WHOI-2014-06

Woods Hole Oceanographic Institution

Stratus 13
Thirteenth Setting of the Stratus Ocean Reference Station

Cruise On Board RV *Ron Brown*
February 25 - March 15, 2014
Valparaiso, Chile - Arica, Chile

by

Sebastien Bigorre,[1] Robert A. Weller,[1] Jeff Lord,[1] Nancy Galbraith,[1] Sean Whelan,[1]
James Coleman,[2] Marcela Pas Contreras,[3] Cristóbal Aguilera,[3]

Woods Hole Oceanographic Institution
Woods Hole, MA 02543

July 2014

Technical Report

Funding was provided by the National Oceanic and Atmospheric Administration
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Upper Ocean Processes Group
Woods Hole Oceanographic Institution
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UOP Technical Report 2014-03

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Albert J. Plueddemann, Chair

Department of Physical Oceanography

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, 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 past cruises that have come between October and January. This cruise was conducted on the NOAA vessel *Ron Brown*.

During the 2014 cruise on the *Ron Brown* to the ORS Stratus site, the primary activities were the recovery of the previous (Stratus 12) WHOI surface mooring, which was adrift since January 25 2014 and drifting northwest, deployment of the new Stratus 13 WHOI surface mooring, in-situ calibration of the buoy meteorological sensors by comparison with instrumentation installed on the ship, CTD casts near the moorings. Surface drifters and subsurface floats were also launched along the track.

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I. Introduction

A. Timeline

The Stratus 13 cruise originated in Valparaiso, Chile on February 25, 2014 and ended in Arica, Chile on March 14, 2014. The track (Figure 1-1) was set to first catch the top of the Stratus 12 mooring, which had parted in late January, then service the NDBC DART installation, then set Stratus 13, and finally recover the bottom of Stratus 12 and complete work at the Stratus site before going into Arica, Chile. WHOI Upper Ocean Processes Group staff left Boston on February 15, arriving in Vina del Mar on February 16. An overview of the chronology of the cruise is provided below. We used Chile (UTC -3) summer daylight saving time during the cruise.

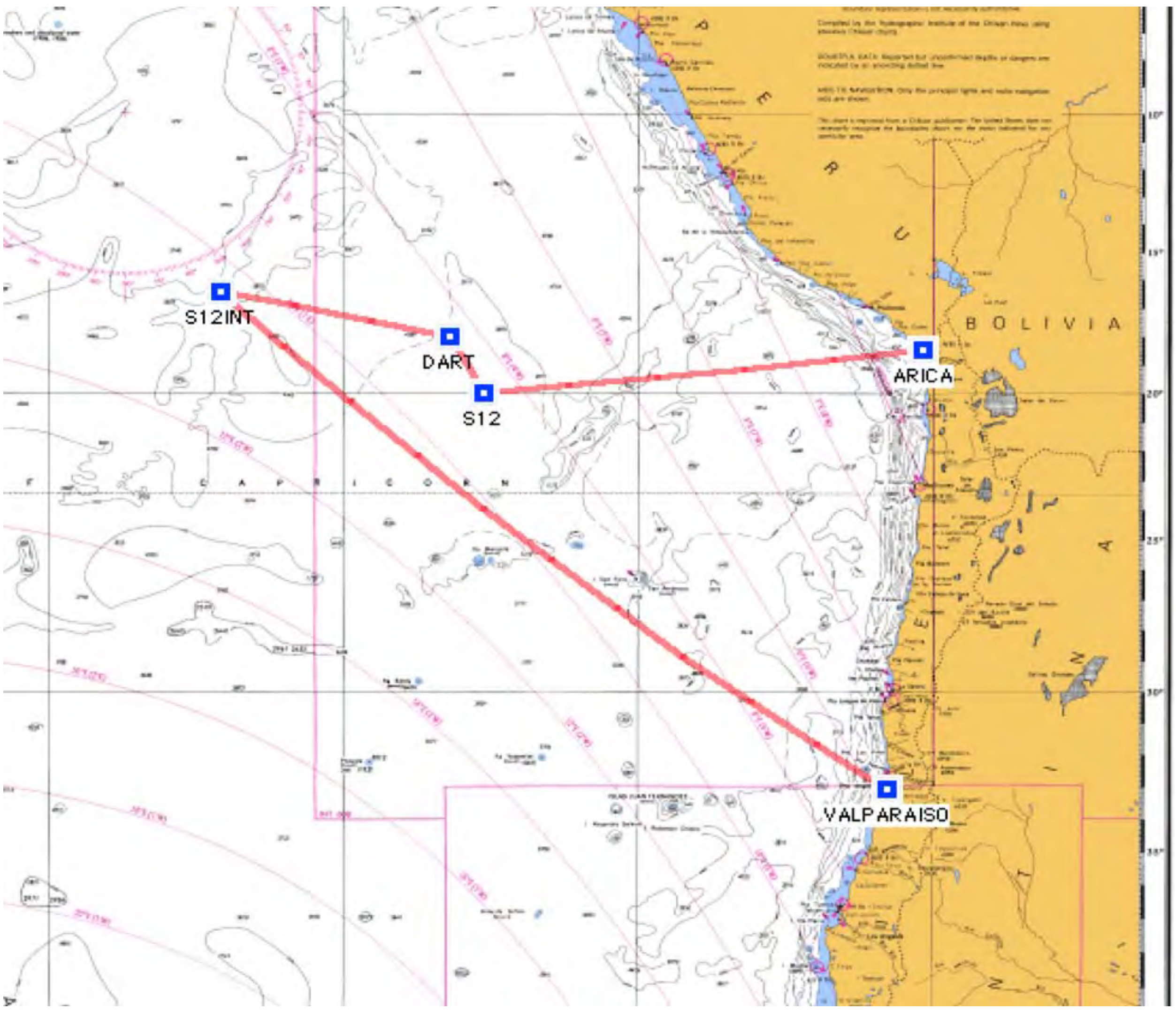


Figure 1-1. Stratus 13 cruise itinerary Valparaiso – Stratus 12 drifting interception –DART tsunami mooring - WHOI Stratus mooring – Arica, Chile.

February 16, Sunday: WHOI personnel arrived in Valparaiso.

February 17, Monday: 20 ft containers and NDBC loaded on ship, which is moored on its port side. One container arrives at 23:00 and is loaded as well.

February 18, Tuesday: Loading finishes. Buoy assembled on back deck.

February 19, Wednesday: Ship anchored outside port. Installed lab equipment, GPS antennae.

February 20, Thursday: NDBC personnel aboard. Loaded 40 ft container on ship. Installed wind flux system on bow mast, 248 inches above deck (deck is 255 inches above waterline; wind height is therefore 12.77 m above water). Argplot running.

February 21, Friday: Buoy with ASIMET systems running and data checked through Argplot. Wind flux system running. No calibration done.

February 22-24: Finish preparations. Lab setup.

February 25, Tuesday: Departed from Valparaiso at 9:30 am local. Fire and abandon ship drills.

February 26, Wednesday: Sailing northwest towards drifting Stratus 12 buoy. Wind is consistently behind us; sailing at 12.5 kn. Leave Chilean waters; start ARGO float and drifter deployments. Re-enter Chilean waters (San Felix islands), stop sampling, stop drifters and float deployments.

February 27, Thursday: Heading northwest to Stratus 12 buoy.

February 28, Friday: Heading northwest to Stratus 12 buoy. Leave Chilean waters. Watch schedule starts. Deploy surface drifters and ARGO floats at regular longitude intervals.

March 1-2: Continue surface drifters and ARGO floats deployments. Watch stops on March 2 in afternoon as we approach Stratus 12 intercept point.

March 3, Monday: Arrival at buoy around 00:30 local; see lights in the night, radar reflector 8.3 miles away. Ship stays on station away and downwind of buoy during the night, to avoid any entanglement in case of drifting line behind buoy. First light, visual inspection. At 09:30 local, small boat launched, attach a line. Buoy ride deemed too precarious because buoy bobs quite a bit. Stratus 12 buoy recovered in the morning through A-frame. Only two instruments are still present on the mooring line under the buoy. A shackle failed apparently. A drifting fishing buoy is entangled to bridle. Depart site at 10:30 local and sail east southeast towards DART site. Watch resumes, surface drifter launches resume.

March 4, Tuesday: Sailing towards DART. Deploy surface drifters and ARGO floats. Fire and abandon ship drills. Fill and drain PRCs on Stratus 13 buoy.

March 5, Wednesday: Sailing towards DART. Dumped data from Stratus 13 spare HRH module (HRH250) mounted on O3 deck. Compares well with primaries on Stratus 13 buoy on fantail. Ship's HRH has a high bias (worse since ship changed course towards east southeast). Arrive at DART. At ~12:00 local, talk to DART release, recover BPR and deploy new BPR and surface mooring nearby. Leave for Stratus around midnight.

March 6, Thursday: Sailing towards STRATUS. Arrive at Stratus 13 location around midday. Bathymetry survey. CTD casts to 1,500m and test releases.

March 7, Friday: Deployed Stratus 13. Rig and deploy surface test array, attached to Stratus 13 buoy.

March 8, Saturday: Recovered subsurface part of Stratus 12. Anchor released at 07:54 local spotted at surface about 200 yards ahead of the ship about an hour later. Wind is 12 to 14 kn, coming from 110 to 130 degrees. Recovery ends around 20:30 local. Ship sails back to Stratus 13 buoy.

March 9, Sunday: At Stratus 13 for ship-buoy comparisons. Anchor survey. Two CTD casts to 4000m. Close look at Stratus 13. Clean up of instruments from Stratus 12 mooring.

March 10, Monday: At Stratus 13 for ship-buoy comparisons. Recover surface array 16:00 local.

March 11, Tuesday: Sailing east back to Arica. Deploy drifters, Argo floats, floats for Lothar Stramma. Watch schedule resumes. Removed standalone units from O3 deck. Ship's drills. One of the ship's engines turned off so ship's speed reduced to 5-6 kn around 20:00 local.

March 12, Wednesday: Sailing east back to Arica at around 6 kn. Float and drifter launches continue. Removed UOP's ASIMET standalones from O3 deck.

March 13, Thursday: Sailing east back to Arica at around 7 kn. Float and drifter launches continue.

March 14, Friday: Sailing east back towards Arica. Sampling stops before Peruvian and Chilean EEZ.

March 15, Saturday: In port in Arica. Unloading of scientific gear.

B. 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 this system is desirable not only because better understanding of the nature of air-sea interactions in this region is needed, but also because climate models presently have SST fields that are too warm in the eastern South Pacific. There is also the need to collect in-situ data to provide ground truth for remote sensing.

The Ocean Reference Station (ORS) 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 has been recovered and redeployed annually, with cruises that have come between October and May. The Stratus 12 mooring was deployed in May 2012. Its replacement, Stratus 13 mooring, was installed in March 2014 during the Stratus 13 cruise, which is detailed in this report.

During the 2014 cruise on the *R. H. Brown* to the ORS Stratus site, the primary activities were recovery of the WHOI Stratus 12 surface mooring, deployment of the new WHOI Stratus 13 surface mooring at a nearby site. At the Stratus mooring, in-situ calibration of the buoy meteorological sensors was done through comparison with WHOI meteorological sensors mounted on the ship. CTD casts were also done near the new mooring for comparison with newly deployed instruments. A near surface temperature and velocity array was also deployed next to Stratus 13 buoy for a few days. Other work included recovery of NOAA DART 32412 Bottom Pressure Recorder (BPR) and its replacement with a new BPR and surface. Finally surface drifters and subsurface ARGO (and other floats for Lothar Stramma) were launched during the cruise. On January 25 2014 the Stratus mooring broke and the Stratus 12 surface buoy became adrift. On this cruise we therefore had to intercept the drifting buoy, which had travelled 1000 miles to the northwest.

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 buoy is outfitted with a PCO_2 sampling system from Chris Sabine (NOAA Pacific Marine Environmental Laboratory, PMEL). It also contains a wave-measuring package designed by NDBC. The IMET data are made available in near real time using satellite telemetry. The mooring line carries instruments to measure ocean salinity, dissolved oxygen, temperature, and currents.

The Stratus 13 buoy must be assembled and tested after shipping and final preparations to moored instrumentation for Stratus 13 carried out. Equipment for the Stratus 13 and NDBC DART was therefore loaded onto the *R. H. Brown* in Valparaiso on February 18 and 19, 2014 and pre-deployment preparation was completed on board the ship in port in Valparaiso. The cruise ended in Arica, where the Stratus gear was unloaded and the science party returned home.

In preparation for the cruise, the Chief Scientist had asked NOAA to apply for clearance to sample in Chilean waters. Due to NOAA's late scheduling of this cruise, there was no chance of obtaining clearance from Chile. The inability to obtain clearance was not communicated until days before the start of the cruise. Plans for AOML drifter deployments and Argo float deployments in Chilean waters were changed at that point so that all deployments would be in international waters.

II. Cruise Preparations

A. Staging and Loading in Valparaiso

On January 8, 2014, two forty-foot containers and two 20-foot containers, loaded with the buoy, mooring components and cruise support gear, were shipped from Woods Hole, Massachusetts to Valparaiso, Chile, in preparation for the Stratus 13 cruise. Arrangements were made with AJ Broom, our agent in Chile, to accept the equipment and provide support for WHOI. This support included a staging area, forklift support, shore crane, and port access. Five WHOI personnel traveled to Valparaiso on February 15, arriving in the afternoon of February 16.

On February 17, WHOI personnel were in Valparaiso's port to begin preparations for the cruise. A first container was delivered on the berth where the *R. H. Brown* was moored. A forklift and crane were available to assist with the unloading of WHOI and NDBC containers, removal of containers from previous scientific expedition from the ship and loading of WHOI 20 foot containers onto the ship. The buoy tower top and hull were assembled with the small crane on the fantail.

During the remaining of the week loading continued as the 40 foot container was delivered later and to allow for crew rest. Cruise personnel set up the local Argos receiver, GPS stations, and the WHOI flux system on the bow mast. Buoy assembly continued and its ASIMET data was transmitted through Argos telemetry. Two Chilean students from the University of Concepcion, completed the science party (see Table 2-1) on February 24. The *R. H. Brown* left Valparaiso at 09:30 local on February 25.

Table 2-1. Scientific participants onboard R/V *Ron Brown* during Stratus 13 cruise.

	Name	Institution	Position
1	Dr. Robert Weller	WHOI	Chief Scientist
2	Mr. Jeff Lord	WHOI	Group Ops Leader
3	Mr. Sebastien Bigorre	WHOI	Research Associate
4	Mr. Sean Whelan	WHOI	Instrumentation Lead
5	Ms. Nancy Galbraith	WHOI	Information Systems
6	Mr. James Coleman	NDBC	DART Technician
7	Mr. David Parrett	NDBC	DART Technician
8	Mr. Cristobal Andrés Aguilera Bravo	Univ. Concepcion	Student
9	Ms. Marcela Pas Contreras	Univ. Concepcion	Student

B. Buoy spin

Buoy spin was conducted in Woods Hole on December 27 2013. The buoy spin is a procedure to check the compasses in the wind sensors mounted on the buoy. A visual reference direction is first set using an external compass. The buoy is then oriented successively at 8 different angles with respect to the reference and the vanes of the anemometers are visually oriented towards the reference direction, and blocked. Wind is recorded for 15 minutes at the end of which the average compass and wind direction is read. Their sum 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. Buoy spin results are shown in Figure 2-1, where compass error is plotted as a function of buoy orientation and the sinusoidal curve is symptomatic of the buoy spin procedure. Compasses on ASIMET wind sensors meet expectations but Vaisala WXT unit has larger errors. See Appendix 1 for the details of the buoy spin.

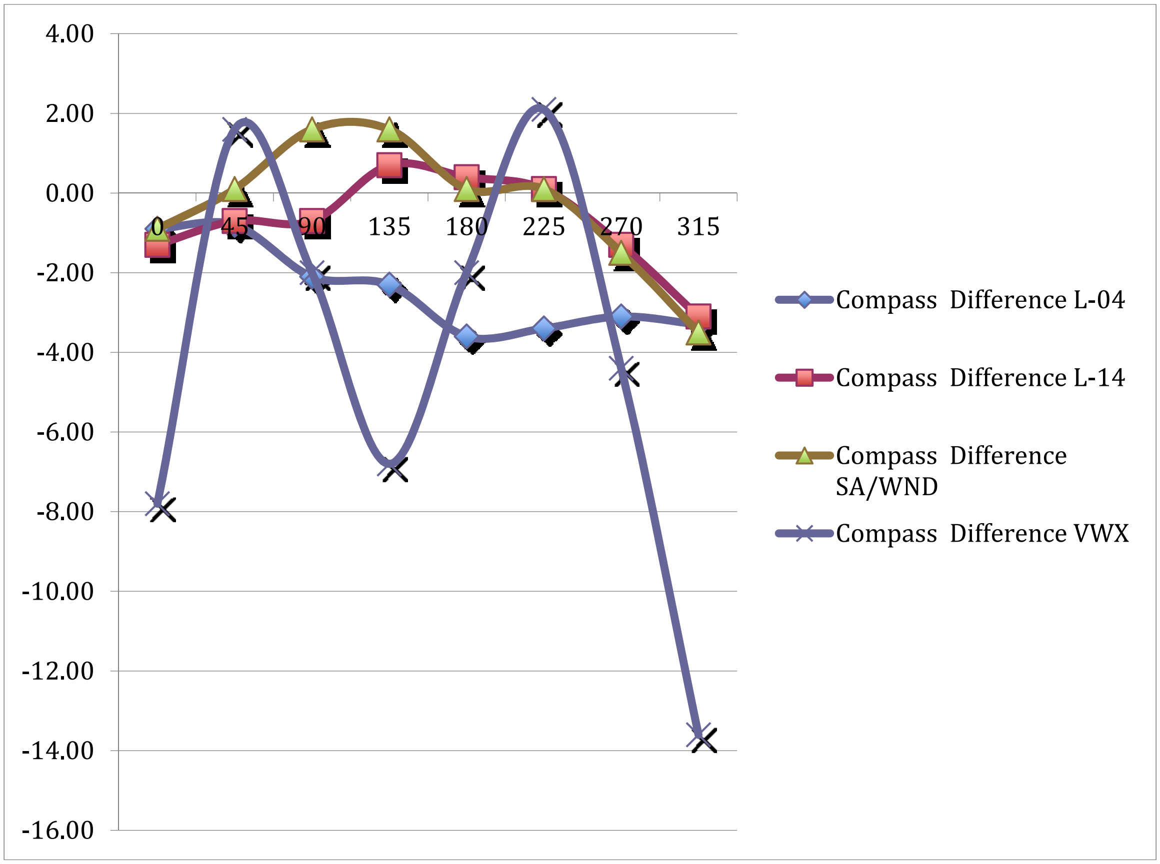


Figure 2.1. Buoy spin of Stratus 13 buoy, in Woods Hole on December 27 2013.

C. Sensor Evaluation and Burn-in

Testing (burn-in) for the ASIMET units deployed on the Stratus 13 buoy began at WHOI in December 2013. Further burn-in was conducted in February while the buoy was on the back deck of the *Ron Brown*. Data from December 2013 burn-in evaluation (see Fig. 2-2 to 2-8) are the 1-minute values recorded in primary loggers 4 and 14 and spare logger 17, and standalone sensors when available. Figures 2-9 and 2-10 show 1-hourly averaged data from the two primary loggers and transmitted through Argos telemetry, while the buoy had just been deployed and the ship was still nearby the mooring. Figure 2-9 shows telemetry data but for rain accumulation only to emphasize performance of precipitation gauges near the fill and drain procedure on March 4.

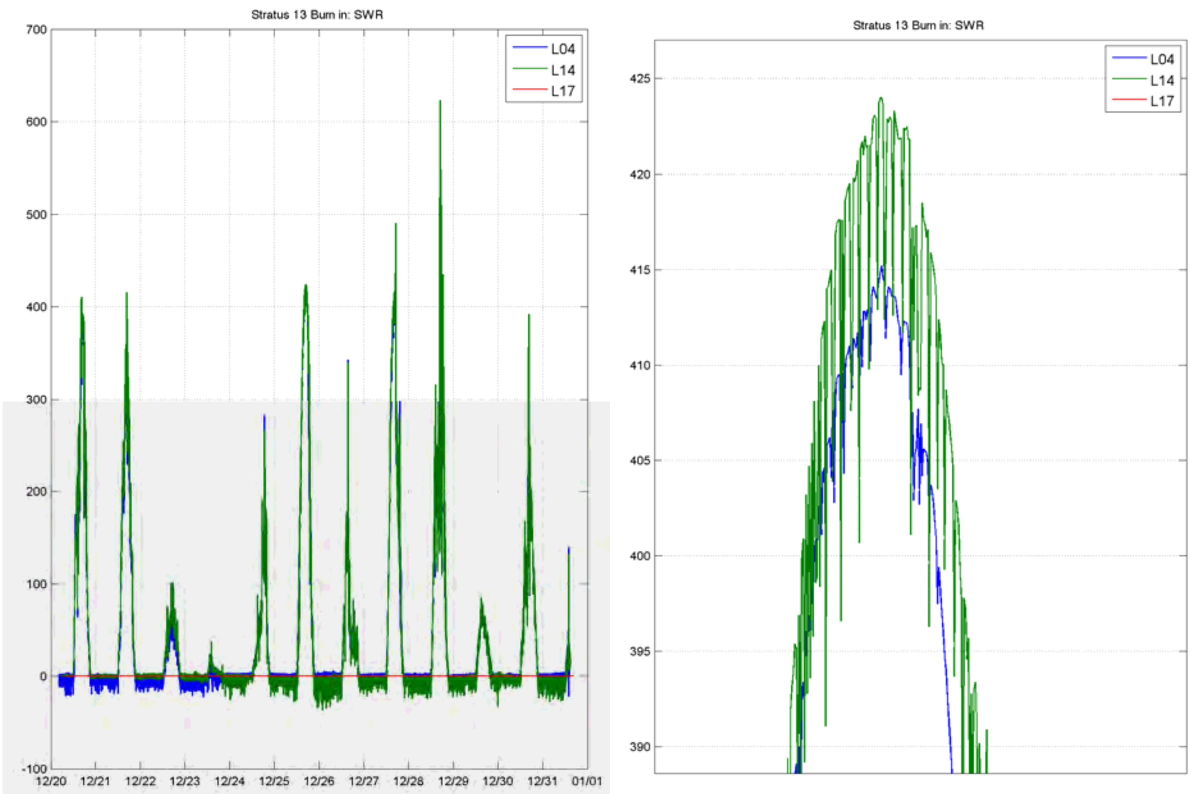


Figure 2-2. Stratus13 burn-in in Woods Hole. Left panel: all period. Right panel: zoom during sunny period (Dec. 25). 1-minute downward shortwave solar radiation (SWR) data, in Wm^{-2}.

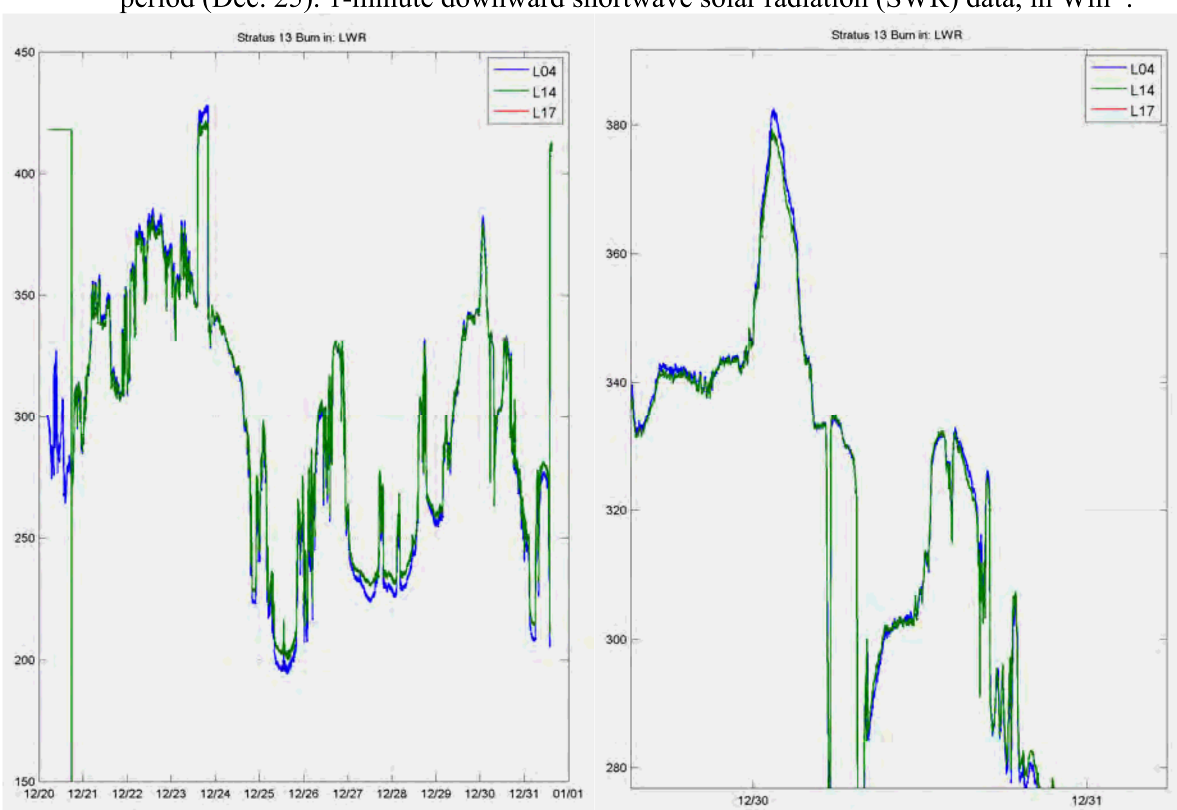


Figure 2-3. Same as Fig. 2-2, but for downward longwave radiation (LWR), in Wm^{-2}.

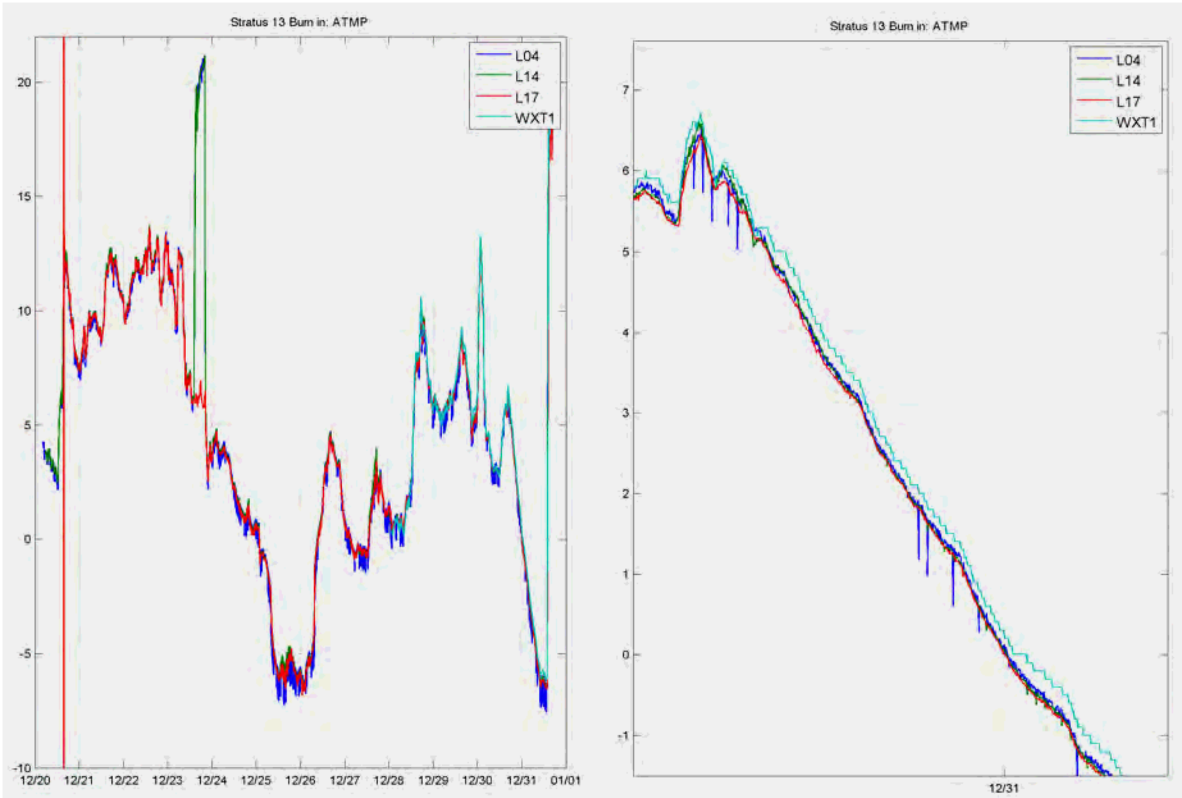


Figure 2-4. Same as Fig. 2-2, but for air temperature (ATMP), in deg °C. Other data from spare logger and Vaisala WXT also shown.

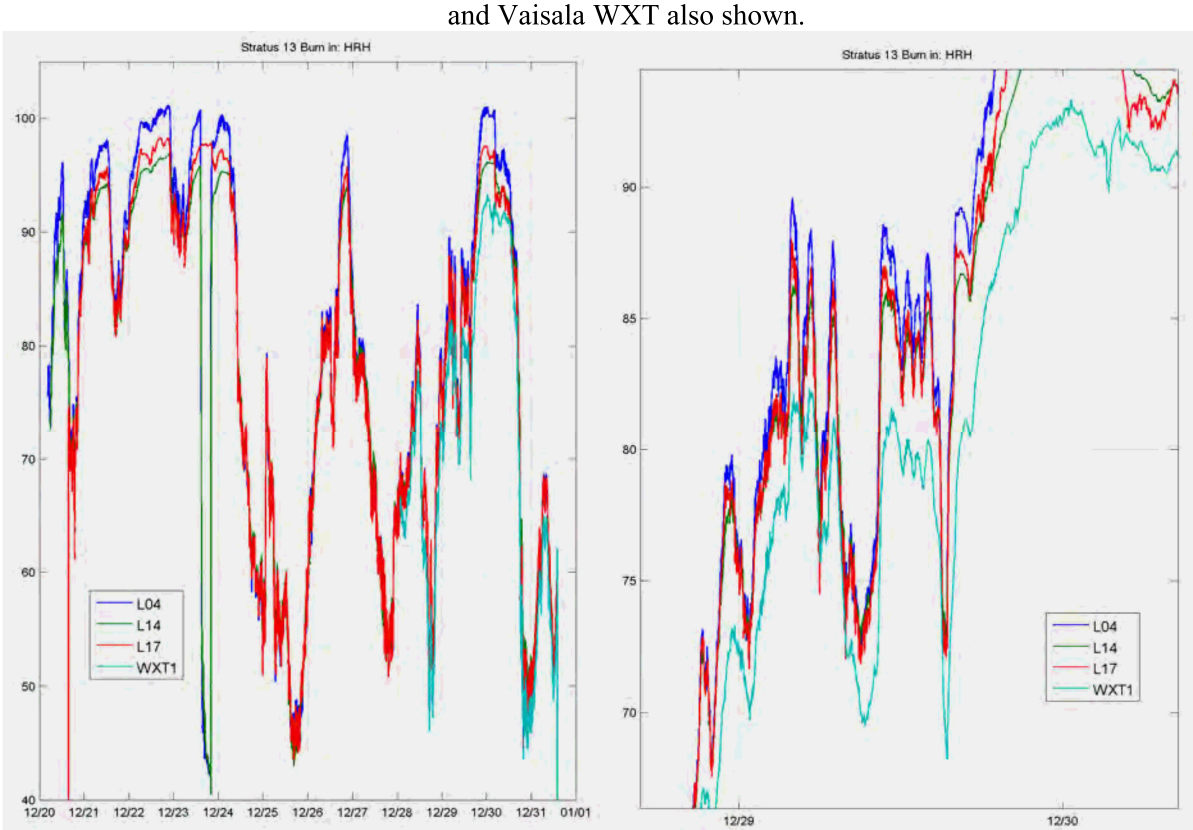


Figure 2-5. Same as Fig. 2-4, but for air relative humidity (HRH), in %RH.

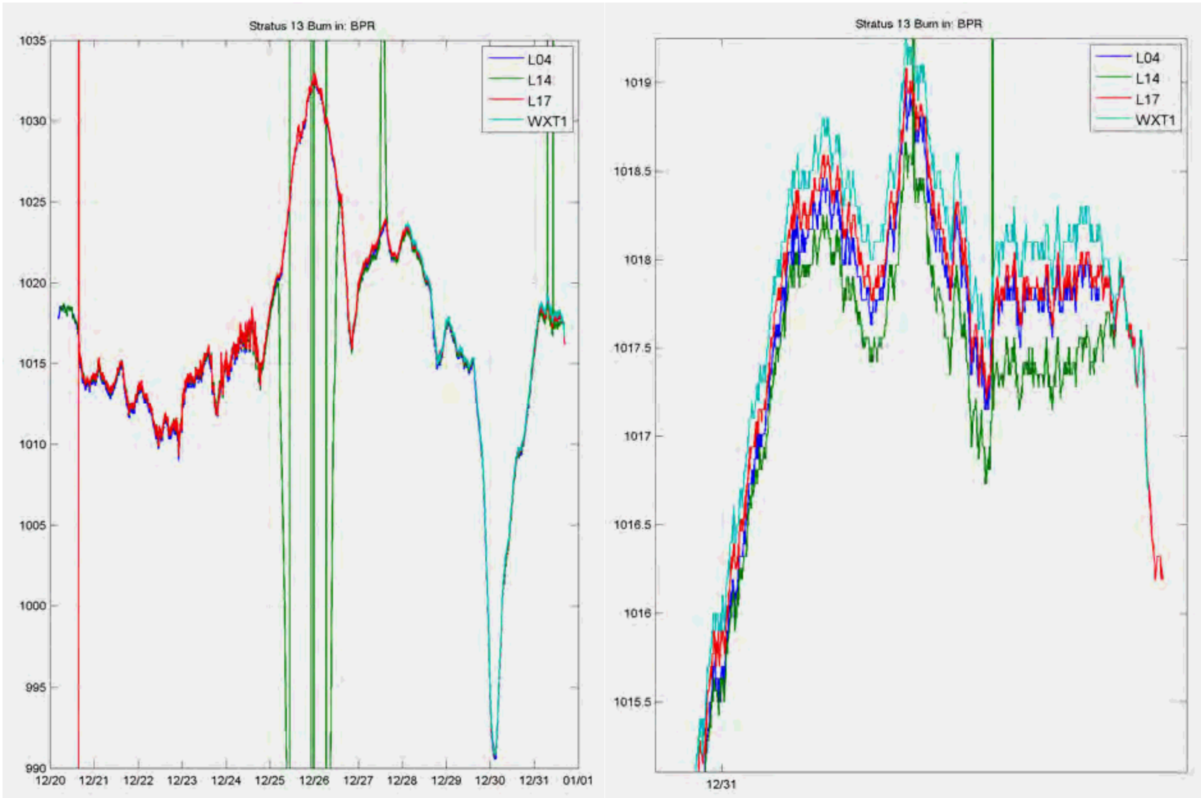


Figure 2-6. Same as Fig. 2-4, but for barometric pressure (BPR), in mb.

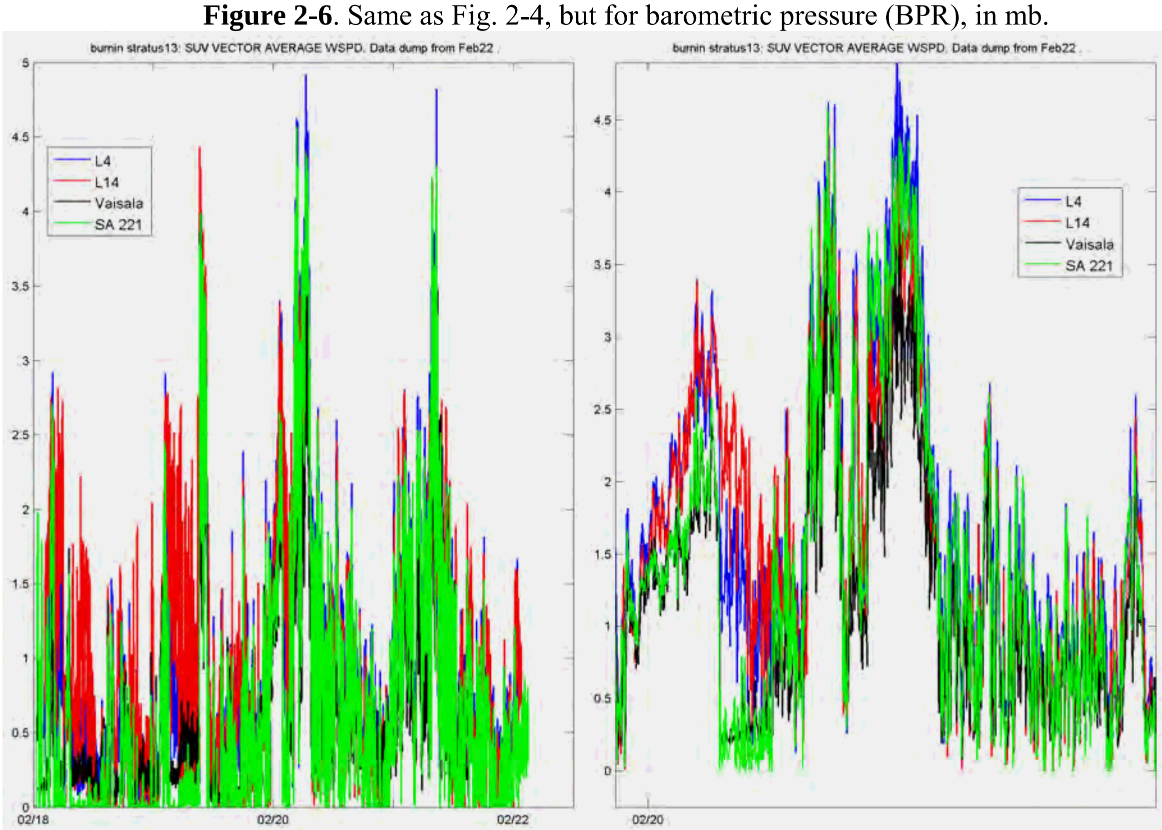


Figure 2-7. Wind speed from primary and standalone ASIMET, Vaisala WXT, on Stratus 13 buoy while `` on ship's fantail in later February. Right panel is a zoom on first half of February 20.

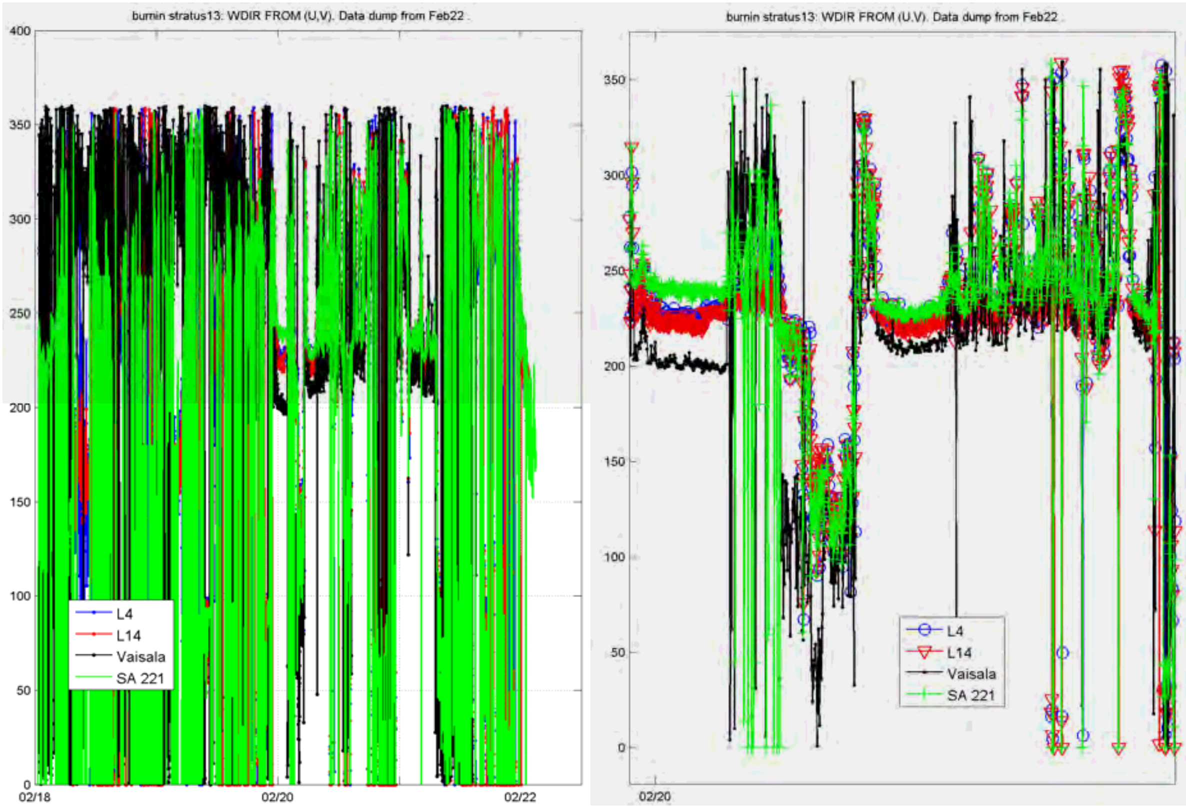


Figure 2-8. Same as Fig. 2-7 but for wind direction.

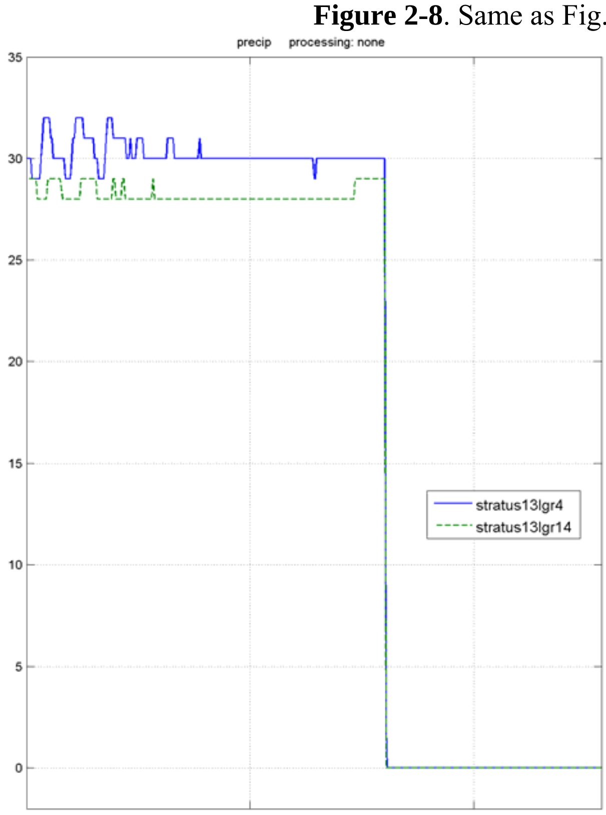


Figure 2-9. ASIMET precipitation accumulation data from Stratus 13 buoy, acquired by telemetry in early March. Fill and drain occurred on March 4.

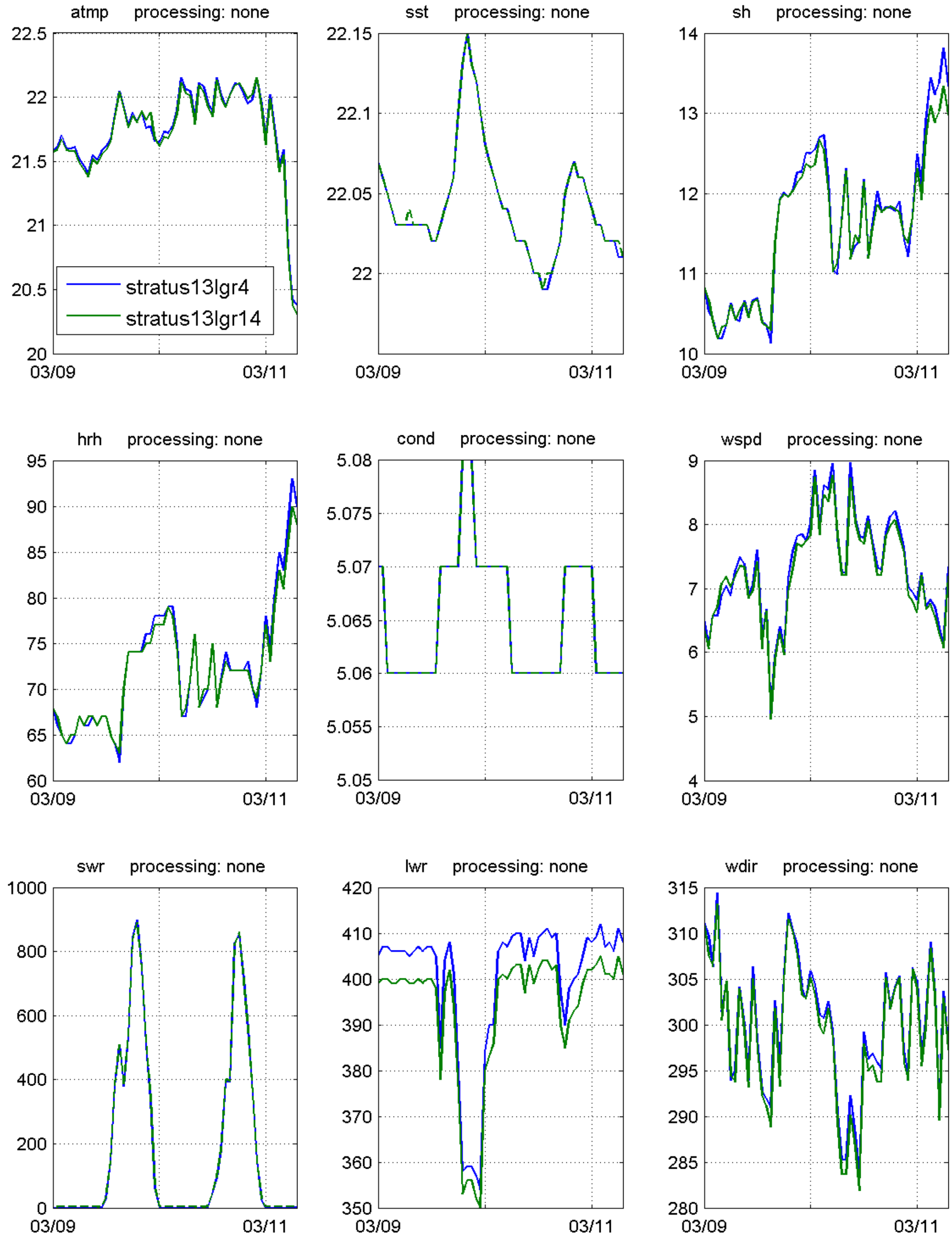


Figure 2-10. Last evaluation of Stratus 13 ASIMET measurements using hourly averaged telemetry data, collected during the inter-comparison period centered on March 10 2014.

III. Stratus 13 Mooring

A. Mooring Design

The buoys used in the Stratus project are equipped with surface meteorological instrumentation, including two Improved Meteorological (IMET) systems (see Figure 3-1). The mooring line also carries subsurface instrumentation that measures conductivity and temperature and a selection of acoustic current meters and profilers and vector measuring current meters (VMCM).

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 13 surface buoy has a 2.7-meter diameter foam buoy with an aluminum tower and rigid bridle. The design of these surface moorings takes into consideration the predicted currents, winds, and sea-state conditions expected during the deployment duration. See Figure 3-2 for the full mooring drawing.

