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Stratus 16
Sixteenth Setting of the Stratus Ocean Reference Station Cruise On Board RV *Ronald H. Brown*

May 5 - 20, 2017
Rodman, Panama - Arica,Chile

by

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January 2021

Technical Report

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Upper Ocean Processes Group
Woods Hole Oceanographic Institution
Woods Hole, MA 02543
UOP Technical Report 2021-03

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Amy Bower, 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 May. This cruise was conducted on the NOAA research vessel *Ronald H. Brown*.

During the 2017 cruise on the *Ronald H. Brown* to the ORS Stratus site, the primary activities were the recovery of the previous (Stratus 15) WHOI surface mooring, deployment of the new Stratus 16 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 ARGO floats were also launched along the track.

Table of Contents

I. INTRODUCTION **8**

A. Timeline 8
B. Background and Purpose 10

II. CRUISE PREPARATIONS **12**

A. Staging and Loading 12
B. Buoy Spin 12
C. Sensor Evaluation and Burn-in 14

III. STRATUS 16 DEPLOYMENT **20**

A. Mooring Design 20
B. Mooring Deployment Deck Operations 23
C. Anchor Survey 32
D. Intercomparison Ship vs Stratus 15 and Stratus 16 33

IV. STRATUS 15 RECOVERY **50**

A. Deck operations 50
B. Instrument and Data Return 55

V. ANCILLARY PROJECTS **65**

A. CTDs 65
B. Drifters and Argo Floats 67

Appendix A. Stratus 16 Buoy Spin 69
Appendix B. Stratus 15 mooring log 70
Appendix C. Stratus 16 Mooring Log 78
Appendix D. Stratus 16 Instrumentation Setup 85

FIGURE I-1. STRATUS 16 CRUISE ITINERARY RODMAN, PANAMA – STRATUS 15 AND 16 – ARICA, CHILE. 10
FIGURE II-1. STRATUS 16 BUOY SPIN DONE IN CHARLESTON, NORTH CAROLINA ON APRIL 20 2017...13
FIGURE II-2. STRATUS 16 BURN-IN DATA FROM APRIL 23 2017 DOWNLOAD: WIND SPEED (M S^{-1})..14
FIGURE II-3. STRATUS 16 BURN-IN DATA FROM APRIL 23 2017 DOWNLOAD: WIND HEADING (DEGREES). 15
FIGURE II-4. STRATUS 16 BURN-IN DATA FROM APRIL 23 2017 DOWNLOAD: AIR TEMPERATURE (ATMP) IN DEGREES CELSIUS. 15
FIGURE II-5. STRATUS 16 BURN-IN DATA FROM APRIL 23 2017 DOWNLOAD: AIR RELATIVE HUMIDITY (HRH) IN %RH. 16
FIGURE II-6. STRATUS 16 BURN-IN DATA FROM APRIL 23 2017 DOWNLOAD: BAROMETRIC PRESSURE (BPR) IN MBARS. 16
FIGURE II-7. STRATUS 16 BURN-IN DATA FROM APRIL 23 2017 DOWNLOAD: SHORTWAVE RADIATION (SWR) IN W M^{-2}. 17
FIGURE II-8. STRATUS 16 BURN-IN DATA FROM APRIL 23 2017 DOWNLOAD: LONGWAVE RADIATION (LWR) IN W M^{-2}. 17
FIGURE II-9. STRATUS 16 BURN-IN DATA FROM APRIL 23 2017 DOWNLOAD: PRECIPITATION (PRC) IN MM..............................18
FIGURE II-10. STRATUS 16 BURN-IN DATA FROM APRIL 23 2017 DOWNLOAD: CONDUCTIVITY (COND) IN S M^{-1}. 18
FIGURE II-11. STRATUS 16 BURN-IN DATA FROM APRIL 23 2017 DOWNLOAD: SEA SURFACE TEMPERATURE (SST) IN °C. 19
FIGURE III-1. STRATUS 16 PRIOR TO DEPLOYMENT: BUOY AND METEOROLOGICAL TOWER. 21
FIGURE III-2. . STRATUS 16 MOORING DIAGRAM...22
FIGURE III-3. STRATUS 16 BUOY IN PREPARATION PRIOR TO DEPLOYMENT...23
FIGURE III-4. STRATUS 16 DEPLOYMENT TRACK, ALONG WITH BATHYMETRY CONTOURS (COLORS) AND FINAL STRATUS 16 ANCHOR POSITION (BLACK CROSS AND CIRCLE); TIME OF DAY LABELLED IN BLACK EVERY 2 HOURS. ANCHOR SURVEY SITES ARE SEEN ON SOUTHEAST PART OF TRACK IN THE BOTTOM RIGHT...24
FIGURE III-5. SHIP SPEED (KTS) DURING STRATUS 16 DEPLOYMENT ON MAY 13 2017. BLACK VERTICAL LINES INDICATE START AND END OF DEPLOYMENT OPERATION. 25
FIGURE III-6. STRATUS 16 DEPLOYMENT, IN CHRONOLOGICAL ORDER: VMCM AT BOTTOM OF FIRST 45 M OF MOORING LINE BELOW BUOY (TOP LEFT), BUOY READY FOR DEPLOYMENT (TOP RIGHT), BUOY DEPLOYED ON PORT SIDE (MIDDLE LEFT), INSTRUMENTS DEPLOYED THROUGH A-FRAME (MIDDLE RIGHT), TRANSITION TO NYLON SECTION IN BASKETS USING H-BIT (BOTTOM LEFT), TRANSITION COLMEGA TO GLASS BALLS (BOTTOM RIGHT). 30
FIGURE III-7. STRATUS 16 DEPLOYMENT; SETTING UP ANCHOR DROP: NYSTRON WITH MOORING TENSION CONNECTED TO STOPPER LINE (TOP LEFT), TEMPORARY LINE FROM WINCH TO CHAIN BELOW NYSTRON (TOP RIGHT), EASING TENSION FROM STOPPER LINE TO WINCH (MIDDLE LEFT AND RIGHT), EASING TENSION FROM WINCH TO ANCHOR (BOTTOM LEFT), GETTING RID OF TEMPORARY LINE AND READY FOR ANCHOR DROP (BOTTOM RIGHT). 31
FIGURE III-8. STRATUS 16 RESULTS OF ANCHOR TRIANGULATION USING *SURVEY.M* PROGRAM. 32
FIGURE III-9. SHIP TRACK (BLACK LINE) FROM MAY 12 TO MAY 17 2017. STRATUS 15 AND 16 ANCHORS (GREEN SQUARES). 33
FIGURE III-10. LEFT: SHIP'S TRACK (BLACK LINE) AND STRATUS 15 BUOY TRACK (BLUE LINE) ON MAY 14-15 2017. STRATUS 15 MOORING ANCHOR (GREEN SQUARE). RIGHT: SHIP'S TRACK (BLACK LINE) AND STRATUS 16 BUOY TRACK (BLUE LINE) ON MAY 16 2017. STRATUS 16 MOORING ANCHOR (GREEN SQUARE)...34
FIGURE III-11. LOCATIONS OF INTER-COMPARISON POINTS USED IN SCATTER PLOTS BELOW...34
FIGURE III-12. PSD AND SHIP SENSORS ON BOW MAST; PSD RADIATION SENSORS ON PORT SIDE OF 02 DECK. 35
FIGURE III-13. TIME-SERIES OF SEA SURFACE TEMPERATURE (SST) FROM: NOAA ESRL "SEA SNAKE" SENSOR (MEASURE UPPER 5 CM OF OCEAN), SHIP'S THERMOSALINOGRAPH (TSG) WITH WATER INTAKE AT 5 M DEPTH, AND STRATUS 15 AND 16 ASIMET SYSTEMS 1 AND 2 (MEASURING AT 0.8 M DEPTH). PERIOD COVERED IS FROM MAY 12 (DOY 132) TO MAY 17 (DOY 137) 2017. NOTE THAT 1) SHIP DEPARTED STRATUS AREA ON MAY 16 AT 20:30 UTC, AND 2) STRATUS 15 BUOY WAS RECOVERED ON MAY 15 AT 21:05 UTC. INTER-COMPARISON AT STRATUS 15 (16) WAS ON MAY 14 (16)..36
FIGURE III-14. SCATTER-PLOT OF SST VALUES FROM STRATUS 15 AND 16 BUOYS VERSUS PSD "SEA SNAKE" DURING INTER-COMPARISONS. 36
FIGURE III-15. TIME-SERIES OF SHORTWAVE INCOMING RADIATION FROM NOAA ESRL (PSD), SHIP (SCS) AND STRATUS 15 AND 16 ASIMET SYSTEMS 1 AND 2, FROM MAY 12 TO 17 2017..37
FIGURE III-16. SCATTER PLOT OF SHORTWAVE INCOMING RADIATION FROM NOAA ESRL (PSD), VERSUS SHIP (SCS) AND STRATUS 15 AND 16 ASIMET SYSTEMS 1 AND 2, DURING INTER-COMPARISONS. 37
FIGURE III-17. TIME-SERIES OF WIND SPEED ADJUSTED TO 3 M FROM NOAA ESRL (PSD), SHIP (SCS) AND STRATUS 15 AND 16 ASIMET SYSTEMS 1 AND 2, FROM MAY 12 TO 17 2017. 38
FIGURE III-18. SCATTER PLOT OF WIND SPEED ADJUSTED TO 3 M FROM NOAA ESRL (PSD), VERSUS SHIP (SCS) AND STRATUS 15 AND 16 ASIMET SYSTEMS 1 AND 2, DURING INTER-COMPARISONS. 38
FIGURE III-19. TIME-SERIES OF AIR TEMPERATURE FROM NOAA ESRL (PSD), SHIP (SCS) AND STRATUS 15 AND 16 ASIMET SYSTEMS 1 AND 2, FROM MAY 12 TO 17 2017. 39

Figure III-20. Scatter plot of air temperature adjusted to 3 m from NOAA ESRL (PSD), versus ship (SCS) and Stratus 15 and 16 ASIMET systems 1 and 2, during inter-comparisons. 39
Figure III-21. Time-series of air specific humidity from NOAA ESRL (PSD), ship (SCS) and Stratus 15 and 16 ASIMET systems 1 and 2, from May 12 to 17 2017. 40
Figure III-22. Scatter plot of air specific humidity adjusted to 3 m from NOAA ESRL (PSD), versus ship (SCS) and Stratus 15 and 16 ASIMET systems 1 and 2, during inter-comparisons. 40
Figure III-23. Time-series of air relative humidity from NOAA ESRL (PSD), ship (SCS) and Stratus 15 and 16 ASIMET systems 1 and 2, from May 12 to 17 2017. 41
Figure III-24. Scatter plot of air relative humidity adjusted to 3 m from NOAA ESRL (PSD), versus ship (SCS) and Stratus 15 and 16 ASIMET systems 1 and 2, during inter-comparisons....41
Figure III-25. Time-series of wind direction from NOAA ESRL (PSD), ship (SCS) and Stratus 15 and 16 ASIMET systems 1 and 2, from May 12 to 17 2017. 42
Figure III-26. Scatter plot of wind direction from NOAA ESRL (PSD), versus ship (SCS) and Stratus 15 and 16 ASIMET systems 1 and 2, during inter-comparisons. 42
Figure III-27. Time-series of longwave incoming radiation from NOAA ESRL (PSD), ship (SCS) and Stratus 15 and 16 ASIMET systems 1 and 2, from May 12 to 17 2017....43
Figure III-28. Scatter plot of longwave incoming radiation from NOAA ESRL (PSD), versus ship (SCS) and Stratus 15 and 16 ASIMET systems 1 and 2, during inter-comparisons. 43
Figure III-29. Time-series of barometric pressure from NOAA ESRL (PSD), ship (SCS) and Stratus 15 and 16 ASIMET systems 1 and 2, from May 12 to 17 2017. 44
Figure III-30. Scatter plot of barometric pressure adjusted to 3 m from NOAA ESRL (PSD), versus ship (SCS) and Stratus 15 and 16 ASIMET systems 1 and 2, during inter-comparisons....44
Figure III-31. Time-series of incoming longwave radiation difference between PSD and SCS measurements (red) and raw shortwave radiation from PSD (blue)....46
Figure III-32. Temperature and salinity profiles from CTD casts 3 (left) and 4 (right) made on May 14 2017 near Stratus 15 mooring, prior to its recovery. Colored symbols denote concomitant data from SBE37 instruments mounted on Stratus 15. 48
Figure III-33. Difference of salinity CTD minus mooring SBE37s for cast 3 and 4 on May 14 2017....48
Figure III-34. Difference of temperature CTD minus mooring for cast 3 (left) and 4 (right) on May 14 2017, using mooring data from SBE37s (top) and SBE39s (bottom)....49
Figure IV-1. Recovery of glass balls from Stratus 15 mooring....52
Figure IV-2. Recovery of Colmega rope using capstan. 52
Figure IV-3. Recovery of caged Aanderaa Seaguard below the Stratus 15 buoy, prior to letting the buoy adrift. 53
Figure IV-4. Recovery of Stratus 15 buoy on port side of the ship using ship's crane. 53
Figure IV-5. Recovery of Stratus 15 buoy on port side using ship's crane....54
Figure IV-6. 1-minute data recovered from logger 4 (system 1) on Stratus 15: air temperature, air humidity, barometric pressure, incoming longwave radiation, incoming shortwave radiation 55
Figure IV-7. 1-minute data recovered from logger 14 (system 2) on Stratus 15: air temperature, air humidity, barometric pressure, incoming longwave radiation, incoming shortwave radiation 56
Figure IV-8. 1-minute data recovered from logger 4 (system 1) on Stratus 15: wind east, wind north, sea surface temperature, sea surface salinity, precipitation. 57
Figure IV-9. 1-minute data recovered from logger 14 (system 2) on Stratus 15: wind east, wind north, sea surface temperature, sea surface salinity, precipitation. 58
Figure IV-10. Salinity data (with offset for readability) from SBE37s recovered from Stratus 15. Legend indicates serial number and nominal depth of each instrument. 59
Figure IV-11. Temperature data (with offset for readability) from SBE37s recovered from Stratus 15. Legend indicates serial number and nominal depth of each instrument. 60
Figure IV-12. Temperature data (with offset for readability) from SBE39s recovered from Stratus 15. Legend indicates serial number and nominal depth of each instrument. 61
Figure IV-13. Current data (with offset for readability) from Aanderaa Seaguards current meters recovered from Stratus 15. Legend indicates serial number and nominal depth of each instrument....62
Figure IV-14. Current data from RDI Workhorse ADCP recovered from Stratus 15. 63
Figure IV-15. Data from Vaisala WXT recovered from Stratus 15. 64

