attached about two meters up this segment of chain. A heavy-duty slip line was passed through the link and secured to two cleats on the deck. The winch payed out until tension was transferred to the slip line. The end of the chain was removed from the winch and shackled to the anchor on the tip plate.

Deck bolts were removed from the anchor tip plate. The starboard crane was shifted so the crane whip would hang over, and slightly aft of the anchor. The whip was lowered and the whip hook secured to the tip plate bridle. A slight strain was applied to the bridle. The chain lashings were removed from the anchor. The slip line was removed, 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 overboard.

The deployment started at 12:00 (UTC), October 16[th] and the anchor was dropped at 17:51 (UTC). During this operation, 40 instruments, 48 pieces of chain or wire, 96 glass balls were assembled along with connecting hardware (links, shackles). An hour after the anchor was dropped, an acoustic survey was made to locate the releases, placed 30 m above the anchor. Table III.D.4 lists the details of the Stratus 7 buoy deployment.

Table III.D.4. Stratus 7 deployment details

Deployment	Date	October 16, 2006
	Time (anchor over)	17:51 UTC
	Position at Anchor Drop	19°45.320'S, 85°31.754'W
	Deployed by	Lord, Weller
	Recorder	Bigorre
	Ship	R/V *Ronald H. Brown*
	Cruise No.	RB-06-07
	Depth (corrected)	4446 m
	Anchor Position	19°45.2852'S, 85°31.9272'W

III.D.4.iii Anchor survey

Following the anchor drop R/V *R.H. Brown* pulled to one side and allowed time for the anchor to reach the sea floor. At that point a three point acoustic survey was carried out. Three points were selected at ranges of 3000 m from the estimated anchor location. Figure III.D.5 shows the track of the ship during the deployment overplotted on the planned deployment track as well as the ship track as it moved around the three anchor survey locations. The anchor was dropped at 19°45.320'S, 85°31.754'W. Water depth on the Seabeam was 4441 m. The Matthews Table correction is +5 m, so water depth at the anchor was 4446 m.

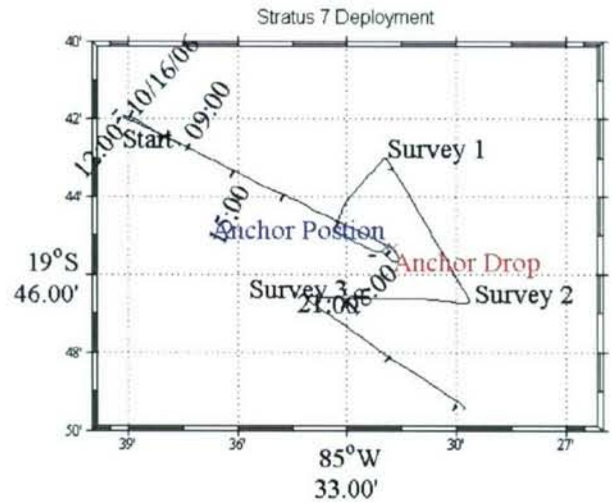


Figure III.D.5. Ship track for Stratus 7 anchor survey.

At each of the three sites, a slant range and a travel time was recorded. The locations of the ship during the ranging at each site and the travel time were then entered into Art Newhall's MATLAB program to generate an anchor position. The acoustic release was 30 m above the anchor, so the depth of the release was 4416 m. The program works with the intersection of the three range arcs and calculates an anchor position on the bottom. Figure III.D.6 shows a screen from running the program; Figure III.D.7 shows the three arcs and anchor location chosen by the program. Table III.D.5 summarizes the deployment and survey information.

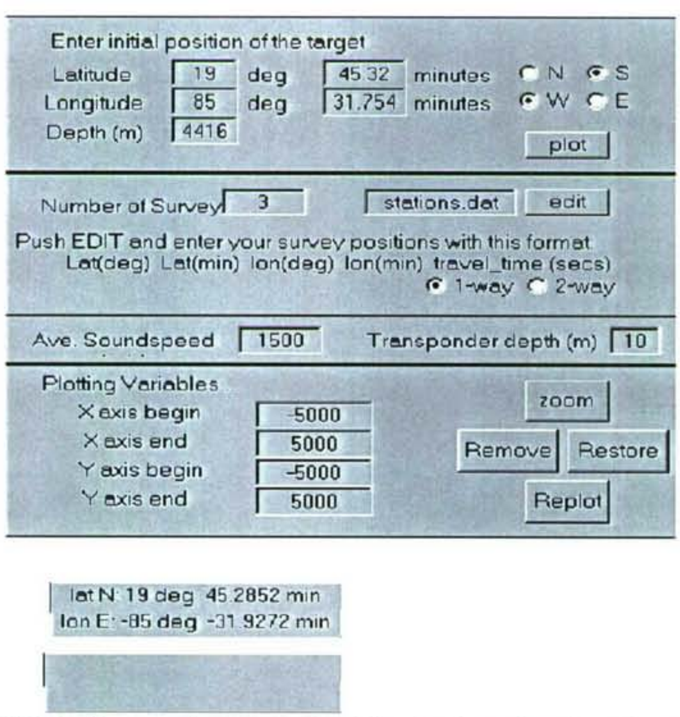


Figure III.D.6. Screen from running Newhall anchor location program.

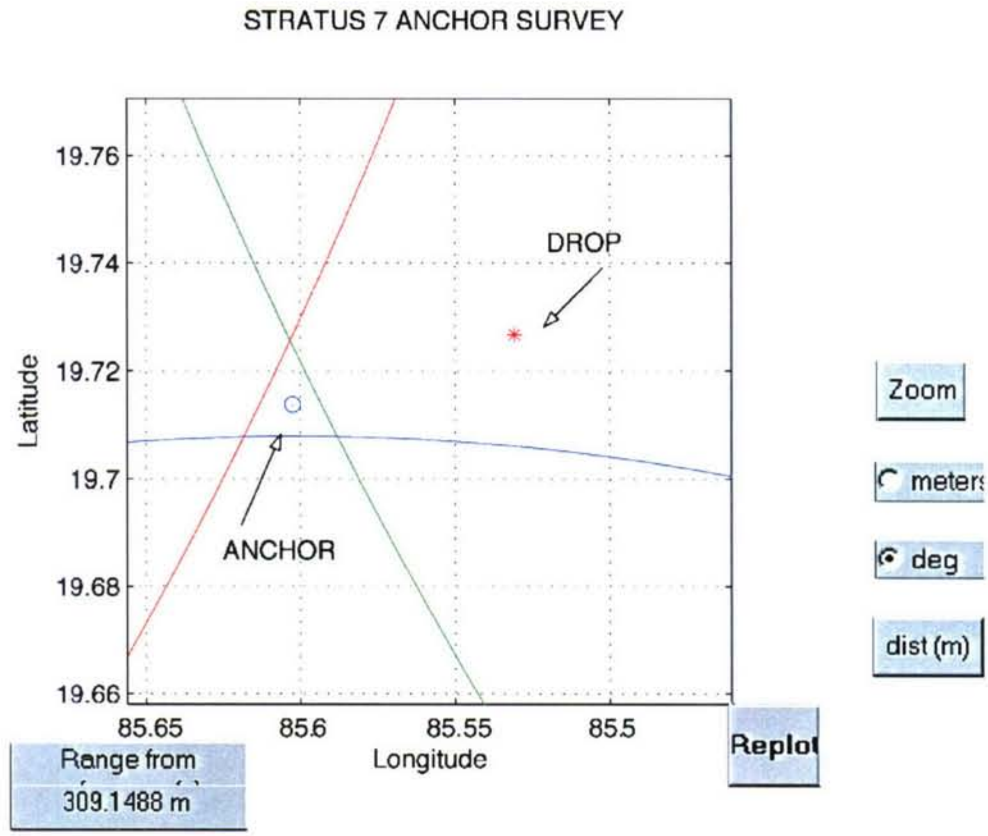


Figure III.D.7. Results from the anchor survey at Stratus 7, showing the selection of the anchor drop site.

Table III.D.5. Stratus 7 anchor survey details.

Stratus 7					
Anchor drop	19° 45.320'S 85° 31.754'W				
Survey Point	Lat	Lon	Travel time (MS)	Slant Range (m)	Horizontal Range (m)
1	19° 43.008'S	85° 31.922'W	4049	6074	4170
2	19° 46.657'S	85° 29.657'W	4282	6424	4666
3	19° 46.593'S	85° 34.133'W	4205	6304	4499
Anchor location	19° 45.2852'S	85° 31.9272'W			
Fallback	308 m	6.9%			

III.E. Stratus 6 Recovery

The Stratus 6 mooring was deployed in October 2005 and recovered in October 2006. Table III.E.1 below gives an overview of recovery and deployment operations.

Table III.E.1: Stratus 6 deployment and recovery overview

Deployment	Date	October 14, 2005
	Time	17:51 UTC
	Position at Anchor Drop	20°02.747'S, 85°11.147'W
	Deployed by	Lord
	Recorder	Hutto
	Ship	R/V *Ronald H. Brown*
	Cruise No.	RB-05-05
	Depth	4481
	Anchor Position	20°2.6703'S, 85°11.3054'W
Recovery	Date	October 18, 2006
	Time	12:45 UTC
	Position of Recovery (Release fired)	20°3.48'S, 85°11.82'W
	Recovered by	Lord
	Recorder	Galbraith
	Ship	R/V *Ronald H. Brown*
	Cruise No.	RB-06-07

III.E.1. Mooring Description

The Stratus 6 mooring was instrumented with meteorological instrumentation on the buoy and subsurface oceanographic equipment on the mooring line, as shown in Figure III.E.1. Tables III.E.2a and III.E.2b below detail the instrumentation.

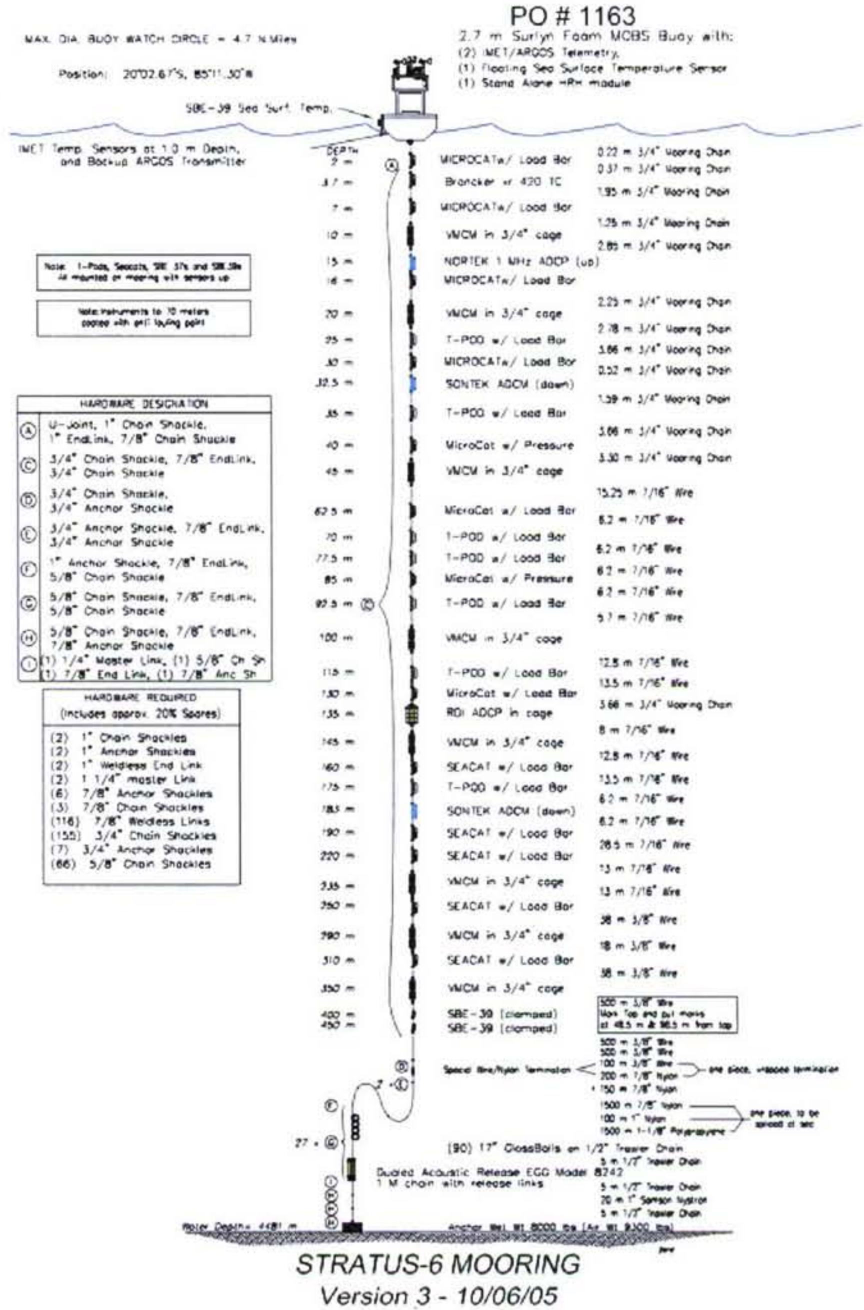


Figure III E.1. Stratus 6 mooring design.

Table III.E.2a.Stratus 6 surface instrumentation

Module	Serial	Firmware Version	Height Cm
System 1			
Logger	L-01	LOGR53 V2.70	
HRH	221	VOS HRH53 V3.2	218
BPR	504	VOS BPR53 V3.3 (Heise)	247
WND	212	VOS WND53 V3.5	260
PRC	207	VOS PRC53 V3.4	249
LWR	221	VOS LWR53 V3.5	279
SWR	505	VOS SWR53 V3.3	279
SST	1837	SBE-37 v2.2A	-151.5
PTT	14709	09805,09807,09811	
System 2			
Logger	L-02	LOGR53 V2.70	
HRH	208	VOS HRH53 V3.2	216
BPR	221	VOS BPR53 V3.3 (Heise)	247
WND	348	VOS WND53 V3.5	262
PRC	505	VOS PRC53 V3.4	249
LWR	204	VOS LWR53 V3.5	279
SWR	207	VOS SWR53 V3.3	279
SST	1834	SBE-37 V2.2A	-151.5
PTT	14612	24337,27970,27971	
Stand Alone Modules			
HRH	503	VOSHRH53 V3.2	222
LWR	506	VOSLWR53 V3.5	279
SiS BEACON	11427	SN # 22	
Floating SST	716	SBE-39	

Table III.E.2b. Stratus 6 subsurface instrumentation (note: TPODs are Brancker)

Instrument	Serial	Depth Meters		Sample Rate (mn)
SBE37SM	1837	Bridle		
SBE37SM	1834	Bridle		
XR 420 CT	10515	3.7		5
SBE16	927	160	Load Bar	5
SBE16	1877	190	Load Bar	5
SBE16	928	220	Load Bar	5
SBE16	994	250	Load Bar	5
SBE16	993	310	Load Bar	
SBE37	1899	2	Load Bar	5
SBE37	2011	7	Load Bar	5
SBE37	1901	16	Load Bar	5
SBE37	1905	30	Load Bar	5
SBE37	1912	40	pressure	5
SBE37	1902	62.5	Load Bar	5
SBE37	1910	85	pressure	5
SBE37	1903	130	Load Bar	5
SBE39	282	400	Clamped	5
SBE39	203	450	Clamped	5
TPOD	3764	25	Load Bar	
TPOD	3839	35	Load Bar	
TPOD	4481	70	Load Bar	
TPOD	4488	77.5	Load Bar	
TPOD	4489	92.5	Load Bar	
TPOD	4494	115	Load Bar	
TPOD	4495	175	Load Bar	
Nortek ADCP	333	15	up	1MHz
Sontek ADCM	D197	32.5	down	1Mhz
Sontek ADCM	D193	183	down	1Mhz
RDI ADCP	1220	135	Ti Cage	

VMCM	057	10	Cage	
VMCM	030	20	Cage	
VMCM	029	45	Cage	
VMCM	053	100	Cage	
VMCM	076	145	Cage	
VMCM	008	235	Cage	
VMCM	034	290	Cage	
VMCM	040	350	Cage	

III.E.2. Mooring Recovery

The STRATUS-6 mooring was recovered buoy-first rather than release-first in an effort to make instruments available for data recovery as soon as possible. A mooring drawing, specifying the mooring components and location of the attached instrumentation, is provided in Figure III.E.1. The TSE winch, ship's trawl winch, capstan and assorted WHOI deck lines and hooks were used during the recovery. The trawl winch leader was led through the ship's mooring block hung in the center of the A-frame. Two air tuggers were positioned inboard on either side of the A-frame. A third tugger was near the center of the deck, approximately 30 feet forward of the transom. The air tugger lines were led so as the buoy transitioned onto the fantail there was adequate forward and side loading on the buoy. This prevented buoy swing, as the hull was brought in through the A-frame.

The ship was positioned downwind from the buoy. The ship's work boat was deployed to take a quick look at the buoy, and to attach the recovery line to the lifting bale on the buoy. Once the ship maneuvered into a position approximately 100 feet from the buoy, the working line was passed from the workboat to the ship. Once the ship had control of the working line, the acoustic release was fired. Acoustic ranging confirmed that the release was free of the anchor. The mooring winch was used to haul the working line in until the trawl wire could be attached to the eye in the recovery line. Once the buoy was securely shackled to the trawl winch, the ship moved ahead slowly and recovered the workboat and personnel.

The A-frame was shifted outboard, and the winch was hauled in, lifting the buoy hull approximately 2m above the water. The buoy rotated so the tower was facing forward. The A-frame shifted inboard close enough to attach air tugger lines to the two side bales on the buoy well. The A-frame was then shifted inboard as the winch hauled in, raising the buoy hull up to a height approximately 2 m above the fantail. At this point, a vertical chain, hung from the A-frame, and fitted with a ¾" chain hook was attached to the mooring chain to transfer the load from the buoy. Two stopper lines were attached to the mooring to provide backup for the chain stopper.

Once the A-frame had swung to the full inboard position, the buoy was lowered to the deck and temporarily lashed. With sufficient slack between the buoy and the vertical stopper, the buoy was disconnected from the mooring and moved to a position on the port side of the main deck.

The trawl winch leader was removed from the block on the A-frame. The TSE mooring winch leader was led through the block and connected to the stopped off 3/4" chain on the mooring. The stopper lines were eased off, transferring tension to the winch. The winch was used to systematically recover all subsurface instruments through the A-frame. The recovery continued, with all of the wire rope, and 350 meters of nylon line wound onto the winch. The remainder of the mooring was recovered using the capstan, dumping line into wire baskets. The final mooring components; 90 glass balls, 5 meters of ½" chain, and the acoustic release were pulled aboard using the mooring winch and all three air tuggers.

III.E.3. Time Spikes

Instruments on Stratus 6 buoy and mooring were spiked before deployment (Table III.E.3) and after recovery (Table III.E.4). A manual spin was made on VMCM's rotors before deployment and after recovery (see Appendix D).

Table III.E.3. Stratus 6 pre-deployment timing spikes.

Instrument	Serial Number	Time 1		Time 2	
SBE37 (salinity spike)	1834, 1837	4 Oct 05	14:05:00	4 Oct 05	19:25:00
SBE37 (ice added)	1834, 1837	4 Oct 05	17:36:00	4 Oct 05	19:25:00
SWR	505, 207	4 Oct 05	17:46:00	4 Oct 05	21:06:00
LWR	221, 204, 506	4 Oct 05	17:46:00	4 Oct 05	21:06:00
PRC (flushed and drained)	207, 505	4 Oct 05	14:25:00		
PRC (add water)	207, 505	4 Oct 05	17:25:00		
PRC (add water)	207, 505	6 Oct 05	13:20:00		
PRC (flushed and drained)	207, 505	6 Oct 05	16:12:00		
SBE16	0146, 0927, 0928, 0993, 0994, 1877	30 Sep 05	15:12:00	30 Sep 05	16:08:00
SBE37	1899, 1901, 1902, 1903, 1905, 1910, 1912, 2011	30 Sep 05	13:21:00	30 Sep 05	14:40:00
SBE39	0203, 0282, 0716, 0717	30 Sep 05	13:21:00	30 Sep 05	14:40:00
Brancker TPODs	3764, 3859, 4481, 4488, 4489, 4494, 4495	4 Oct 05	10:33:00	4 Oct 05	12:51:00
Nortek	333	5 Oct 05	09:31:00	5 Oct 05	13:04:00
RDI	1220	5 Oct 05	13:07:00	5 Oct 05	17:47:00
Brancker XR420	10515	4 Oct 05	10:33:00	4 Oct 05	11:33:00
Sontek	D193, D197	5 Oct 05	09:31:00	5 Oct 05	09:31:00

Table III.E.4. Stratus 6 post-recovery timing spikes.

Instrument	Serial Number	Time1		Time2	
WND	212,348	10/18	14:02:00	~	~
LWR	221,204	10/19	16:35:30	~	~
SWR	505,207	10/19	16:35:30	~	~
PRC	207,505	10/19	17:03:30	~	~
Bridle SST	1837,1834	10/18	0:31:30	10/19	1:33:30
FSST SBE39	716	10/18	22:33:30	10/18	23:58:30
XR420	10515	10/18	22:33:30	10/18	23:58:30
SBE16	927,1877,928,994,993	10/19	0:08:30	10/19	1:27:30
SBE37	1899,2011,1901,1905, 1912,1902,1910,1903	10/18	22:26:30	10/18	23:58:30
SBE39	282,203	10/18	22:31:30	10/18	23:58:30
T-POD	3764,3839,4481,4488, 4489,4494,4495	10/18	22:23:30	10/18	23:58:30
NORTEK	333	10/19	0:08:30	10/19	1:27:30
SONTEK	D197,D193	10/19	0:06:30	10/19	1:27:30
RDI	1220	10/19	1:28:30	10/19	2:45:30
VMCM	8	10/19	23:37:00	~	~
VMCM	29	10/20	0:10:00	~	~
VMCM	30	10/20	0:05:00	~	~
VMCM	34	10/19	23:46:00	~	~
VMCM	40	10/19	23:51:00	~	~
VMCM	53	10/19	23:59:00	~	~
VMCM	57	10/19	23:55:00	~	~
VMCM	76	10/19	23:43:00	~	~

III.E.4. Instrument Performance

The primary data processing task, after recovering a buoy, is to duplicate all the instrument data to prevent possible loss. Further processing for inventory purposes and first-look troubleshooting is also done as time allows. On the Stratus 6 recovery cruise, most of the instruments were processed through the inventory stage.

III.E.4.i. Surface (ASIMets):

ASIMet logger flash cards were read on a Linux (dual-boot) PC as soon as they were extracted from the instruments. These cards are read with a simple Linux "dd" command, embedded in a shell script that is customized for each laptop, to deal with different PCMCIA set-up in different versions of Linux. After being read, the files are copied to the Windows side of the laptop for processing.

There are C programs available to read the logger cards on a PC; it is a two-step process that must be run under either the DOS command window or under Cygwin, a shell that runs in Windows. Binary ASIMet files are written by the DS87C530 microcontroller, and are big-endian, so the binary data needs to be byte-swapped before reading it with C on a PC.

On this cruise, new Matlab code was used to read the files. Because Matlab can read non-native binary files, this is a simple translation, the input files are opened using the command: infid=fopen(infname,'rb','b'); data values are then read with the Matlab fread command, with byte lengths as specified in the logger documentation.

The new Matlab code produces an intermediate ASCII file and a mat-file with named arrays holding the data. The ASCII file is generated as a work-around for Matlab's memory management limits, and can be discarded after the mat-file is created.

The ASIMet modules also store data internally on flash card, these were read with the same shell script on the Linux system. The files were then processed with C programs, since there is no Matlab code available yet for modules. Each file is run through a byte-swapping program and a conversion program specific to the module type. The ASCII output files are then converted to mat-files with a single Matlab script that reads a specified number of parameters and returns named vectors of variables.

Figures III.E.2 through 5 show the 1 minute sampled data from the 2 systems of ASIMet meteorological sensors. No magnetic correction was applied to the wind data.

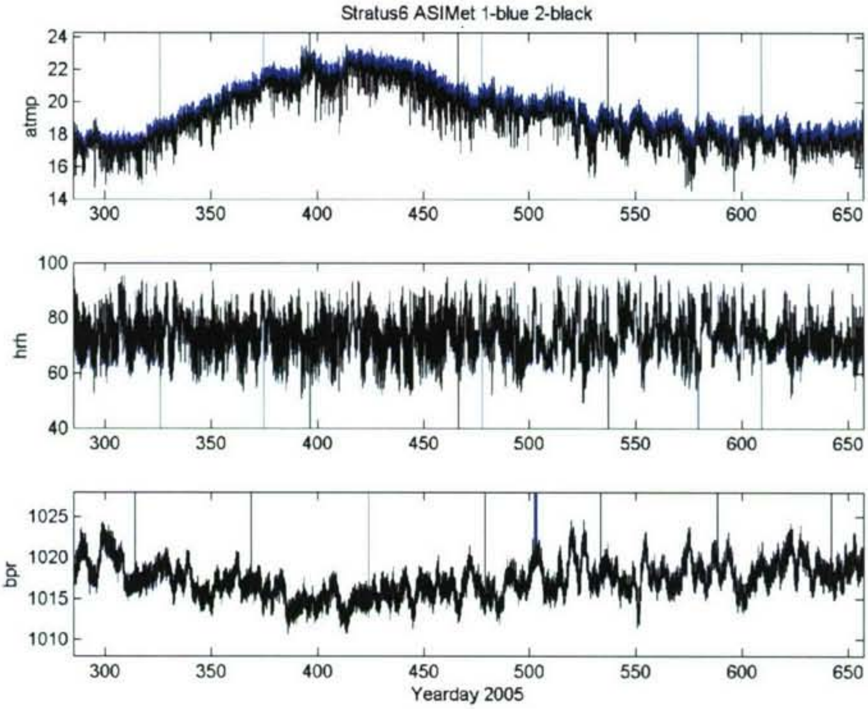


Figure III.E.2. ASIMet 1 minute data. Air temperature (top), air humidity (center), barometric pressure (bottom).

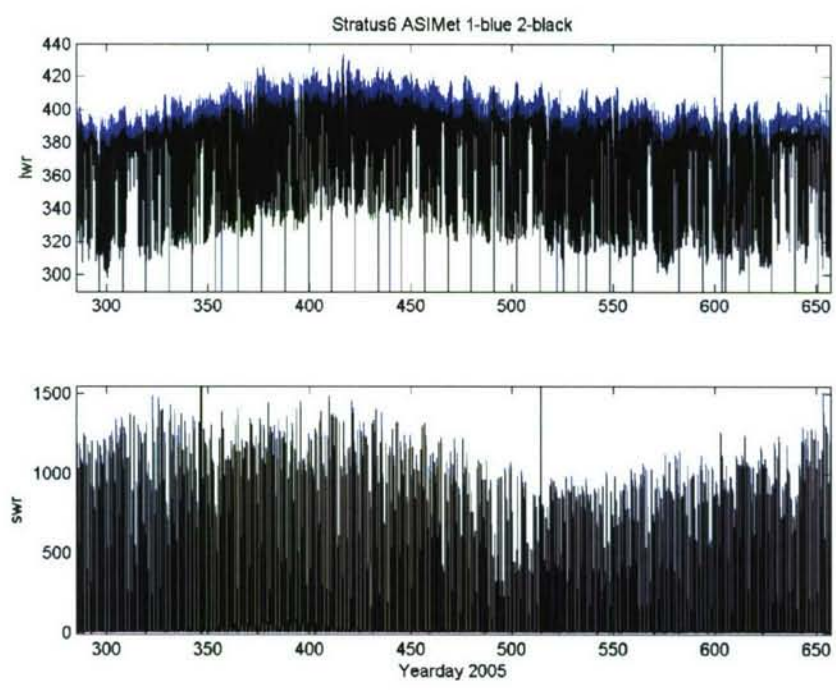


Figure III.E.3. ASIMet 1 minute downward radiation data. Longwave (top), shortwave (bottom).

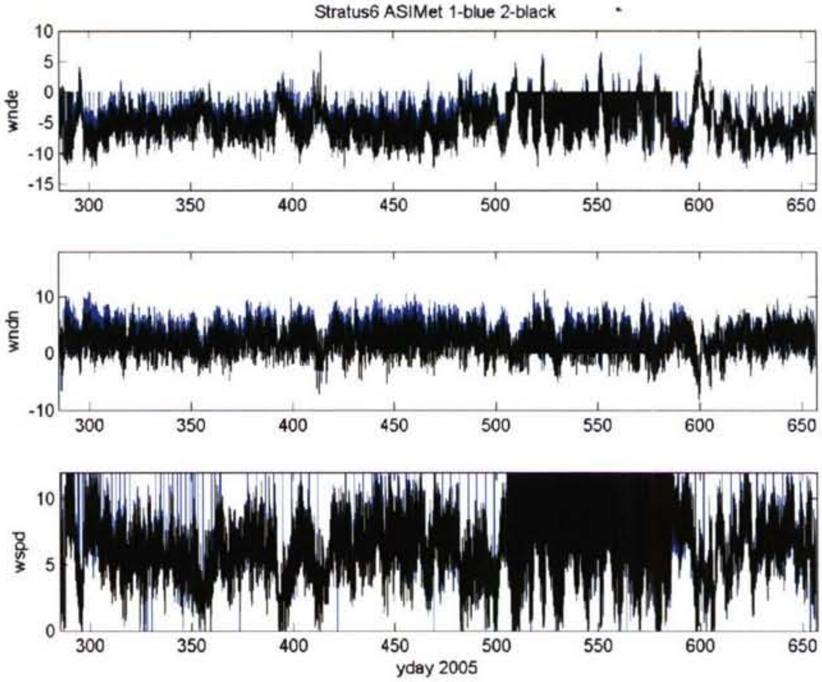


Figure III.E.4. ASIMet 1 minute wind data. Eastward velocity (top), northward velocity (center), speed (bottom).

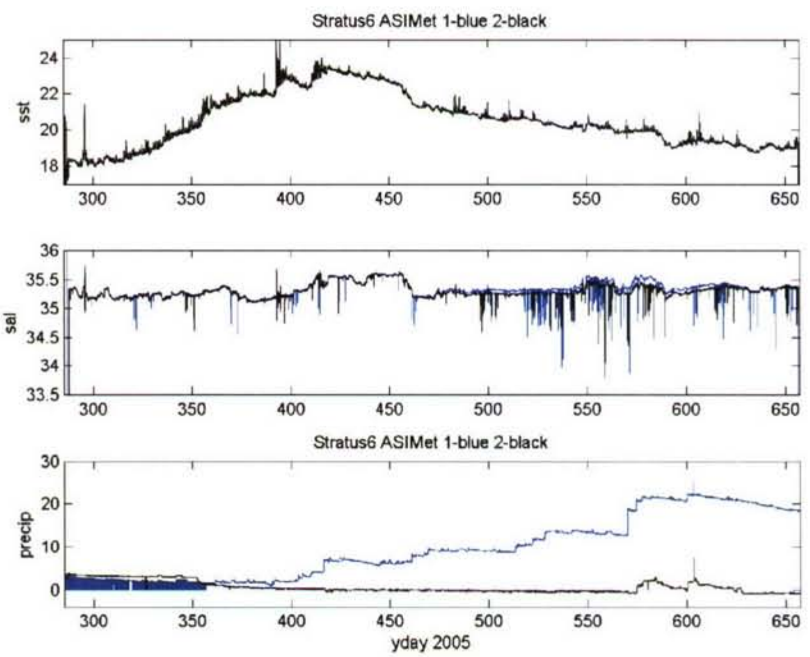


Figure III.E.5. ASIMet 1 minute data. Sea surface temperature (top), sea surface salinity (center), precipitation (bottom).

III.E.4.ii. Subsurface:

As much as possible, subsurface data is processed at sea for inventory and archive purposes. The Seabird SBE-37s and SBE-39s, and the Brancker XR420, which output calibrated ASCII data, are read into Matlab and plotted. The VMCMs, which record binary data on PCMCIA Intel type-II flash cards, are decoded with a Matlab program. New Matlab code was written on this cruise to process Brancker TPODs, which output thermistor counts in an ASCII file. SBE-16s were processed using a Seabird program that outputs calibrated data in ASCII, but these data files have not yet been evaluated. Figure III.E.6 shows the temperature data from the subsurface instruments. Of the subsurface instruments that were processed at sea, only one did not return data, Brancker TPOD 4481 at 70 meters, which had a bad record rate. Figure III.E.7 shows VMCM data and the effect of fishing lines (May 2006), as well as an eddy in December 2005.

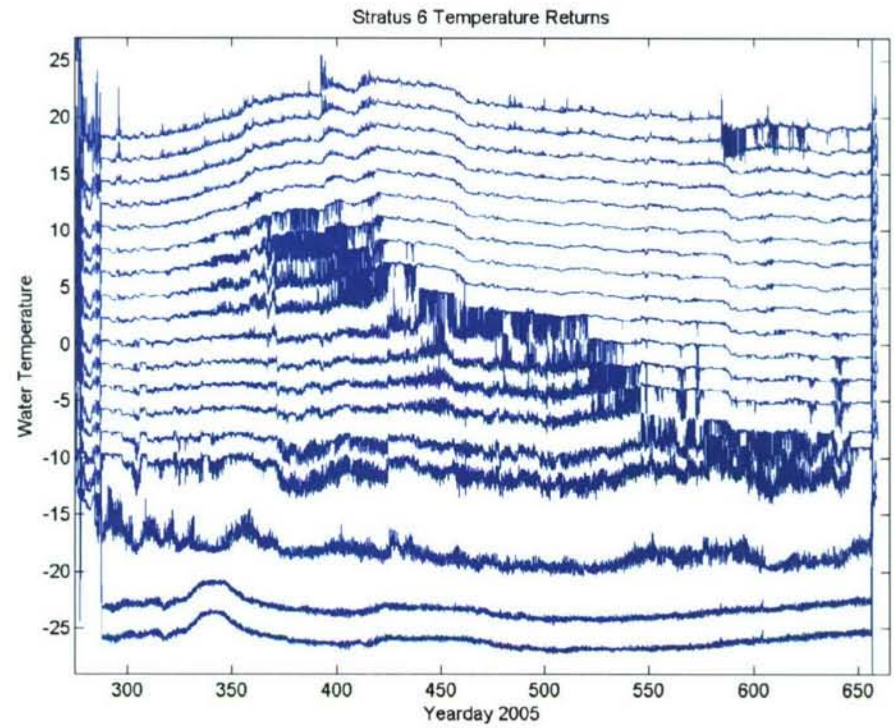


Figure III.E.6. Data return for Stratus 6 temperature recorders. Records are from SBE-39s, SBE-37s, Brancker XR420 and TPODs, but the SBE-16s are not plotted.

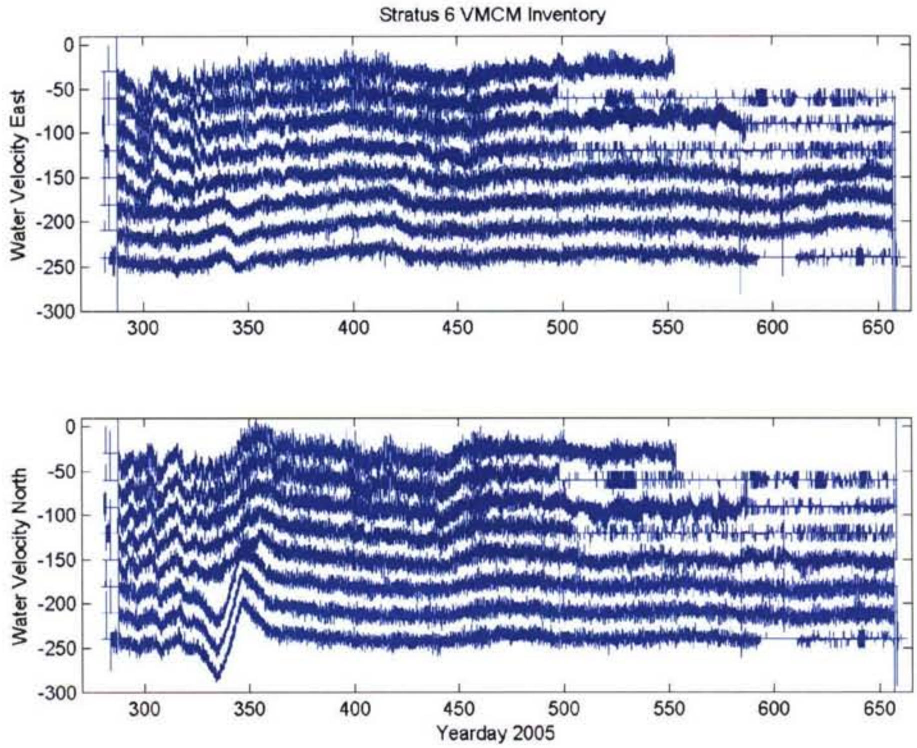


Figure III.E.7. Stratus 6 VMCM data return, showing effects of fishing line in propellers. Velocity east and north in cm/s.

III.E.4.iii. Argos transmission problems

ASIMet logger L-2 on Stratus 6 stopped transmitting Argos messages on March 2, 2006. Upon arrival at the mooring site, no Argos L-2 messages were received via the Alpha Omega Uplink receiver until the buoy was on deck, within 50 feet from the Alpha Omega antenna, with direct line of site. While on deck, sporadic messages were received from L-2; during the entire recovery operation, the L-1 transmission was normal.

A "chirp" test was done and L-1 sounded loud and clear. L-2 did not sound. The antennas were then swapped by proper procedure and antenna cables thoroughly inspected. The L-2 antennae chirped loud and clear and L-1 did not. A conclusion was drawn that the antennas themselves were functioning properly.

Antennas were switched back and a watt meter indicated that L-2 PTT was not transmitting. A hypothesis was formulated that PTT #14612 on L-2 was transmitting sporadically, weakly, or not at all. Further testing back at WHOI would confirm this.

Table III.E.5: Stratus 6 Recovery Voltages

	Voltage		
	Logger P-13	**Module P-14**	**PTT P-19**
L-1	14.09	10.71	16.154
L-2	13.22	12.45	16.169

A thorough visual inspection was conducted on each logger board. Voltages were measured; recorded values are shown in Table III.E.5. Note the suspiciously high PTT voltages. Later diagnosis would conclude that PTT power jumpers were misaligned, resulting in the PTTs utilizing module power. Each PTT uses 3 stacks of batteries, none of which registered any voltage drop.

Communication was made with L-2 and a status message noted that the logger itself functioned properly with the PTT module updating successfully. A status message was then attempted with L-1 and no communications could be established. Power was cycled and communication was established. A status message indicated an unusually low number of records for L-1, 59396 versus 548736 on L-2. The loggers were then powered down and flash cards removed.

Close inspection of transmission performance indicated that there had been a problem with throughput from this system since power-up, which had gone undetected, probably because of better satellite coverage or reception during the system's burn-in. There were no noticeable gaps in the near-real-time data stream until deployment.

Figure III.E.8 shows gaps in the near-real-time data stream; blue dots are data records received from ASIMet SN 1, red are from logger SN 2. Data gaps in the L-2 stream become more pronounced during the first few months of the deployment, and data transmissions stop completely on March 2, 2006.

An analysis of the internally recorded flash card data on L-1 indicated that the logger had, at about 18:00 on October 19, 2006, begun writing data in the wrong area of the flash card. This resulted in a loss of data between 13-Nov-2005 23:52:00 and 15-Nov-2005 10:01:00, as these records were overwritten. Records that were recovered from this area of the flash card contained data from 19-Oct-2006.

It is assumed that this problem was reflected in the status message received from L-1 indicating an unusually low number of records for L-1; the logger continued to write to this area of the flash card until it was powered down.