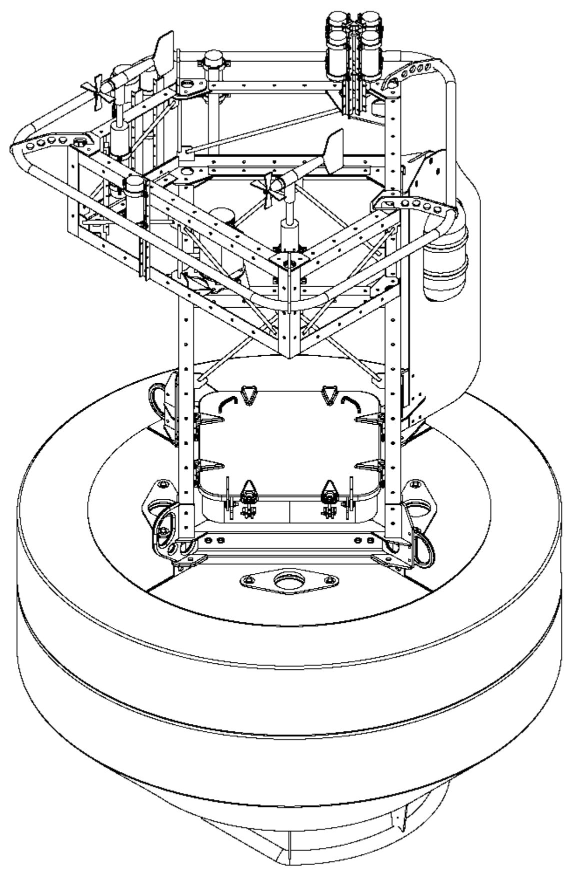
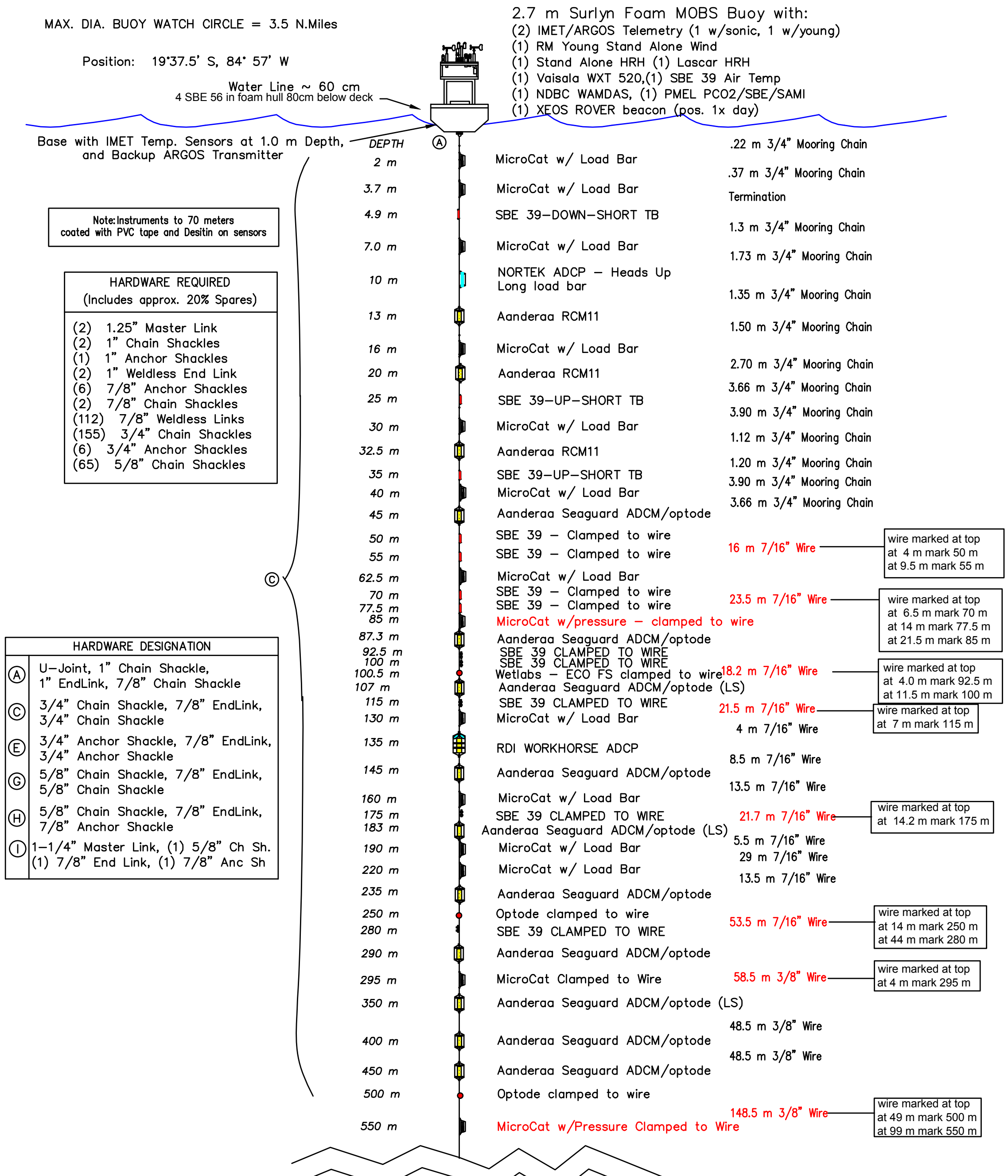


Figure 3-1: Representation of Stratus 9 ASIMET buoy (Stratus 13 is similar).

03/02/2014

PO # 1265

STRATUS 13TH DEPLOYMENT
final - as deployed 3/8/2014



SHEET 1 OF 2

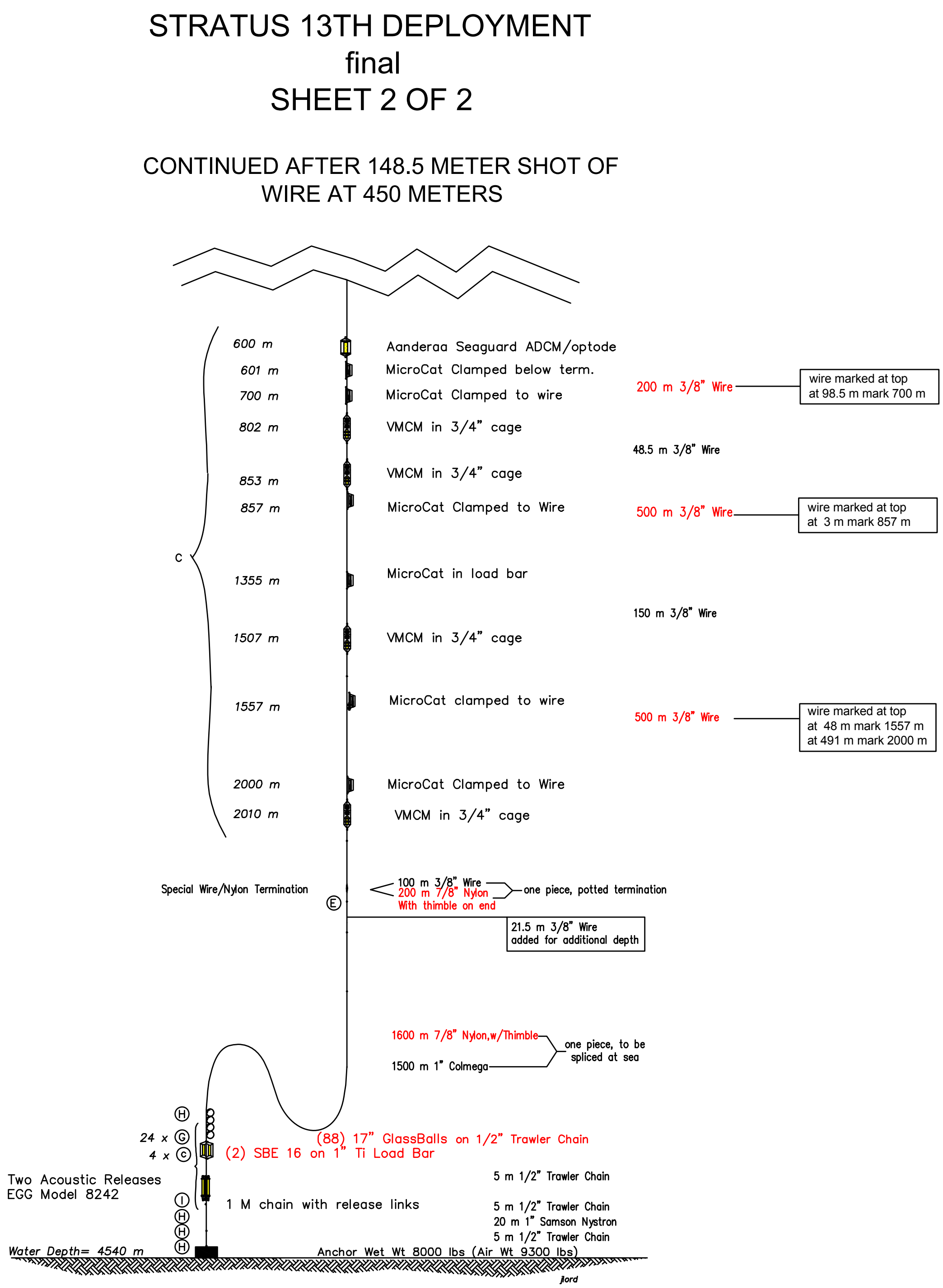


Figure 3-2. Stratus 13 mooring diagram.

B. Buoy Instrumentation

The Air-Sea Interaction Meteorology (ASIMET) system is a suite of meteorological surface sensors that measure air temperature (ATMP), relative humidity (HRH), sea surface temperature and conductivity (SST, SSC), wind speed and direction (WSPD, WDIR), barometric pressure (BPR), shortwave radiation (SWR), longwave radiation (LWR), and precipitation (PRC). These variables are used to compute air-sea fluxes of heat, moisture and momentum using bulk aerodynamic formulas, (*e.g.* COARE algorithm). On buoys, ASIMET modules (one or more sensors plus front-end electronics) may be self-powered and self-logging, connected to a central power supply and logger, or both. Modules are housed in titanium cylinders and typically deployed in pairs, with meteorological modules mounted on the buoy tower and a pair of temperature-conductivity sensors attached to the bridle leg. A central logger records 1-minute data from all the modules on a common time base, and also creates hourly averaged data that are transmitted to shore via Argos satellite telemetry. Some of the 1-minute data are averages within each minute (see ASIMET documentation on http://frodo.whoi.edu/asimet). The Stratus mooring also includes a pCO2 system from Dr. Chris Sabine of NOAA PMEL and an NDBC wave sensor package.

1) ASIMET

Table 3-1 lists the time of the spikes (ice bath) imposed in the ASIMET data records before deployment on Stratus 13, while Table 3-2 contains the list of ASIMET sensors deployed.

Table 3-1: Stratus 13 surface instrumentation spikes and notes.

Logger 1 (L-04): start 2/18/2014 14:09 All modules start 2/18/2014 14:00, except SST start 2/18/2014 12:00
SWR 504, LWR 205 uncover 2/18/2014 16:57
PRC 502: 300 ml 2/18/2014 17:07. Fill/drain 100 ml 3/4/2014
SST 1838: Start 2/18/2014 12:00. In ice bath 2/19/2014 15:29, out 2/22/2014 11:40. Off 2/25/2014 17:07
Logger 2 (L-14): start 2/18/2014 14:16 All modules start 2/18/2014 14:11, except SST start 2/18/2014 12:00
SWR 226, LWR 221 uncover 2/18/2014 16:57
PRC 207: 300 ml 2/18/2014 17:07. Fill/drain 100 ml 3/4/2014
SST 2053: Start 2/18/2014 12:00. In ice bath 2/19/2014 15:29, out 2/22/2014 11:40. Off 2/25/2014 17:07
WND 221: Start 2/18/2014 12:42
HRH 214 Sensirion: Start 2/18/2014 12:38
SBE 39 1447: Start 2/18/2014 17:00
VWX 1: Start 2/18/2014 12:47
Lascar 243: Start 2/18/2014 17:00
SWR K&Z 801: Start 2/21/2014 12:21. Dump 2/25/2014 14:34. Pulled 2/25 17:00. On O3 deck bow:26. Pulled on 3/1 10:00. Installed new card and arranged cables inside and placed back on O3 deck 3/1 12:02.

Table 3-2. Stratus 13 ASIMET instrumentation on buoy (heights are referenced to buoy deck, which is 60 cm above waterline

System 1			
Module	**Serial**	**Firmware Version**	**Height (cm)**
Logger PORT	**L-04**	LOGR53 v4.11cf	
HRH	**249**	VOSHRH53 v4.29cf	230
BPR	**502**	VOSBPR53 v4.03cf (Heise)	237
SWND	**216**	SONICWND53 v4.11cf	271
PRC	**502**	VOSPRC53 v4.03cf	250
LWR	**205**	VOSLWR53 v4.02cf	279
SWR	**504**	VOSSWR53 v4.01cf	279
SST	**1838**	SBE37-SM 485 V 2.3b	-151
PTT	**12789**	27916, 27917, 27918	
System 2			
Module	**Serial**	**Firmware Version**	**Height (cm)**
Logger STARBOARD	**L-14**	LOGR53 v4.11cf	230
HRH	**247**	VOSHRH53 v4.29cf	237
BPR	**210**	VOSBPR53 v4.03cf (Heise)	267
WND	**239**	VOSWND53 v4.02cf	250
PRC	**207**	VOSPRC53 v4.03cf	279
LWR	**221**	VOSLWR53 v4.02cf	279
SWR	**226**	VOSSWR53 v4.01cf	
SST SBE37	**2053**	SBE37-SM 485 V 2.3b	-151
PTT	**18171**	27919, 27920, 27921	
Stand-Alone Modules			
Module	**Serial**		**Height (cm)**
WND	**221**	VOS WND53V4.02 cf	267
HRH (Sensirion)	**214**	VOS HRH53 V4.40 cf	226
SBE39	**1447**	V 2.2 Sample 300 seconds	234
VWX	**1**	VOSWXT520 v4.03cf	253
LASCAR	**243**	V 0.1	233
SWR K&Z (not deployed)	**801**	VOSSWR53 V4.01cf	279
PCO2 (air block)	**8**		
SAMI	**P21**		
SBE16 (PMEL)	**6566**		
SIS Argos	**11427**		
XEOS Rover beacon		IMEI# 300434060815350	200
NDBC Station 32012 Wave package WAMDAS s/n: 06014 v1.40. 3DM-GX1 8470 Iridium modem IMEI: 300224010100810. SIM: 89881 69312 00205 1278 Magnetic variation = 6.86 degrees East			

2) Sea Surface Temperature

Two Sea-Bird SBE 37s are mounted to the bottom of the buoy hull at approximately one meter depth. These instruments are part of the IMET system and provide data of temperature and conductivity near the sea surface from one single measurement each minute. Hourly averages are also transmitted through Argos in near real time. The full 1-minute data are transmitted to the logger whereas the internal memory of the SBE 37 records only 5-minute data. In addition to these SST sensors, an array of Seabird 56 sensors was placed in holes in the buoy foam hull. Table 3-3 lists the SST instrument array on the buoy hull.

Table 3-3: Stratus 13 Sea Surface Temperature Array. Orientation is in degrees, positive clockwise, with buoy vane=0 (AFT) and buoy front =180 (FORWARD).

Instrument	Serial	Depth Below Deck (cm)	Orientation Degrees
SBE56	2064	-90	0 (AFT)
SBE56	2065	-90	90 (PORT)
SBE56	2066	-90	180 (FORWARD)
SBE56	2067	-90	225 (STARBOARD)

3) Air Temperature and Relative Humidity

Rotronic MP-101A sensor. Accuracy after UOP lab calibration, 1%RH, 0.05°C. Drift (post vs. pre cal after 1 yr): 1%RH, 0.05°C (Colbo and Weller, 2009). The sensor probe is protected by a Rotronic MF25 membrane filter and placed inside a modified R.M. Young multi-plate radiation shield for standard use. Sensors are installed opposite to the buoy vane to provide unobstructed air flow and minimize heat-island effects. Measurement is formed from one single snapshot each minute. There are indications from recent deployments during the past two years that the Rotronic sensors can drift from their calibration after shipping and lead to unacceptable biases. An additional air temperature was therefore installed on Stratus 12 and 13; it consisted of a Seabird SBE 39 with solar shield and sampled air temperature once every 5 minutes.

A new Sensirion HRH sensor was also deployed as a standalone unit on the Stratus 13 buoy to test its performance. According to the manufacturer, resolution for HRH and ATMP are 1.8 %RH and 0.3 °C, while accuracies are 0.05%RH and 0.01 °C. The datasheet also claims drifts less than 0.5%RH and 0.04 °C but mentions these could be higher due to environmental conditions like high concentrations of volatile organic compounds. The SHT75 contains a capacitive sensor element for measuring relative humidity while temperature is measured by a band-gap sensor. For more information, see Sensirion's website: http://www.sensirion.com/en/products/humidity-temperature/humidity-sensor-sht75/.

4) Precipitation

RM Young 50202 Self-siphoning rain gauge. Accuracy of rain rate after lab calibration, 1 mm/hr (Serra et al., 2001). Measurement is formed from one single snapshot each minute.

5) Shortwave radiation

Eppley Precision Spectral Pyranometer (PSP). Accuracy from comparison to standard, 2 W/m^2 (Colbo and Weller, 2009). Drift (post vs. pre calibration after 1 yr): 2 W/m^2 (Colbo & Weller, 2009). Sensor mounted higher than other instruments on buoy to avoid shadowing. One minute sample is formed by averaging over 6 snapshot measurements taken 10 seconds apart.

6) Longwave radiation

Eppley Precision Infrared Radiometer (PIR). Accuracy from comparison to standard, 2 W/m^2 (Colbo and Weller, 2009). Drift (post vs. pre calibration after 1 yr): 2 W/m^2 (Colbo and Weller, 2009). Measurement is formed from one single snapshot each minute.

7) Barometric pressure

Heise DXD (Dresser Instruments). Accuracy after UOP lab calibration, 0.2 mb. Drift (post vs. pre cal after 1 yr): 1.5 mb (Colbo and Weller, 2009). Measurement is formed from one single snapshot each minute.

8) Wind

R.M. Young 5103 wind monitor. Accuracy after UOP lab calibration, 1%, 3 degrees. Drift (post vs. pre cal after 1 yr): 0.1 m/s, 2.0 deg (Colbo and Weller 2009). Sensor is mounted opposite to the buoy vane to avoid flow disturbance. Velocity speed is measured from propeller rotations over 5 seconds, one vane measurement each second, and a single snapshot of compass during these 5 seconds. For each 5 seconds segment, a vector average is formed from the 5 seconds average vane and single snapshot compass. Eleven of these 5 seconds velocity vectors are averaged at the end of the minute interval to form the final velocity output. A scalar average of wind speed is also computed from the rotations of the propellers, but this measurement is noisier and recorded on the memory card with less resolution.

A Gill Sonic Wind Sensor was incorporated on the Stratus 13 buoy. The anemometer measures the time taken for an ultrasonic pulse to travel from one transducer to the opposite transducer and then compares it with the time taken for another pulse to travel in the opposite direction. Likewise, differences are measured between other pairs of transducers allowing calculations of both wind speed and direction. This sensor samples at 40 Hz and the 1-minute data is formed from eleven 5-seconds averages, similar to the RM Young wind processing.

9) Subsurface Argos Transmitter

A Subsurface Mooring Monitoring Beacon (SMM 500), built by Sensoren Instrumente Systeme GmbH (SiS), was mounted upside down on the bottom of the buoy. This is a backup recovery aid in the event that the mooring parts and the buoy capsizes.

10) 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 to monitor the status of instruments and the quality of data they provide.

11) PCO_2

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. The PCO2 system on the Stratus mooring is a component of the OceanSITES moored PCO2 network.

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 CO_2 from a closed loop of air and a span gas (414 ppm CO_2) produced and calibrated by NOAA's Earth System Research Laboratory (ESRL).

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 CO_2 Website: http://www.pmel.noaa.gov/co2/story/Stratus. 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.

12) Wave Package

The WAMDAS wave system used on the Stratus 12 and 13 buoys is made by Neptune Sciences and acquired from NDBC. This includes wave measurements, GPS positions and times. It utilizes a 3-axis motion package made by MicroStrain Inc. The WAMDAS is capable of transmitting and storing data. The transmitted data is sent via Iridium communications on an hourly basis. This message is ultimately transmitted to NDBC where the data are subjected to automated quality-control checks and then posted on the NDBC web site. The data are stored in raw and processed format on a 1 GB compact flash card in the instrument.

13) Vaisala WXT520

The Vaisala Weather Transmitter WXT520 measures barometric pressure, humidity, precipitation, temperature, and wind speed and direction. It uses ultrasound to determine horizontal wind speed and direction. Barometric pressure, temperature, and humidity measurements are combined in the PTU module using capacitive measurement for each parameter. The WXT520 also measures accumulated rainfall, rain intensity and duration of the rain — all in real time. The signals exerting from the impacts are proportional to the volume of the raindrops. Hence, the signal from each drop can be converted directly to the accumulated rainfall. According to manufacturer, accuracies are 0.3 m/s or 3% for wind speed, 3° for wind direction, 0.3°C for air temperature, 3%RH below 90%RH (in practice we find this sensor to have a low HRH bias larger than this value when compared to ASIMET sensors), 0.1 mbar for barometric pressure, 5% for rain accumulation (not including wind effects).

C. Subsurface Instrumentation

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

Before a buoy launch and after its recovery, different physical signals are imprinted in the instruments’ records at determined times. These spikes reveal 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. VMCM rotors are spun and then blocked.

Table 3-4 summarizes the subsurface instrumentation set up. The details of the set up are shown in Appendix 2. Mooring logs are in Appendixes 3 and 4 and contain descriptions of deployment and mooring instrumentation for Stratus 13 and 12.

Table 3-4. Set up of Stratus 13 subsurface instrumentation. (Seaguard LS were deployed for Lothar Stramma at Geomar, Kiel, Germany).

Instrument	Serial	Depth (m)	Sample	Start Date	Start Time	Spike Start	Spike Stop
Nortek Profiler	357	10	1800 sec	28-Feb-14	22:00	3/1/14 14:12	
optode	691	250					
optode	943	500					
RCM11	78	13	3600 sec	26-Feb-14	11:59	2/28/14 10:45	2/28/14 11:10
RCM11p	79	20	3600 sec	26-Feb-14	12:04	2/28/14 10:45	2/28/14 11:10
RCM11p	13	32.5	3600 sec	26-Feb-14	11:55	2/28/14 10:45	2/28/14 11:10
RDI 300 KHZ	1218	135	3600 sec	1-Mar-14	17:00	3/1/14 19:24	3/1/ 22:27
SBE16	1873	deep	1800 sec	28-Feb-14	13:00	2/28/14 13:27	2/28/14 14:21
SBE16	1875	deep	1800 sec	28-Feb-14	13:00	2/28/14 13:27	2/28/14 14:21
SBE37	1325t	2	300 sec	28-Feb-14	11:00	2/28/14 14:38	2/28/14 16:21
SBE37	1326t	3.7	300 sec	28-Feb-14	11:00	2/28/14 16:27	2/28/14 16:59
SBE37	1328t	7	300 sec	28-Feb-14	11:00	2/28/14 16:27	2/28/14 16:59
SBE37	1329t	16	300 sec	28-Feb-14	11:00	2/28/14 14:38	2/28/14 16:21
SBE37	1330t	30	300 sec	28-Feb-14	11:00	2/28/14 14:38	2/28/14 16:21
SBE37	8211t	40	300 sec	28-Feb-14	11:00	2/28/14 14:38	2/28/14 16:21
SBE37	8217t	62.5	300 sec	28-Feb-14	11:00	2/28/14 16:27	2/28/14 16:59
SBE37	8215t	130	300 sec	28-Feb-14	11:00	2/28/14 14:38	2/28/14 16:21
SBE37	8212t	160	300 sec	28-Feb-14	11:00	2/28/14 16:27	2/28/14 16:59
SBE37	*8216t*	190	300 sec	28-Feb-14	11:00	2/28/14 16:27	2/28/14 16:59
SBE37	8225c	220	300 sec	28-Feb-14	11:00	2/28/14 16:27	2/28/14 16:59
SBE37	8224c	1355	300 sec	28-Feb-14	11:00	2/28/14 16:27	2/28/14 16:59

SBE37 clamped	1906c	295	300 sec	28-Feb-14	11:00	2/28/14 16:27	2/28/14 16:59
SBE37 clamped	1908c	601	300 sec	28-Feb-14	11:00	2/28/14 14:38	2/28/14 16:21
SBE37 clamped	8220c	700	300 sec	28-Feb-14	11:00	2/28/14 16:27	2/28/14 16:59
SBE37 clamped	8218c	857	300 sec	28-Feb-14	11:00	2/28/14 16:27	2/28/14 16:59
SBE37 clamped	8219c	1557	300 sec	28-Feb-14	11:00	2/28/14 14:38	2/28/14 16:21
SBE37 clamped	8221c	2000	300 sec	28-Feb-14	11:00	2/28/14 16:27	2/28/14 16:59
SBE37 P clamped	1909pc	85	300 sec	28-Feb-14	11:00	2/28/14 14:38	2/28/14 16:21
SBE37 P clamped	3733tp	550	300 sec	28-Feb-14	11:00	2/28/14 14:38	2/28/14 16:21
SBE39	35	4.9	300 sec	26-Feb-14	1900	2/28/14 11:23	2/28/14 12:25
SBE39	38	25	300 sec	26-Feb-14	1900	2/28/14 11:23	2/28/14 12:25
SBE39	44	35	300 sec	26-Feb-14	1900	2/28/14 11:23	2/28/14 12:25
SBE39	48	50	300 sec	26-Feb-14	1900	2/28/14 11:23	2/28/14 12:25
SBE39	49	55	300 sec	26-Feb-14	1800	2/28/14 11:23	2/28/14 12:25
SBE39	102	70	300 sec	26-Feb-14	1800	2/28/14 11:23	2/28/14 12:25
SBE39	103	77.5	300 sec	26-Feb-14	1800	2/28/14 11:23	2/28/14 12:25
SBE39	203	92.5	300 sec	26-Feb-14	1800	2/28/14 11:23	2/28/14 12:25
SBE39	276	100	300 sec	26-Feb-14	1800	2/28/14 11:23	2/28/14 12:25
SBE39	284	115	300 sec	26-Feb-14	1800	2/28/14 11:23	2/28/14 12:25
SBE39	719	175	300 sec	26-Feb-14	1800	2/28/14 11:23	2/28/14 12:25
SBE39	720	280	300 sec	26-Feb-14	1800	2/28/14 11:23	2/28/14 12:25
SBE56	2064	0	15 sec	28-Nov-14	1200	2/28/14 12:25	2/28/14 12:49
SBE56	2065	0	15 sec	28-Nov-14	1200	2/28/14 12:25	2/28/14 12:49
SBE56	2066	0	15 sec	28-Nov-14	1200	2/28/14 12:25	2/28/14 12:49
SBE56	2067	0	15 sec	28-Nov-14	1200	2/28/14 12:25	2/28/14 12:49
Seaguard	138	45	30 min	26-Feb-14	1800	2/28/14 11:38	2/28/14 12:08
Seaguard	140	87.3	30 min	26-Feb-14	1800	2/28/14 11:38	2/28/14 12:08
Seaguard	141	145	30 min	26-Feb-14	1800	2/28/14 11:38	2/28/14 12:08
Seaguard	142	235	30 min	26-Feb-14	1800	2/28/14 12:11	2/28/14 13:22
Seaguard	143	290	30 min	26-Feb-14	1800	2/28/14 12:11	2/28/14 13:22
Seaguard	144	400	30 min	26-Feb-14	1800	2/28/14 12:11	2/28/14 13:22
Seaguard	181	450	30 min	26-Feb-14	1800	2/28/14 12:11	2/28/14 13:22
Seaguard	182	600	30 min	26-Feb-14	1800	2/28/14 12:11	2/28/14 13:22
Seaguard (LS)	961	107	30 min	26-Feb-14	1800	2/28/14 10:45	2/28/14 11:10

Seaguard (LS)	964	183	30 min	26-Feb-14	1800	2/28/14 10:45	2/28/14 11:10
Seaguard (LS)	969	350	30 min	26-Feb-14	1800	2/28/14 10:45	2/28/14 11:10
VMCM	4	802	60 sec	23-Mar-14	13:30		
VMCM	31	853	60 sec	23-Mar-14	13:31		
VMCM	32	1507	60 sec	23-Mar-14	13:29		
VMCM	42	2010	60 sec	23-Mar-14	13:31		
wetlabs FLSB	2866	100	99.9 minutes	4-Mar-14	10:04		
SBE37 (SST)	2035	1.51	300 sec	18-Feb-14	12:00	2/28/14 12:27	2/28/14 12:51
SBE37 (SST)	1838	1.51	300 sec	18-Feb-14	12:00	2/28/14 12:27	2/28/14 12:51

1) 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.

2) 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. The beams have a 20° angle. Head is in the Janus configuration (4 acoustic beams to identify upstream flow).

3) Nortek

The Nortek Aquadopp current meters and profilers use Doppler technology to measure currents. The Aquadopps we use on Stratus usually have 3 beams tilted at 25 degrees and use a transmit frequency of 1 or 2 MHz, with a higher ranging for the lower frequency signal. The internal tilt and compass sensors allow for the rotation of the current vector from beam coordinates into East, North and upward directions.

4) Aanderaa RCM 11 and SEAGUARD

The Aanderaa RCM 11 measures the horizontal current speed and direction, as well as temperature. The instrument can operate continuously or in eight intervals from 1 to 120 minutes.

The new SEAGUARD RCM series replaces the industry Standard RCM 9 and RCM 11 series. It has been completely redesigned from bottom up and employs modern technology in the datalogger section and in the different sensor solutions. Some of these instruments also include an external oxygen sensor.

5) SBE39 Temperature Recorder

The Sea-Bird model SBE39 is a small, light weight, durable and reliable temperature logger. It is a high-accuracy temperature recorder (pressure optional) with internal battery and non-volatile memory for deployment at depths up to 10,500 meters (34,400 feet).

6) SBE37 MicroCat Conductivity and Temperature Recorder

The MicroCat, model SBE37, is a high-accuracy conductivity and temperature recorder with internal battery and memory. The temperature range is -5° to +35ºC, and the conductivity range is 0 to 6 Siemens/meter. The pressure housing is made of titanium and is rated for 7,000 meters. The 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.

7) Seabird56

The SBE 56 is a low-cost, high-accuracy, battery-powered temperature and time logger.
The SBE 56's pressure-protected thermistor has a 0.5 second time constant, providing excellent accuracy (initial accuracy 0.002 °C) and resolution when fast sampling at 2 Hz (0.5 sec). It has exceptional stability; drift is typically less than 0.002 °C per year.

8) Seabird16

The SBE 16 SEACAT is designed to measure and record temperature and conductivity in the range -5 to +35 °C at high levels of accuracy (0.01 °C) and resolution (0.001 °C) while deployed in either a fixed or moored application. Powered by internal batteries, SEACAT is capable of recording data for periods of a year or more. Data may be acquired at intervals of 15 seconds to 8 hours in one-second increments.

9) Acoustic Release

The acoustic release used on the Stratus 12 and 13 moorings are 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.

10) Wetlabs Fluorometer

Stratus 13 was our first mooring to be equipped with a newly acquired fluorometer. The Environmental Characterization Optics, or ECO miniature fluorometer allows the user to measure relative chlorophyll, CDOM, uranine, phycocyanin, or phycoerythrin concentrations by directly measuring the amount of fluorescence emission in a sample volume of water. The ECO uses an LED to provide the excitation source. An interference filter is used to reject the small amount of out-of-band light emitted by the LED. The light from the source enters the water volume at an angle of approximately 55–60 degrees with respect to the end face of the unit. Fluoresced light is received by a detector positioned where the acceptance angle forms a 140-degree intersection with the source beam. An interference filter is used to discriminate against the scattered excitation light.

Do not face the sensor directly into the sun or other bright lights. Raw data from the ECO meter is output in counts from the sensor, ranging from 0 to approximately 16000. The scale factor is factory-calculated by obtaining a consistent output of a solution with a known concentration, then subtracting the meter's dark counts. The scale factor, dark counts, and other characterization values are given on the instrument's characterization sheet. For chlorophyll, WET Labs uses the chlorophyll equivalent concentration (CEC) as the signal output using a fluorescent proxy approximately equal to 25 µg/l of a *Thalassiosira weissflogii* phytoplankton culture:

Scale Factor = 25 µg/l / (Chl Equivalent Concentration – dark counts). For example: 25 / (3198 – 71) = 0.0080.

D. Current Meter Setup

The setup of current meters and profilers is a trade off between measurement precision and length of the record (battery life). For profilers, the number of cells and subsequent range is also a criterion. The setup of acoustic current meters and profilers for Stratus 13 was slightly different from what had been done for Stratus 12. For details of the setup, see Table 3-5 and Appendix 2.

Unfortunately, all Nortek sensors and their data on Stratus 12 were destroyed because the instrument cases imploded from the high pressure near the seafloor when the mooring broke. For Stratus 13, we set the Nortek 2MHz profiler to sample at 1 Hz for 180s to be able to average out the swell (~15s period at Stratus site) and wave signal. Power level for pinging was set to HIGH (HIGH- is 6 dB less than HIGH and was the setting chosen in two previous deployments, but turned out to be insufficient). Sampling interval was set to 30 minutes, in 12 bins of 1 m size. With this configuration, battery utilization computed by the Nortek software during instrument setup is 197%, and an assumed duration of 540 days. This estimate is based on one Lithium battery (near 160 W.h capacity) and the housing was extended to accommodate extra battery packs. The compass update rate was set at 1s, which is important for consistency with sampling rate of 1 Hz.

Note that for a profiler near the surface, by choosing cells that are higher than the water surface, it is possible to diagnose possible problems in the data because there is a lot of backscatter caused by the air-water interface. For example, if a beam does not show a maximum in the signal intensity near the surface, its record should be used with caution. Also, if the maximum in intensity appears in different cells for different beams, it indicates that the instrument (and therefore the mooring line) was probably tilted. However, the signal is valid only below and away from the surface because of the side lobe reflections (maximum distance is therefore a function of cos(α), where α is the angle of the beam with the vertical).

The RDI Workhorse Sentinel (at 135 m depth) operates at 307,200 Hz, with 4 beams at 20^{o} from the vertical. For Stratus 13 the blanking distance was set to 1.76m; 150 pings per ensemble and

1s per ping and 1hr for output sampling were selected. The difference with Stratus 12 was that bin size was reduced to 8 m since the signal has difficulty reaching the upper 40 m or so.

Table 3-5. Setup of acoustic current meters and profilers for Stratus 13.

Instrument	Nortek 357	RDI 1218	Aanderaa RCM 11 (13, 78, 79)	Aanderaa Seaguard (138, 140, 141 to 144, 181, 182)
Sampling Freq kHz	2000	307.2		
Measurement Interval (s)	1800	3600	1800	1800
Number cells	12	12	1	1
Cell size (m)	1	8		2.5
Blanking distance (m)	1	1.76		0.5
Average Interval (s)	180	150		300 pings
Measurement load (%)	4	n/a	n/a	n/a
Power level	HIGH	n/a	n/a	n/a
Battery utilization (%)	197	n/a	n/a	n/a
Battery days	540			706
Compass update rate (s)	1	n/a	n/a	n/a
Vertical precision (cm/s)	0.4	n/a	n/a	n/a
Horizontal precision (cm/s)	1.1			

E. Mooring Operations

1) Deployment of Stratus 13 and anchor survey

The decision was taken to deploy Stratus 13 a bit to the east of previous sites, making use of our knowledge of the bathymetry from past cruises. There was a large, flat area to serve as a target. With the wind out of the Southeast, a track for the deployment was set up as shown in Figure 3-3. The start (S2) was 10 nm from the 'target', S13T, and a safety zone of 2 nm extended beyond to S1. The afternoon before the deployment, *R. H. Brown* transited from DART to S1, with the multibeam on, and then turned and ran from S1 to S2, mapping the bottom.

The ship set up in the vicinity of S2 while the surface buoy was being deployed. Early in the deployment, the TSE winch was noted making loading noises on payout so work was halted while the ship's engineers changed the hydraulic fluid filter, which did not reduce the noise. The ship was steaming relative to the water but not advancing over the ground. Figure 3-4 shows the deployment track.

There was, in sea surface height maps, an eddy in the vicinity of the deployment, so it appears that the ship was steaming into the current. The deployment pressed on, with the current helping to stretch the mooring out, though the ship was not making much distance along the track. With the anchor being rigged, the ship was just over 3 nm along the track. This was far enough along, based on the survey, for an acceptable depth, so the work went ahead to drop the anchor at about 3.4 nm along the track as shown in Figure 3-4.

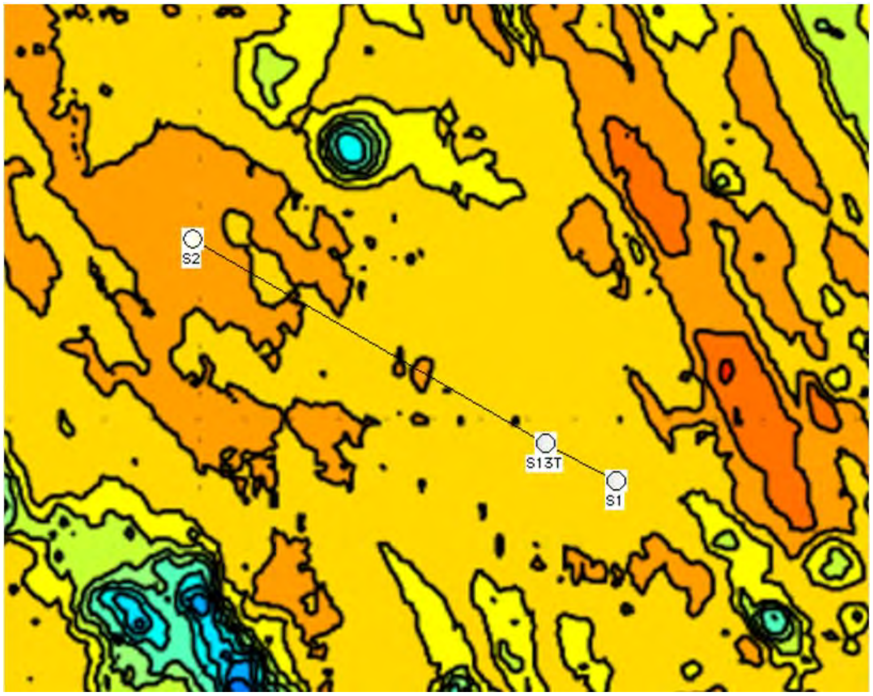


Figure 3-3. Planned track line for Stratus 13 deployment plotted on top of composite bathymetry map. The depths on the track from S2 to S1 ranged from 4,569m to 4,502 m. The orange color is deeper than the mustard color.

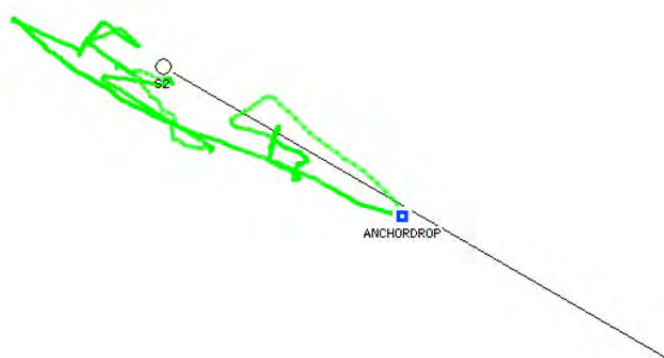


Figure 3-4. The northwest end of the planned deployment track, from S2 along the black line to the southeast.

Acoustic survey
An acoustic survey of the anchor position for Stratus 13 was carried out on the morning of March 9, 2014. The initial setup was for three points about 3,000m from the anchor drop, as shown in Table 3-6:

Table 3-6. Triangulation stations for Stratus 13 anchor acoustic survey.

Waypoint	Latitude	Longitude
2	19° 35.973'S	84° 58.143'W
3	19° 36.821'S	84° 55.440'W
4	19° 39.152'S	84° 57.930'W
Anchor drop (4541 m)	19° 37.5561'W	84° 57.0134'W

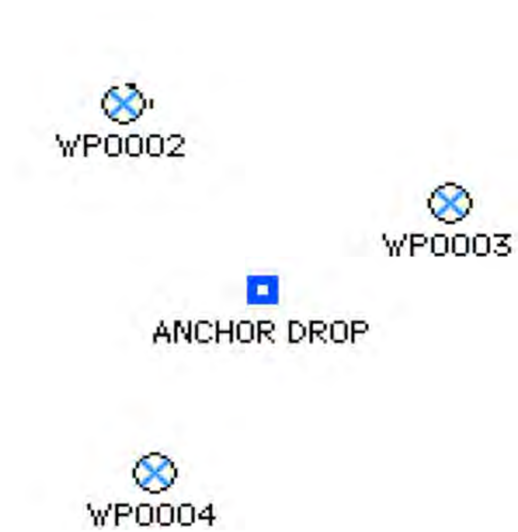


Figure 3-5. Locations of the triangulation stations for the acoustic survey of Stratus 13 anchor.

The initial ranging from WP2 failed, so the ship was moved closer. Ranging from WP3 and WP4 succeeded. The positions and slant ranges/travel times are in Table 3-7:

Table 3-7. Acoustic ranges for Stratus 13 anchor survey.

Waypoint	Latitude	Longitude	Slant range (m)	Travel time (s)
2	19° 36.5172'S	84° 58.1397'W	5152	6.780
2	19° 36.5230'S	84° 58.1387W	5136	6.840
2	19° 36.5337'S	84° 58.1290'W	5126	6.835
2	19° 36.5431'S	84° 58.1193W	5112	6.817
3	19° 36.8126'S	84° 55.4386'W	5526	7.368
3	19° 36.8121'S	84° 55.4386'W	5524	7.366
4	19° 39.1318'S	84° 57.9642'W	5621	7.495
4	19°39.1327'S	84° 57.9640'W	5622	7.497
4	19°39.1342'S	84° 57.9643'W	5626	7.502

The travel times were used with the survey point positions and Art Newhall's program to find the intersections of three range circles. A sound speed of 1509 m s^{-1} was used based on past CTDs and Matthews Tables. In parallel, a commercial program, MCal, was used. The laptop is plugged into the GPS NMEA data stream and connected to the release deck box. MCal commands the box to ping and collects the travel time data for the return and then works to solve for the position of the acoustic transponder, in this case the Stratus 13 release, as shown in Table 3-8. Anchor location as recorded on the mooring log uses the MCal calculation (see Table 3-9). The two acoustic releases (SN 31366 and SN 30844) were disabled March 9, 2014 at the end of the survey. The ship was moved from WP4 closer to the anchor to ensure good communication.

Table 3-8. Stratus 13 anchor coordinates based on acoustic survey and different triangulation software applications.

Anchor Drop	19° 37.5561'S	84° 57.0134'W
Anchor position – Newhall	19° 37.4833'S	84° 57.1404'W
Anchor position-MCal	19° 37.4714'S	84° 57.1394'W
Fallback –Newhall	259.5 m, 301°	5.7% water depth
Fallback -MCal	270 m, 306°	5.9% water depth

Table 3-9. Location of Stratus 13 anchor as shown in mooring log.

Stratus 13	Deployed 3/7/2104	1801 UTC
Anchor Drop	19° 37.5561'S	84° 57.0134'W
Anchor position-MCal	19° 37.4714'S	84° 57.1394'W
Water depth	4541 m	

2) Mooring Deployment Operations

The Stratus 13 surface mooring was set using a two-phase mooring technique. Phase 1 involved 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 (a tension cart was used to pre-tension the nylon and wire during the winding process) with the following mooring components listed from deep to shallow:

- 300 m 7/8" nylon – nylon to wire shot
- 450 m 3/8" wire - nylon to wire shot
- 500 m 3/8" wire
- 500m 3/8" wire
- 48.5 m 3/8" wire
- 148.5 m 3/8" wire
- 48.5 m 3/8" wire
- 48.5 m 3/8" wire
- 58.5 m 3/8" wire
- 53.3 m 7/16" wire
- 53.5 m 7/16" wire
- 29 m 7/16" wire
- 50 m spectra working line

Prior to the deployment of the mooring, the working line was passed out through the center of the A-frame, around the aft port quarter then forward along the rail to the instrument lowering area. Three wire handlers were stationed around the aft port rail and A-frame. The wire handlers' job was to keep the working line from fouling in the ship's propellers and to pass the line around the stern after the buoy was deployed.

To begin the mooring deployment, the ship held position in Dynamic Positioning mode with the bow positioned into the wind. The crane boom was positioned over the instrument lowering area to allow a vertical lift of at least four meters. All subsurface instruments for this phase had been staged in order of deployment in the 20-foot cargo container just forward of the buoy. All instrumentation had chain or wire rope shackled to the top of the instrument load bar or cage. A shackle and ring was attached to the top of each shot of chain.

The first instrument segment to be lowered was an Aanderaa ADCM at 45m. This instrument had a 3.66-meter shot of chain shackled to the top of the instrument cage, and a 16-meter shot of 7/16" wire rope shackled to the bottom. This segment of wire was shackled into the working line coming from the winch. The crane hook, suspended over the instrument lowering, area was lowered to approximately 1 meter off the deck. A six-foot sling was hooked onto the crane and passed through a ring to the top of the 3.66-meter shot of chain shackled to the top of the current meter.

The crane was raised so the chain and instrument were lifted off the deck. The crane slowly lowered the wire and attached mooring components into the water. The line handlers positioned around the stern eased line over the port side, paying out enough to keep the mooring segment vertical in the water. An air tugger with a chain hook was used to haul on the chain and take the load from the crane. 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 SBE 37 MicroCat. The load from this instrument array was stopped off using a slip line passed through a pear link shackled into the chain above the load bar. The 2-meter MicroCat was shackled to hardware and chain connecting them to the universal joint on the bottom of the buoy. The vertical instrument array hanging in the water was joined to the two instruments attached to the bottom of the buoy.

The next operation was launching the buoy. Three slip lines were rigged on the buoy to maintain control during the lift. Lines were rigged on the buoy bottom, the tower, and a buoy deck bail. The 30 ft. slip line was used to stabilize the bottom of the buoy 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, could be released without fouling against the tower. The deck slip line was removed just following the release of the buoy.

With the three slip lines in place, the crane was positioned over the buoy. The quick release hook, with a 1" sling link, was attached to the crane hook. Slight tension was taken up on the crane 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 of 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 buoy had settled into the water (approximately 15 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 .5 knot through the water to maintain a safe distance between the buoy and the ship. The bottom end of the shot of wire shackled to the working line was pulled enough to clamp the SBE 39's 4 meters and 9.5 meters from the top of the wire.

A traveling block was suspended from the A-frame. The free end of the working line was passed through the block. The next instrument, a 62.5 meter depth MicroCat on a Ti load bar pre-attached wire shot was shackled to the end of the stopped off mooring. The bottom of this wire was shackled into the top of the wire on the winch. The wire was pulled onto the winch to take up the slack. The winch slowly took the mooring tension from the stopper lines.

The winch line pulled back, lifting the instrument off the deck as it was raised. 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 2010 meters. Smaller instruments were clamped to the wire rope as the wire was payed off the winch.

At this point, the mooring was stopped off, and a 21.5 meter shot of wire rope was inserted into the mooring to make up for the added water depth at the target deployment site.

The winch continued to pay out wire and nylon line until all mooring components that had been pre-wound were payed out. The end of the 200 m nylon was stopped off about 15 feet from the transom using a sling though the thimble.

An H-bit cleat was positioned aft of the TSE winch and secured to the deck. The free end of the 3100 meter shot of nylon/Colmega line, stowed in three wood-lined wire baskets was wrapped 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 payout speed relative to the ship's speed. Another person sprayed water on the H-bit to keep the line from heating up.

While the nylon and Colmega line was being payed out, the crane was used to lift the 88 glass balls out of the open top container. These balls were staged fore and aft, in four ball segments, on the port side of the deck.