Figure IV-16. Offsets (median from all deployment) between longwave sensor on system 1 and 2 recovered from Stratus 15 as a function of concomitant shortwave radiation also measured on Stratus 15. 64
Figure V-1. Profiles from CTD casts conducted during Stratus 16 cruise in May 2017. 66
Figure V-2. Locations of drifters and Argo floats deployments during. Stratus 16 cruise in May 2017. 67

Table III-1. Stratus 16 anchor survey. Coordinates of surveys points and acoustic ranges. 32
Table III-2. Statistics of comparison between PSD, ship and Stratus 15 and 16 measurements during period May12-17 and during inter-comparisons. 45
Table V-1. List of CTD casts operated during Stratus 16 cruise. 65
Table V-2. Locations of drifters deployments during Stratus 16 cruise. 68
Table V-3. Locations of Argo floats deployments during Stratus 16 cruise. 68

I. Introduction

A. Timeline

Stratus 16 deployment cruise was conducted on the NOAA research vessel *Ronald H. Brown*, sailing from Rodman, Panama to the Stratus site and ended in Arica, Chile. The ship left Rodman, Panama on the morning of May 5, 2017 and docked in Arica, Chile on the morning of May 20, 2017. The track (Figure 1-1) was set to first deploy the Stratus 16 mooring then recover the Stratus 15 mooring, and complete work at the Stratus site before sailing to Arica, Chile. WHOI Upper Ocean Processes Group staff left Boston for Panama, on May 3. Twenty-four surface drifters were deployed for NOAA AOML and 8 Argo floats were deployed for NOAA PMEL. An overview of the chronology of the cruise is provided below. Local time during this cruise was 4 hours off UTC (UTC -4), except for the first few days (UTC -5 until early morning on May 9). Ship entered international waters on May 9 around 16:30 UTC.

April 17 – 26: Staging in Charleston, North Carolina: unload containers, assemble buoy, buoy spin, ship loading, install cables for GPS and Argos telemetry antennae, load and store equipment for next leg (TAO moorings), lash equipment on deck and in labs.

April 26, Wednesday: Ship *Ronald H. Brown* departs Charleston, North Carolina, around 15:00 EST. WHOI group flies back home. Ray Graham (WHOI) and Sergio Pezoa stay onboard the ship for the transit to Rodman, Panama.

May 3, Wednesday: WHOI group flies to Panama.

May 4, Thursday: WHOI group boards ship in Rodman.

May 5, Friday: Ship departs Rodman around 10:00 am, Panama time.

May 6 - 8: Transit towards Stratus site at 11 knots, within national waters.

May 9, Tuesday: Change local time from UTC -5 to UTC -4 in early morning. Exit EEZ and enter international waters around 16:30 UTC. Conduct CTD test cast to 500 m, followed by acoustic releases (3) test to 1,500 m. Shipboard data acquisition (met, TSG, ADCP) starts. Drifter deployment. Boat conducts surprise drill (man overboard) prior to stop at CTD station.

May 10, Wednesday: Argo and drifter deployments continue during transit to Stratus.

May 11, Thursday: Argo and drifter deployments continue during transit to Stratus.

May 12, Friday: Arrive at Stratus 15 in early morning. Release anchor, retrieve acoustic releases and titanium bracket to reuse on Stratus 16. Redeploy glass balls and let Stratus 15 drift freely and monitor drift direction. Then move to Stratus 16 site for practice runs gauging wind, currents and swell effects on ship.

May 13, Saturday: Deploy Stratus 16, followed by anchor survey. Drive by for pictures and waterline, and then move towards Stratus 15.

May 14, Sunday: Arrive at Stratus 15 around 02:00 UTC, stay about 1 nm away to avoid any risk of collision with glass balls. CTD to 4,000 m at 12:00 UTC, about 2 nm from mooring.

May 15, Monday: Recovery Stratus 15. Anchor released at 11:16 UTC, last instrument recovered at 21:45 UTC. Departs to Stratus 16 area around 23:00 UTC.

May 16, Tuesday: Intercomparison at Stratus 16; ends around 20:30 UTC. Drive by Stratus 16 buoy for pictures at 21:00 UTC, then heads NW towards first bathymetry survey point. Multibeam survey starts at 23:00 UTC on northern edge of current bathymetry map, going east at 10 kts. Instrument cleanup and data download.

May 17, Wednesday: Survey ends around 01:00 UTC, heads east towards Arica. Data download continues. Drifters and Argo floats deployments.

May 18, Thusday: Sailing east towards Arica. Data download continues. Drifters and Argo floats deployments.

May 20, Saturday: Ship arrives in Arica around 13:00 UTC

May 22, Monday: Unloading of scientific equipment from ship. Loading of scientific equipment into container until 1700 UTC

May 23-24: Travel home.

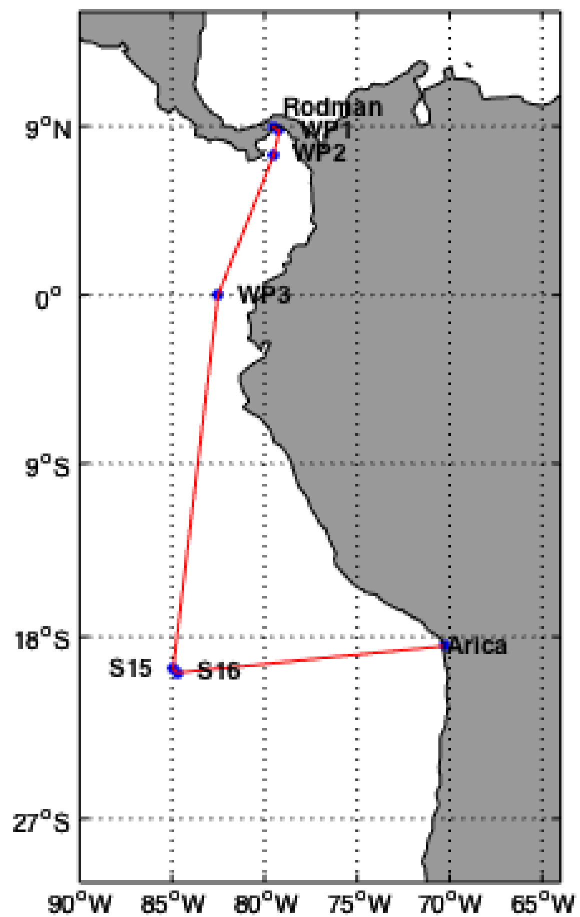


Figure I-1. Stratus 16 cruise itinerary Rodman, Panama – Stratus 15 and 16 – Arica, Chile.

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 15 mooring was deployed in June 2016. Its replacement, Stratus 16 mooring, was installed on May 13 2017 during the Stratus 16 cruise, which is detailed in this report.

During the 2017 Stratus cruise on the NOAA research ship *Ronald H. Brown*, the primary activities were recovery of the WHOI Stratus 15 surface mooring, deployment of the new WHOI Stratus 16 surface mooring at a nearby site. At the Stratus mooring, in-situ calibration of the buoy meteorological sensors was done through comparison with ESRL (Environmental Systems Research Laboratory) meteorological sensors mounted on the ship, as well as the ship's onboard sensors. CTD casts were also done near the new mooring for comparison with newly deployed instruments. Surface drifters and subsurface ARGO were launched during the cruise. A missing part (assembly of acoustic releases) on the Stratus 16 prior to its deployment required us to release Stratus 15 from its anchor, retrieve a similar part to redeploy on Stratus 16. Stratus 15 was therefore left to drift for three days prior to its full recovery.

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 PCO2 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.

No clearance was obtained to sample in Chilean or other national waters. Plans for drifter and Argo float deployments in Chilean waters were made so that all deployments would be in international waters.

II. Cruise Preparations

A. Staging and Loading

On April 14 2017, two 5302 box trucks and two 20-foot containers, loaded with the buoy, mooring components and cruise support gear, were shipped from Woods Hole, Massachusetts to Charleston, South Carolina, in preparation for the Stratus 16 cruise. Arrangements were made with the Federal Law Enforcement Training Center (FLETC) and NOAA port office to work at pier Papa the week of April 17- 26th to build the Stratus 16 buoy and prepare for the cruise. This support included a staging area, forklift support, and port access. Shore side crane and heavy lift forklift were provided by All Crane LLC. Four WHOI personnel traveled to Charleston on April 17; two more WHOI personnel traveled to Charleston for added support on April 21st.

On April 18, WHOI personnel were at the NOAA port facility to begin mobilizing for the cruise. All three trucks, two 5302's and one flat bed containing two WHOI owned 20' containers, were delivered and offloaded on April 18th using NOAA's forklift and All Crane's 75-ton crane and heavy lift forklift. All equipment was staged on Pier Papa near the Brown.

During the week the buoy was built up, anchors were assembled, and a buoy spin was completed. The morning of April 21 the crew of the Brown along with WHOI's personal, started loading the ship with mooring components and lab gear. ESRL flux tower gear was also loaded.
On April 24 two flatbed trucks containing TAO anchors and TAO Hazmat were delivered to Pier Papa. Two NOAA Affiliates used NOAA's forklift and assisted with the ship's deck crew to move the TAO gear on board.

B. Buoy Spin

Buoy spin was conducted in port in Charleston on April 20 2017 (see Figure II-1 and Appendix 1 for details of the buoy spin). Note that a prior buoy spin was conducted in Woods Hole on April 3 2017 that included a third ASIMET wind sensor, to be used as a spare. After that initial buoy spin, the spare wind was indeed swapped with one of the primary wind sensors.

For the buoy spin, the buoy is oriented in different directions, usually eight of them roughly equally spaced along a 360 degrees circle. At each position, the vanes of the wind sensors are oriented towards a known direction, usually identified with a faraway object such as an electric pole or a tall tree. The wind sensors then samples for about 15 minutes. Once the data is downloaded and analyzed, the wind direction from all sensors should be about the same. Discrepancies typically arise that are up to 5 degrees and are caused by inaccuracy of the reference direction, compass error, including the local magnetic distortion (due to the latter, it is best not to conduct a buoy spin on an area with large amounts of metal, such a pier with reinforced concrete). The other benefit from the buoy spin is that it documents the orientation of the compasses relative to the buoy itself.