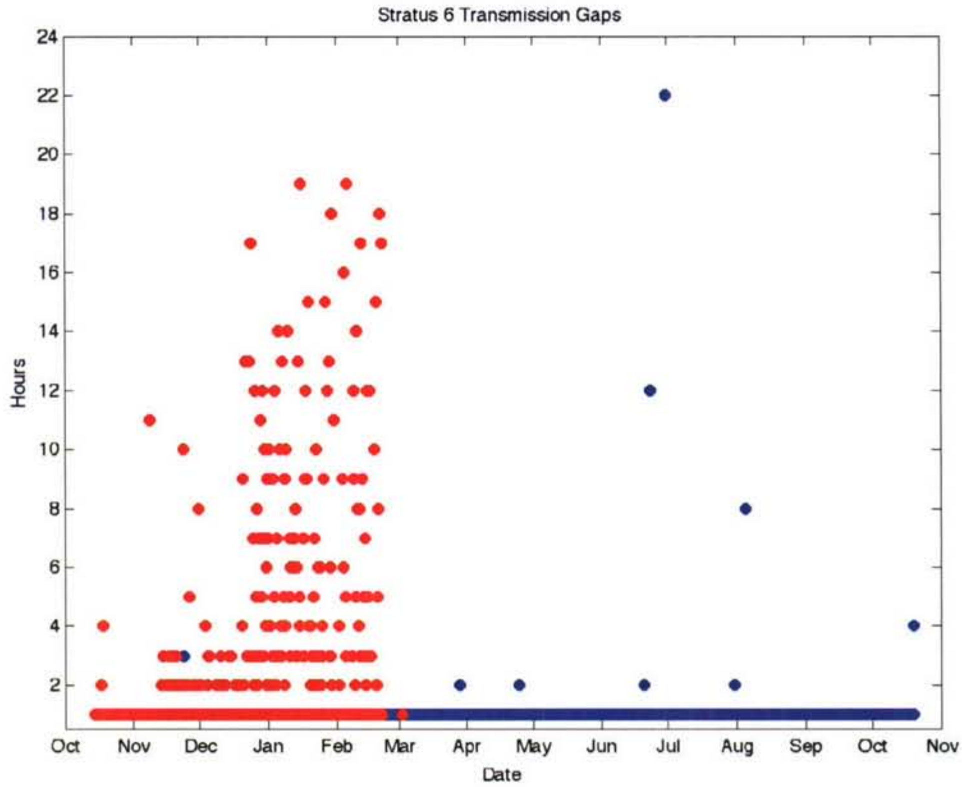


Figure III.E.8. Argos transmissions from loggers L-01 and L-02 on Stratus 6. Gaps in hours.

III.E.5. Antifoulant Performance

Below are observations of the recovered buoy and instruments.

- Traces of SUNWAVE paint were still visible on the foam section of the buoy hull. Gooseneck barnacles were attached to the foam from the waterline to the base of the buoy. The density of barnacles was similar to what was observed on the STRATUS 5 buoy. There were a few mature barnacles, but most appeared to be young. The application of a tie coat, plus additional coats of SUNWAVE may have helped slightly.
- Overall fouling on instrumentation was typical for the STRATUS moorings. Instruments in the first 15 meters were heavily fouled. However, the coil on the XR420 C/T at 3.7 meters, and the heads of the NORTEK ADCP at 15 meters appeared to be free from fouling.
- Heavy fouling was seen on instruments down to 10 meters. However, the 10-meter VMCM stings and props were relatively free of goosenecks. This appears to be the result of the application of E-paint products. The clamps on the 10 meter VMCM pressure case were heavily fouled.

- Moderate fouling ended at 45 meters, and fouling below 70 meters was negligible. There were no barnacles below 145 meters.
- Most of the ZO used on instruments had ablated almost completely. On some instruments below 10 meters, it appears to have been effective at reducing fouling near the instrument sensors.
- There is no significant fouling on Ti trawl guards or Stainless Steel cage parts. It doesn't appear worthwhile to paint these parts.
- Load bars get some fouling whether coated or not.
- Barnacle density is heaviest near neoprene strips, and at crevices such as where delrin clamps wrap around an instrument, or where T/C shield mount to pressure cases.
- Fouling on VMCM propellers was very light. There was no evidence of the algae that coated the mooring segments down to 20 meters on the Stratus 6 mooring.

Table III.E.6 shows methods used for coating the buoy hull and instrumentation for the Stratus 6 deployment

Table III.E.6. Stratus 6 antifouling applications

Description	Coating	Color	Coats	Method
Buoy Hull	Bar Rust Primer SUNWAVE	Gray White	1 4	Roller Roller
Floating SST SST Frame	ZO ZO	White White	2 2	Brush Spray
SBE 37s on hull bottom	ZO	White	1	Brush
Load Bars Trawl guards not treated	ZO	WHITE	Brushed in area of sensors. Some bars had residual coatings	
**All instruments to 70 Meters	ZO	White	1	Brush – applied only in area of sensors
Seacat/Microcat shields	ZO	White	1	Brush
RDI ADCP heads (135 M) RDI Frame –top section Residual trilux on heads	BIO-GREASE ZO(residual trilux)	Clr White	1 1	Grease applied with gloves
VMCM #57 10 m Props Sting Cage	 Epaint "p" - ZO ZO	 Gray White White	 2 2 1	 Spray Brush/Spray Brush
VMCM # 030 10 m Props Sting Cage	 Epaint "p" - ZO ZO	 Gray White White	 2 2 1	 Spray Brush/Spray Brush
ADCM/ADCP transducers	Epaint – Bio Grease		1	Grease applied with gloves

** Brancker T-pod coated at end cap near thermistor and down case 3" SeaCat and MicroCat – shields removed and coated, tubes coated, ½ of pressure case coated Sontek (32.5 M), Nortek (15M), Brancker XR420 painted all over case and load bar with ZO.

IV. ESRL AND RHB MEASUREMENTS

IV.A. Background on Instruments

The Physical Science Division (PSD) air-sea flux and cloud group conducted measurements of fluxes and near-surface bulk meteorology during the fall field program to recover the WHOI Ocean Reference Station buoy at (20ºS, 85ºW). The PSD flux system was installed initially on the R/V *Ronald H. Brown* (RHB) in Charleston, SC, in April 2006. It was used in conjunction with the Atlantic Monsoon Multidisciplinary Analyses (AMMA) in June and July of 2006 and the Texas Air Quality Study (TexAQS) in August and September 2006 on board the RHB. It was tested and brought back into full operation in Panama in early October 2006. The official start of the experiment and data collection was 1000 UTC October 13, 2006 (JD 286). We arrived on station at the WHOI buoy on day 288 (Oct 15, 2006), departing 1400 UTC on day 294 (Oct 21, 2006).

The air-sea flux system consists of six components: (1) A fast turbulence system with ship motion corrections mounted on the jackstaff. The jackstaff sensors are: GILL Sonic anemometer, Fast Ozone Sensor's inlet, LiCor LI-7500 fast CO_2/hygrometer, and a Systron-Donner motion-pak. (2) A mean T/RH sensor in an aspirator on the jackstaff. (3) Solar and IR radiometers (Eppley pyranometers and pyrgeometers) mounted on top of a seatainer on the 02 deck. (4) A near surface sea surface temperature sensor consisting of a floating thermistor deployed off port side with outrigger. (5) A Riegl laser rangefinder wave gauge mounted on the bow tower. (6) An optical rain gauge mounted on the bow tower. Slow mean data (T/RH, PIR/PSP, etc) are digitized on a Campbell 23x datalogger and transmitted via a combination of RS-232 and wireless as 1-minute averages. A central data acquisition computer logs all sources of data via RS-232 digital transmission:

1. Sonic Anemometer
2. Licor CO2/H2O
3. Slow means (Campbell 21x)
4. Laser wave sensor
5. Fast ozone sensor
6. Systron-Donner Motion-Pak
7. Ship's Computer System
8. PSD GPS

The 8 data sources are archived at full time resolution. At sea we run a set of programs each day for preliminary data analysis and quality control. As part of this process, we produce a quick-look ascii file that is a summary of fluxes and means. The data in this file come from three sources: The PSD sonic anemometer (acquired at 10 Hz), the Ship's Computer System (SCS) (acquired at 0.5 Hz) and the PSD mean measurement systems (sampled at 0.1 Hz and averaged to 1 min). The sonic is 5 channels of data; the SCS file is 17 channels and the PSD mean system is 77 channels. A series of programs are run that read these data files, decode them, and write daily text files at 1 min time resolution. A second set of programs reads the daily 1-min text files, time matches the three data sources, averages them to 5 and 30 minutes, computes fluxes, and writes new daily flux files. The 5 and 30-min daily flux files have been combined into a single file *flux_5hf_stratus_06.txt*. The 1-min daily ascii files are stored as *proc_nam_dayDDD.txt* (nam='pc', 'scs', or 'son'; DDD=yearday where 000 GMT January 1, 2006 =1.00). File structure is described in the original matlab files that write the data, *prt_nam_06.m*. Atmospheric aerosols were measured with a Particle Measurement Systems (PMS) Lasair-II aerosol spectrometer. The Lasair-II draws air through an intake and uses scatter of laser light from individual particles to determine the size. Particles are counted in six size bins: 0.1-0.2, 0.2-0.3, 0.3-0.5, 0.5-1, 1-5, and greater than 5.0 μm diameters. The PSD system was mounted in the seatainer on the 02 deck with the intake on the upwind side of the container. The system ran at 1.0 cfm (0.028 m3/min) sample volume flow rate with a count deconcentrator that reduces the counts a factor of 10 (to prevent coincidence errors).

A new instrument was added to the standard ESRL flux package. The first-ever direct eddy correlation (EC) measurements of ozone flux from the ship. First tested during TexAQS, refinements to the instrument and sampling were made during a short in port stop in Charleston, SC between TexAQS and STRATUS 2006. This Fast Ozone Sensor (FOS) was designed in Boulder as a collaborative effort between NOAA and CU researchers to help understand more about the destruction of ozone at the oceans surface. This sensor was located on the 03 deck with a sampling line run to the jackstaff where the inlet was mounted near the sonic anemometer.

PSD/Flux and UM also operated six remote systems:

1. Vaisala CT-25K cloud base ceilometer
2. C-band scanning-weather radar
3. 9.4 GHz Doppler cloud radar
4. 915 MHz vertically pointed Doppler wind profiler
5. Terascan Satellite receiver
6. Radiometrics 1100 2-channel microwave radiometer

The ceilometer is a vertically pointing lidar that determines the height of cloud bottoms from time-of-flight of the backscatter return from the cloud. The time resolution is 30 seconds and the vertical resolution is 15 m. The raw backscatter profile and cloud base height information deduced from the instrument's internal algorithm are stored in daily files with the naming convention *RYYMMDDhh.DAT* where YY=06, MM=10, DD=day, and hh=start hour of the file. File structure is described in *ceilo_readme_stratus06.txt*.

The RHB's Doppler C-band radar was operational for only the first portion of the experiment when an azimuth failure occurred. The Doppler C-Band radar operated in 2 modes. Every 10 minutes 2 tasks were scheduled: a 125 km volume scan at 11 elevation angles (0.0, 0.5, 1.0, 2.0, 3.0, 4.0, 5.0, 10, 15, 20, and 30 degrees) and a 250 km 1-degree surveillance scan. On Oct. 16 this radar stopped operating due to a problem with the AZ drive. Raw data and products derived form the raw data were archived to DVD.

The UM 9.4-GHz radar antenna was mounted on the roof of the seatainer. The cloud radar systems can be used to deduce profiles of cloud droplet size, number concentration, liquid water concentration, etc., in stratus clouds. If drizzle (i.e., droplets of radius greater than about 50 μm) is present in significant amounts, then the microphysical properties of the drizzle can be obtained from the first three moments of the Doppler spectrum.

The microwave radiometer is the same one that has been deployed on numerous TAO/PACS cruises and on EPIC2001. Operating at 20 and 30 GHz, this passive system monitored the total column liquid water and water vapor producing point every 15 secs.

The 915-MHz profiler was operated continuously in a vertically point mode as the newly mounted satellite receiver dome is believed to affect wind measurements calculated from the oblique beams. A 60 m 4-bit pulse coding was used with a sample resolution of 42 sec.

A SeaSpace satellite receiver was operational for STRATUS 06 and collected High Resolution Picture Transmission (HRPT) data from NOAA's polar orbiting satellites (12, 14, 15, 17, 18). HRPT data were archived to DVD and quicklook images (VIS, IR, SST and TC) archived along with the flux data.

IV.B. Selected Samples

IV.B.1. Flux Data

Preliminary flux data is shown for Julian Day = 292 (October 19, 2006) as the RHB remains on station at the buoy site at 20S, 85W (Figure IV.B.1). The time series of ocean and air temperature is given in Figure IV.B.2. The water temperature is about 19.4C and the air temperature is about 18.0C. The true wind direction (Figure IV.B.3) and true wind speed (Figure IV.B.4) for the flux and ship sensors show modulation by boundary-layer scale organization. The effect of clouds on the downward solar flux is shown in Figure IV.B.5 and on the IR flux in Figure IV.B.6 from both the flux and ship sensors. For the solar flux, broken clouds are apparent in the jagged form of the curve during the day. For IR flux, clear skies have values of about 320 Wm^{-2} and cloudy skies values around 385 Wm^{-2}. The IR flux suggests some breaks in the clouds in late afternoon. Modeled clear sky values are shown in each figure for reference. Figure IV.B.7 shows the time series of four of the five primary components of the surface heat balance of the ocean (solar flux is left out). The largest term is the latent heat (evaporation) flux, followed by the net IR flux (downward minus upward plus); the sensible heat flux and the flux carried by precipitation are very small. We are using the meteorological sign convention for the turbulent fluxes so all three fluxes actually cool the interface in this case. The time series of net heat flux to the ocean is shown in Figure IV.B.8. The sum of the components in Figure IV.B.7 is about -177 Wm^{-2}, which can be seen in the night time trace; the large positive peak during the day is due to the solar flux. The integral over the entire day gives an average flux of -20 Wm-2, indicating cooling of the ocean mixed layer.

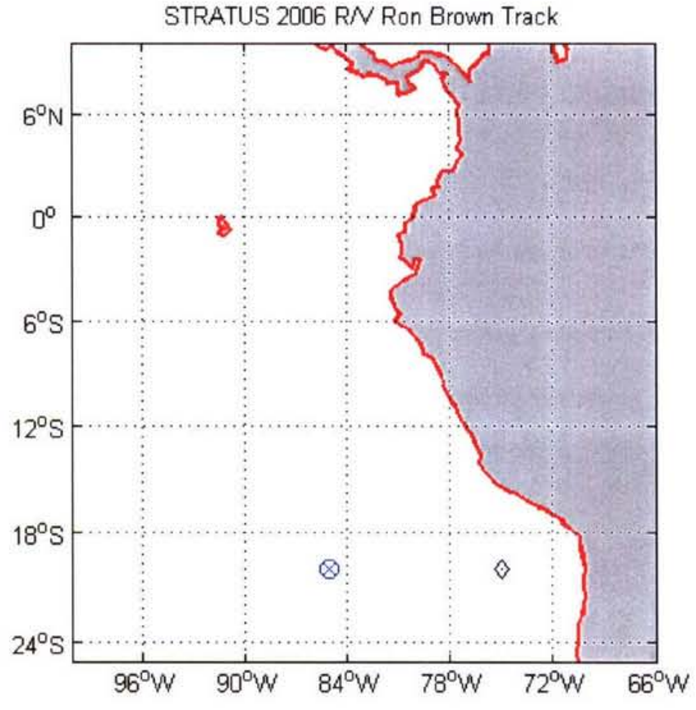


Figure IV.B.1. Cruise track for RBH on October 19 (DOY 292). The x marks the WHOI buoy location; the diamond is the DART buoy.

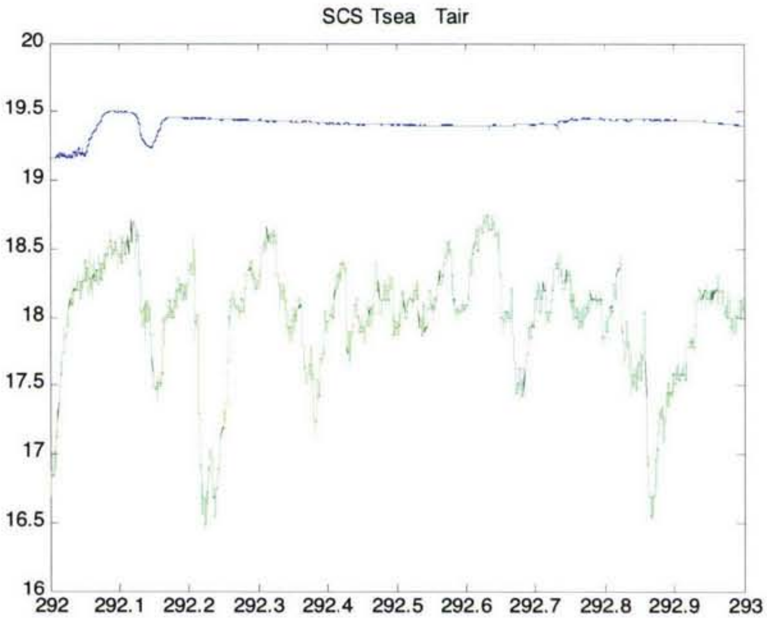


Figure IV.B.2. Time series of near-surface ocean temperature (blue) and 15-m air temperature (green).

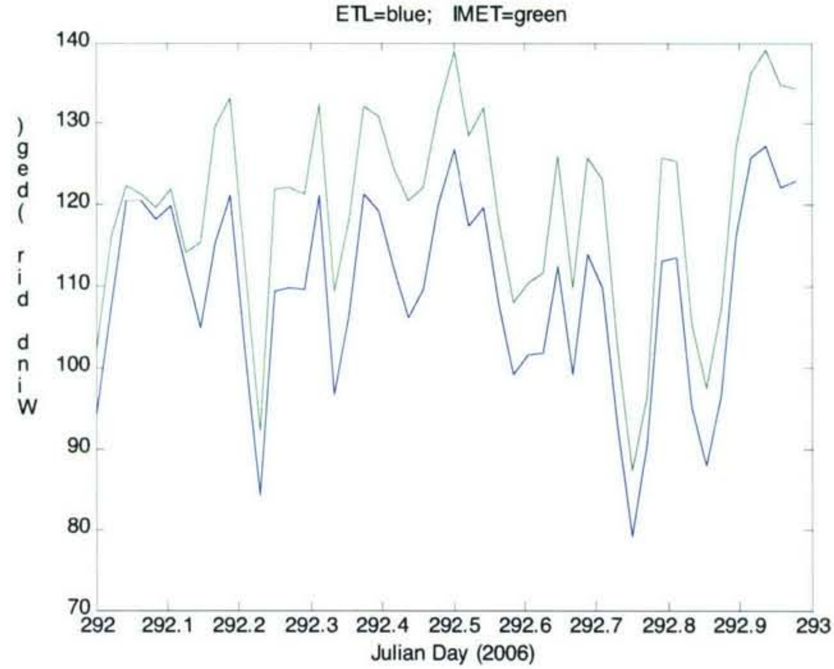


Figure IV.B.3. True wind direction from the PSD sonic anemometer (18 m) and the IMET propvane (15 m).

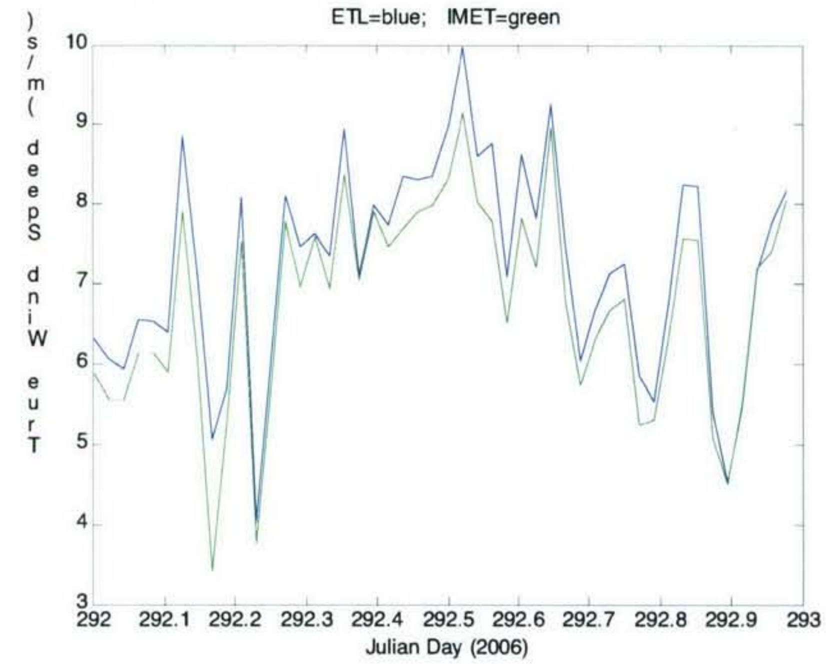


Figure IV.B.4. True wind speed from the PSD sonic anemometer (18 m) and the ship's propvane (15 m).

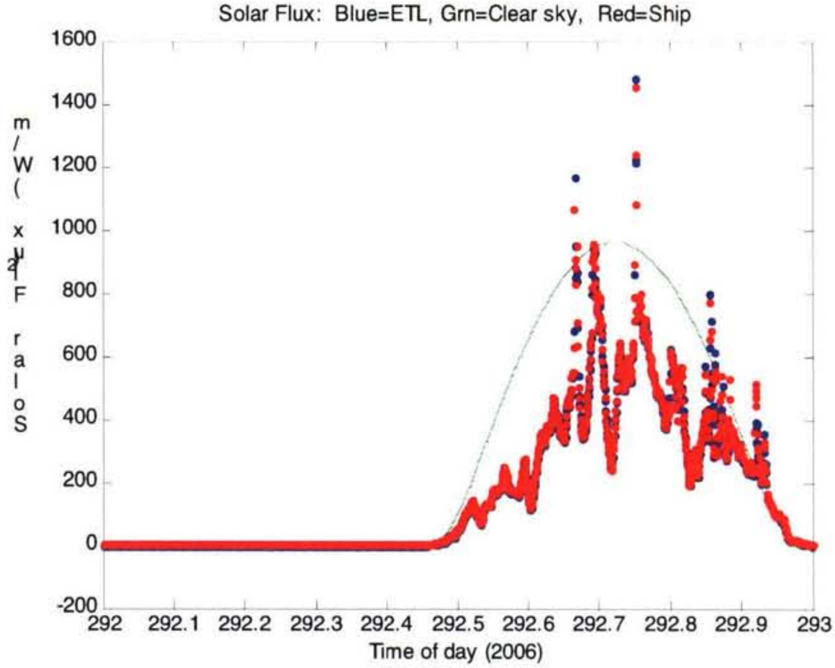


Figure IV.B.5. Time series of downward solar flux from PSD and ship Eppley sensors. The green line is a model of the expected clear sky value.

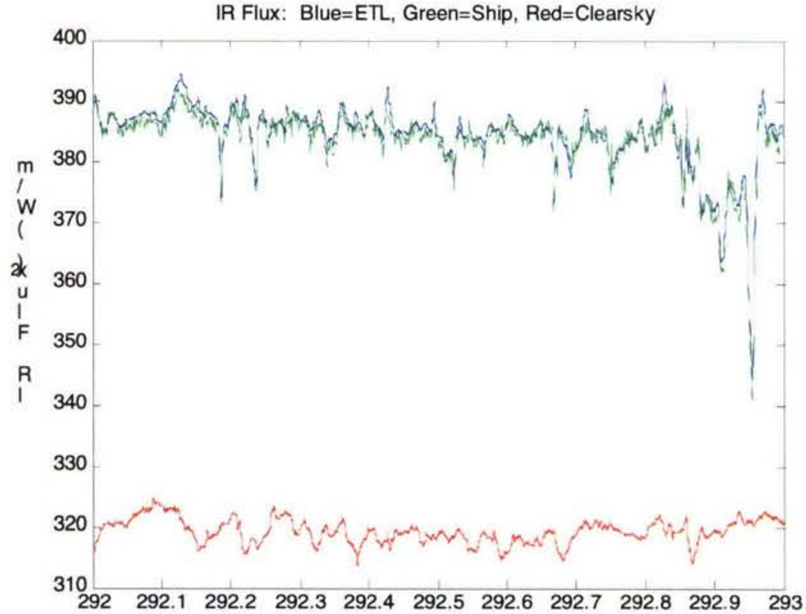


Figure IV.B.6. Time series of downward IR flux from PSD and ship Eppley sensors. The red line is a model of the expected clear sky value.

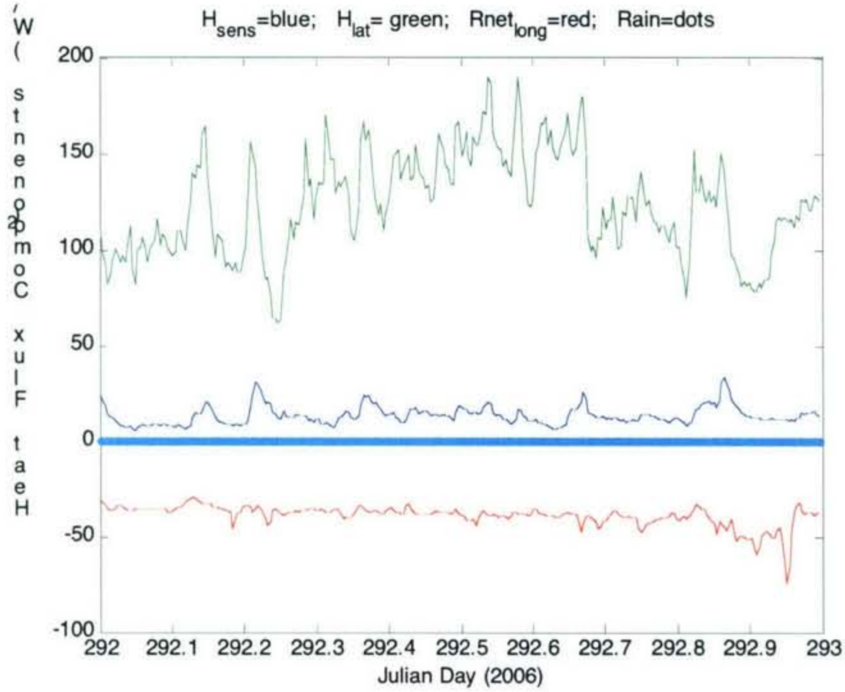


Figure IV.B.7. Time series of non-solar surface heat flux components: sensible (blue), latent (green), and net IR (red).

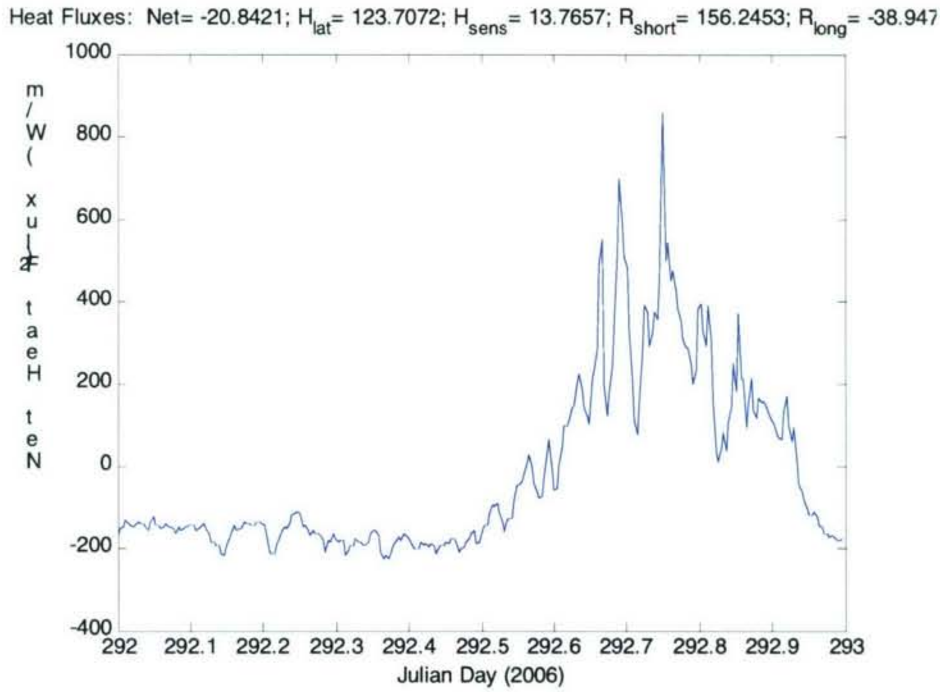


Figure IV.B.8. Time series of net heat flux to the ocean surface. The values at the top of the graph are the average for the day for each component of the flux.

IV.B.2. Remote Sensing Data

A sample ceilometer 24-hr time series for cloud base height for October 19 is shown in Figure IV.B.9. This day had 99% cloud cover with the dominant stratocumulus layer cloud bases at 1500 m and occasional lower level 'scud' clouds with bases about 750 m. Small amounts of drizzle can be seen as the few low-altitude dots. A sample time-height cross section (X-band . Figure IV.B.10) from the UM cloud radar is shown for a 12-hr period on October 19. This figure shows the time-height image of the SNR from the X-band cloud Doppler radar for the first twelve hours of 19 Oct 2006. The cloud top (CT) estimated using the wind profiler SNR maxima is shown with (*), while the Ceilometer detected cloud base (CB) height is also shown with (.). The vertical stripes represent drizzle with red indicating the strongest periods. Ship board precipitation sensors indicate that the drizzle was not reaching the ground or had become so light that it wasn't detected by the optical rain gauges or measured by the IMET siphon rain gauge. Although sensitive to drizzle, the X-band radar fails to capture the thin stratus clouds observed throughout the period. There is little variation observed in the cloud top height, while the cloud base varies considerably during drizzle events resulting in a significant variation in the cloud thickness. Another noticeable feature is the height of the top of the drizzle being approximately the middle of the cloud rather than the popular belief of cloud top.

Time series from the microwave radiometer for day 292 (October 19) are shown in Figure IV.B.11. The upper panel shows column integrated water vapor; the lower panel shows the integrated liquid water path (LWP) of the stratus clouds. The data are from the Radiometrics mailbox radiometer. Peaks in LWP correspond to periods with drizzle. In the early day, they are concomitant with peaks in integrated water vapor. These are also times when the cloud base deepens.

A sample time series from the laser wave gauge is shown in Figure IV.B.12. This device measures the range from a point on the mast to a point on the ocean. The distance includes the motions of the sea surface (waves) plus motion of the ship up and down relative to mean sea level. The ship motion component will be removed using motion correction data from the flux system.

The wind profiler operates at 33 cm wavelength where it is sensitive enough to detect returns from turbulent variations in radar refractive index, principally associated with gradients in atmospheric moisture; it is also sensitive to precipitation. Sensitivity to moisture gradients causes the marine inversion to show up clearly as a band of increased backscatter intensity. Both of these factors cause improved height performance in stormy conditions. During Stratus 2006 the profiler gave continuous retrievals of the boundary-layer depth. Sea clutter tends to invalidate the reflected power at heights below 500 m, although the minimum usable height depends on the amount of white-capping, sea state, the dryness of the atmosphere, and ship operational factors (underway versus stopped, etc). A sample of profiler BL heights is shown in Figure IV.B.13 in conjunction with the cloud base retrieved from the ceilometer backscatter. Horizontal yellow stripes below 500 m are the result of clutter explained above.

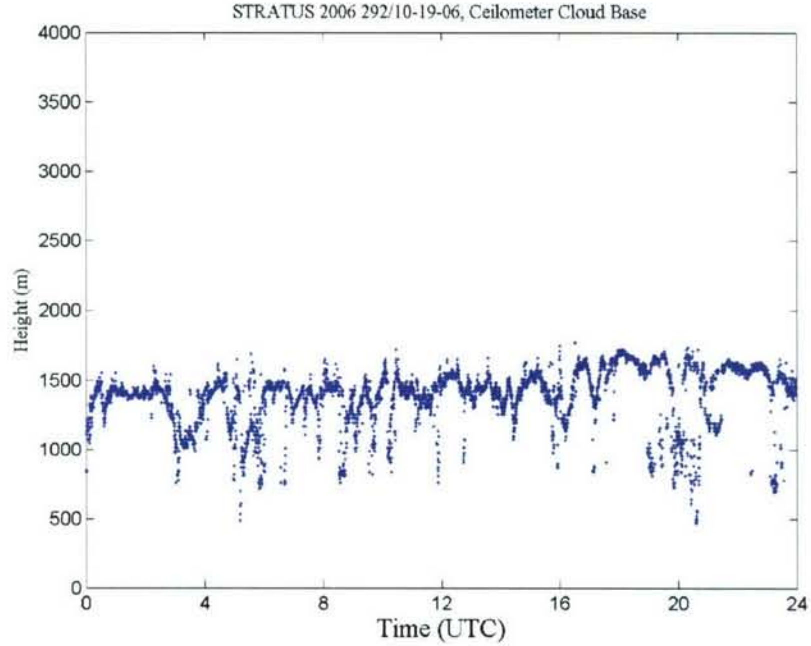


Figure IV.B.9. Cloud-base height information extracted from the ceilometer backscatter data for day 292 (October 19, 2006).

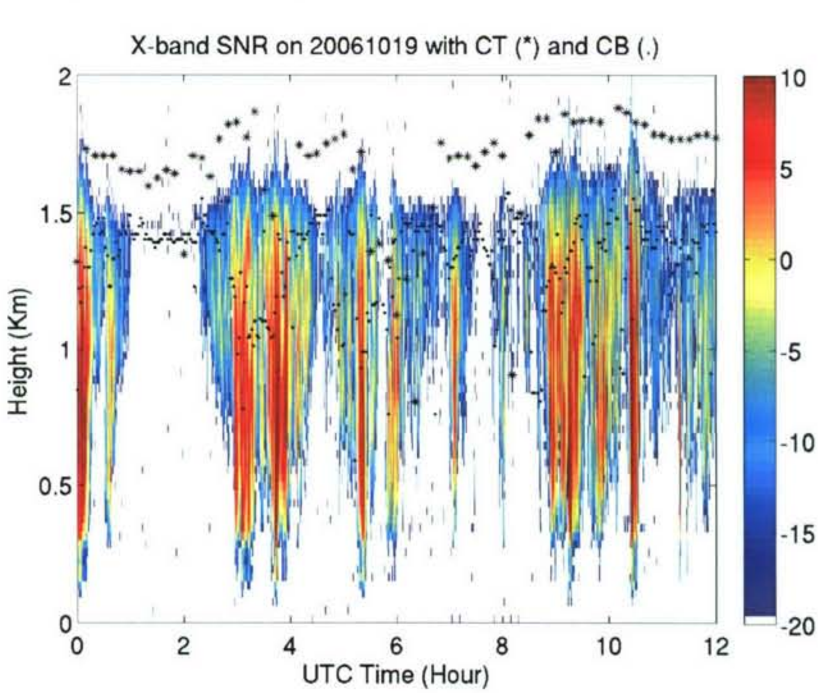


Figure IV.B.10. Time-height cross section data from 9.4 GHz cloud radar data for day 292 (October 19, 2006): backscatter intensity (SNR); '*' is cloud tops (CT) retrieved from wind profiler reflectivity data, '.' cloud base (CB) retrieved from ceilometer backscatter data. The deep vertical streaks are drizzle not reaching the ground.

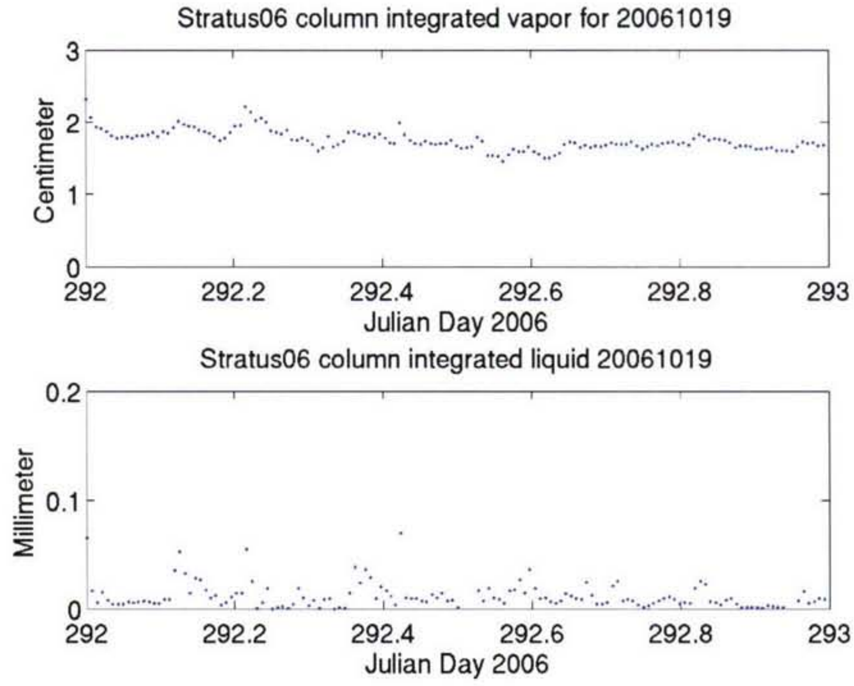


Figure IV.B.11. Time series of data from the Radiometrics microwave radiometer: column water vapor (upper panel), column water liquid (lower panel) for day 292 (October 19, 2006).

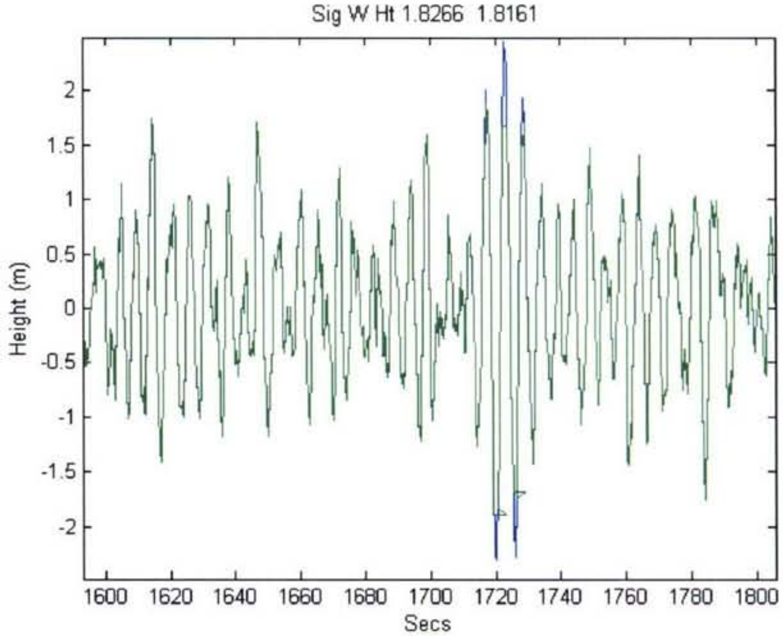


Figure IV.B.12. Sample wave time series from 1000 UTC on day 292 (October 19) from the laser rangefinder. The trace shows elevation of the sea surface relative to the bow of the ship. The dominant wave period is about 6 seconds.

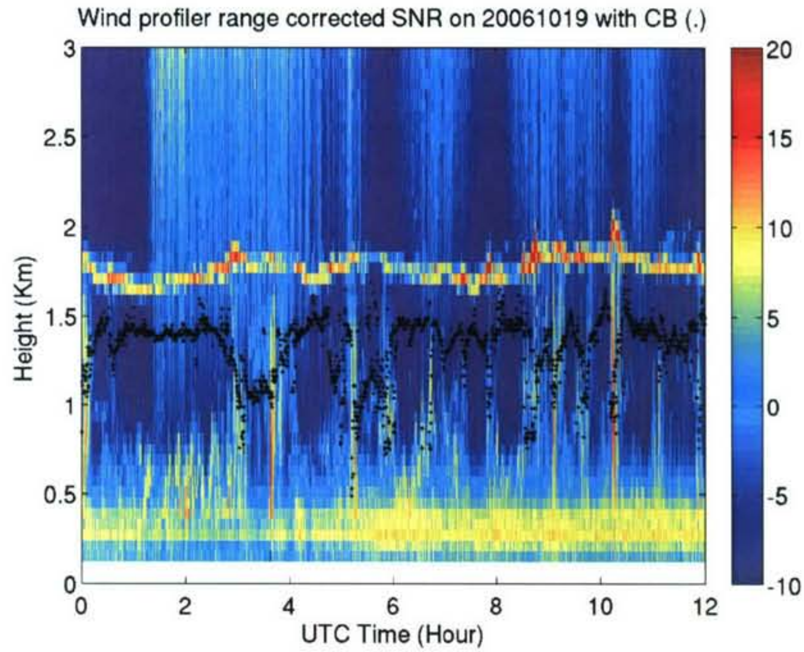


Figure IV.B.13. Range corrected SNR from the 915 MHz profiler, October 19, 2006. Dots '.' denote retrieved cloud base (CB) from ceilometer backscatter.