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

The 88 glass balls are bolted on 1/2" trawler chain in 4 ball (4 meter) increments. The first two sets of glass balls was 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 seven of the eight balls were off the stern. Stopper lines were attached, the winch leader was removed, and two more string of glass balls were inserted into the mooring line. This process was repeated until all 88 balls were deployed.

A 1" titanium load bar with two SBE 16 C/T loggers was shackled to the last glass ball segment. After that, a five-meter shot of ½" chain was connected to the mooring. The winch took tension on the mooring, stopper lines were removed, and a chain hook connected to the air tugger line running through the block on the A-frame lifted the SBE 16s off the deck. The winch payed out with the tugger, and the instruments were eased over the transom. The tugger went slack, and the chain hook was removed.

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.

A chain hook connected to the air tugger line running through the block on the a-frame lifted the acoustic releases off the deck. The winch payed out with the tugger, and the instruments were eased over the transom. The tugger went slack, 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 one meter up this segment of chain. A heavy-duty slip line was passed through the link and secured to the winch leader. The winch payed out until tension was transferred to the slip line. The chain lashings were removed from the anchor. The end of the chain was removed from the winch and shackled to the anchor on the tip plate.

The ship’s starboard side crane was positioned over the anchor and tip plate. The crane hook was connected to the chain bridle on the tip plate. The slip line was slowly eased out until mooring tension was transferred to the anchor. The crane wire pulled up enough to raise the tip plate and slide the anchor off the stern.

F. Instrument Intercomparisons

1) Ship meteorological data

The ship's meteorological sensors are integrated into the Scientific Computing System (SCS), which allows for centralized data acquisition and logging from numerous sensors with different sampling rates. One central data set of all sensors is logged continuously, and user-specified subsets of sensor data and independent sampling rates may also be logged simultaneously. All data are time stamped from the ship's high-precision UTC clock and GPS navigation parameters can be easily included within any data set. For more information about the scientific equipment on *Ronald H. Brown*, see http://www.moc.noaa.gov/rb/science/equipment.html. Most sensors are installed on the jackstaff on the 01 deck. Sensors heights on the jackstaff were: 10.55 m (barometric pressure), 7.90 m (RM Young wind, ASIMET HRH/ATMP and PRC), 6.30 m (UOP sonic flux system). The height of 01 deck near the jackstaff was about 6 m above the waterline. The thermosalinograph (TSG) unit is a SBE 21 installed under the bow, 5.6 m below the waterline.

2) Intercomparison results

Air-sea fluxes were computed using ship’s meteorological data, including SST from the TSG, and the COARE 3.5 bulk algorithm. There were indications that the ship’s HRH and ATMP measurements were a bit high (see for example Figures 4-42 and 4-43), so these were first corrected by substracting biases of 0.5 °C and 1.5 %RH, respectively. Using the COARE 3.5 algorithm, measurements were then adjusted from the height of the ship’s sensors to heights where the UOP sensors were located (standalones on 03 deck (see IV.C) and sensors deployed on Stratus 13 buoy). Hourly averages were then computed to compare with hourly averages received by telemetry from the Stratus 13 buoy. The inter-comparison period when the ship was downwind of the Stratus 13 buoy started on 2014/3/9 03:30 UTC and ended on 2014/3/11 04:30 UTC. Figure 3-6 shows the mean vertical profiles averaged over the inter-comparison period, of potential air temperature, SH (specific humidity) and HRH (relative humidity) and WSPD (wind speed). These profiles are based on the ship’s measurements and the COARE 3.5 height adjustment to a high-resolution vertical vector. The average values from UOP ASIMET sensors are indicated with the crosses (S13 buoy) and round open circles (standalones on 03 deck). The horizontal lines centered on these symbols represent one standard deviation of the difference between UOP ASIMET and time-varying profile values. The black dots at the bottom of the profiles represent the surface values used to construct the profiles and based on the ship’s measurements and COARE 3.5 algorithm.

The newly deployed sensors on Stratus 13 buoy are in agreement with the profiles. The ASIMET WSPD is slightly higher than the ship, but this may be due to the flow distortion on the ship, which slightly reduces horizontal wind speed on the bow. UOP sensors placed on the 03 deck are mostly in agreement as well; a more detailed study of the 03 deck measurements is in section IV.C. For the moment, it suffices to say that the sensors 213, 230 and 219, which were the two primaries and standalone on the recovered Stratus 12 buoy had good temperature values, except for 219, and low HRH (except 219 which agreed with profile). Sensor 250 had very limited data for this period and should not be considered here.

Figure 3-7 to 3-12 show the time-series of these meteorological measurements from the ship (with adjustment to height of sensors on buoy) and from the Stratus 13 buoy. Scatter plots for radiations are also shown. Figure 3-13 shows comparison of the measurements of conductivity and temperature of water near the surface, using CTD casts made on March 9 at 14:57 (cast 1) and 17:35 (cast 2) UTC, near the Stratus 13 buoy.

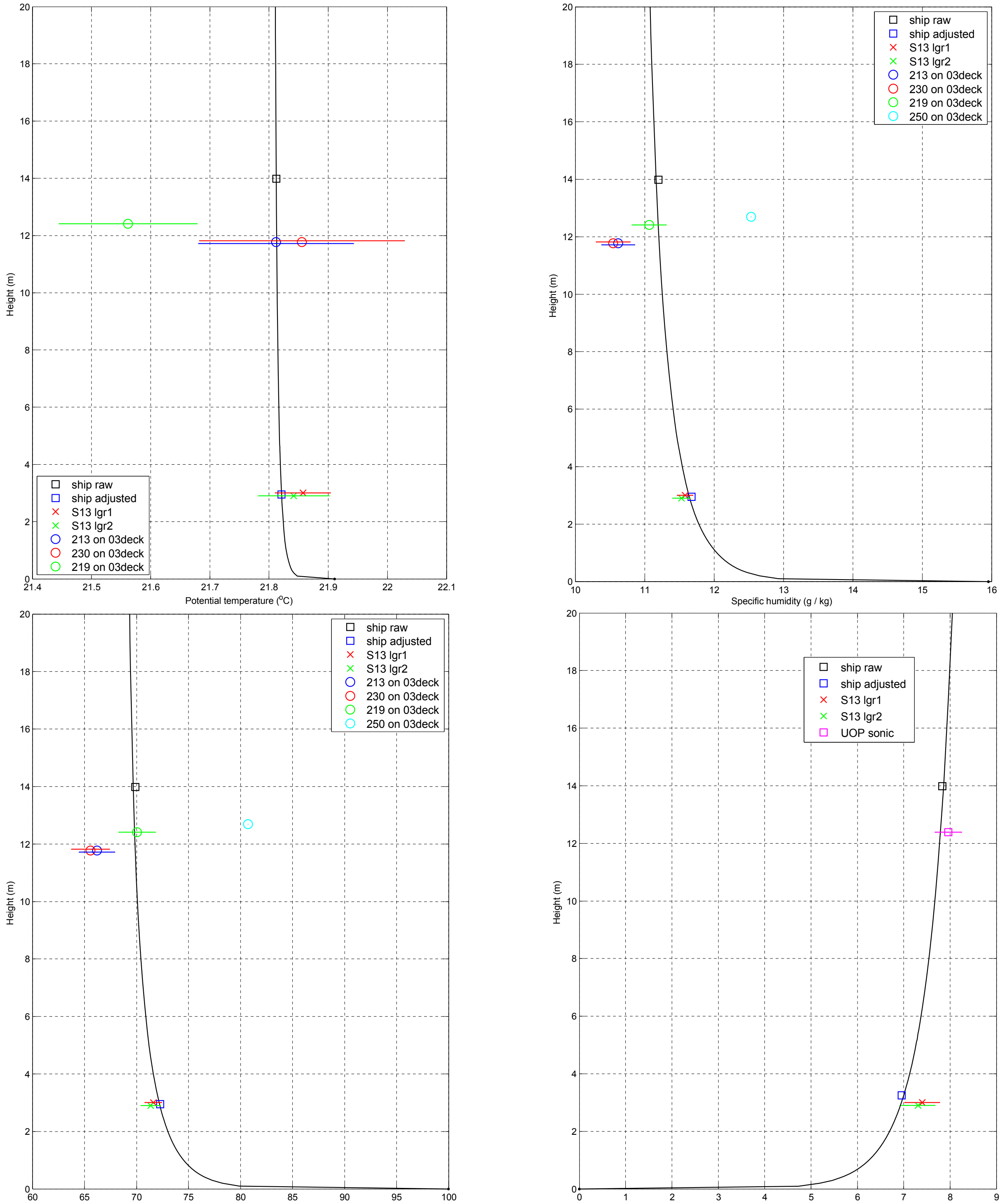
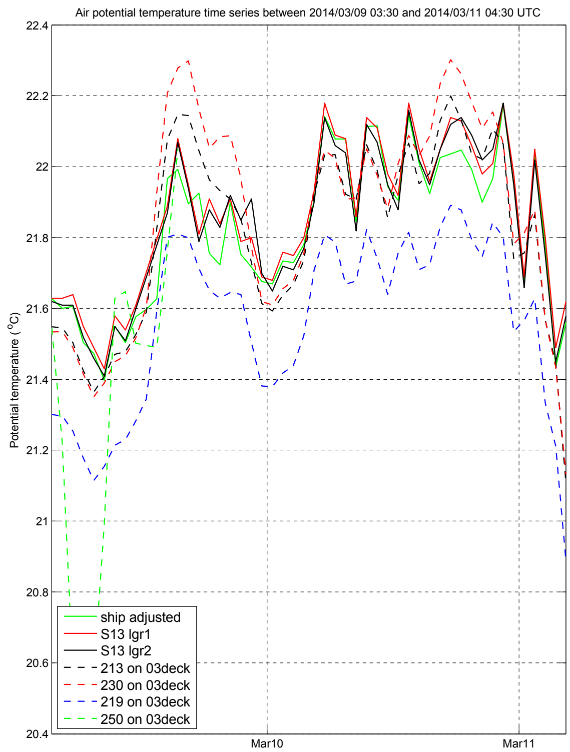


Figure 3-6. Profiles of meteorological variables using ship's measurements and COARE 3.5 algorithm. Mean profiles (black) are averages from inter-comparison period 2014/3/9 03:30 to 2014/3/11 04:30 UTC. Horizontal lines with symbols (crosses for S13 buoy and open circles for UOP sensors on 03 deck) denote the UOP ASIMET measurements: one standard deviation from (*Figure 3-6, continued*) profile and mean value, respectively. Top left: potential air temperature, top right: specific humidity, bottom left: relative humidity, bottom right: wind speed.



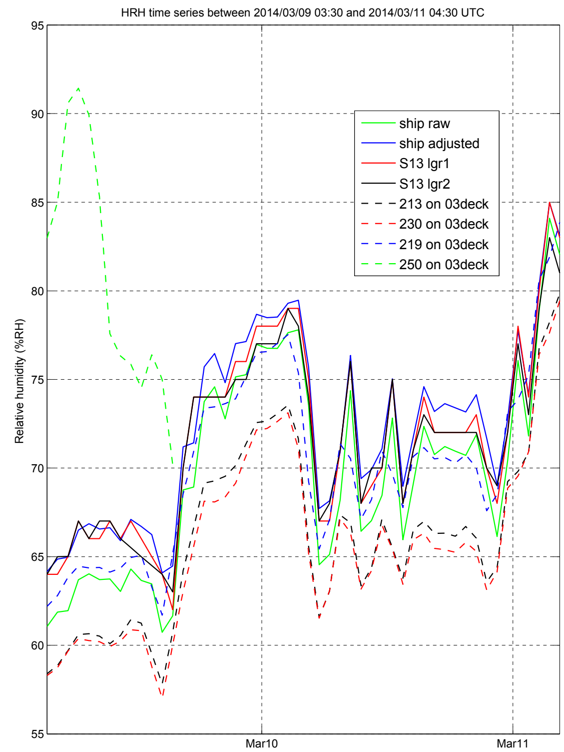
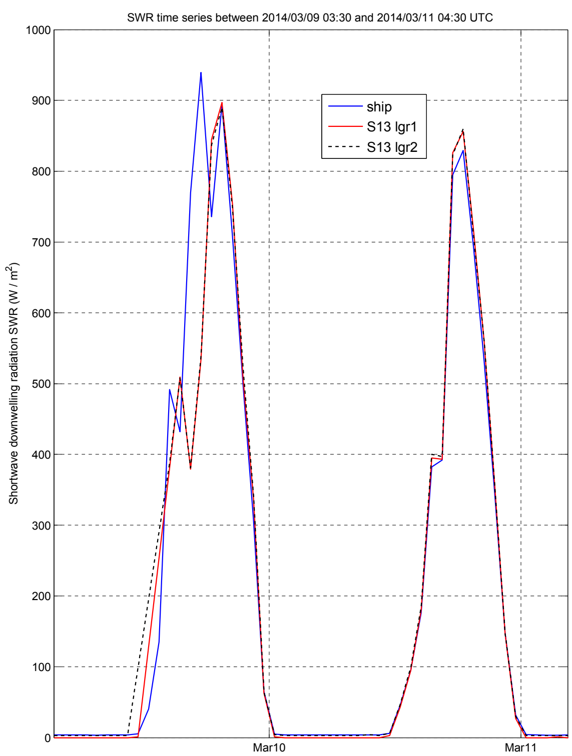


Figure 3-7. Time series for Stratus 13 buoy inter-comparison period: air potential temperature (left) and relative humidity (right).



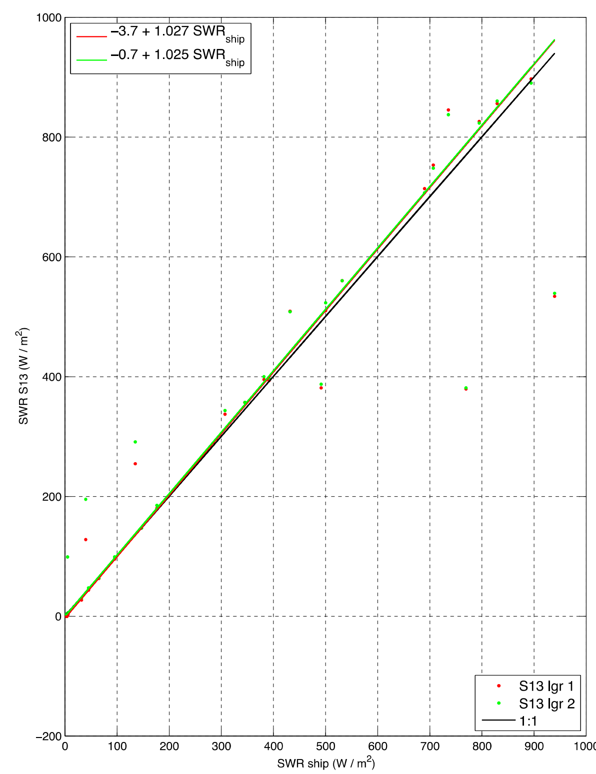


Figure 3-8. Shortwave downwelling radiation during Stratus 13 buoy inter-comparison period: time series (left) and scatter plot and least square fits using robustfit.m Matlab function (right).

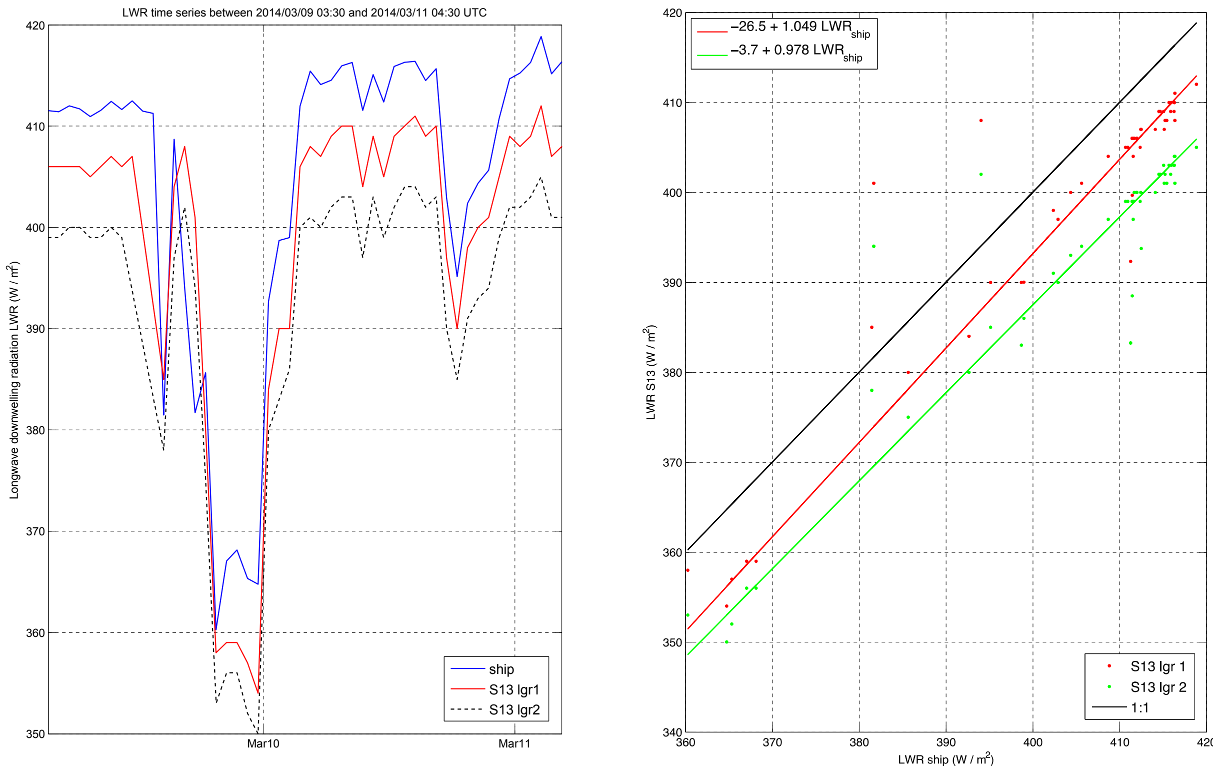


Figure 3-9. As in Fig. 3-8 but for longwave downwelling.

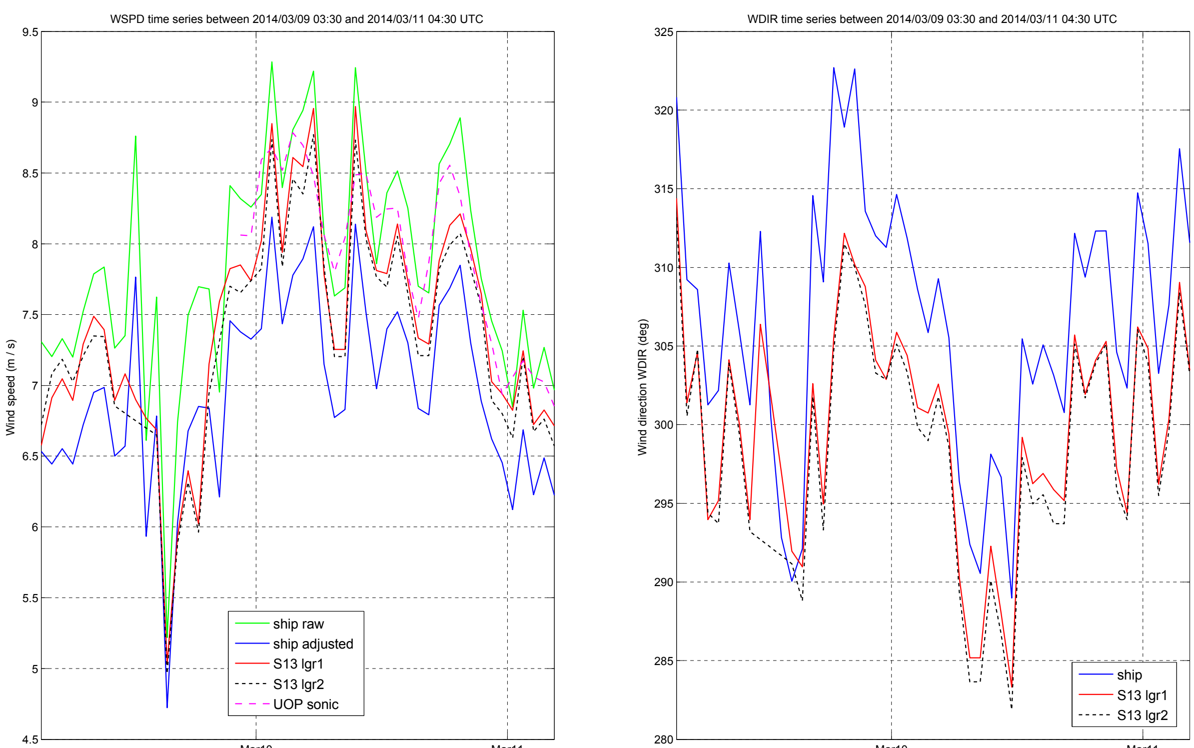
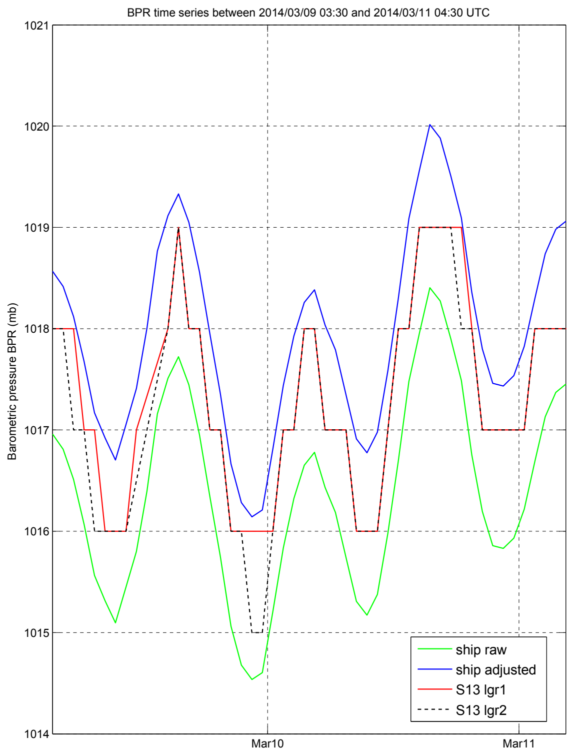


Figure 3-10. Time series for Stratus 13 buoy inter-comparison period: wind speed (left) and wind heading (right).



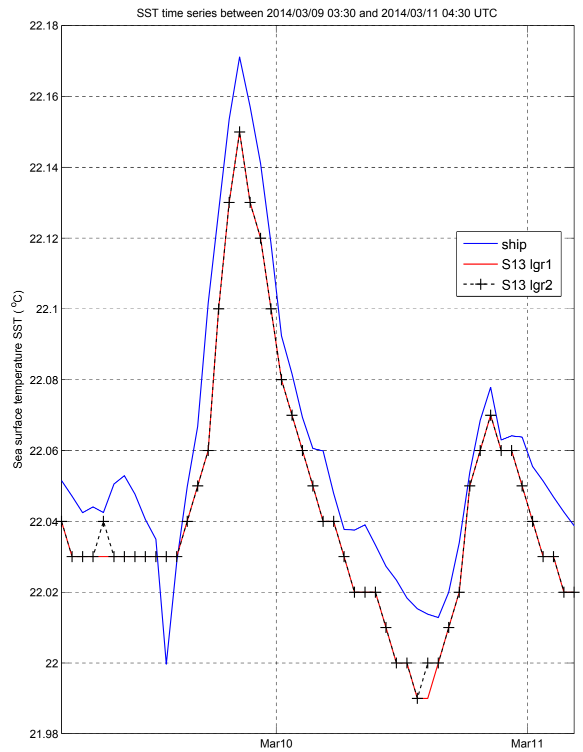
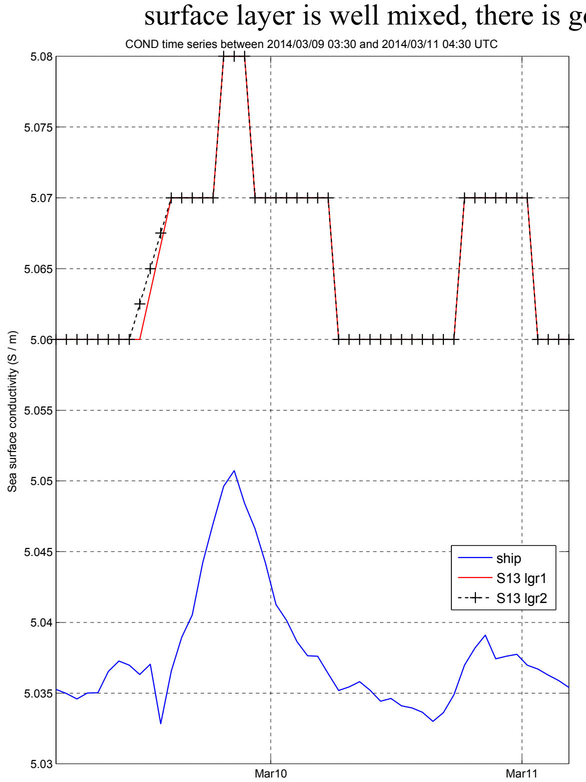


Figure 3-11. Time series for Stratus 13 buoy inter-comparison period: barometric pressure (left) and sea surface temperature (right). Note that at night time (low SST), when no warming occurs and the near surface layer is well mixed, there is good agreement between ship and buoy SSTs.



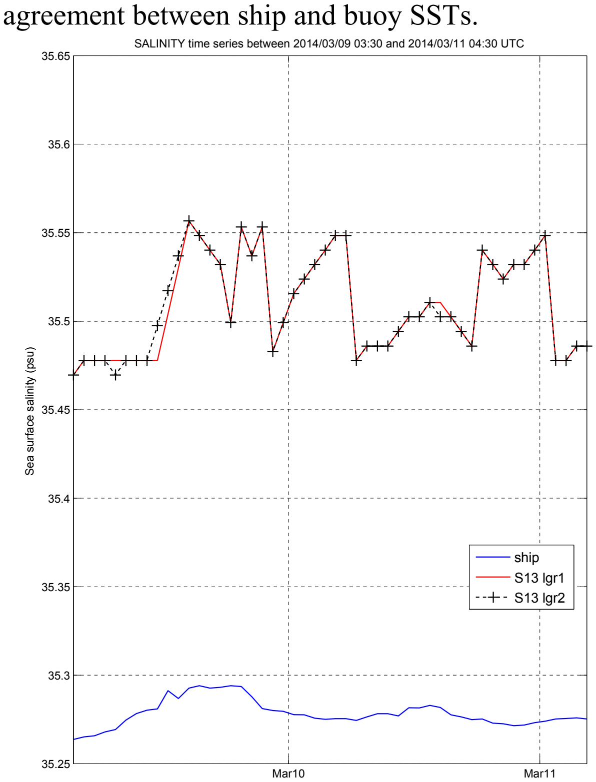


Figure 3-12. Stratus 13 buoy inter-comparison: conductivity (left) and salinity (right).

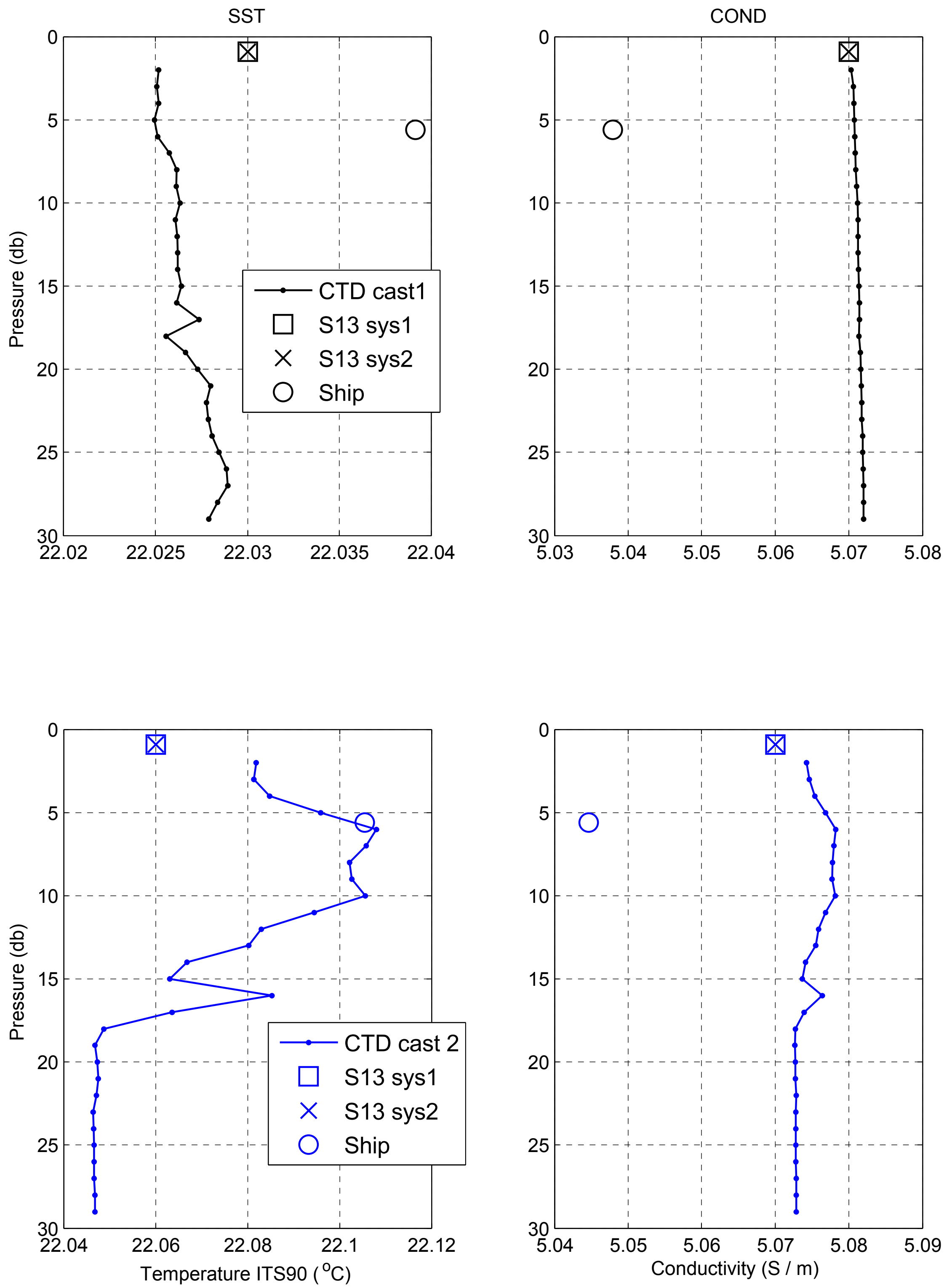


Figure 3-13. Intercomparison between CTD casts, ship TSG and Stratus 13 buoy measurements of near surface conductivity and temperature. CTD casts were made on March 9 near the Stratus 13 buoy.

IV. Stratus 12 Mooring

A. Recovery

On January 27 2014, 20 months after it was deployed, the STRATUS 12 mooring broke free. It continued to drift in a northwesterly direction at a speed of approximately 1 knot. The first objective of the STRATUS 13 cruise was to recover the surface buoy with ASIMET systems and any subsurface instruments hanging below the buoy.

On March 6, the *Ron Brown* reached the buoy, and preparations were made to recover at first light. Ship and WHOI personnel used the ship's workboat to attach a lifting line to the pickup bale on the buoy. The buoy was observed to be riding high on the water and very unstable. It was assumed there were not many instruments or mooring components under it.

The winch leader from the TSE mooring winch was led trough the block in the A-frame and attached to the buoy lifting line that had been passed from the workboat. The winch pulled the buoy up slowly until it was suspended out of the water. The A-frame was brought in enough to attach an air tugger line to the tower top. As the A-frame and winch came in, the tugger kept tension on the tower to keep the buoy from spinning. Two additional tugger lines were attached to the buoy deck as the buoy came aboard.

The A-frame came all the way inboard and lowered the buoy to the deck. There were only two instruments below the buoy. A broken shackle below the second instrument was the cause of the mooring failure (Figs. 4-1 and 4-2). Thus, the first phase of the mooring recovery was complete.

On March 8, the remaining parts of the STRATUS 12 mooring were recovered. The acoustic release was activated at 07:45 local time. At approximately 08:45, the glass balls were spotted approximately ½ mile off the bow.

The ship approached the mooring, and deployed the small boat so WHOI personnel could rig a secure pickup line into the mooring components. The static load of the glass balls and mooring components was estimated at approximately 9,000 pounds.

Once the pickup line was transferred from the small boat to the ship, it was recovered.

The pickup line on the glass balls was shackled into the *Ron Brown*'s trawl winch wire. The winch slowly brought the balls out of the water. The mooring winch, air tuggers and stopper lines were used to secure the mooring and help bring the balls onto the deck. The acoustic releases and deep SBE 16 C/T loggers were removed from the mooring line.

Figure 4-1. Bottom part of remaining mooring line under the drifting Stratus 12 buoy. Only a link left with no shackle below. The shackle seen here is the one above, which was attached to the instrument above.

Figure 4-2. Hardware near the failure point under the recovered Stratus 12 buoy. Bushings that were isolating titanium load bars from shackles are worn out and zinc coating on pins and shackles is gone.

Stopper lines then secured the rest of the mooring at the termination into the end of the Colmega line. At this point, there was no tension on the glass balls and they could be separated and moved out of the way.

Once the glass balls were moved from the center of the deck, the capstan was rigged for recovery of the synthetic line through the block on the A-frame. This line was under about 4,000 pounds of tension from the remaining mooring components hanging below it. Care was taken during recovery to insure that only the personnel necessary for the recovery were in the "danger zone" in case the line parted during recovery. As the line was pulled in by the capstan, it was piled into wire baskets.

When the termination between the 1650-meter section of nylon and the special wire to nylon segment was pulled from the water, stopper lines were used to take the mooring tension from the capstan. The termination was separated, and the mooring tension transferred to the TSE winch.

A traveling block was rigged by passing the trawl wire through the ropemaster block on the A-frame, and attaching a wide-bodied snatch block to it. The winch leader was passed through this block and shackled to the mooring line. Recovery of the mooring continued with the winch pulling up the remaining synthetic line. As the last of the nylon line came out of the water, it was observed that there were loops of wire rope under tension wrapped around the nylon line. The nylon line was frayed and strands were broken. A shackle was inserted into one of the loops of wire, and stopper lines were attached to the wire as a backup in case the line broke. The line broke 30 seconds later, and the entire mooring load went to the loop of wire captured by the stopper lines.

Recovery continued by attaching the stopped off mooring to the winch. The winch pulled more wire out of the water, but there were tangles in the wire almost immediately. Large tangles of wire were pulled through the block and onto the winch whenever possible. When the tangles were unmanageable, wire clamps were used to tie the pieces of mooring wire together (Fig. 4-3), and loops that were not holding the tension of the mooring were cut out.

Eventually, clumps of several instruments, completely tangled in fishing gear, wire and chain were brought to the surface and pulled onto the deck (Figs 4-4 and 4-5) using the winch, crane, air tuggers, stopper lines, web slings, and wire pullers to maneuver the entire mess, including 31 instruments, on board without stopping to disconnect anything.

Once the entire mooring was on board, care was taken to remove the section of chain with the pin from the broken shackle (Figs. 4-6 and 4-7), and to carefully inspect and document each instrument for the mooring log.

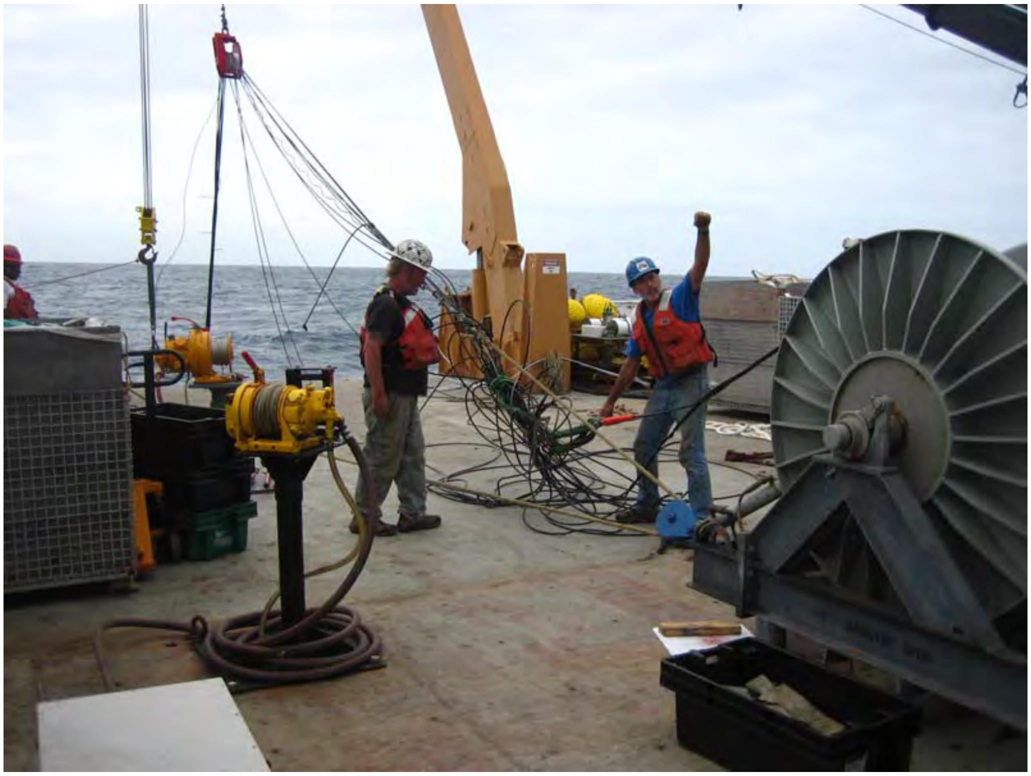


Figure 4-3. Stratus 12 recovery: tangle of wire with one end tied to the TSE winch and wire clamps connected to stop line to check which wire holds tension and cut the others.

Figure 4-4. Stratus 12 recovery: wire and instruments from Stratus 12 mooring after it fell to the bottom. Fishing gear fouling is heavy.

Figure 4-5. Same as Fig 4-4. Last clump of instrument recovered.
All instruments were recovered; last one was RDI ADCP.

Figure 4-6. The failed part of mooring Stratus 12 (see also Fig. 4-7).

Figure 4-7. The end of a chain with a pin and cotter pin but no shackle, seen during the recovery of Stratus 12 mooring which had fallen to the ocean floor (see also Fig. 4-6).

B. Stratus 12 data return

1) Subsurface record inventory

Figure 4-8 to 4-15 show the data records collected by subsurface instruments on Stratus 12. Seabirds with pressure sensors showed evidence of leakage. SSTs did not respond at recovery and were sent back to manufacturer who could recover very little data from memory cards. Clock checks using timed ice baths are shown in Appendix 5. For more information about Stratus 12, see mooring log in Appendix 4.

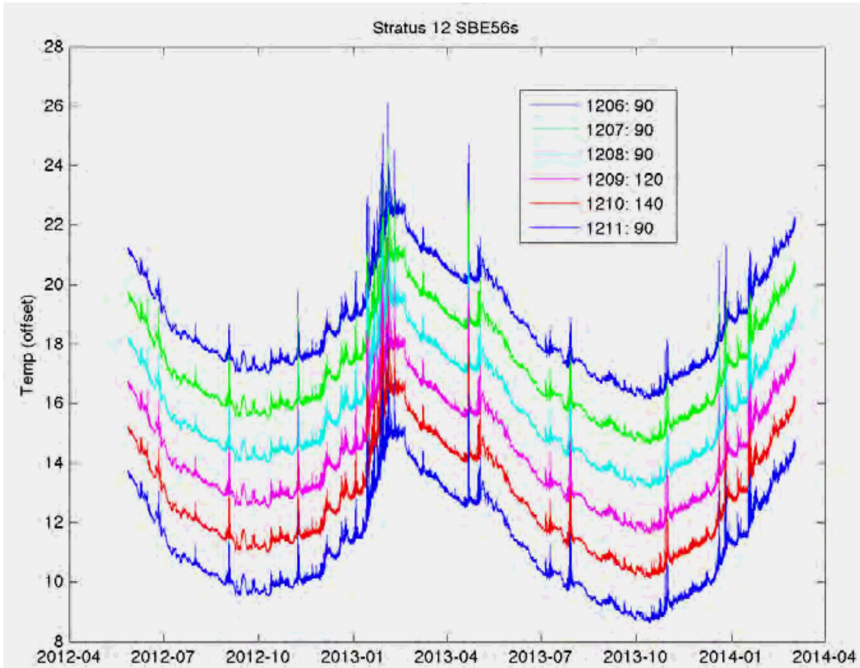


Figure 4-8. Temperature (SST) records from SBE56s located in the foam of the Stratus 12 buoy. Angles (degrees) relative to buoy vane are indicated in legend.

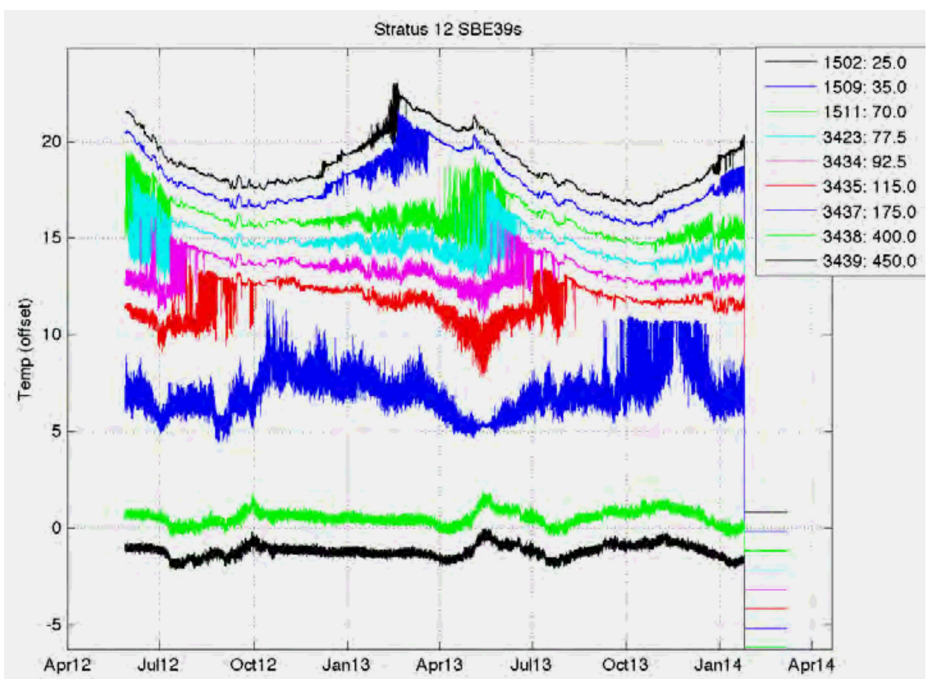


Figure 4-9. Temperature records from SBE39s on the Stratus 12 mooring.

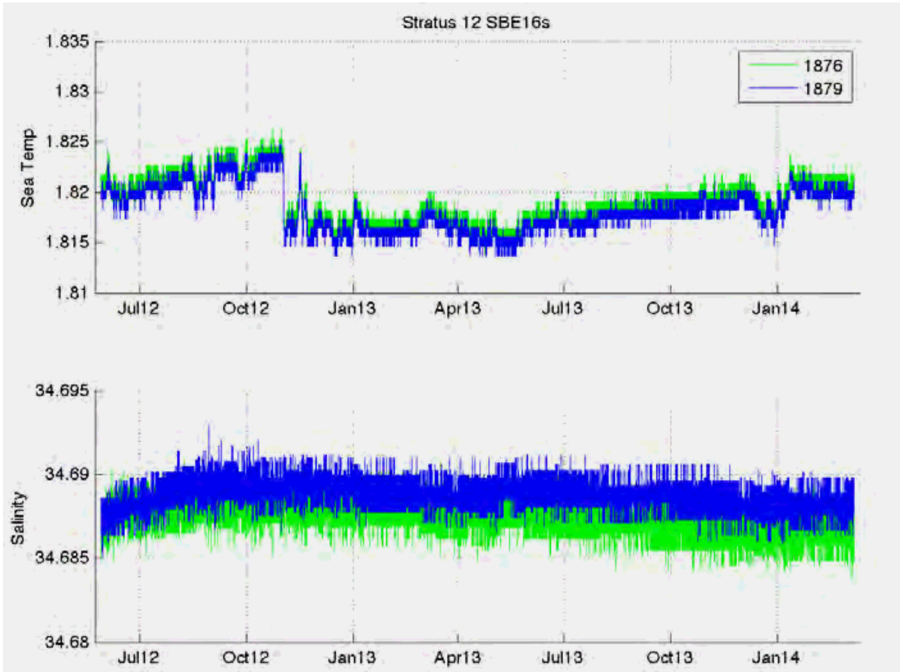


Figure 4-10. Temperature and salinity records from deep SBE16s on the Stratus 12 mooring.

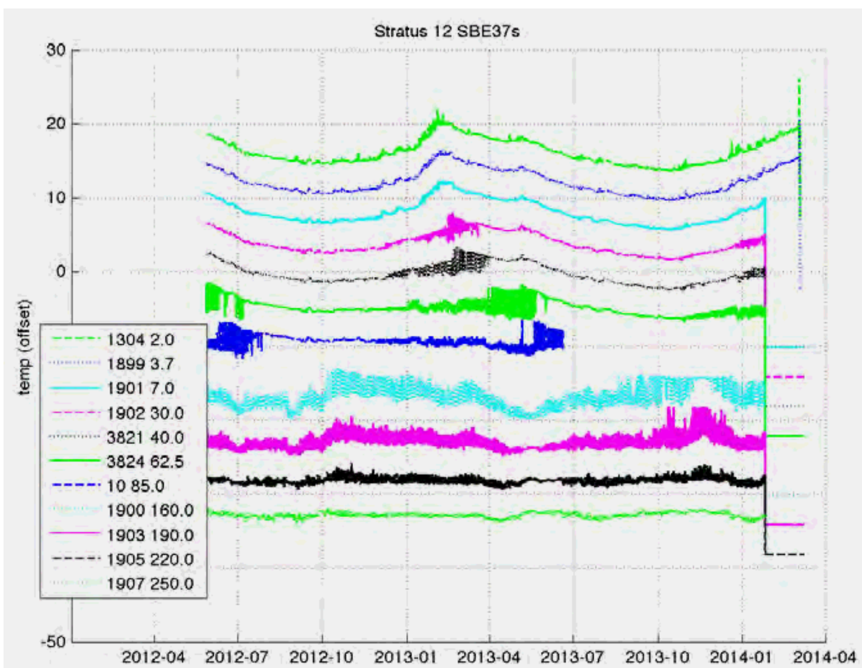


Figure 4-11. Temperature records from SBE37s on the Stratus 12 mooring.