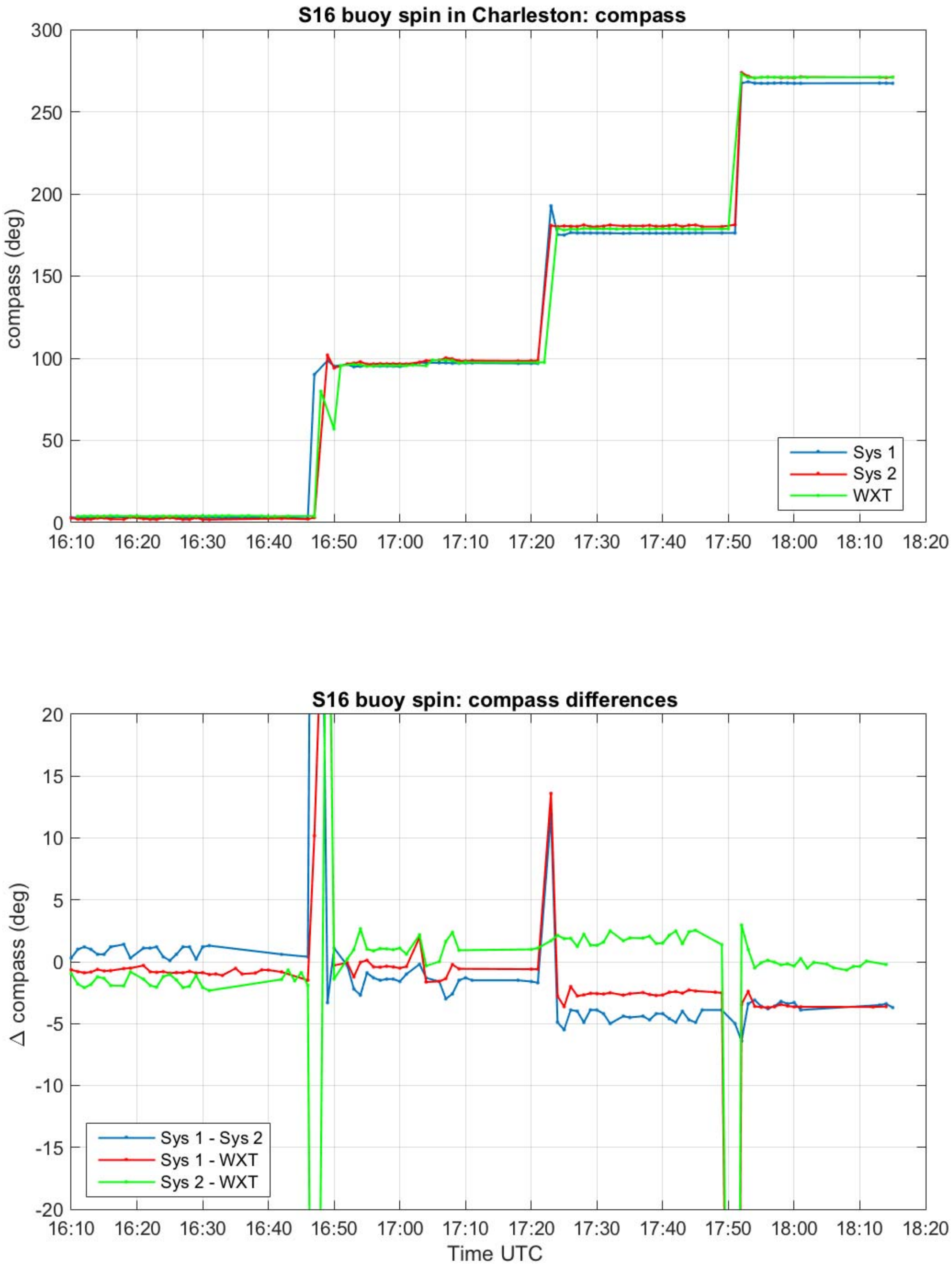


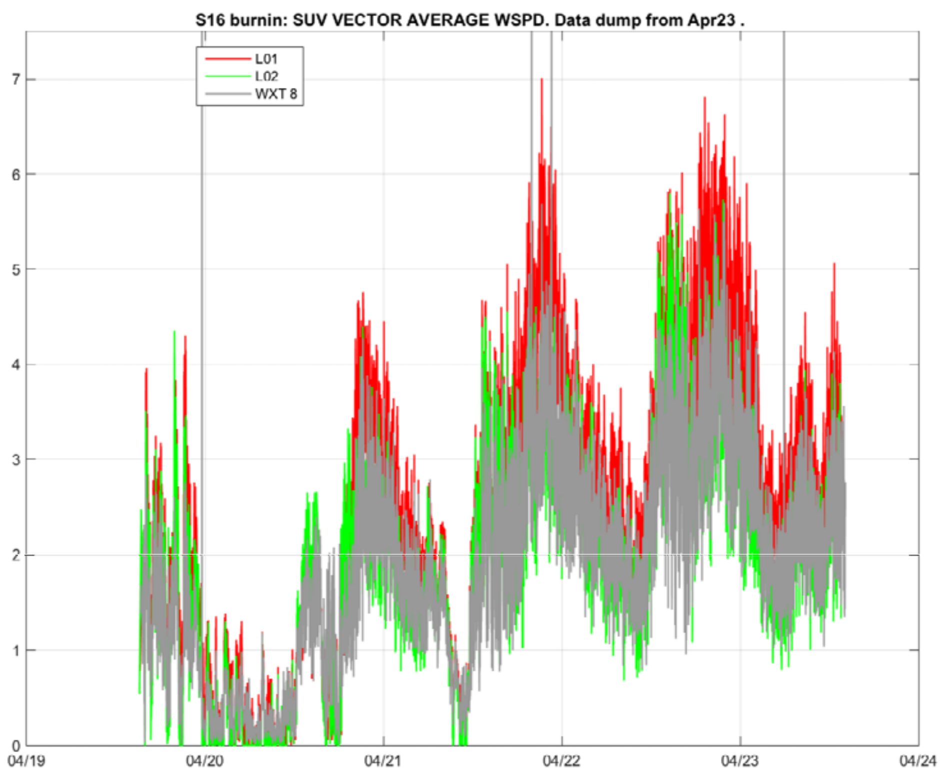
Figure II-1. Stratus 16 buoy spin done in Charleston, North Carolina on April 20 2017

C. Sensor Evaluation and Burn-in

For burn-in, the buoy was mounted with ASIMET (two primaries and one stand-alone systems) and other instrumentation in the same configuration as the one planned for deployment, and placed outside at WHOI in a clear area. Systems were running, collecting data and telemetry transmitted hourly data. Spare instruments were also mounted on a similar buoy next to Stratus 16. Some burn-in occurred in the late Fall 2016 and then resumed in the early Spring 2017, after a two months interruption in winter due to low temperatures. On several occasions during this period the data was downloaded and processed to ensure all instrument was functioning properly and that their measurements were accurate.

The last data download on land, with reasonable exposure, occurred in port in Charleston on April 23. The data download included two ASIMET loggers, two stand-alone sensors (HRH and SWR), SBE39AT, and Vaisala WXT. Figures below present data from April 23rd data download.

Figure II-2. Stratus 16 burn-in data from April 23 2017 download: wind speed (m s^{-1}).



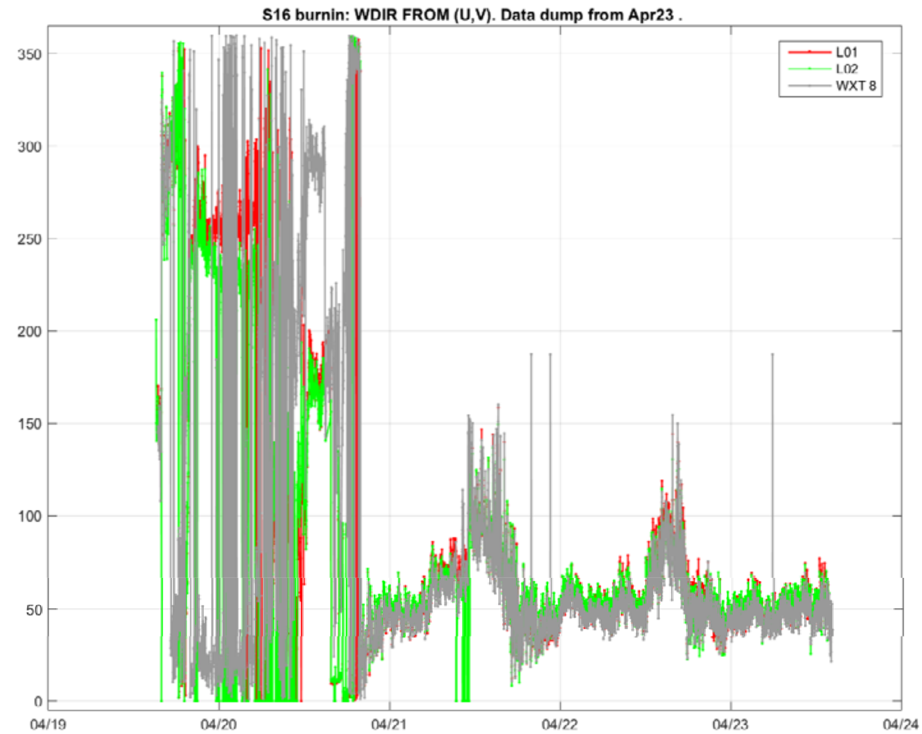


Figure II-3. Stratus 16 burn-in data from April 23 2017 download: wind heading (degrees).

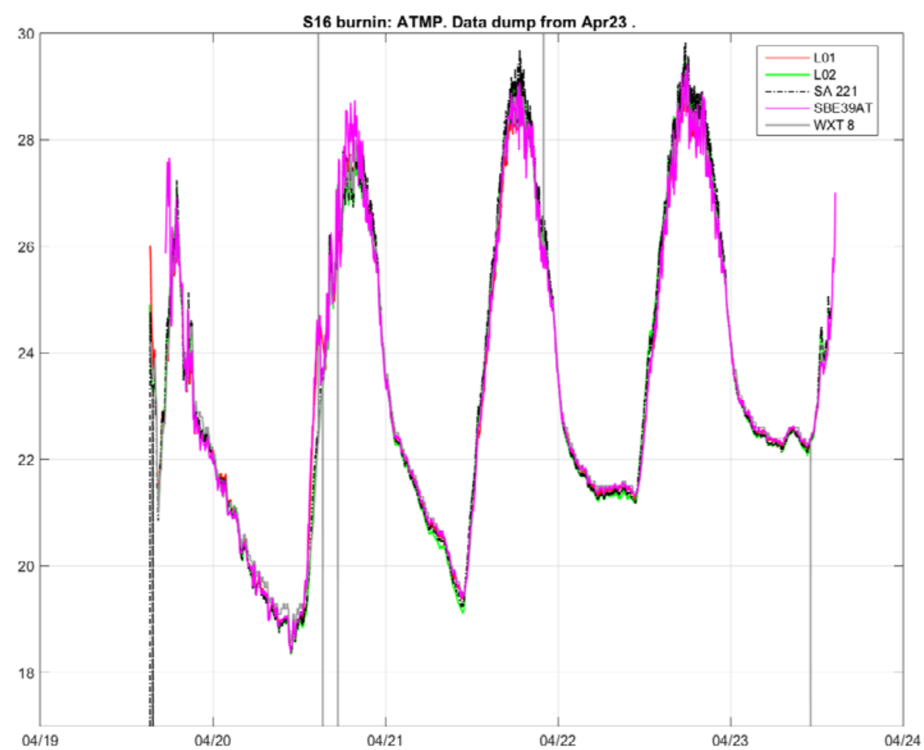


Figure II-4. Stratus 16 burn-in data from April 23 2017 download: air temperature (ATMP) in degrees Celsius.

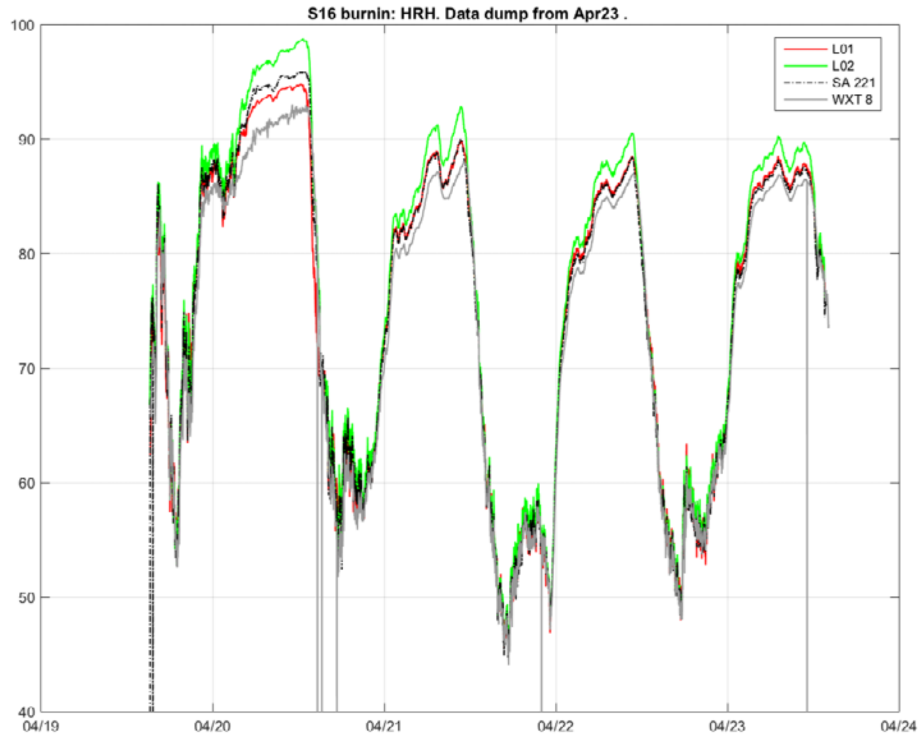


Figure II-5. Stratus 16 burn-in data from April 23 2017 download: air relative humidity (HRH) in %RH.

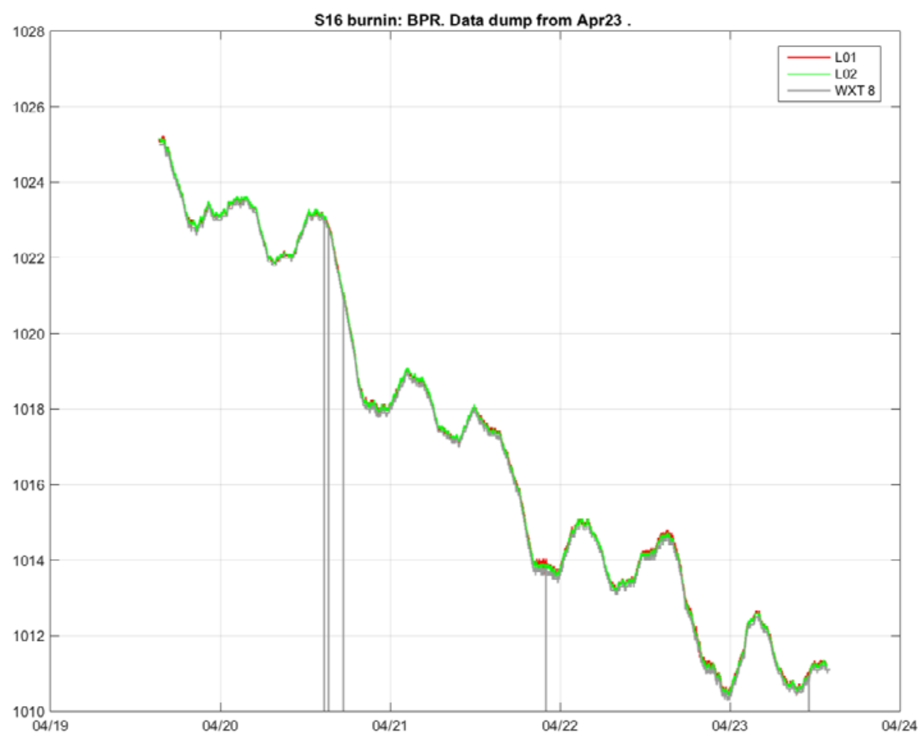


Figure II-6. Stratus 16 burn-in data from April 23 2017 download: barometric pressure (BPR) in mbars.