IV.C. Cruise Summary

IV.C.1. Basic Time Series

The ship track for the entire cruise is shown in Figure IV.C.1, Panama City, Panama, to Valparaiso, Chile. The 5-min average time series for sea/air temperature are shown in Figure IV.C.2 and for wind speed and N/E components in Figure IV.C.3. The change in conditions for the first three days of the record is associated with the run south along 85 W from Panama. Then on day 293 we departed the WHOI location and moved toward the DART buoy at 20S, 74.8W. The near-surface sea-air temperature difference is about 1°C in the vicinity of the WHOI buoy. Figure IV.C.4 shows a weak diurnal variation in the wind component. Primarily because of the consistent low-level cloud cover, there is very little diurnal signal in the sea surface temperature. Time series for flux quantities are shown as daily averages. Figure IV.C.5 gives the flux components and Figure IV.C.6 the cloud forcing for net surface radiative fluxes. Cloud forcing is the difference in the measured radiative flux from that which would be expected if there were no clouds. It is essentially a measure of the effect of clouds on the energy budget of the ocean. A negative cloud forcing implies the cloud cools the ocean (e.g., by reflecting solar flux). Figure IV.C.7 shows ceilometer cloud information for the same time period as Figure IV.C.6. Correlating the cloud fraction in the lower panel of Figure IV.C.7 to Figure IV.C.6 it is easy to see the effects of a cloudless period on day 290. Day 288 flux data are missing due to a problem with the data collection PC.

Unlike STRATUS 2005, there is no evidence of a diurnal cycle of cloudiness (i.e., thinning or clearing after local noon) at 20 S which lead to fairly large values of net heat flux and solar flux; afternoon clearing which led to a much greater 24-hr average solar flux. Bulk meteorological variables and turbulent heat fluxes are shown for the transect from ~0 S to 20S along 85W in Figure IV.C.8. This shows the winds peaking at 15S, but no maximum in latent heat as in 2005. The eastern return transect (Figure IV.C.9) looks similar to transects along 20 S in previous years.

Data from the PMS Lasair-II aerosol spectrometer is shown in Figure IV.C.10. This instrument counts particles in size ranges from 0.1 to 5 μm diameter based on scattering of light from a laser beam. This size range includes most of the so-called accumulation-mode aerosols that represent most of the particles activated to form droplets in clouds. Note the extremely low numbers for particles > 5 μm. Thus, the total number of aerosols counted by this device is expected to correlate with cloud condensation nuclei and the number of cloud drops. The distribution is normally strongly bimodal as a result of cloud processing in the marine boundary layer. The Lasair-II only observes the large particle size mode. The concentration varies with a time scale of several days. This is the result of the complex interaction between entrainment, advection, production and scavenging of aerosols. An interesting feature this year is the dramatic decrease that occurred between day 287 and 288. In 2004 the average total number concentration from December 8th to the 18th was 180 (cm-3). In 2005, the median in the vicinity of the buoy was 85 (cm-3).

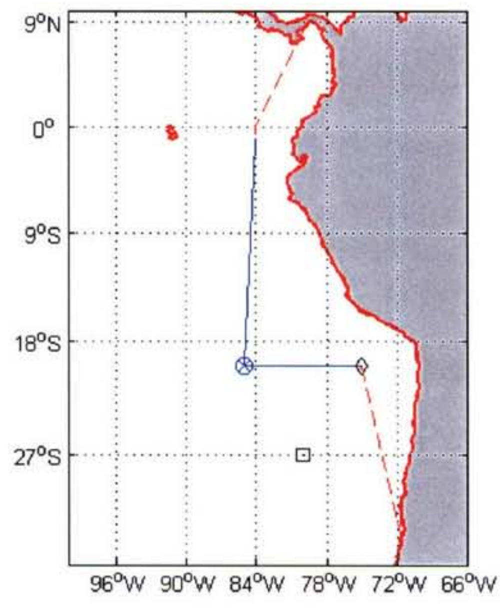


Figure IV.C.1. Cruise track for Stratus 2006 cruise Panama City, Panama, to Valparaiso, Chile. Solid blue line is data collection period.

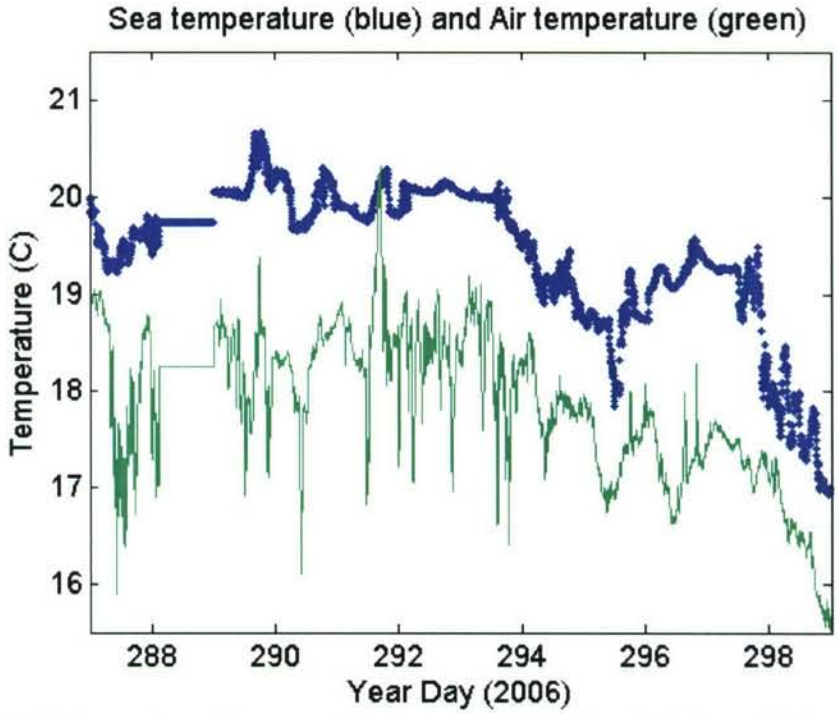


Figure IV.C.2. Time series of near-surface ocean temperature (blue) and 15-m air temperature (green) for the 2006 RHB Stratus cruise.

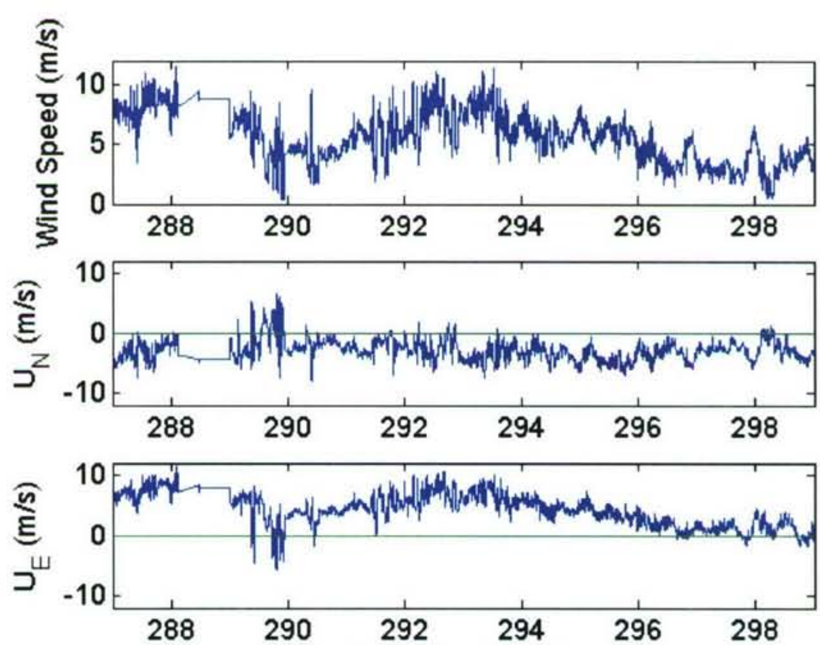


Figure IV.C.3. Time series of wind speed (upper panel), northerly component (middle panel), and easterly component (lower panel) for the 2006 RHB Stratus cruise.

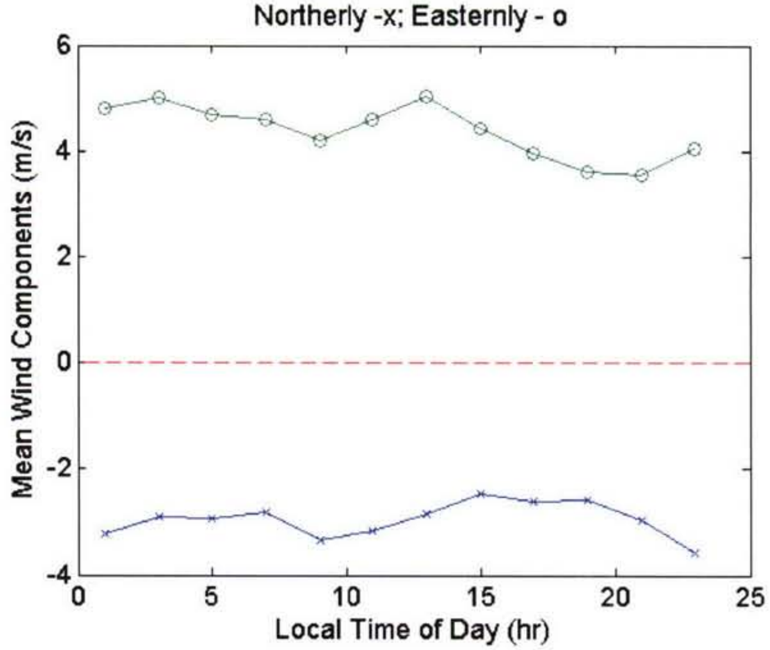


Figure IV.C.4. Diurnal average of northerly and easterly wind components for period near 20S, 85W.

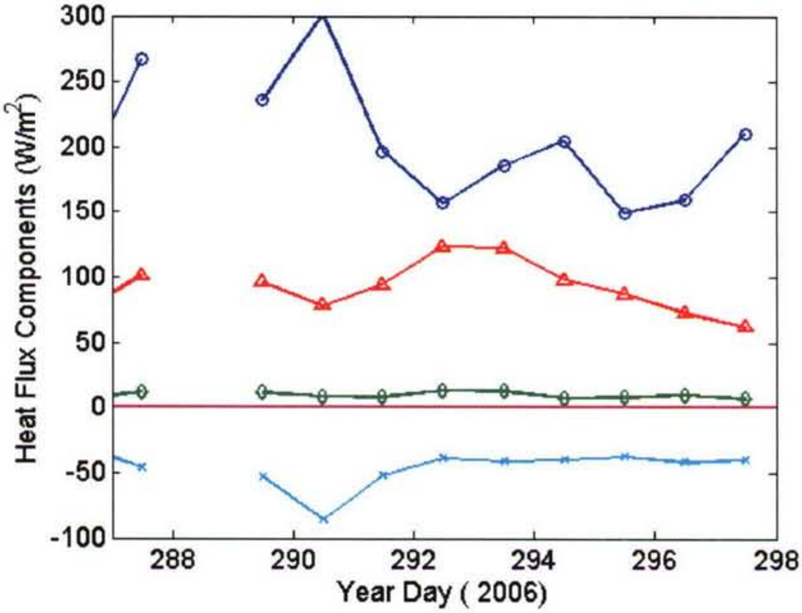


Figure IV.C.5. Time series of 24-hr average heat flux components: solar flux – dark blue circles; latent heat flux – red triangles; sensible heat flux – green diamonds; net IR flux cyan x's. Data for day 288 missing.

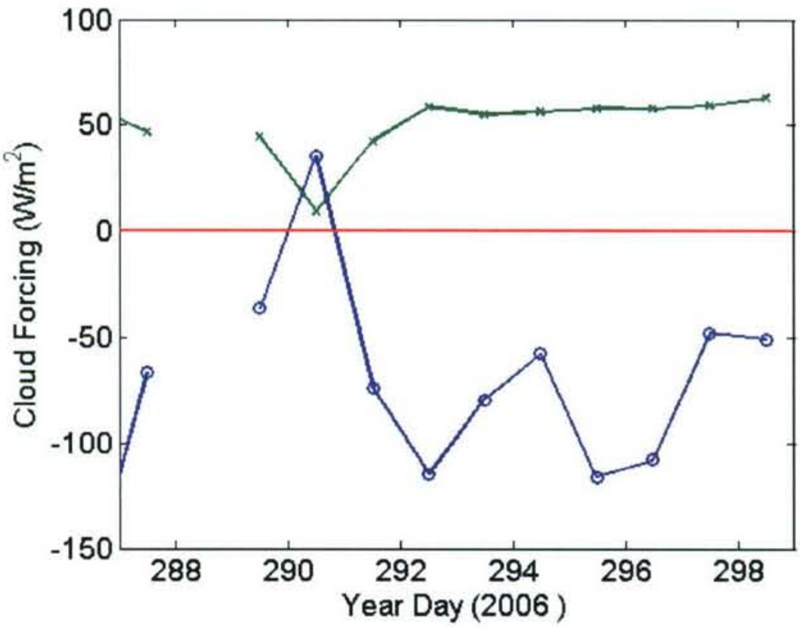


Figure IV.C.6. Time series of daily averaged radiative cloud forcing: IR CF (W/m^2) – green, Solar CF (W/m^2) – blue. Data for day 288 missing.

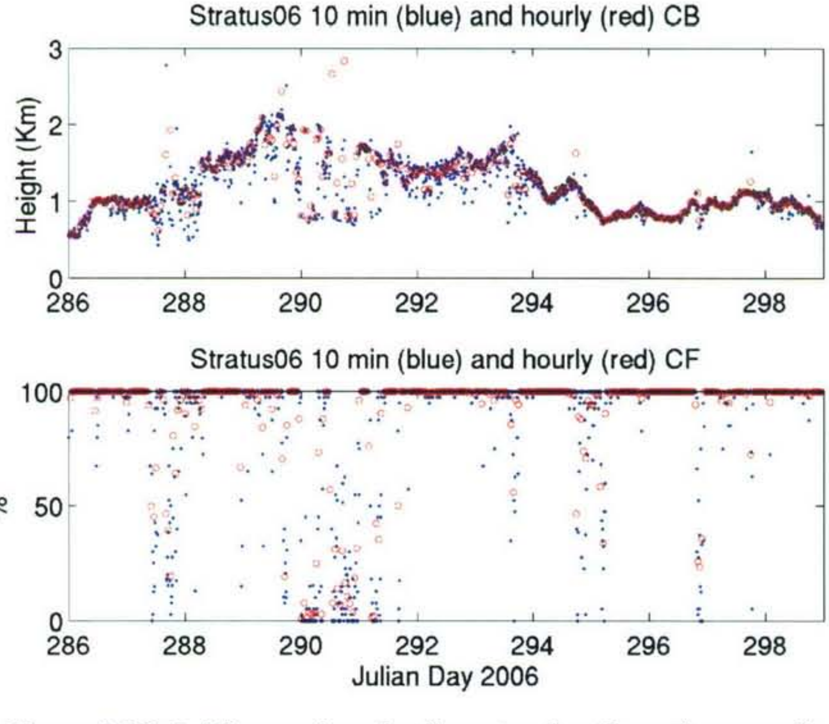


Figure IV.C.7. Time series of ceilometer cloud base (top panel) and cloud fraction (lower panel).

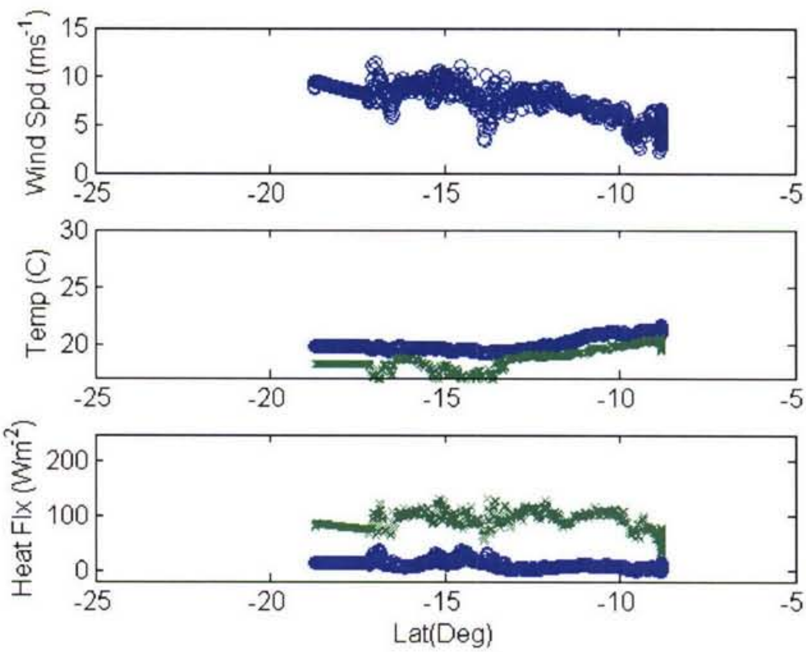


Figure IV.C.8. Selected variables from the N-S transect along 85W. Upper panel is wind speed; the middle panel is sea surface temperature (blue) and air temperature (green); the lower panel shows sensible (blue) and latent (green) heat fluxes.

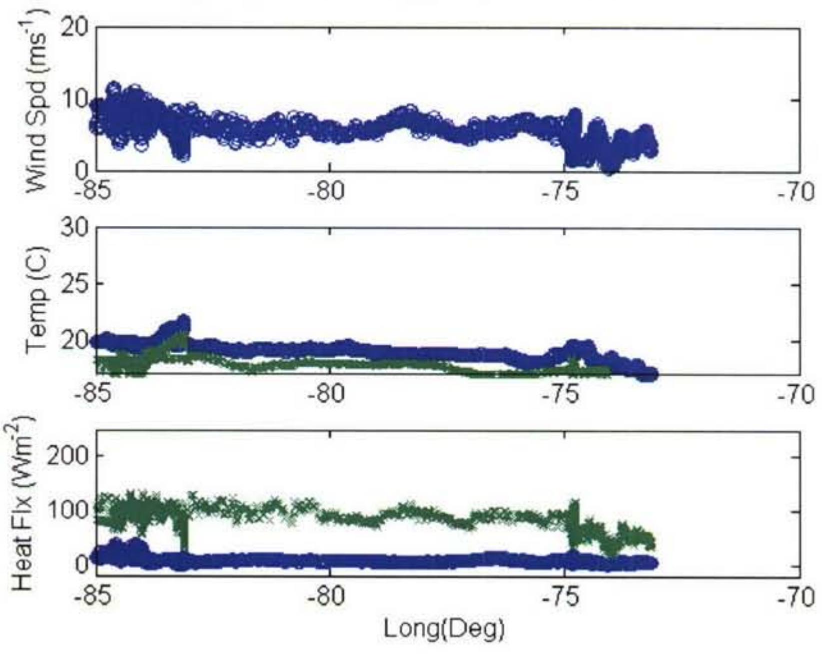


Figure IV.C.9. Same as Figure IV.C.8, but for the W-E transect along 20S from 85W to 70W.

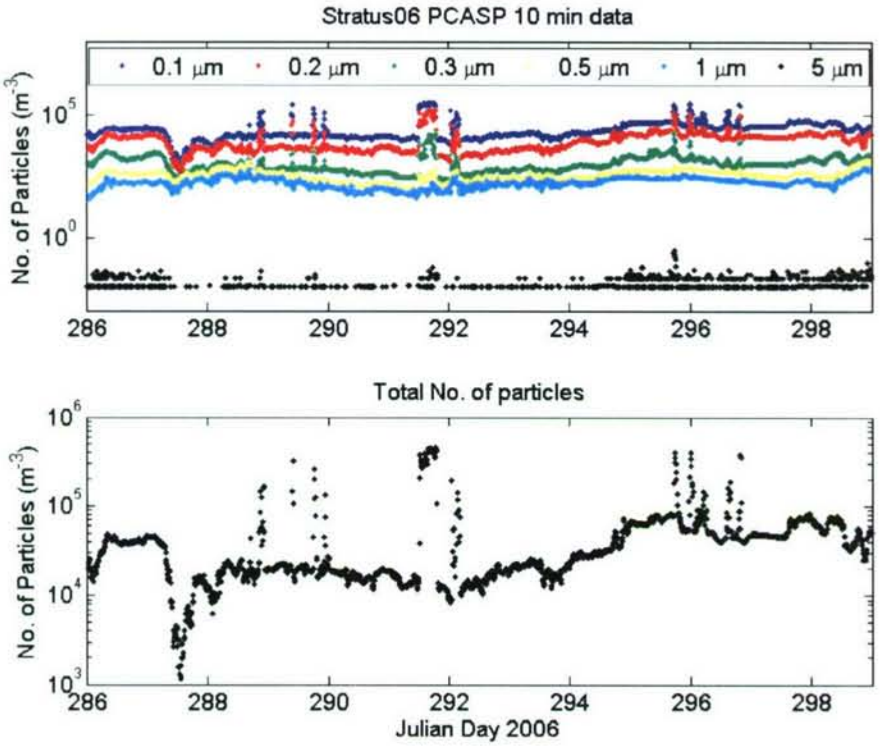


Figure IV.C.10. Aerosol concentrations from Lasair-II spectrometer. Upper panel: aerosol concentrations for 0.1-0.2 (blue), 0.2-0.3 (red), 0.3-0.5 (green), 0.5-1.0 (yellow), and 1.0-5.0 (cyan), >5.0 (black),. Lower panel: total number concentration for aerosols larger than 0.1 micron diameter. Spikes are caused by the ship's exhaust.

IV.C.2. Boundary Layer and Cloud Properties

Table IV.C.1 shows daily averages of the cloud fraction calculated from the ceilometer cloud base, cloud base calculated from the ceilometer, and number of total aerosols. This table shows that it was very cloudy with only one day (290) that could be considered clear and an 87% cloud fraction over the entire 13 day period. The shaded region signifies the period at the WHOI buoy. Cloud base heights show a trend for higher cloud bases at the buoy decreasing in height both to the north and east. These heights are slightly lower than the base of the inversion measured by the radiosondes.

Table IV.C.1. Cloud properties from ceilometer.

Date UTC	Cloud fraction (%)	Cloud base (m)	Total aerosols No. per m^{-3}	Inversion Base (m)
286	99	846	3.5927644e+04	
287	82	1254	1.9434768+04	
288	96	1360	2.3515866+04	
289	92	1958	3.0181718+04	
290	26	1784	1.6989641+04	
291	82	1505	1.1631425+05	
292	99	1387	2.1796396+04	
293	96	1460	1.9864254+04	
294	94	1493	3.4631861+04	
295	94	836	8.0347916+04	
296	90	875	7.2582176+04	
297	98	1058	5.6289023+04	
298				

Beginning at 1100 UTC on October 13 and ending at 2300 UTC on October 25 we completed 71 successful rawinsonde launches. Beginning Oct 15 radiosondes were launched every 4 hours (6 times daily). A time-height color contour plot of temperature is shown in the upper panel of Figure IV.C.11; the lower panel shows the relative humidity with respect to ice. A pronounced temperature inversion is evident at approximately 2.0 km while on station at the WHOI buoy and then lowering to nearer 1.0 km as we headed east. The time series of wind speed and direction are shown in Figure IV.C.12. The winds are consistent with climatology, with southeasterlies prevailing within the boundary layer and westerlies aloft. The nominal height for the transition from westerlies to easterlies descended steadily during the experiment to coinside with the moisture transition described above. The boundary-layer inversion is more clearly seen in potential temperature (Figure IV.C.13).

The time series of cloud base height from the ceilometer is shown in Figure IV.C.7. Only one microwave radiometer system was used on this cruise. The microwave radiometer is calibrated using a tipcal process that requires clear skies. The Radiometrics system performs tipcals automatically every hour. The time series of data from the mailbox system is shown in Figure IV.C.14. The total column water vapor agrees extremely well with sonde column water vapor values in the stratus region shown in Figure IV.C.15.

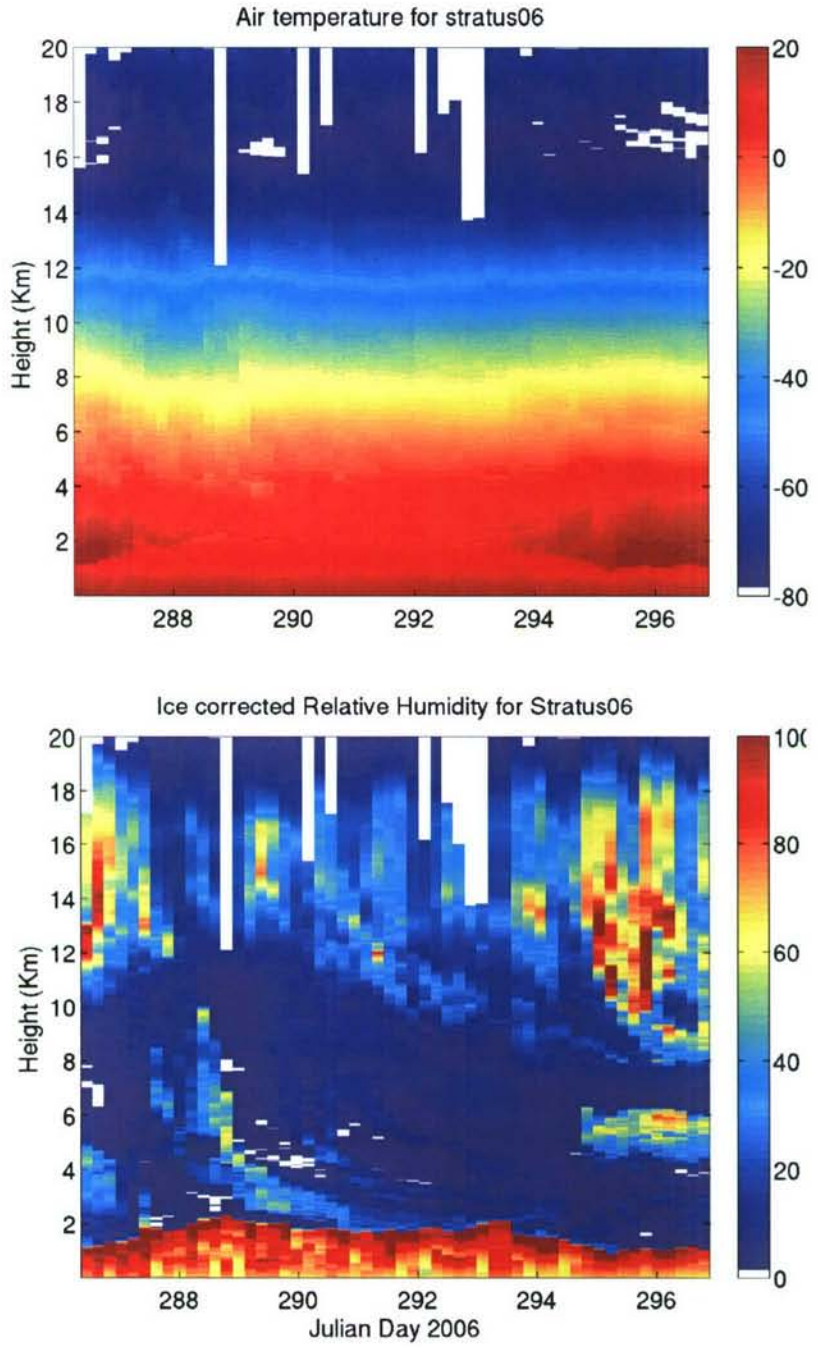


Figure IV.C.11. Time-height color contour plots from radiosondes launched during the 2006 Stratus cruise. The upper panel is temperature; the lower panel is relative humidity with respect to ice.

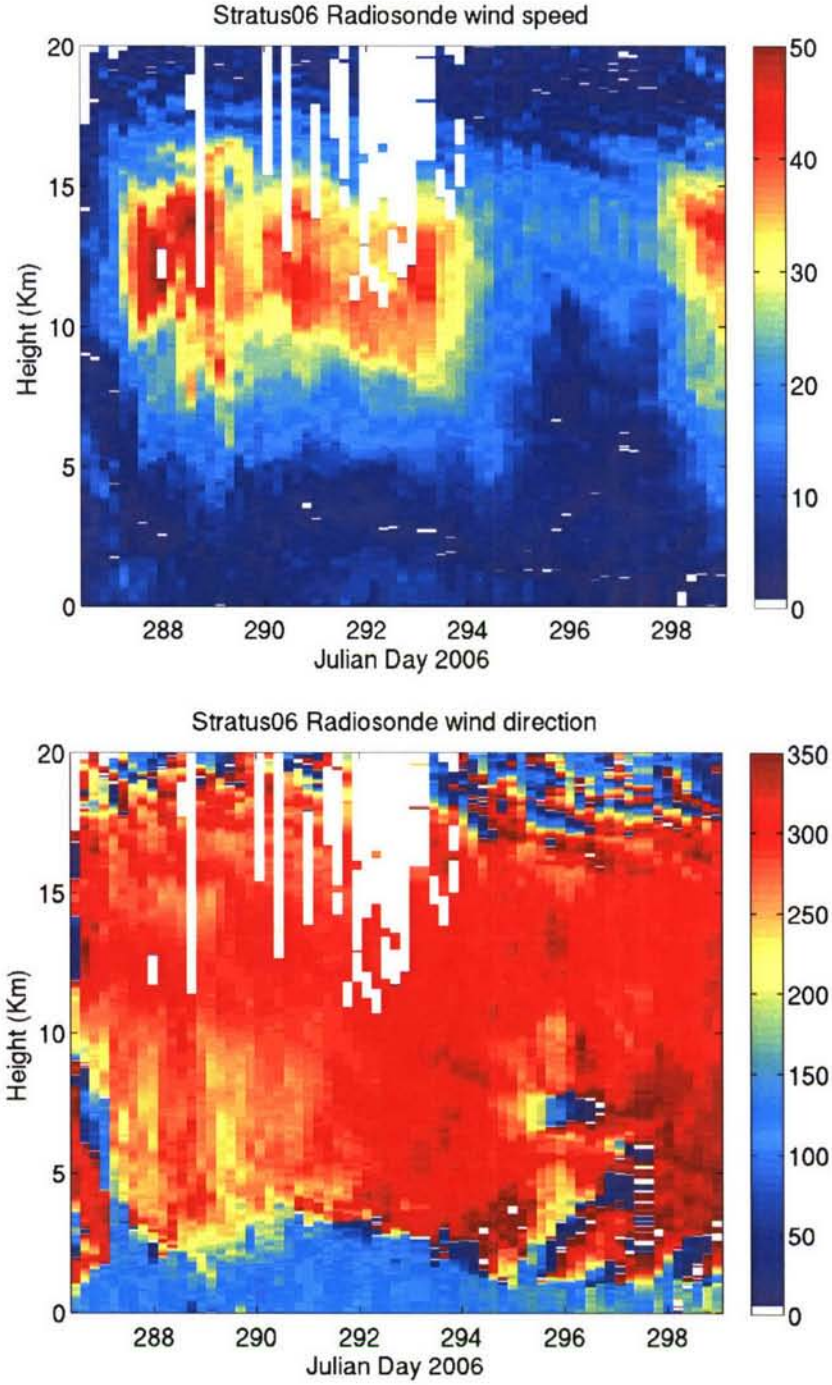


Figure IV.C.12. Time-height color contour plots from radiosondes launched during the 2006 Stratus cruise. The upper panel is wind speed; the lower panel is wind direction.

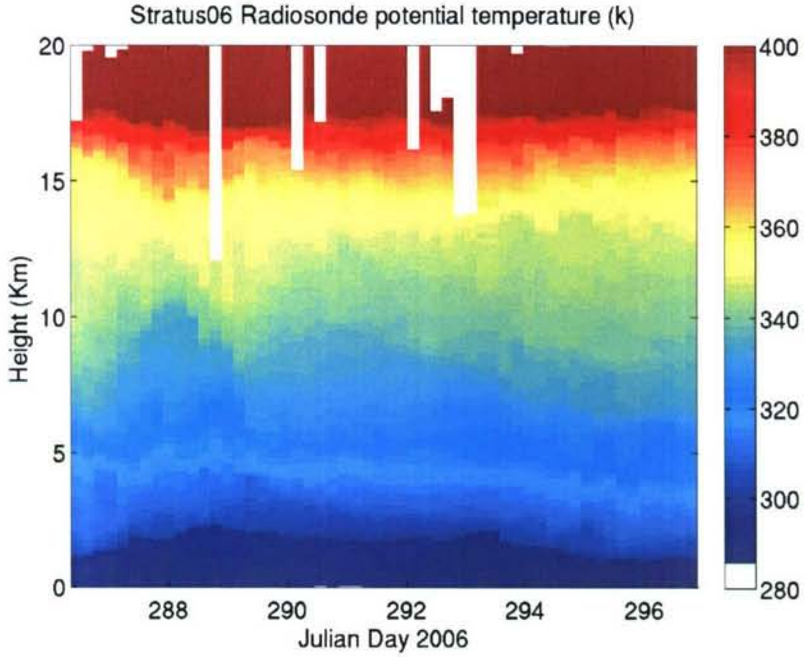


Figure IV.C.13. Time-height color contour plots of potential temperature from radiosondes launched during the 2006 Stratus cruise. This height scale emphasizes the atmospheric boundary layer.

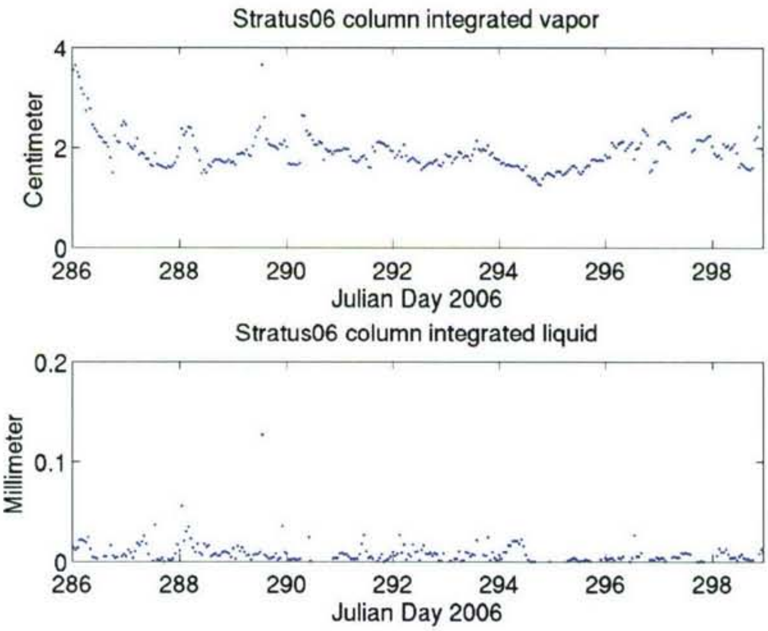


Figure IV.C.14. Time series of microwave radiometer-derived values for column integrated water vapor (upper panel) and column integrated liquid water (lower panel.

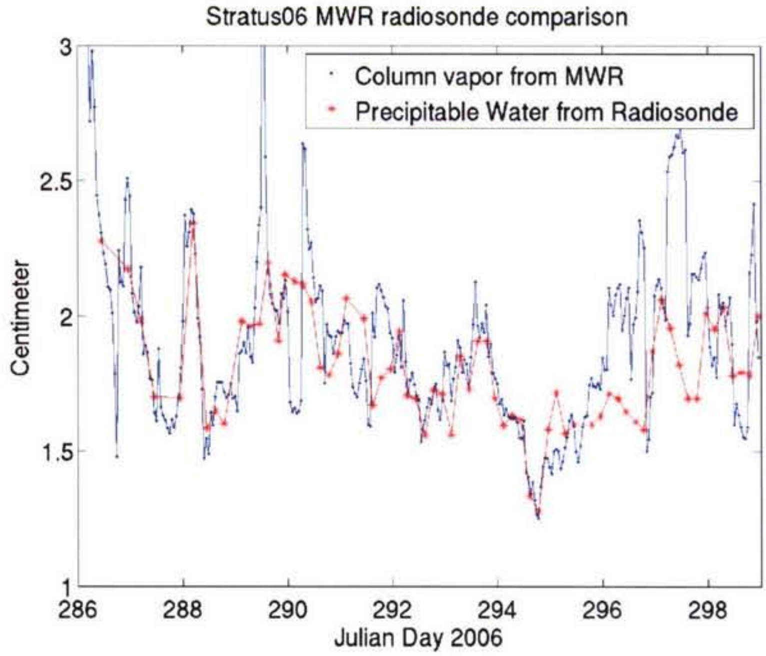


Figure IV.C.15. Time series of column integrated water vapor for the microwave radiometer (blue dots) precipitable water from the radiosonde (red x's).

IV.C.3. Remote sensors

Figures IV.C.16 and IV.C.17 show products derived from the C-band Doppler radar. Hourly wind profiles (Figure IV.C.16) and the wind field (Figure IV.C.17) at 1.0-2.0 km initially is consistent with the radiosonde winds. Additional analysis and comparisons are needed with these data. Visualization of the scale cloud structure within the experimental region is shown in Figure IV.C.18. In addition to this visible image, IR images are also collected.

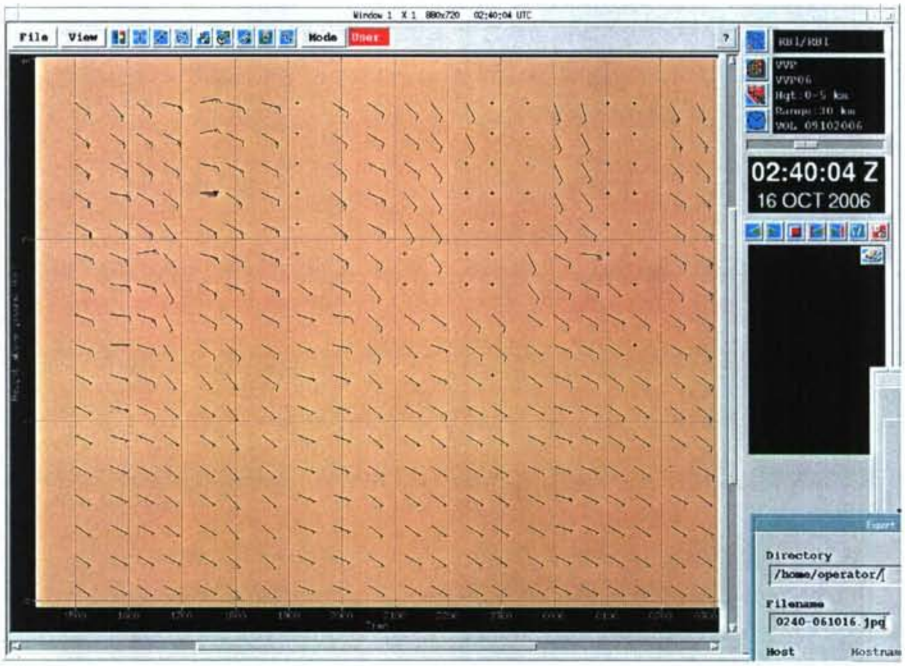


Figure IV.C.16. C-Band Doppler radar wind profiles calculated using SIGMET VVP routine. Hourly wind profiles (0-3km) from volume scan. 02:40 UTC October 16, 2006.

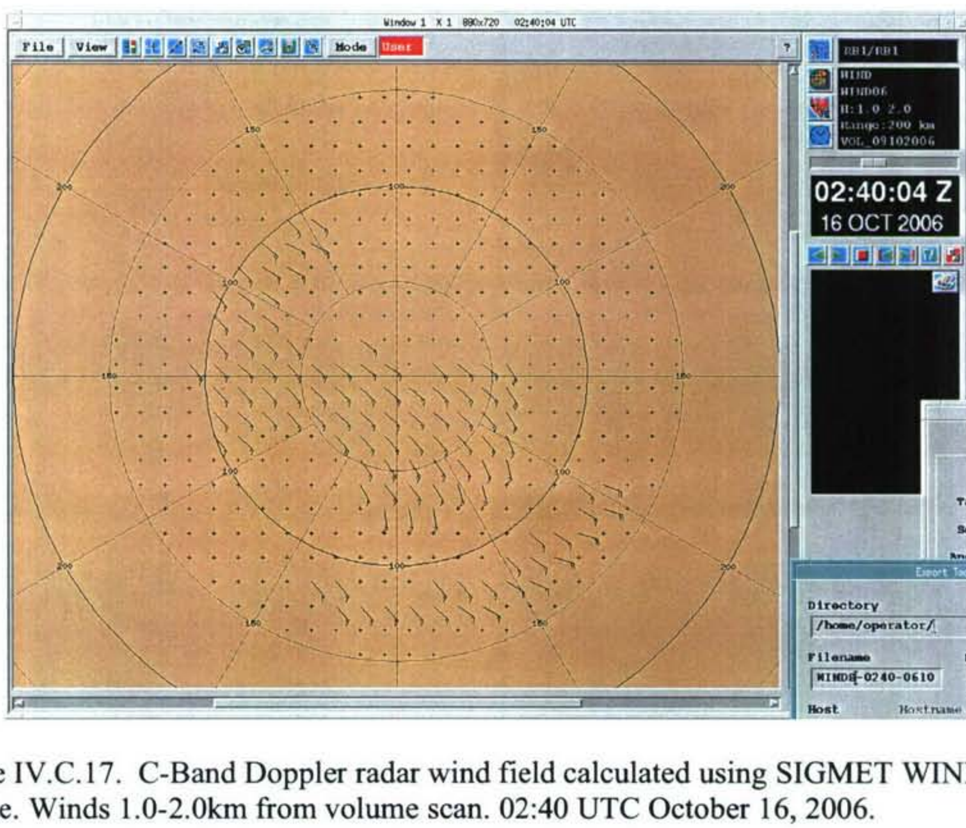


Figure IV.C.17. C-Band Doppler radar wind field calculated using SIGMET WINDS routine. Winds 1.0-2.0km from volume scan. 02:40 UTC October 16, 2006.