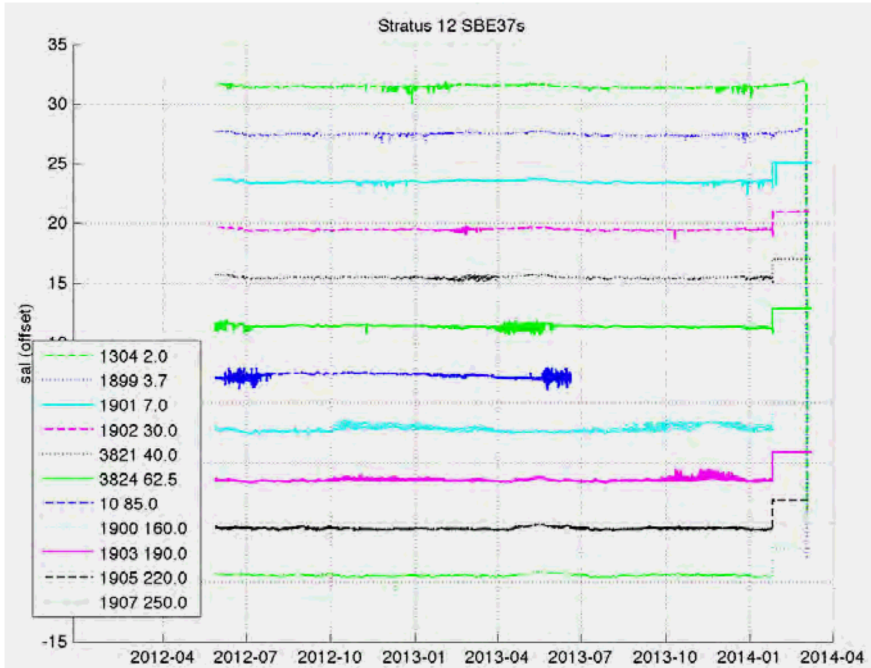


Figure 4-12. Salinity records from SBE37s on the Stratus 12 mooring.

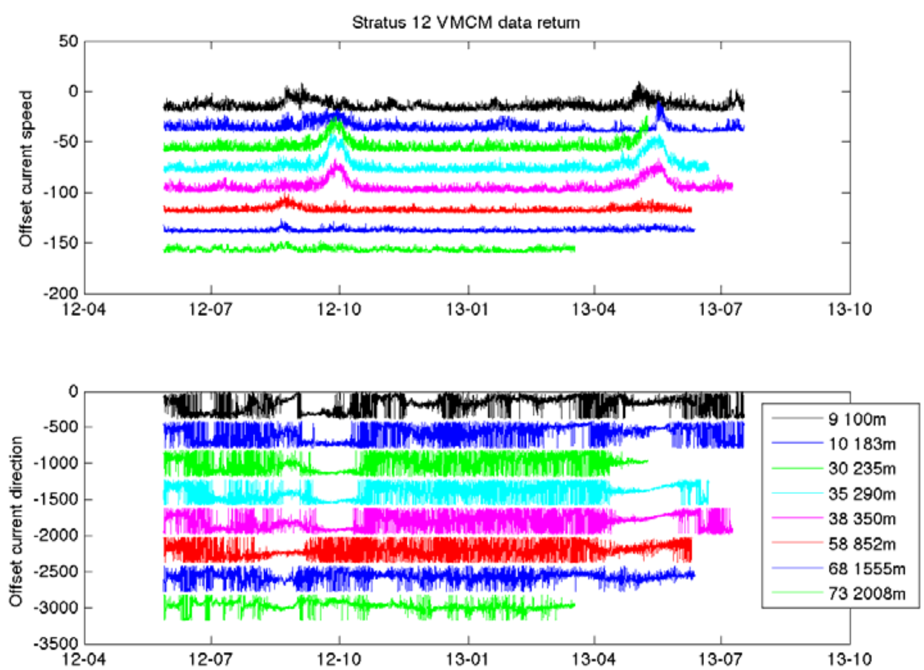


Figure 4-13. Current velocity records from VMCMs on the Stratus 12 mooring.

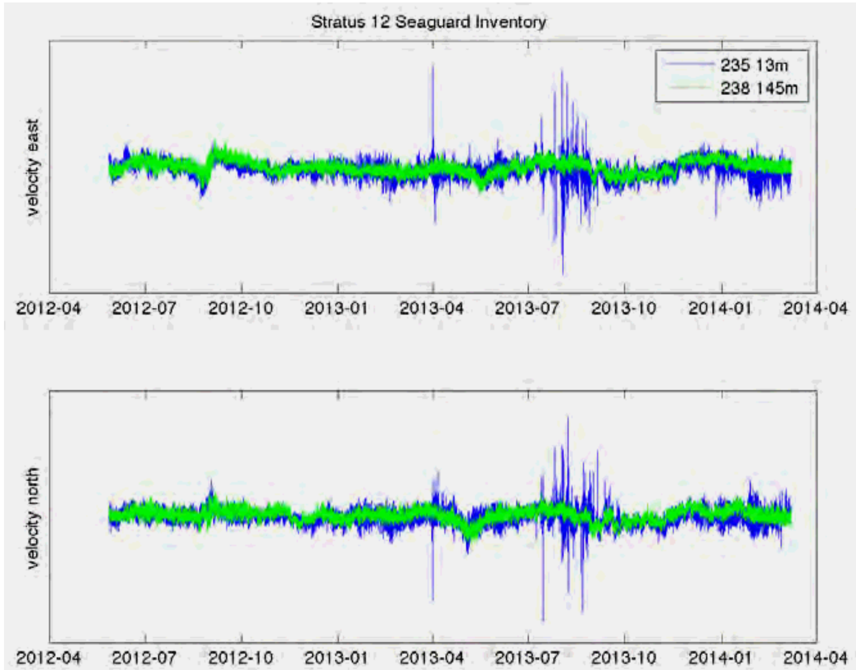


Figure 4-14. Current velocity records from Aanderaa Seaguards on the Stratus 12 mooring.

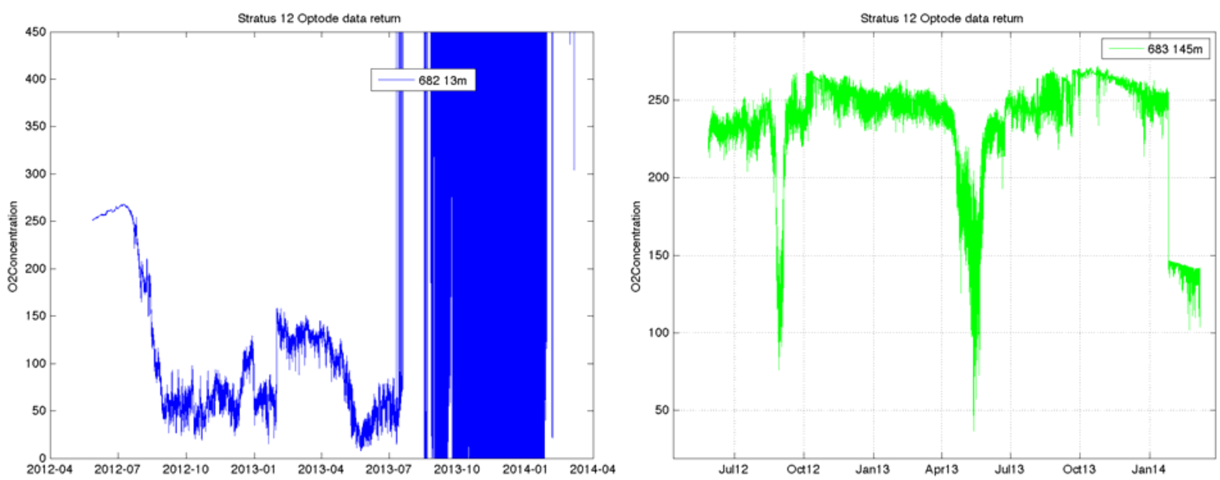


Figure 4-15. Oxygen records from optodes coupled to Aanderaa Seaguards on the Stratus 12 mooring, at 13m (left) and 145 m (right) depths.

2) Surface record inventory

Figures 4-16 to 4-27 show the time-series of data collected by surface instruments on Stratus 12 buoy. Logger 2 stopped logging in early January 2014, due to depleted batteries. Logger 1 was still recording good data at recovery time in March 2014.

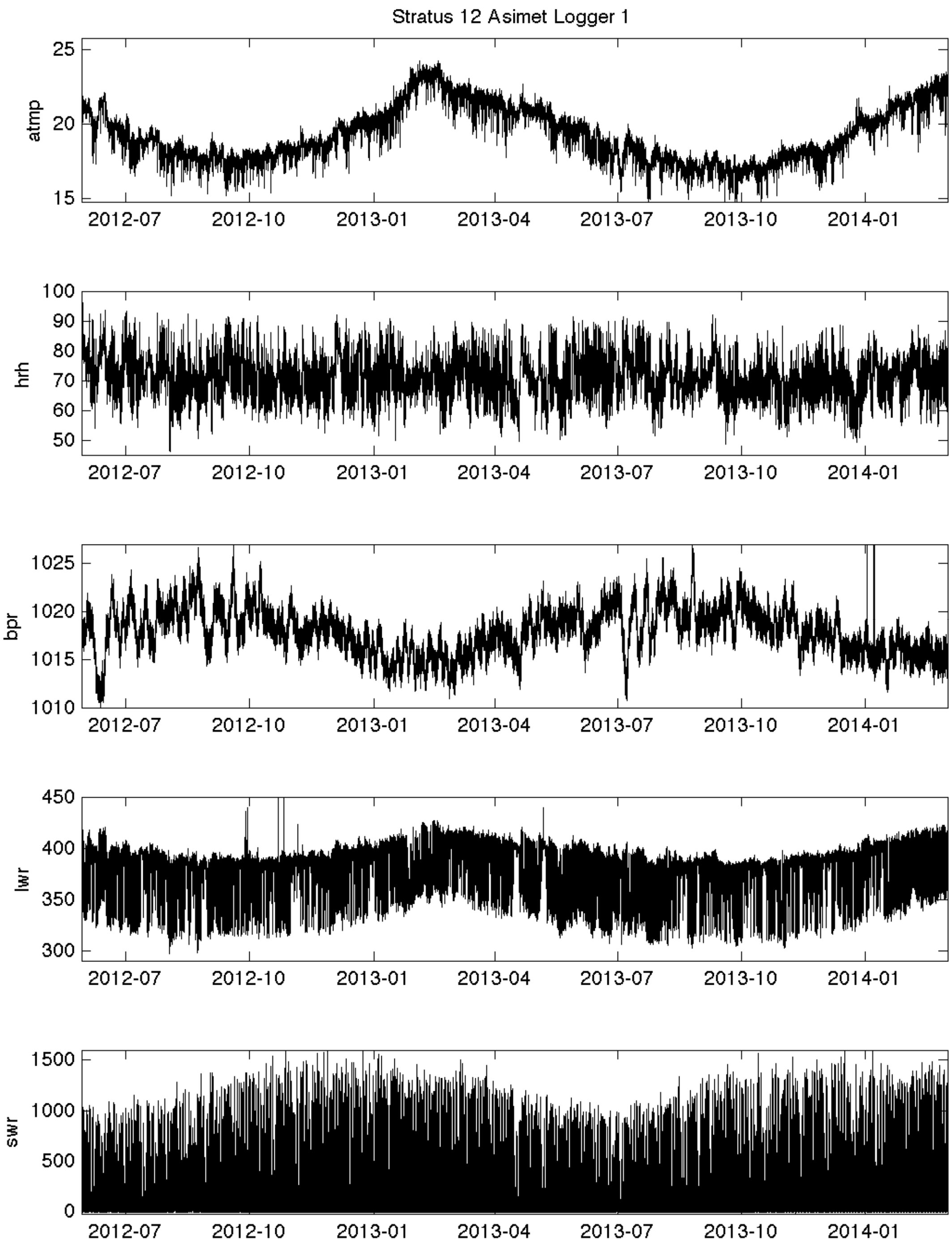


Figure 4-16. ASIMET data (ATMP, HRH, BPR, LWR, SWR) from logger 1 on Stratus 12.

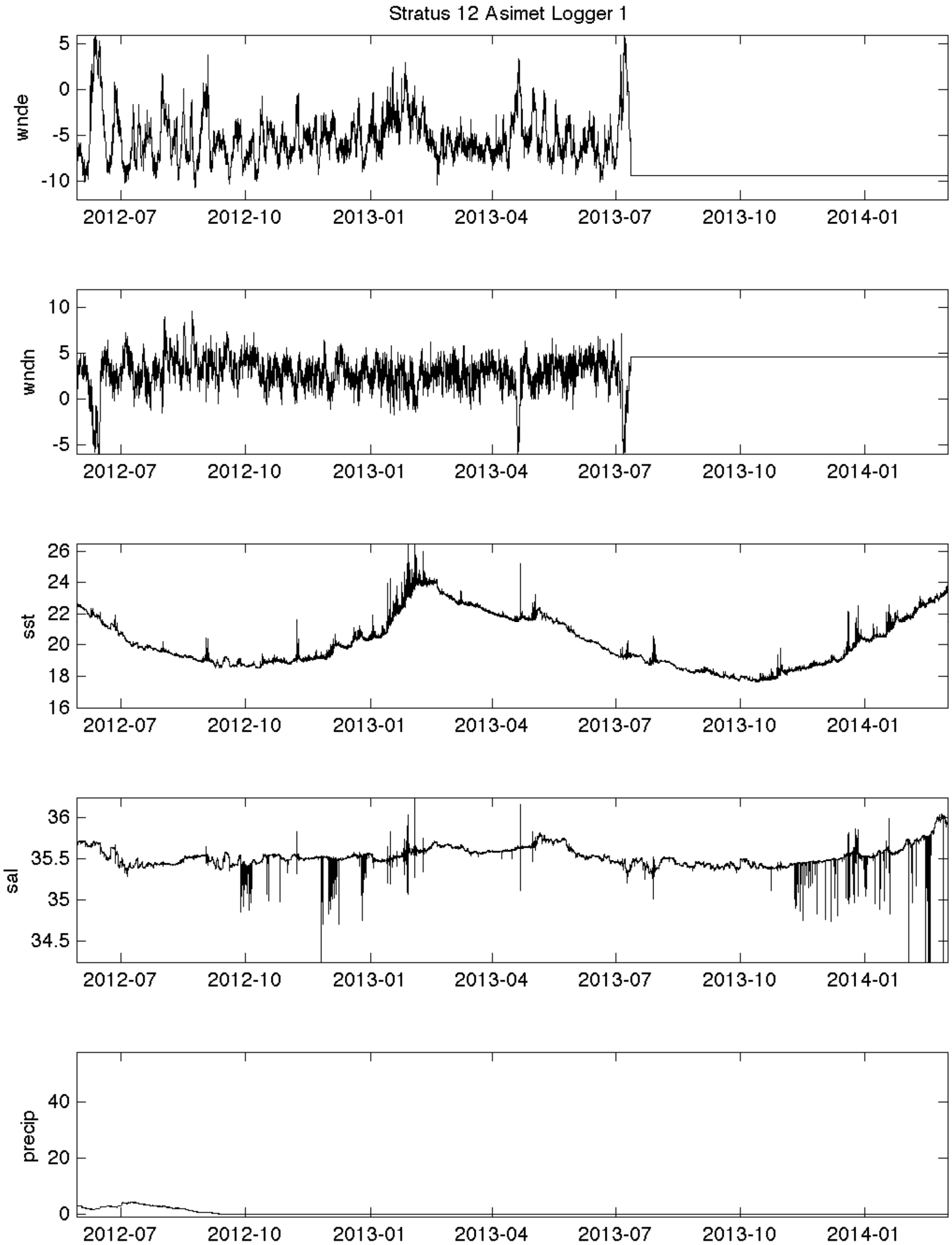


Figure 4-17. ASIMET data (WNDE (eastward wind velocity), WNDN (northward), SST, SAL (near surface salinity), precipitation) from logger 1 on Stratus 12.

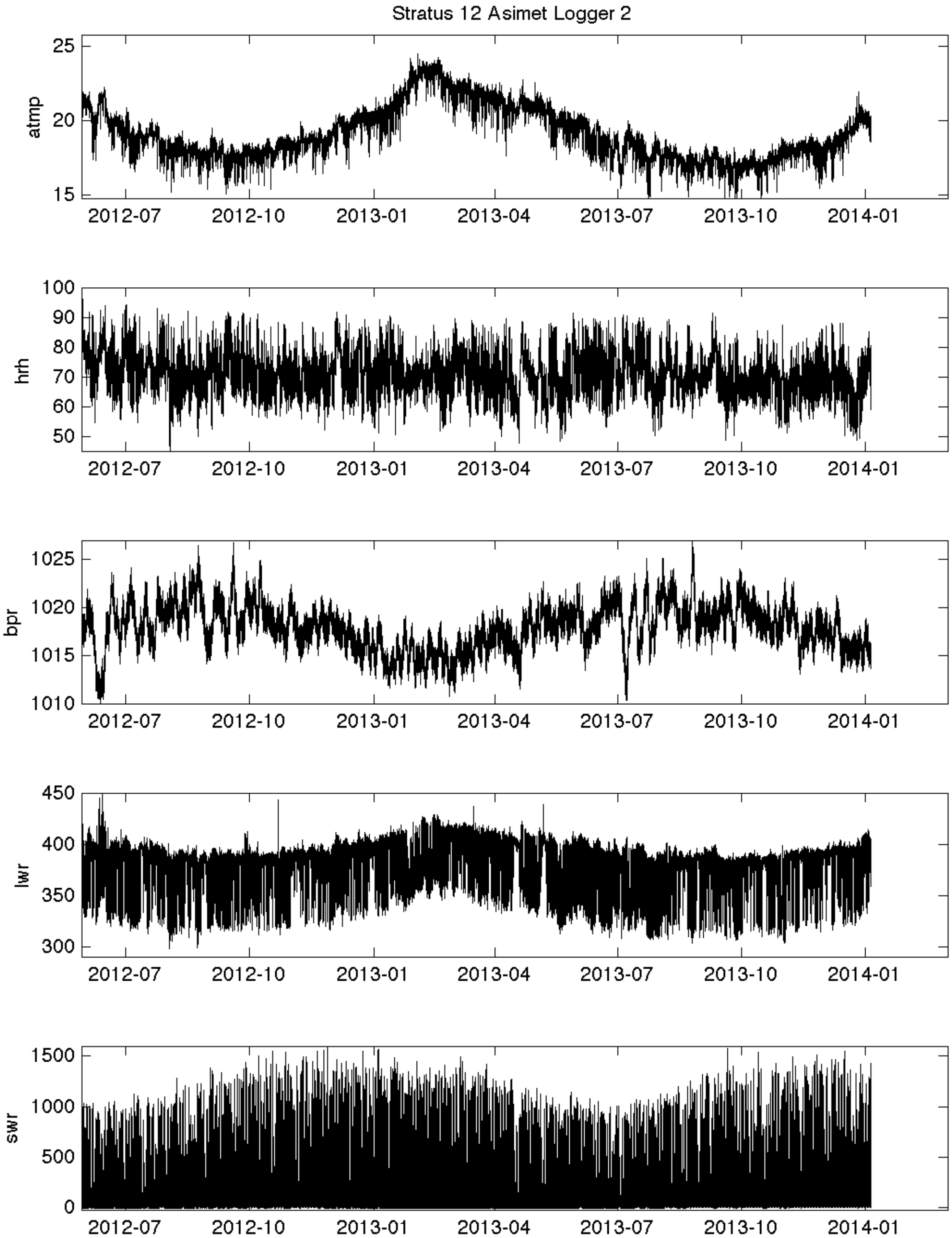


Figure 4-18. ASIMET data (ATMP, HRH, BPR, LWR, SWR) from logger 2 on Stratus 12.

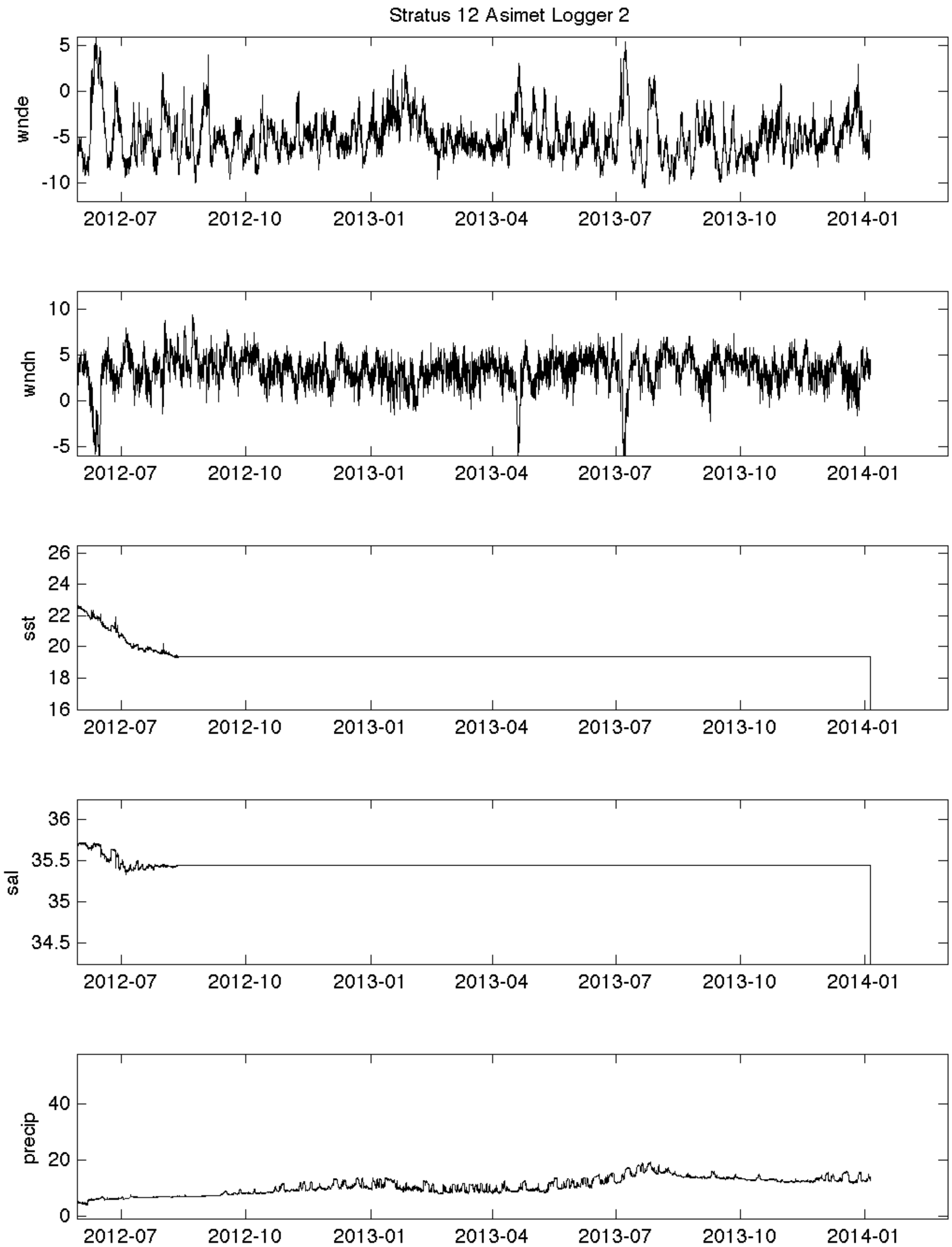


Figure 4-19. ASIMET data (WNDE (eastward wind velocity), WNDN (northward), SST, SAL (near surface salinity), precipitation) from logger 2 on Stratus 12.

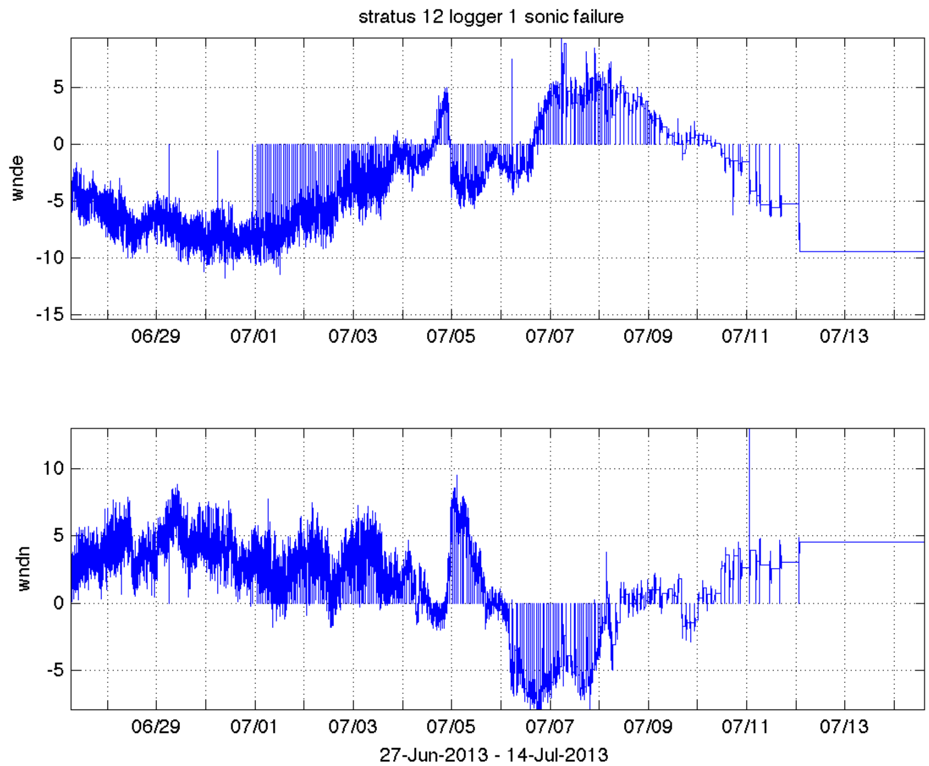


Figure 4-20. Wind velocity data from logger 1 (sonic wind # 217) on Stratus 12.

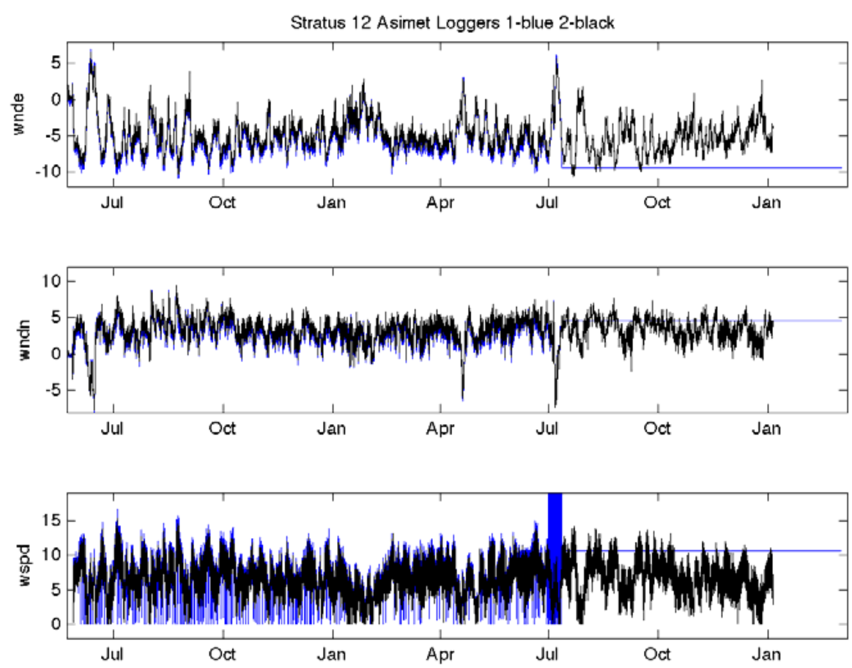


Figure 4-21. ASIMET wind data from two loggers on Stratus 12.

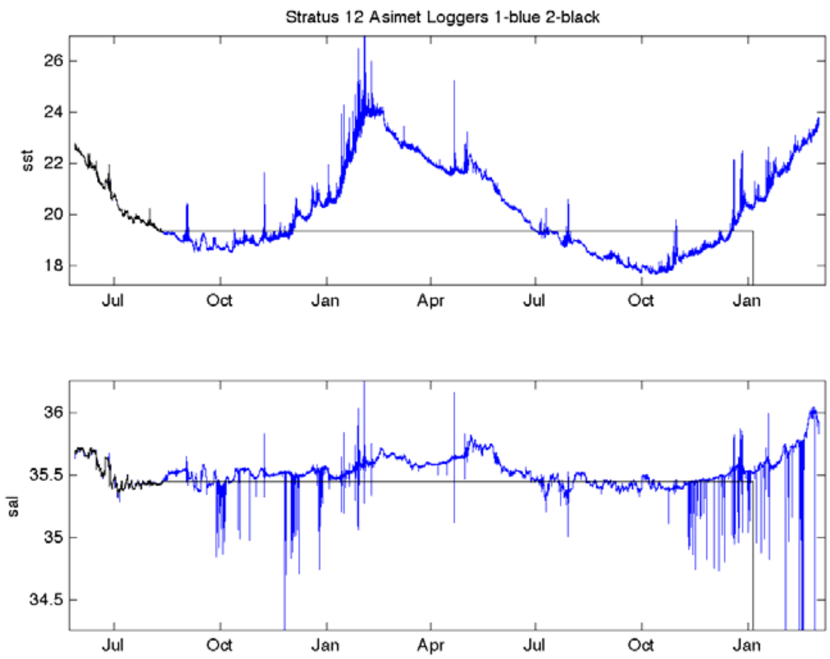


Figure 4-22. ASIMET SST and near surface salinity data from two loggers on Stratus 12.

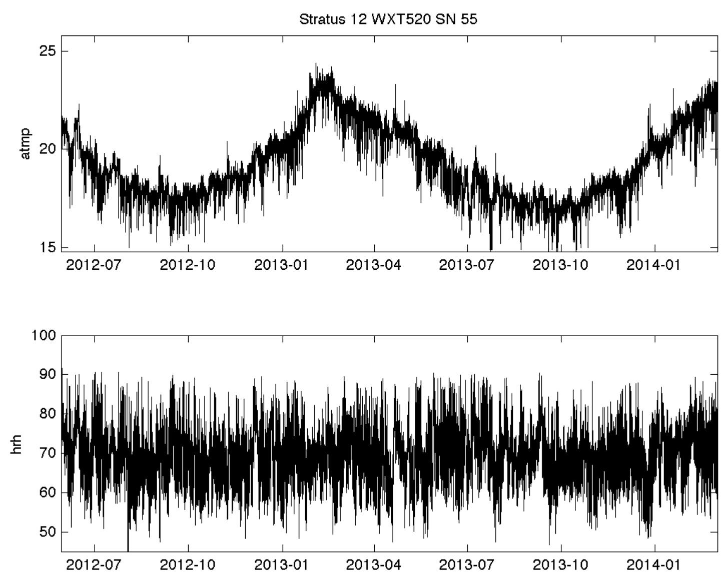


Figure 4-23. ATMP and HRH data from Vaisala WXT 520 on Stratus 12.

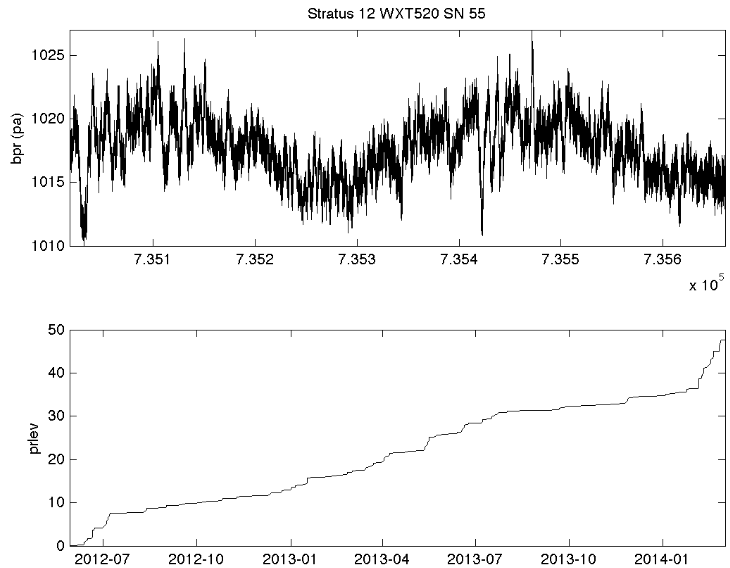


Figure 4-24. BPR and precipitation data from Vaisala WXT 520 on Stratus 12.

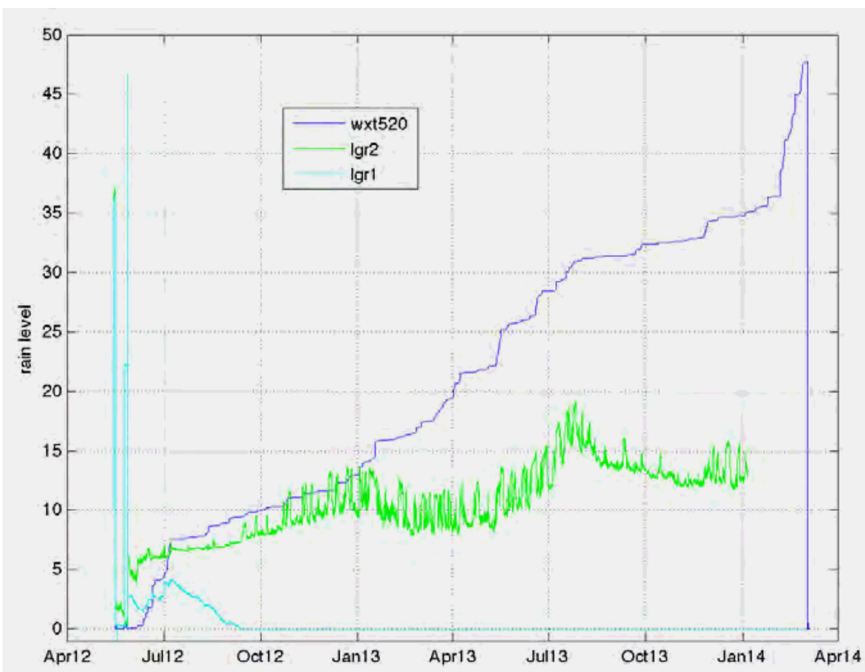


Figure 4-25. Precipitation data from two ASIMET systems and Vaisala WXT 520 on Stratus 12.

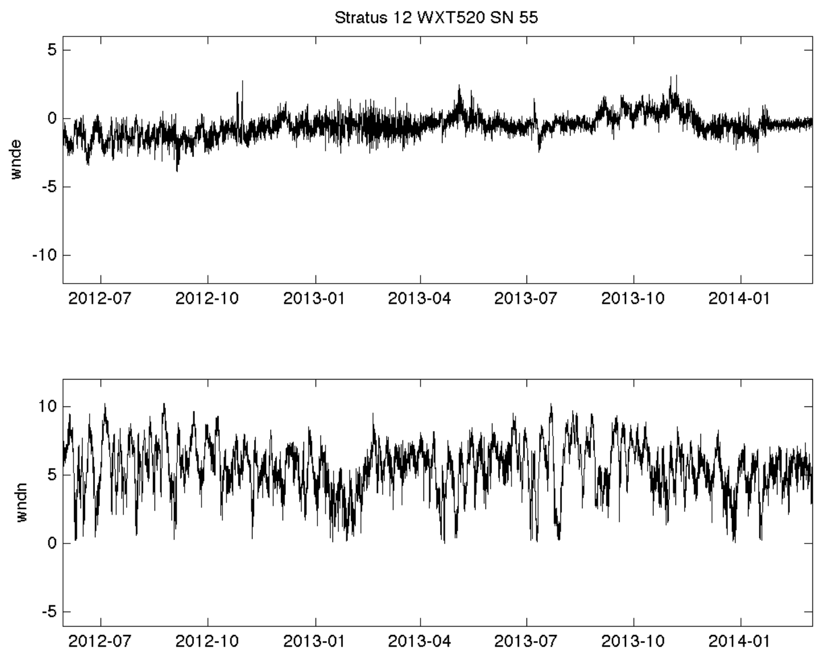


Figure 4-26. Wind velocity (WNDE, WNDN) data from Vaisala WXT 520 on Stratus 12.

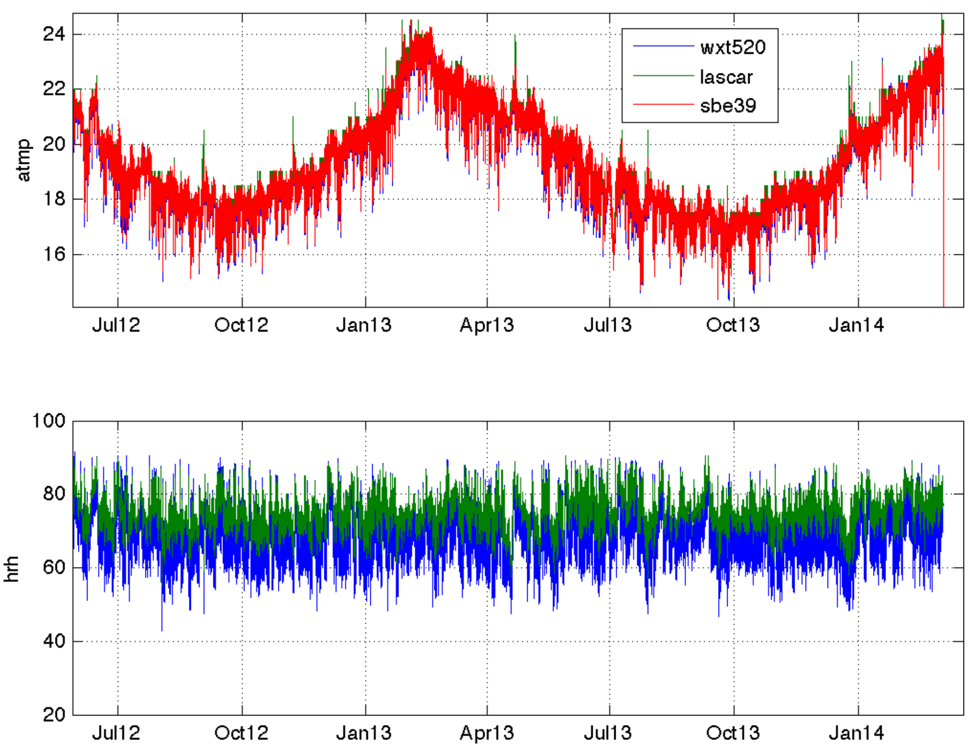


Figure 4-27. ATMP and HRH data from Vaisala WXT 520 and Lascar sensors (SBE39 AT included as well for ATMP) on Stratus 12.

C. Stratus 12 Inter-comparison

Because the Stratus 12 was recovered almost 22 months after its deployment some of its sensors were out of power (logger 2) and not recording anymore. The buoy was also drifting freely so inter-comparison with measurements from ship's sensors was very limited in time (about 7 hours on the morning of March 3) when the ship was stationed near the buoy. The buoy was on deck by 12:56 UTC. Figures 4-28 to 4-38 show the inter-comparison between ship and buoy measurements. Ship's measurements were adjusted to buoy height using COARE 3.5. The original 1-minute ship data was averaged to 10 minutes blocks, and 1-minute buoy data remained unchanged except for a correction for ASIMET's clock drift.

Figure 4-28. SST intercomparison between drifting Stratus 12 buoy (1-minute) and ship data (10-minute averages), on March 3 2014. SST sensors are at 0.8 m and 5.6 m deep for Stratus 12 (logger) and ship, respectively. SBE56 sensors on Stratus 12 very close to the surface, in the buoy foam hull.

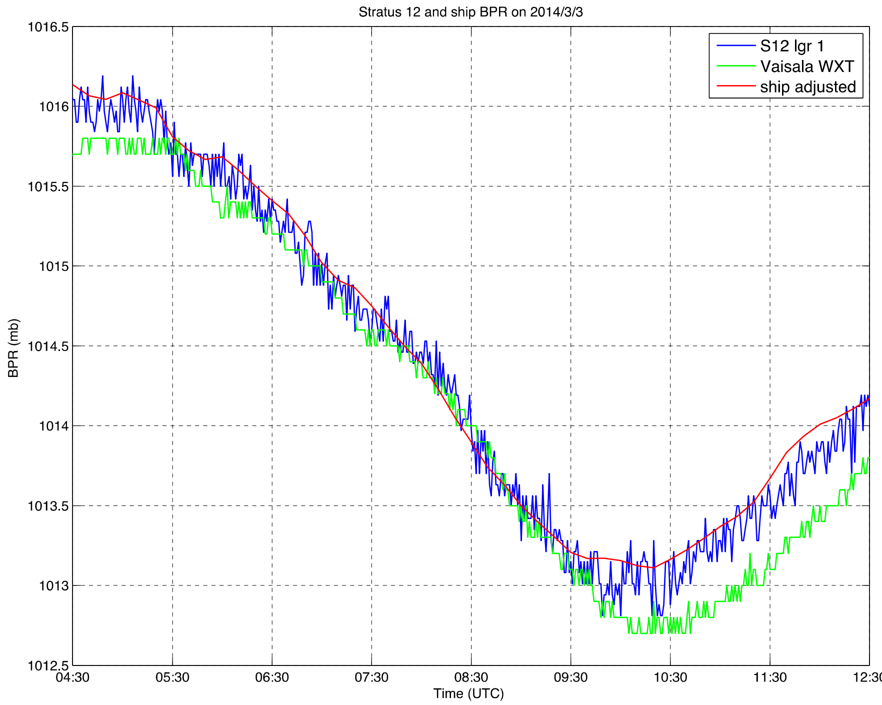


Figure 4-29. Barometric pressure (BPR) intercomparison between drifting Stratus 12 buoy (1-minute) and ship data (10-minute averages), on March 3 2014. Ship BPR adjusted to height of sensor on buoy.

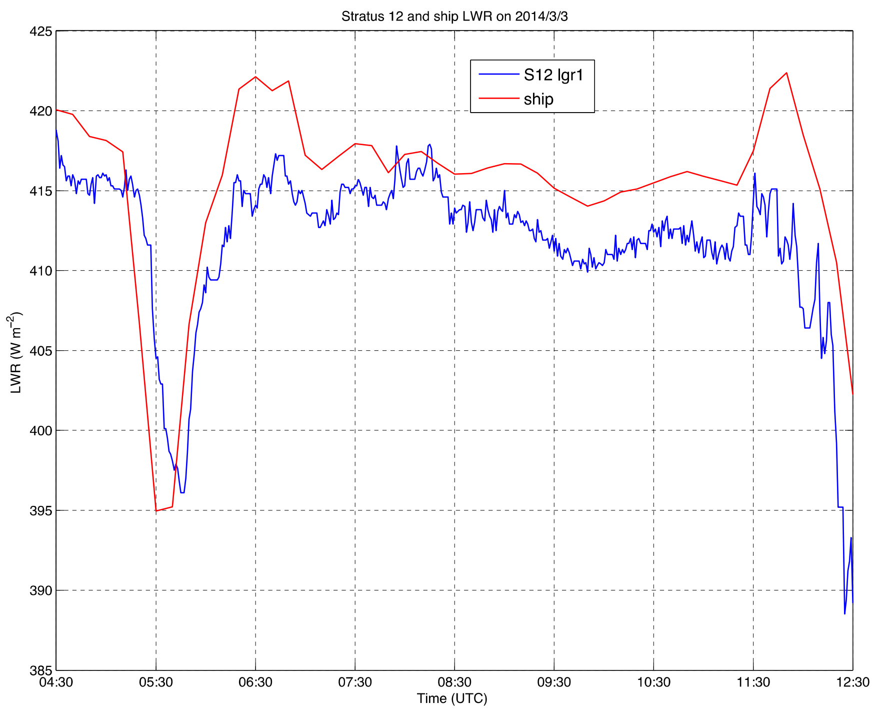


Figure 4-30. Longwave radiation (LWR) intercomparison between drifting Stratus 12 buoy (1-minute) and ship data (10-minute averages), on March 3 2014.

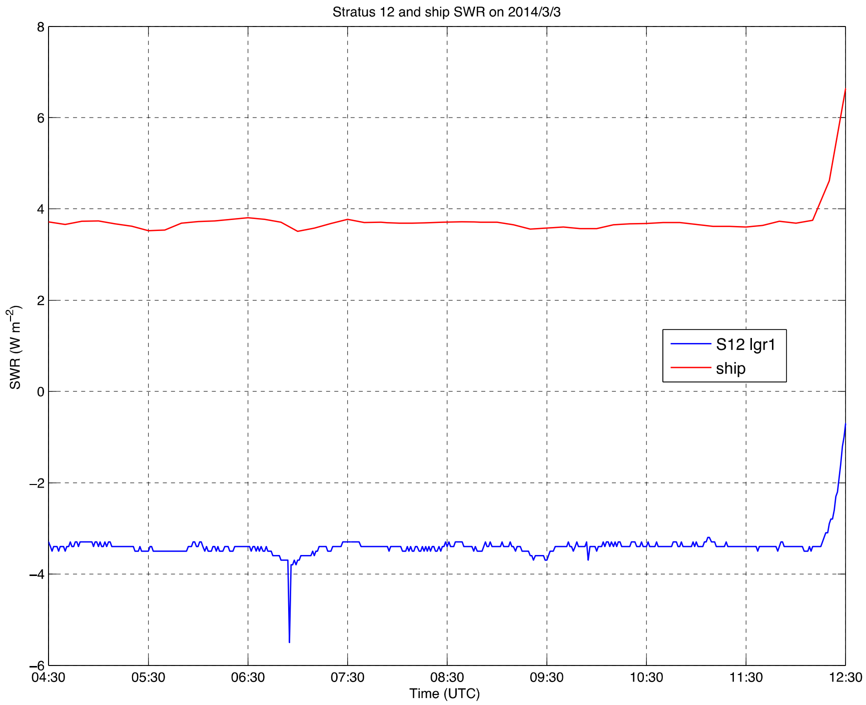


Figure 4-31. Shortwave radiation (SWR) intercomparison between drifting Stratus 12 buoy (1-minute) and ship data (10-minute averages), on March 3 2014.

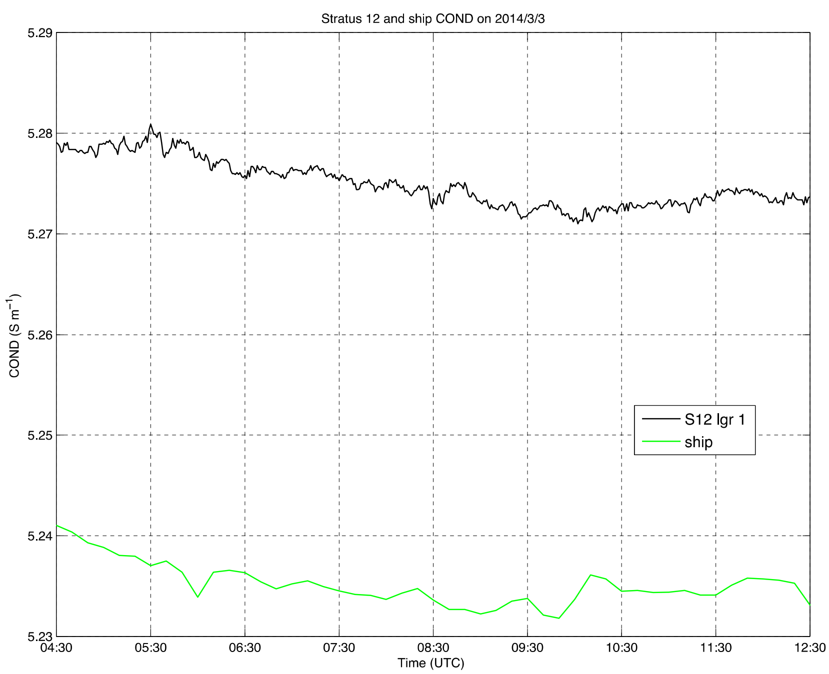


Figure 4-32. Conductivity (COND) intercomparison between drifting Stratus 12 buoy (1-minute) and ship data (10-minute averages), on March 3 2014. COND sensors are at 0.8 m and 5.6 m depth on Stratus 12 and ship, respectively.