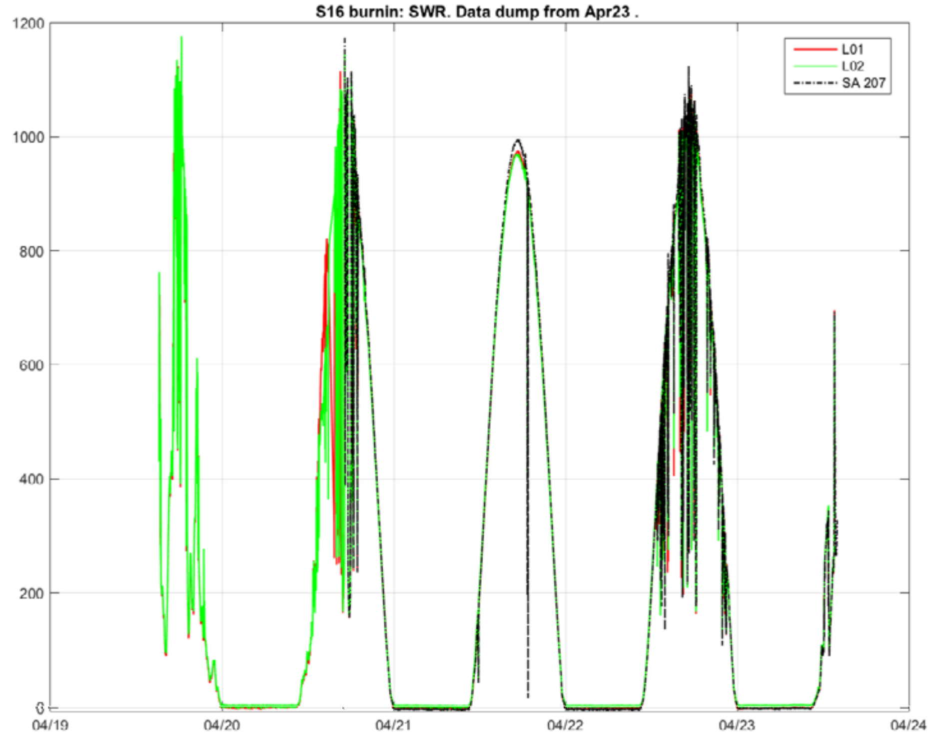
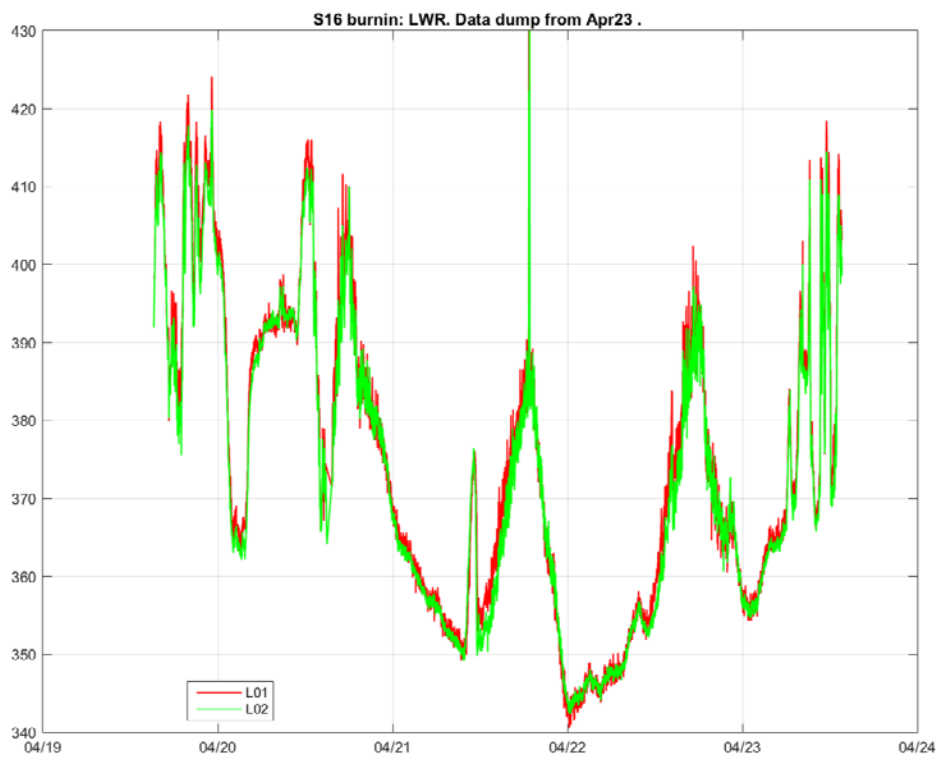


Figure II-7. Stratus 16 burn-in data from April 23 2017 download: shortwave radiation (SWR) in W m^{-2}.

Figure II-8. Stratus 16 burn-in data from April 23 2017 download: longwave radiation (LWR) in W m^{-2}.



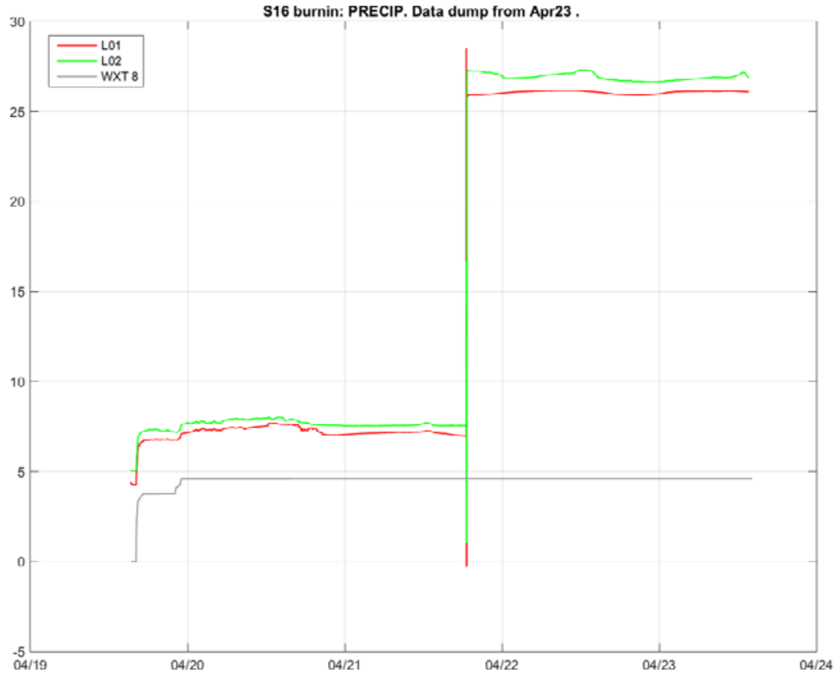


Figure II-9. Stratus 16 burn-in data from April 23 2017 download: precipitation (PRC) in mm.

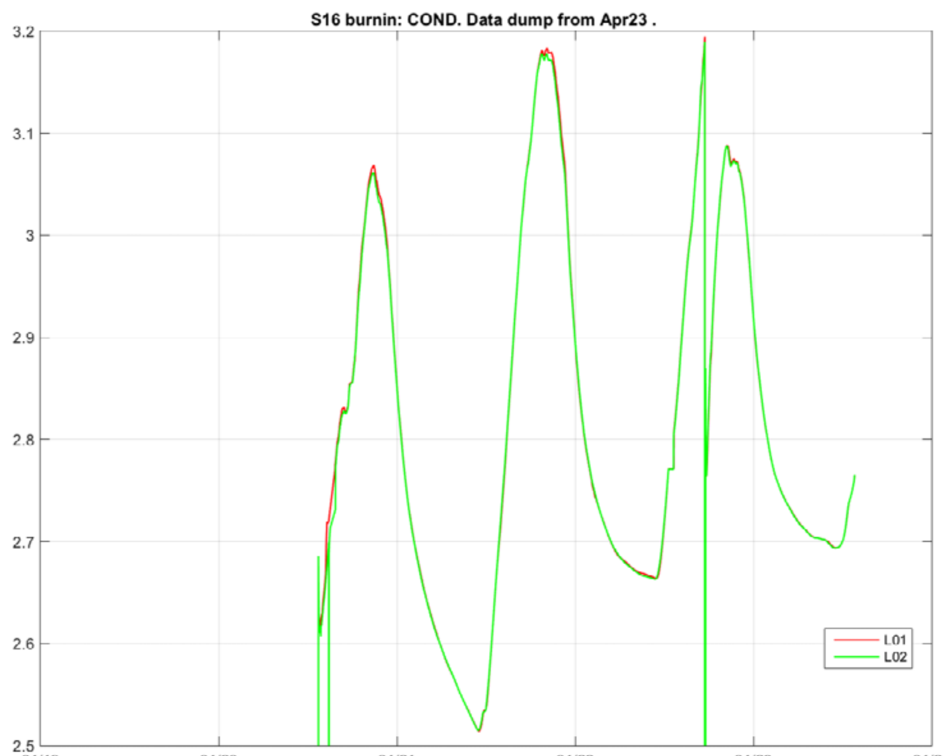


Figure II-10. Stratus 16 burn-in data from April 23 2017 download: conductivity (COND) in S m^{-1}.

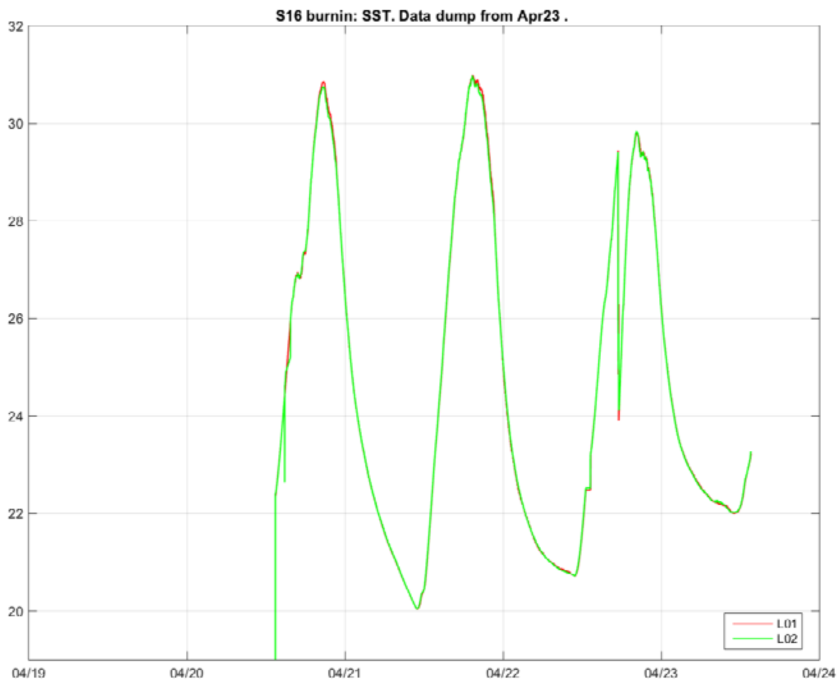


Figure II-11. Stratus 16 burn-in data from April 23 2017 download: sea surface temperature (SST) in °C.

III. Stratus 16 Deployment

A. Mooring Design

The buoys used in the Stratus project are equipped with surface meteorological instrumentation, including two Improved Meteorological (IMET) systems (see Figure III-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 16 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 III-2 for the full mooring drawing.