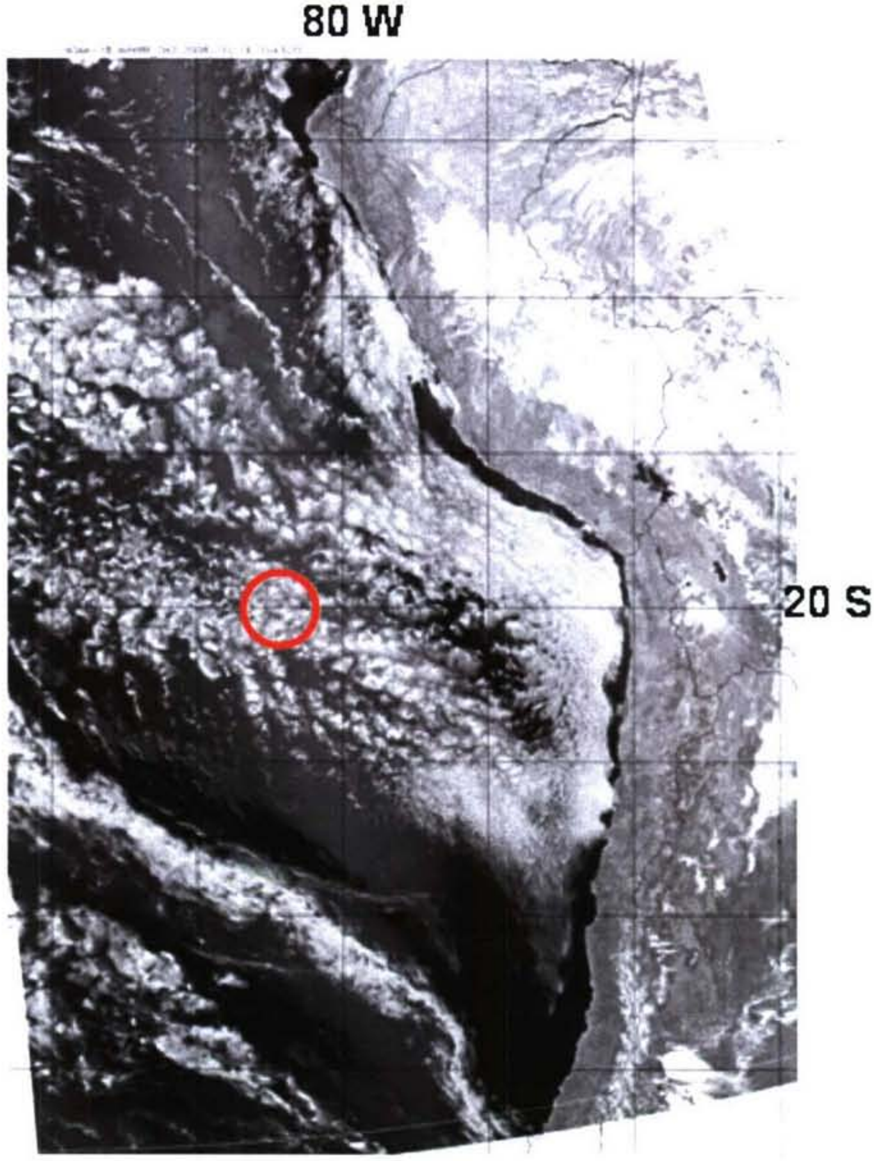


Figure IV.C.18. Terascan satellite visible image NOAA-18 2043 UTC October 19, 2006. Red circle is the location of the STRATUS buoy (20 S, 85W)

IV.D. Intercomparisons

Intercomparisons are a key strategy in data quality assurance for the climate reference buoys and the use of research vessel measurements for climate-quality data archives. The PSD flux system is intended to produce measurements of turbulent flux bulk variables and radiative fluxes that have the required accuracy for climate research. For this cruise, a set of intercomparisons were done for bulk meteorology and radiative fluxes.
*The PSD flux system acquired all relevant ship IMET-based measurements.
*PSD and ship radiative fluxes were compared with the WHOI buoy (sitting on the deck) and an array of IMET radiative sensors (mounted in an array on the 03 deck).

IV.D.1. PSD-Ship Comparisons

We compared PSD and ship measurements for wind speed and direction, sea surface and air temperature, relative humidity, and solar and IR downward radiative flux. All measurements agreed within the accuracy required for flux evaluations. The ship wind system does experience flow blockage by the jackstaff for relative winds from the starboard side. A detailed analysis will be done later.

IV.E. PSD Data Cruise Archive

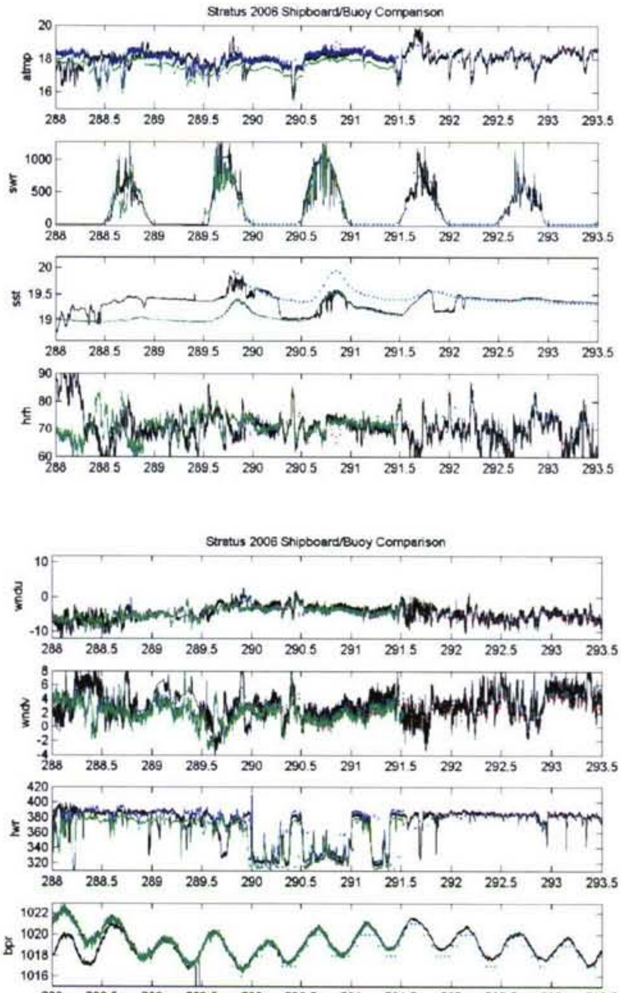
Selected data products and some raw data were made available at the end of the cruise for the joint cruise archive. Some systems (radar, turbulence, microwave radiometer) generate too extravagantly to be practical to share. Compared to processed information, the raw data is of little use for most people.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

All data during the cruise were archived to an external hard drive in a structure similar to the structure below. These data will be put on an ftp site back in Boulder. The procedure to access this ftp site and its data content is explained in Appendix B.

V. INSTRUMENTS INTERCOMPARISONS

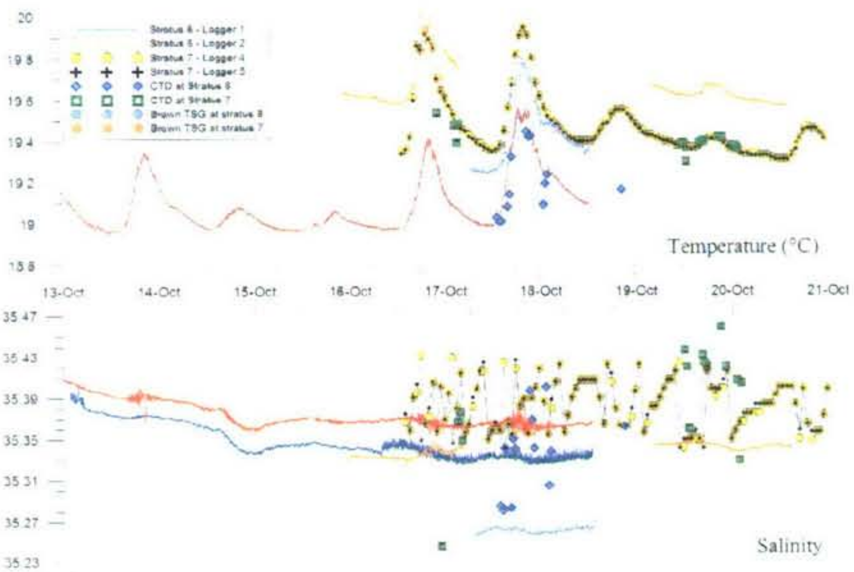
V.A. RHB to IMET comparisons

Over several years the UOP group has developed a system for comparing data from shipboard meteorological and sea surface sensors with ASIMet data transmitted via Argos in near-real time. This system allows us to confirm proper operation of our sensors and to gain more information about local conditions near our moorings. Further details on the ship's data (access, processing, format, etc) is shown in appendix C. Figures V.A.1.a,b show time series of ASIMET and ship SCS data.



FigureV.A.1a,b: Shipboard SCS data is in black, the blue and green lines are internally-recorded ASIMet data from the Stratus 6 buoy, and the cyan and magenta dots are hourly averages of ASIMet data from the Stratus 7 buoy transmitted via Argos.

FigureV.A.2 below shows the intercomparison of SST (upper panel) and sea surface salinity (SSS) (lower panel). Stratus 6 and 7 subsurface data is at 1.5 m depth, CTD data is at ~1.5 m depth and thermosalinograph data from R.H. Brown is at 5.6 m depth. Sampling rates are variable: 1 min for Stratus 6 buoy, 1 hour for Stratus 7 buoy, 1 min for thermosalinograph data and 1 sec for CTD data. The differences in the sampling rates could introduce some of the differences seen in SST and SSS. The bias in SST thermosalinograph data (0.2°C), and consequently in salinity (0.1 PSU), may be associated with a warming effect due to the long distance between the thermosalinograph and the water intake.



FigureV.A.2: SST and CTD comparison between Stratus 6,7 and SCS data.

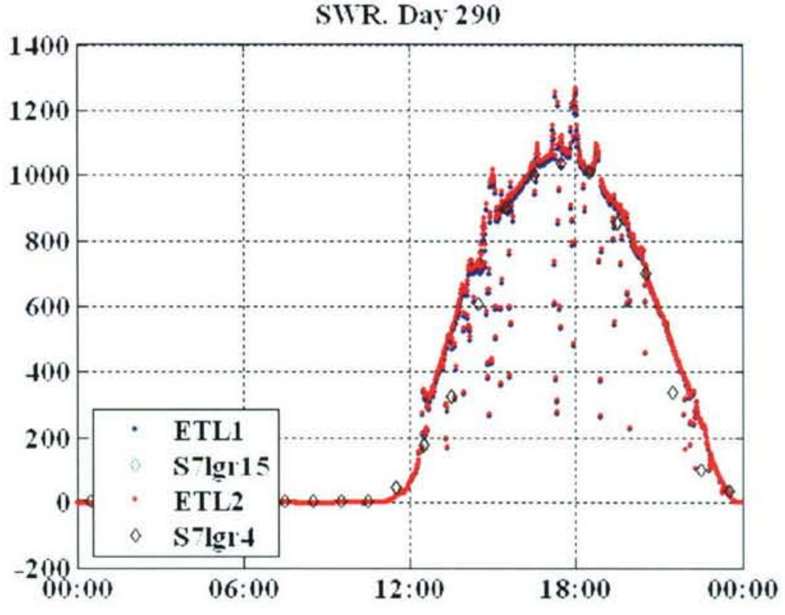
V.B. ETL-UOP Comparisons

On October 17 (year day 290), R/V RHB was stationed next to the Stratus 6 site for intercomparison of instruments. Stratus 6 was recovered the next day and the 1 minute data was recovered. After its recovery the buoy rested on the fantail. The Stratus 7 buoy was deployed on October 16 and an intercomparison was also operated near the buoy site. The UOP group also mounted a shortwave (SN 210) and a longwave (SN 502) IMET system on the O2 deck, in front of the ETL seatainers. These two standalones recorded one minute data; unfortunately, LWR 502 has a data gap between year days 288.5 and 292.5. We compare here the different instruments on the buoys as well as the solar standalones with ETL data. October 17 was a clear day (FigureV.B.1) which helped identify the different biases for solar units. FigureV.B.2 shows a bias between ETL and UOP PSPs. There is indication of a small SWR positive offset on UOP's PSP night values. Daily values show a variable bias, which sign varies during the day and with instrument. However ETL values tend to be higher during the afternoon. The difference with Stratus 6 is higher (FigureV.B.3), and ETL values are higher in the morning. UOP standalone and ETL relative difference is within 5% during daytime with higher difference when the sun is low. Stratus 6 values follow the same trend, although there are more pronounced differences

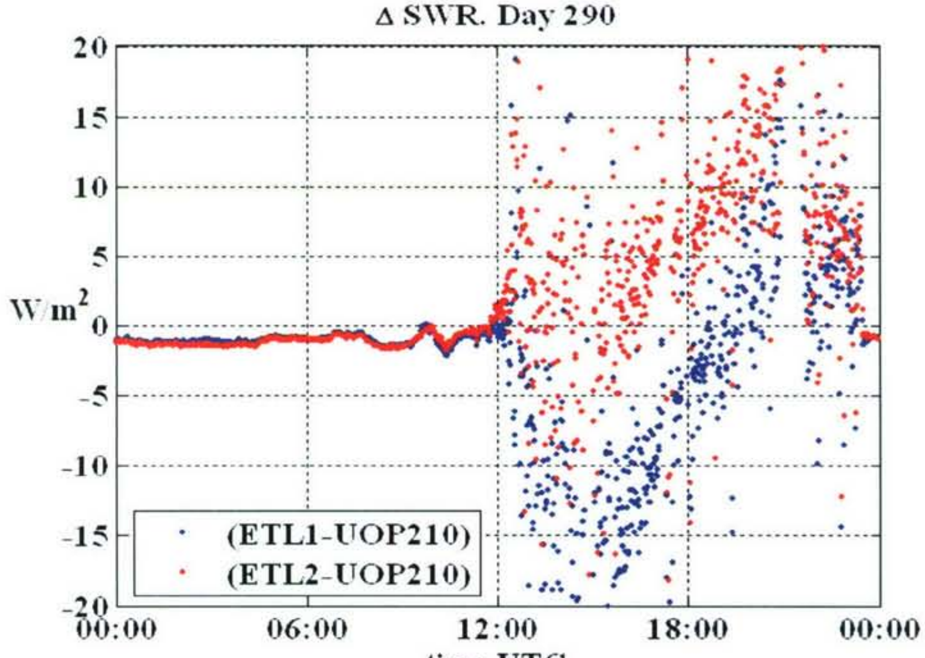
(FigureV.B.4). SWR integrated over the day are within 2% of each other. Longwave radiation from ETL sensors and the UOP standalone agree well (Figure V.B.5) as does Stratus 6 data (FigureV.B.6) with a bias within 10 W/m^2 and the relative difference between Stratus 6 values and SCS and ETL, on day 290, are within 5% for most times and constant during the day.

Other atmospheric variables were compared. For the period where R/V RHB was stationed at the Stratus 6 site (day 290.3 to 292) and at the Stratus 7 site (day 292.3 293.5). Air temperature measured by ETL sensors tend to be higher than the ones measured on the UOP buoys. The agreement between the latter and SCS values is better on the other hand (Figures V.B.7 and 8), but there is a clear tendency for buoy values to be lower. The agreement is within 5%. Relative humidity agree well (relative difference within +/-5%) especially with ETL values (FiguresV.B.9 and 10). SST values from the buoys are lower due to the higher depth of the sensor (Figures V.B.11 and 12), but the agreement remains good (1% with SCS and 4% which uses a sea snake and is therefore at the air-sea interface). FigureV.B.13 shows the wind comparison, without any height adjustment, so that ETL and SCS have higher values as the corresponding sensors are mounted on the jackstaff in the bow at approximately 15 m above the waterline. A more thorough comparison between sensors was conducted between year day 290.5 and 291.5 when R/V RHB was at the Stratus 6 buoy site. Figure V.B.14 shows ETL (18 m) and SCS (15 m) winds, along with Stratus 6 buoy (3.3 m) corrected to 18 m height using COARE3.0 algorithm. The winds are averaged over 5 minutes. Figure V.B.15 shows the wind relative difference between ETL and other sensors for wind speed (upper panel) and wind direction (lower panel). The agreement between sensors improves at the end of the period shown when the boundary layer was becoming instable. Figure V.B.16 has the histogram for the values in upper panel of previous figure, concerning ETL and Stratus 6 wind speed relative difference. This shows how the height adjustment recenter the Stratus 6 winds towards ETL values, but with a tendency for higher values than ETL.

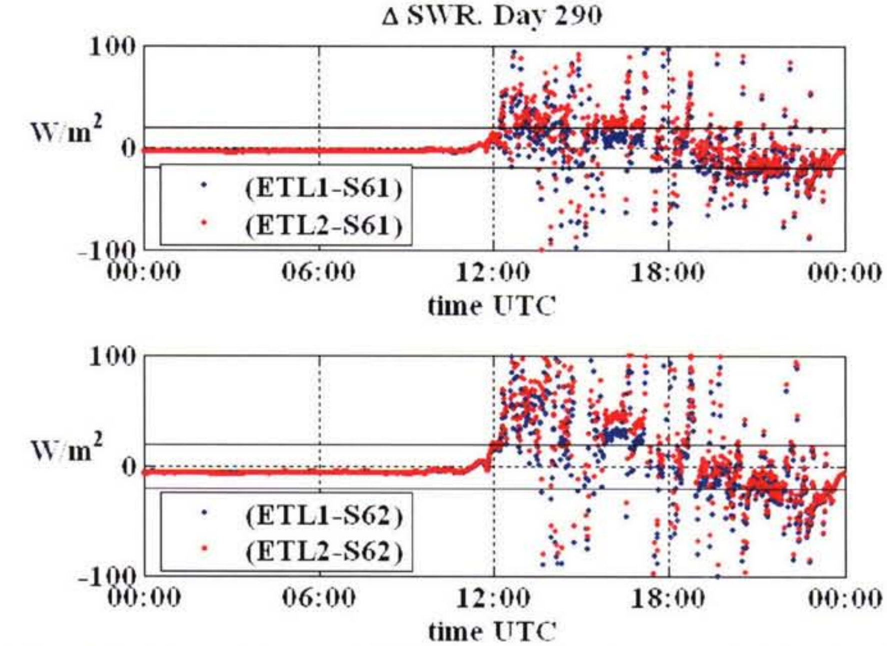
On the early morning of October 17, air temperature dropped by 2 degrees rather quickly (Figure V.B.17). At the same time, rain was detected and relative humidity increased. Note that although Figure V.B.17 uses SCS, R/V RHB was stationed at Stratus 6 site during this cold air event and data from the buoy shows the same signal. At the same time, there was a peak in water column vapor, detected by the microwave radiometer run by ETL (see Chapter IV.B). It is interesting to note that rain had been detected earlier in the day, while the ship was in transit to the Stratus 6 location, without any air cooling and while SST were higher than at the Stratus 6 site. Wind speed also peaks during this event (Figure V.B.13).



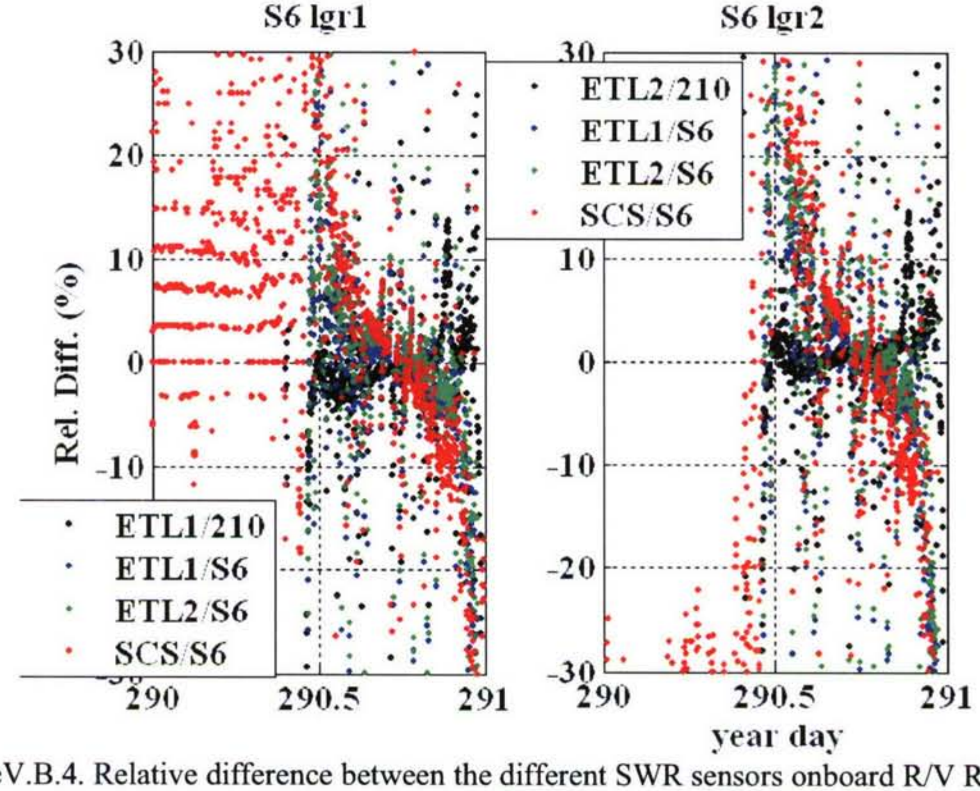
FigureV.B.1. SWR data on October 17, 2006. 1 minute data from ETL PSP and hourly averages Stratus 7 (deployed the day before).



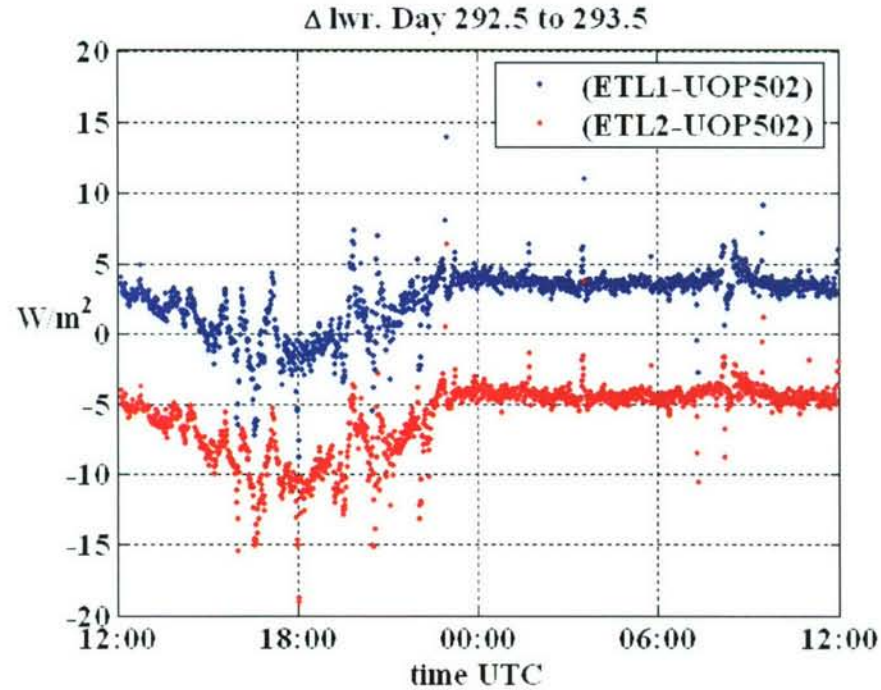
FigureV.B.2. SWR difference between ETL and UOP standalone 210 on O2 deck for October 17, 2006.



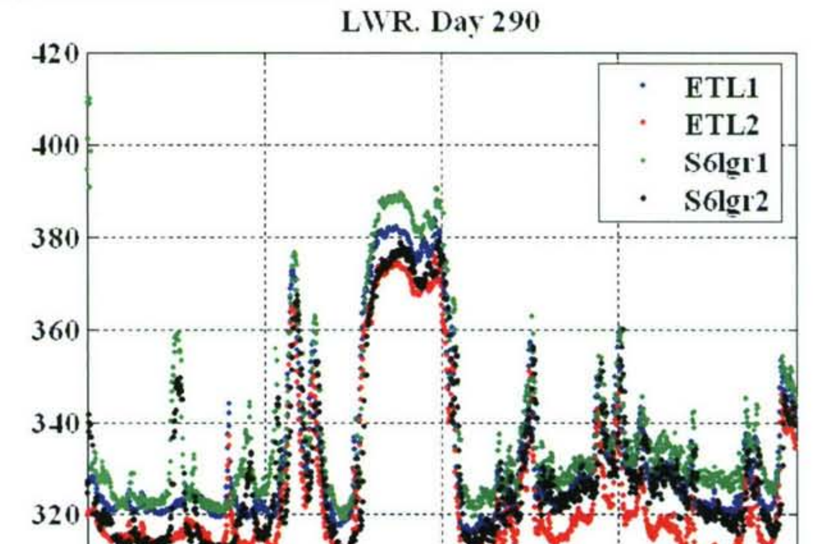
FigureV.B.3. SWR difference between ETL and Stratus 6 buoy on October 17. Two PSPs from ETL are on seatainer's roof on O2 deck. Stratus 6 data is from the two logger systems on the buoy. Black horizontal lines show the +/- 20 W/m^2 limits.



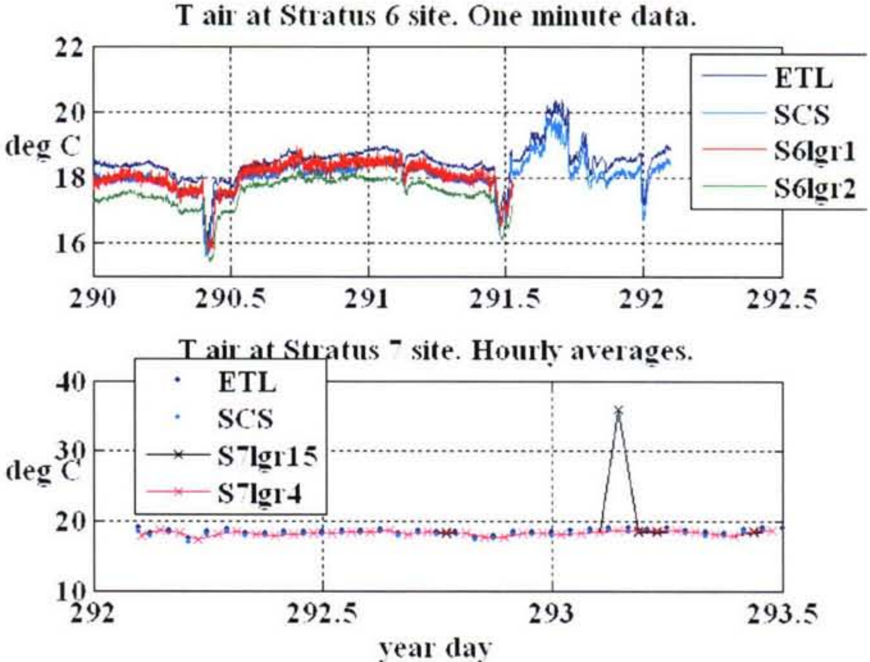
FigureV.B.4. Relative difference between the different SWR sensors onboard R/V RHB and the Stratus 6 (2 loggers). The black dots are the ETL and standalone UOP on O2 deck comparison.



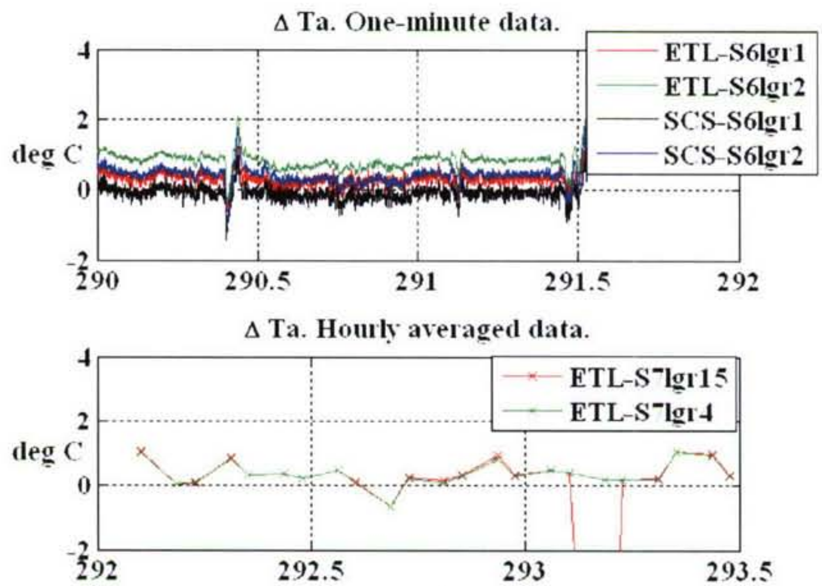
FigureV.B.5. LWR difference between ETL and UOP standalone 502 on O2 deck for October 19-20, 2006. R/V RHB near Stratus 7 site.



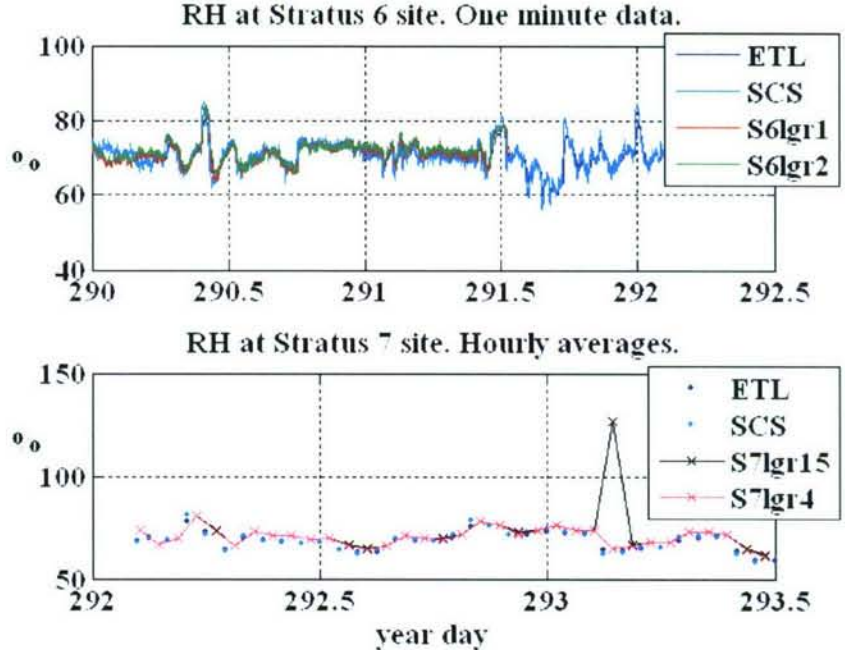
FigureV.B.6. LWR from ETL and Stratus 6 on October 17, 2006 when R/V RHB was stationed near the buoy.



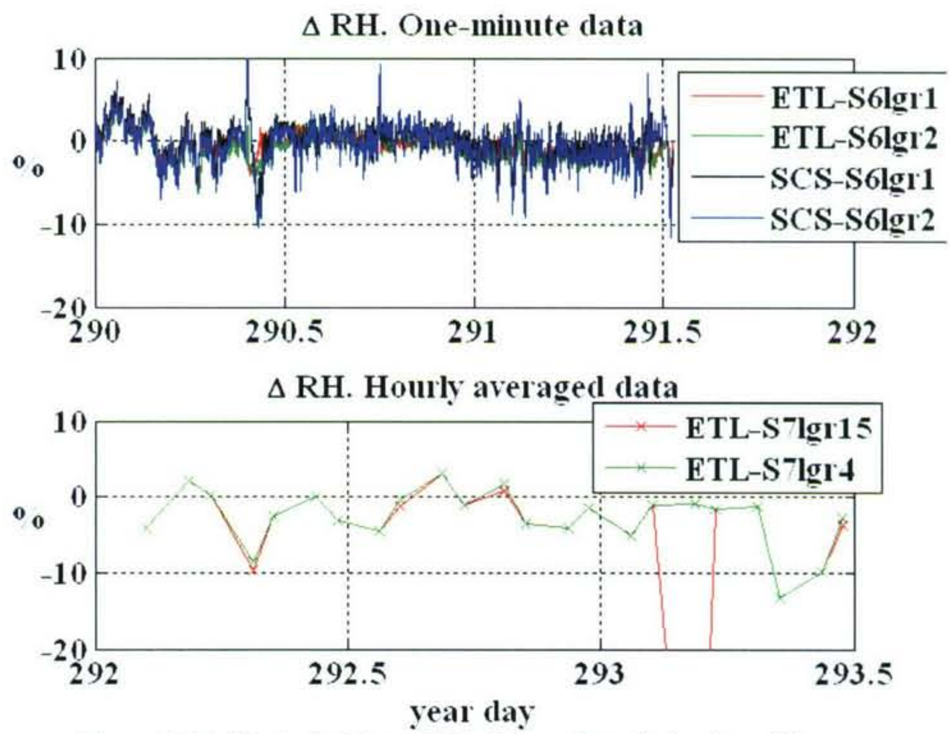
FigureV.B.7. Air temperature comparison between one minute data from the ship system (SCS), ETL and the IMET sensors on the Stratus buoys. Stratus 7 data is available only has hourly averages transmitted through Argos.



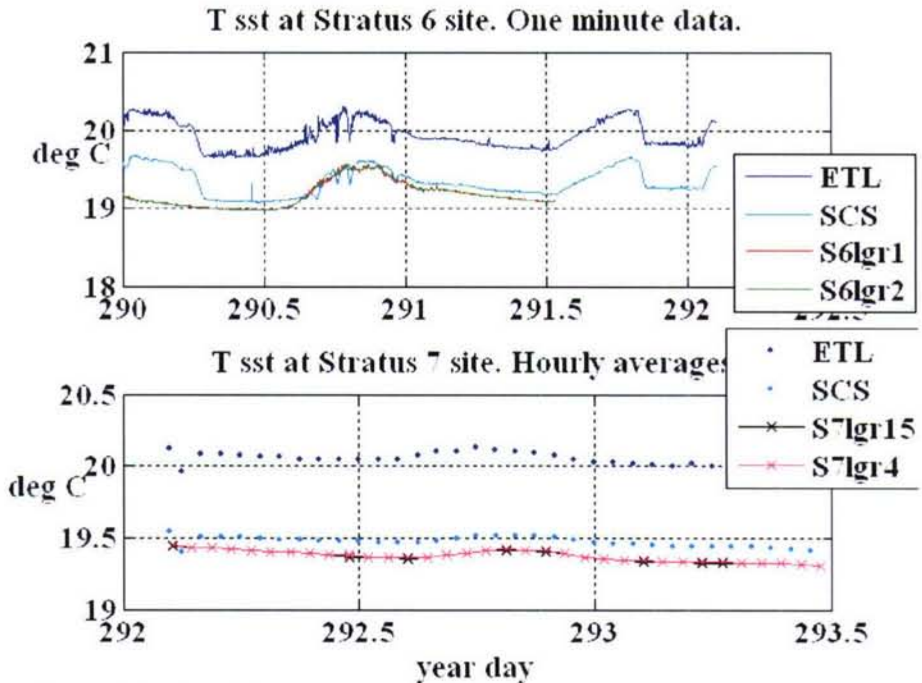
FigureV.B.8. Air temperature difference between ETL, SCS and the IMET sensors on the Stratus buoys.



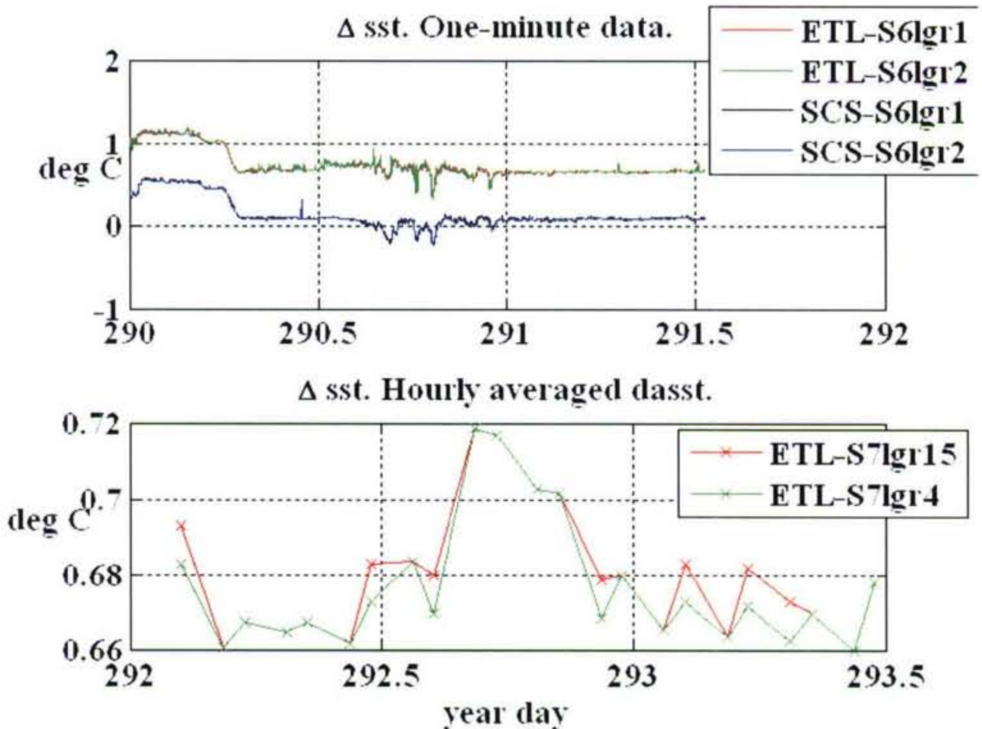
FigureV.B.9. As in FigureV.B.7, but for relative humidity.



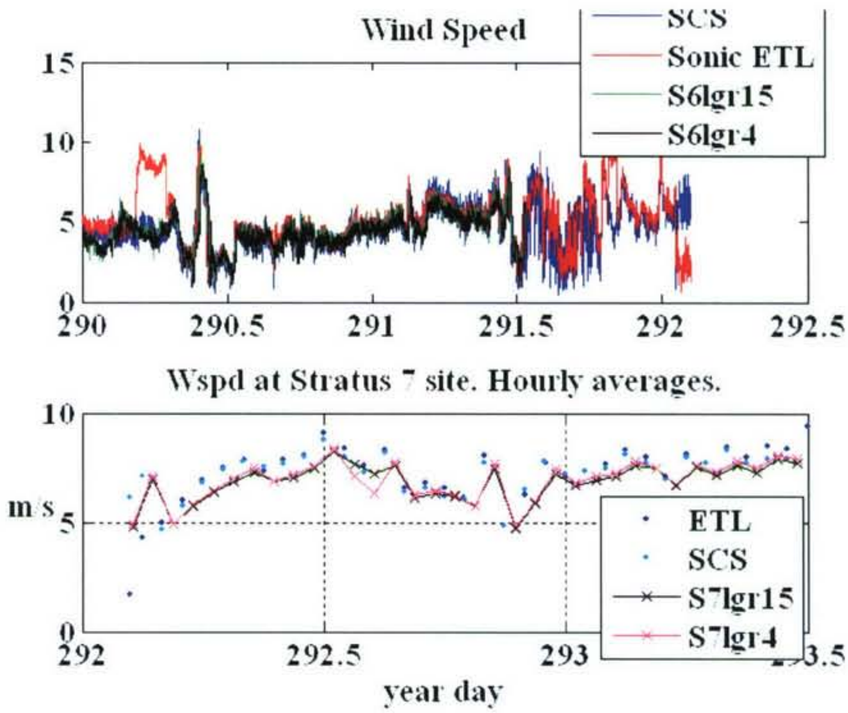
FigureV.B.10. As in FigureV.B.8, but for relative humidity.