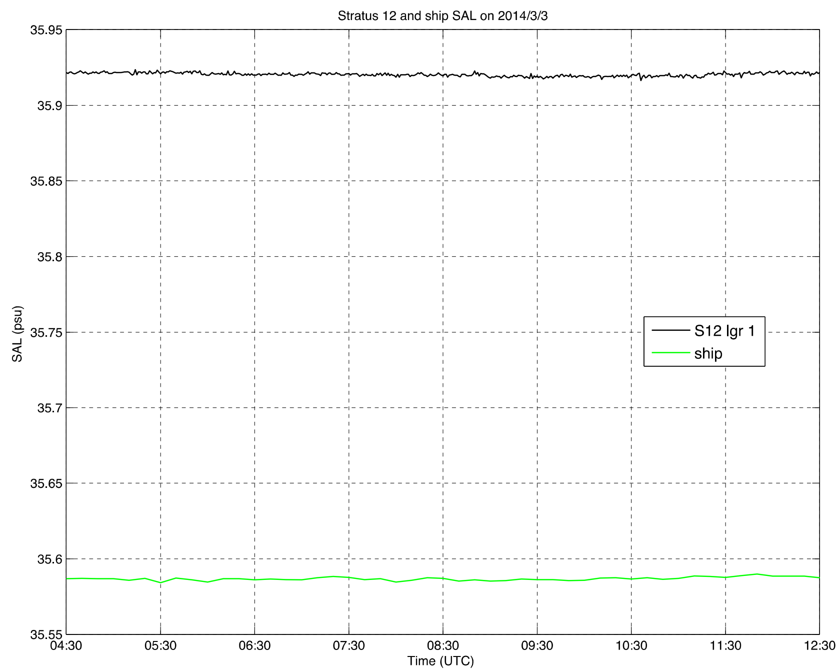


Figure 4-33. Salinity (SAL) intercomparison between drifting Stratus 12 buoy (1-minute) and ship data (10-minute averages), on March 3 2014. Based on SST and COND sensors that are at 0.8 m and 5.6 m deep on Stratus 12 and ship, respectively.

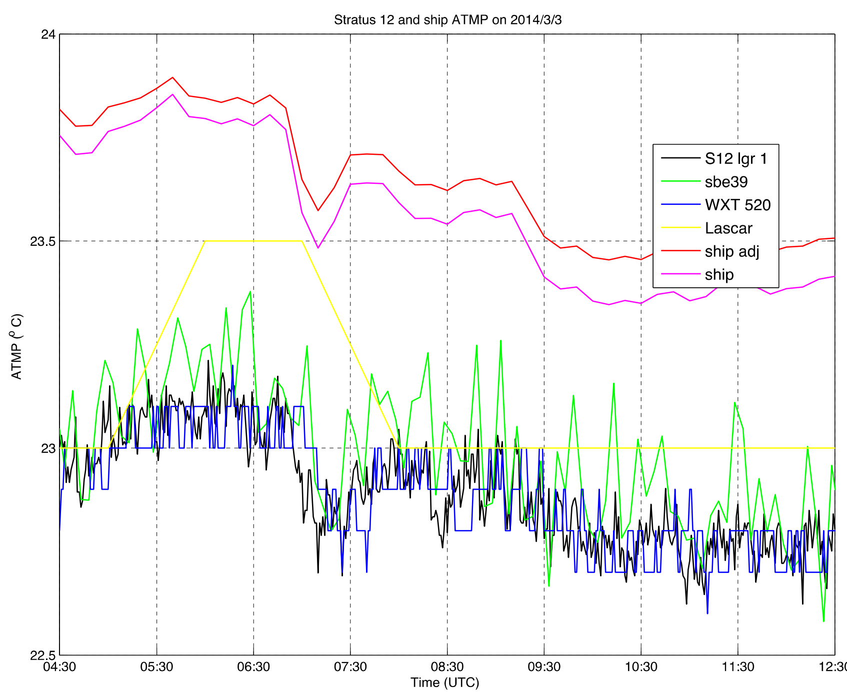


Figure 4-34. Atmospheric temperature (ATMP) intercomparison between drifting Stratus 12 buoy (1-minute) and ship data (10-minute averages), on March 3 2014. Ship ATMP as measured and adjusted to height of sensors on buoy.

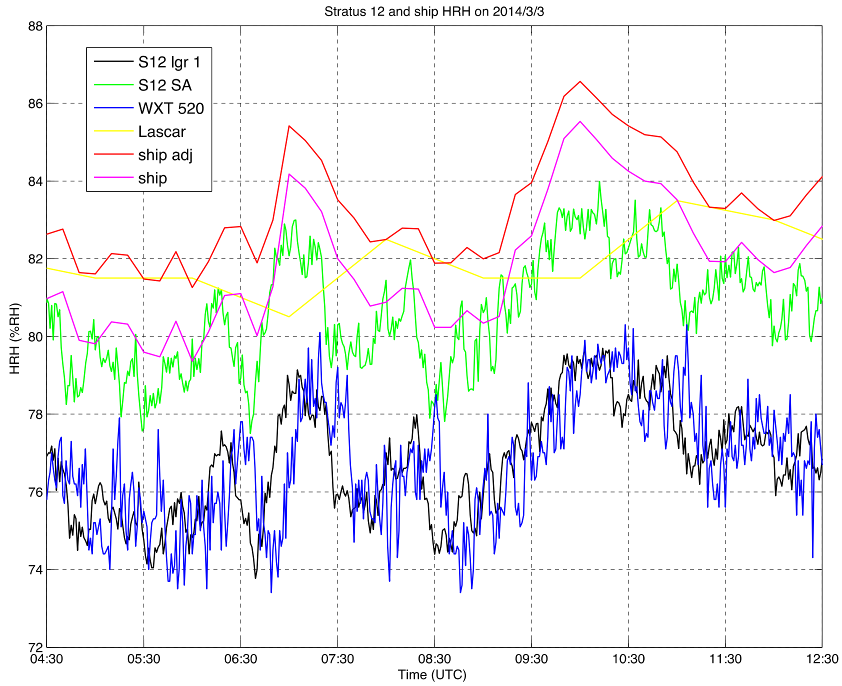


Figure 4-35. Atmospheric relative humidity (HRH) intercomparison between drifting Stratus 12 buoy (1-minute) and ship data (10-minute averages), on March 3 2014. Ship HRH as measured and adjusted to height of sensors on buoy.

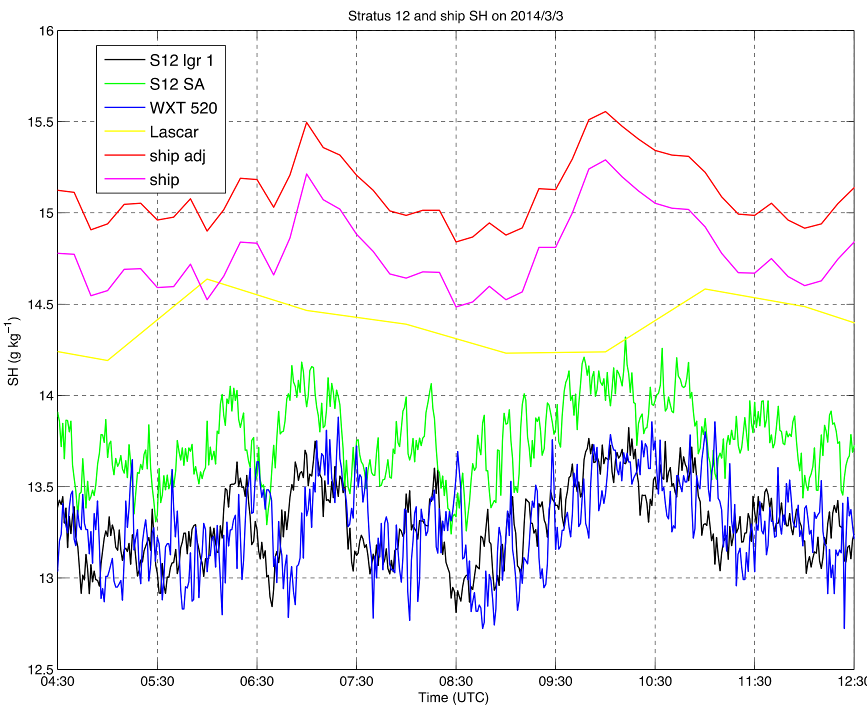


Figure 4-36. Atmospheric specific humidity (SH) intercomparison between drifting Stratus 12 buoy (1-minute) and ship data (10-minute averages), on March 3 2014. Ship SH is computed from HRH and ATMP as measured and adjusted to height of sensors on buoy.

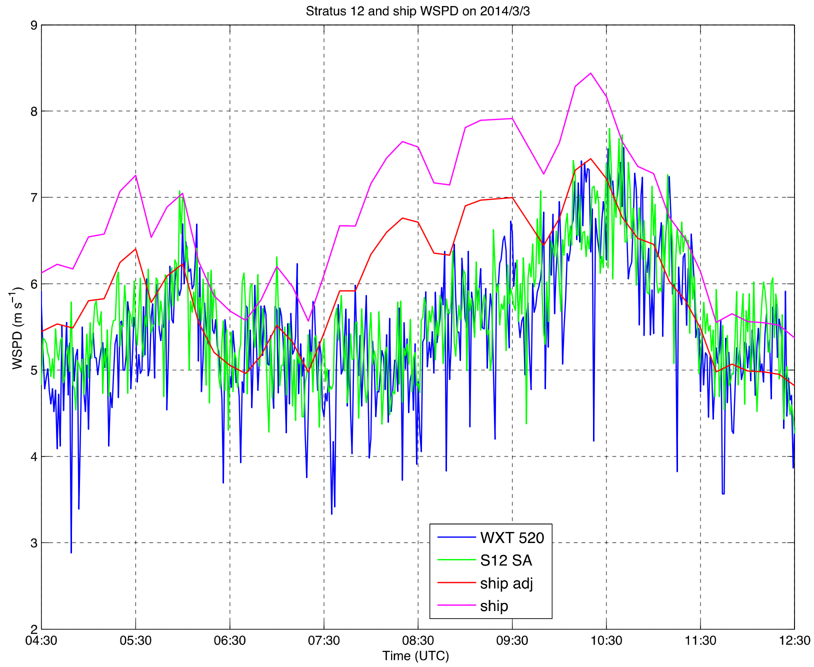


Figure 4-37. Wind speed (WSPD) intercomparison between drifting Stratus 12 buoy (1-minute) and ship data (10-minute averages), on March 3 2014. Ship WSPD is shown as measured and adjusted to height of sensors on buoy. Only the stand-alone WSPD sensor on Stratus 12 was still recording data at recovery.

Figure 4-38. Wind direction (WDIR) intercomparison between drifting Stratus 12 buoy (1-minute) and ship data (10-minute averages), on March 3 2014. Oceanographic convention (heading).

After recovery, we installed the HRH/ATMP sensors from S12 on the 03 deck (see Fig. 4-39) as stand-alone units, in order to evaluate their performance from March 4 to 10, 2014. These sensors were: HRH 213 (Logger 1), HRH 230 (Logger 2), HRH 219 (standalone). We also added freshly calibrated sensor HRH250 for this inter-comparison and use it as standard of reference.

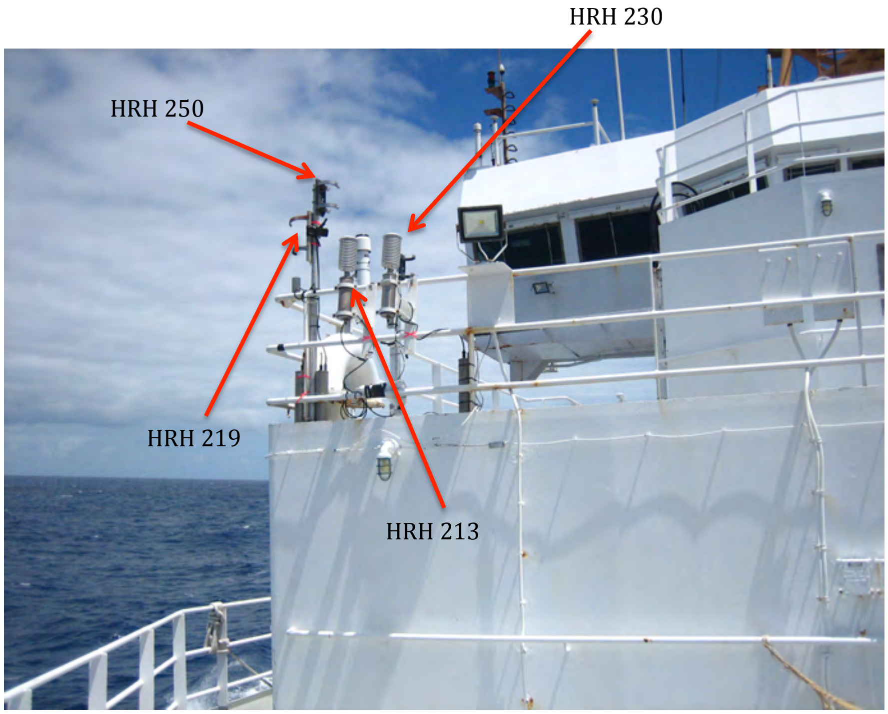


Figure 4-39. Standalone ASIMET sensors installed on 03 deck of R/V Ron Brown. HRH 250 and 219 had just been removed at the time of the picture.

After several days of measurements, records indicated the presence of a few biases on some of these instruments (Fig. 4-40 to 4-41). The two S12 primaries (Sensors 213 and 230) exhibited very similar temperature (ATMP), but both were biased cold by about 0.1 °C compared to the reference sensor 250; standalone 219 had a cold bias of 0.25 °C. For relative humidity (HRH), sensor 219 tracked 250, whereas the two primaries, 213 and 230, had a 4%RH low bias.

These post-recovery biases are consistent with trends in the data collected throughout the S12 deployment. Figures 4-44 and 4-45 show the time-series of ATMP and HRH from the S12 sensors, as differences of hourly data from logger 1 and every other sensor on the buoy. Time-series shown stop in January 2014 since this is when logger 2 stopped recording. Data used for these figures is from night periods only in order to avoid diurnal warming effects, which affected each sensor differently. It is apparent that ATMP from the two loggers tracked each other very well during the whole deployment. On the other hand there is a consistent downward trend of ATMP from logger 1 (and logger 2 must be similar) when compared to the SBE39AT, WXT and Lascar sensors, which lead to a low bias near 0.1 °C, consistent with Fig 4-42. Note that ATMP from standalone 219 seemed to drift non-linearly with time.

Similarly, Figure 4-45 indicates that HRH from logger 1 drifted low compared to standalone 219, Lascar and WXT. The drift seemed mostly linear in time, with a 3%RH drop over 20 months.

Compared to logger 2, HRH from logger 1 was about 0.5 %RH low and increased linearly in time during the first time, at which point it was about 0.5 %RH high and remained there until January 2014.

These linear trends are quantified using the Matlab function robustfit.m (an iteratively reweighted least squares method that minimizes outliers effect on regression). The apparent drift is consistent with the post-recovery inter-comparison data shown in figures 4-41 and 4-43. The bias then is about 4 %RH, although the trends in Figure 4-45 reaches only about 3 %RH. There is indication at post-recovery that logger 1 HRH is slightly higher than HRH from logger 2; however it is not as high as 0.5 %RH as shown in the trend.

Two corrections for HRH from loggers 1 and 2 were tested. The first correction was based on the offset and a linear estimation of its drift. Qualitatively, both HRH from loggers drifted low relative to all other sensors. Because standalone sensor 219 gave HRH values very close to freshly calibrated HRH 250 at post-recovery, the drift of the HRH from the loggers relative to HRH from sensor 219 was used as the value to correct the offset drift (Fig. 4-45, top-right panel). In the same manner, ATMP from the loggers was corrected for offset drift, but this time the correction was based on comparison with ATMP values from SBE39 AT sensor (Fig. 4-44, bottom-left panel). Thus, this correction of ATMP and HRH from loggers 1 and 2 can be summarized as:

$HRH_{logger}(corrected) = HRH_{logger}\ (raw) + 0.0045 * (T – T_{start}) / (T_{end} – T_{start})$

$ATMP_{logger}\ (corrected) = ATMP_{logger}\ (raw) + 0.00014 * (T – T_{start}) / (T_{end} – T_{start})$

where T_{start} and T_{end} are dates of deployment and recovery of Stratus 12 buoy, respectively.

An alternative correction is based on the drift of a scalar rather than an offset. Assuming HRH from standalone sensor 219 did not drift, or at least very little compared to HRH from sensors connected to the loggers, we can estimate a correction scalar from the ratio HRH(logger) / HRH(219). First, we used Figure 4-46, which indicates that HRH from logger 1 had a low bias at deployment, compared to HRH from other sensors on logger 2 and standalone 219. This is in agreement with the burn-in for the Stratus 12 buoy prior to its deployment in 2012 (see Stratus 12 cruise report). We thus estimate that HRH(logger 1) should be scaled up by a factor 1/0.996 at the beginning of the Stratus 12 deployment. HRH(logger2) on the opposite was assumed to be measuring the true HRH. Second we estimated the scalar factor at the end of the deployment using the post-recovery comparison when all sensors were installed on the 03 deck. We tested different scaling factors and chose the one that once applied to HRH (from logger) would minimize the root mean square error with HRH 250 at post-recovery (Fig. 4-47) and obtained the values 0.948 and 0.942 for loggers 1 and 2, respectively. The correction for the scalar drift was again assumed to be linear in time:

$HRH_{logger1}(corrected) = HRH_{logger1}(raw) * [1/0.996 + (1/0.948 – 1/0.996)*(T – T_{start}) / (T_{end} – T_{start})]$

$HRH_{logger2}(corrected) = HRH_{logger2}(raw) * [1 + (1/0.942 – 1)*(T – T_{start}) / (T_{end} – T_{start})]$

Application of this correction leads to improved data shown in Figure 4-48 and 4-49. Drifts are reduced as well as biases. The histograms of HRH(logger) – HRH(other) are shown in Fig. 4-50. Typical difference between corrected logger HRH and sensor 219 has a RMSE between 0.9 and 1 %RH and standard deviation is a bit more than 0.4 %RH. This means that ASIMET HRH bias is near 1 %RH. Lascar (WXT) HRH was biased high (low) and had larger inaccuracies than ASIMET. They also had a drift but much smaller than the ASIMET.

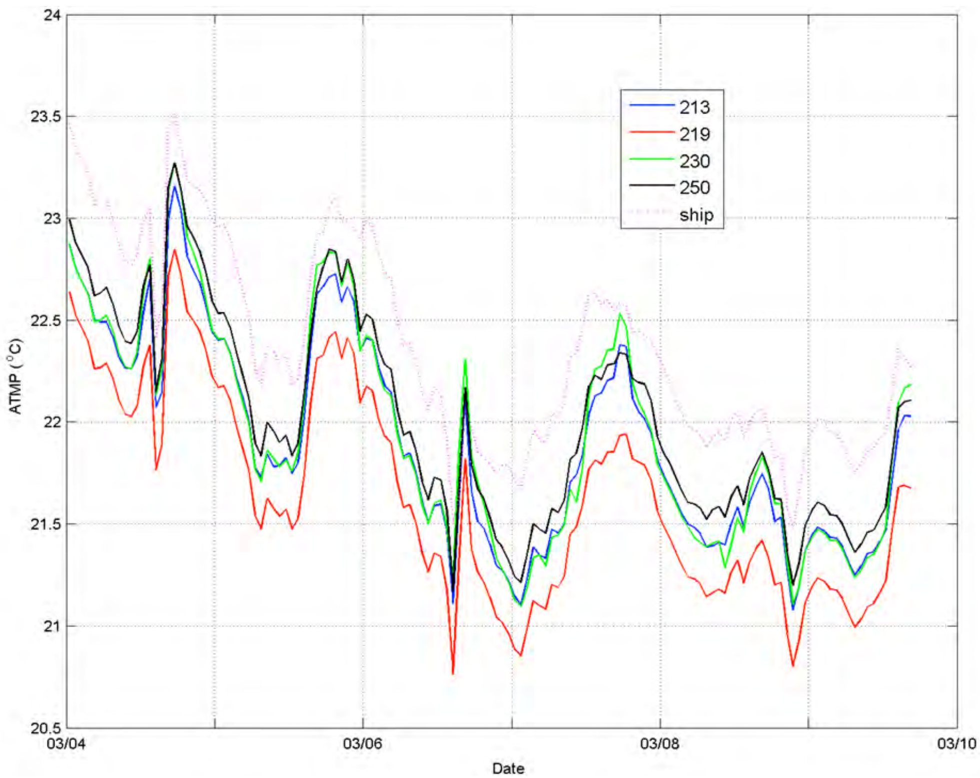


Figure 4-40. Air temperature (ATMP) from sensors installed on O3 deck after S12 recovery.

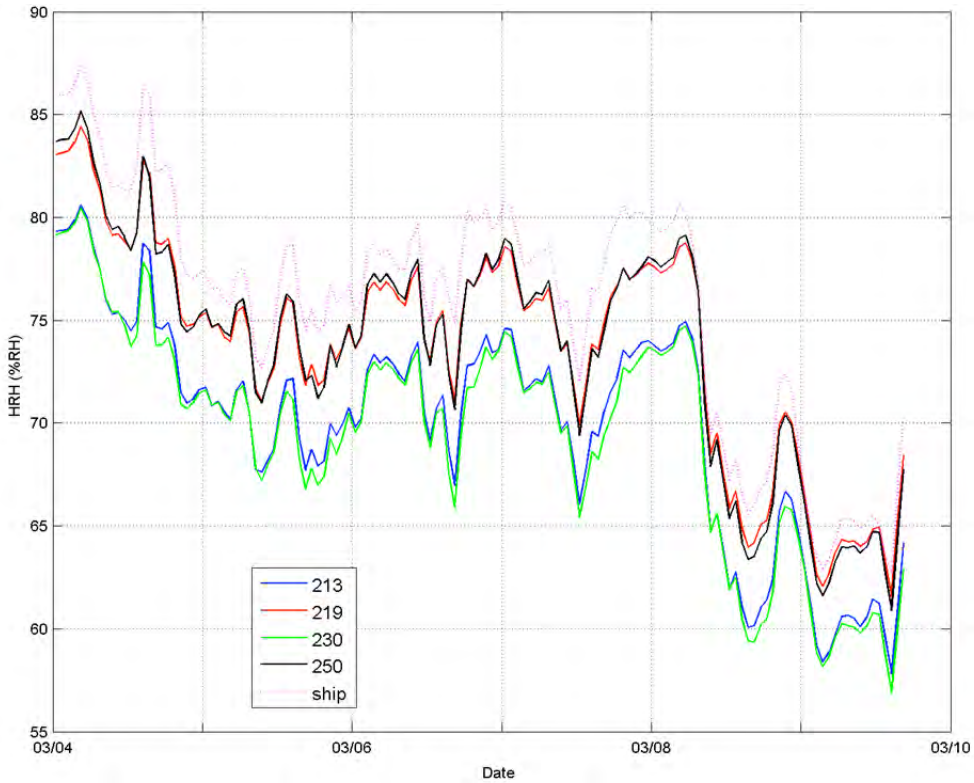


Figure 4-41. As in Figure 4-40 but for relative humidity (HRH).

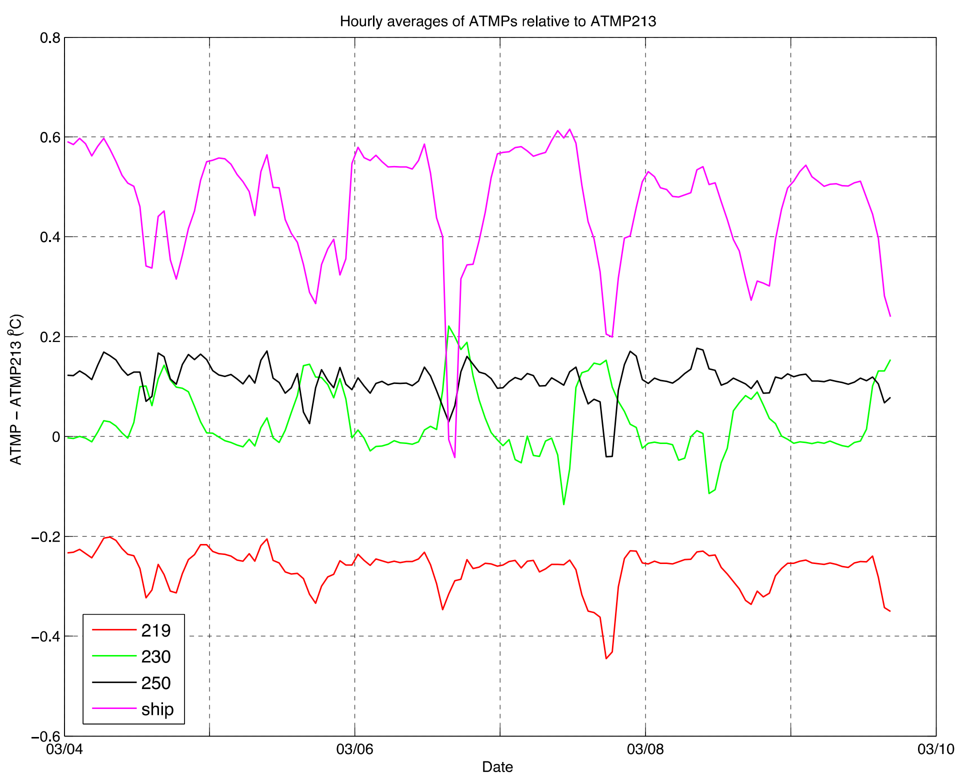


Figure 4-42. ATMP difference between sensors on 03 deck and sensor 213.

Figure 4-43. Same as Fig. 4-41 but for HRH.

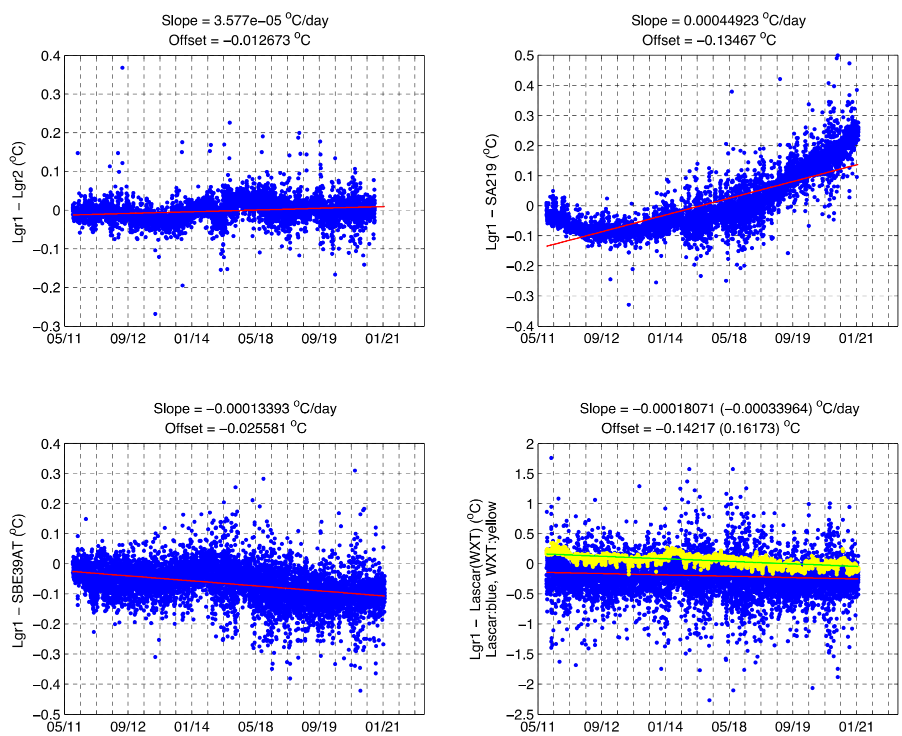


Figure 4-44. Time-series (from May 2012 to Jan 2014) of ATMP difference between Logger 1 (sensor 213) and other ATMP available on Stratus 12. Straight lines are linear fits of night time data, using Matlab routine robustfit.m, whose slope and offset are indicated above each plot.

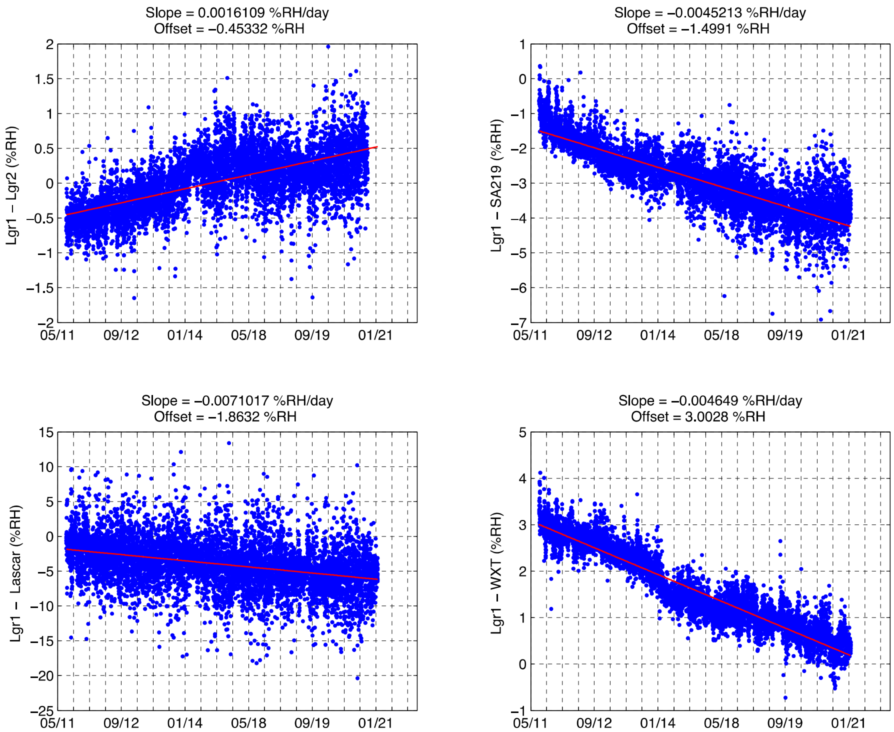


Figure 4-45. As in fig. 4-44 but for HRH.

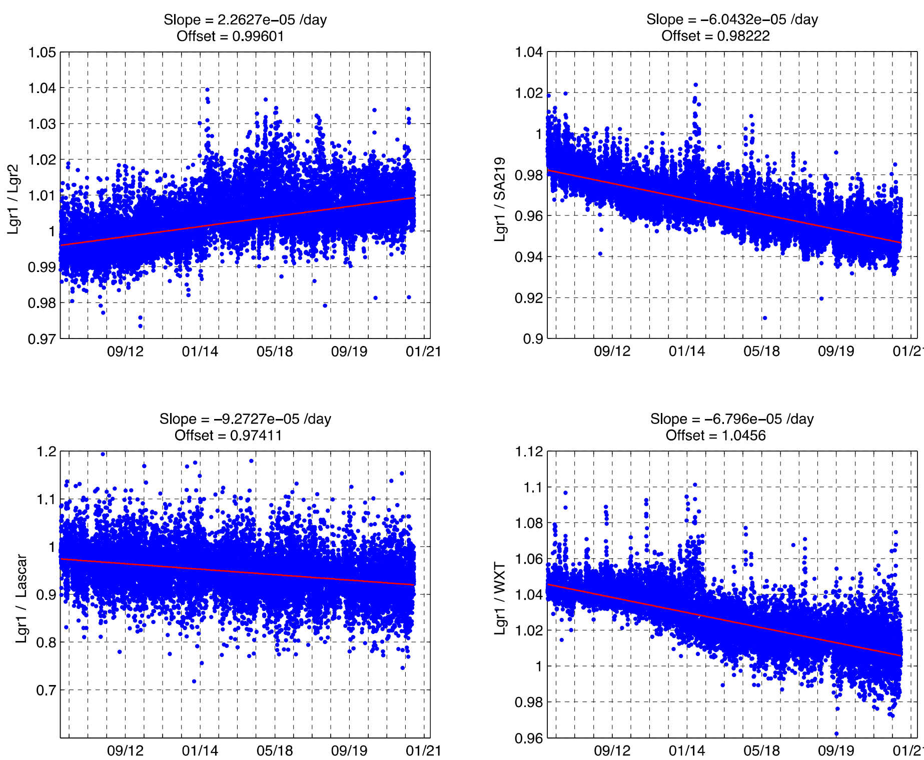


Figure 4-46. Time-series of ratio HRH(logger 1) / HRH(other). Red lines are linear trends based on regression with Matlab function robustfit.m.

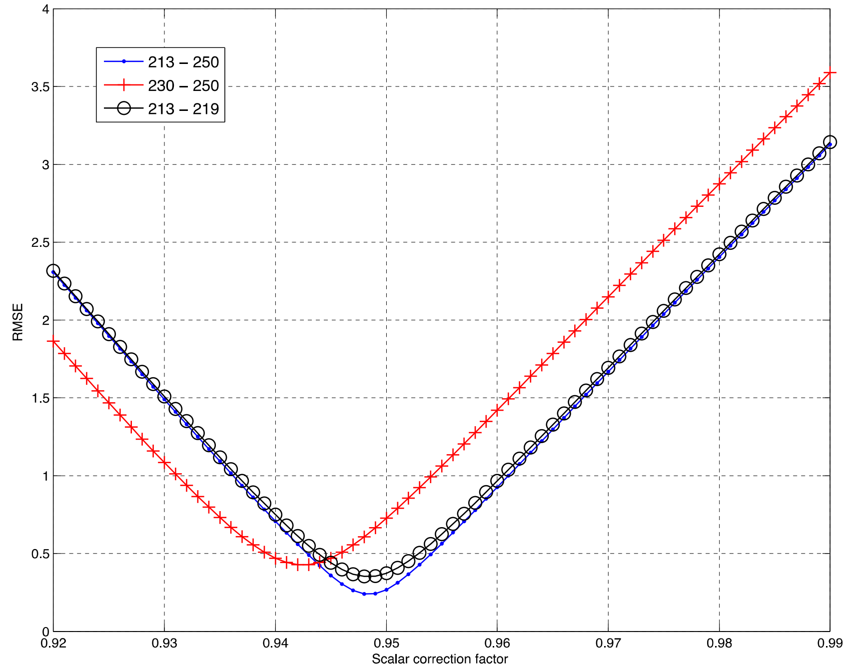


Figure 4-47. Root mean square deviation between HRH from sensor 213 (logger 1), 230 (logger 2) and HRH 250 (newly calibrated) and standalone HRH 219, as a function of scalar correction factor applied to HRH 213 and 230.

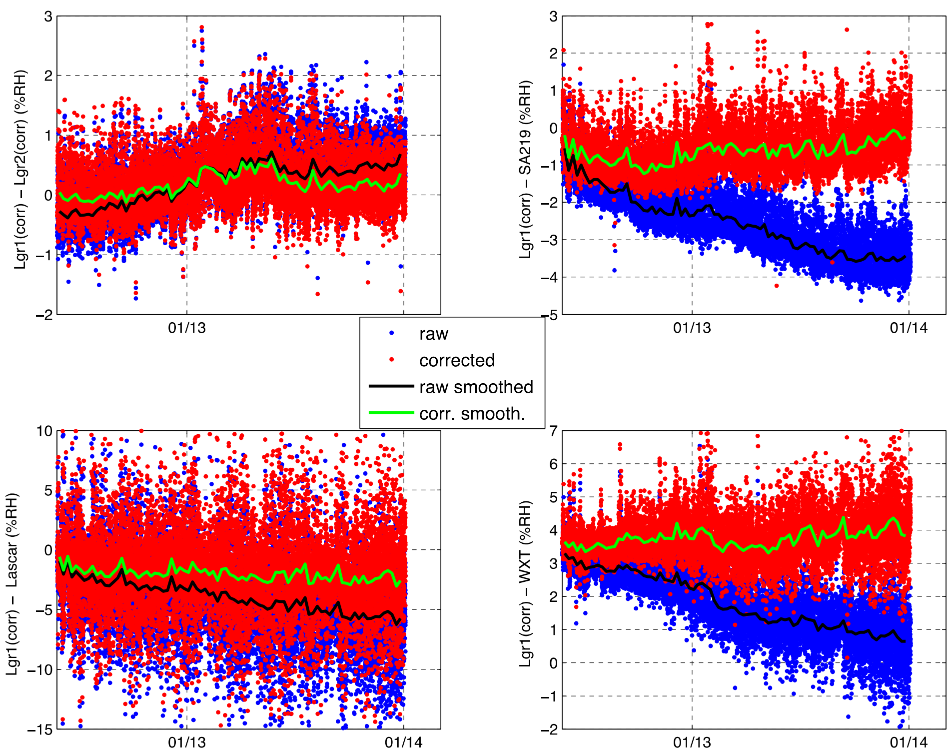


Figure 4-48. Time-series of offsets of HRH between S12 sensors for uncorrected data (blue) as in Fig. 4-45, and for logger data corrected (red) using linear drift of scalar. The black (green) lines are the 7-day averages for the uncorrected (corrected) data.

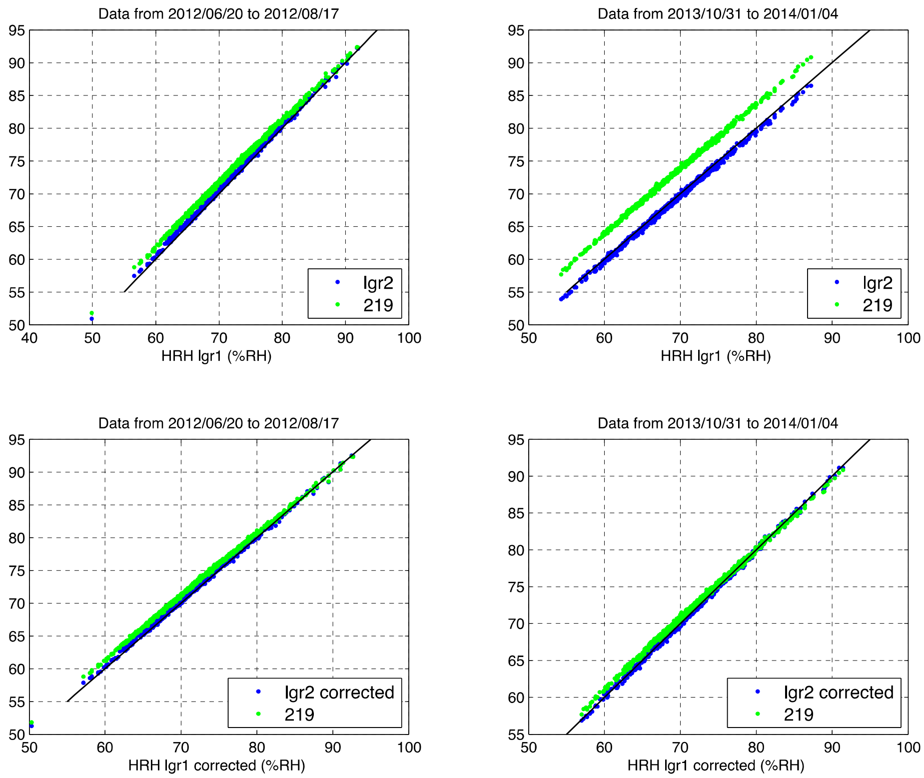


Figure 4-49. Scatter plots of HRH between sensor on logger 1 and other HRH sensors on S12. Uncorrected data is in blue. Corrected data for loggers using linearly drifting scalar factor is in green. Left (right) plots are data near S12 deployment, (recovery).

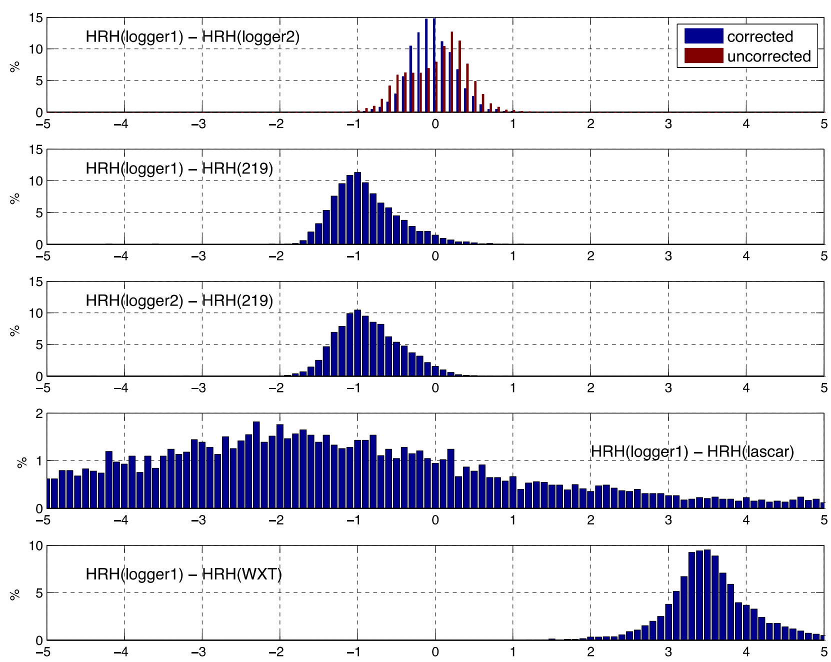


Figure 4-50. Histograms of HRH(logger) – HRH(other) in 0.1 %RH bins.

V. Ancillary Projects

A. DART Mooring

1) Background

To ensure early detection of tsunamis and to acquire data critical to real-time forecasts, NOAA has placed Deep-ocean Assessment and Reporting of Tsunami (DART®) stations at sites in regions with a history of generating destructive tsunamis. NOAA completed the original 6-buoy operational array in 2001 and expanded to a full network of 39 stations in March, 2008. Originally developed by NOAA, as part of the U.S. National Tsunami Hazard Mitigation Program (NTHMP), the DART® Project was an effort to maintain and improve the capability for the early detection and real-time reporting of tsunamis in the open ocean. (See http://nctr.pmel.noaa.gov/Dart/index.html for more info).

DART® presently constitutes a critical element of the NOAA tsunami program. The Tsunami Program is part of a cooperative effort to save lives and protect property through hazard assessment, warning guidance, mitigation, research capabilities, and international coordination. NOAA's National Weather Service (NWS) is responsible for the overall execution of the Tsunami Program. This includes operation of the U.S. Tsunami Warning Centers (TWC) as well as leadership of the National Tsunami Hazard Mitigation Program. It also includes the acquisition, operations and maintenance of observation systems required in support of tsunami warning such as DART®, local seismic networks, coastal, and coastal flooding detectors. NWS also supports observations and data management through the National Data Buoy Center (NDBC). For more information on DART, see http://www.ndbc.noaa.gov/dart/dart.shtml.

2) Overview

DART® systems consist of an anchored seafloor bottom pressure recorder (BPR) and a companion moored surface buoy for real-time communications. An acoustic link transmits data from the BPR on the seafloor to the surface buoy (Fig. 5-1). 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. The data are then relayed via Iridium satellite link to ground stations, which demodulate the signals for immediate dissemination to alert systems, via internet.

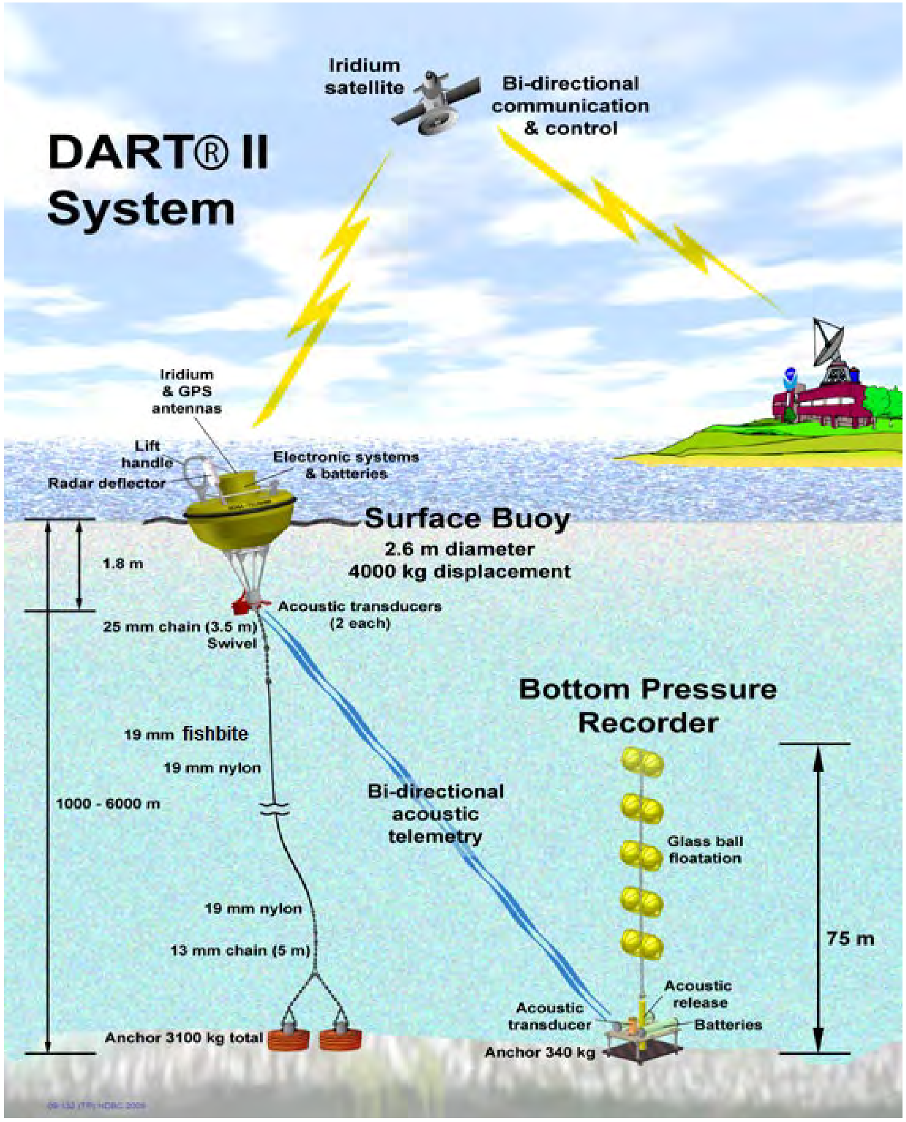
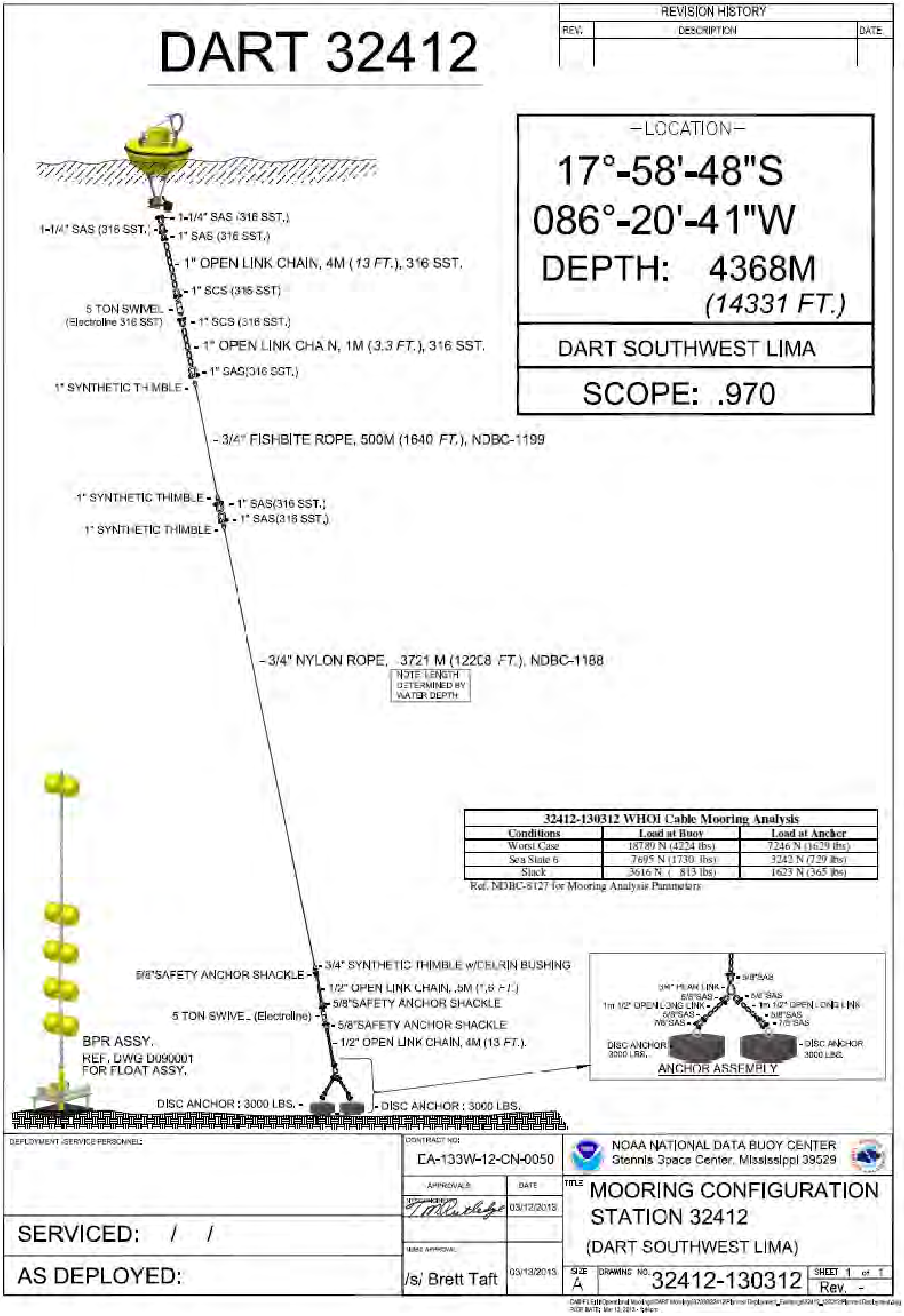


Figure 5-1. DART system overview.