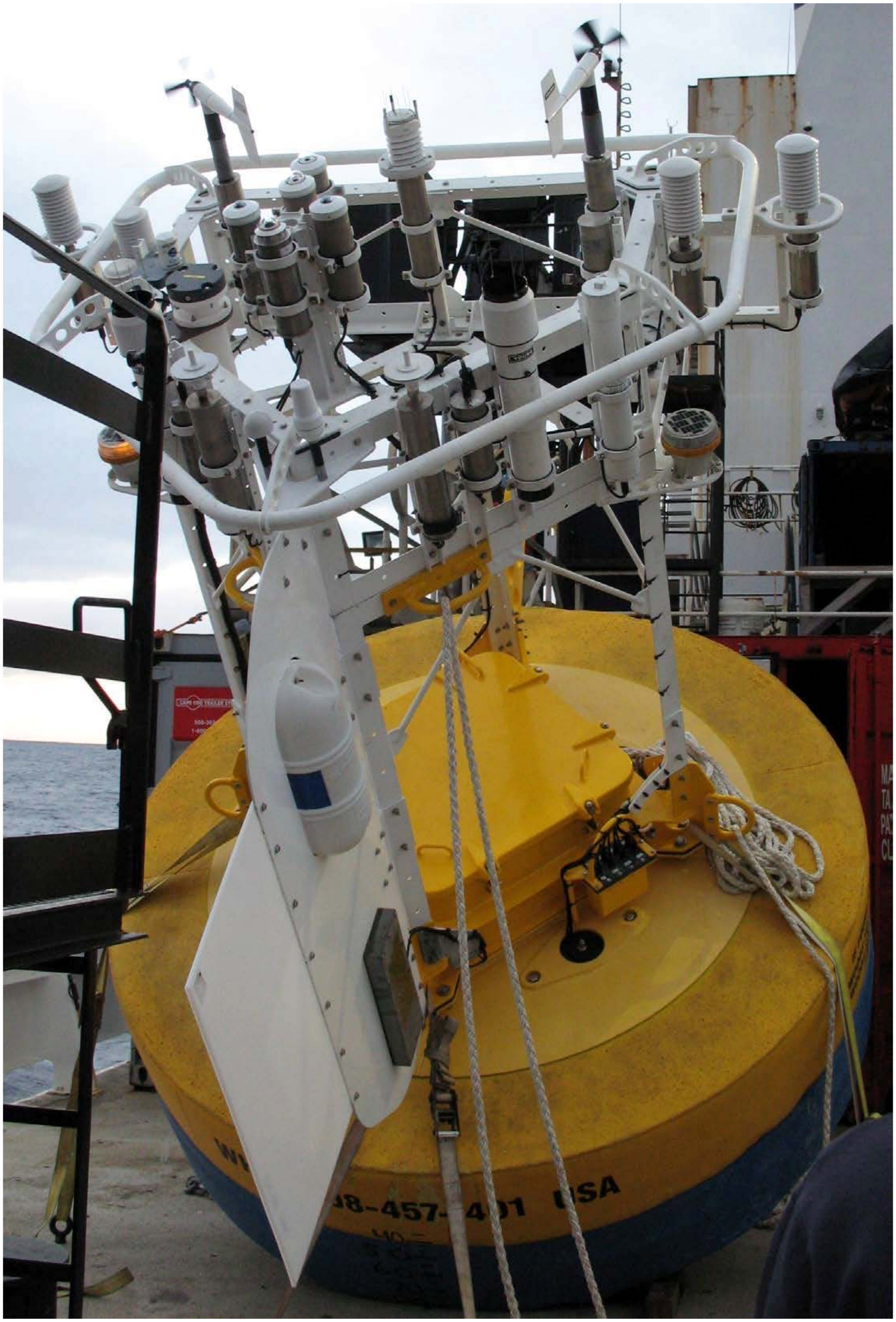


Figure III-1. Stratus 16 prior to deployment: buoy and meteorological tower.

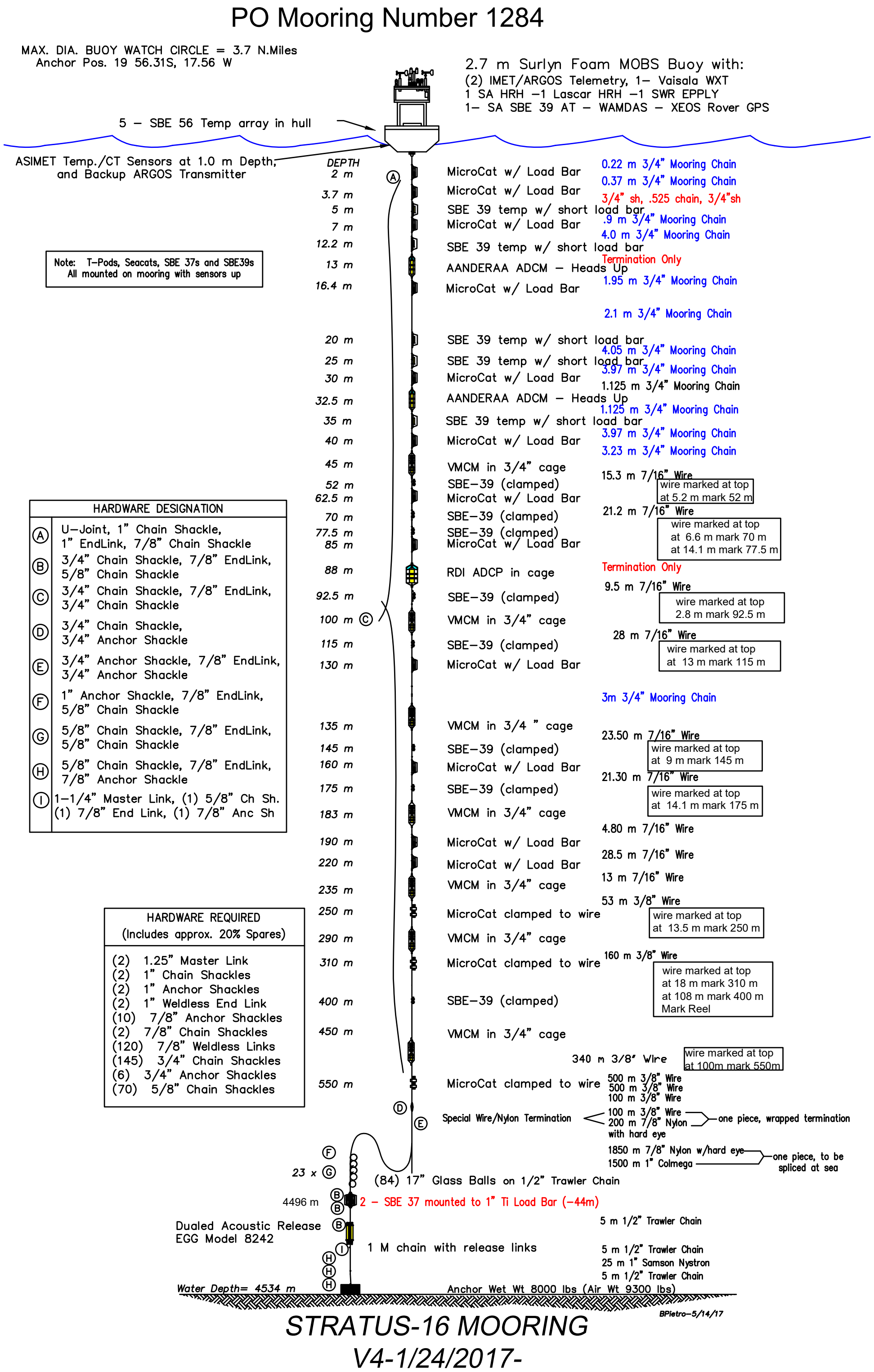


Figure III-2. . Stratus 16 mooring diagram.

B. Mooring Deployment Deck Operations

Figure III-3. Stratus 16 buoy in preparation prior to deployment.

The deployment started on May 13 2017 at 12:30 UTC with the upper 45 m of chain and instruments, followed by the buoy launch at 13:46 UTC. The last instrument at 550 m depth was deployed at 15:46 UTC, the 84 glass balls at 18:10 UTC and the anchor at 19:40 UTC. From the first instrument deployed to the anchor drop, the Stratus 16 deployment track was 6.2 nm with heading 147° T. The deployment track is shown in Figure III-4.

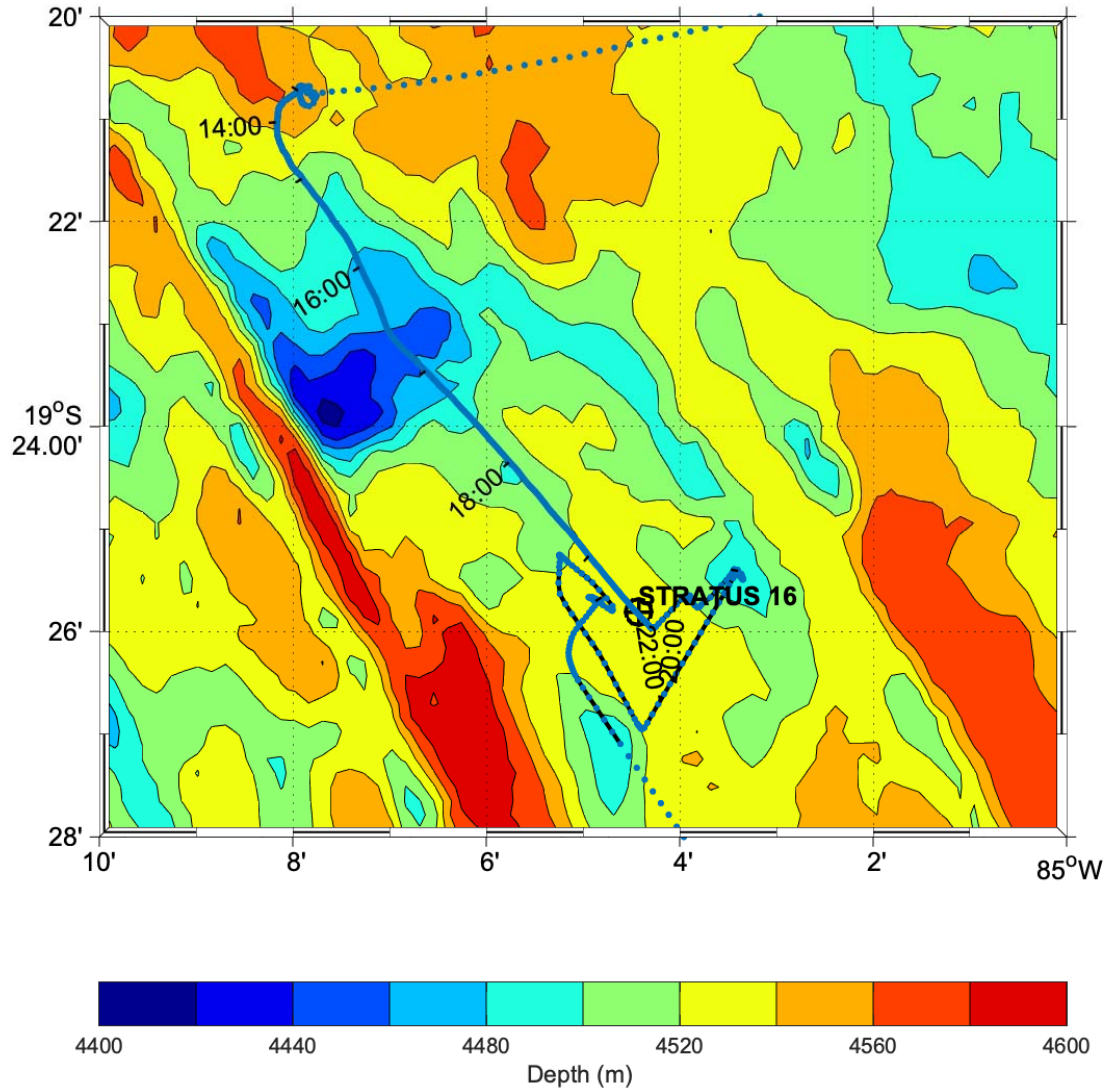


Figure III-4. Stratus 16 deployment track, along with bathymetry contours (colors) and final Stratus 16 anchor position (black cross and circle); time of day labelled in black every 2 hours. Anchor survey sites are seen on southeast part of track in the bottom right.

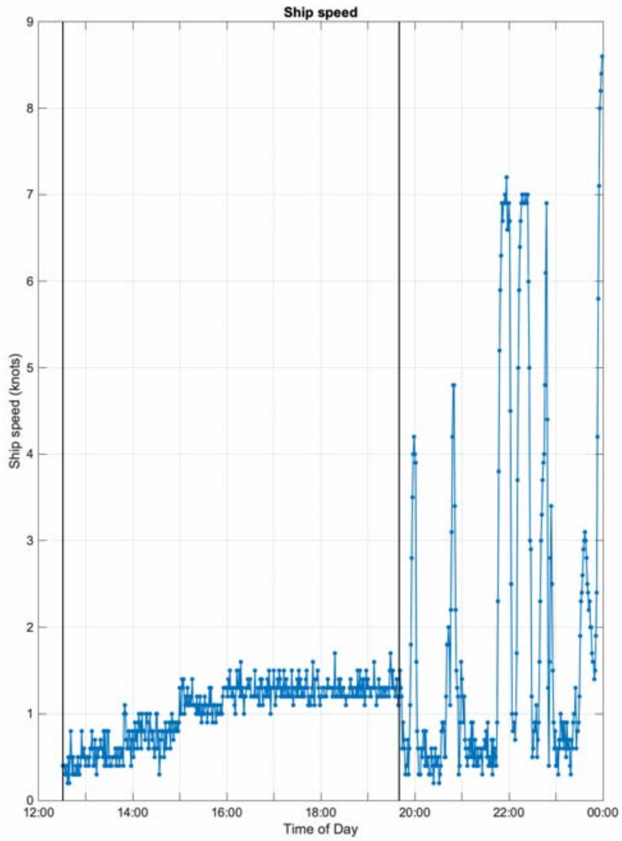


Figure III-5. Ship speed (kts) during Stratus 16 deployment on May 13 2017. Black vertical lines indicate start and end of deployment operation.