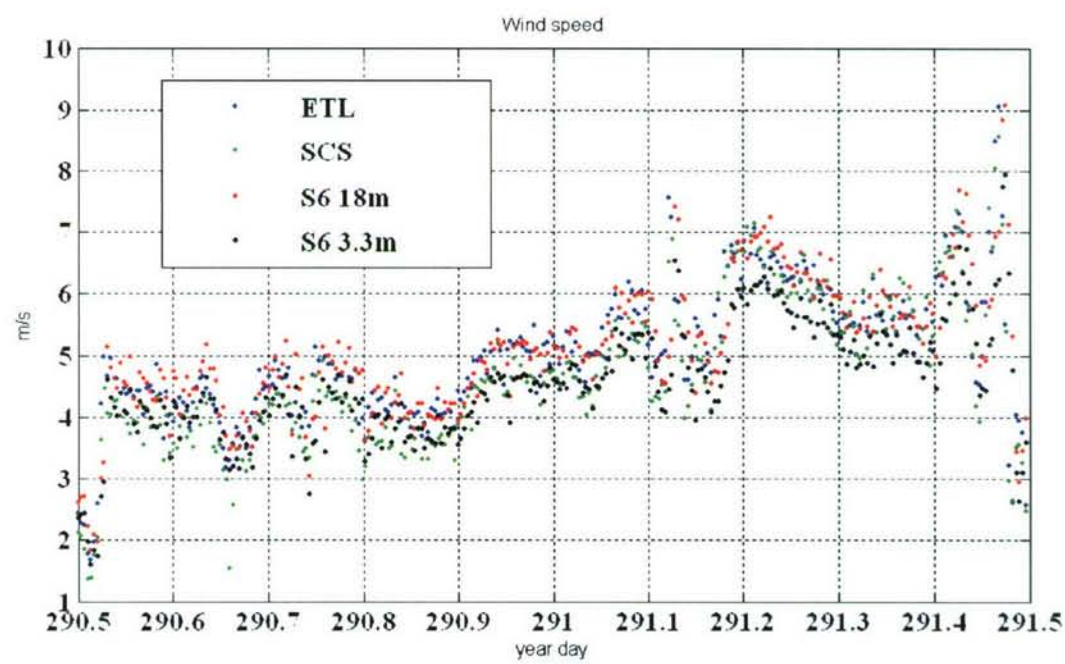
FigureV.B.11. As in FigureV.B.7, but for sea surface temperature.



FigureV.B.12. As in FigureV.B.8, but for sea surface temperature.



FigureV.B.13. Wind speed data comparison.



FigureV.B.14. Wind speed from ETL, SCS and Stratus 6 buoy (unchanged and adjusted to 18m).

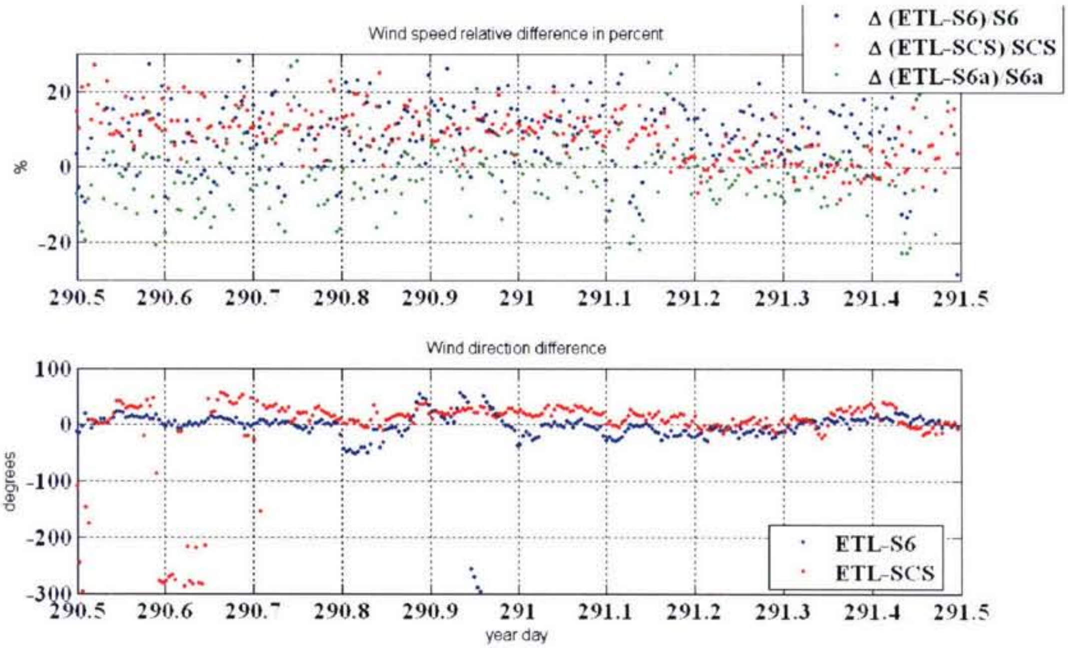


Figure V.B.15. Upper: Relative difference (%) in wind speed between ETL and SCS and Stratus 6 adjusted to 18m. Lower: Wind direction difference between ETL and others.

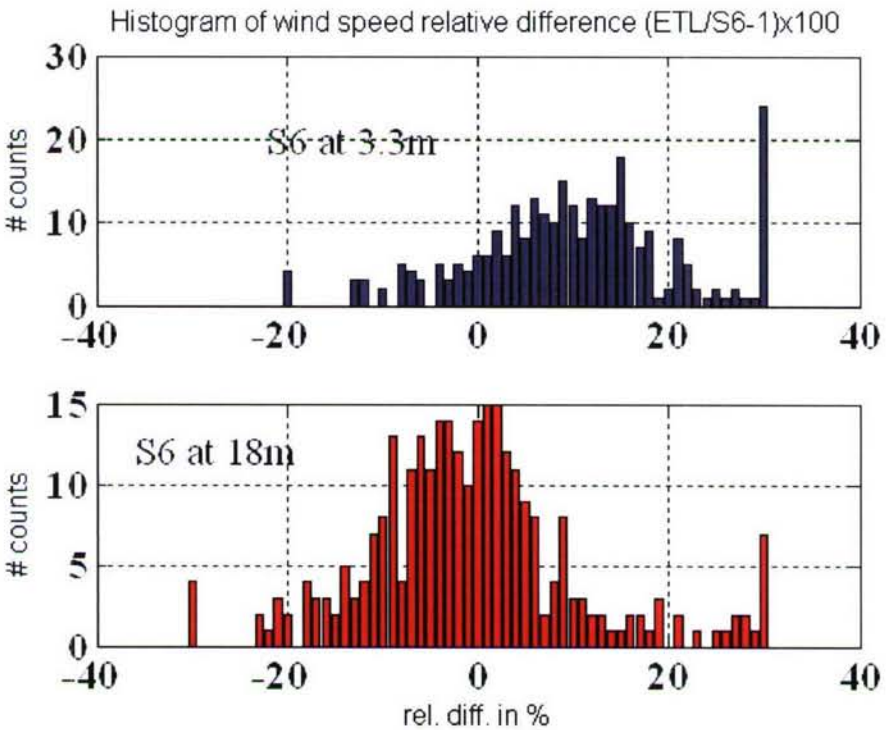


Figure V.B.16. Histogram for values in upper panel of Figure V.B.15. Upper:ETL vs.Stratus 6. Lower: ETL vs. Stratus 6 values adjusted to 18 m.

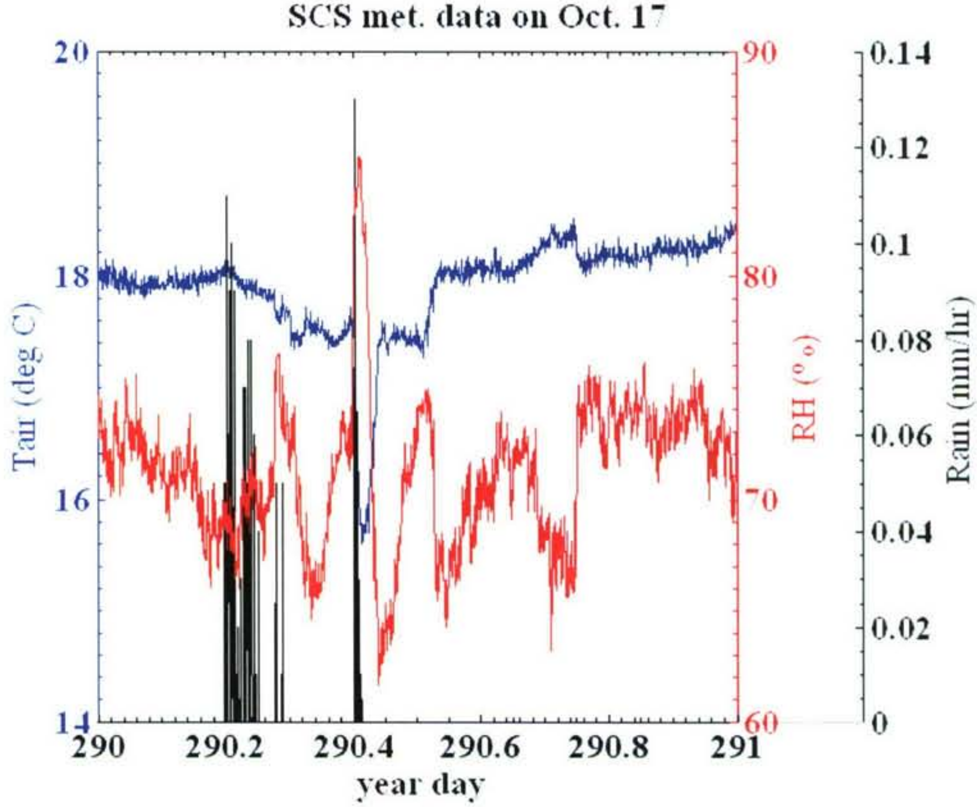


Figure V.B.17. Meteorological data from SCS on day 290. Stratus 6 buoy data is similar.

VI. ANCILLARY PROJECTS

VI.A. CTD Casts

VI.A.1 Introduction*:*

CTD Casts casts were conducted at the recovery site of Stratus 6 buoy and the deployment site of Stratus 7 and DART II buoy. A total of 32 CTD casts were made with a Seacat Profiler (Sea-Bird SBE 19, s/n 2361). Figure VI.A.1 shows the position of the three buoys. The casts conducted at the Stratus 6 site were not more than 2 km apart from the buoy. The casts at the Stratus 7 buoy were not more than 10 km apart for casts 1-4 and 3 km apart for the rest of the casts (18-28). From the 32 casts, 13 were made at the Stratus 6 site (12 shallow casts, 500 m, and 1 deep cast, 4200 m), 15 casts at the Stratus 7 site (14 shallow casts, 500 m, and 1 deep cast, 4200 m), and 4 shallow casts (500 m) at the DART II buoy site. Table VI.A.1 shows the time, location, depth and maximum depth reached for each cast. The methodology used for processing the CTD data is described in section VI.A.2. The CTD profiles and TS plots for each cast is presented in section VI.A.3, also a brief analysis of the results is made. The processed data of the casts is used in section V for comparison and validation of the Stratus 6 and 7 subsurface data. Comparisons are also made with ship's thermosalinograph data.

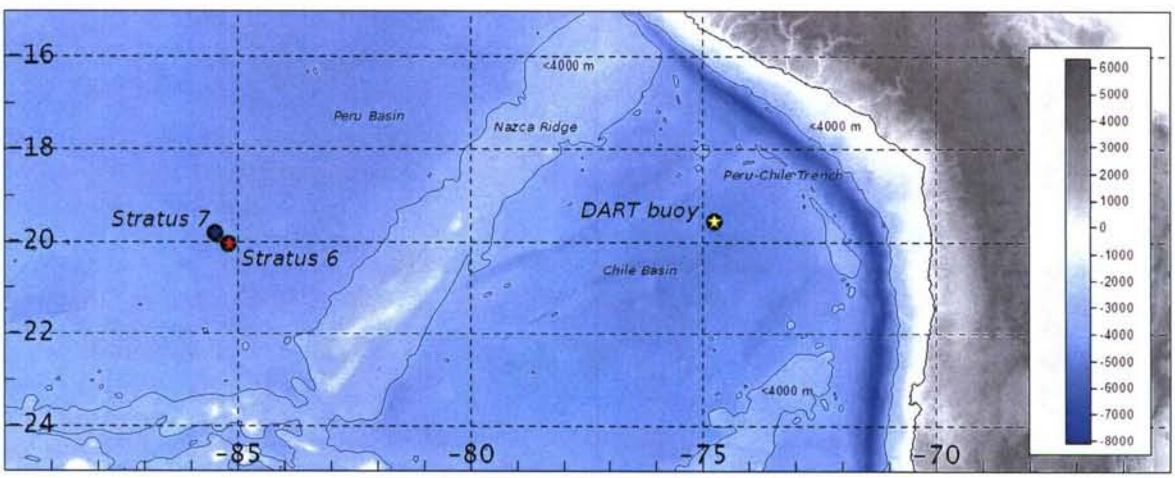


Figure VI.A.1: Location of the Stratus 6, Stratus 7 and DART II buoys. CTD casts were conducted at each site.

Table VI.A.1: **CTD casts information**

Cast	Site	Start down time(UTC)	Stop time (UTC)	Start Position	Position at depth	Final Position	Dept h (m)	Wire Out (m)
1	Stratus 7	16 Oct 2006 22:28	17 Oct 2006 02:25	19°49.448'S 85°29.803' W	19°49.448' S 85°29.835' W	19°49.445' S 85°29.836'W	4497	4200
2	Stratus 7	17 Oct 2006 02:51	17 Oct 2006 03:20	19°49.448'S 85°29.835'W	19° 49.440' S 85°29.838'W	19°49.440'S 85°29.836' W	4494	500
3	Stratus 7	17 Oct 2006 03:22	17 Oct 2006 03:50	19°49.443'S 85°29.834'W	19°49.442'S 85°29.836'W	19°49.838'S 85°29.834'W	4490	500
4	Stratus 7	17 Oct 2006 03:54	17 Oct 2006 04:20	19°49.443'S 85°29.834'W	19°49.440'S 85°29.833'W	19°49.440'S 85°29.833'W	4490	500
5	Stratus 6	17 Oct 2006 13:38	17 Oct 2006 14:06	20°03.615'S 85°11.849'W	20°03.615' S 85°11.849'W	20°03.615'S 85°11.849'W	4491	500
6	Stratus 6	17 Oct 2006 14:09	17 Oct 2006 14:38	20°03.615'S 85°11.849'W	20°03.615'S 85°11.849'W	20°03.615'S 85°11.849'W	4491	500
7	Stratus 6	17 Oct 2006 14:40	17 Oct 2006 15:08	20°03.615'S 85°11.849'W	20°03.615'S 85°11.849'W	20° 03.615' S 85°11.849'W	4491	500
8	Stratus 6	17 Oct 2006 16:14	17 Oct 2006 16:42	20°03.573'S 85°11.776'W	20°03.563'S 85°11.796'W	20°03.520'S 85°11.837' W	4488	500
9	Stratus 6	17 Oct 2006 16:45	17 Oct 2006 17:14	20° 03.518' S 85°11.838'W	20° 03.522' S 85°11.851'W	20° 03.522' S 85°11.851'W	4483	500
10	Stratus 6	17 Oct 2006 17:16	17 Oct 2006 17:46	20°03.421'S 85°11.785'W	20°03.420'S 85°11.785'W	20°03.404'S 85°11.775'W	4479	500
11	Stratus 6	17 Oct 2006 21:05	17 Oct 2006 21:36	20°03.330'S 85°11.930'W	20°03.330'S 85°11.929'W	20°03.334'S 85°11.928'W	4485	500
12	Stratus 6	17 Oct 2006 21:36	17 Oct 2006 22:06	20°03.335'S 85°11.932'W	20°03.335'S 85°11.931'W	20°03.334'S 85°11.932'W	4490	500
13	Stratus 6	17 Oct 2006 22:09	17 Oct 2006 22:36	20°03.333 S 85°11.932'W	20°03.333'S 85°11.932'W	20°03.333'S 85°11.932'W	4489	500
14	Stratus 6	18 Oct 2006 01:16	18 Oct 2006 01:44	20°03.478'S 85°11.897'W	20°03.478 S 85°11.897 W	20°03.478'S 85°11.892'W	4479	500
15	Stratus 6	18 Oct 2006 01:46	18 Oct 2006 02:15	20°03.478'S 85°11.897'W	20°03.479'S 85°11.897'W	20°03.478'S 85°11.898'W	4491	500
16	Stratus 6	18 Oct 2006 02:19	18 Oct 2006 02:48	20°03.478'S 85°11.897'W	20°03.480'S 85°11.898'W	20°03.480'S 85°11.898'W	4487	500
17	Stratus 6	18 Oct 2006 20:50	19 Oct 2006 00:44	20°02.810'S 85°11.283'W	20°02.815'S 85°11.286'W	20°02.815'S 85°11.285'W	4482	4200
18	Stratus 7	19 Oct 2006 12:01	19 Oct 2006 12:30	19°45.752'S 85°33.515'W	19°45.752'S 85°33.515'W	19°45.737'S 85°33.517'W	4519	500
19	Stratus 7	19 Oct 2006 12:33	19 Oct 2006 13:02	19°45.738'S 85°33.512'W	19°45.740'S 85°33.519'W	19°45.735'S 85°33.517'W	4517	500
20	Stratus 7	19 Oct 2006 13:04	19 Oct 2006 13:34	19°45.753'S 85°33.515'W	19°45.717'S 85°33.541'W	19°45.723'S 85°33.535'W	4520	500
21	Stratus 7	19 Oct 2006 16:28	19 Oct 2006 16:54	19°45.730'S 85°33.722'W	19°45.732'S 85°33.719'W	19°45.732'S 85°33.719'W	4516	500
22	Stratus 7	19 Oct 2006 16:58	19 Oct 2006 17:25	19°45.733'S 85°33.717'W	19°45.733'S 85°33.717'W	19°45.733'S 85°33.717'W	4511	500

23	Stratus 7	19 Oct 2006 17:28	19 Oct 2006 17:56	19°45.733'S 85°33.717'W	19°45.733'S 85°33.717'W	19°45.733'S 85°33.717'W	4511	500
24	Stratus 7	19 Oct 2006 21:03	19 Oct 2006 21:32	19°45.573'S 85°33.659'W	19°45.573'S 85°33.659'W	19°45.573'S 85°33.659'W	4522	500
25	Stratus 7	19 Oct 2006 22:08	19 Oct 2006 22:36	19°45.573'S 85°33.659'W	19°45.573 S 85°33.659'W	19°45.573'S 85°33.659'W	4522	500
26	Stratus 7	20 Oct 2006 00:59	20 Oct 2006 01:28	19°45.571'S 85°33.616'W	19°45.571'S 85°33.616'W	19°45.571'S 85°33.616'W	4522	500
27	Stratus 7	20 Oct 2006 01:32	20 Oct 2006 02:00	19°45.571'S 85°33.616'W	19°45.571'S 85°33.616'W	19°45.571'S 85°33.616'W	4522	500
28	Stratus 7	20 Oct 2006 02:03	20 Oct 2006 02:33	19°45.571'S 85°33.616'W	19°45.571'S 85°33.616'W	19°45.570'S 85°33.617'W	4523	500
29	DART Buoy	23 Oct 2006 20:39	23 Oct 2006 21:08	19°35.123'S 74°47.423'W	19°35.125'S 74°47.419'W	19°35.125'S 74°47.419'W	4919	500
30	DART Buoy	23 Oct 2006 23:12	23 Oct 2006 23:40	19°35.127'S 74°47.424'W	19°35.126'S 74°47.424'W	19°35.124'S 74°47.424'W	4919	500
31	DART Buoy	24 Oct 2006 00:16	24 Oct 2006 00:48	19°35.128'S 74°47.425'W	19°35.128'S 74°47.425'W	19°35.128'S 74°47.425'W	4919	500
32	DART Buoy	24 Oct 2006 03:19	24 Oct 2006 03:50	19°35.128'S 74°47.424'W	19°35.128'S 74°47.424'W	19°35.128'S 74°47.424'W	4919	500

VI.A.2 CTD data processing:

CTD data was processed using the software 'SEASOFT-Win32 SBE Data Processing' provided by Sea-Bird Electronics. A seven steps semi automated batch processing scheme was applied to each of the 32 CTD casts. A brief description of each step is given below, for a more extensive discussion refer to SBE Data Processing manual.

1- Data Conversion:

Converts raw data in hexadecimal format (.hex file) to engineering units. The converted data is stored in a .cnv file in ASCII format. Both upcast and downcast were processed and no scans were removed. Only primary variables (scan, pressure, conductivity and temperature) are extracted in this step.

2 – Section:

Extracts rows of data from the input .cnv file, based on a pressure range or scan number range, and writes the rows to an output .cnv file. An analysis based on pressure and conductivity values was made for each cast in order to identify the range of scans with deck data or an initial surface soak. Table VI.A.2 resumes the scan range used in each CTD cast.

3 – Wildedit:

Wild Edit marks spikes in the data by replacing the data value with a flag (badflag). The data is analized in blocks of 100 scans. Two passes are made for each block of scans. The first pass of the algorithm obtains an estimate of the data true standard deviation and mean. All data outside the 95% limit (2 standard deviations) is temporarily removed. The second pass computes mean and standard deviation without the temporarily removed data of the first pass, all data with values greater than 20 standard deviations is removed. Wild edit is applied to pressure, temperature and conductivity.

4- Filter:

A low-pass filter is applied to pressure, conductivity and temperature. The low-pass filter smoothes high frequency that otherwise will degrades the performance of the loop edit processing module when applied to pressure. Pressure data is typically filtered with a time constant equal to four times the CTD scan rate (2 seconds for SBE 19). The recommended time constant (0.5 seconds) for SBE 19 conductivity and temperature values was used. To produce zero phase (no time shift), the filter is run forward and backward through the data.

5- Loop Edit:

Removes data with pressure slowdowns or reversals, typically caused by ship heave. No data associated with an initial surface soak is attempted to be removed (this is already done in step two). A fixed minimum velocity of 0.1 m/s was used as threshold. If CTD velocity is less than the threshold velocity or pressure is less than previous pressure the scan is marked with badflag.

6- Derive:

Computes salinity, potential temperature and sigma-theta.

7- Bin Average:

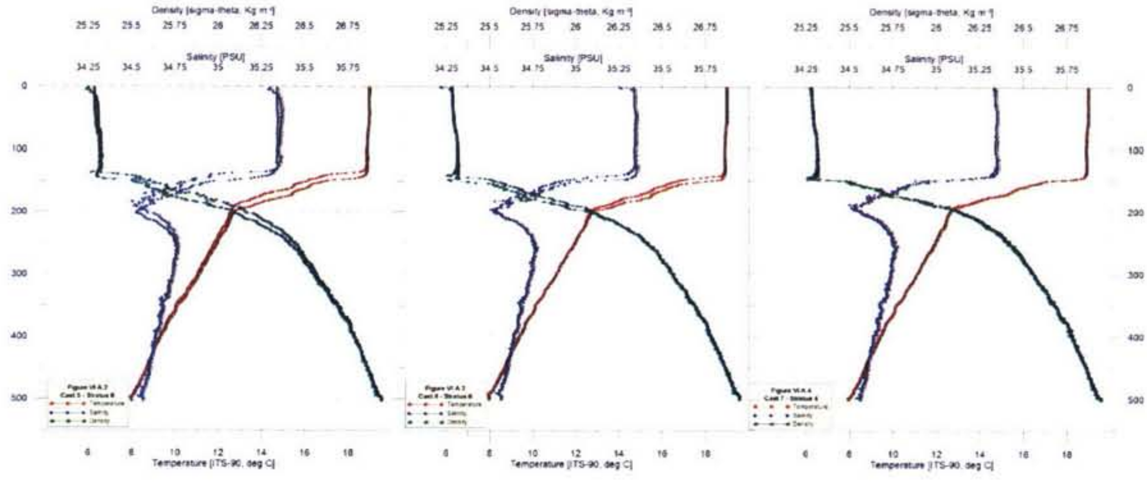
Averages data using an average interval of 1 db.

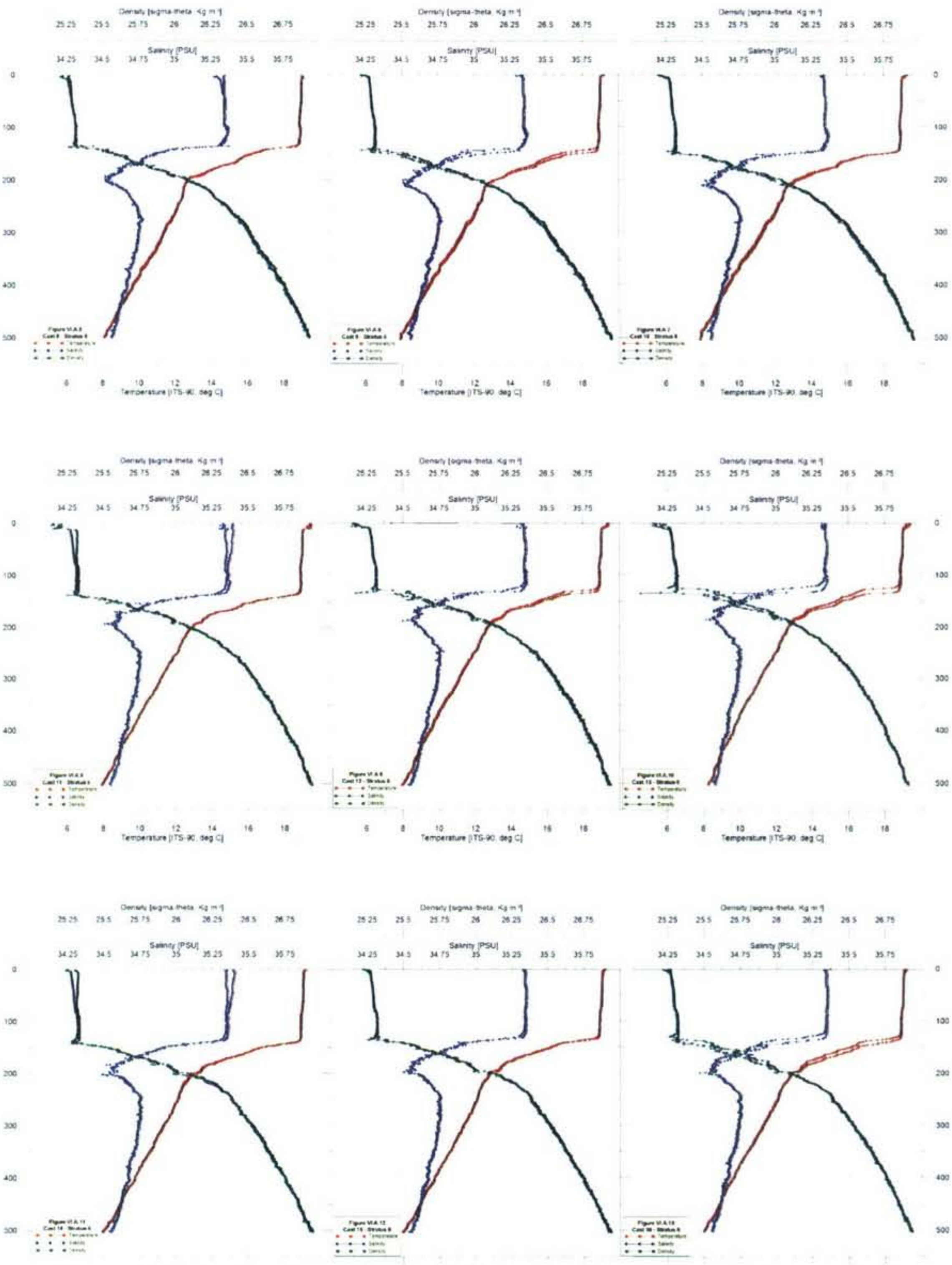
Table VI.A.2: Initial and Final scans used in extract SB module of CTD processing scheme.

Cast	Initial Scan	Final Scan	Cast	Initial Scan	Final Scan	Cast	Initial Scan	Final Scan
1	152	28674	**12**	70	3672	**23**	144	3462
2	153	3787	**13**	93	3492	**24**	222	3671
3	117	3507	**14**	184	3748	**25**	159	3551
4	87	3540	**15**	98	3675	**26**	235	3795
5	156	3609	**16**	96	3648	**27**	101	3701
6	99	3534	**17**	156	28437	**28**	121	3841
7	138	3554	**18**	208	3788	**29**	204	3538
8	118	3425	**19**	71	3686	**30**	177	3612
9	81	3540	**20**	73	3681	**31**	220	3893
10	71	3526	**21**	213	3576	**32**	192	3625
11	235	3675	**22**	162	3475			

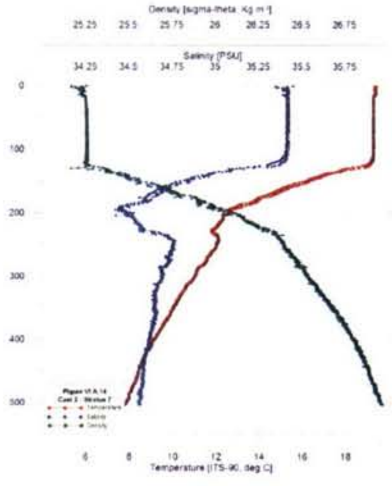
VI.A.3 Results:

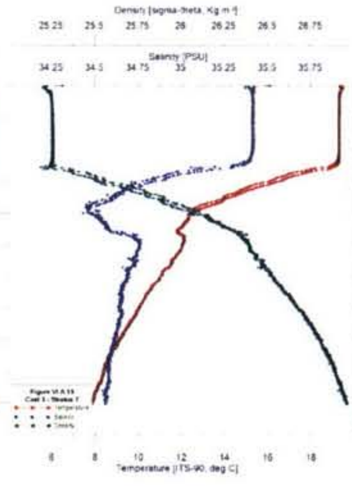
All the shallow CTD profiles at Stratus 6 site were conducted between October 16, 1:30pm and October 17, 3:00am. The resulting temperature, salinity and potential density profiles are shown in figures VI.A.2 to VI.A.13. As expected, there are no significant differences between the profiles. All the profiles present a well defined mixed layer that occupies the first 150 m. The thermocline reaches 200 m, resulting in a 0.15 °C/m gradient. Figures VI.A.14 to VI.A.27 show the shallow CTD profiles at the Stratus 7 site, the first 3 casts were conducted between October 16, 2:50am and 4:20am. The remaining casts were made between October 19, 12:00am and October 20, 2:30am. As in Stratus 6 site, the mixed layer is well defined. An analysis of the profiles reveals that the mixed layer at Stratus 7 site is slightly shallower (130 m) and warmer (0.5°C) than in Stratus 6 site. Figures VI.A.28 to VI.A.31 show the CTD profiles at the DART II buoy. The profiles, conducted between October 23, 8:30pm and October 24, 4:00am, although they present a mixed layer, is not as well defined as the more offshore sites of Stratus 6 and 7. The thermocline reaches 100 m, shallower than the Stratus sites, and has a 0.1°C/m gradient. The TS plots for each shallow cast are presented in figures VI.A.32 to VI.A.61. CTD profiles and TS diagrams for the deep casts at Stratus 6 and 7 are presented in figures VI.A.62 to VI.A.65. Finally a TS diagram with all the CTD data collected (~161600 observations) is presented in Figure VI.A.66.

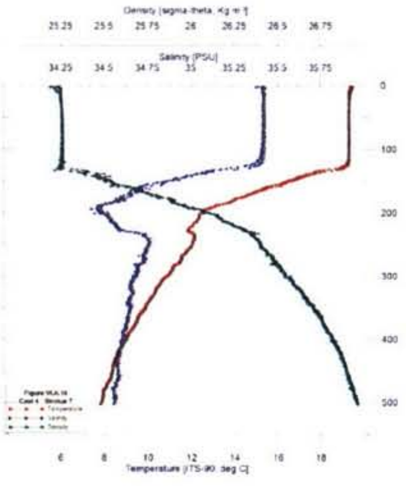


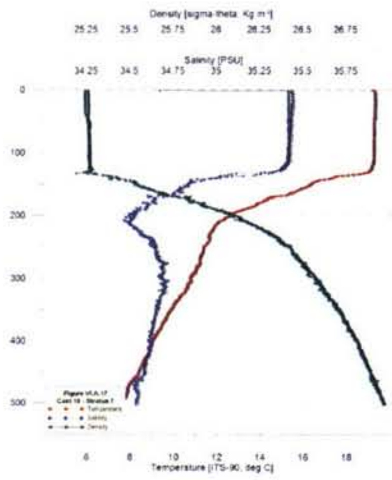


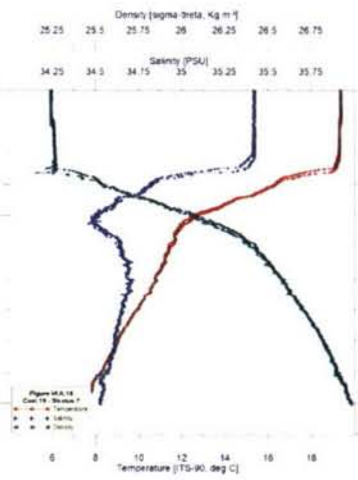
Figures VI.A.2 to VI.A.13: CTD casts at Stratus 6 site.

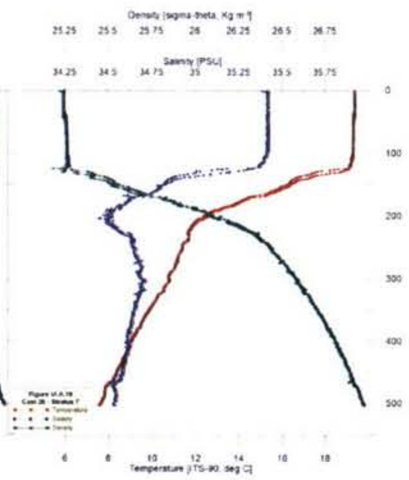

Density [sigma-theta, Kg m-3]
25.25 25.5 25.75 26 26.25 26.5 26.75
Salinity [PSU]
34.25 34.5 34.75 35 35.25 35.5 35.75
0 100 200 300 400 500
Figure VI.A.14
6 8 10 12 14 16 18
Temperature [ITS-90, deg C]

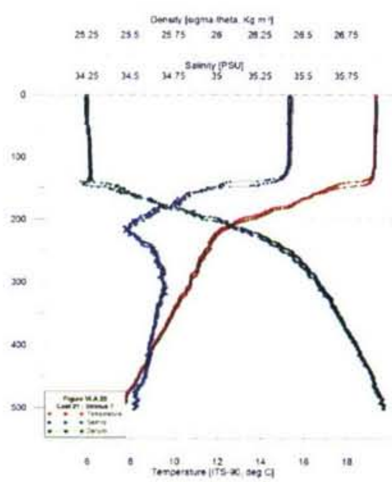

Density [sigma-theta, Kg m-3]
25.25 25.5 25.75 26 26.25 26.5 26.75
Salinity [PSU]
34.25 34.5 34.75 35 35.25 35.5 35.75
Figure VI.A.15
6 8 10 12 14 16 18
Temperature [ITS-90, deg C]

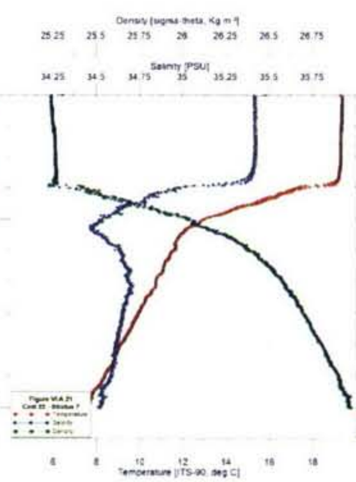

Density [sigma-theta, Kg m-3]
25.25 25.5 25.75 26 26.25 26.5 26.75
Salinity [PSU]
34.25 34.5 34.75 35 35.25 35.5 35.75
0 100 200 300 400 500
Figure VI.A.16
6 8 10 12 14 16 18
Temperature [ITS-90, deg C]

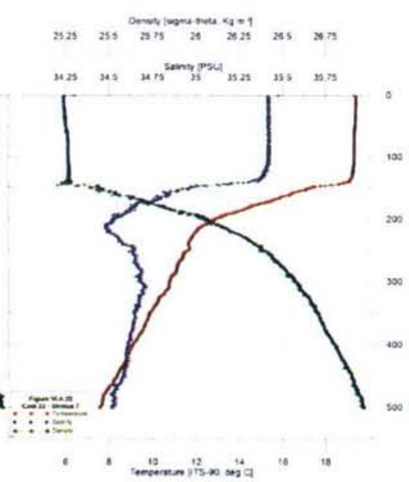

Density [sigma-theta, Kg m-3]
25.25 25.5 25.75 26 26.25 26.5 26.75
Salinity [PSU]
34.25 34.5 34.75 35 35.25 35.5 35.75
0 100 200 300 400 500
Figure VI.A.17
6 8 10 12 14 16 18
Temperature [ITS-90, deg C]

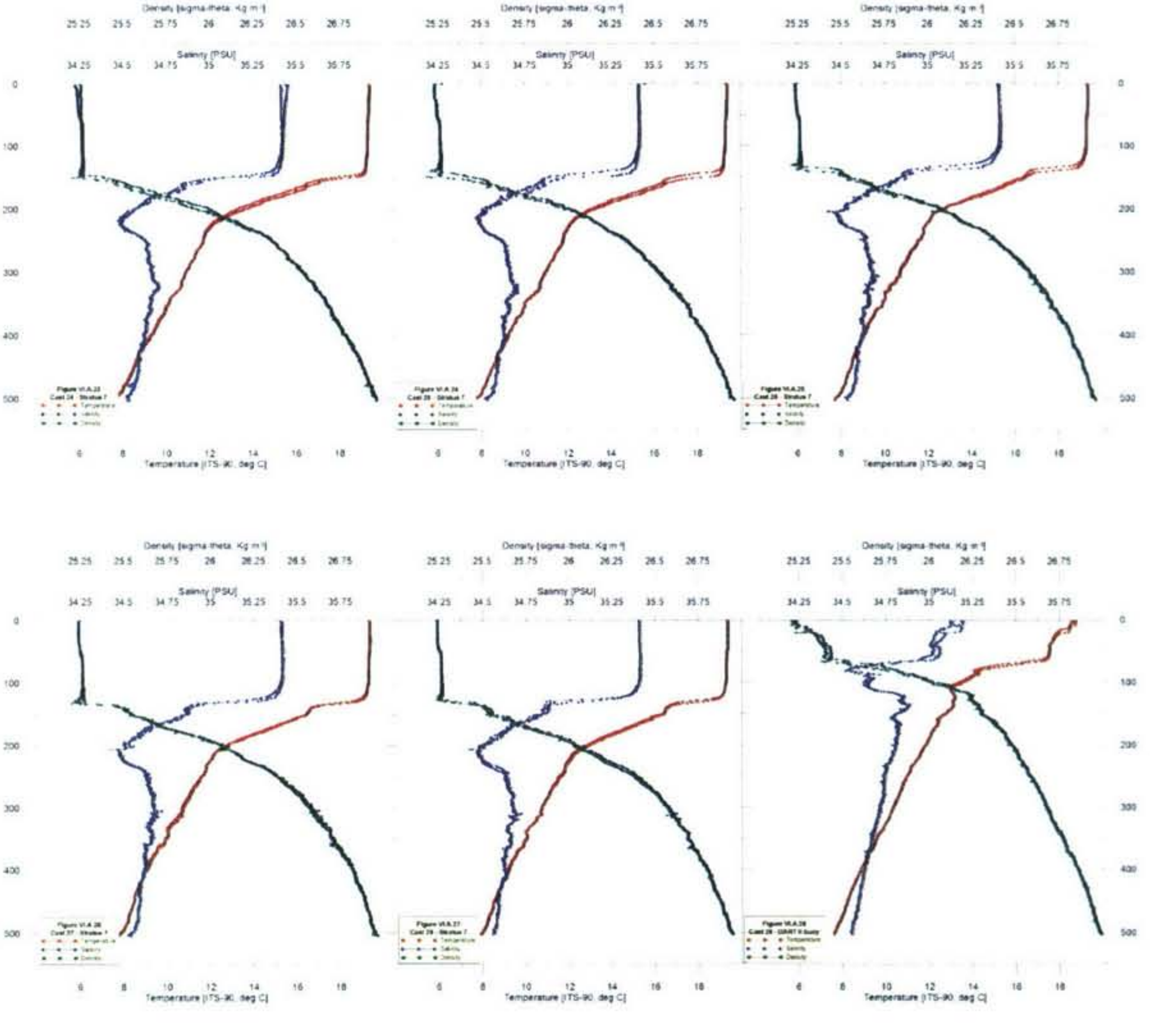

Density [sigma-theta, Kg m-3]
25.25 25.5 25.75 26 26.25 26.5 26.75
Salinity [PSU]
34.25 34.5 34.75 35 35.25 35.5 35.75
Figure VI.A.18
6 8 10 12 14 16 18
Temperature [ITS-90, deg C]


Density [sigma-theta, Kg m-3]
25.25 25.5 25.75 26 26.25 26.5 26.75
Salinity [PSU]
34.25 34.5 34.75 35 35.25 35.5 35.75
0 100 200 300 400 500
Figure VI.A.19
6 8 10 12 14 16 18
Temperature [ITS-90, deg C]

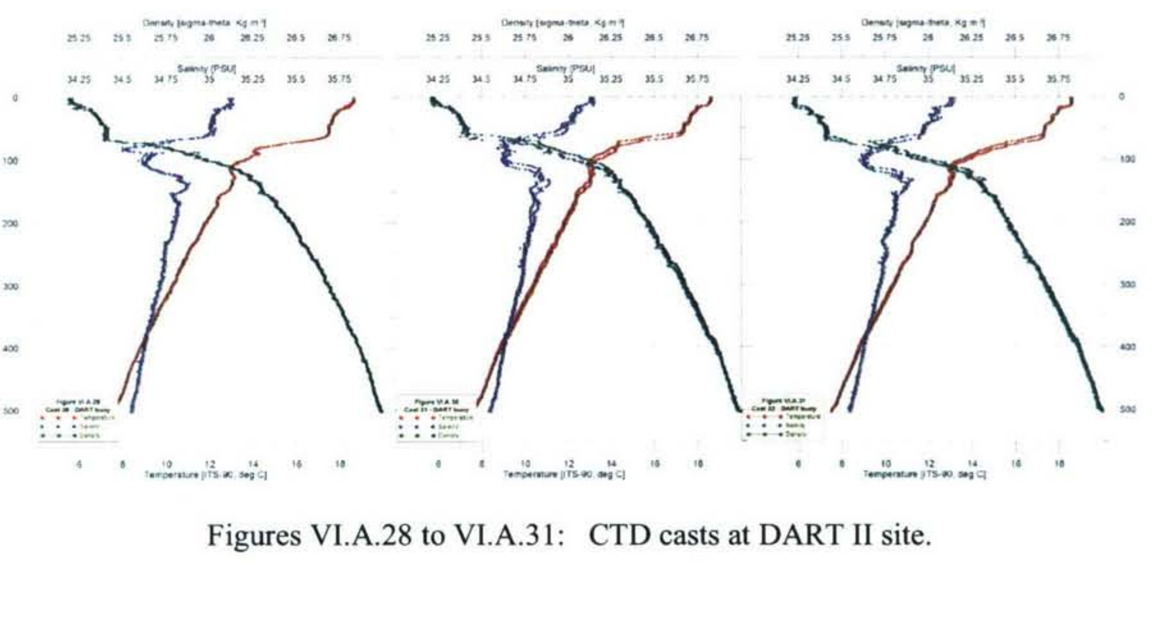

Density [sigma-theta, Kg m-3]
25.25 25.5 25.75 26 26.25 26.5 26.75
Salinity [PSU]
34.25 34.5 34.75 35 35.25 35.5 35.75
0 100 200 300 400 500
Figure VI.A.20
6 8 10 12 14 16 18
Temperature [ITS-90, deg C]


Density [sigma-theta, Kg m-3]
25.25 25.5 25.75 26 26.25 26.5 26.75
Salinity [PSU]
34.25 34.5 34.75 35 35.25 35.5 35.75
Figure VI.A.21
6 8 10 12 14 16 18
Temperature [ITS-90, deg C]


Density [sigma-theta, Kg m-3]
25.25 25.5 25.75 26 26.25 26.5 26.75
Salinity [PSU]
34.25 34.5 34.75 35 35.25 35.5 35.75
0 100 200 300 400 500
Figure VI.A.22
6 8 10 12 14 16 18
Temperature [ITS-90, deg C]



Figures VI.A.14 to VI.A.27: CTD casts at Stratus 7 site.