3) DART Station 32412

DART® station 32412 was first established in November 2007. Prior to this cruise, the station was last serviced in May 2011 in which a new buoy, surface mooring and BPR were exchanged. The buoy broke free from its surface mooring in November 2012. During cruise RB-14-01, the adrift buoy was approximately 2,200 nautical miles southwest of its original mooring site. Prior to cruise RB-14-01, the DART® system designated for station 32412 was tested at the National Data Buoy Center at Stennis Space Center, MS in accordance with all NDBC testing standards. A custom mooring was constructed using a previous NOAA siting diagram with a known water depth.



32412-130312 WHOI Cable Mooring Analysis		
Conditions	Load at Buoy	Load at Anchor
Worst Case	18789 N (4224 lbs)	7246 N (1629 lbs)
Sea State 6	7695 N (1730 lbs)	3242 N (729 lbs)
Slack	3616 N (813 lbs)	1623 N (365 lbs)

Figure 5-2. Custom mooring at NDBC 32412

The system was re-integrated in Valparaiso, Chile on the NOAA Ship Ronald H. Brown on 2/21/2014. It was left powered on for the duration of the cruise prior to deployment and passed all shore side testing by NDBC's Mission Control Center (MCC) at Stennis Space Center, MS. Prior to arrival, bathymetry was conducted while passing the new mooring location en route to the existing bottom pressure recorder (BPR). This would be used to confirm the previously sited water depth. Our findings provided us with a relatively flat area with a negligible change in depth. Once we arrived at the existing station, the acoustic release on the BPR was activated to release from its anchor. The BPR ascended at its normal rate of 60 meters per minute. The BPR surfaced as expected and was recovered without incident.

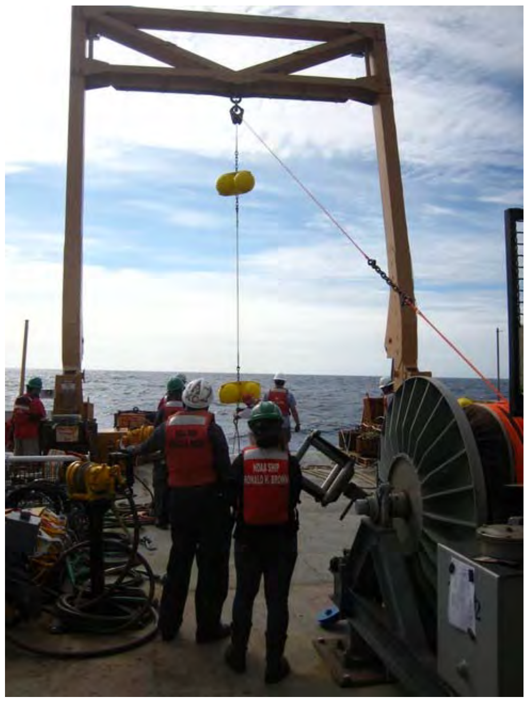
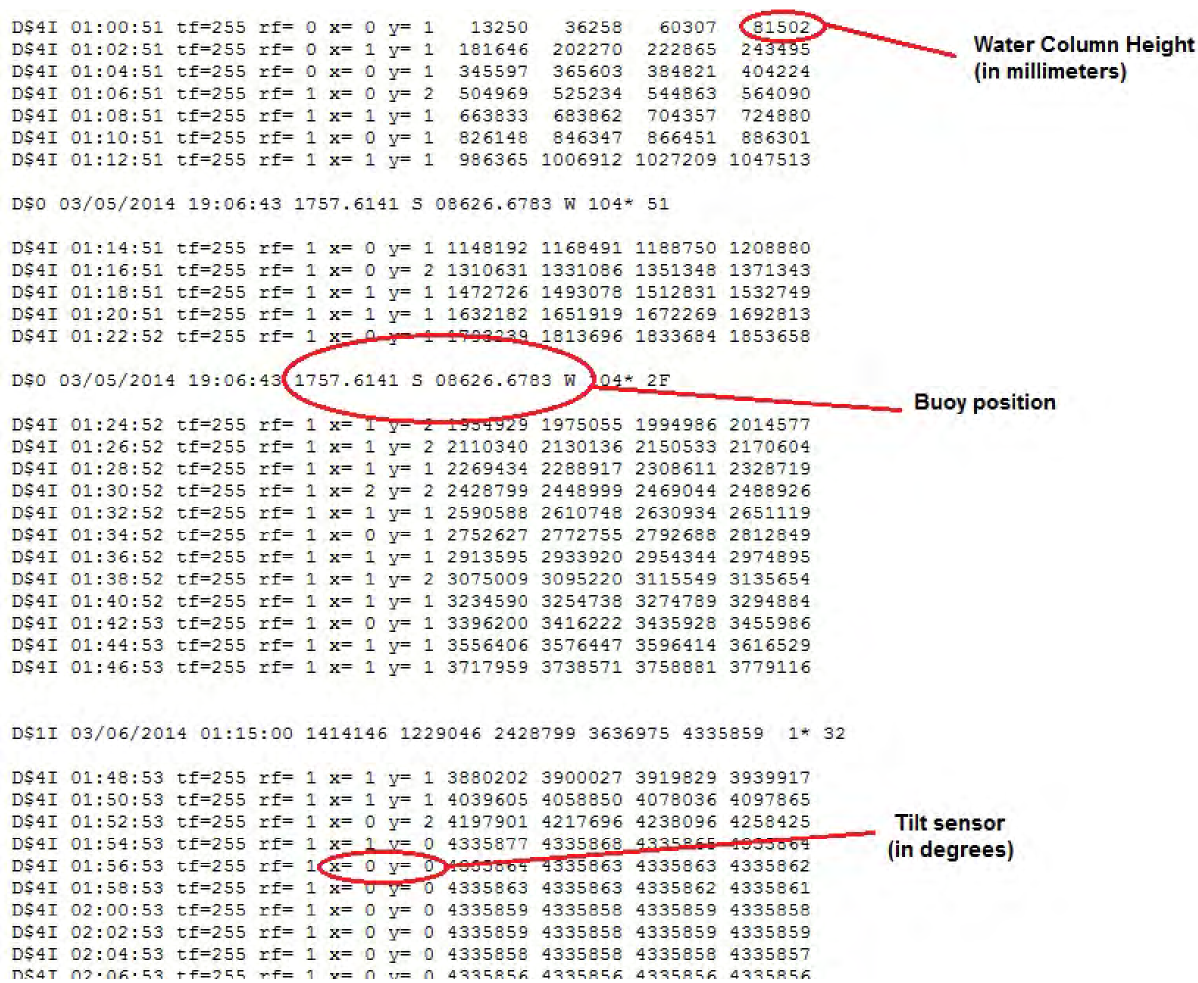


Figure 5-3. Recovering the existing NDBC BPR mooring.

The ship then positioned to deploy the buoy and surface mooring. An anchor drop point was estimated by NDBC technicians on board that would allow anchor fallback to the intended position on the mooring diagram. The buoy, surface mooring, and anchors were deployed at position 17° 58' 54"S, 86° 20' 29"W at 00:19 UTC on March 6 2014. We waited approximately 40 minutes for the mooring to settle. An estimate of the anchor fallback location is 17° 58' 48"S, 86° 20' 41"W.