The Stratus 16 surface mooring was set using a two-phase mooring technique. Phase 1 involved the lowering of approximately 45 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:
100 m 7/8" nylon- (Nylon to Wire Shot)
100 m 7/8" over braid nylon (Nylon to Wire Shot)
100 m 3/8" wire (Nylon to Wire Shot)
100m 3/8" wire
500 m 3/8" wire
500 m 3/8" wire
340 m 3/8" wire
160 m 3/8" wire
53 m 3/8" wire
28.5 m 7/16" wire
21.3 m 7/16" wire
23.50 m 7/16" wire
28 m 7/16" wire

21.2 m 7/16” wire
100 m 3/4" 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. Five 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 shackled to the top of the instrument load bar or cage. A shackle and ring were attached to the top of each shot of chain.

The first instrument segment to be lowered was a VMCM at 45m. This instrument had a 3.23-meter shot of chain shackled to the top of the instrument cage, and the100m spectra winch leader shackled to the bottom of the instrument cage. The crane hook, suspended over the instrument lowering, area was lowered to approximately 1 meter off the deck. The hook from the crane was secured into the ring to the top of the 3.23-meter shot of chain shackled to the top of the VMCM. The crane was raised so the chain and instruments were lifted off the deck. The crane slowly lowered the 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. A 6-foot sling with a chain hook shackled on it was used as the stopper line. The sling was basketed around an eyebolt on the deck apx six feet from the edge of the ship. The stopper line was attached to the top portion of the chain just below the link and the load was transferred from the crane to the stopper. The hook on the crane was removed. Lowering continued with 10 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 5 meter SBE 39. 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. A 50 ft. slip line was used to stabilize the bottom of the buoy at the start of the lift. Another 50 ft. slip line was rigged on the tower 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 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 stopper line holding the suspended 45 meters of instrumentation was eased off to allow the buoy to take the load. The buoy was raised up and swung outboard as the slip lines kept the hull in check. The lower slip line was removed first, followed by the tower slip line. Once the buoy had settled into the water (approximately 20 ft. from the side of the ship), and the release hook had gone slack, the quick release was tripped. The crane swung forward to keep the block away from the buoy. The slip line to the buoy deck bail was cleared at about the same time. The ship then maneuvered slowly ahead to allow the buoy to come around to the stern.

The winch operator slowly hauled in the slack line 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 VMCM shackled to the working line was pulled up and stopped off using two stopper lines. After the winch transferred the load to the stopper lines the spectra winch leader was detached from the VMCM and off spooled from the winch and the 15.3 meter shot of 7/16 wire rope was attached.

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 550 meters. Smaller instruments were clamped to the wire rope as the wire was payed off the winch.

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 84 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 84 glass balls are bolted on 1/2" trawler chain in 4 ball (4 meter) increments. The first two sets of glass balls were dragged into position and shackled together. One end was attached to the mooring at the transom. The other end was shackled to the winch leader. The winch pulled the mooring line tight, stopper lines were removed, and the winch payed out until seven of the eight balls were off the stern. A stopper line was 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 84 balls were deployed.

A 1" titanium load bar with two SBE 37 MicroCat's was shackled to the last glass ball segment. After that, a five-meter shot of 1⁄2" 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 37's 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 25-meter Nystron anchor pendant was shackled to that chain, and another 5-meter section of 1⁄2" 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 lying 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 were attached one meter above 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.

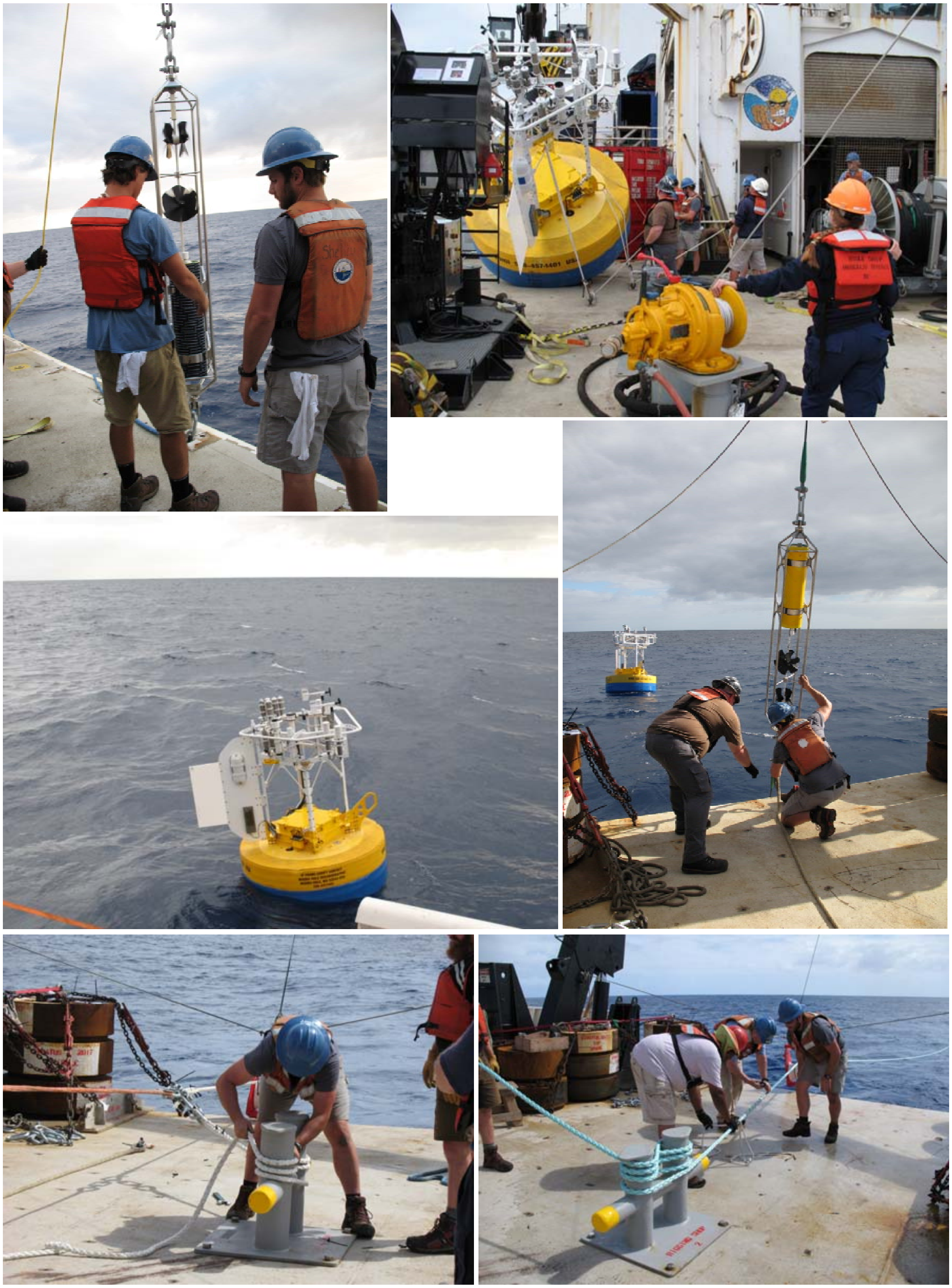


Figure III-6. Stratus 16 deployment, in chronological order: VMCM at bottom of first 45 m of mooring line below buoy (top left), buoy ready for deployment (top right), buoy deployed on port side (middle left), instruments deployed through A-frame (middle right), transition to nylon section in baskets using H-bit (bottom left), transition Colmega to glass balls (bottom right).

Figure III-7. Stratus 16 deployment; setting up anchor drop: Nystron with mooring tension connected to stopper line (top left), temporary line from winch to chain below Nystron (top right), easing tension from stopper line to winch (middle left and right), easing tension from winch to anchor (bottom left), getting rid of temporary line and ready for anchor drop (bottom right).

C. Anchor Survey

Stratus 16 anchor was dropped from R/V *Ronald H. Brown* at 1940 UTC on May 13 2017 at 19° 25.894' S, 85° 04.361' W (-19.4316, -85.0727), in 4523 m of water. The anchor survey was done by triangulation from 3 survey points using acoustic ranging on releases 32 m above the anchor. The deck box that collected acoustic ranges used a speed of sound of 1500 m/s; the historical local speed of sound we used to compute the solution was 1509 m/s. The survey information is provided in Table III-1. The solution for Stratus 16 anchor triangulation was computed with Arthur Newhall's Matlab code Acoustic Survey *survey.m* (see Figure III-8). The surveyed anchor was therefore 19 25.8101' S, 085 04.4254' W and the water depth at the anchor site was measured with the onboard. Multibeam using the historical speed of sound was 4534 m. The fallback between anchor drop and anchor location on the seafloor was 189 m.

Table III-1. Stratus 16 anchor survey. Coordinates of surveys points and acoustic ranges.

Ranging (m)	Lat (dd mm ss) S	Lon (dd mm ss) W	Lat (dd.dddd)	Lon (dd.dddd)
Point 1:				
5520	19° 25' 24.3621" S	85° 03' 23.9013" W	-19.4234	-85.0566
4875	19° 25' 23.9478" S	85° 03' 24.1391" W	-19.4233	-85.0567
4876	19° 25' 23.8427" S	85° 03' 24.2588" W	-19.4233	-85.0503
Point 2:				
4935	19° 26' 56.6628" S	85° 04' 24.3711" W	-19.4491	-85.0734
4935	19° 26' 56.4463" S	85° 04' 24.5365" W	-19.4490	-85.0738
4916	19° 26' 55.9829" S	85° 04' 25.7250" W	-19.4489	-85.0738
Point 3:				
4782	19° 25' 17.1604" S	85° 05' 13.3566" W	-19.4214	-85.0870
4782	19° 25' 17.1068" S	85° 05' 13.4010" W	-19.4214	-85.0871
4783	19° 25' 17.0511" S	85° 05' 13.4478" W	-19.4214	-85.0871

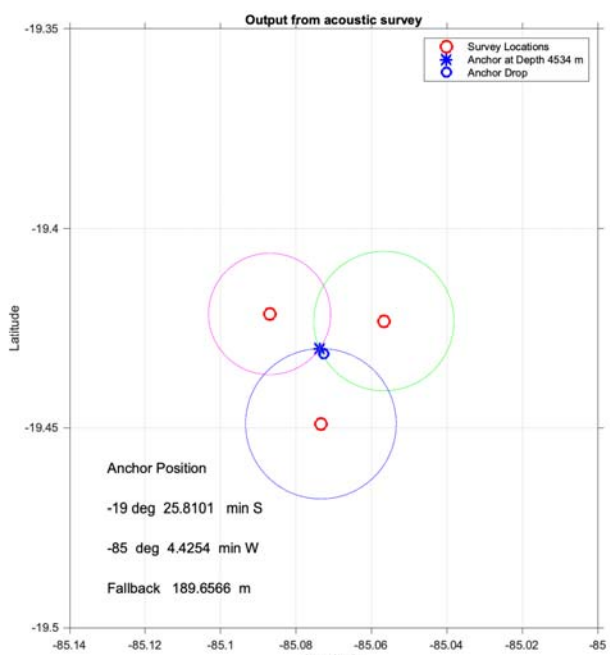


Figure III-8. Stratus 16 results of anchor triangulation using *survey.m* program.

D. Intercomparison Ship vs Stratus 15 and Stratus 16

Figure III-9 show positions of R/V *Ronald H. Brown* when it was near the buoys. The ship arrived from the north at Stratus 15 on May 12 when the mooring was released from its anchor and the buoy was left adrift. Stratus 16 mooring was deployed on May 13. The ship was within 1 nm of Stratus 15 on May 14 (2 nm away during CTD to 4,000 m depth) during the inter-comparison (Figure III-10); the Stratus 15 buoy was drifting freely at this time as it had been released from its anchor on May 12. The ship continued to be near Stratus 15 until the buoy was recovered May 15. The ship was near Stratus 16 on May 16 during the inter-comparison (Figure III-10) until 20:30 UTC at which point it sailed to the northwest to start a bathymetry survey prior to transit to Arica.