Figures VI.A.28 to VI.A.31: CTD casts at DART II site.

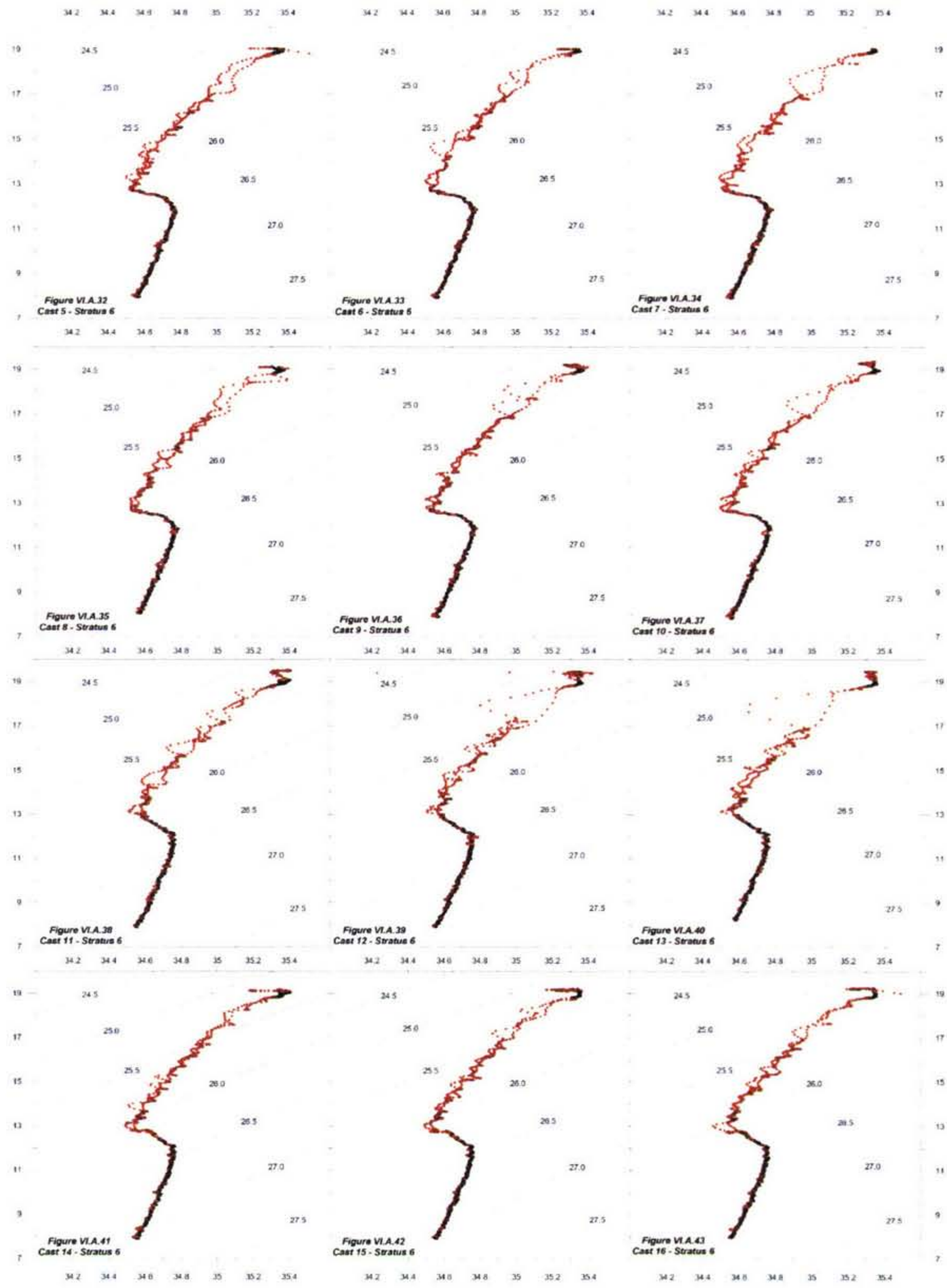


Figure VI.A.32 Cast 5 - Stratus 6

Figure VI.A.33 Cast 6 - Stratus 6

Figure VI.A.34 Cast 7 - Stratus 6

Figure VI.A.35 Cast 8 - Stratus 6

Figure VI.A.36 Cast 9 - Stratus 6

Figure VI.A.37 Cast 10 - Stratus 6

Figure VI.A.38 Cast 11 - Stratus 6

Figure VI.A.39 Cast 12 - Stratus 6

Figure VI.A.40 Cast 13 - Stratus 6

Figure VI.A.41 Cast 14 - Stratus 6

Figure VI.A.42 Cast 15 - Stratus 6

Figure VI.A.43 Cast 16 - Stratus 6

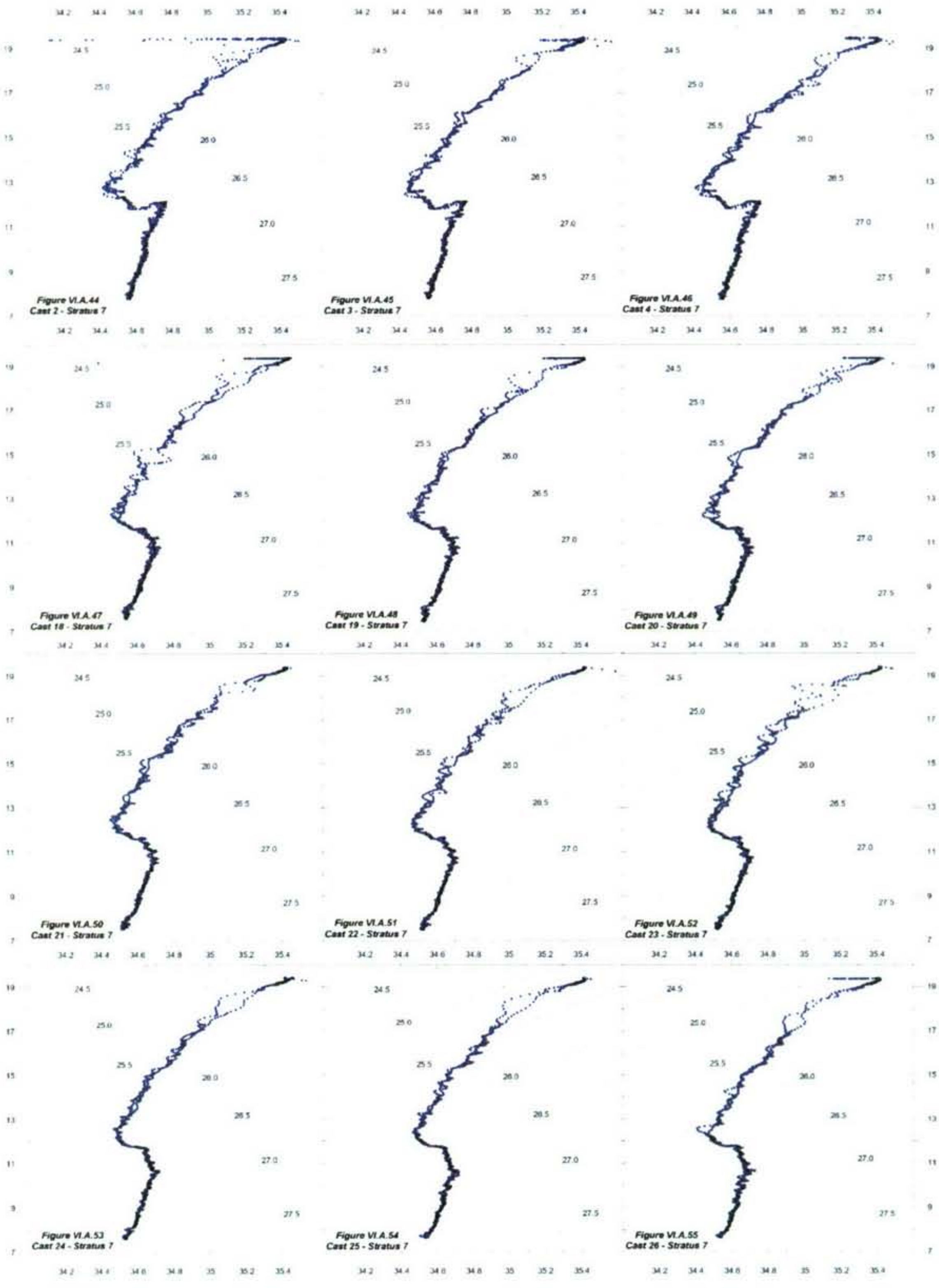


Figure VI.A.44 Cast 2 - Stratus 7

Figure VI.A.45 Cast 3 - Stratus 7

Figure VI.A.46 Cast 4 - Stratus 7

Figure VI.A.47 Cast 18 - Stratus 7

Figure VI.A.48 Cast 19 - Stratus 7

Figure VI.A.49 Cast 20 - Stratus 7

Figure VI.A.50 Cast 21 - Stratus 7

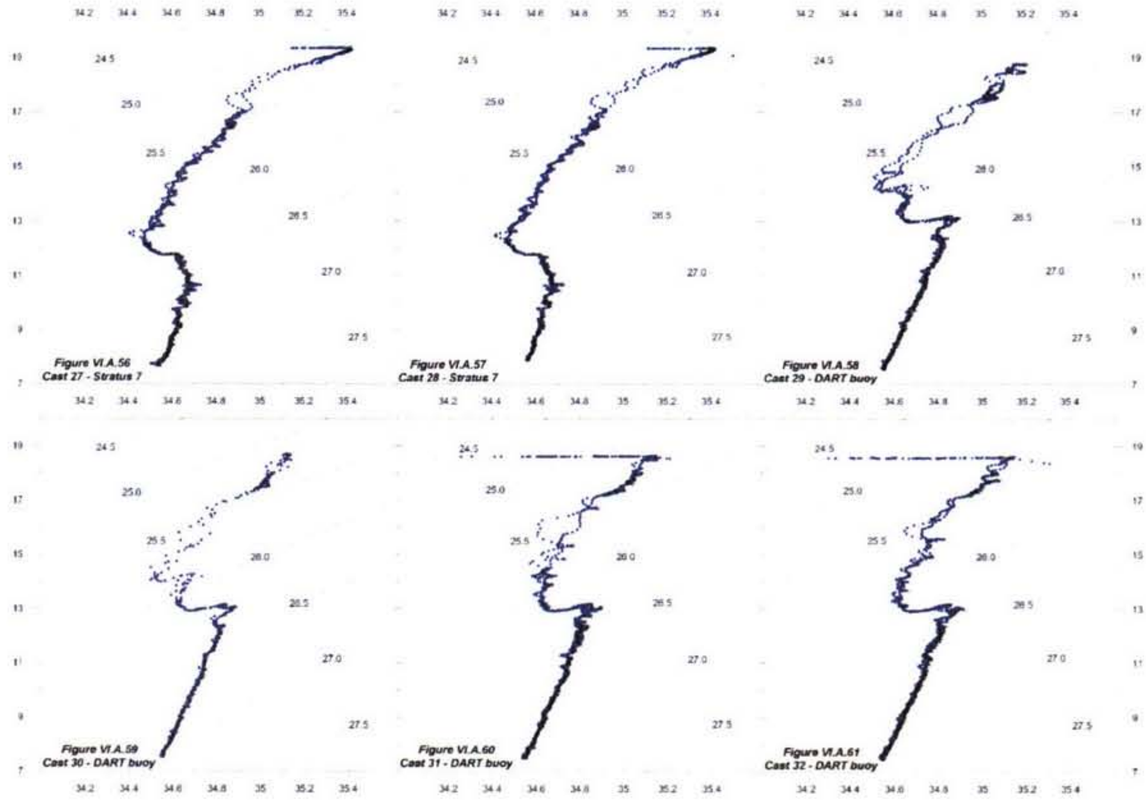
Figure VI.A.51 Cast 22 - Stratus 7

Figure VI.A.52 Cast 23 - Stratus 7

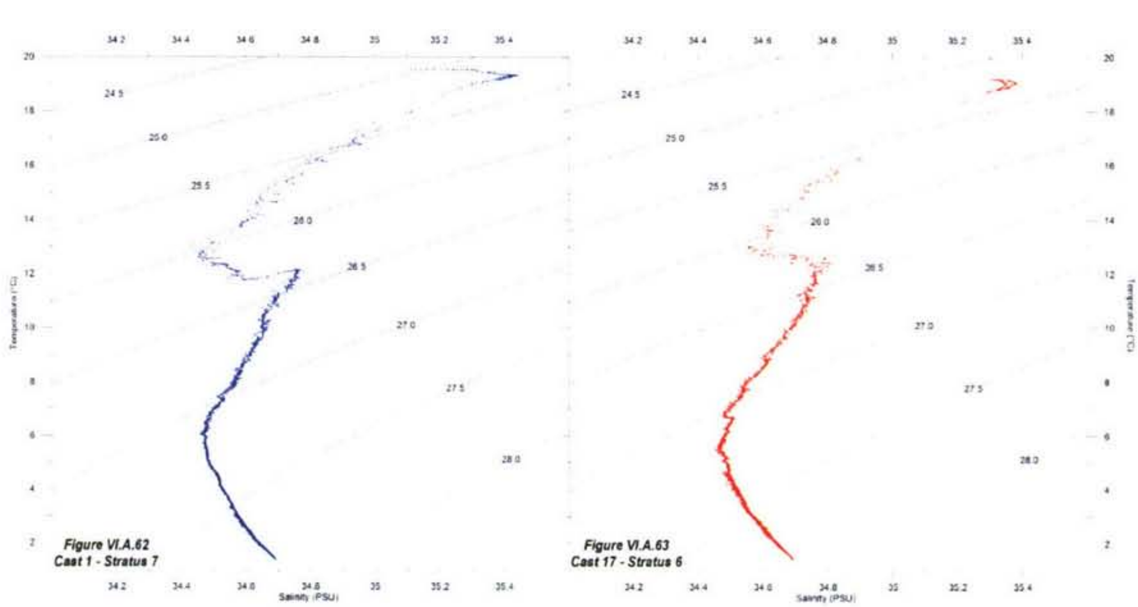
Figure VI.A.53 Cast 24 - Stratus 7

Figure VI.A.54 Cast 25 - Stratus 7

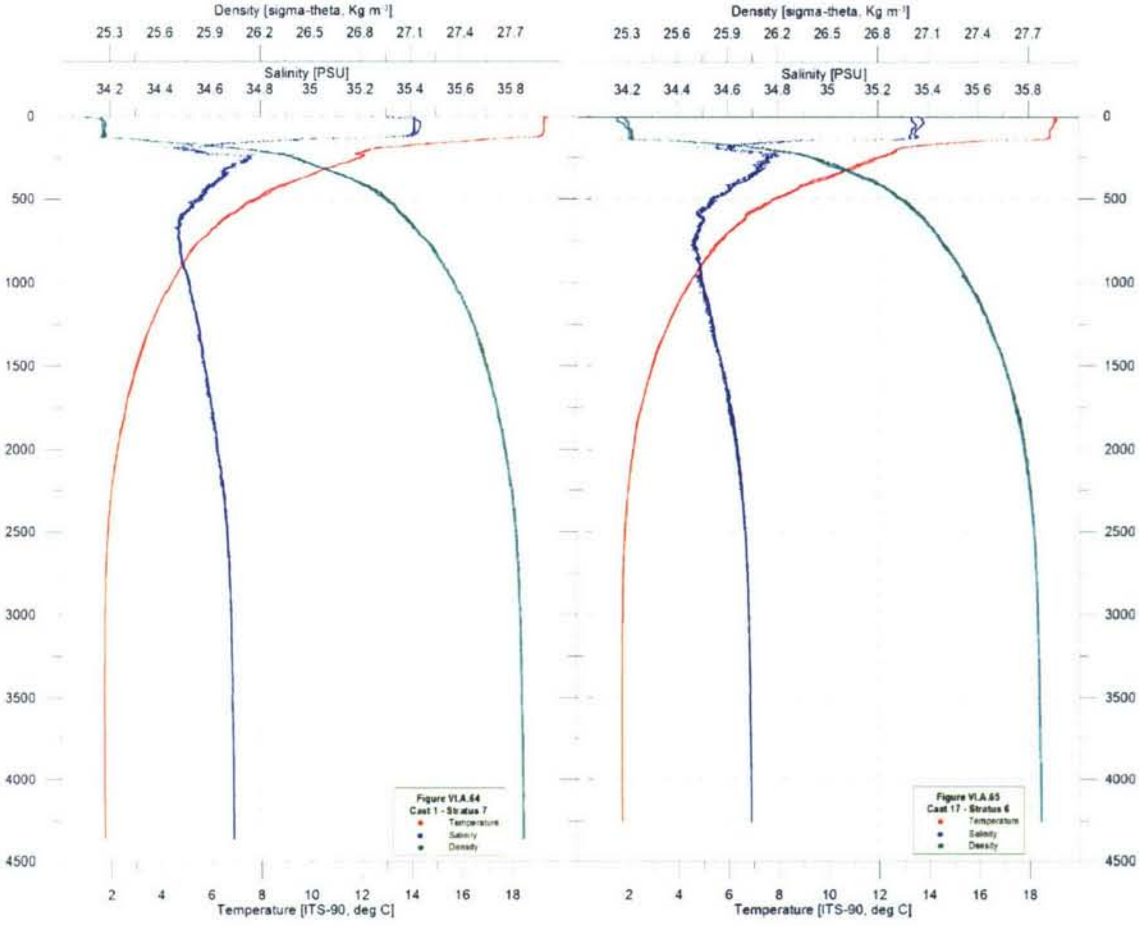
Figure VI.A.55 Cast 26 - Stratus 7



Figures VI.A.32 to VI.A.61: TS plots for shallow CTDs.



Figures VI.A.62 to VI.A.63: TS plots for deep CTD casts at Stratus 7 and 6 sites.



Figures VI.A.64 to VI.A.65: Deep CTD casts at Stratus 2006 cruise.

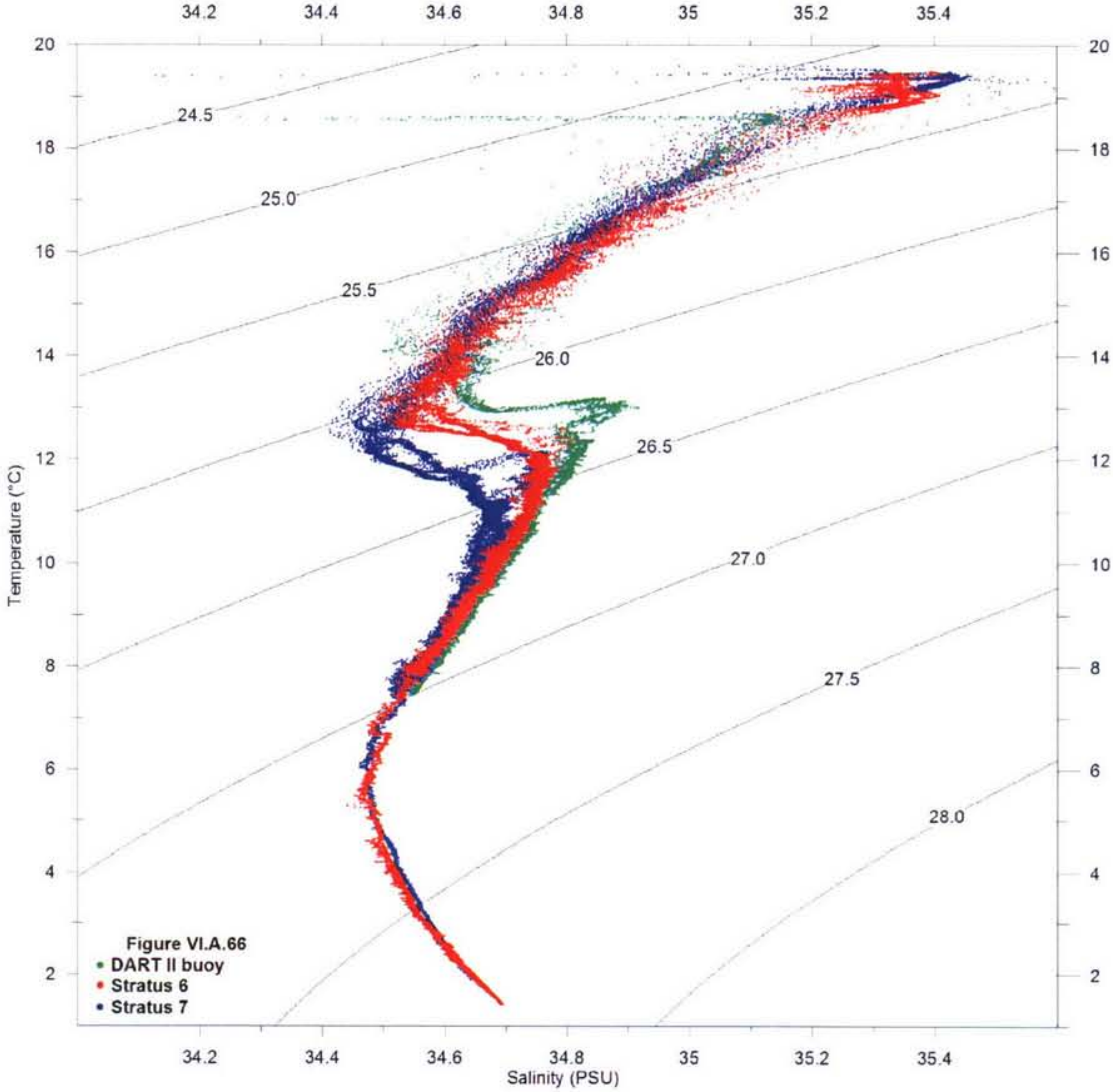


Figure VI.A.66: TS plot for all CTD casts during Stratus 2006 cruise.

VI.B. Deployment of Argo Floats and Drifters

During the Stratus 2006 cruise, a 24-hour watch schedule was set up. Watch standers were responsible for updating the cruise log, deploying Argo floats and surface drifters, and assisting the ESRL group with radiosonde deployments.

For more information on, and data from Argo floats, please visit the Argo website at http://www.argo.net/. The Global Drifter Program, also has a website that has information and data on their floats at http://www.aoml.noaa.gov/phod/dac/gdp.html.

The floats and drifters were deployed at specified locations. The ship was not stopped for deployments of the Argo floats (ship speed reduced) or surface drifters. Deployment details are given below in Table VI.B.1.

Table VI.B.1. Deployment times and locations for the ARGO floats and drifters.

Type	ID	Activation Time	Deployment		Comment
			Date Time UTC	Position.	
Float A1	673	10/13/06 14:10:00	10/13/06 15:53:00	83°19.394'W 10°00.052'S	
Drifter D1	63109		10/13/06 15:50:00	83°19.370'W 10°00.022'S	
Drifter D2	63126		10/14/06 01:38:00	83°41.311'W 12°00.339'S	
Drifter D3	63107		10/14/06 11:17:00	84°03.341'W 14°00.390'S	
Float A2	666	10/14/06 11:23:00	10/14/06 11:23:00	84°03.705'W 14°02.347'S	Noise after activation
Drifter D4	63124		10/14/06 21:24:00	84°25.417'W 15°59.620'S	
Drifter D5	63108		10/15/06 07:35:00	84°47.869'W 17°59.644'S	
Float A3	675	10/14/06 22:00:00	10/15/06 07:37:00	84°47.869'W 17°59.644'S	
Drifter D6	63110		10/20/06 14:46:00	85°26.715'W 19°45.374'S	
Float A4	677	10/14/06 11:12:00	10/20/06 14:48:00	85°26.715'W 19°45.374'S	
Drifter D7	63114		10/21/06 02:30:00	82°59.870'W 19°44.527'S	
Float A5	668	10/21/06 02:37:00	10/21/06 07:28:00	82°00.402'W 19°44.209'S	
Float A6	669	10/21/06 19:54:00	10/21/06 21:25:00	78°59.803'W 19°43.293'S	
Drifter D9	63111		10/21/06 21:25:00	78°59.803'W 19°43.293'S	
Drifter 10	63113		10/22/06 06:34:00	76°59.907'W 19°42.677'S	
Float A7	671	10/22/06 10:39:00	10/22/06 11:09:00	75°59.551'W 19°42.370'S	
Drifter D1	63122		10/24/06 12:27:00	74°47.00'W 19°41.00'S	
Drifter D12	63123		10/24/06 18:43:00	74°31.303'W 21°00.651'S	
Drifter 13	63115		10/25/06 04:30:00	74°04.013'W 23°00.563'S	
Drifter D14	63116		10/25/06 13:54:00	73°36.300'W 25°00.300'S	
Drifter D15	63126		10/25/06 23:56:00	73°08.300'W 26°59.876'S	

VI.C. SHOA DART II Tsunami Buoy

VI.C.1. Overview

The Hydrographic and Oceanographic Service of the Chilean Navy (SHOA) made an effort to acquire and deploy a DART II system (Deep-Ocean Assessment and Reporting of Tsunami) for its early tsunami detection and real-time reporting capability. Although seismic networks and coastal tide gauges are indispensable for assessing the hazard during an actual event, an improvement in the speed and accuracy of real-time forecasts of tsunami inundation for specific sites requires direct tsunami measurement between the source and a threatened community. Currently, only a network of real-time reporting, deep-ocean bottom pressure (BPR) stations can provide this capability.

Tsunamis can be highly directional. DART stations must be properly spaced to provide reliable estimates of the primary direction and magnitude of the energy propagation. A method for establishing a detection system's location will consider various tradeoffs between early tsunami detection, adequate source zone coverage, and DART system survivability. A proposed network will be designed to provide adequate coverage of tsunamis originating in source regions that threaten Chile coastal communities: The Nazca Subduction Zone.

The DART mooring system is illustrated in Figure VI.C.1. Each system consists of a seafloor BPR and a moored surface buoy with related electronics for real-time communications. The BPR uses a pressure transducer manufactured by Paroscientific, Inc., to make 15-second averaged measurements of the pressure exerted on it by the overlying water column. These transducers use a very thin quartz crystal beam, electrically induced to vibrate at their lowest resonant mode. In DART II applications, the transducer is sensitive to changes in wave height of less than a millimeter. An acoustic link is used to transmit data from the BPR on the seafloor to the surface buoy (Figure VI.C.1). The data are then relayed via Iridium satellite link to ground stations, which demodulate the signals for immediate dissemination to Sistema Nacional de Alarma de Maremotos (SNAM) in SHOA, via internet.

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

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

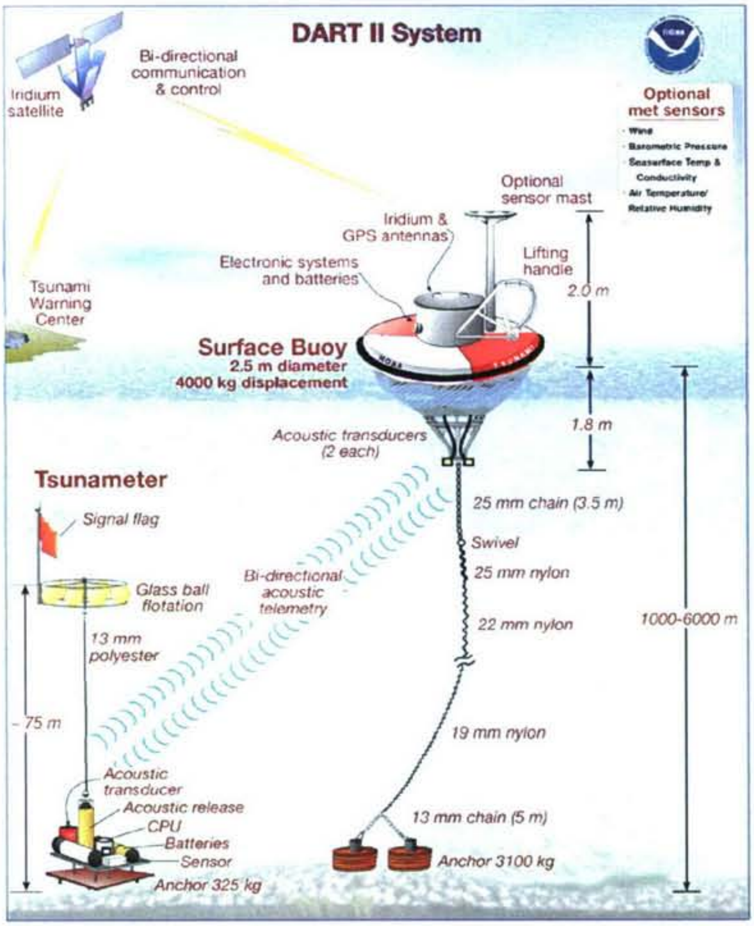


Figure VI.C.1: Schematic of the DART mooring system

The Hydrographic and Oceanographic Service of the Chilean Navy, in charge of the National Seaquake Warning System of Chile (SNAM), is making an effort to improve its capabilities to comply with responsibilities assigned by law; therefore in November 2003, a DART system was installed off the north coast of Chile, near Iquique. Unfortunately, the system had a problem with batteries, and in June 2004 the DART buoy and BPR was removed. The DART I system had been designed to operate for at least two years without maintenance. DART I buoy was deployed on December 6, 2004, and recovered on October 22, 2006.

The DART system's technology will allow the National Seaquake Warning System to improve its capability to evaluate and disseminate warnings in an efficient and timely manner and will avoid false alarms and possible losses as a consequence. The anchoring of this first DART II buoy in Chile (19°34.9343'S, 74°46.8957'W) and in South America, is a big step towards mitigation efforts against tsunamigenic events in close and long range sites. This is not only a great contribution to the Chilean coastal communities, but also to the coastal communities in the Pacific Basin and to the International Tsunami Warning System.

VI.C.2. DART II Surface Mooring

The DART II buoy received a set of meteorological and subsurface instruments for the UOP group. The picture in Figure VI.C.2 shows the buoy with its wind, longwave and shortwave radiation sensors. It also carries two humidity sensors that have a lower cost and will be tested during this deployment. The surface modules are standalones. Table VI.C.1 has the details of the surface instrumentation. The RM Young wind sensor and its compassed were checked through a buoy spin (Figure VI.C.3) procedure similar to the one described in II.B for the Stratus 6 and 7 buoys.

The DART II buoy mooring line was also rigged with oceanographic subsurface instruments. The design of this mooring and position of instruments are shown on Fig VI.C.4. Table VI.C.2 and VI.C.3 show the set up and time spikes for the subsurface instruments on the deployed DART II mooring.

Figure VI.C.2. DART II surface mooring with its reduced set of IMET sensors.

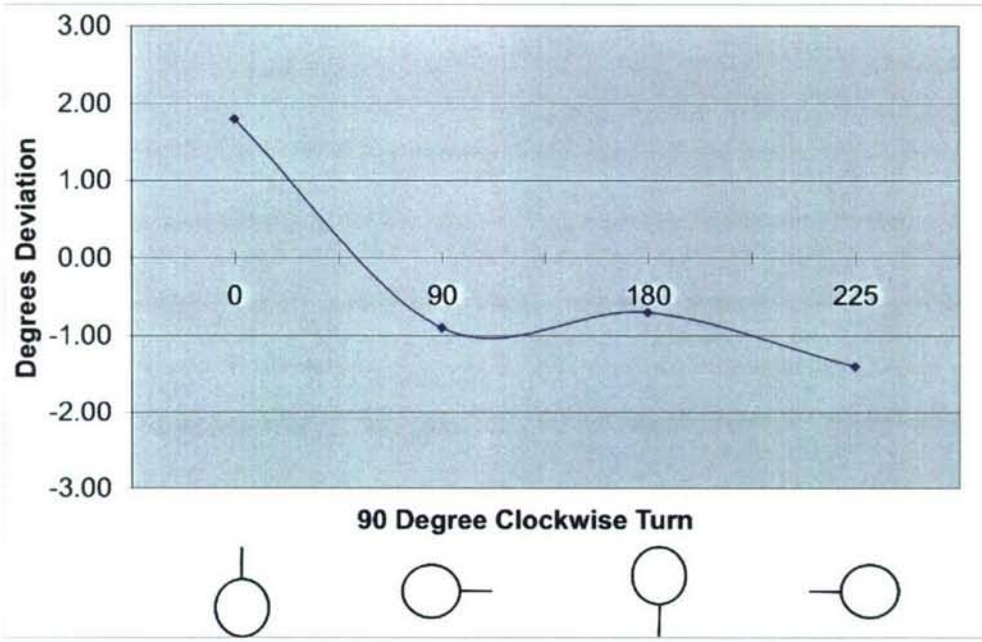


Figure VI.C.3 Buoy spin for WND 344 sensor on DART II buoy.

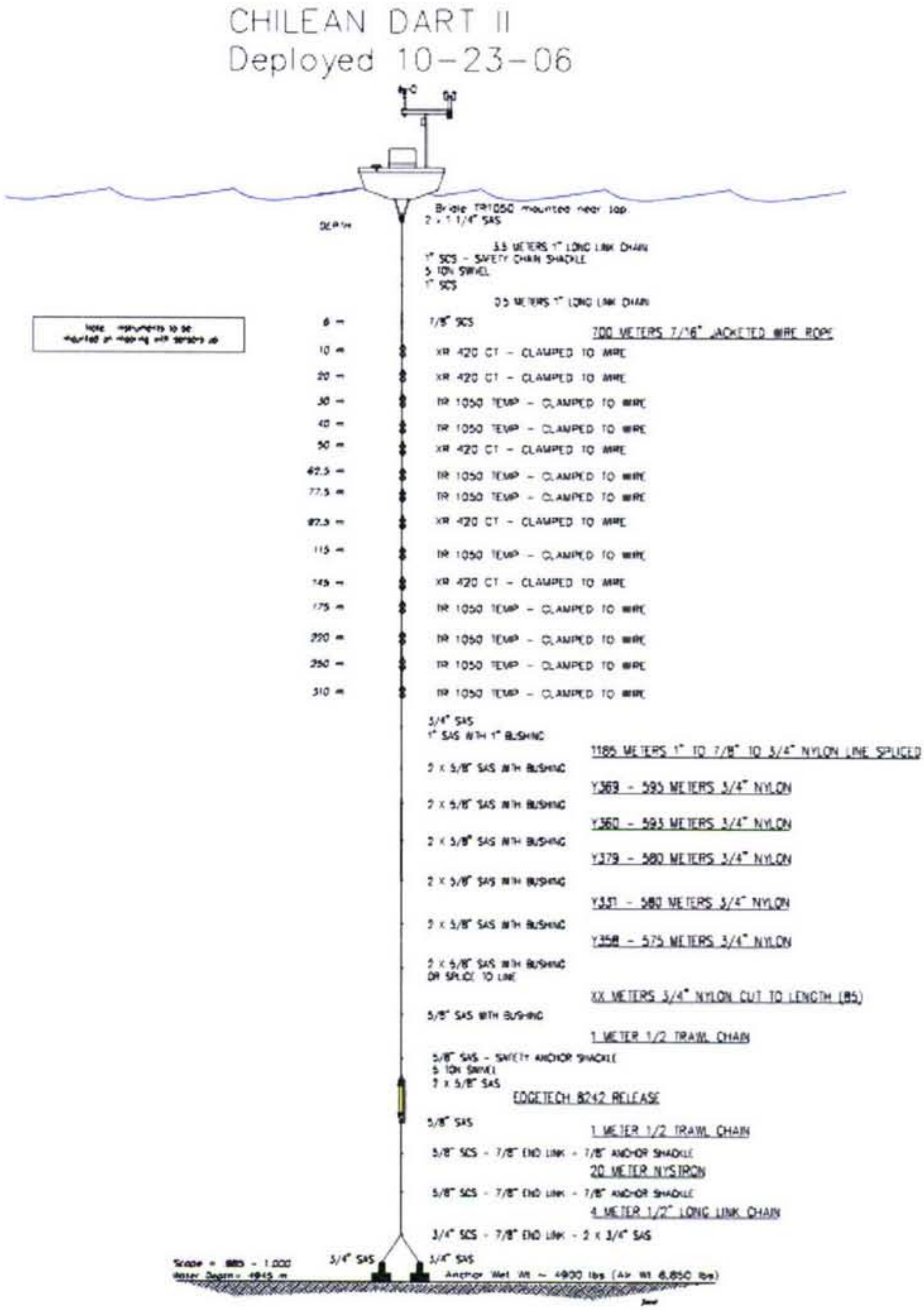


Fig VI.C.4. DART II mooring design.

Table VI.C.1 DART II surface instruments.

Module	Serial Number	Firmware Version	Height Cm	Sample Rate	Start Sample	
WND	344	VOSWND53 V3.5	245	5min	9/24/06	13:58:30
LWR	213	VOSLWR53 V3.5	232	5min	9/24/06	13:58:30
SWR	201	VOSSWR53 V3.3	231	5min	9/24/06	13:58:30
LASCAR	5		196	1hr	10/22/06	11:00:00
LASCAR	6		224	1hr	10/23/06	12:00:00

Table VI.C.2 Subsurface instruments on DART II.