The BPR was then prepared for deployment. Once deployed, it reports water column height (in millimeters) in 30 second resolution every two minutes via acoustic transmission for 3 hours in addition to its normal operation. It also reports 2-axis tilt sensor data (in degrees). This data ensures that when the BPR settles, the acoustical range to the buoy will have even coverage in the buoy's watch circle. The BPR was deployed at position 17° 58'47"S, 86° 20' 43"W at 00:59 UTC on March 6 2014. After 53 minutes, the data had it landing at 01:54 UTC with a tilt of X=0 and Y=0, indicating a flat surface. After verification of the surface buoy's normal 6 hour transmission, the station was released as operational.



```
D$4I 01:00:51 tf=255 rf= 0 x= 0 y= 1   13250   36258   60307   81502
D$4I 01:02:51 tf=255 rf= 0 x= 1 y= 1  181646  202270  222865  243495
D$4I 01:04:51 tf=255 rf= 0 x= 0 y= 1  345597  365603  384821  404224
D$4I 01:06:51 tf=255 rf= 1 x= 0 y= 2  504969  525234  544863  564090
D$4I 01:08:51 tf=255 rf= 1 x= 1 y= 1  663833  683862  704357  724880
D$4I 01:10:51 tf=255 rf= 1 x= 0 y= 1  826148  846347  866451  886301
D$4I 01:12:51 tf=255 rf= 1 x= 1 y= 1  986365 1006912 1027209 1047513

D$O 03/05/2014 19:06:43 1757.6141 S 08626.6783 W 104* 51

D$4I 01:14:51 tf=255 rf= 1 x= 0 y= 1 1148192 1168491 1188750 1208880
D$4I 01:16:51 tf=255 rf= 1 x= 0 y= 2 1310631 1331086 1351348 1371343
D$4I 01:18:51 tf=255 rf= 1 x= 1 y= 1 1472726 1493078 1512831 1532749
D$4I 01:20:51 tf=255 rf= 1 x= 1 y= 1 1632182 1651919 1672269 1692813
D$4I 01:22:52 tf=255 rf= 1 x= 0 y= 1 1793239 1813696 1833684 1853658

D$O 03/05/2014 19:06:43 1757.6141 S 08626.6783 W 104* 2F

D$4I 01:24:52 tf=255 rf= 1 x= 1 y= 2 1954929 1975055 1994986 2014577
D$4I 01:26:52 tf=255 rf= 1 x= 1 y= 2 2110340 2130136 2150533 2170604
D$4I 01:28:52 tf=255 rf= 1 x= 1 y= 1 2269434 2288917 2308611 2328719
D$4I 01:30:52 tf=255 rf= 1 x= 2 y= 2 2428799 2448999 2469044 2488926
D$4I 01:32:52 tf=255 rf= 1 x= 1 y= 1 2590588 2610748 2630934 2651119
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D$4I 01:44:53 tf=255 rf= 1 x= 1 y= 1 3556406 3576447 3596414 3616529
D$4I 01:46:53 tf=255 rf= 1 x= 1 y= 1 3717959 3738571 3758881 3779116


D$1I 03/06/2014 01:15:00 1414146 1229046 2428799 3636975 4335859  1* 32

D$4I 01:48:53 tf=255 rf= 1 x= 1 y= 1 3880202 3900027 3919829 3939917
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D$4I 01:52:53 tf=255 rf= 1 x= 0 y= 2 4197901 4217696 4238096 4258425
D$4I 01:54:53 tf=255 rf= 1 x= 1 y= 0 4335877 4335868 4335865 4335864
D$4I 01:56:53 tf=255 rf= 1 x= 0 y= 0 4335864 4335863 4335863 4335862
D$4I 01:58:53 tf=255 rf= 1 x= 0 y= 0 4335863 4335863 4335862 4335861
D$4I 02:00:53 tf=255 rf= 1 x= 0 y= 0 4335859 4335858 4335859 4335858
D$4I 02:02:53 tf=255 rf= 1 x= 0 y= 0 4335859 4335858 4335859 4335859
D$4I 02:04:53 tf=255 rf= 1 x= 0 y= 0 4335858 4335858 4335858 4335857
D$4I 02:06:53 tf=255 rf= 1 x= 0 y= 0 4335856 4335856 4335856 4335856
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Figure 5-4. Data from NDBC BPR deployment.

B. Deployment of Argo Floats and Drifters

During the Stratus 13 cruise, a 24-hour under way watch schedule was established. Watch standers were responsible for Argo and Webb floats and surface drifters. Webb floats were deployed for Lothar Stramma (Geomar, Kiel, Germany) and included oxygen sensors. Before Webb float deployments, plugs had to be removed from float sensors and the ship speed was reduced to 2 knots. The float deployments locations are shown in Table 5-1, 5-2 and in Figures 5-5, 5-6.

Table 5-1. Location and times of the launches of the Argo floats deployed during the Stratus 13 cruise.

Float ID	START DATE/TIME (UTC)	DEPLOY DATE/TIME (UTC)	DEPLOYMENT POSITION
7224	2/23/14 15:57	2/26/14 10:08	30 21.8 S 75 52.9 W
7215	2/23/14 14:40	2/27/14 19:01	29 16.5 S 77 37.7 W
7227	2/23/14 16:58	2/28/14 9:30	24 31.7 S 85 1.02 W
7206	2/23/14 14:34	2/28/14 23:08	22 53.11 S 87 30.32 W
7225	2/23/14 16:56	3/1/14 12:33	21 13.6 S 89 59.18 W
7223	2/23/14 14:53	3/5/14 13:48	17 47.85 S 87 29.75 W
7222	2/23/14 14:43	3/11/14 7:12	19 35.928 S 84 55.7 W
7214	2/23/14 14:38	3/11/14 19:24	19 25.22 S 82 29.18 W
7226	2/23/14 14:46	3/13/14 9:30	19 01.31 S, 77 29.89 W
7221	2/23/14 14:50	3/13/14 18:41	18 55.42 S, 76 14.74 W

Table 5-2. Webb float deployments for Lothar Stramma.

Float ID	DEPLOY DATE/TIME (UTC)	DEPLOYMENT POSITION
6689	3/11/14 6:55	19 36.02 S, 84 58.18 W
6693	3/11/14 6:55	19 36.02 S, 84 58.18 W
6690	3/11/14 16:43	19 27.32 S, 83 01.5 W
6694	3/11/14 16:43	19 27.32 S, 83 01.5 W
6691	3/12/14 9:35	19 15.54 S, 80 30.36 W
6695	3/12/14 9:35	19 15.54 S, 80 30.36 W
6692	3/13/14 13:28	18 58.95 S, 76 59.44 W

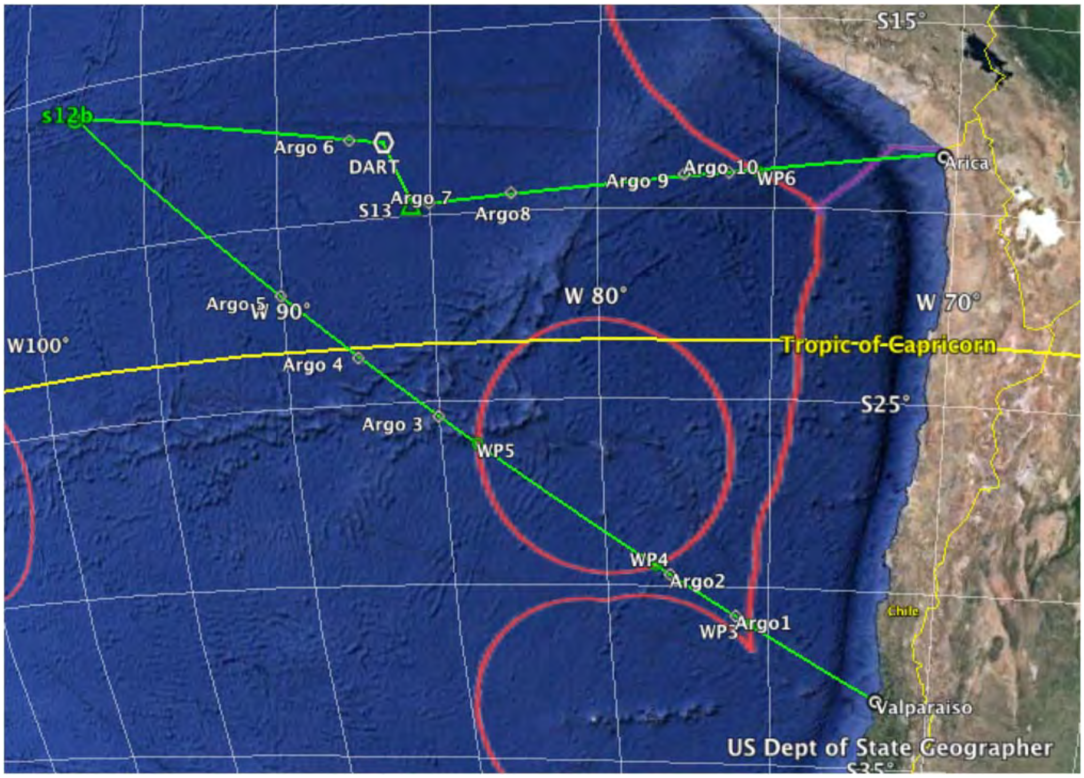

Figure 5-5. Deployment locations for Argo floats during Stratus 13 cruise. Red lines denote the Exclusive Economic Zones in the region of the Stratus 13 cruise. The purple one east of Arica is the new EEZ near the Peru-Chile border.

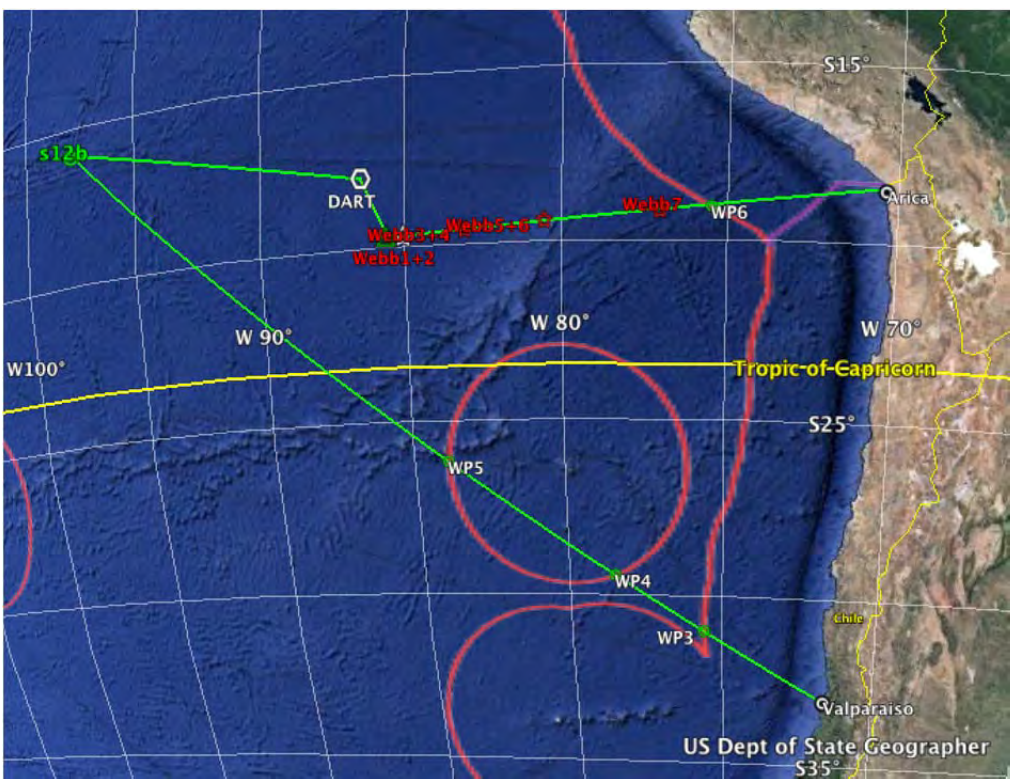

Figure 5-6. Deployment locations for Webb floats, for L. Stramma) during Stratus 13 cruise.

The surface drifter, Figure 5-7, is a high-tech version of the "message in a bottle". It consists of a surface buoy and a subsurface drogue (sea anchor), attached by a long, thin tether. The buoy measures temperature and other properties, and has a transmitter to send the data to passing satellites. The drogue dominates the total area of the instrument and is centered at a depth of 15 meters beneath the sea surface. More information on the Global Drifter Program can be found at http://www.aoml.noaa.gov/phod/dac/gdp.html. The drifters were deployed at specified locations. The ship was not slowed for deployments of the surface drifters. Deployment locations of surface drifters are shown in Table 5-3 and Figure 5-8.

Figure 5-7. Typical Surface Drifter.

Table 5-3. Location and times of surface drifters launches during the Stratus 13 cruise.

Drifter #	ID	Day	Time (UTC) hh:mm	Deploy Lat deg mm.mm (S)	Deploy Long deg mm.mm (W)
DRIFTER 1	122690	2/26/14	10:08	30 21.85	75 52.9
DRIFTER 2	122691	2/26/14	13:22	29 58	76 31.2
DRIFTER 3	122689	2/26/14	16:18	29 36.11	77 06.42
DRIFTER 4	122688	2/27/14	19:01	29 16.5	77 37.7
DRIFTER 5	122676	2/28/14	4:09	25 11.5	84 00.0
DRIFTER 6	122678	2/28/14	9:31	24 31.7	85 01.02
DRIFTER 7	122679	2/28/14	14:55	23 52.9	85.59.9
DRIFTER 8	122681	2/28/14	20:12	23 14.3	86 58.0
DRIFTER 9	122677	3/1/14	1:52	22 32.2	88 00.1
DRIFTER 10	122683	3/1/14	7:08	21 54	88 58.9
DRIFTER 11	122680	3/1/14	12:34	21 13.6	89 59.2
DRIFTER 12	122682	3/1/14	18:05	21 33	90 59
DRIFTER 13	122685	3/1/14	23:32	19 52	92 00
DRIFTER 14	122684	3/2/14	5:05	19 11.1	93 00
DRIFTER 15	122687	3/2/14	10:29	18 30.9	93 59
DRIFTER 16	116103	3/2/14	16:16	17 45.8	95 00
DRIFTER 17	122686	3/2/14	21:57	17 02.04	96 00
DRIFTER 18	116098	3/3/14	13:10	16 18.2	97 04.4
DRIFTER 19	116101	3/3/14	23:24	16 37	95 00
DRIFTER 20	116099	3/4/14	9:45	16 56.1	92 59.3
DRIFTER 21	116102	3/4/14	19:50	17 14.9	90 59.7
DRIFTER 22	122666	3/5/14	6:17	17 33.8	89 00
DRIFTER 23	122667	3/5/14	16:18	17 52.46	86 59.8
DRIFTER 24	122644	3/11/14	7:14	19 35.95	84 56.01
DRIFTER 25	122622	3/11/14	16:28	19 27.56	83 01.9
DRIFTER 26	122660	3/12/14	4:58	19 18	81 00
DRIFTER 27	122665	3/12/14	21:36	19 08.8	79 00
DRIFTER 28	122663	3/13/14	13:24	18 08.9	76 59.7
DRIFTER 29	122661	3/13/14	20:06	18 54.4	76 03.2

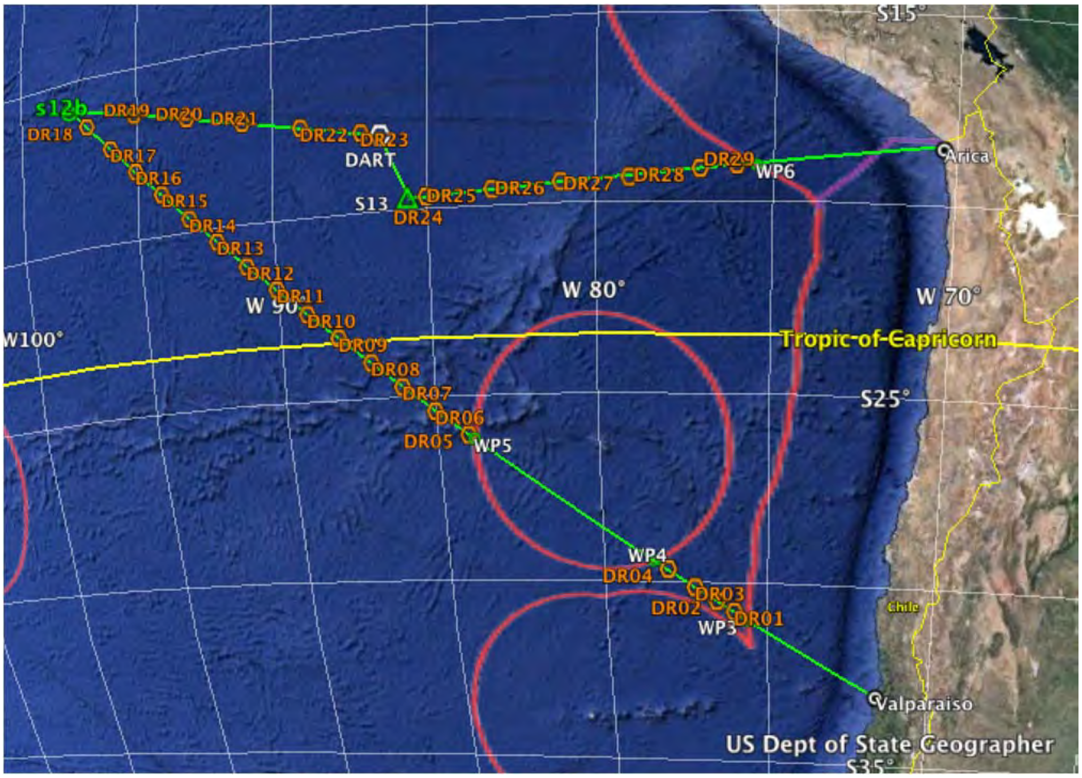

Figure 5-8. Deployment locations for surface drifters during the Stratus 13 cruise.

C. Deployment of near surface mini-array

A mini array was fabricated to use for short-term measurements at the STRATUS 13 mooring site during the period of March 7 2014, 19:28 UTC to March 10 2014 18:03 UTC. The mini array was tethered to the STRATUS 13 buoy hull by a 30-meter section of polypropylene line.

A WHOI 3 ball radio float was modified for this array. A XEOS Sable beacon was attached to the float to track the array in the event of separation from the STRATUS 13 buoy. A 37-meter segment of jacketed wire rope was shackled to the radio float to act as the strength member to mount instruments. 60 pounds of ¾" mooring chain was attached to the bottom of the wire to provide some rigidity to the line.

5 RBR XR 420 data loggers were used to measure water temperature every 5 seconds at 25cm increments from the surface to 30 meters. Each XR 420 logger had a 12-meter temperature array of quick response thermistors spaced at 50 cm. Two loggers were used to measure from the surface to 12 meters. Thermistors were staggered for 25 cm resolution. Two loggers were used to measure from 12.25 meters to 24.50 meters, and a single logger was used to measure from 24.50 to 30.5 meters. Two Nortek Aquadopp current profilers were used to measure near surface currents. One Nortek was mounted at approximately 11 meters depth looking up, and the other was mounted at approximately 13 meters depth looking down. Two RBR DR-150 pressure

(absolute; atmospheric signal should be removed to compute depth) sensors were mounted at approximately 15 meters and 30 meters to provide reference depths of instruments during the deployment. Mini-array measurements depths and time spikes are in Table 5-4. Figure 5-9 also shows the array before deployment, and Figures 5-10 to 5-14 a first look at the data.

Table 5-4. Depths of measurements on mini-array.

Instrument	SN	Depth of logger (m) negative in air	Number of sensors	Depth first sensor (m)	Depth last sensor (m)	Depth interval (m)	Time in ice bath (first sensor after logger)
XR 420	21950	-0.5	24	0	11.5	0.5	2014/03/10 18:34:45
XR 420	21951	-0.25	24	0.25	11.75	0.5	2014/03/10 18:46:30
XR 420	21952	11.5	24	12	23.5	0.5	2014/03/10 19:02:39
XR 420	21953	11.75	24	12.25	23.75	0.5	2014/03/10 18:56:50
XR 420	21954	23.5	24	24	29.75	0.25	2014/03/10 19:07:03
DR-150	9792	12.25	1				
DR-150	9796	29.75	1				
Nortek	5347	10.25	15	9.2	-5.2	1	
Nortek	8013	13.25	20	14.8	23.8	1	

Figure 5-9. Mini-array laying out on deck before deployment. Note the surface frame with three flotation glass balls (top center), which also holds two XR420 loggers. 12 m further down the line are the next two similar loggers and a DR-150 pressure sensor, with one Nortek profiler above and one below them. Another 12 m is the last XR420 logger and the last instrument is the second DR-150 (top left).

The Nortek profilers were set to profile every 4 minutes, at which point the Norteks would ping for 3-minute and average the data in each bin. A wave mode was interspersed in the profile schedule every 28 minutes. In wave mode, only the first bin was sampled (no more profiling), at 2 Hz for 10 minutes (see Table 5-5 with the setup of Nortek profilers deployed on the mini-array).

Table 5-5. Setup of Nortek profilers deployed on surface mini-array.

Nortek 5347, at 10 m, looking up	Nortek 8013, at 13 m, looking down
Deployment : tarray	Deployment : tarray
Current time : 3/4/2014 6:27:31 PM	Current time : 3/4/2014 6:16:56 PM
Start at : 3/6/2014 1:00:00 AM	Start at : 3/6/2014 1:00:00 AM
--	--
Profile interval (s) : 240	Profile interval (s) : 240
Number of cells : 15	Number of cells : 20
Cell size (m) : 1.00	Cell size (m) : 1.00
Blanking distance (m) : 0.52	Blanking distance (m) : 0.53
Measurement load (%) : 88	Measurement load (%) : 88
Average interval (s) : 180	Average interval (s) : 180
Power level : HIGH	Power level : HIGH
Number of wave samples : 1200	Number of wave samples : 1200
Wave interval (s) : 1680	Wave interval (s) : 1680
Wave sampling rate (Hz) : 2	Wave sampling rate (Hz) : 2
Wave cell size (m) : 1.00	Wave cell size (m) : 1.00
Compass upd. rate (s) : 1	Compass upd. rate (s) : 1
Coordinate System : ENU	Coordinate System : ENU
Speed of sound (m/s) : MEASURED	Speed of sound (m/s) : MEASURED
Salinity (ppt) : 35	Salinity (ppt) : 35
Analog input 1 : NONE	Analog input 1 : NONE
Analog input 2 : NONE	Analog input 2 : NONE
Analog input power out : DISABLED	Analog input power out : DISABLED
File wrapping : OFF	File wrapping : OFF
TellTale : OFF	TellTale : OFF
Acoustic modem : OFF	Acoustic modem : OFF
Serial output : OFF	Serial output : OFF
Baud rate : 115200	Baud rate : 115200
--	--
Assumed duration (days) : 5.0	Assumed duration (days) : 5.0
Battery utilization (%) : 41.0	Battery utilization (%) : 43.0
Battery level (V) : 13.1	Battery level (V) : 13.8
Recorder size (MB) : 361	Recorder size (MB) : 3886
Recorder free space (MB) : 360.973	Recorder free space (MB) : 3885.972
Memory required (MB) : 7.4	Memory required (MB) : 7.4
Vertical vel. prec (cm/s) : 0.3	Vertical vel. prec (cm/s) : 0.3
Horizon. vel. prec (cm/s) : 0.8	Horizon. vel. prec (cm/s) : 0.8
--	--
Instrument ID : AQD 5347	Instrument ID : AQD 8013
Head ID : AQP 3897	Head ID : AQP 4375
Firmware version : 3.32	Firmware version : 3.38
--	--
AquaPro Version 1.36.06	AquaPro Version 1.36.06

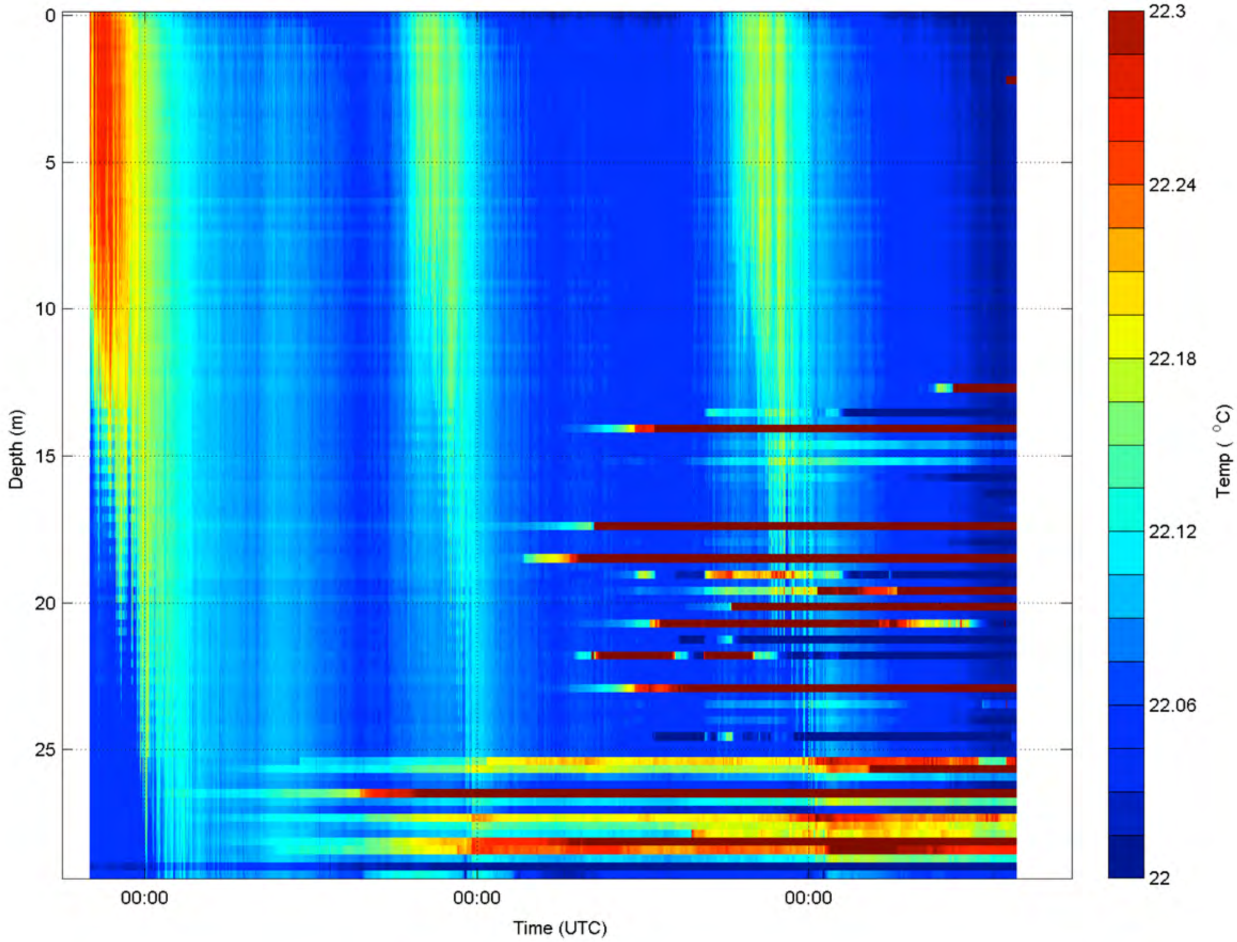

Figure 5-10. Temperature profile from Brancker T-chains on surface array between March 7 and 10 2014.

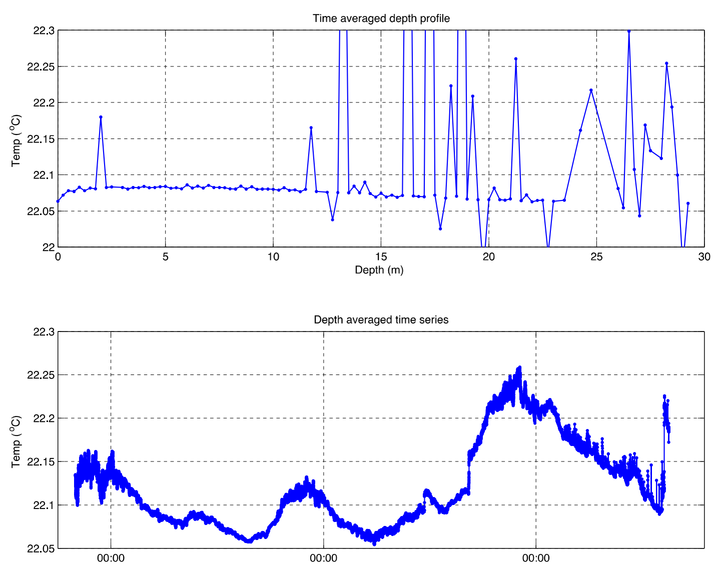

Figure 5-11. Temperature mean profile from Brancker T-chains on surface array: vertical profile and time-series of time mean and depth averaged data in Figure 5-10.

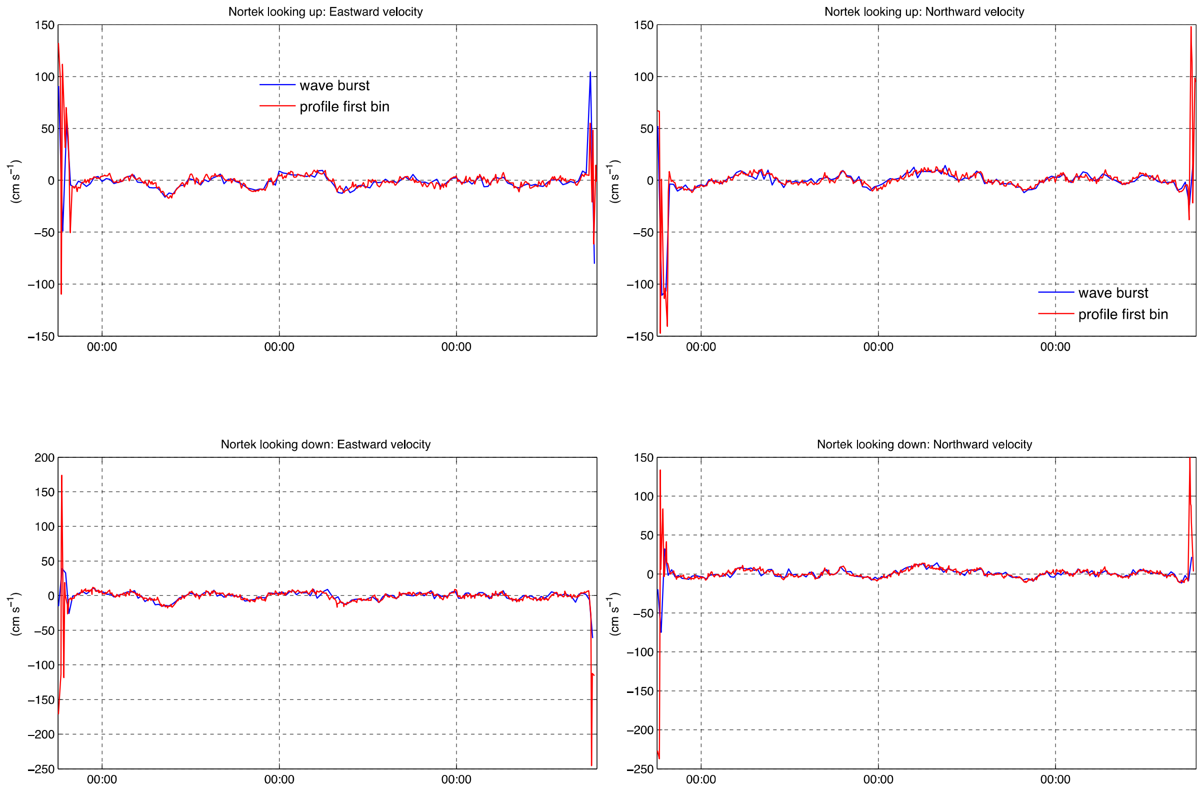

Figure 5-12. Eastward (left column) and Northward (right column) velocities as measured by Nortek profiler looking up (SN 5347, at 10 m; upper row) and looking down (SN 8013, at 13 m; lower row), using profile mode (red) or wave burst (blue).

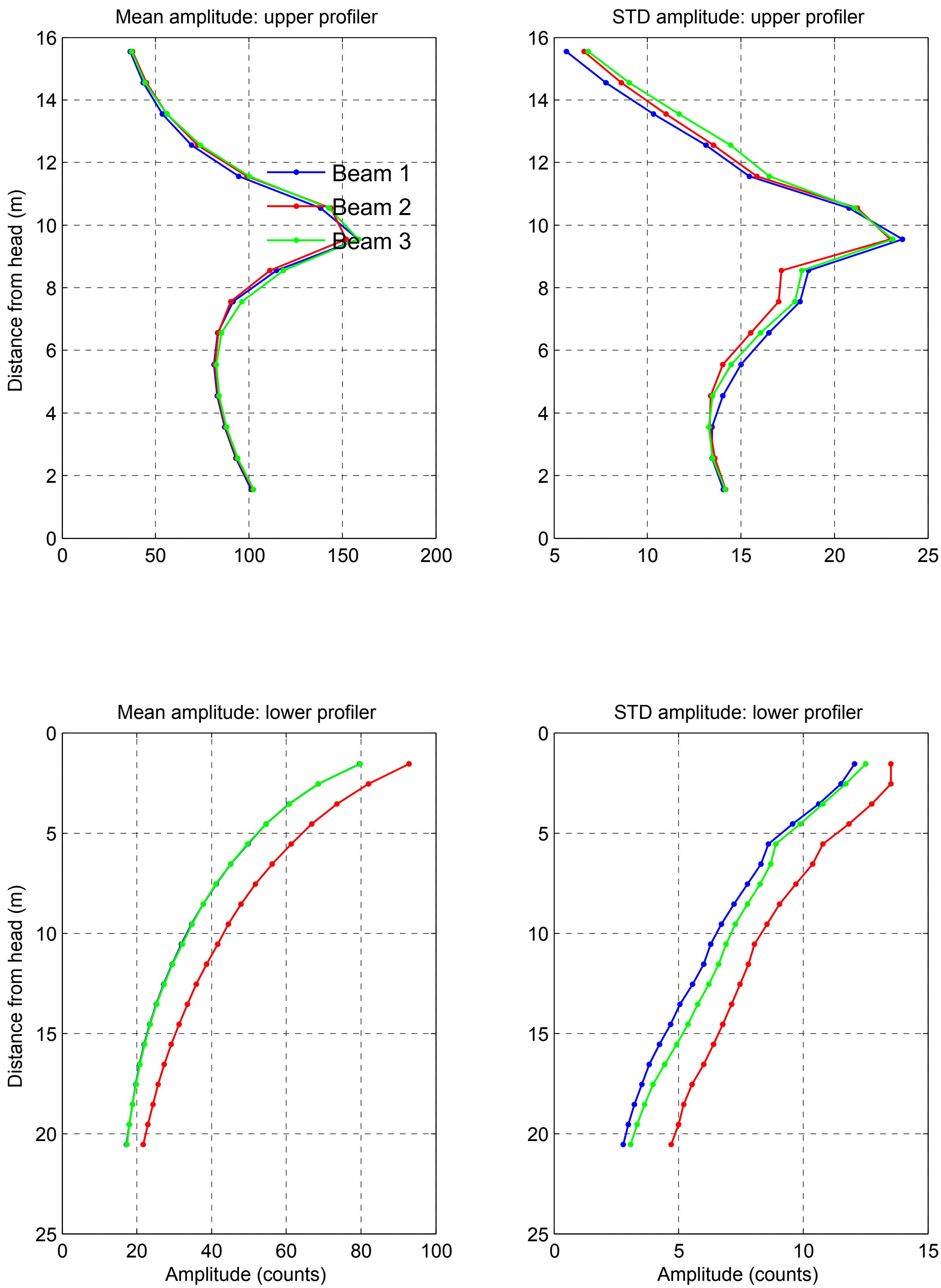

Figure 5-13. Profiles of signal amplitude from Nortek 5347 at 10m looking up (upper row) and Nortek 8013 at 13 m looking down (lower row).

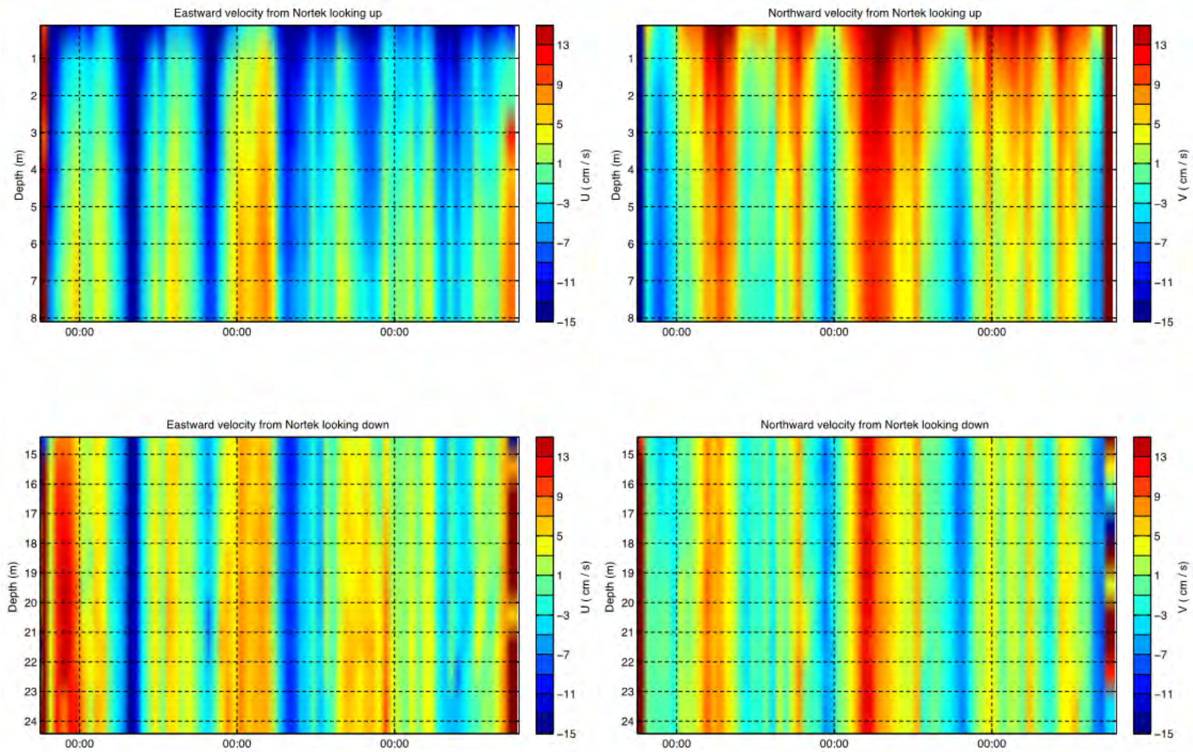

Figure 5-14. Profiles of eastward (left column) and northward velocities (right column) from Nortek 5347 at 10m looking up (upper row) and Nortek 8013 at 13 m looking down (lower row).

D. CTD

Two CTD were done on March 9 during the inter-comparison period when the ship was stationed near the newly deployed Stratus 13 buoy. The CTD sensor used was Seabird 19 (V3.1 SN 2361) with pump. Headers of the data files indicate this CTD had been calibrated in February 2013. CTD casts were done to 4000 m depth with a 0.5 second sampling interval. First cast was done at (19° 40.509 S, 85° 00.251 W) at 14:55 UTC, the second one was at (19° 40.241 S, 85° 00.233 W) at 17:33 UTC. Figures 5-15 and 5-16 show profiles from these two CTD casts.

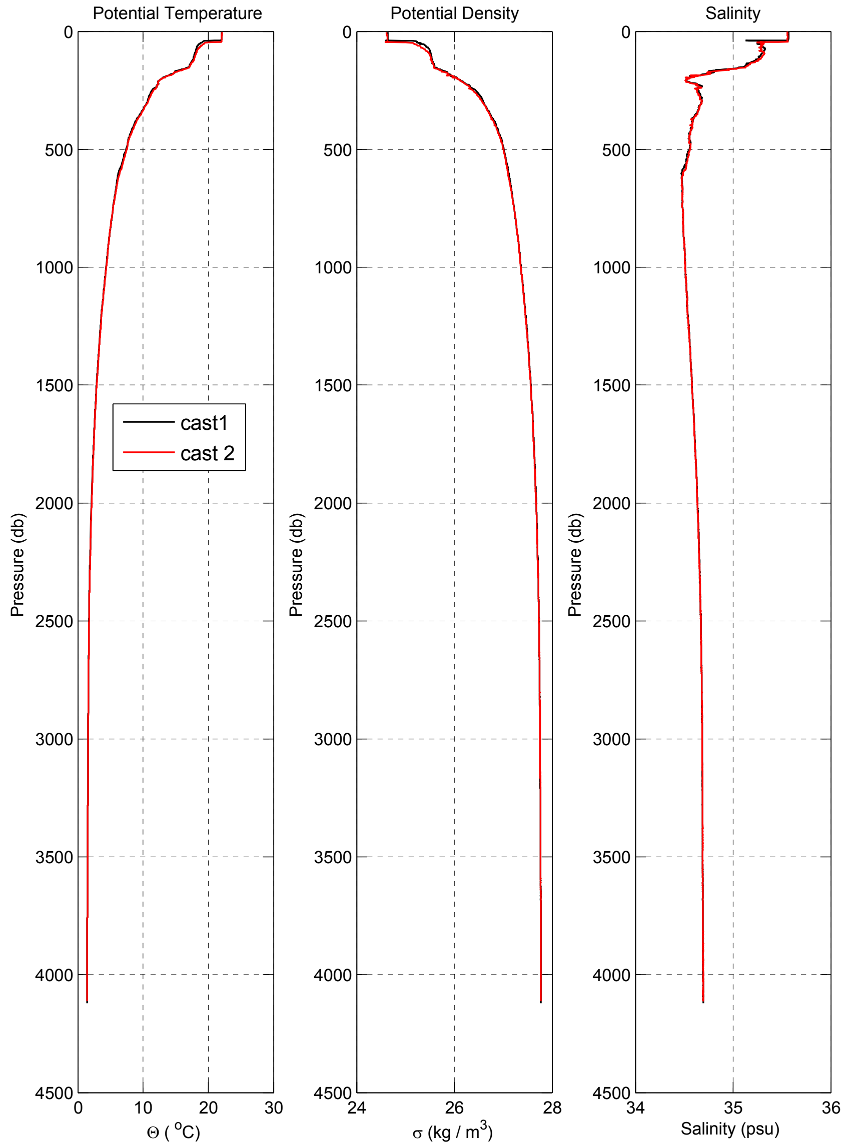

Figure 5-15. CTD casts made during Stratus 13 cruise, on March 9 2014.

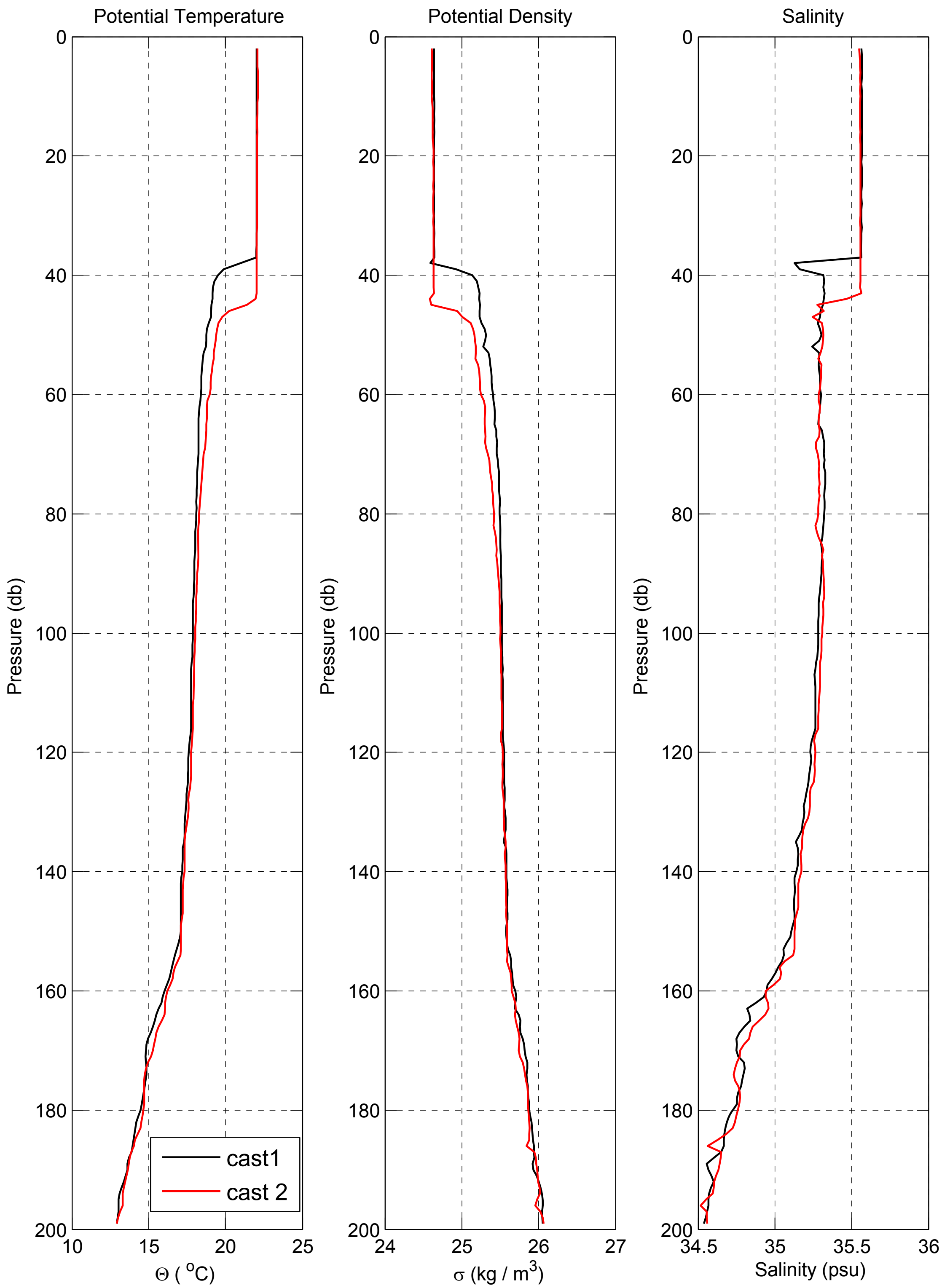

Figure 5-16. Same as Fig. 5-10 but zoomed on upper 200 m.

E. Volunteer Experiences

Marcela Paz Contreras:
Given my interest in oceanography, due to my studies in geophysics at the University of Concepción, the opportunity to be part of the scientific research cruise Stratus 13 was an excellent experience, not only from the professional point of view, but also as a life experience. It was something absolutely new for me because I had no idea how it would be to sail for 19 days. Additionally, since my native language is Spanish, this was a great opportunity to increase my knowledge of the English language.

It was very enriching to observe oceanographic work in action and to go beyond the theory. I was able to understand the process necessary to obtain measurements and the difficulties faced at the moment of making the observations, for example, the bio-fouling effect and how it's combatted with simple, eco-friendly techniques.

Regarding the work during the cruise, I was on the watch schedule for the deployment of Argo drifters; I did not know how easy it would be to launch these instruments and how useful they are in taking the measurements that will contribute to a better description of the eastern South Pacific, where measurements have been scarce.

Additionally, it was very interesting to see the buoys that were deployed to obtain a better understanding of mesoscale eddies. I did not know some of the results obtained from the buoy and mooring measurements, such as the evidence of the absence of oxygen, which motivates me to study and better understand the dynamics of this phenomenon.

In summary, the trip not only increased my knowledge, but also allowed me to learn about topics that I was absolutely unfamiliar with. I also want to thank the WHOI scientific team as well as the RH Brown crew for their kindness and patience while explaining the work they were doing as well as for their great disposition, which made the trip a very pleasant one.

Cristóbal Aguilera:
I'm an undergraduate Geophysics student, from the University of Concepción. I managed to get in board due to a contact made by my thesis guide professor, Dr. Óscar Pizarro, who offered me the chance to get here. And to be honest, I had been waiting for the opportunity of traveling in a scientific vessel, since the work field is a really important aspect of science itself.

My primary goal on this cruise was to watch, in field, how the data I always work with is acquired. I had taken a few courses about Oceanographic Instruments in the University, but well, theory never equals practice, so most of things we did on the cruise were all new to me.

I was amazed for the amount of instruments there were in a single buoy, not to say the time and effort it took to deploy it into the ocean. I always thought it would be an easy and almost trivial task. How wrong I was. It took almost three days and many people working hard to successfully the Stratus 13 buoy. I wish I could have done more than only watch! However, it was a great experience anyway. Now, every time I work with arrays of data, I will know there was a huge work behind it.

From a purely scientific point of view, it was also a rich experience. I was able to see *in situ* the actual behavior of ocean and its waves, instead only modeling and analyzing through numerical and computational tools, and that is a good and refreshing change. Also, the data collected during and post cruise is of special interest for me, due to the topic of my thesis project, which is focused in coastal upwelling, and how the remote, low frequency waves, affect the pycnocline's response to the wind stress, so the information of the ocean behavior near the coast is vital for my project, and I now know how is it obtained and what are the possible error sources.

And more in a personal aspect, I felt very comfortable and well received, as much in the scientific team as in the crew. Everyone were very patient with me, and me not so good in english (I'm still learning it), and everyone was willing to use some of their time to explain to me some of the many things I didn't know. So I can say this cruise exceeded my expectations in every possible aspect. I'd like to be more thorough and detailed in this point, but I fell I'm lacking words and expressions.

Finally, I'd like to thank the WHOI and its people (I don't want to name someone in particular, because that would mean leaving someone outside, and that's not good!) for letting me enjoy this great experience. It has been a pleasure.

Thanks and Acknowledgements

We wish to thank the crew of the *R. H. Brown* who were very helpful to make this cruise successful. Special thanks go to the deck crew and Bruce Cowden for an amazing work during mooring operations, in particular on recovery day. Many thanks to the Chilean students who actively participated in the work at sea.

References

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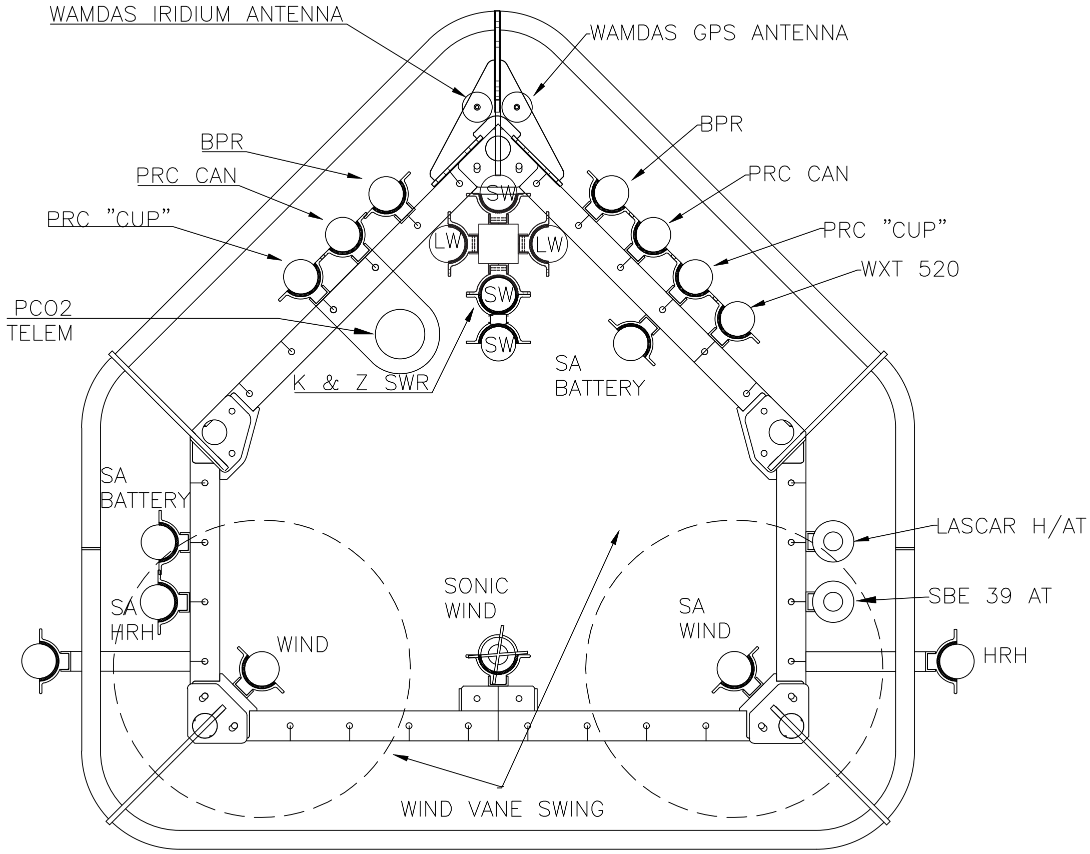
APPENDIX 1: Stratus 13 buoy spin in Woods Hole



STRATUS 13
TOWER TOP V5 01/04/13

Heading	**0**				
Turn	**0**				
	Time	**Date**			
Vanes Secured UTC	14:00:00	27-Dec-13			
System 1		**VANE**	**Compass**	**Direction**	**Sample Time**
Logger	**L-04**				
SWND	**216**	N/A	359.10	N/A	14:38:00
System 2		**Vane**	**Compass**	**Direction**	**Sample Time**
Logger	**L-14**				
WND	**239**	2.70	358.70	1.40	14:40:00
		VANE	**Compass**	**Direction**	**Sample Time**

WND 221	Stand Alone	2.90	359.10	2.00	14:50:00
		VANE	**Compass**	**Direction**	**Sample Time**
VWX 001	Stand Alone	N/A	352.20	N/A	14:51:00
Heading	**0**				
Turn	**45**				
	Time	**Date**			
Vanes Secured UTC	14:55:00	27-Dec-13			
System 1		**VANE**	**Compass**	**Direction**	**Sample Time**
Logger	**L-04**				
SWND	**216**		44.20		15:30:00
System 2		**Vane**	**Compass**	**Direction**	**Sample Time**
Logger	**L-14**				
WND	**239**	317.20	44.30	1.50	15:32:00
		VANE	**Compass**	**Direction**	**Sample Time**
WND 221		317.60	45.10	2.70	15:35:00
		VANE	**Compass**	**Direction**	**Sample Time**
VWX 001			46.60		15:36:00
Heading	**0**				
Turn	**90**				
	Time	**Date**			
Vanes Secured UTC	14:00:00	27-Dec-13			
System 1		**VANE**	**Compass**	**Direction**	**Sample Time**
Logger	**L-04**				
SWND	**216**		87.90		16:28:00
System 2		**Vane**	**Compass**	**Direction**	**Sample Time**
Logger	**L-14**				
WND	**239**	272.90	89.30	2.20	16:29:00
		VANE	**Compass**	**Direction**	**Sample Time**
WND 221		271.30	91.60	2.90	16:24:00
		VANE	**Compass**	**Direction**	**Sample Time**
VWX 001			88.00		16:26:00
Heading	**0**				
Turn	**135**				
	Time	**Date**			
Vanes Secured UTC	16:34:00	27-Dec-13			
System 1		**VANE**	**Compass**	**Direction**	**Sample Time**

Logger	**L-04**				
SWND	**216**		132.70		16:48:00
System 2		**Vane**	**Compass**	**Direction**	**Sample Time**
Logger	**L-14**				
WND	**239**	228.00	135.70	3.70	16:50:00
		VANE	**Compass**	**Direction**	**Sample Time**
WND 221		225.11	136.60	1.71	16:56:00
		VANE	**Compass**	**Direction**	**Sample Time**
VWX 001			128.20		16:54:00
Heading	**0**				
Turn	**180**				
	Time	**Date**			
Vanes Secured UTC	17:00:00	27-Dec-13			
System 1		**VANE**	**Compass**	**Direction**	**Sample Time**
Logger	**L-04**				
SWND	**216**		176.40		17:58:00
System 2		**Vane**	**Compass**	**Direction**	**Sample Time**
Logger	**L-14**				
WND	**239**	183.30	180.40	3.70	17:59:00
		VANE	**Compass**	**Direction**	**Sample Time**
WND 221		178.80	180.10	358.90	17:51:00
		VANE	**Compass**	**Direction**	**Sample Time**
VWX 001			178.00		17:52:00
Heading	**0**				
Turn	**225**				
	Time	**Date**			
Vanes Secured UTC	18:05:00	27-Dec-13			
System 1		**VANE**	**Compass**	**Direction**	**Sample Time**
Logger	**L-04**				
SWND	**216**		221.60		18:15:00
System 2		**Vane**	**Compass**	**Direction**	**Sample Time**
Logger	**L-14**				
WND	**239**	136.80	225.10	1.90	18:17:00
		VANE	**Compass**	**Direction**	**Sample Time**
WND 221		133.30	225.10	358.40	18:25:00
		VANE	**Compass**	**Direction**	**Sample Time**
VWX 001			227.10		18:20:00

Heading	**0**				
Turn	**270**				
	Time	**Date**			
Vanes Secured UTC	18:27:00	27-Dec-13			
System 1		**VANE**	**Compass**	**Direction**	**Sample Time**
Logger	**L-04**				
SWND	**216**		266.90		19:26:00
System 2		**Vane**	**Compass**	**Direction**	**Sample Time**
Logger	**L-14**				
WND	**239**	91.90	268.70	0.60	19:24:00
		VANE	**Compass**	**Direction**	**Sample Time**
WND 221		89.40	268.50	357.90	18:29:00
		VANE	**Compass**	**Direction**	**Sample Time**
VWX 001			265.60		19:29:00
Heading	**0**				
Turn	**315**				
	Time	**Date**			
Vanes Secured UTC	19:30:00	27-Dec-13			
System 1		**VANE**	**Compass**	**Direction**	**Sample Time**
Logger	**L-04**				
SWND	**216**		311.70		20:29:00
System 2		**Vane**	**Compass**	**Direction**	**Sample Time**
Logger	**L-14**				
WND	**239**	47.20	311.90	359.10	20:30:00
		VANE	**Compass**	**Direction**	**Sample Time**
WND 221		47.30	311.50	358.80	20:35:00
		VANE	**Compass**	**Direction**	**Sample Time**
VWX 001			301.40		20:33:00

APPENDIX 2: Subsurface Instrument Setup (and SBE 39 ATMP)

Subsurface SBE 37s:

SBE37SM-RS232 3.0j SERIAL NO. 8212 28 Feb 2014 08:40:37
vMain = 6.90, vLith = 2.86
samplenumber = 0, free = 838860
not logging, waiting to start at 28 Feb 2014 11:00:00
sample interval = 300 seconds
data format = converted engineering
transmit real-time = no
sync mode = no
pump installed = no
reference pressure = 0.0 decibars
<Executed/>

SBE37SM-RS232 3.0j SERIAL NO. 8216 28 Feb 2014 08:42:44
vMain = 6.98, vLith = 2.86
samplenumber = 0, free = 838860
not logging, waiting to start at 28 Feb 2014 11:00:00
sample interval = 300 seconds
data format = converted engineering
transmit real-time = no
sync mode = no
pump installed = no
reference pressure = 0.0 decibars
<Executed/>

SBE37SM-RS232 3.0j SERIAL NO. 8221 28 Feb 2014 08:45:02
vMain = 6.97, vLith = 2.86
samplenumber = 0, free = 838860
not logging, waiting to start at 28 Feb 2014 11:00:00
sample interval = 300 seconds
data format = converted engineering
transmit real-time = no
sync mode = no
pump installed = no
reference pressure = 0.0 decibars
<Executed/>

SBE37SM-RS232 3.0j SERIAL NO. 8218 28 Feb 2014 08:47:50
vMain = 6.97, vLith = 2.87
samplenumber = 0, free = 838860
not logging, waiting to start at 28 Feb 2014 11:00:00
sample interval = 300 seconds
data format = converted engineering
transmit real-time = no
sync mode = no
pump installed = no
reference pressure = 0.0 decibars
<Executed/>

SBE37-SM V 2.6b SERIAL NO. 1328   28 Feb 2014 08:50:50
not logging: waiting to start at 28 Feb 2014 11:00:00
sample interval = 300 seconds
samplenumber = 0, free = 233016
do not transmit real-time data
do not output salinity with each sample
do not output sound velocity with each sample
store time with each sample
number of samples to average = 4
reference pressure = 0.0 db
serial sync mode disabled
wait time after serial sync sampling = 30 seconds
internal pump not installed
temperature = 20.86 deg C

SBE37-SM V 2.6b SERIAL NO. 1326   28 Feb 2014 08:54:55
not logging: waiting to start at 28 Feb 2014 11:00:00
sample interval = 300 seconds
samplenumber = 0, free = 233016
do not transmit real-time data
do not output salinity with each sample
do not output sound velocity with each sample
store time with each sample
number of samples to average = 4
reference pressure = 0.0 db
serial sync mode disabled
wait time after serial sync sampling = 30 seconds
internal pump not installed
temperature = 21.07 deg C

SBE37SM-RS232 3.0j SERIAL NO. 8224 28 Feb 2014 09:39:46
vMain = 7.01, vLith = 2.88
samplenumber = 0, free = 838860
not logging, waiting to start at 28 Feb 2014 11:00:00
sample interval = 300 seconds
data format = converted engineering
transmit real-time = no
sync mode = no
pump installed = no
reference pressure = 0.0 decibars
<Executed/>

SBE37SM-RS232 3.0j SERIAL NO. 8225 28 Feb 2014 09:45:50
vMain = 6.88, vLith = 2.88
samplenumber = 0, free = 838860
not logging, waiting to start at 28 Feb 2014 11:00:00
sample interval = 300 seconds
data format = converted engineering
transmit real-time = no
sync mode = no
pump installed = no
reference pressure = 0.0 decibars
<Executed/>

SBE37SM-RS232 3.0j SERIAL NO. 8220 28 Feb 2014 09:47:33
vMain = 6.90, vLith = 2.89
samplenumber = 0, free = 838860
not logging, waiting to start at 28 Feb 2014 11:00:00
sample interval = 300 seconds
data format = converted engineering
transmit real-time = no
sync mode = no
pump installed = no
reference pressure = 0.0 decibars

SBE37-SM V 2.6b SERIAL NO. 1906 28 Feb 2014 09:50:12
not logging: waiting to start at 28 Feb 2014 11:00:00
sample interval = 300 seconds
samplenumber = 0, free = 233016
do not transmit real-time data
do not output salinity with each sample
do not output sound velocity with each sample
store time with each sample
number of samples to average = 4
reference pressure = 0.0 db
serial sync mode disabled
wait time after serial sync sampling = 30 seconds
internal pump not installed
temperature = 21.61 deg C

SBE37-SM V 2.6b SERIAL NO. 1908 28 Feb 2014 09:52:23
not logging: waiting to start at 28 Feb 2014 11:00:00
sample interval = 300 seconds
samplenumber = 0, free = 233016
do not transmit real-time data
do not output salinity with each sample
do not output sound velocity with each sample
store time with each sample
number of samples to average = 4
reference pressure = 0.0 db
serial sync mode disabled
wait time after serial sync sampling = 30 seconds
internal pump not installed
temperature = 21.65 deg C

SBE37-SM V 2.6b SERIAL NO. 1330 28 Feb 2014 09:55:09
not logging: waiting to start at 28 Feb 2014 11:00:00
sample interval = 300 seconds
samplenumber = 0, free = 233016
do not transmit real-time data
do not output salinity with each sample
do not output sound velocity with each sample
store time with each sample
number of samples to average = 4
reference pressure = 0.0 db
serial sync mode disabled
wait time after serial sync sampling = 30 seconds
internal pump not installed
temperature = 22.45 deg C

SBE37SM-RS232 3.0j SERIAL NO. 8211 28 Feb 2014 09:58:28
vMain = 6.92, vLith = 2.89
samplenumber = 0, free = 838860
not logging, waiting to start at 28 Feb 2014 11:00:00
sample interval = 300 seconds
data format = converted engineering
transmit real-time = no
sync mode = no
pump installed = no
reference pressure = 0.0 decibars

SBE37SM-RS232 3.0j SERIAL NO. 8215 28 Feb 2014 10:00:08
vMain = 7.01, vLith = 2.89
samplenumber = 0, free = 838860
not logging, waiting to start at 28 Feb 2014 11:00:00
sample interval = 300 seconds
data format = converted engineering
transmit real-time = no
sync mode = no
pump installed = no
reference pressure = 0.0 decibars

SBE37SM-RS232 3.0j SERIAL NO. 8217 28 Feb 2014 10:02:38
vMain = 6.99, vLith = 2.90
samplenumber = 0, free = 838860
not logging, waiting to start at 28 Feb 2014 11:00:00
sample interval = 300 seconds
data format = converted engineering
transmit real-time = no
sync mode = no
pump installed = no
reference pressure = 0.0 decibars

SBE37SM-RS232 3.0j SERIAL NO. 8219 28 Feb 2014 10:06:50
vMain = 6.99, vLith = 2.89
samplenumber = 0, free = 838860
not logging, waiting to start at 28 Feb 2014 11:00:00
sample interval = 300 seconds
data format = converted engineering
transmit real-time = no
sync mode = no
pump installed = no
reference pressure = 0.0 decibars

SBE37-SM V 2.6 SERIAL NO. 3733   28 Feb 2014 10:09:34
not logging: waiting to start at 28 Feb 2014 11:00:00
sample interval = 300 seconds
samplenumber = 0, free = 190650
do not transmit real-time data
do not output salinity with each sample
do not output sound velocity with each sample
store time with each sample
number of samples to average = 4
serial sync mode disabled
wait time after serial sync sampling = 30 seconds
internal pump not installed
temperature = 22.30 deg C

SBE37-SM V 2.6b SERIAL NO. 1909   28 Feb 2014 10:11:21
not logging: waiting to start at 28 Feb 2014 11:00:00
sample interval = 300 seconds
samplenumber = 0, free = 190650
do not transmit real-time data
do not output salinity with each sample
do not output sound velocity with each sample
store time with each sample
number of samples to average = 4
serial sync mode disabled
wait time after serial sync sampling = 30 seconds
internal pump not installed
temperature = 22.39 deg C

SBE37-SM V 2.6b SERIAL NO. 1325   28 Feb 2014 10:13:02
not logging: waiting to start at 28 Feb 2014 11:00:00
sample interval = 300 seconds
samplenumber = 0, free = 233016
do not transmit real-time data
do not output salinity with each sample
do not output sound velocity with each sample
store time with each sample
number of samples to average = 4
reference pressure = 0.0 db
serial sync mode disabled
wait time after serial sync sampling = 30 seconds
internal pump not installed
temperature = 21.99 deg C

SBE37-SM V 2.6b SERIAL NO. 1329   28 Feb 2014 10:23:43
not logging: waiting to start at 28 Feb 2014 11:00:00
sample interval = 300 seconds
samplenumber = 0, free = 233016
do not transmit real-time data
do not output salinity with each sample
do not output sound velocity with each sample
store time with each sample
number of samples to average = 4
reference pressure = 0.0 db
serial sync mode disabled
wait time after serial sync sampling = 30 seconds
internal pump not installed
temperature = 22.00 deg C

SST SBE 37:
S>#01ds
SBE37-SM 485 V 2.3b SERIAL NO. 1838
09 Jan 2014 10:49:47
not logging: received stop command
sample interval = 300 seconds
samplenumber = 0, free = 233016
store time with each sample
do not output salinity with each sample
do not output sound velocity with each sample
reference pressure = 0.0 db
do not output density with each sample
do not output depth with each sample
A/D cycles to average = 4
internal pump not installed
temperature = 20.03 deg C
S>#01datetime=02182014105130
?cmd S>#01DateTime=02182014105325
?cmd S>date=0101214
#01date=010101
?cmd S>#01date=010114
?cmd S>#01 datetime=02182014105525
S>#0102mmddyy=021814
S>#01hhmmss=110010

SBE37-SM 485 V 2.3b SERIAL NO. 1838
18 Feb 2014 11:00:14
not logging: received stop command
sample interval = 300 seconds
samplenumber = 0, free = 233016

store time with each sample
do not output salinity with each sample
do not output sound velocity with each sample
reference pressure = 0.0 db
do not output density with each sample
do not output depth with each sample
A/D cycles to average = 4
internal pump not installed
temperature = 19.97 deg C
S>#01startmmddttyy=021814
S>#01starthhmmssy=120000
start time = 18 Feb 2014 12:00:00
S>#01startlater
start time = 18 Feb 2014 12:00:00

SBE37-SM 485 V 2.3b SERIAL NO. 1838
18 Feb 2014 11:02:11
not logging: waiting to start at 18 Feb 2014
12:00:00
sample interval = 300 seconds
samplenumber = 0, free = 233016
store time with each sample
do not output salinity with each sample
do not output sound velocity with each sample
reference pressure = 0.0 db
do not output density with each sample
do not output depth with each sample
A/D cycles to average = 4
internal pump not installed
temperature = 19.94 deg C

SBE37-SM 485 V 2.3b SERIAL NO. 2053
18 Feb 2014 11:03:36
logging not started
sample interval = 300 seconds
samplenumber = 0, free = 233016
store time with each sample
do not output salinity with each sample
do not output sound velocity with each sample
reference pressure = 0.0 db
do not output density with each sample
do not output depth with each sample
A/D cycles to average = 4
internal pump not installed
temperature = 20.68 deg C
S>#01mmddyy=021814
S>#01hhmmss=110410

SBE37-SM 485 V 2.3b SERIAL NO. 2053
18 Feb 2014 11:04:13
logging not started
sample interval = 300 seconds
samplenumber = 0, free = 233016
store time with each sample
do not output salinity with each sample
do not output sound velocity with each sample
reference pressure = 0.0 db
do not output density with each sample
do not output depth with each sample
A/D cycles to average = 4
internal pump not installed
temperature = 20.57 deg C

SBE37-SM 485 V 2.3b SERIAL NO. 2053
18 Feb 2014 11:04:32
logging not started
sample interval = 300 seconds
samplenumber = 0, free = 233016
store time with each sample
do not output salinity with each sample
do not output sound velocity with each sample
reference pressure = 0.0 db
do not output density with each sample
do not output depth with each sample
A/D cycles to average = 4
internal pump not installed
temperature = 20.54 deg C
S>#01startmmddyy=021814
S>S#01#01hhmmss=110527

SBE37-SM 485 V 2.3b SERIAL NO. 2053
18 Feb 2014 11:05:41
logging not started
sample interval = 300 seconds
samplenumber = 0, free = 233016
store time with each sample
do not output salinity with each sample
do not output sound velocity with each sample
reference pressure = 0.0 db
do not output density with each sample
do not output depth with each sample
A/D cycles to average = 4
internal pump not installed
temperature = 20.45 deg C
S>#starthhmmsmmmmddyy=021814

SBE37-SM 485 V 2.3b SERIAL NO. 2053
18 Feb 2014 11:06:16
logging not started
sample interval = 300 seconds
samplenumber = 0, free = 233016
store time with each sample
do not output salinity with each sample
do not output sound velocity with each sample
reference pressure = 0.0 db
do not output density with each sample
do not output depth with each sample
A/D cycles to average = 4
internal pump not installed
temperature = 20.33 deg C
S>#01startmmddyy=021814
S>#01starthhmmss=120000

start time = 18 Feb 2014 12:00:00
S>#01startlater
start time = 18 Feb 2014 12:00:00

SBE37-SM 485 V 2.3b SERIAL NO. 2053
18 Feb 2014 11:07:18
not logging: waiting to start at 18 Feb 2014 12:00:00
sample interval = 300 seconds
samplenumber = 0, free = 233016
store time with each sample
do not output salinity with each sample
do not output sound velocity with each sample
reference pressure = 0.0 db
do not output density with each sample
do not output depth with each sample
A/D cycles to average = 4
internal pump not installed
temperature = 20.36 deg C

Subsurface SBE 39s:

SBE 39 V 1.7 SERIAL NO. 00203
26 Feb 2014 15:23:15
not logging: waiting to start at 26 Feb 2014 18:00:00
sample interval = 300 seconds
samplenumber = 0, free = 299593
serial sync mode disabled
real-time output disabled
SBE 39 configuration = temperature only
binary upload does not include time
temperature = 23.79 deg C

SBE 39 V 1.7a SERIAL NO. 00276
26 Feb 2014 15:30:12
not logging: waiting to start at 26 Feb 2014 18:00:00
sample interval = 300 seconds
samplenumber = 0, free = 299593
serial sync mode disabled
real-time output disabled
SBE 39 configuration = temperature only
binary upload does not include time
temperature = 23.28 deg C

SBE 39 V 1.7a SERIAL NO. 00720
26 Feb 2014 15:35:53
not logging: waiting to start at 26 Feb 2014 18:00:00
sample interval = 300 seconds
samplenumber = 0, free = 299593
serial sync mode disabled
real-time output disabled
SBE 39 configuration = temperature only
binary upload does not include time
temperature = 23.98 deg C

SBE 39 V 1.7a SERIAL NO. 00103
26 Feb 2014 15:47:54
not logging: waiting to start at 26 Feb 2014 18:00:00
sample interval = 300 seconds
samplenumber = 0, free = 299593
serial sync mode disabled
real-time output disabled
SBE 39 configuration = temperature only
binary upload does not include time
temperature = 23.46 deg C

SBE 39 V 1.7a SERIAL NO. 00284
26 Feb 2014 16:28:23
not logging: waiting to start at 26 Feb 2014 18:00:00
sample interval = 300 seconds
samplenumber = 0, free = 299593
serial sync mode disabled
real-time output disabled
SBE 39 configuration = temperature only
binary upload does not include time
temperature = 27.40 deg C

SBE 39 V 1.7a SERIAL NO. 00719
26 Feb 2014 16:34:13
not logging: waiting to start at 26 Feb 2014 18:00:00
sample interval = 300 seconds
samplenumber = 0, free = 299593
serial sync mode disabled
real-time output disabled
SBE 39 configuration = temperature only
binary upload does not include time
temperature = 23.96 deg C

SBE 39 V 1.7a SERIAL NO. 00102
26 Feb 2014 16:48:29
not logging: waiting to start at 26 Feb 2014 18:00:00
sample interval = 300 seconds
samplenumber = 0, free = 299593
serial sync mode disabled
real-time output disabled
SBE 39 configuration = temperature only
binary upload does not include time
temperature = 23.63 deg C

SBE 39 V 1.7a SERIAL NO. 00049
26 Feb 2014 16:53:39

not logging: waiting to start at 26 Feb 2014
18:00:00
sample interval = 300 seconds
samplenumber = 0, free = 299593
serial sync mode disabled
real-time output disabled
SBE 39 configuration = temperature only
binary upload does not include time
temperature = 27.99 deg C

SBE 39 V 1.7a SERIAL NO. 00048
26 Feb 2014 18:41:13
not logging: waiting to start at 26 Feb 2014
19:00:00
sample interval = 300 seconds
samplenumber = 0, free = 299593
serial sync mode disabled
real-time output disabled
SBE 39 configuration = temperature only
binary upload does not include time
temperature = 23.86 deg C

SBE 39 V 1.7a SERIAL NO. 00038
26 Feb 2014 18:46:05
not logging: waiting to start at 26 Feb 2014
19:00:00
sample interval = 300 seconds
samplenumber = 0, free = 299593
serial sync mode disabled
real-time output disabled
SBE 39 configuration = temperature only
binary upload does not include time
temperature = 24.07 deg C

SBE 39 V 1.7a SERIAL NO. 00044
26 Feb 2014 18:50:08
not logging: waiting to start at 26 Feb 2014
19:00:00
sample interval = 300 seconds
samplenumber = 0, free = 294326
serial sync mode disabled
real-time output disabled
SBE 39 configuration = temperature only
binary upload does not include time
temperature = 24.55 deg C

SBE 39 V 1.7a SERIAL NO. 00035
26 Feb 2014 18:54:15
not logging: waiting to start at 26 Feb 2014
19:00:00
sample interval = 300 seconds
samplenumber = 0, free = 299593
serial sync mode disabled
real-time output disabled
SBE 39 configuration = temperature only
binary upload does not include time
temperature = 25.13 deg C

Surface Air Temperature SBE 39

S>DS
SBE 39 V 2.2 SERIAL NO. 1447 18 Feb 2014
16:02:06
battery voltage = 9.1
not logging: received stop command
sample interval = 300 seconds
samplenumber = 0, free = 599186
serial sync mode disabled
real-time output disabled
SBE 39 configuration = temperature only
binary upload does not include time
temperature = 19.89 deg C
S>MMDDYY=021814
S>HHMMSS=160215

S>DS
SBE 39 V 2.2 SERIAL NO. 1447 18 Feb 2014
16:03:19
battery voltage = 9.0
not logging: waiting to start at 18 Feb 2014
17:00:00
sample interval = 300 seconds
samplenumber = 0, free = 599186
serial sync mode disabled
real-time output disabled
SBE 39 configuration = temperature only
binary upload does not include time
temperature = 19.67 deg C

Suburface SBE 16

SEACAT V4.1b SERIAL NO. 1875
02/28/14 13:19:32.458

clk = 32767.609, iop = 98, vmain = 8.9, vlith = 1.6
at 02/28/14 13:00:00.000 sample interval = 1800 sec

samples = 1, free = 260821, lwait = 0 msec
SW1 = C0H, battery cutoff = 5.6 volts
no. of volts sampled = 0
mode = normal
logdata = YES

SEACAT V4.1b SERIAL NO. 1873
02/28/14 13:20:02.908
clk = 32768.258, iop = 110, vmain = 8.9, vlith = 1.5
at 02/28/14 13:00:00.000 sample interval = 1800 sec
samples = 1, free = 260821, lwait = 0 msec
SW1 = C0H, battery cutoff = 5.6 volts
no. of volts sampled = 0
mode = normal
logdata = YES

Seabird 56

SBE56 SN 05602065
Firmware version SBE56 V0.96
Sample period (sec): 60.0
Date/Time: 28-Feb-2014 11:09:05
Start sampling at: 28-Feb-2014 12:00:00
Current temperature: 23.5627
Events recorded: 0
Battery changed: 28-Feb-2014 11:09:02
Number of samples in memory: 0
Memory remaining: 30.86 years
Calculated battery life remaining: 4.57 years
Set time to: 28-Feb-2014 11:09:11

SBE56 SN 05602066
Firmware version SBE56 V0.96
Sample period (sec): 60.0
Date/Time: 28-Feb-2014 11:05:15
Start sampling at: 28-Feb-2014 12:00:00
Current temperature: 22.8346
Events recorded: 0
Battery changed: 28-Feb-2014 11:04:59
Number of samples in memory: 0
Memory remaining: 30.86 years
Calculated battery life remaining: 4.57 years
Set time to: 28-Feb-2014 11:05:21

SBE56 SN 05602067
Firmware version SBE56 V0.96
Sample period (sec): 60.0
Date/Time: 28-Feb-2014 10:58:25
Start sampling at: 28-Feb-2014 12:00:00
Current temperature: 23.0093
Events recorded: 0
Battery changed: 28-Feb-2014 10:57:09
Number of samples in memory: 0
Memory remaining: 30.86 years
Calculated battery life remaining: 4.57 years
Set time to: 28-Feb-2014 10:58:48

SBE56 SN 05602068
Firmware version SBE56 V0.96
Sample period (sec): 60.0
Date/Time: 28-Feb-2014 11:01:58
Start sampling at: 28-Feb-2014 12:00:00
Current temperature: 22.8137
Events recorded: 0
Battery changed: 28-Feb-2014 11:01:47
Number of samples in memory: 0
Memory remaining: 30.86 years
Calculated battery life remaining: 4.57 years
Set time to: 28-Feb-2014 11:02:11

Nortek current meters and profilers

Deployment : ST13
Current time : 2/28/2014 9:05:04 PM
Start at : 2/28/2014 10:00:00 PM
Comment:
stratus 13 2mhz

Profile interval (s) : 1800
Number of cells : 12
Cell size (m) : 1.00
Blanking distance (m) : 1.00
Measurement load (%) : 4
Average interval (s) : 180
Power level : HIGH
Wave data collection : DISABLED
Compass upd. rate (s) : 1
Coordinate System : ENU
Speed of sound (m/s) : MEASURED
Salinity (ppt) : 35
Analog input 1 : NONE
Analog input 2 : NONE
Analog input power out : DISABLED
File wrapping : OFF
TellTale : OFF
Acoustic modem : OFF
Serial output : OFF
Baud rate : 9600

Assumed duration (days) : 540.0
Battery utilization (%) : 197.0 (1 lithium battery but instrument has 3)
Battery level (V) : 11.1
Recorder size (MB) : 25

Recorder free space (MB) : 24.973
Memory required (MB) : 3.5
Vertical vel. prec (cm/s) : 0.4
Horizon. vel. prec (cm/s) : 1.1

Instrument ID : AQD 0357

Head ID : AQP 0274
Firmware version : 1.17

AquaPro Version 1.36.06
Copyright (C) Nortek AS

Subsurface Vector Measuring Current Meters

VM001
Model: STAR ENGINEERIN
SerNum: VM2032
CfgDat: 08APR02
Firmware: VMCM2 v3.24
RTClock: 2014/02/23 13:29:49
Logging Interval: 60; Current Tick: 3
Compass Ontime=2 Offtime=13
EDI Intel-compatible 20MB PCMCIA CARD present
- CARD OK!
FLASH card capacity: 20840436
Records used: 0; available: 612954
Main Battery Voltage: 0.00
TPOD Firmware: VMTPOD53 v3.00
TPOD Info: VMTPOD VMT032 07MAY13
THERM032
Sampling GO

VM001
Model: STAR ENGINEERIN
SerNum: VM2031
CfgDat: 09APR02
Firmware: VMCM2 v3.24
RTClock: 2014/02/23 13:31:09
Logging Interval: 60; Current Tick: 9
Compass Ontime=2 Offtime=13
EDI Intel-compatible 20MB PCMCIA CARD present
- CARD OK!
FLASH card capacity: 20840436
Records used: 0; available: 612954
Main Battery Voltage: 0.00
TPOD Firmware: VOD53 v3.00
TPOD Info: VMTPOD VMT031 01NOV12
THERM031
Sampling GO

VM001
Model: STAR ENG.
SerNum: VM2004
CfgDat: 05APR02
Firmware: VMCM2 v3.24
RTClock: 2014/02/23 13:30:35
Logging Interval: 60; Current Tick: 4
Compass Ontime=2 Offtime=13
EDI Intel-compatible 20MB PCMCIA CARD present
- CARD OK!
FLASH card capacity: 20840436
Records used: 0; available: 612954
Main Battery Voltage: 0.00
TPOD Firmware: VMTPOD53 v3.00
TPOD Info: VMTPOD VMT004 01NOV12
THERM004
Sampling GO

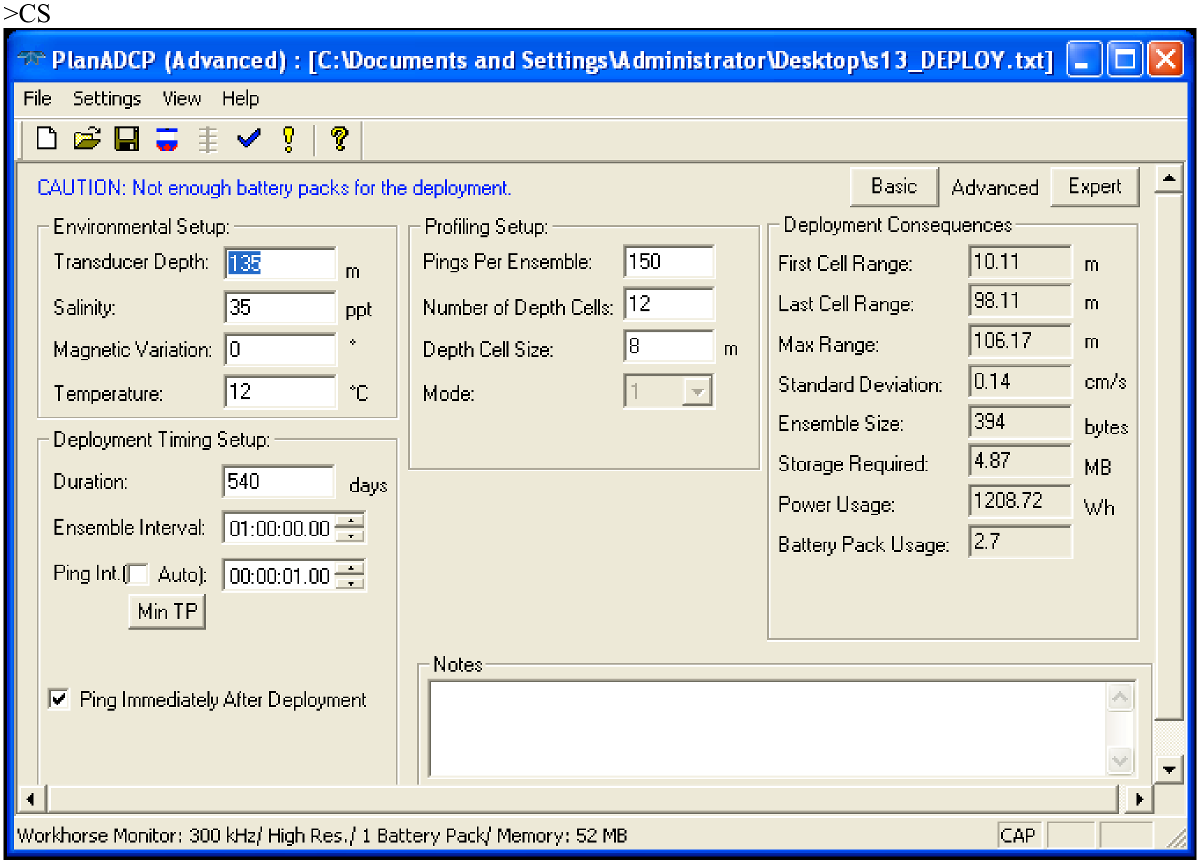
VM001
Model: STAR ENGINEERIN
SerNum: VM2042
CfgDat: 08APR02
Firmware: VMCM2 v3.24
RTClock: 2014/02/23 13:31:49
Logging Interval: 60; Current Tick: 4
Compass Ontime=2 Offtime=13
EDI Intel-compatible 20MB PCMCIA CARD present
- CARD OK!
FLASH card capacity: 20840436
Records used: 0; available: 612954
Main Battery Voltage: 0.00
TPOD Firmware: VMTPOD53 v3.00
TPOD Info: VMTPOD VMT042 01NOV12
THERM042
Sampling GO

Subsurface RDI workhorse profiler

[BREAK Wakeup A]
WorkHorse Broadband ADCP Version 50.40
Teledyne RD Instruments (c) 1996-2010
All Rights Reserved.
>DEPLOY?
Deployment Commands:
CF = 11101 --------------- Flow Ctrl (EnsCyc;PngCyc;Binry;Ser;Rec)
CK ----------------------- Keep Parameters as USER Defaults