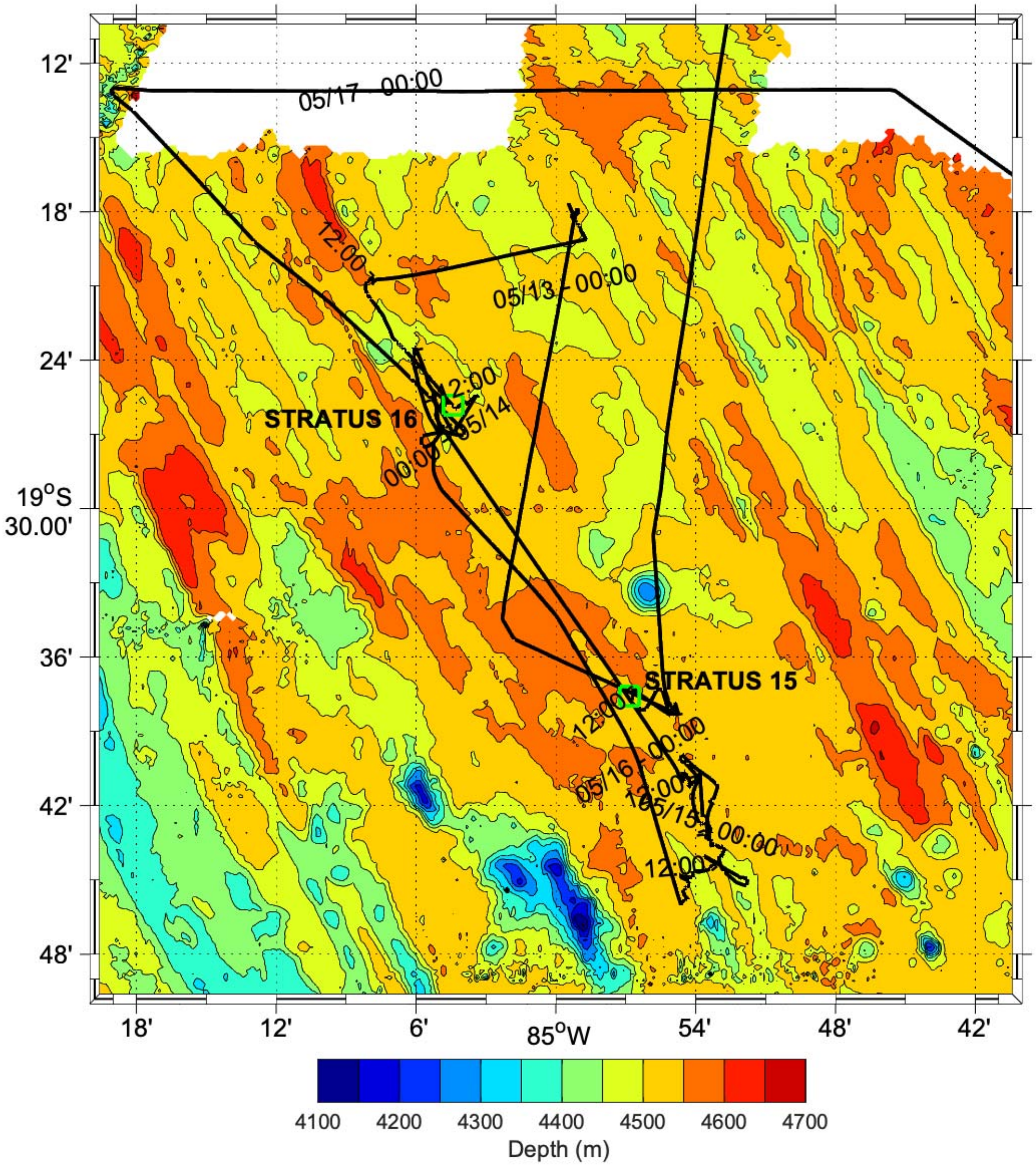


Figure III-9. Ship track (black line) from May 12 to May 17 2017. Stratus 15 and 16 anchors (green squares).

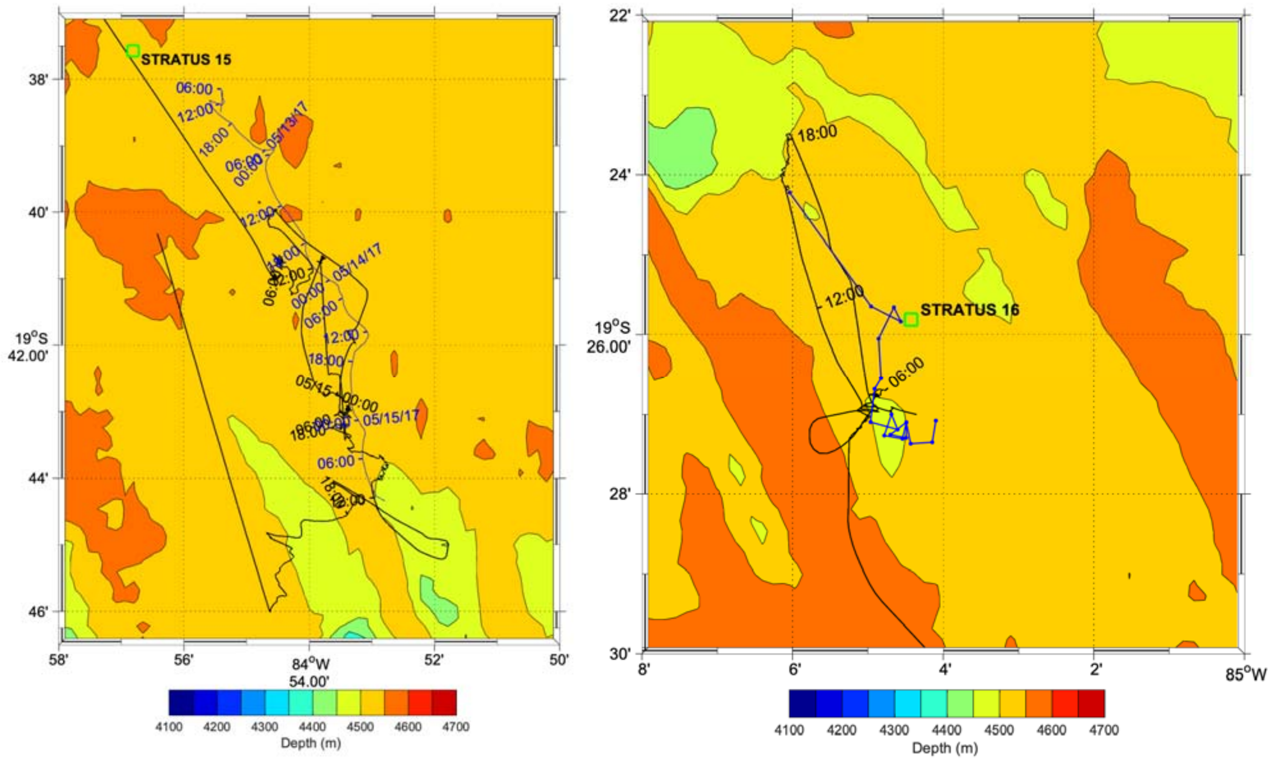


Figure III-10. Left: ship's track (black line) and Stratus 15 buoy track (blue line) on May 14-15 2017. Stratus 15 mooring anchor (green square). Right: ship's track (black line) and Stratus 16 buoy track (blue line) on May 16 2017. Stratus 16 mooring anchor (green square).

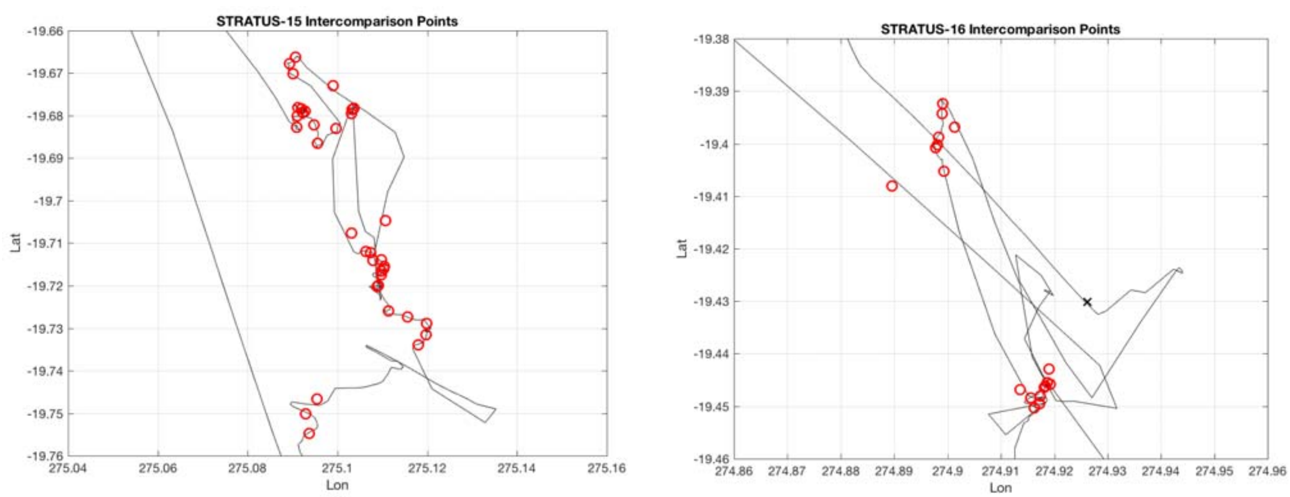


Figure III-11. Locations of inter-comparison points used in scatter plots below.

During the inter-comparisons, the ship was bow into the wind and near the Stratus 15 and Stratus 16 buoys, so that measurements from the ship, including the sensors from NOAA Earth Systems Research Laboratory, Physical Science Division (PSD), could be compared with the buoy observations. Figure III-12 show PSD sensors on the ship were placed either on the bow mast (wind, air temperature and humidity and barometric pressure), the 02 deck (radiations) or the seasnake (SST) on the port side. Sensors that are part of the ship permanent data collection are denoted as SCS (Scientific Computer System). ASIMET from systems 1 and 2 data from the Stratus 16 buoy were provided by satellite telemetry using internet connection. This telemetry data is hourly averaged, does not include quality control, and has lower resolution due to bandwidth constraints during transmissions. ASIMET data from the Stratus 15 buoy were averaged to hourly values from the 1-minute raw data.

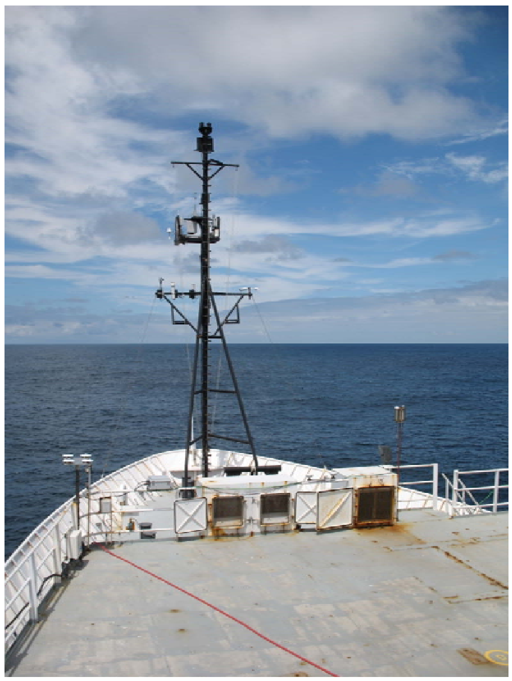


Figure III-12. PSD and ship sensors on bow mast; PSD radiation sensors on port side of 02 deck.

Figure III-13 to Figure III-30 below present the time-series and scatter plots of the data collected from May 12 to 17, and during the inter-comparisons (see Figure III-11). These comparisons are summarized in Table III-2. There is a remarkable agreement in the meteorological measurements between platforms. Humidity measurements from the buoys tend to be slightly higher than measurements from the ship. Figure III-31 shows the bias in longwave radiation between PSD and SCS sensor is correlated to incoming shortwave radiation, which could indicate radiation leakage.

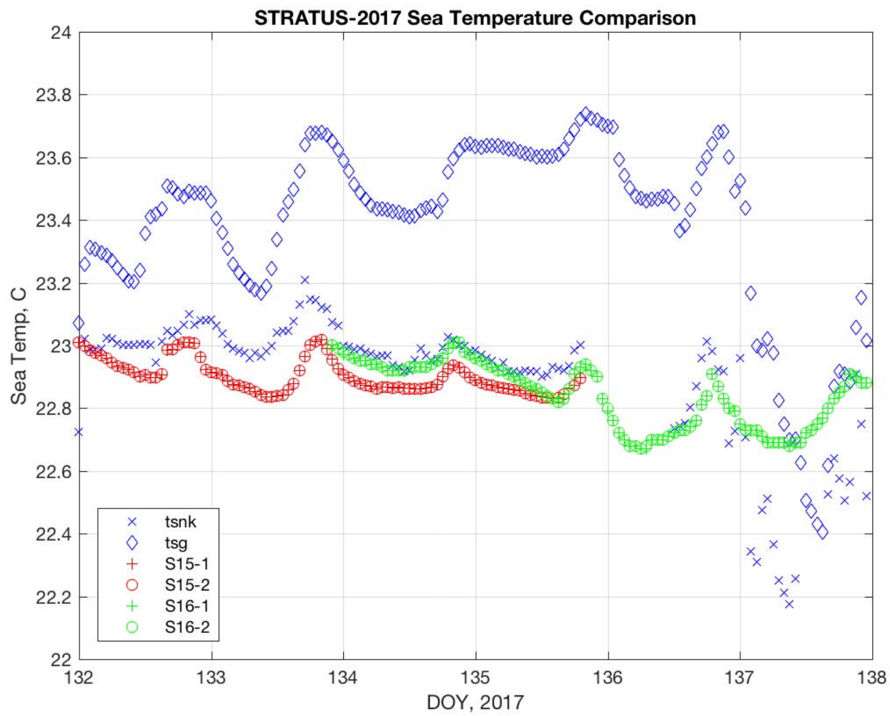


Figure III-13. Time-series of Sea Surface Temperature (SST) from: NOAA ESRL "sea snake" sensor (measure upper 5 cm of ocean), ship's thermosalinograph (TSG) with water intake at 5 m depth, and Stratus 15 and 16 ASIMET systems 1 and 2 (measuring at 0.8 m depth). Period covered is from May 12 (DOY 132) to May 17 (DOY 137) 2017. Note that 1) ship departed Stratus area on May 16 at 20:30 UTC, and 2) Stratus 15 buoy was recovered on May 15 at 21:05 UTC. Inter-comparison at Stratus 15 (16) was on May 14 (16).