Instrument	Serial Number	Start	End	Sample	Depth (m)
TR-1050	12694	10/01/06 0100	11/30/2008 000000	2	1.2 (bridle)
XR420-CT	12942	10/01/06 0100	11/30/2008 000000	3	10
XR420-CT	12943	10/01/06 0100	11/30/2008 000000	3	20
XR420-CT	12944	10/01/06 0100	11/30/2008 000000	3	50
XR420-CT	12945	10/01/06 0100	11/30/2008 000000	3	92.5
XR420-CT	12946	10/01/06 0100	11/30/2008 000000	3	145
TR-1050	12695	10/01/06 0100	11/30/2008 000000	2	30
TR-1050	12696	10/01/06 0100	11/30/2008 000000	2	40
TR-1050	12697	10/01/06 0100	11/30/2008 000000	2	62.5
TR-1050	12698	10/01/06 0100	11/30/2008 000000	2	77.5
TR-1050	12699	10/01/06 0100	11/30/2008 000000	2	115
TR-1050	12700	10/01/06 0100	11/30/2008 000000	2	175
TR-1050	12701	10/01/06 0100	11/30/2008 000000	2	220
TR-1050	12702	10/01/06 0100	11/30/2008 000000	2	250
TR-1050	12703	10/01/06 0100	11/30/2008 000000	2	310
Releases		***enable***	***disable***	***release***	
Buoy	31268	460234	460251	444130	
BPR	31240	455555	455576	443027	

Table VI.C.3 Time spikes for subsurface instruments on DART II.

Instrument	Serial Number	Spike Start		End Spike	
XR420-CT	12942,12943,12944,12945,12946	17:55:30	20-Oct	19:20:30	20-Oct
TR-1050	12694,12695,12696,12697,12698,12699,12700, 12701,12702,12703	17:55:30	20-Oct	19:20:30	20-Oct

VI.C.2.i. DART II Deployment

After two years in service, the DART I buoy was replaced by a new DART II buoy on October 23th 2006 with the help of the SHOA staff. The work started by anchoring the surface buoy, which was tied on the port side, on the ship's deck. Once the buoy was in the ocean, its mooring line was deployed. First, a 7/16" steel covered cable was dropped, then nylon cable followed, to achieve an approximate depth of 4945 m; these were tied to a 6200 kg anchor.

Once the mooring of the buoy was achieved, by dropping the anchor in October 23th 2006 at approximately 09:00 (Z+4), the preparation work for the anchoring of the bottom-pressure sensor (BPR) started.

The work followed a certain order, starting with the high depth glass spheres that will allow the recovery of the instrument; these were connected by a nylon rope and finally to a 50 m yalex rope that was then tied to the BPR, which contained the anchor in its base. Once the mooring was checked, the BPR anchoring maneuver started, and was completed a 13:00 (Z+4).

VI.C.2.ii. DART II Anchor Survey

The deployment and anchor survey track are shown in Fig VI.C.5. Details for the anchor survey of the surface mooring are summarized in Table VI.C.4. Anchor location results from 3 point acoustic ranging on BPR and on acoustic release on SHOA surface mooring. The ship was taken to 3 survey points roughly 4000 m from anchors. Acoustic ranging was carried out, giving a horizontal range in meters as well as an acoustic travel time in milliseconds. The positions of the survey points at the time of the ranging were recorded as well as the time/range. This information was input into two MATLAB programs that facilitate drawing 3 range arcs and in finding the intersection of those 3 arcs. One program is the Acoustic Survey Software; the other program is ECours. The Acoustic Survey Software is the one preferred for choosing the location (see Figure VI.C.6 and 7). Ecours was run as a check to catch any error in entering information when running the Acoutsic Survey Software (see Figure VI.C.8).

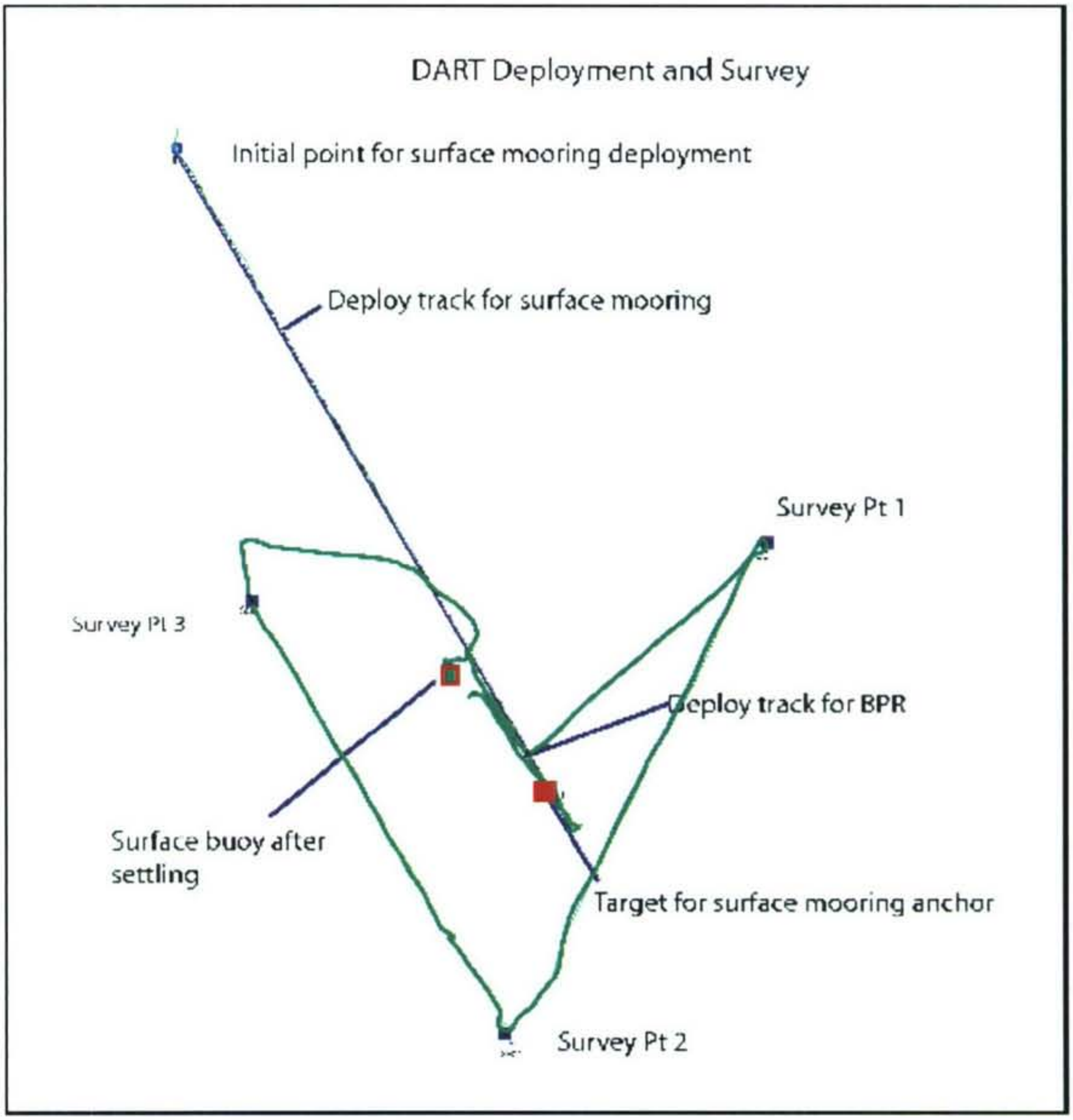


Figure VI.C.5 DART II deployment and survey track.

Table VI.C.4. Anchor survey for DART II surface mooring

Anchor Survey:			
	Latitude	**Longitude**	**Time/Hor. Range**
Survey Point 1	19° 34.324'S	74° 45.282'W	4256 ms
	19° 34.321'S	74° 45.285'W	4045 m
Survey Point 2	19° 37.540'S	74° 47.171'W	3825 ms
	19° 37.540'S	74° 47.171'W	2912 m
Survey Point 3	19° 34.638'S	74° 48.987'W	4378 ms
	19° 34.670'S	74° 48.979'W	4302 m
Anchor Drop Location	19° 36.149'S	74° 46.740'W	
Water depth (corrected)=4945 m			
Height of acoustic release off bottom= 27 m			
Surface transducer depth=10m			
Anchor location from MATLAB Acoustic Survey Software:			
	19°35.9343'S	74°46.8957'W	
Fallback from anchor drop: 448 m			
Anchor location from MATLAB Ecours program:			
	19°35.9622'S	74°46.8851'W	
Fallback from anchor drop: 377 m			

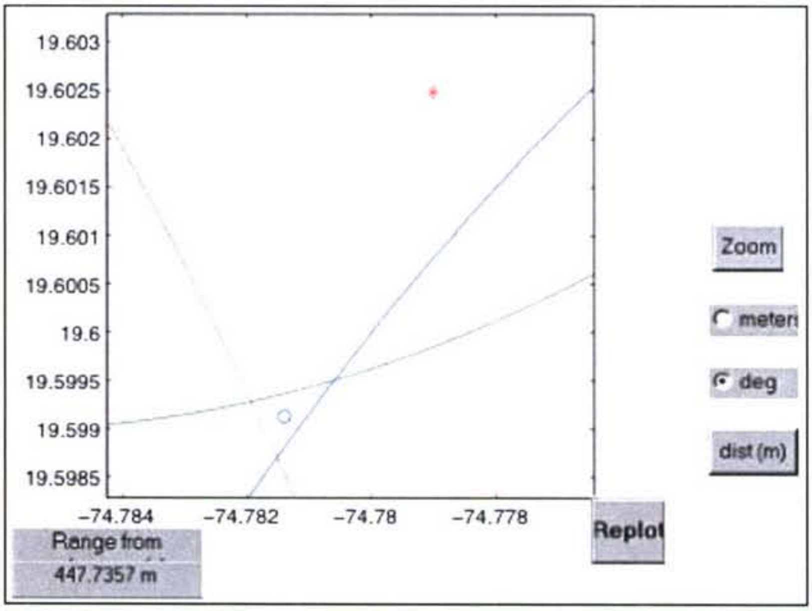


Figure VI.C.6. DART II anchor triangulation plot from Acoustic Survey Software.

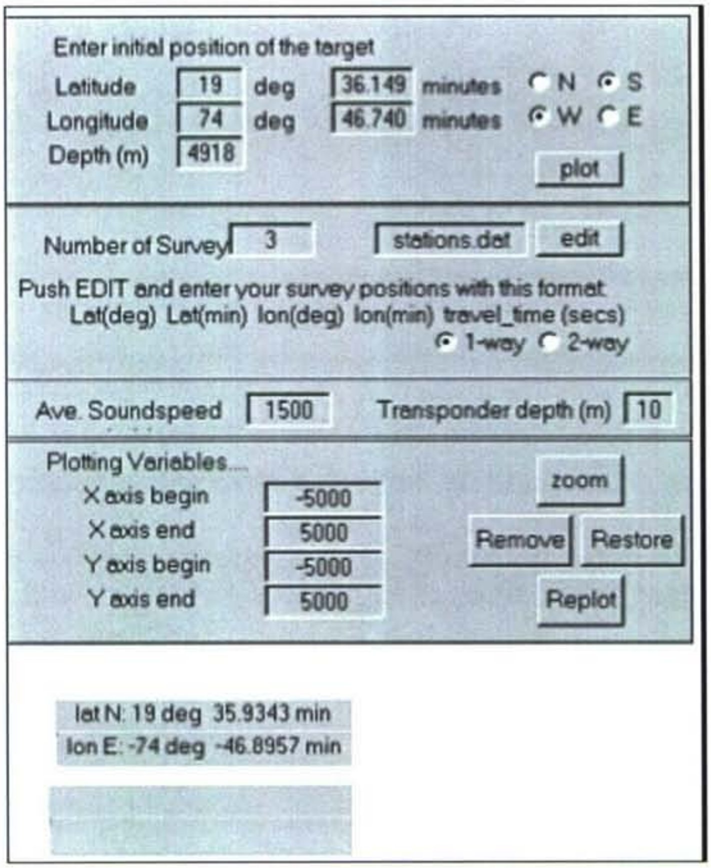


Figure VI.C.7. DART II anchor location. Screen capture from Newhall's program.

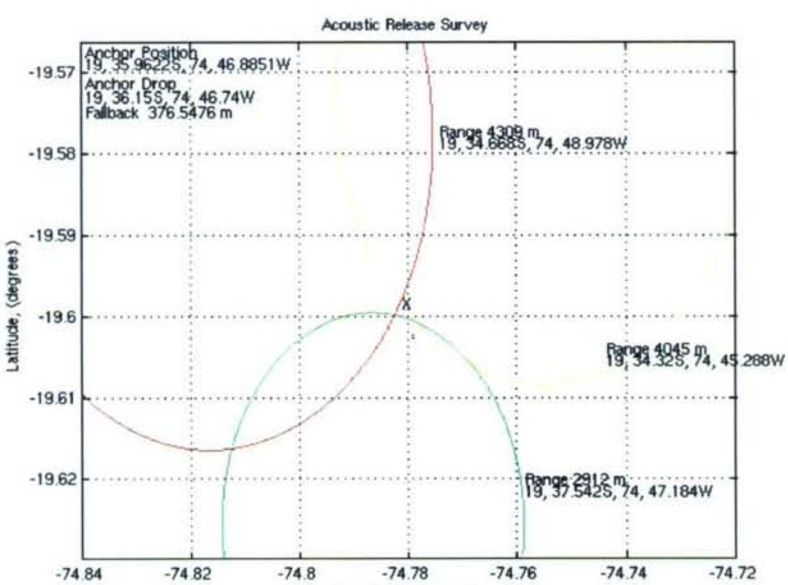


Figure VI.C.8. DART II anchor triangulation using ECours.

VI.C.2.iii. DART Bottom Pressure recorder

The same procedure as for the anchor was used to locate the BPR. Details are in Table VI.C.5. Figures VI.C.9 and 10 are triangulation plots and results from Acoustic Survey Software and Newhall's program. Figure VI.C.11 is triangulation plot from ECours.

Table VI.C.5. Anchor survey for BPR.

Anchor survey			
	Latitude	**Longitude**	**Time/Hor. Range**
Survey Point 1	19°34.325'S	74°45.280'W	4222 ms
	19°34.319'S	74°45.281'W	3964 m
Survey Point 2	19°37.567'S	74°47.182'W	4030 ms
	19°37.574'S	74°47.182'W	3505 m
Survey Point 3	19°34.568'S	74°49.009'W	4168 ms
	19°34.515'S	74°49.021'W	3908 m
Anchor Drop Location	19°35.722'S	74°47.013'W	
Water depth (corrected)=4945 m			
Height of acoustic release off bottom= 1 m			
Surface transducer depth=10m			
Anchor location from MATLAB Acoustic Survey Software:			
	19°35.6433'S	74°47.1053'W	
Fallback from anchor drop: 182 m			
Anchor location from MATLAB Ecours program:			
	19°35.656'S	74°47.0993'W	
Fallback from anchor drop: 118.5 m			

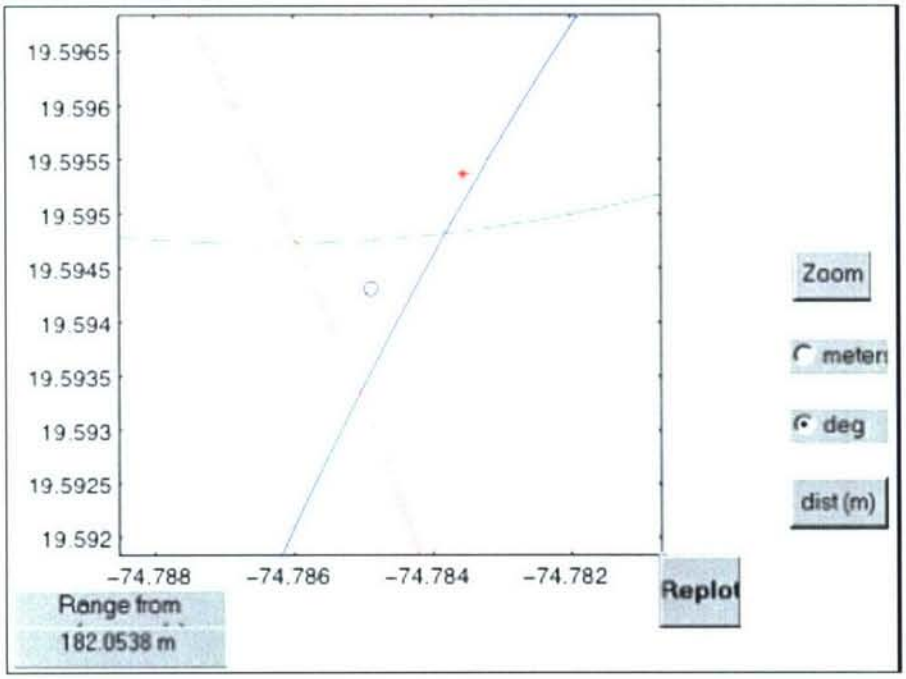
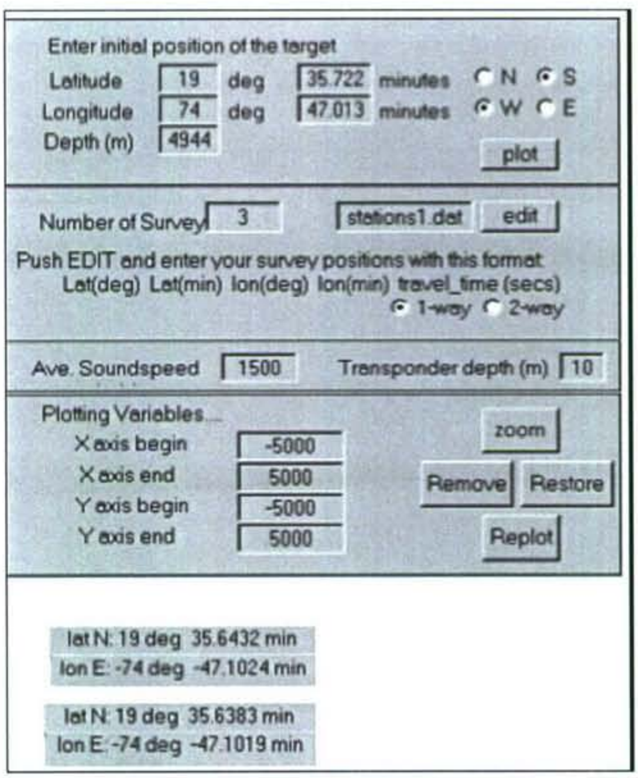


Figure VI.C.9. BPR location. Triangulation plot from Acoustic Survey Software.



FigureVI.C.10. BRP location. Screen capture from Newhall's program.

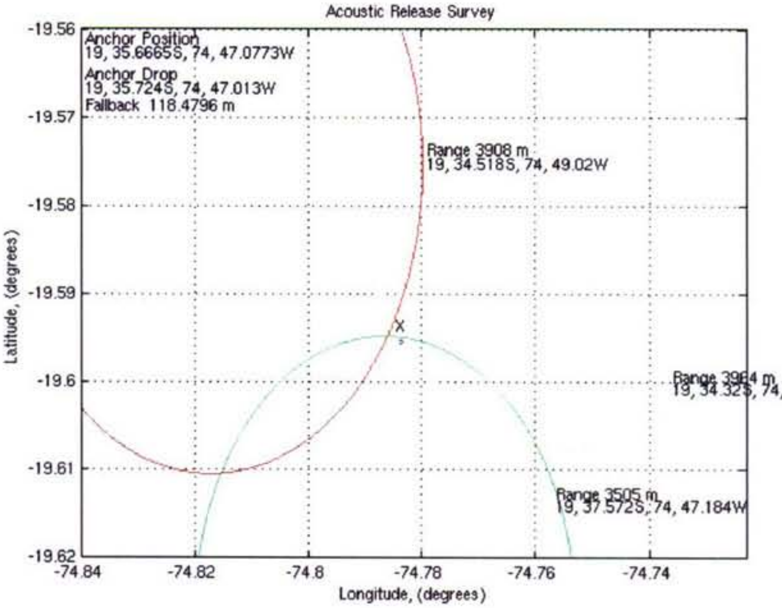


Figure VI.C.11. BPR anchor triangulation using ECours.

VI.C.2.iv. Separation of Surface Buoy Anchor and BPR

At 1930 local on October 23, 2006, the buoy location (by ship GPS and radar) was:

19°35.37'S, 74°47.40'W

Using the Acoustic Survey Software locations:

Surface mooring anchor location:

19°35.9343'S, 74°46.8957'W

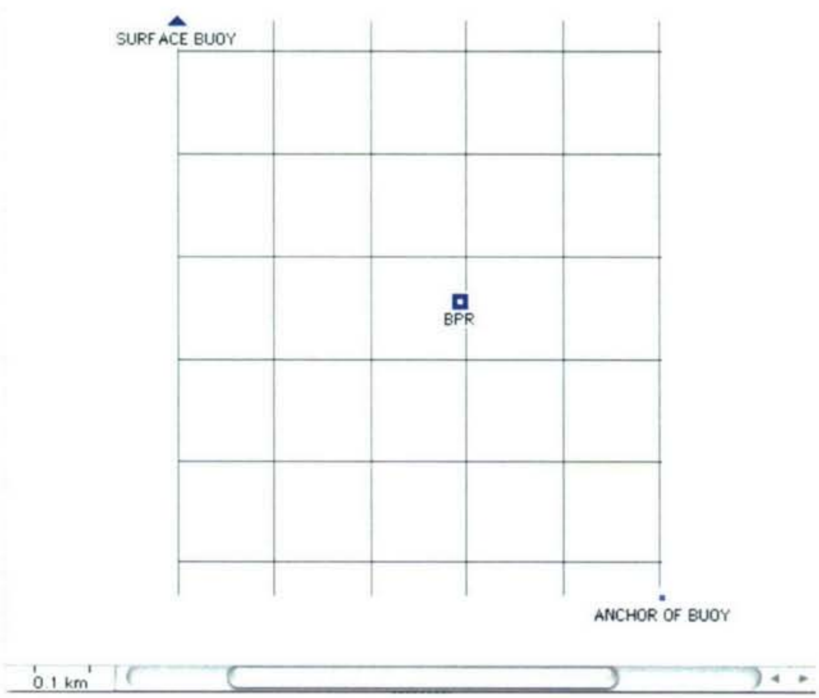
BPR bottom location:

19°35.6433'S, 74°47.1053'W

The BPR was dropped between the surface buoy and the anchor. The buoy at this time was 721.5 m at 314.5° true relative to the BPR (see Table VI.C.6 and FigureVI.C.12).

Table VI.C.6. DART II buoy anchor and BPR location survey

Surface mooring anchor location from MATLAB Acoustic Survey Software			
	19° 35.9343'S	74° 46.8957'W	
BPR bottom location from MATLAB Acoustic Survey Software			
	19° 35.6433'S	74° 47.1053'W	
Separation			651.3 m 325° true
From ECours software, surface mooring anchor location			
	19°35.9622'S	74° 46.8851'W	
From Ecours, BPR bottom location			
	19°35.656'S	74° 47.0993'W	
Separation			679.2 m 326° true



FigureVI.C.12. Location of DART II surface mooring, anchor and BPR, on Oct. 23.

VI.D. pCO2

Upwelling in the equatorial Pacific leads to enhanced productivity and degassing of CO2 across a region ranging from the coast of South America to past the International Date Line. The vast area affected makes this region a significant contributor to global biogeochemical cycles. Variability in the South American upwelling region has been linked to a wide range of ecosystem and biogeochemical changes. Understanding this variability is a primary reason for the ongoing work at the Stratus site. Although this mooring has been used to study the local ocean physics and heat fluxes, it does not currently have any carbon sensors.

Adding a pCO2 system to the Stratus mooring expands the OceanSITES moored pCO2 network. The current network is developing in the Equatorial and North Pacific. This site provides the next logical step for an expansion into the South Pacific.

CO2 measurements are made every three hours in marine boundary layer air and air equilibrated with surface seawater using an infra-red detector. The detector is calibrated prior to each reading using a zero gas derived by chemically stripping CO2 from a closed loop of air and a span gas (414 ppm CO2) produced and calibrated by NOAA's Earth System Research Laboratory (ESRL).

For an overview of the system, visit:
http://www.pmel.noaa.gov/co2/moorings/eq_pco2/pmelsys.htm. PMEL pCO2 system 0011 was used for this deployment.

A summary file of the measurements is transmitted once per day and plots of the data are posted in near real-time to the web. To view the daily data, visit the NOAA PMEL Moored CO2 Website:
http://www.pmel.noaa.gov/co2/moorings/stratus/stratus_main.htm. Within a year of system recovery, the final processed data are submitted to the Carbon Dioxide Information Analysis Center (CDIAC) for release to the public.

During the transit to the Stratus location, an inter-comparison was made with the NOAA Ship *Ronald H. Brown*'s permanently installed underway pCO2 system (Figure VI.D.1). An additional comparison was made while the ship remained within 1200 meters of the buoy for a 24 hour period.

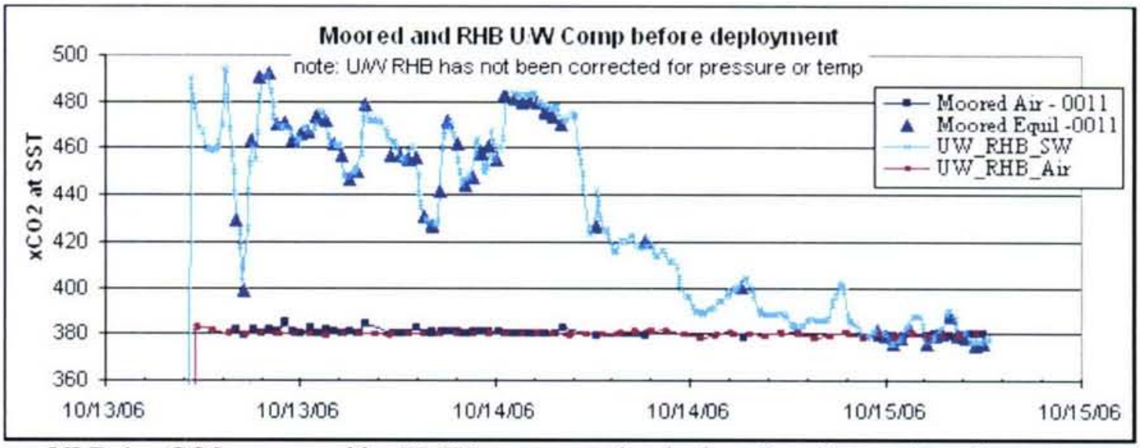


Figure VI.D.1. pCO2 measured by PMEL system to be deployed on Stratus 7 and system onboard R/V RHB.

VI.E. Aerosols

University of Hawaii's personnel conducted study of aerosols. Unfortunately, since the mass spectrometer stopped functioning in the beginning of the cruise, an important part of the intended aerosol study did not take place. However, aerosol size distribution, chemical size distribution, and total condensation nucleus concentration instrumentation were operated.

The differential mobility analyzer (DMA) has measured the aerosol size distribution over 10 - 500 nm for the entire cruise. The total condensation nuclei counter (CN) has also been working well for the entire cruise. This data will hopefully reveal the production and evolution of cloud condensation nuclei in the boundary layer. It will be interesting to look for the possible impact of continental SO2 emissions (smelters, etc.) on the CN concentration and size distribution as the cruise transitioned from the clean boundary layer near the STRATUS site to the more inshore position of the Tsunami buoy.

In addition to CN concentration and size distribution, several size segregated aerosol samples were collected with a Multiple Orifice Uniform Deposit Impactor (MOUDI). These samples will be analyzed after the cruise to determine the size distribution of important inorganic species such as sulfate, nitrate, chloride, ammonium, etc. A comparison with inshore and offshore samples will be important, as will a comparison over different boundary layer conditions.

The PMEL sea water dimethylsulfide (DMS) instrument was also operated for Jim Johnson and Tim Bates. Data look good for the entire period after RHB entered international waters.

The time-series for the Condensation Nuclei (CN) concentration (one minute averages) is shown in Figure VI.E.1. Most data gaps were due to contamination from the ship's exhaust. The remaining few large (but short) peaks could also be due to contamination, but this is not certain at the moment. A particular area of interest is between 10/14 to 10/15, where the CN concentration is very low. A question that one can address is when the particle concentration is this low (often due to wet deposition, i.e. drizzling events remove articles from the atmosphere), what are the sources of condensation nucleui that eventually lead to cloud formation? Maybe DMS?

Also, not shown in this plot, because of incomplete wind data at this moment, is the period when R/V RHB approached Chile. During this period, the CN concentration consistently exceeded ~1000 NO./cc -- a clear evidence for a continental influence on marine aerosols.

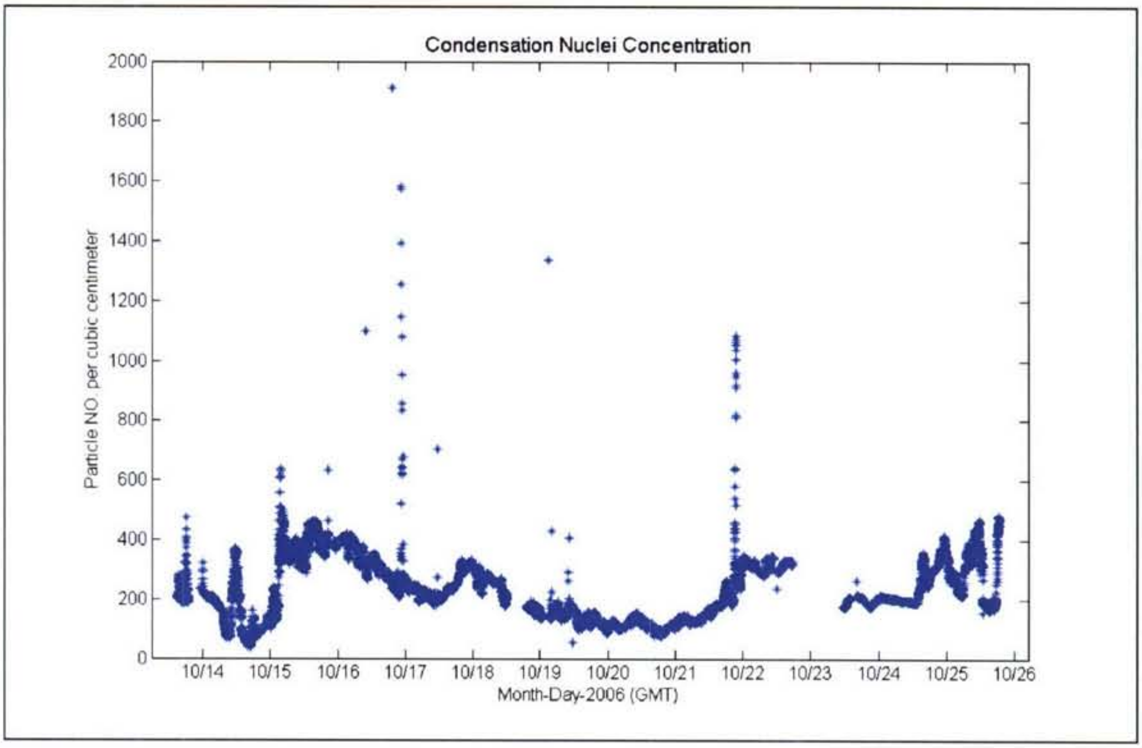


Figure VI.E.1.Time-series of Condensation Nuclei during Stratus 2006 cruise.

VI.F. Teacher at Sea Program

Brett Hoyt is the sole teacher at the Yellowstone County Detention Facility located in Billings Montana. He works for and is paid by School District #2 also located in Billings. He teaches both male and female inmates who are seeking their GED diploma or improving academic skills so as to be ready to enter college. His students, at the present time, range in age from 18 to 66 years of age. He teaches Math, Science, Writing, Social Studies, Reading, and College Algebra classes. Inmates at the detention facility are forbidden to have internet access so Mr. Hoyt sought out and adopted two 6th grade classes from Burlington Elementary School Mr. Hoyt's participation in the cruise was sponsored by NOAA's Teacher at Sea (TAS) program in partnership with NOAA's Office of Climate Observation.

On board Mr. Hoyt worked closely with the Upper Oceans Processes Group from Woods Hole Oceanographic Institution. Senior Scientist Bob Weller gave him an active role by assigning a daily four-hour watch in the main lab. Duties include monitoring the ship's location and deploying drifters and Argo Floats at the correct coordinates. Mr. Hoyt also participated in atmospheric studies by helping prepare and launch radiosondes attached to helium filled balloons. This presented an opportunity to watch the data streaming in and interpret the information. Mr. Hoyt also assisted with the deployment and retrieval of the Stratus 7 and Stratus 6 buoy's.

While on board Mr. Hoyt worked with and interviewed various members of the scientific teams and ship's officers and crew. Logs were sent out via email for publication on the TAS website. These logs described the scientists, the equipment employed, and personal reflections from the teacher. When applicable, lesson plans/activities were included in each log for Elementary, Middle School, and High School levels. These activities were directly related to the day's events. Student's questions were answered via email. Photos were included with each log and the improved Internet access was instrumental in the quality of the logs produced. Mr. Hoyt indicated that participating in this cruise was the experience of a lifetime and that mere words do not do justice to the amount of gratitude and appreciation he feels about being given the opportunity to participate and share with the world his experience in TEACHER AT SEA.

Acknowledgements

This project was funded through grants from the Office of Global Programs of the National Oceanic and Atmospheric Administration (NOAA Grant NA17RJ1223). The UOP Group would like to thank the crew of the R/V *Ronald H. Brown* and all of the scientific staff for their help during the Stratus 2006 cruise.

APPENDIX A: STRATUS 7 BURN-IN NOTES

DATE:	ACTIVITY:
17 MAY 06	L-04 (system 1) and L-15(system 2) clocks set, FLASH cards erased and burn in started with HRH's, BPR's, and SST's.
31 MAY 06	L-04 Stop: 11:26:30 UTC File: S7L04_01.DAT= records 1 to 16380 Records = 19791 S7L04_02.DAT= records 16350 to 19791 Restart sampling: 12:16:30 L-15 Stop: 12:17:30 UTC File: S7L15_01.DAT= records 1 to 16380 Records = 19842 S7L15_02.DAT= records 16350 to 19842 Restart sampling: 13:09:30
2 JUN 06	Added SWR219 to L-04 @ 11:41 UTC. Both SST's put in bucket pf mixed water @ 12:50 UTC.
15 JUN 06	L-04 Stop: 11:56:30 UTC File:S7L04_03.DAT= records 19750 to 36130 Records = 41370 S7L04_04.DAT= records 36100 to 41370 Restart sampling: 13:12:30 L-15 Stop: 13:13:30 UTC File:S7L15_03.DAT= records 19800 to 36180 Records = 41445 S7L15_04.DAT= records 36150 to 41445 Restart sampling: 14:07:30
16 JUN 06	HRH230 removed from L-15 (to be used for WHOTS 3 spare).
6 JUL 06	Added PTT's to both L-04 and L-15, but they aren't transmitting.
18 JUL 06	Added SWR212 and HRH504 to L-15. Added WND222 to L-04. Found a wiring problem between the logger and the junction plate. WND on L-04 not responding. Repaired and WND working. PTT's both powered up. L-04 PTT – ok @ 1.2W, L-15 PTT - found broken in ribbon cable between logger and PTT. Fixed the wire and the PTT output = 500mW. Wire, repaired but the PTT not transmitting. Found L-15 processor bd. not updating PTT. Took processor bd. from another logger – PTT ok 1W out. WND215 plugged in to L-15. Both FLASH cards erased. Buoy moved outside @ 18:15 UTC. SST's in bucket of saltwater @ 19:05 UTC.
19 JUL 06	ARGOS data shows that L-04 WND=0's. Unplugged WND222 from L-04 @ 18:00 UTC, plugged back in @ 18:05 UTC. Logger now shows wind data.
20 JUL 06	Found L-04 WND222 reporting 0's again. Cycled power on WND222 @ 11:45 UTC, WND222 came back to life and reporting numbers now. Swapped Wind modules between L-04 and L-15 @ 11:50 UTC. Swapped Winds back to original setup and removed WND222 from L-04 @ 15:30 UTC. Added PRC206 to L-15 @ 11:35 UTC. Buoy moved inside @ 18:20 UTC for impending storm.
21 JUL 06	Plugged PRC206 into L-15 @ 19:15 UTC.
24 JUL 06	Plugged PRC205 into L-04 @ approx. 11:00 UTC.
26 JUL 06	Filled and drain L-04/PRC @ 14:23:30 UTC. Filled and drain L-15/PRC @ 14:26:00 UTC. 100 ml of water added to L-04/PRC @ 17:03:30. 100 ml of water added to L-15/PRC @ 16:59:30.
27 JUL 06	Found L-04/PRC not recording values, cable between the gauge and module electronics was disconnected. Plugged in the cable @ 10:40 UTC. 100 ml of water added to L-04/PRC @ 12:02:00 UTC. 100 ml of water added to L-15/PRC @ 12:04:30 UTC. 100 ml of water added to L-04/PRC @ 14:07:30 UTC.

	100 ml of water added to L-15/PRC @ 14:06:30 UTC.
	Filled and drain L-04/PRC @ 17:33 UTC.
	Filled and drain L-15/PRC @ 17:34 UTC.
28 JUL 06	L-04 Stop: 11:21:30 UTC File:S7L04_05.DAT= records 1 to 14001
	Records = 14001
	Restart sampling: 12:02:30
	L-15 Stop: 12:04:30 UTC File:S7L15_05.DAT= records 1 to 14039
	Records = 14039
	Restart sampling: 12:40:30
	L-07 powered up as spare, clock set, FLASH erased, PRC primed. Spare outside @ 18:00 UTC. Has all sensors except LWR and HRH. Spare is transmitting.
4 AUG 06	Added water to the SST bucket @ 10:50 UTC.
8 AUG 06	Buoy spin performed on primaries and spare.
9 AUG 06	LWR214 plugged in to L-04 @ 14:18:00 UTC.
10 AUG 06	Plugged in LWR218 in to L-15 @ 09:50 UTC.
	Plugged in HRH232 in to L-7(spare) @ 09:51 UTC.
11 AUG 06	L-04 Stop: 13:16:30 UTC File:S7L04_06.DAT= records 14000 to 30380
	Records = 34219 S7L04_07.DAT= records 30350 to 34219
	Restart sampling: 14:00:30
	L-15 Stop: 14:01:30 UTC File:S7L15_06.DAT= records 14000 to 30380
	Records = 34234 S7L15_02.DAT= records 30350 to 34234
	Restart sampling: 14:46:30
	L-07 Stop: 14:48:30 UTC File:S7L07_01.DAT= records 1 to 16380
	Records = 19974 S7L07_02.DAT= records 16350 to 19974
	Restart sampling: 15:33:30
	Found the SST on the spare system (L-07) failed after 3 days. Pulled SST 1727 from the spare and plugged in SST 3601 in to spare. Spare SST placed in the bucket with others. Moved buoy closer to spare. Burn in continues @ 17:45 UTC.
	Stand alone SWR201 placed outside and burning in @ 20:06 UTC.
14 AUG 06	ARGOS data shows the spare SST still not working. Found broken wire on the spare. Fixed the wire and put SST 1727 back on the spare. Burning in again by 12:15 UTC.
	Mounted standalone HRH205 outside on spare platform @ 15:20 UTC.
15 AUG 06	ARGOS plots shows a slight time offset on the spare (L-07). Found the clock to be 1 hour off. Stopped sampling and reset the clock. Sampling started @ 13:45 UTC.
	2 ea. Easylog USB RH/Temp. sensors (Easylog#3 &Easylog#4) put outside with spare for burn in @ 17:00 UTC.
18 AUG 06	L-04 Stop: 10:56:30 UTC File:S7L04_08.DAT= records 34200 to 44115
	Records = 44115
	Restart sampling: 14:00:30
	L-15 Stop: 11:21:30 UTC File:S7L15_08.DAT= records 34200 to 44109
	Records = 44109
	Restart sampling: 11:43:30
	L-07 Stop: 11:45:30 UTC File:S7L07_03.DAT= records 19950 to 29779
	Records = 29779
	Restart sampling: 12:11:30
	HRH231 Records = 188 File:HRH231_01.dat = records 1 to 188
	HRH205 Records = 93 File:HRH205_01.dat = records 1 to 93
	SWR201 Records = 160 File:SWR201_01.dat = records 1 to 160
19–27 AUG 06	Stand alone WND344 and LWR502/L-07 brought outside for burn in
28 AUG 06	L-04 Stop: 12:26:30 UTC File:S7L04_09.DAT= records 44100 to 58581

Records = 58581
Restart sampling: 12:58:30

L-15 Stop: 13:00:30 UTC   File:S7L15_09.DAT= records 44100 to 58585
Records = 58585
Restart sampling: 13:30:30

L-07 Stop: 13:32:30 UTC   File:S7L07_04.DAT= records 29750 to44260
Records = 44260
Restart sampling: 14:03:30

HRH231	Records = 430	File:HRH231_02.dat = records 1 to 430
HRH205	Records = 335	File:HRH205_02.dat = records 1 to 335
SWR201	Records = 402	File:SWR201_02.dat = records 1 to 402
WND344	Records = 162	File:WND344_01.dat = records 1 to 162

29 AUG 06 2 ea. Easylog USB RH/Temp. sensors (Easylog#3 &Easylog#4) brought inside for data dump @ approx. 12:30 UTC.
SWR222 removed from spare (L-07) and SWR210 plugged in to L-07 @ 19:42 UTC.
Burn in Evaluation show the following:

1) Stand alone WND344 problem.
2) HRH205(Stand alone Vaisala) and HRH504(L-15) have problems.
3) PRC216(L-07) and PRC206(L-15) have problem with noise at near full levels.