```
CR # --------------------- Retrieve Parameters (0 = USER, 1 = FACTORY)
CS ----------------------- Start Deployment
EA = +00000 -------------- Heading Alignment (1/100 deg)
EB = +00000 -------------- Heading Bias (1/100 deg)
ED = 01350 --------------- Transducer Depth (0 - 65535 dm)
ES = 35 ------------------ Salinity (0-40 pp thousand)
EX = 11111 --------------- Coord Transform (Xform: Type,Tilts,3 Bm,Map)
EZ = 1111101 ------------- Sensor Source (C,D,H,P,R,S,T)
RE ----------------------- Recorder ErAsE
RN ----------------------- Set Deployment Name
TE = 01:00:00.00 --------- Time per Ensemble (hrs:min:sec.sec/100)
TF = **/**/**,**:**:** --- Time of First Ping (yr/mon/day,hour:min:sec)
TP = 00:01.00 ------------ Time per Ping (min:sec.sec/100)
TS = 14/03/01,15:59:44 --- Time Set (yr/mon/day,hour:min:sec)
WD = 111 100 000 --------- Data Out (Vel,Cor,Amp; PG,St,P0; P1,P2,P3)
WF = 0176 ---------------- Blank After Transmit (cm)
WN = 012 ----------------- Number of depth cells (1-128)
WP = 00150 --------------- Pings per Ensemble (0-16384)
WS = 0800 ---------------- Depth Cell Size (cm)
WV = 175 ----------------- Mode 1 Ambiguity Vel (cm/s radial)
>CR1
[Parameters set to FACTORY defaults]
>RE
Must use 'RE ErAsE' or 're ErAsE' to erase recorder!
Recorder not erased.
>RE ErAsE  erasing...
Recorder erased.
Total capacity   =   52168704 bytes
Total bytes used =          0 bytes in 0 files
Total bytes free =   52168704 bytes
>TS14/03/01 16:03:35
>TS?
TS 14/03/01,16:03:38 --- Time Set (yr/mon/day,hour:min:sec)
>CF11101
>EA0
>EB0
>ED1350
>ES35
>EX11111
>EZ1111101
>WA50
>WD111100000
>WF176
>WN12
>WP150
>WS800
>WV175
>TE01:00:00.00
>TP00:01.00
>TF14/03/01 17:00:00
>TF?
TF 14/03/01,17:00:00 --- Time of First Ping (yr/mon/day,hour:min:sec)
>TS?
TS 14/03/01,16:08:35 --- Time Set (yr/mon/day,hour:min:sec)
>CK
[Parameters saved as USER defaults]
```

```
>DEPLOY?
Deployment Commands:
CF = 11101 --------------- Flow Ctrl (EnsCyc;PngCyc;Binry;Ser;Rec)
CK ----------------------- Keep Parameters as USER Defaults
CR # --------------------- Retrieve Parameters (0 = USER, 1 = FACTORY)
CS ----------------------- Start Deployment
EA = +00000 -------------- Heading Alignment (1/100 deg)
EB = +00000 -------------- Heading Bias (1/100 deg)
ED = 01350 --------------- Transducer Depth (0 - 65535 dm)
ES = 35 ------------------ Salinity (0-40 pp thousand)
EX = 11111 --------------- Coord Transform (Xform: Type,Tilts,3 Bm,Map)
EZ = 1111101 ------------- Sensor Source (C,D,H,P,R,S,T)
RE ----------------------- Recorder ErAsE
RN ----------------------- Set Deployment Name
TE = 01:00:00.00 --------- Time per Ensemble (hrs:min:sec.sec/100)
TF = 14/03/01,17:00:00 --- Time of First Ping (yr/mon/day,hour:min:sec)
TP = 00:01.00 ------------ Time per Ping (min:sec.sec/100)
TS = 14/03/01,16:11:43 --- Time Set (yr/mon/day,hour:min:sec)
WD = 111 100 000 --------- Data Out (Vel,Cor,Amp; PG,St,P0; P1,P2,P3)
WF = 0176 ---------------- Blank After Transmit (cm)
WN = 012 ----------------- Number of depth cells (1-128)
WP = 00150 --------------- Pings per Ensemble (0-16384)
WS = 0800 ---------------- Depth Cell Size (cm)
WV = 175 ----------------- Mode 1 Ambiguity Vel (cm/s radial)
>CS
```



Seaguards (SNs: 138, 140, 141, 142, 143, 144, 181, 182)

DCS:
pings =300
sound speed= 1500
start distance= .5m
cell size= 2.5m
burst mode= y
fixed= no
tilt compensation= on
z pulse active= on
x axis normal
y axis normal
forward ping active = y

OPTODE:
enable airsat = y
enable raw data= y
enable temp= y
enable hum comp= y

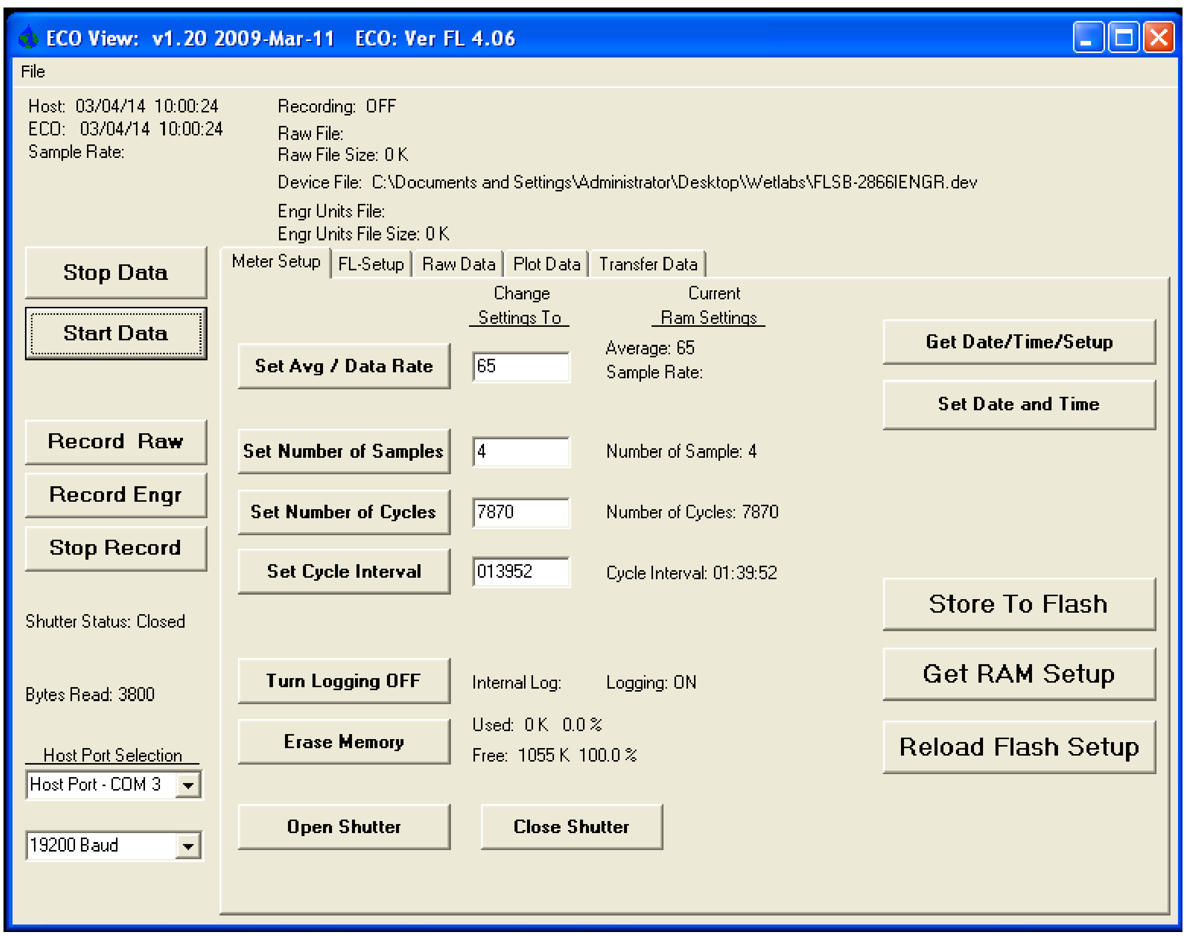
Control Panel
Set Time
Zero Card

Deployment Settings
Platform, Recorder, Storage Manager (wizard)
Site Info
Sample Interval= 30 minutes
Start when powered on
Enabled Sensors
Store Internally= y

Admin Tools
Calculator
30 minute sample 1800 seconds
2 lithium 7v, 30 Ah
battery days= 706
memory days= 175,000 (see notes)

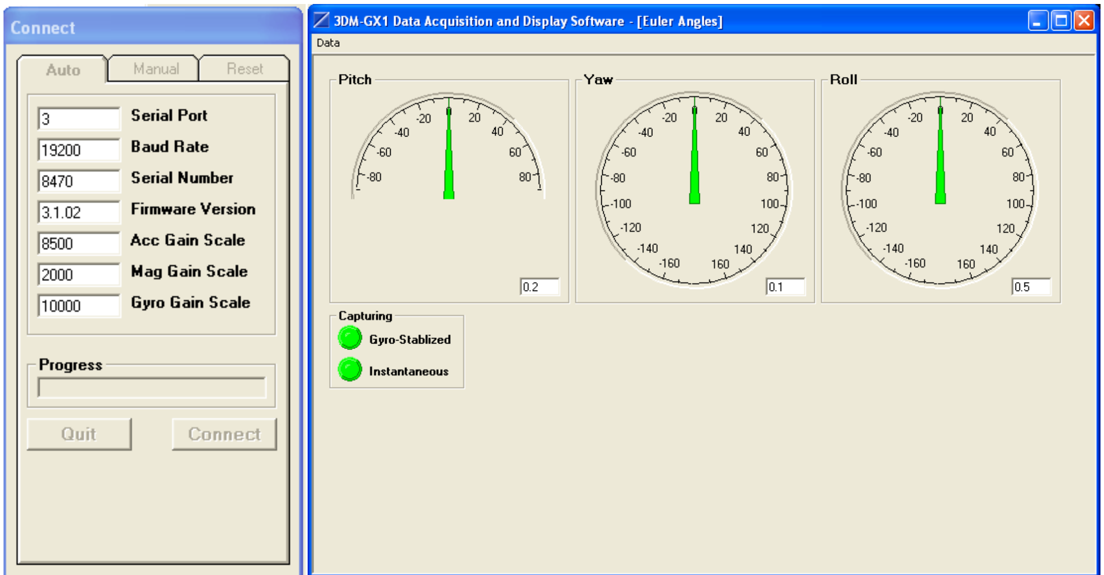
Fluorometer:

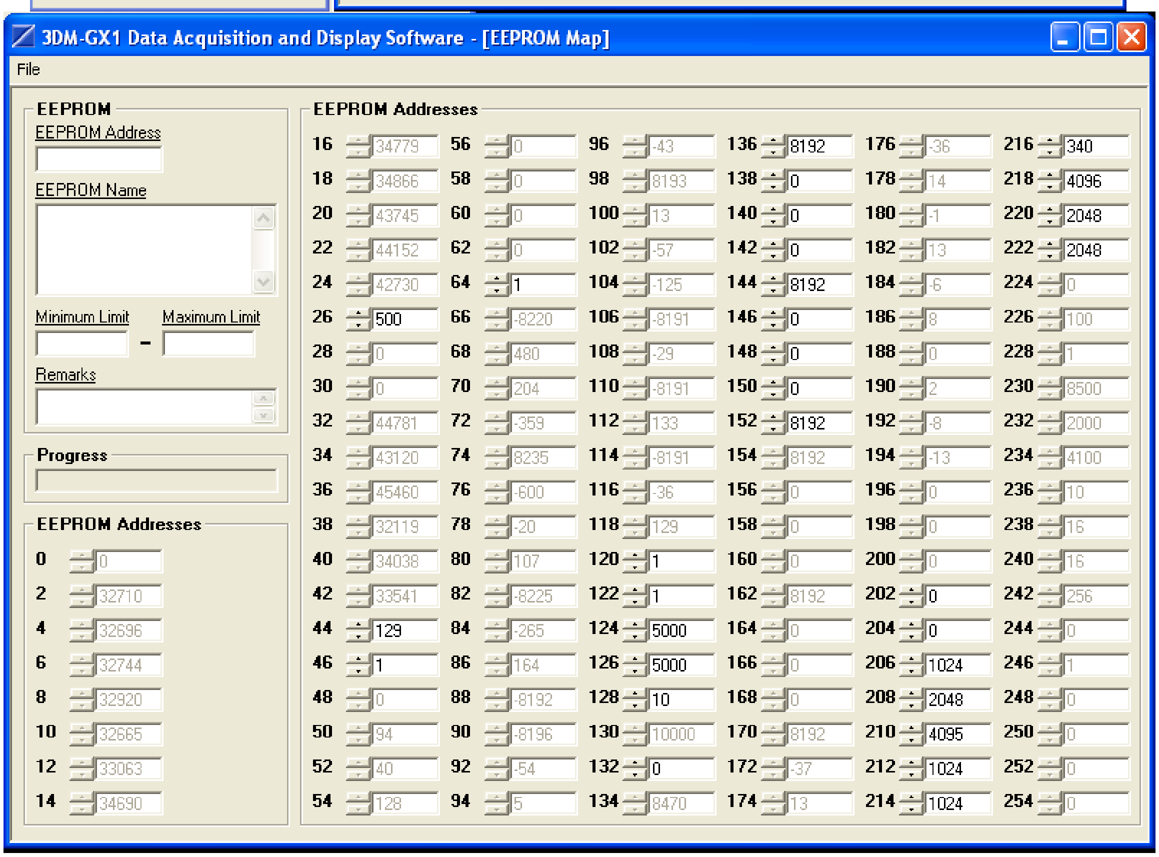
See figure below



WAMDAS Wave package:

See figures below





APPENDIX 3: Stratus 13 Mooring Log

Moored Station Log

(fill out log with black ball point pen only)

ARRAY NAME AND NO. Stratus 13 MOORED STATION NO. 1265

Launch (anchor over)

Date (day-mon-yr) 07 - MARCH - 2014	Time 18 01 01 UTC
Deployed by LORD	Recorder/Observer GALBRAITH
Ship and Cruise No. RON BROWN RB14-01	Intended Duration
Depth Recorder Reading ~~5441~~ 4541 m	Correction Source CTD data base
Depth Correction m	
Corrected Water Depth 4541 RHB multibeam m	Magnetic Variation (E/W)
Anchor Drop Lat. (N/S) 19° 37.5561'S	Lon. (E/W) 84° 57.0134'W
Surveyed Pos. Lat. (N/S) 19° 37.4714'S	Lon. (E/W) 84° 57.1394'W
Argos Platform ID No. WATCH CIRCLE 3.7 nm	Additional Argos Info on pages 2 and 3
Acoustic Release Model ORE	Tested to 1,500 m
Release No. 1 (sn) 31336	Release No. 2 (sn) 30844
Interrogate Freq. 11k	Interrogate Freq. 11
Reply Freq. 12k	Reply Freq. 12
Enable 471461	Enable 16647
Disable 471516	Disable 166504
Release 44775	Release 151330

Recovery (release fired)

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

Distance from waterline to buoy deck 60

1

ARRAY NAME AND NO. STRATUS 13 1265 MOORED STATION NO. 1265

Surface Components

Buoy Type MOBS **Color(s) Hull/Tower** BLUE BELOW YELLOW DECK / WHITE

Buoy Markings IF FOUND ADRIFT CONTACT WOODS HOLE OCEANOGRAPHIC WOODS HOLE MA 02543 USA 508 457 1401 50, 60, 70, 80

Surface Instrumentation

Item	ID #	Height*	Comments
ASIMET	4		LOGR 53 v4.11cf
HRH	249	230	
BPR	502	237	
SWND	216	271	
PRC	502	250	
LWR	205	279	
SWR	504	279	
SST	1838		
PTT-ARGOS	12789		WILDCAT, 27916, 27917, 27918
LOGGER	14		
HRH	247	~~237~~ 230	
BPR	210	~~267~~ 237	
WND	239	~~250~~ 267	
PRC	207	250	
LWR	221	279	
SWR	226	279	
SST			
PTT-ARGOS	18171		27919, 27920 27921 - WILDCAT
WND	221	267	
HRH-SENS	214	226	
WXT	1	253	
SASCAR	243	233	
SBE39	1447	234	
XEOS ROVER			300434 060 815 350

*Height above buoy deck in centimeters

2

ARRAY NAME AND NO. STRATUS 13 MOORED STATION NO. 1265

Subsurface Instrumentation on Buoy and Bridle			
Item	ID #	Depth†	Comments
WAMDAS	6014	-	
SIS	22		ARGOS BEACON ID 11427
SBE56	2064	90	AFT - 0°
SBE56	2065	90	PORT - 90
	2066	90	FWD - 180
	2067	90	STBD -
PCO2	8		PMEL
SAMI	21		"
SBE16	6566		"

†Depth below buoy deck in centimeters

3

ARRAY NAME AND NO. STRAUS 13 MOORED STATION NO. 1265

Item No.	Length (m)	Item	Depth	Inst No.	Time Over	Time Back	Notes
1		BUOY		1148			VA OFF DECK 1147
2	.22	3/4" CHAIN					
3		SBE 37	2	1325			
4	.37	3/4" CHAIN					1133: 2m inst attached to 3.2-45 m
5		SBE 37	3.7	1326	1127		
6		SBE 39	4.9	35	1127		DOWN
7	1.3	3/4 CHAIN					
8		SBE 37	7	1328	1125		
9	1.73	3/4 CHAIN					
10		NORTEK P	10	357	1123		HEAD UP
11	1.35	3/4 CHAIN					
12		RCM 11	13	78	1121		
13	1.5	3/4 CHAIN					
14		SBE37	16	1329	1121		
15	2.7	3/4 CHAIN					
16		RCM 11	20	79	1119		
17	3.66	34 CHAIN ~~SBE 39~~	2.				
18		SBE 39	25	38	1117		UP
19	3.9	3/4 CHAIN					
20		SBE 37	30	1330	1115		
21	1.12	3/4 CHAIN					
22		RCM 11	32.5	13	1113		
23	1.2	3/4 CHAIN					
24		SBE 39	35	44	1113		
25	3.9	3/4 CHAIN					

4

ARRAY NAME AND NO. STRATUS 13 MOORED STATION NO. 1265

Item No.	Length (m)	Item	Depth	Inst No.	Time Over	Time Back	Notes
26		SBE37	40	8211	1110		
27	3.66	3/4 CHAIN					
28		SEAGUARD ADCM	45	138	1108		OPTODE 188
29	16	7/16 WIRE					1220012
30		SBE 39	50	48	1203		
31		SBE 39	55	49	1205		
32		SBE37	62.5	8212	1214		
33	23.5	7/16 WIRE					122007
34		SBE 39	70	102	1217		
35		SBE 39	77.5	103	1218		
36		SBE37P	85	1909	1221		STOPPING OFF TO CHECK WINCH
37		SEAGUARD ADCM	87.3	140	1312		OPTODE 189
38	18.2	7/16 WIRE ~~SBE 39~~		~~203~~			12200-11
39		SBE39	92.5	203 ~~276~~	1315		
40		SBE 39	100	276	1319		
41		ECO FS	100.5	2866	1319		WETLABS CAP OFF 1317
42		SEAGUARD ADCM	107	961	1324		COND # 726 PRESS ~~414~~ ~~438~~ 474 OPTODE 1072 T:430 BOTH AR
43	21.5	7/16 WIRE					12200-10
44		SBE 39	115	284	1326		
45		SBE 37	130	8215	1329		
46	4	7/16 WIRE					12200-16
47		RDI ADCP	135	1218	1334		UPWARD LOOKING
48	8.5	7/16 WIRE					12200-18
49		SEAGUARD ADCM	145	141	1337		OPTODE 190
50	13.5	7/16 WIRE					# 12200 17

5

ARRAY NAME AND NO. STRATUS 13 MOORED STATION NO. 1265

Item No.	Length (m)	Item	Depth	Inst No.	Time Over	Time Back	Notes
51		SBE 37	160	8212	1341		~~12200-8~~
52	21.7	7/16 WIRE					12200-8
53		SBE 39	175	719	1343		
54		SEAGUARD ADCM	183	964	1346		OPTODE 1087 COND 724 PRESS SN 475 T 431
55	5.5	7/16 WIRE					12200.19
56		SBE 37	190	8216	1350		
57	29	7/16 WIRE					12200-6
58		SBE 37	220	8225	1356		
59	13.5	7/16 WIRE					12200 14
60		SEAGUARD ADCM	235	142	1400		OPTODE 267
61	53.5	7/16 WIRE					12200-4
62		OPTODE	250		1405		
63		SBE 39	280	720 ~~780~~	1408		
64		SEAGUARD ADCM-O	290	143	1411		OPTODE 268
65	58.5	3/8 WIRE					120793B
66		SBE 37	295	1906	1413		
67		SEAGAURD ADCM-O	350	969	1418		P473 C722 T429 O ~~433~~ 1088
68	48.5	3/8 WIRE					10242 13
69		SEAGAURD ADCM O	400	144	1424		OPTODE 269
70	48.5	3/8 WIRE					10242-7-A
71		SEAGUARD ADCM-O	450	181	1430		OPTODE 404
72	148.5	3/8 WIRE					12200-17
73		OPTODE	500	943	1434		
74		SBE 37P	550	3733	1440		
75		S.G. ADCM O	600	182	1446		OPTODE 405

ARRAY NAME AND NO. STRATUS 13 MOORED STATION NO. 1265

Item No.	Length (m)	Item	Depth	Inst No.	Time Over	Time Back	Notes
76	200	3/8 WIRE					11237-5
77		SBE 37	601	1908	1448		
78		SBE 37	700	8220 ~~8221~~	1454		SWAPPED SNS W 2000m UNIT
79		VMCM	802	4	1500		1458 BANDS OFF
80	48.5	3/8 WIRE					10242 7D
81		VMCM	853	31	1504		1503 BANDS OFF
82	500	3/8 WIRE					12200-2
83		SBE 37	857	8218	N 1507		
84		SBE 37	~~8~~1355	8224	1521		
85	150	3/8 WIRE					9074-3A
86		VMCM	1507	32	1528		1527 PROPS SPUN
87	500	3/8 WIRE					12200-1
88		SBE 37	1557	8219	1530		
89		SBE 37	2000	8221 ~~8220~~	1542		MARKED FOR 700m (SWAPPED)
90		VMCM	2010	42	1548		BANDS OFF 1545
91	21m 100	3/8 WIRE					122009 SHOT ADDED, DEEPER LOCATION 10214-8
92	200	7/8 NYLON			1551-		
93	1600	7/8 NYLON			1605-		
94	1500	COLMEGA			1630-1651		
95		88 GLASS BALLS					IN AT 17:34
96		PAIR SBE 16	1873 1875		1735		
97	5	1/2 CHAIN RELEASES			1750		
98	5 20	1/2 CHAIN SAMSON					
99	5	1/2 CHAIN					
100		ANCHOR			1801		

SWAPPED SBE37S @ 700m + 2000m because SN 8221 HAD TO HAVE ENDCAP ADJUSTED

7

APPENDIX 4: Stratus 12 mooring log

Moored Station Log

(fill out log with black ball point pen only)

ARRAY NAME AND NO. STRATUS XII **MOORED STATION NO.** 1247

Launch (anchor over)

Date (day-mon-yr) 27 MAY 2012 Time 22:03:04 UTC

Deployed by J LORD Recorder/Observer N GALBRAITH

Ship and Cruise No. MELVILLE MV1207 Intended Duration 1 year

Depth Recorder Reading ~~2kHz~~ 4562.2 m MULTIBEAM DEPTH Correction Source CTD

Depth Correction CTD fed to Seabeam m Sound speed 1563.3 m/s

Corrected Water Depth 4538.97 m Magnetic Variation (E/W) 16.5

Anchor Drop Lat. (N/S) 19° 56.333 Lon. (E/W) 85° 17.594

Surveyed Pos. Lat. (N/S) 19 56.3064 Lon. (E/W) ~~85° 09.517~~ 85° 17.5598

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

Acoustic Release Model Tested to m

Release No. 1 (sn) 35316 Release No. 2 (sn) 31335

Interrogate Freq. 11 Interrogate Freq. 11

Reply Freq. 12 Reply Freq. 12

Enable 111273 Enable 471427

Disable 111303 Disable 471442

Release 127413 Release 447756

Recovery (release fired)

Date (day-mon-yr) 08-MAR-2014 Time 10:55:55 UTC

Latitude (N/S) 19 56.023 S Longitude (E/W) 85 17.956 W

Recovered by LORD Recorder/Observer GALBRAITH

Ship and Cruise No. RB-14-01 On Station 600 days Actual duration days

Distance from waterline to buoy deck ~65 cm

BUOY ADRIFT 25-01-2014 >14:00 UTC BUOY ON DECK 2014-03-07 1256 UTC

1

ARRAY NAME AND NO. STRATUS XII MOORED STATION NO. 1247

Surface Components
SURLYN FOAM
Buoy Type MOBS **Color(s) Hull Tower** YELLOW DECK, BLUE UNDER; TOWER WHITE
Buoy Markings IF FOUND ADRIFT CONTACT WOODS HOLE OCEANOGRAPHIC WHOI 508 548 1401 USA

Surface Instrumentation

Item	ID #	Height*	Comments
HRH-1	213	231	ON ASIMET LOGGER SN 1
BPR-1	219	236.5	
SWND-1	217	266	
PRC-1	204	245	
LWR-1	219	285	
SWR-1	501	285	
HRH-2	230	231	ON ASIMET LOGGER SN 2
BPR-2	217	236.5	
WND-2	240	266.5	
PRC-2	208	246	
LWR-2	209	285	
SWR-2	503	285	
WND	225	256	STAND-ALONE
HRH	219	227	
SBE 39	5275	202	
WXT520	5	266.5	
LASCAR	9174	212	

***Height above buoy deck in centimeters** DECK HT ~65cm

2

ARRAY NAME AND NO. STRATUS XII MOORED STATION NO. 1247

Subsurface Instrumentation on Buoy and Bridle

Item	ID #	Depth†	Comments
SBE 37-1	1725		
SBE37-2	1839		
WAMDAS	4003		IMEI 300 124 000 115 920 w/ MAGVAR +7
Sis	268		ID 25702
SBE56	1206	-90	AFT
SBE56	1207	-90	PORT
SBE 56	1208	-90	FWD
SBE56	1209	-120	FWD
SBE56	1210	-140	FWD
SBE 56	1211	-90	STBD
PCO2	108		PMEL
SAMI			PMEL
SBE 16	6543		PMEL

†Depth below buoy deck in centimeters

3

ARRAY NAME AND NO. STRATUS XII MOORED STATION NO. 1247

Item No.	Length (m)	Item	Depth	Inst No.	Time Over	Time Back	Notes
1		BODY			1507	2014/3/3 12:56	BACK 2014/03/03 LOI SAT, LOL PORT
2	.22	3/4 CHAIN					
3		SBE 37	2	1304		3/3 1256	
4	.37	3/4 CHAIN					
5		SBE 37	3.7	1899		3/3 1256	MOORING BELOW THIS 2014 03/08
6	1.95	3/4 CHAIN			1444		
7		SBE 37	7	1901	1444		
8	1.95	3/4 CHAIN					
9		NORTEK ADCP	10	1666	1442		1MHZ PROFILER
10	1.12	~~AANDERAA~~ CHAIN ~~ADCM~~	(3/4 CHAIN)				
11		AANDERAA ADCM	13	235	1440		SEAGUARD
12	.6	3/4 CHAIN					
13		NORTEK ADCM	15	2064	1438		2MHZ CM
14	4	SBE 37P	16.4	7836	1438		
15	2.4	3/4 CHAIN					
16		NORTEK ADCM	20	402	1428		2MHZ CM
17	3.23	3/4 CHAIN					
18		SBE 39	25	1502	1426		
19	3.66	3/4 CHAIN					
20		SBE 37	30	1902	1424		
21	1.35	3/4 CHAIN					
22		NORTEK ADCP	32.5	333	1422		2MHZ PROFILER
23	.75	3/4 CHAIN					
24		SBE 39	35	1509	1420		~~SEASONDE~~
25	3.66	3/4 CHAIN					

ARRAY NAME AND NO. STRATUS XII MOORED STATION NO. 1247

Item No.	Length (m)	Item	Depth	Inst No.	Time Over	Time Back	Notes
26		SBE37	40	3821	1417		
27	3.66	3/4 CHAIN					
28		NORTEK ADCM	45	1688	1414		2mHz CM
29	8.5	7/16 WIRE		10242-28A			10242 28 A 1412 -
30		NORTEK ADCM	55	9883	1520		2mHz CM
31	6.1	7/16 WIRE		11237 14			
32		SBE 37	62.5	3824	1527		
33	21.1	7/16 WIRE		11237-18			
34		SBE 39	70	1511	1531		
35		SBE 39	77.5	3423	1533		
36		SBE 37	85	10	1538		
37	13.3	7/16 WIRE					
38		SBE39	92.5	3434	1540		
39		VMCM	100	9	1559		1540 HANDS OFF
40	27.8	7/16 WIRE					
41		SBE 39	115	3435	1601		
42		SBE 37P	130	8004	1603		
43	3.66	3/4 CHAIN					
44		RDI ADCP	135	12254	1605	2323 ~~2142~~	WORKHORSE 300kHz
45	8.5	7/16 WIRE					
46		AANDERAA ADCM	145	238	1610 1609		SEAGUARD
47	13.5	~~RBR OXY~~ WIRE					
48		RBR OXY	147	50026	1610 1609		
49		SBE 37	160	1900	1614		
50	21.3	7/16 WIRE					11237-16

ARRAY NAME AND NO. STRATUS XII MOORED STATION NO. 1247

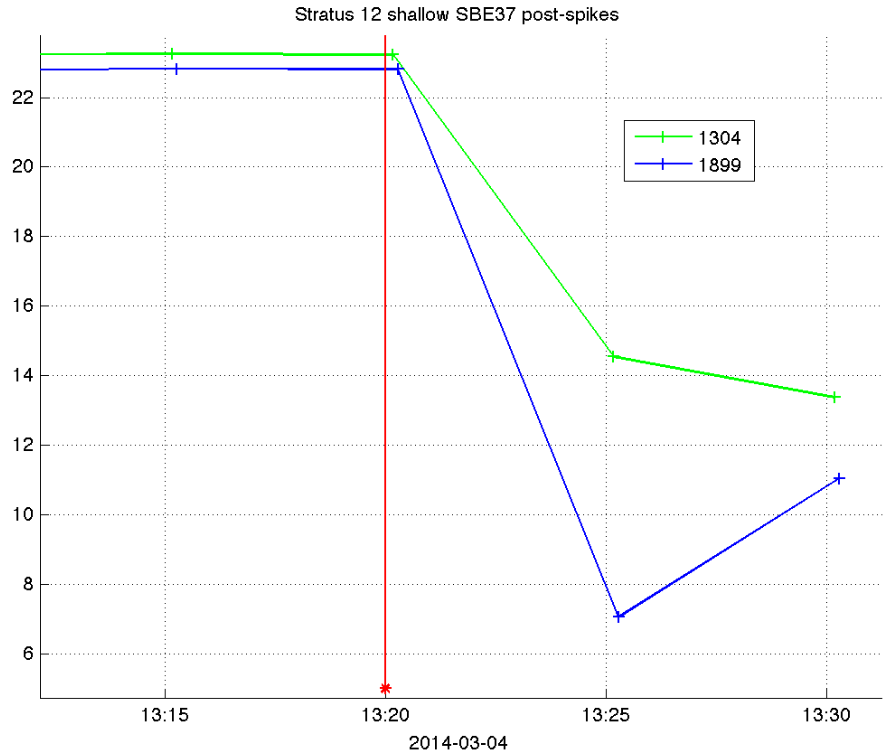
Item No.	Length (m)	Item	Depth	Inst No.	Time Over	Time Back	Notes
51		SBE 39	175	3437	1616		
52		VMCM	183	10	1619		BANDS OFF, SPIN 1617
53	4.8	7/16 WIRE					11237-15
54		SBE 37	190	1903	1623	2225	NO NOZZLE
55	28.5	7/16 WIRE					11237-17
56		SBE 37	220	1905	1628		
57	13	7/16 WIRE					11237-16
58		VMCM	235	30	1635		1627 BAND/SPIN
59	53	3/8 WIRE		11237-7			
60		SBE 37	250	1907	1636	2225	NO NOZZLE
61		VMCM	290	35	1640		1635 BANDS OFF/SPIN
62	57	3/8 WIRE		11237-8			
63		SBE 37	310	2011	1642		
64		VMCM	350	38	1647	2216	FISHING LINE ON BOTH LOWER PROPS + CASE 1641 BANDS/SPIN BANDS ON 2223
65	500	3/8 WIRE		11237-1			11237-1
66		SBE39	400	3438	1649	2211	loose endcap fishing gear, bracket broken
67		SBE 39	450	3439	1654	2149	
68		VMCM	852	58	1707	2126	PROPS SPINNING BANDED 2130 1704 BANDS/SPIN
69	500	3/8 WIRE		11237-2			
70	200	3/8 WIRE		102422A			
71		VMCM	1555	68	1728	1959	1914 OUT OF WATER, PROPS SPINNING FREELY 1720 BANDS OFF SPIN
72	450	3/8 WIRE		11237-4			
73		VMCM	2008	73	1756	2142	1733 BANDS OFF, SPIN BANDS ON 2148 11237-6 IS THE ADDED 53M SHOT
74	53 100	3/8 WIRE	ONE PIECE	10242-6A WRAPPED	1801 TERM		53M WIRE ADDED BASED ON SITE DEPTH
75	200	7/8 NYLON			1805-1811	1834-1841	ON WINCH STARTING AT 1825

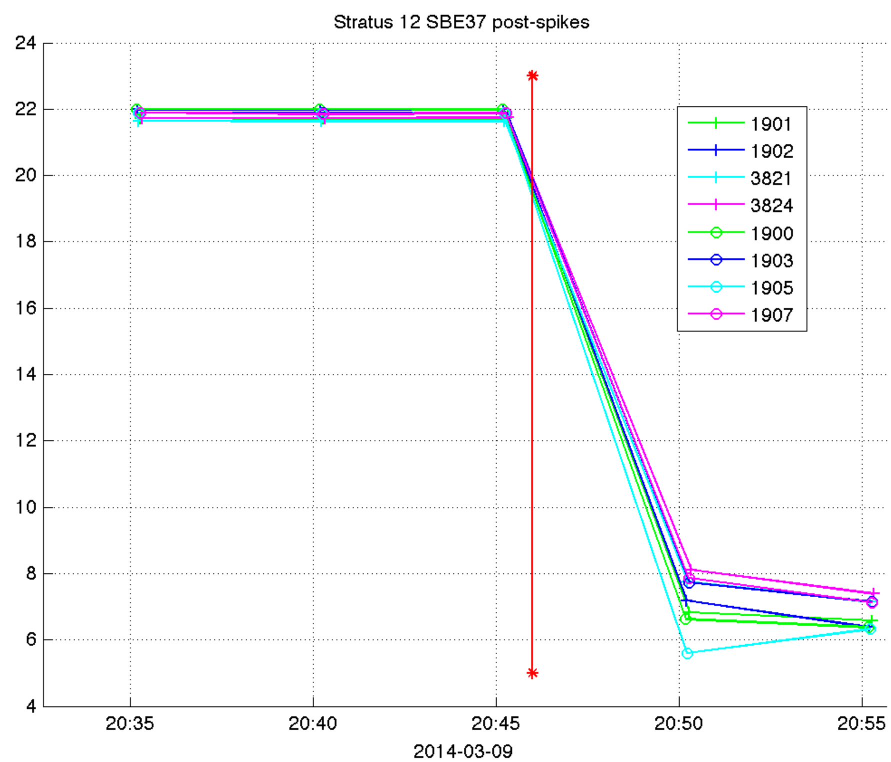
6

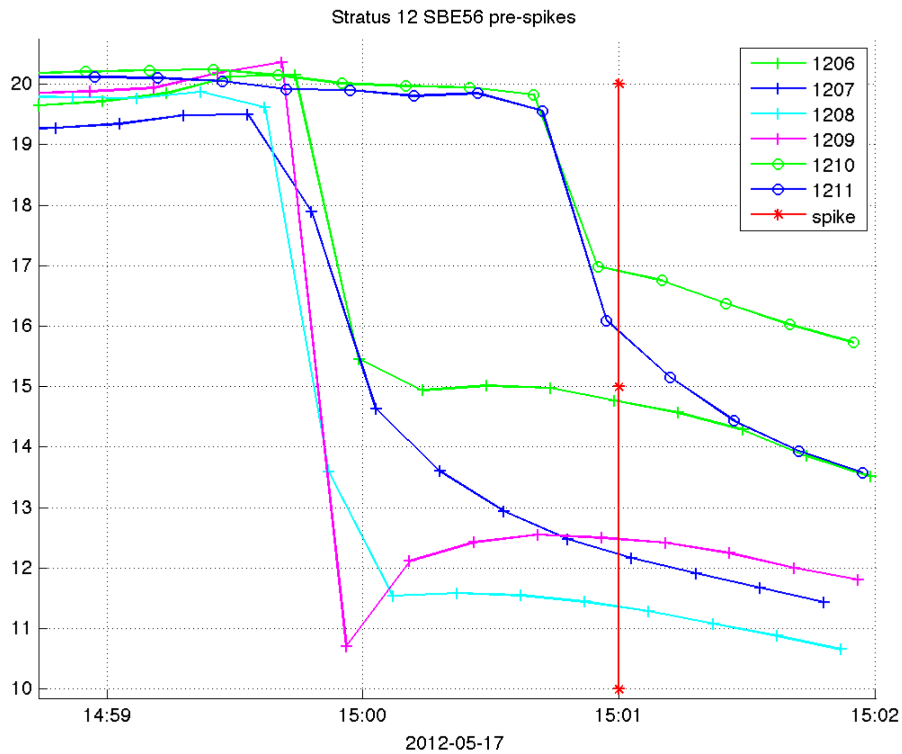
ARRAY NAME AND NO. STRATUS XII MOORED STATION NO. 1247

Item No.	Length (m)	Item	Depth	Inst No.	Time Over	Time Back	Notes
							1726 ~~TERMINATION~~ SPLICE 1707
76	1650	7/8 NYLON			1812-1914	1617-8	SPLICE @1648 MIDDLE LINE: 1650 RAT NEST IN LINE BOX, SOME
77	1500	1 col mega POLY			2004 19:14-	1350 -	SPLICE 1545 CHEWING APPARENT
78		88 GLASS BALLS			2012 - 2047		BALLS ON WINCH 1245 FIRST BALLS ON DECK 1250
79		SBE 16		1876	2052	1311	
80		SBE 16		1879 ~~1889~~	2052		1879 WAS originally recorded as 1889
81							
82	5	TRAWLER CHAIN					
83		RELEASES		35316 + 31335	2105	1314	
84	5	1/2" TRAWLER CHAIN					
85	20	1" SAMSON					
86	5	1/2" TRAWL CHAIN					
87		ANCHOR					
88							
89							
90							
91							
92							
93							NEED 22 STRUCKS HHT HHT HHT HHT II
94							
95							
96							
97							
98							
99							
100							

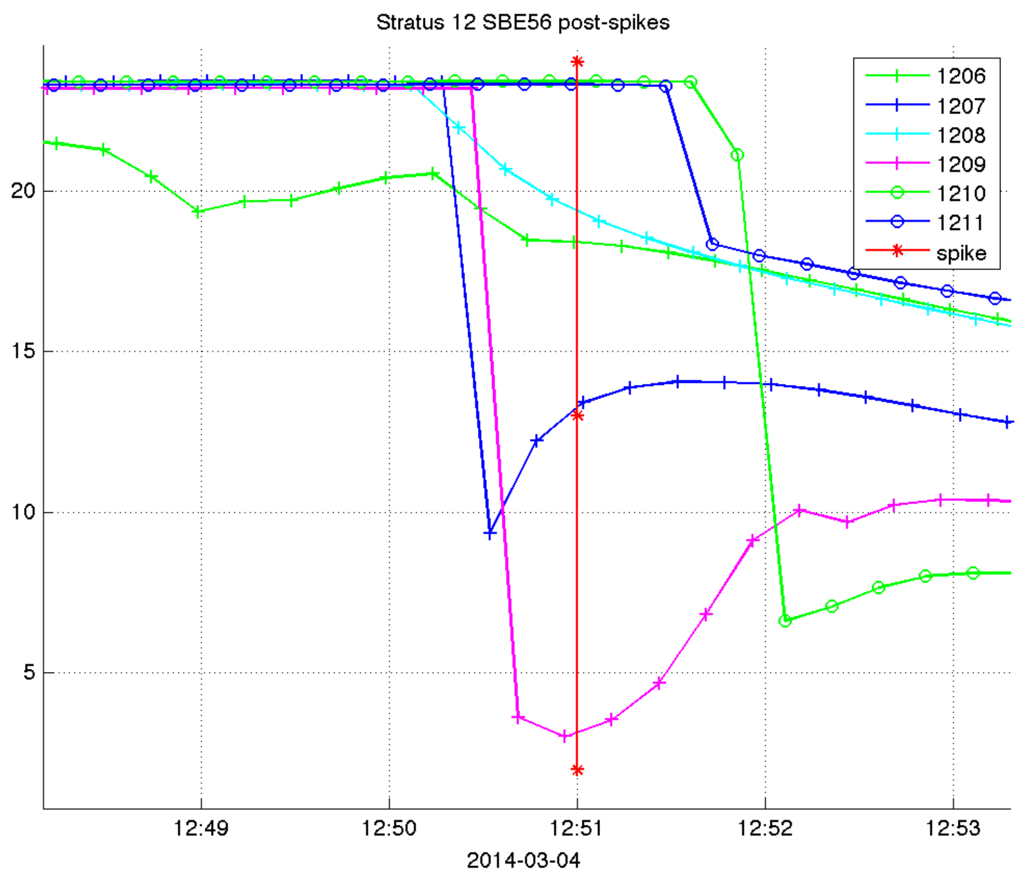
APPENDIX 5: Time spikes for Stratus 12 instrumentation.



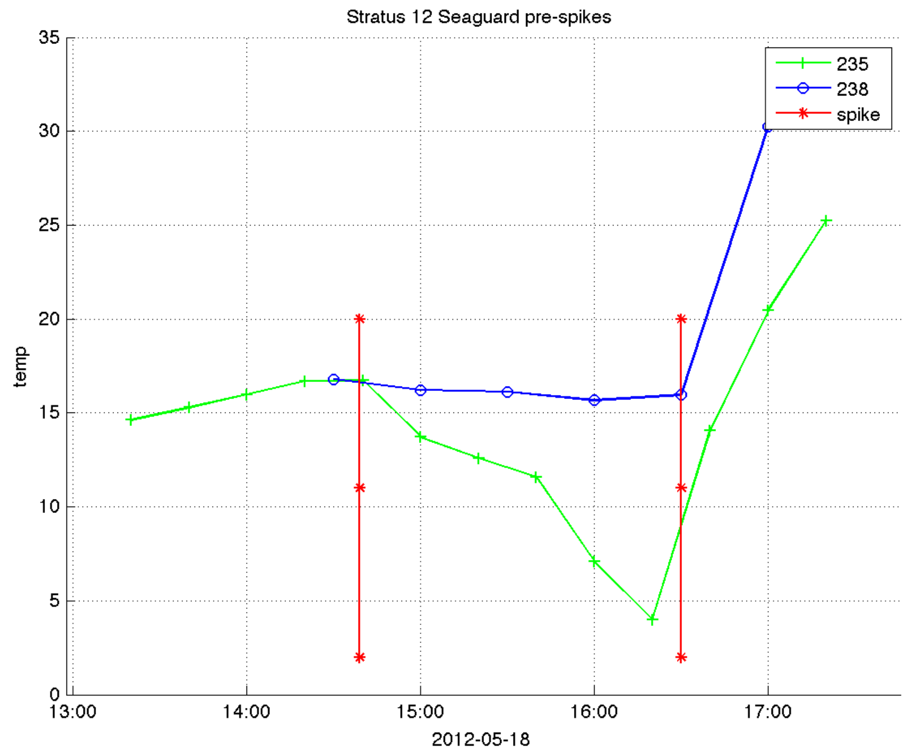


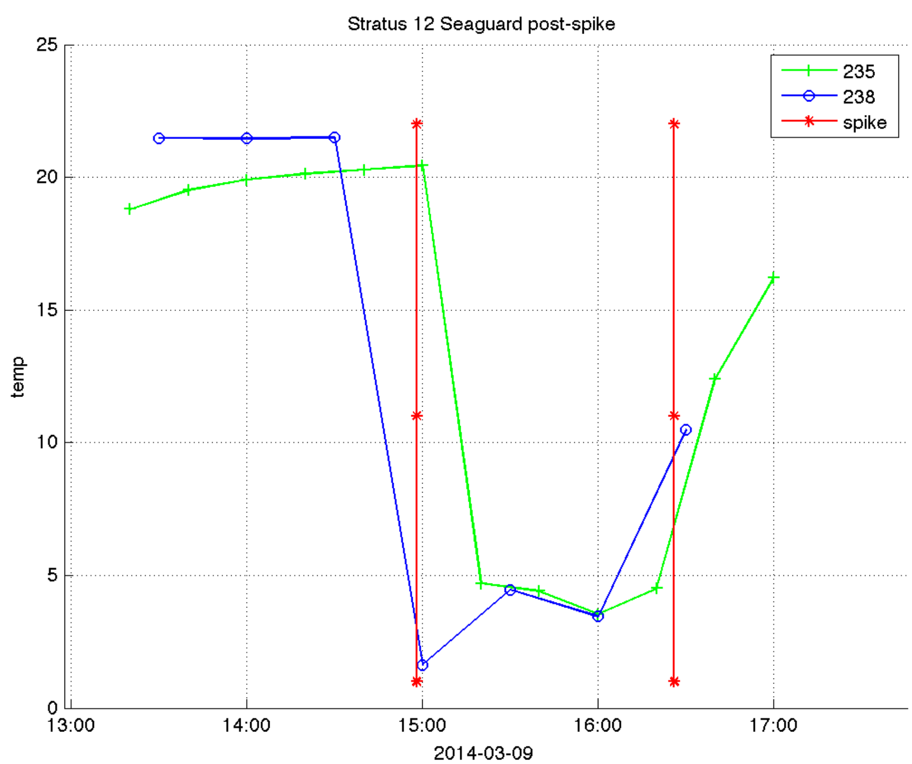


Stratus 12 SBE56 pre-spikes
1206
1207
1208
1209
1210
1211
spike
20
19
18
17
16
15
14
13
12
11
10
14:59
15:00
15:01
15:02
2012-05-17



Stratus 12 SBE56 post-spikes
1206
1207
1208
1209
1210
1211
spike
20
15
10
5
12:49
12:50
12:51
12:52
12:53
2014-03-04


Stratus 12 Seaguard pre-spikes
235
238
spike
temp
35
30
25
20
15
10
5
0
13:00
14:00
15:00
16:00
17:00
2012-05-18


Stratus 12 Seaguard post-spike
235
238
spike
temp
25
20
15
10
5
0
13:00
14:00
15:00
16:00
17:00
2014-03-09

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16. Abstract (Limit: 200 words)

The Ocean Reference Station at 20°S, 85°W under the stratus clouds west of northern Chile is being maintained to provide ongoing climate-quality records of surface meteorology, 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 past cruises that have come between October and January. This cruise was conducted on the NOAA vessel Ron Brown. During the 2014 cruise on the Ron Brown to the ORS Stratus site, the primary activities were the recovery of the previous (Stratus 12) WHOI surface mooring, which was adrift since January 25, 2014 and drifting northwest, deployment of the new Stratus 13 WHOI surface mooring, in-situ calibration of the buoy meteorological sensors by comparison with instrumentation installed on the ship, CTD casts near the moorings. Surface drifters and subsurface floats were also launched along the track.

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Valparaiso, Chile

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