30 AUG 06 Unplugged HRH504 from L-15 @ 11:06 UTC, and brought to Jason for checks.
Unplugged HRH205 as stand alone @ 11:12 UTC, and brought to Jason for checks.
Removed HRH231 as stand alone, converted to RS485, and plugged in to L-15 @ 11:33 UTC.
Unplugged HRH232 from spare(L-07) @ 11:34 UTC., converted to RS232, and plugged in as stand alone @ 11:42 UTC.
Unplugged PRC216 from spare(L-07) @ 11:42 UTC. and brought to Jason for checks.
Removed WND344 as stand alone and brought to Jason for checks.
PRC216 readjusted and plugged back in to L-07 @ 16:10 UTC.
HRH217 plugged in to L-07 @ 17:38 UTC.
Removed PRC206 from L-15 @ 17:50 UTC, and given to Jason for adjustment.
Plugged PRC206 back in to L-15 @ 20:30 UTC.

31 AUG 06 Brought WND344 back outside as Stand alone @ 19:00 UTC.

1 SEP 06 Placed 2 ea. Easylog RH/Temp. sensors (Easylog#5 &Easylog#6) outside for burn in comparison @ 13:00 UTC.

5 SEP 06 L-04 Stop: 10:51:30 UTC   File:S7L04_10.DAT= records 58550 to 69973
Records = 69973
Restart sampling: 11:16:30

L-15 Stop: 11:17:30 UTC   File:S7L15_10.DAT= records 58550 to 69972
Records = 69972
Restart sampling: 11:43:30

L-07 Stop: 11:45:30 UTC   File:S7L07_05.DAT= records 44250 to 55641
Records = 55641
Restart sampling: 12:09:30

HRH232	Records = 627	File:HRH232_01.dat = records 1 to 627
SWR201	Records = 592	File:SWR201_03.dat = records 1 to 592
WND344	Records = 114	File:WND344_02.dat = records 1 to 114

Easylog #5 & #6 brought inside for data dump @ 12:30 UTC.

6 SEP 07 Removed galv. bolts from the stand alone WND bracket @ 14:15 UTC.
Unplugged HRH216 from L-04 and unplugged HRH232 as stand alone @ 13:10 UTC.

	Converted HRH232 from RS232 to RS485 and converted HRH216 from RS485 to RS232.
	Plugged in HRH232 to L-04 and HRH216 as stand alone @ 13:23 UTC.
8 SEP 06	LWR213 placed outside as stand alone @ 17:57 UTC.
	L-07 Stop sampling @ 09:30:30 UTC for WND direction comparison with WND344.
	1st point: L-07 Compass=292.9 Vane=68.3 Direction=1.2 Degrees
	WND344 Compass=63.0 Vane=295.9 Direction=359.9 Degrees
	Total Difference = 1.3 Degrees
	2nd point: L-07 Compass=293.6 Vane=160.4 Direction=94.0 Degrees
	WND344 Compass=62.3 Vane=27.6 Direction=89.8 Degrees
	Total Difference = 4.2 Degrees
	3rd point: L-07 Compass=293.9 Vane=235.2 Direction=169.1 Degrees
	WND344 Compass=62.9 Vane=104.7 Direction=167.6 Degrees
	Total Difference = 1.5 Degrees
	L-07 Spare transmitter turned off @ 09:53 UTC.
10 SEP 06	L-04 Stop: 10:17:30 UTC File:S7L04_11.DAT= records 69950 to 77114
	Records = 77114
	Restart sampling: 10:44:30
	L-15 Stop: 10:46:30 UTC File:S7L15_11.DAT= records 69950 to 77114
	Records = 77114
	Restart sampling: 11:14:30
	L-07 Stop: 11:16:30 UTC File:S7L07_06.DAT= records 55600 to 62768
	Records = 62768
	Restart sampling: 11:32:30
	HRH216 Records = 0 No FLASH card installed?
	SWR201 Records = 711 File:SWR201_04.dat = records 1 to 711
	WND344 Records = 232 File:WND344_03.dat = records 1 to 232
	LWR213 Records = 42 File:LWR213_01.dat = records 1 to 42
	Data shows RH/AT spiking to be better with the spare transmitter off, but not totally better.
	Both primary transmitters turned off @ 13:12 UTC.
	Put new FLASH card in HRH216 by13:00 UTC.
11 SEP 06	Found the error in the WND and LWR over-plots were caused by bad Matlab programs. Re-plotted with the correct programs and the stand alone WND and LWR over-plot with the others.
12 SEP 06	PRC206 removed from L-15 and PRC208 plugged in to L-15 @ 18:40 UTC.
	PRC208 filled and drained and approx. 20 ml added.
13 SEP 06	L-04 Stop: 12:05:30 UTC File:S7L04_12.DAT= records 77000 to 81514
	Records = 81514
	Restart sampling: 12:15:30
	L-15 Stop: 12:34:30 UTC File:S7L15_12.DAT= records 77000 to 79932
	Records = 79932 Note: (Logger had no comms. Had to cycle
	Restart sampling: 12:42:30 power for logger to come to life)
	L-07 Stop: 12:20:30 UTC File:S7L07_07.DAT= records 62600 to 67135
	Records = 67135
	Restart sampling: 12:32:30
	HRH216 Records = 73 File:HRH216_01.dat=records 1 to 73
	SWR201 Records = 785 File:SWR201_05.dat = records 1 to 785
	WND344 Records = 305 File:WND344_04.dat = records 1 to 305
	LWR213 Records = 71 File:LWR213_02.dat = records 1 to 71

	LWR213 has dropouts in the data. Removed as stand alone and brought inside for checkout. Jason replaced the FLASH card and the LWR was brought outside approx. 15:15 UTC.		
	Put new bearings in WND344.		
14 SEP 06	Put new prop. on WND344 @ 18:30 UTC.		
15 SEP 06	L-04 Stop: 12:12:30 UTC		File:S7L04_13.DAT= records 81500 to 84390
	Records = 84390		
	Restart sampling: 12:21:30		
	L-15 Stop: 12:22:30 UTC		File:S7L15_13.DAT= records 79900 to 82790
	Records = 82790		
	Restart sampling: 12:30:30		
	L-07 Stop: 12:31:30 UTC		File:S7L07_08.DAT= records 67100 to 70014
	Records = 70014		
	Restart sampling: 12:38:30		
	HRH216	Records = 121	File:HRH216_02.dat=records 1 to 121
	SWR201	Records = 832	File:SWR201_06.dat = records 1 to 832
	WND344	Records = 353	File:WND344_05.dat = records 1 to 353
	LWR213	Records = 44	File:LWR213_03.dat = records 1 to 44
18 SEP 06	L-04 Stop: 08:18:30 UTC		File:S7L04_14.DAT= records 84350 to 88466
	Records = 88466		
	Restart sampling: NA – Burn in complete!		
	L-15 Stop: 08:34:30 UTC		File:S7L15_14.DAT= records 82750 to 86874
	Records = 86874		
	Restart sampling: NA – Burn in complete!		
	L-07 Stop: 08:52:30 UTC		File:S7L07_09.DAT= records 70000 to 74107
	Records = 74107		
	Restart sampling: NA – Burn in complete!		
	HRH216	Records = 189	File:HRH216_03.dat=records 1 to 189
	SWR201	Records = 900	File:SWR201_07.dat = records 1 to 900
	WND344	Records = 422	File:WND344_06.dat = records 1 to 422
	LWR213	Records = 64	File:LWR213_04.dat = records 1 to 64
18 SEP 06	Burn in completed all gear powered down for shipping.		

APPENDIX B: ESRL DATA AND FTP ACCESS

FOR Access to the FTP site:
    ftp voodoo.etl.noaa.gov
    username anonymous
    password (email address)
    cd et6/archive/STRATUS_2006

Data Archive Directories:
STRATUS_2006
RHB
    balloon
        Raw
        Processed
        Processed_Images
        Raw_Images
    Ceilometer
        Raw
        Processed
        Processed_Images
        Raw_Images
    Flux
        Raw
        Processed
        Processed_Images
        Raw_Images
    Fast_Ozone_Sensor
        Raw
        Processed
        Processed_Images
        Raw_Images
    radar
        cband
        profiler
            Raw
            Processed
            Processed_Images
            Raw_Images
        xband
    radiometer
        Mailbox
            Raw
            Processed
            Processed_Images
            Raw_Images
    Scientific_analysis
    terrascan
        Raw_Images

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APPENDIX C: SHIP AND ESRL DATA

Shipboard data on the Stratus 7 deployment cruise was available as "event files" created by the Scientific Computer System (SCS) software running on the Ron Brown. These files are configured by the Brown's Survey Technician on a directory that is made available on the local area network. A single file holds relative humidity, air temperature, shortwave and longwave data; wind, air pressure, surface CTD, sst, and precipitation are each stored in individual files.

Event files are appended in real time in a cruise-specific directory, which for this cruise was //rbscsacq/eventdata/whoi-stratus-7. To access this directory over the network for automated processing, a laptop needs to be on the network in the default workgroup.

To collect the raw event files, we used a shell script called get_ship.sh. This saved the event files to the matlab/work/ships directory on the laptop, overwriting them every hour. The script ran under cygwin, a windows utility providing bash shell functions. Note that the ELG files should be manually backed up in a separate directory to prevent possible loss of data if the shipboard Survey Technician clears out the event files, also note that the ST may change the format or the numeric numeric code the event file names occasionally.

```
#!/bin/sh
# get_ship.sh
while [ 1 -eq 1 ]; do
 cp -f /cygdrive/e/*.ELG .
 sleep 3000 ; done
```

As data was accumulated, another script processed the raw files, making flat files that could be read directly into Matlab.

This script parses each of the event files, extracting the fields of interest:

```
#!/bin/sh
# get_met.sh
cp S:/*.ELG data
# ATMOS: Date, Time, Lat, Lon, hrh, atmp, swr, lwr
tail +1 data/ATMOS_001.ELG |\
   sed 's/,,/,-999.99,/g' |\
   awk -F, '(NF == 9){print $1,$2,$5,$6,$7,$8}' |\
   sed 's/:/ /g' | sed 's;/; ;g' |\
   grep -v "[A-Z]" > data/atmos.asc
# BAROMETER: Date,Time, Lat, Lon, BPR-Correct-SeaLevel
tail +1 data/BAROMETER_001.ELG | sed 's/,,/,-999.99,/g' |\
   awk -F, '(NF == 6){print $1,$2,$5}' |\
   sed 's/:/ /g' | sed 's;/; ;g' |\
   grep -v "[A-Z]" > data/baro.asc
# SST: Date,Time, Lat, Lon, imet_sst,
 tail +1 data/SST_001.ELG | sed 's/,,/,-999.99,/g' |\
   awk -F, '(NF == 6){print $1,$2,$5}' |\
   sed 's/:/ /g' | sed 's;/; ;g' |\
   grep -v "[A-Z]" > data/sst.asc
# TSG: Date,Time, Lat, Lon, sst, cond, sal, fluoro
```

```
 tail +1 data/TSG_001.ELG  | sed 's/,,/,-999.99,/g' |\
   awk -F, '(NF == 9){print $1,$2,$5,$6,$7}'  | \
   sed 's/:/ /g' | sed 's;/; ;g' | \
   grep -v "[A-Z]" > data/tsg.asc
# WIND: Date,Time, Lat, Lon, GYRO, RWDir,RWSpK, TWDir, TWSpdK
 tail +1 data/WIND_001.ELG  | sed 's/,,/,-999.99,/g' |\
   awk -F, '(NF == 12){print $1,$2,$5,$6,$7,$8,$9,$10,$11}'  | \
   sed 's/:/ /g' | sed 's;/; ;g' | \
   grep -v "[A-Z]" > data/wind.asc
# RAIN: Date,Time, Lat, Lon, imetRain,HasseRainRate,Hasse-SideCount,
 tail +1 data/RAIN_001.ELG  | sed 's/,,/,-999.99,/g' |\
   awk -F, '(NF == 8){print $1,$2,$5,$6,$7}'  | \
   sed 's/:/ /g' | sed 's;/; ;g' | \
   grep -v "[A-Z]" > data/rain.asc
```

The files written by getmet.sh were loaded into Matlab with a script that created structures for each file. Because the time in the individual SCS files varies, they can't be combined to create a single time series without some loss of accuracy. The Matlab program go.m writes individual files containing named parameters extracted from the flat files, and combineSCS.m puts them into structures in a single mat file.

```
    % get_scs.m
  load data/atmos.asc
  yday=datenum(atmos(:,3),atmos(:,1),atmos(:,2),...
    atmos(:,4),atmos(:,5),atmos(:,6))- datenum(2006,1,0);
  [yday,indx,j] = unique(yday);
  atmos = atmos(indx,:);          hrh  = atmos(:,7);
  atmp  = atmos(:,8);             swr  = atmos(:,9);
  lwr  = atmos(:,10);
     save data/atmos.mat yday hrh atmp swr lwr
```

ETL data

We also had access to data collected by the NOAA ESRL (formerly ETL) group. This data was made available daily, and was processed in a similar way to SCS data files, but the script was run only once per day, at about 9 PM.

```
#!/bin/sh
# get_etl.sh
yd=`date "+%j"`
yd=`expr $yd - 1`
for file in //Etldas11/I/STRATUS_2006/RHB/flux/Raw/day${yd}/P2_${yd}*
do
  awk -F, \
  '{print $3,$4,$5,$23,$24,$25,$28,$29,$19,$20,$26,$21,$22,$27,$30}' \
  ${file} >> data/etl${yd}.asc
Done
```

This script accessed only the "P2" files, which contained surface met parameters; sst, air temperature, relative humidity, two shortwave radiation sensors, components of longwave radiation from 2 instruments, and rain rate from an optical rain gauge.

APPENDIX D: MOORING LOGS

Moored Station Log

(fill out log with black ball point pen only)

ARRAY NAME AND NO. Stratus 7 MOORED STATION NO. 1176

Launch (anchor over)

Date (day-mon-yr) 10/16/2006	Time 17:51:00 UTC
Latitude (N/S, deg-min) 19° 45.320'	Longitude (E/W, deg-min) ~~19 85 320~~ -85° 31.754'
Deployed by Lord, Weller	Recorder/Observer Sebastien Bigorre
Ship and Cruise No. R/V Ron Brown	Intended Duration 12 months
Depth Recorder Reading 4441 m	Correction Source Matthew's table
Depth Correction 5m Matthew's table m	
Corrected Water Depth 4446 m	Magnetic Variation (E/W) E 7.6833°
Argos Platform ID No.	Additional Argos Info on pages 2 and 3

Surveyed Anchor Position

Lat (N/S) 19° 45.2852' S Long. (E/W) 85° 31.9272' W

Acoustic Release Model

Release No. 32481 / 32478	Tested to 500 , 1500 m
Receiver No.	Release Command 132132 / 132043
Enable 114617 / 114442	Disable 114634 / 114461
Interrogate Freq. 11 kHz	Reply Freq. 12 kHz

Recovery (release fired)

Date (day-mon-yr)	Time UTC
Latitude (N/S, deg-min)	Longitude (E/W, deg-min)
Recovered by	Recorder/Observer
Ship and Cruise No.	Actual duration days

Distance from actual waterline to buoy deck m

1

Surface Components

Buoy Type Foam   Color(s) Hull Yellow   Tower White

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

Surface Instrumentation

Item	ID #	Height*	Comments
HRH	232	223	System #1
BPR	207	237.5	
WND	222	273	
PRC	205	241	
LWR	214	283	
SWR	219	282	
SST	1727	-151	
Logger	L-04		
PTT# 18171	27919		
	27920		
	27921		
HRH	231	223	System #2
BPR	217	237	
WND	215	271	
PRC	208	241	
LWR	218	283	
SWR	212	282	
SST	1835	-151	
Logger	L-15		
PTT# 12789	27916		
	27917		
	27918		
HRH	216	194.5	Stand alone
LASCAR	3	168.5	Stand alone
LASCAR	4	213	Stand alone

*Height above buoy deck in centimeters

2

Subsurface Instrumentation on Buoy and Bridle

Item	ID #	Depth†	Comments
TR-1050	12707	*-12.5	* from top of float
SBE-37	72	*-5.5	
pCO$_2$	0011		
Beacon	104		Subsurface Argos ID 24576

†Depth below buoy deck in centimeters

3

Moored Station Number ________________

Item No.	Length (m)	Item	Inst No.	Time Over	Notes	Data No.	Depth (m)	Time Back	Notes
1	0.22	3/4" chain							
2		XR 420	10514	11:44:40	buoy in water		2		
3	0.37	3/4" chain							
4		SBE37	1325	12:44			3.7		
5	1.95	3/4" chain							
6		SBE 37	1326	12:24:52 ~~12:23:30~~			7		
7	1.72	3/4" chain							
8		Aanderaa	13	12:22			10		heads up
9	3.66	3/4" chain							
10		Nortek	2128	12:19:30			15		heads up/termination early
11		SBE37	1328	12:19:30			16		
12	2.63	3/4" chain							
13		Aanderaa	78	12:17:30			20		heads up
14	3.66	3/4" chain							
15		SBE 39	476	12:15:30			25		
16	3.66	3/4" chain							
17		SBE 37	1329	12:14			30		
18	1.20	3/4" chain							
19		Aanderaa	79				32.5		heads up
20	1.20	3/4" chain							
21		SBE 39	477				35		
22	1.20	3/4" chain							

Item No.	Length (m)	Item	Inst No.	Time Over	Notes	Data No.	Depth (m)	Time Back	Notes
23		SBE 37	1330				37.5		
24	1.20	3/4" chain							
25		SBE 37	1906				40		
26	~~5.75~~ 5.25	3/4" wire							
27		VMCM	003		rubber band ✓ - Spin 12:05:[illegible]		45		
28	2.38	3/4" chain							
29		Sontek	D208	12:58:50			50		heads down
30	3.66	3/4" chain							
31		VMCM	004	13:03	rubber band ✓ - spin 12:58:50		55		
32	5.25	7/16" wire							
33		SBE 37	1908	13:06:30			62.5		
34	6.2	7/16" wire							
35		SBE 39	48	13:11:30	rain started		70		
36	6.2	7/16" wire							
37		SBE 39	49	13:14:25			77.5		
38	6.2	7/16" wire							
39		SBE 37	1909	13:16:15			85		
40	6.2	7/16" wire							
41		SBE 39	102	13:[illegible]:40			92.5		
42	2.40	3/4" chain							
43		SBE 37	2012	13:[illegible]:40			96.5		
44	2.40	3/4" chain							
45		SBE 39	103	13:[illegible]			100		

Moored Station Number ____________

Item No.	Length (m)	Item	Inst No.	Time Over	Notes	Data No.	Depth (m)	Time Back	Notes
46	13.75	7/16" wire							
47		SBE 39	276	13:30:31			115		
48	13.75	7/16" wire							
49		SBE 37	2015	13:33:00			130		
50	3.66	3/4" chain							
51		RDI	1281	13:34:55			135		
52	8	7/16" wire							
53		VMCM	009	13:37:25	rubber band. Spin ✓ 13:35:36		145		
54	12.8	7/16" wire							
55		SBE 16	146	13:40:10			160		
56	13.5	7/16" wire							
57		SBE 39	284	13:42:00			175		
58	5.75	7/16" wire							
59		VMCM	013	13:43:54	rubber band. Spin ✓ 13:41:40		182.5		
60	5.75	7/16" wire							
61		SBE 16	991	13:47:46			190		
62	28.5	7/16" wire							
63		SBE 16	1873	13:51:44			220		
64	13	7/16" wire							
65		VMCM	016	13:54:10	rubber band. Spin ✓ 13:51:00		235		
66	13	7/16" wire							
67		SBE 16	1875	13:59:22			250		

Item No.	Length (m)	Item	Inst No.	Time Over	Notes	Data No.	Depth (m)	Time Back	Notes
68	38	3/8" wire							
69		VMCM	061	14:02:50	rubber band spin ✓ 13:58:51		290		
70	18	3/8" wire							
71		SBE 16	1881	14:05:20			310		
72	38	3/8" wire							
73		VMCM	062	14:08:55	rubber band. spin ✓ 14:05:10		350		
74	500	3/8" wire							
75		SBE 39	719	14:10			400		clamped
76		SBE 39	720	14:12:48			450		clamped
77		VMCM	083	14:16:50	rubber band. spin ✓ 14:15:00		852		
78	500	3/8" wire		end of wire in water @ 14 40					
79	500	3/8" wire		1050 L					
80	100	3/8" wire							one piece, wrapped [illegible]
81	200	7/8" wire		15:05					
82	150	7/8" wire		15:14					
83	1500	7/8" nylon							one piece, spliced at sea
84	100	1" nylon							
85	1500	1 1/4" poly		16:45 end in water					
86		17" glass balls		17:17					
87	5	1/2" chain							
88		release		17:40					Dual.d. EG&G 8242
89	5	1/2" chain							
90	20	1" Samson nystron							

Moored Station Log

(fill out log with black ball point pen only)

ARRAY NAME AND NO. SHOA/DART MOORED STATION NO. II
yellow deck, red hull, white tower . SHOA TSUNAMI

Launch (anchor over)

Date (day-mon-yr) 10/23/2006 Time 13.57 30 UTC
Latitude (N/S, deg-min) 19° 36.147' Longitude (E/W, deg-min) ~~76~~ 74° 46.740'
Deployed by ______ Recorder/Observer Bigerre
Ship and Cruise No. Ron Brown 06-07 Intended Duration 2 years
Depth Recorder Reading 4945 m Correction Source Mathew's table
Depth Correction 5 m
Corrected Water Depth 4950 m Magnetic Variation (E/W) ______
Argos Platform ID No. ______ Additional Argos Info on pages 2 and 3

Surveyed Anchor Position

Lat (N/S) 19°35'.413 S Long. (E/W) 74° 46' .7104 W

Acoustic Release Model

Release No. ~~444130~~, SN# 31268 Tested to ______ m
Receiver No. Release Command 444130
Enable 460234 Disable 460251
Interrogate Freq. 11 kHz Reply Freq. 12 kHz

Recovery (release fired)

Date (day-mon-yr) ______ Time ______ UTC
Latitude (N/S, deg-min) ______ Longitude (E/W, deg-min) ______
Recovered by ______ Recorder/Observer ______
Ship and Cruise No. ______ Actual duration ______ days
Distance from actual waterline to buoy deck 0.40 m

1

Surface Components

Buoy Type DART II   Color(s) Hull ________   Tower ________

Buoy Markings ________________________________

Surface Instrumentation

Item	ID #	Height*	Comments
WND	344	245	
LWR	213	232	
SWR	201	231	
Lascar HRH	5	196	
Lascar HRH	6	224	

*Height above buoy deck in centimeters

2

Subsurface Instrumentation on Buoy and Bridle

Item	ID #	Depth[†]	Comments
TR 1050	12694	120 cm	

[†]Depth below buoy deck in centimeters

Moored Station Number PART II

Item No.	Length (m)	Item	Inst No.	Time Over	Notes	Data No.	Depth (m)	Time Back	Notes
1	3.5	1" chain							
2		5 ton swivel							
3	0.5	1" chain							
4	700	7/16" wire							
5		XR 420	12942	10:58			10		
6		XR 420	12943	10:58			20		
7		TR 1050	12695	10:58			30		
8		TR 1050	12696	10:58			40		
9		XR 420	12944	10:58			50		
10		TR 1050	12697	10:58			62.5		
11		TR 1050	12698	10:58			77.5		
12		XR 420	12945	11:01			92.5		
13		TR 1050	12699	11:03			115		
14		XR 420	12946	11:06			145		wire repaired below
15		TR 1050	12700	11:14			175		
16		TR 1050	12701	11:17			220		
17		TR 1050	12702	11:22			250		
18		TR 1050	12703	11:31			310		wire repaired above
19	1185	nylon							1" to 7/8" to 3/4" spliced
20	595	3/4" nylon	Y369						
21	593	3/4" nylon	Y360						
22	580	3/4" nylon	Y379						

Item No.	Length (m)	Item	Inst No.	Time Over	Notes	Data No.	Depth (m)	Time Back	Notes
23	580	3/4" nylon	Y331						
24	575	3/4" nylon	Y358						
25		3/4" nylon							
26	1	1/2 trawl chain							
27		5 ton swivel							
28		Edgetech release	31268	13:30					
29	1	1/2 trawl chain							
30	20	nystron							
31	4	1/2" chain							
32		anchor					4980		wet wt 4900 lbs air wt 6850 lbs
33									
34									
35									
36									
37									
38									
39									
40									
41									
42									
43									
44									
45									

Moored Station Log

PAGE 1

(fill out log with black ball point pen only)

ARRAY NAME AND NO. Stratus 6 MOORED STATION NO. 1163

Launch (anchor over)

Date October 14, 2005 (day-mon-year) Time 17:51 UTC

Latitude 20° 02.747' (deg-min) N or (S) Longitude 85° 11.47' (deg-min) E or (W)

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

Deployed by: Lord et.al Recorder/Observer: Hutto

Ship and Cruise No R/V Ron Brown Intended duration: 365 days

Depth Recorder Reading 4476 m Correction Source: Mathew's Table

Depth Correction 5 m

Corrected Water Depth 4481 m Magnetic Variation: ______ E or W

Anchor Position: Lat. 20° 2.6703' N or (S) Long. 85° 11.3054' E or (W)

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

Acoustic Release Information Dual 8242's

Release No. 30845 / 30848 Tested to 4400 meters

Receiver No. NA Release Command 151355/151262

Interrogate Freq. 11 Khz Reply Freq. 12 Khz

Recovery (release fired)

Date 18-10-06 (day-mon-year) Time 12:45 UTC

Latitude 20° 3.48 (deg-min) N or (S) Longitude 85° 11.82 (deg-min) E or (W)

Postion Source: (GPS), LORAN, SAT. NAV., OTHER ______

Recovered by: LORD Recorder/Observer: GALBRAITH

Ship and Cruise No. RV RonBrown Actual duration: ______ days

Distance from actual waterline to buoy deck ______ meters

1163 **PAGE 2**

Surface Components

Buoy Type Foam **Color(s) Hull** yellow **Tower** white

Buoy Markings If Found Contact Woods Hole Oceanographic Woods Hole MA 02543 USA 508-548-1401

Surface Instrumentation

Item	ID	Height *	Comments
HRH	221	218	System #1
BPR	504	247	
WND	212	260	
PRC	207	249	
LWR	221	219	
SWR	505	279	
Logger	L-1		
PTT #14709	9806		
	9807		
	9811		
HRH	208	216	System #2
BPR	221	247	
WND	348	262	
PRC	505	249	
LWR	204	279	
SWR	207	279	
Logger	L-2		
PTT #14612	24337		
	27970		
	27971		
HRH	503	222	Stand Alone
LWR	506	279	Stand Alone
Floating SST	0716		
SIS Beacon	11427		SN # 22

* Height above buoy deck

Sub-Surface Instrumentation on Buoy and Bridle

Item	ID	Depth†	Comments
SBE37	1831	1.5 m	System #1
SBE37	1834	1.5 m	System #2

† 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
Glass Balls	17" in hard hats	17"	90	yellow

No. of Flotation Clusters ______

Anchor Dry Weight 1300 lbs

MOORED STATION NUMBER 11693

Item No.	Lgth [m]	Item	Inst No.	Time Over	Notes	Data No.	Calc Dpth	Time Back	Notes
1	0.22	3/4" Chain						1259	
2		SBE37	1899	12:24			2.0	1259	
3	0.37	3/4" chain							
4		XR420	10515	12 24	BRAKE		5 7	1316	
5	1.95	3/4" chain							
6		SBE37	2011	12:10			7.0	1316	
7	1.25	3/4" chain							
8		VMCM	057	12 10	12:08 [illegible] off		10	1319	*
9	2.85	3/4" chain							
10		Nortek	333	12:07			15	1322	[illegible] facing up
11		SBE37	1901	12:07			16	1323	
12	2.25	3/4" chain							
13		VMCM	030	12.04	12:02 [illegible]		20	1324	FISHING LINE IN PROPS
14	2.78	3/4" chain							
15		TPOD	3764	12 02			25	1330	
16	3.66	3/4" chain							
17		SBE37	1905	12:00			30	1331	
18	0.52	3/4" chain							
19		Sontek	D197	12:00			32.5	1335	ADCM facing down
20	1.59	3/4" chain							

Date/Time	Comments
Oct. 14, 2005	12:24 Buoy in water
Oct. 18 2006	12 38 (VIA SMALL BOAT) - LINE FROM SHIP TO BUOY
	FLOATING SST SENSOR MOVING 'SLUGGISHLY' DUE TO BIOFOULING
	1254 BUOY OUT OF WATER ON A FRAME
	1258 BUOY ON DECK

* VM 57 BEARINGS GONE, PROPELLER ALIGNMENT BAD; EDGE OF PROP HITS CAGE BAR ON UPPER PROP

MOORED STATION NUMBER 116[illegible]3

Item No.	Lgth [m]	Item	Inst No.	Time Over	Notes	Data No.	Calc Dpth	Time Back	Notes
21		TPOD	3839	11:57			35	1335	
22	3.66	3/4" chain							
23		SBE37	1912	11:55			40	1338	
24	3.30	3/4" chain							
25		VMCM	029	11:53	11:48 bands off		45	1341	JAMMED WITH FISHING LINE
26	15.25	7/16" wire							
27		SBE37	1902	12:47			62.5	1421	
28	6.2	7/16" wire							
29		TPOD	4481	12:50			70	1425	
30	6.2	7/16" wire							
31		TPOD	4488	12:53			77.5	1428	
32	6.2	7/16" wire							
33		SBE37	1910	12:55			85	1432	
34	6.2	7/16" wire							
35		TPOD	4489	12:56			92.5	1437	
36	5.1	7/16" wire							
37		VMCM	053	13:00	12:56 bands off		100	1440	WIRE TO PROPS
38	12.8	7/16" wire							
39		TPOD	4494	13:04			115	1445	
40	13.5	7/16" wire							

Date/Time	Comments
2006/10/18 1402	VANES OFF

MOORED STATION NUMBER 11645

Item No.	Lgth [m]	Item	Inst No.	Time Over	Notes	Data No.	Calc Dpth	Time Back	Notes
41	~~3.35~~	SBE37	1903	13:06			130	1448	
42	3.66	3/4" chain							
43		RDI	1220	13:09			135	1451	
44	8	7/16" wire							
45		VMCM	076	13:12	13:09 bands off		145	1454	LOWER PROPS SPINNING, UPPER PROPS STUCK WITH ~~WIRE~~ LINE
46	12.8	7/16" wire							
47		SBE16	0927	13:15			160	1459	
48	13.5	7/16" wire							
49		TPOD	4495	13:17			175	1502	
50	6.2	7/16" wire							
51		SontK	D193	13:19			183	1506	ADCM facing down
52	6.2	7/16" wire							
53		SBE16	1877	13:23			190	1509	PRESSURE PLUGS SLIGHTLY BENT
54	28.5	7/16" wire							
55		SBE16	0928	13:26			220	1514	
56	13	7/16" wire							
57		VMCM	008	13:29	13:26 bands off		235	1518	PROPS SPINNING FREELY
58	13	7/16" wire							
59		SBE16	0914	13:31			250	1522	
60	38	3/8" wire							

Date/Time	Comments
	RDI AT 135 M WAS UP-FACING (JUST TO CONFIRM)

MOORED STATION NUMBER 1143

Item No.	Lgth [m]	Item	Inst No.	Time Over	Notes	Data No.	Calc Dpth	Time Back	Notes
61		VMCM	034	13.34	13:31 bands off		290	1527	fishing wire top spinning, bottom not
62	3	3/8" wire							
63		SBE16	0993	13:37			310	1534	fishing line
64	38	3/8" wire							
65		VMCM	040	13:39	13:37 bands off		350	1541	PROPS OUT SPINNING
66	300	3/8" wire						1610 -	
67		SBE39	0282	13:42			400	1614	clamped on
68		SBE39	0205	13:43			450	1616	clamped on
69	500	3/8" wire		13:55				1629 -	
70	500	3/8" wire		14:17				1644 -	
71	100	3/8" wire		14:47				1655 -	one piece wrapped termination
72	200	7/8" nylon		14:52					
73	150	7/8" nylon		15 00					
74	1500	7/8" nylon		15:11				1721 -	one piece spliced
75	100	1" nylon		15:47					
76	1500	1 1/8" poly		15:50					
77		17" Glass Balls		17:12	All balls in			1835 -	40 total on 1/2" chain
78	5	1/2" chain		17:19					
79		Acoustic Release		17:26					EG&G Model 8242
80									

5m → 1/2" chain

Date/Time	Comments
Oct. 14, 2005	4123-5 (500m) and 4069-24 (100m) wire shots have cracks

~~||||~~ ~~||||~~ ~~||||~~ ~~||||~~ |||

MOORED STATION NUMBER 11643

Item No.	Lgth [m]	Item	Inst No.	Time Over	Notes	Data No.	Calc Dpth	Time Back	Notes
81	5	½" chain		17:26					
82	20	1" Samson Nystron		17:36					
83	5	½" chain		17:51					
84		Anchor		17:51					Wet Wt. 8000 lbs
85									
86									
87									
88									
89									
90									
91									
92									
93									
94									
95									
96									
97									
98									
99									
100									

Date/Time	Comments

APPENDIX E. STRATUS 2006 RADIOSONDE LOG

STRATUS 2006 Radiosonde Log

Date-Time (UTC)	#	Max mb	Max ht	Comment
20061011-1815	T	57.7	19867	Test/training launch
20061013-1057	1	89.4	17209	10 deg inversion ~1km
20061013-1659	2	49.4	20771	
20061013-2259	3	57.7	19788	
20061014-0459	4	32	23428	
20061014-1056	5	59.8	19550	
20061014-1659	6	29.8	23851	
20061014-2258	7	57	19852	
20061015-0455	8	35	22860	
20061015-1054	9	32.8	23270	
20061015-1456	10	38.6	22246	
20061015-1856	11	23.1	25415	Starting WHOI transits
20061015-2257	12	39.8	22042	No archive file, only EDT
20061016-0301	13	37.1	22500	
20061016-0702	14	28.1	24201	On station for WHOI
20061016-1056	15	39.3	22100	New buoy in water as launch ended
20061016-1501	16	208	12105	Lost signal, trouble with sonde at launch
20061016-1945	17	35.9	22654	Late due to working on C-Band
20061016-2253	18	39	22135	
20061017-0301	19	31.7	23423	
20061017-0703	20	30.9	23613	
20061017-1058	21	39	22129	
20061017-1455	22	35.1	22827	
20061017-1900	22	121	15400	Decorated balloon for TAS
20061017-2256	23	30.1	23753	
20061018-0259	24	89.1	17195	
20061018-0654	25	371	8074	
20061018-1059	26	26.1	24647	
20061018-1456	27	36.8	22509	
20061018-1859	28	35.2	22771	
20061018-2259	29	43.2	21486	
20061019-0301	30	37.2	22434	Poor signal top of flight
20061019-0655	31	45.3	21212	
20061019-1056	32	35.7	22674	
20061019-1457	33	106.1	16168	Lost signal
20061019-1859	34	54.3	20099	
20061019-2256	35	82.7	17608	
20061020-0253	36	76.6	18079	

STRATUS 2006 Radiosonde Log

Date-Time (UYC)	#	Max mb	Max ht	Comment
20061020-0703	37	159.5	13742	
20061020-1057	38	157.3	13819	Possible interference from Argos signal 401MHz
20061020-1459	39	28.1	24216	Argos float deployed before this launch Heading for DART buoy
20061020-1856	40	75.3	18185	RS90 sonde poor winds at launch!! Poor signal
20061020-2252	41	35.2	22764	
20061021-0252	42	57.9	19747	
20061021-0653	43	43	21544	
20061021-1056	44	42.8	21584	
20061021-1459	45	35.9	22687	
20061021-1857	46	45.7	21193	
20061021-2307	47	51.6	20450	One bad older RS92 no satellites!!
20061022-0301	48	22.3	25734	
20061022-0654	49	43.6	21475	
20061022-1104	50	36.4	22607	One bad older RS92 no satellites!!
20061022-1455	51	32.3	23372	
20061022-1900	52			
20061022-2300	53			
20061023-0300	54			
20061023-0700	55			
20061023-1100	56			
20061023-1500	57			
20061023-1900	58			
20061023-2300	59			
20061024-0300	60			
20061024-0700	61			
20061024-1100	62			
20061024-1500	63			
20061024-1900	64			
20061024-2300	65			
20061024-0300	66			
20061024-0700	67			
20061024-1100	68			
20061024-1500	69			
20061024-1900	70			
20061024-2300	71			
20061025-0300	72			
20061025-0700	73			
20061025-1100	74			
20061025-1500	75			
20061025-1900	76			
20061025-2300	77			

50272-101

REPORT DOCUMENTATION PAGE	1. REPORT NO. 2007-01	2.	3. Recipient's Accession No.

4. Title and Subtitle
Stratus Ocean Reference Station (20°S, 85°W) Mooring Recovery and Deployment Cruise, R/V *Ronald H. Brown* Cruise 06-07 October 9, 2006–October 27, 2006

5. Report Date February 2007

6.

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8. Performing Organization Rept. No.

9. Performing Organization Name and Address

Woods Hole Oceanographic Institution
Woods Hole, Massachusetts 02543

10. Project/Task/Work Unit No.

11. Contract(C) or Grant(G) No.
(C) NA17RJ1223
(G)

12. Sponsoring Organization Name and Address
National Oceanic and Atmospheric Administration

13. Type of Report & Period Covered
Technical Report

14.

15. Supplementary Notes
This report should be cited as: Woods Hole Oceanog. Inst. Tech. Rept., 2007-01.

16. Abstract (Limit: 200 words)

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

During the October 2006 cruise of NOAA's R/V *Ronald H. Brown* to the ORS Stratus site, the primary activities where recovery of the Stratus 6 WHOI surface mooring that had been deployed in October 2005, deployment of a new (Stratus 7) WHOI surface mooring at that site, in-situ calibration of the buoy meteorological sensors by comparison with instrumentation pub on board by staff of the NOAA Earth System Research Laboratory (ESRL, formerly ETL), and observations of the stratus clouds and lower atmosphere by NOAA ESRL. A buoy for the Pacific tsunami warning system was also serviced in collaboration with the Hydrographic and Oceanographic Service of the Chilean Navy (SHOA). The old DART (Deep-Ocean Assessment and Reporting of Tsunami) buoy was recovered and a new one deployed which carried IMET sensors and subsurface oceanographic instruments. Argo floats and drifters were also launched and CTD casts carried out during the cruise. The ORS Stratus buoys are equipped with two Improved Meteorological (IMET) systems, which provide surface wind speed and direction, air temperature, relative humidity, barometric pressure, incoming shortwave radiation, incoming longwave radiation, precipitation rate, and sea surface temperature. The IMET data are made available in near real time using satellite telemetry. The mooring line carries instruments to measure ocean salinity, temperature, and currents. The ESRL instrumentation used during the 2006 cruise included cloud radar, radiosonde balloons, and sensors for mean and turbulent surface meteorology. Stratus 7 also received a new addition to its set of sensors: a partial CO2 detector from the Pacific Marine Environmental Laboratory (PMEL). Aerosol measurements were also carried out onboard RHB by personnel of the University of Hawaii. Finally, the cruise hosted a teacher participating in NOAA's Teacher at Sea Program.

17. Document Analysis a. Descriptors

Stratus
upper ocean
air-sea interaction

b. Identifiers/Open-Ended Terms

c. COSATI Field/Group

18. Availability Statement	19. Security Class (This Report)	21. No. of Pages
Approved for public release; distribution unlimited.	UNCLASSIFIED	154
	20. Security Class (This Page)	22. Price

(See ANSI-Z39.18) *See Instructions on Reverse* OPTIONAL FORM 272 (4-77)
(Formerly NTIS-35)
Department of Commerce