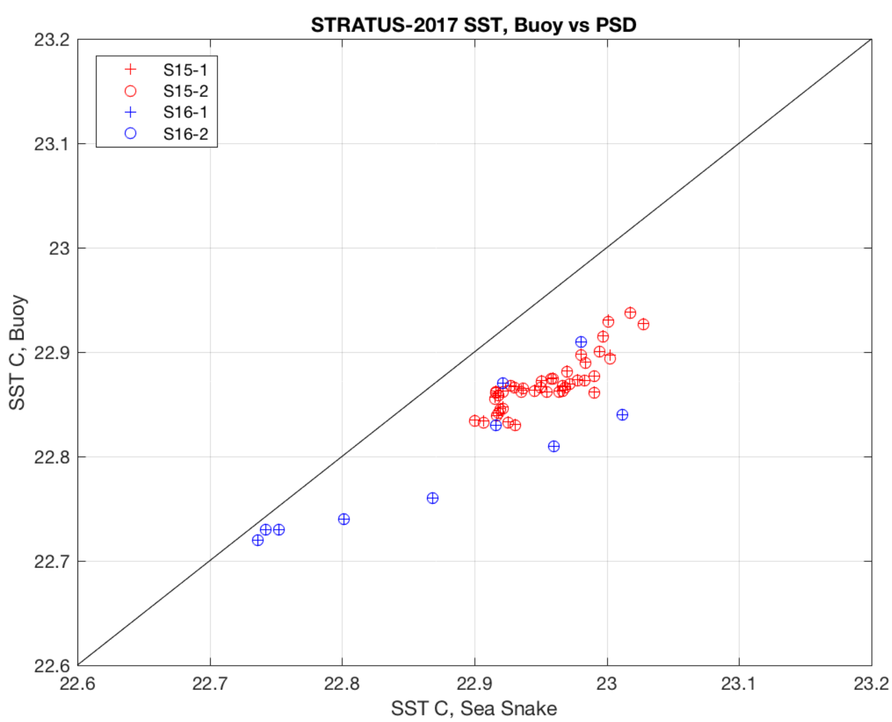


Figure III-14. Scatter-plot of SST values from Stratus 15 and 16 buoys versus PSD "sea snake" during inter-comparisons.

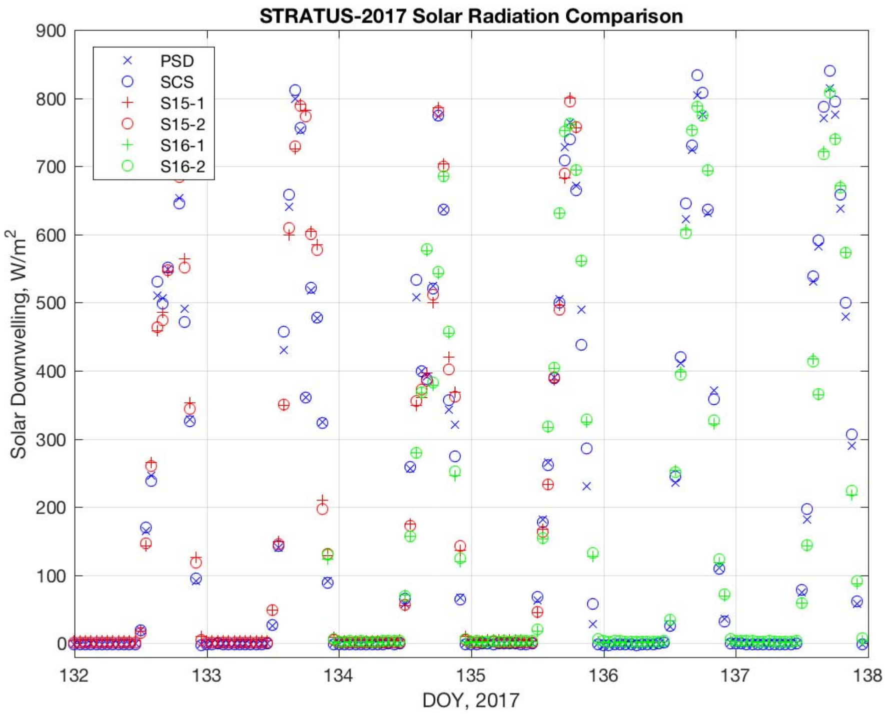


Figure III-15. Time-series of shortwave incoming radiation from NOAA ESRL (PSD), ship (SCS) and Stratus 15 and 16 ASIMET systems 1 and 2, from May 12 to 17 2017.

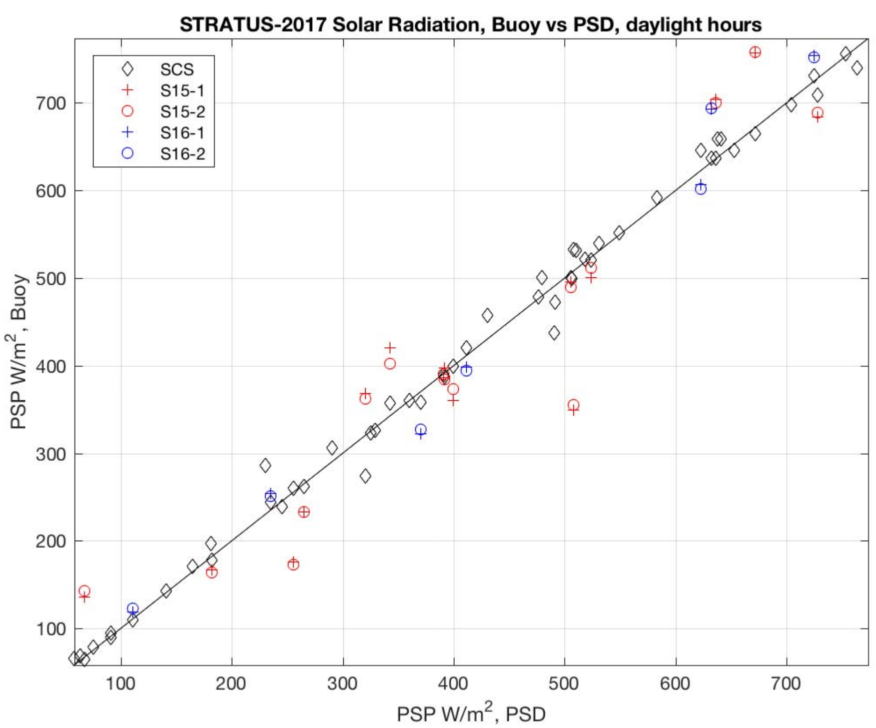


Figure III-16. Scatter plot of shortwave incoming radiation from NOAA ESRL (PSD), versus ship (SCS) and Stratus 15 and 16 ASIMET systems 1 and 2, during inter-comparisons.

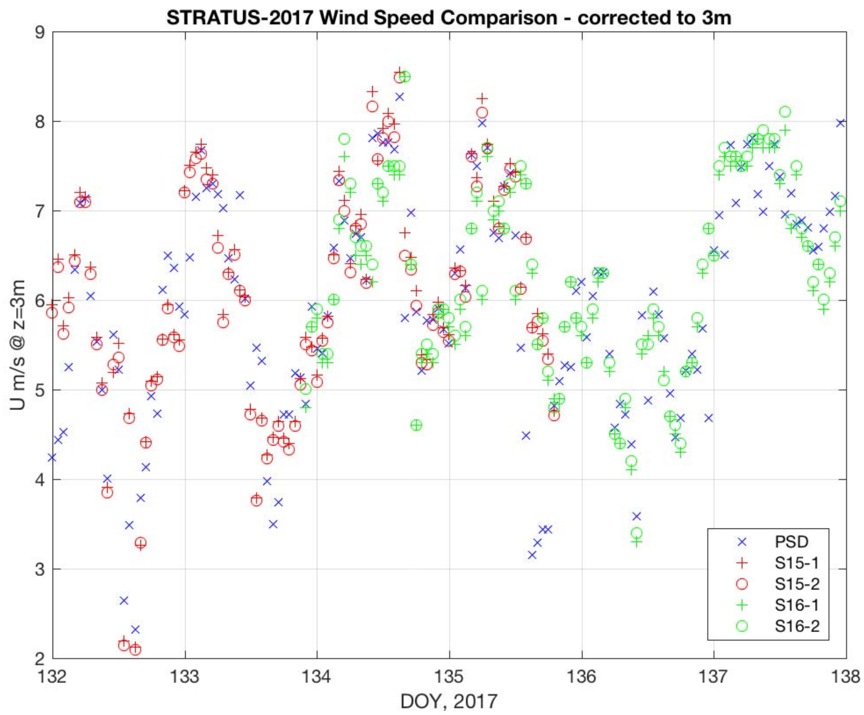


Figure III-17. Time-series of wind speed adjusted to 3 m from NOAA ESRL (PSD), ship (SCS) and Stratus 15 and 16 ASIMET systems 1 and 2, from May 12 to 17 2017.

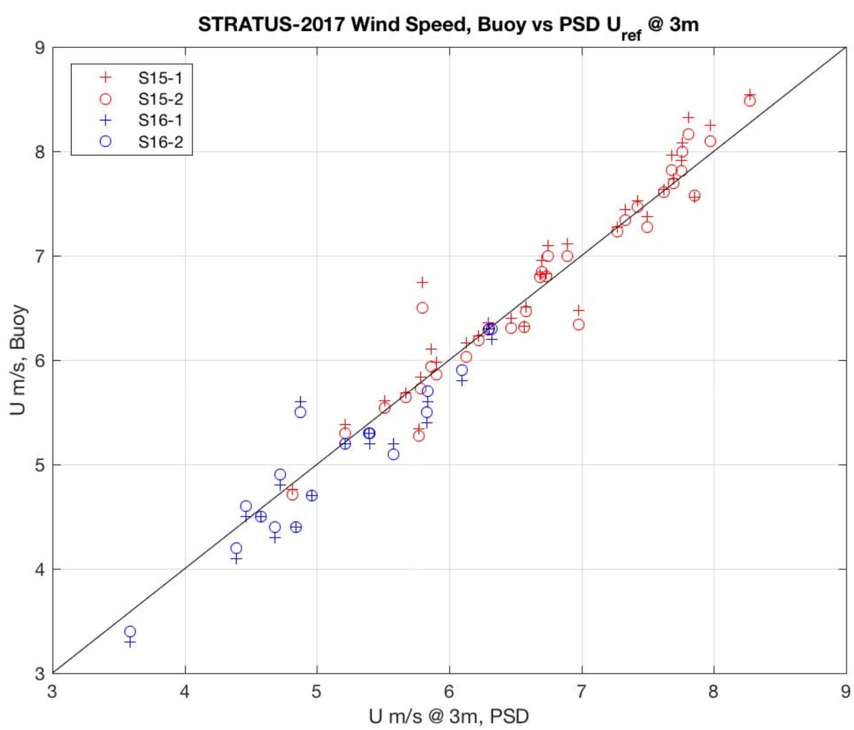


Figure III-18. Scatter plot of wind speed adjusted to 3 m from NOAA ESRL (PSD), versus ship (SCS) and Stratus 15 and 16 ASIMET systems 1 and 2, during inter-comparisons.

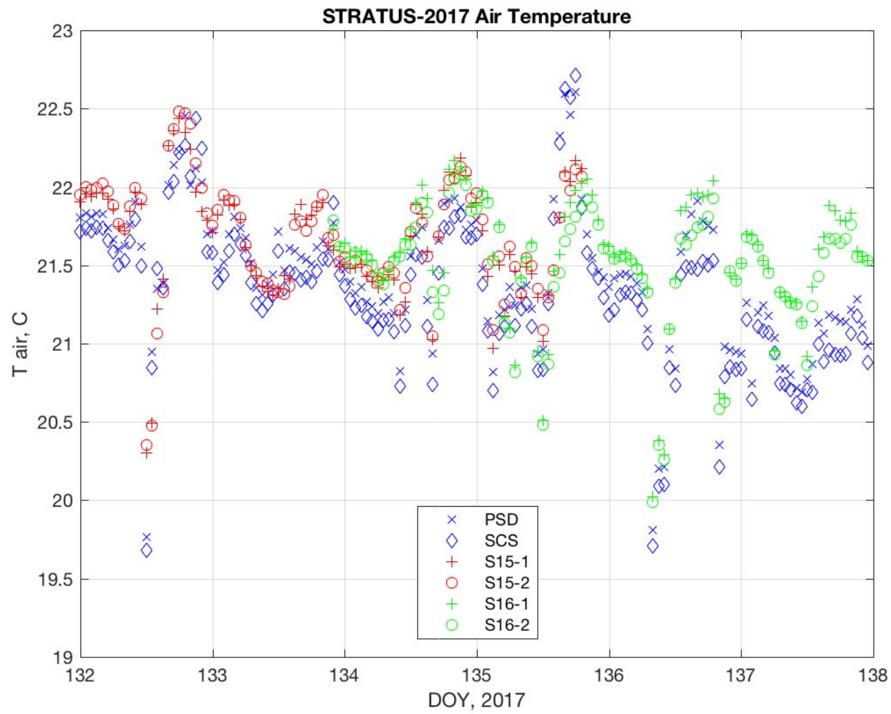


Figure III-19. Time-series of air temperature from NOAA ESRL (PSD), ship (SCS) and Stratus 15 and 16 ASIMET systems 1 and 2, from May 12 to 17 2017.

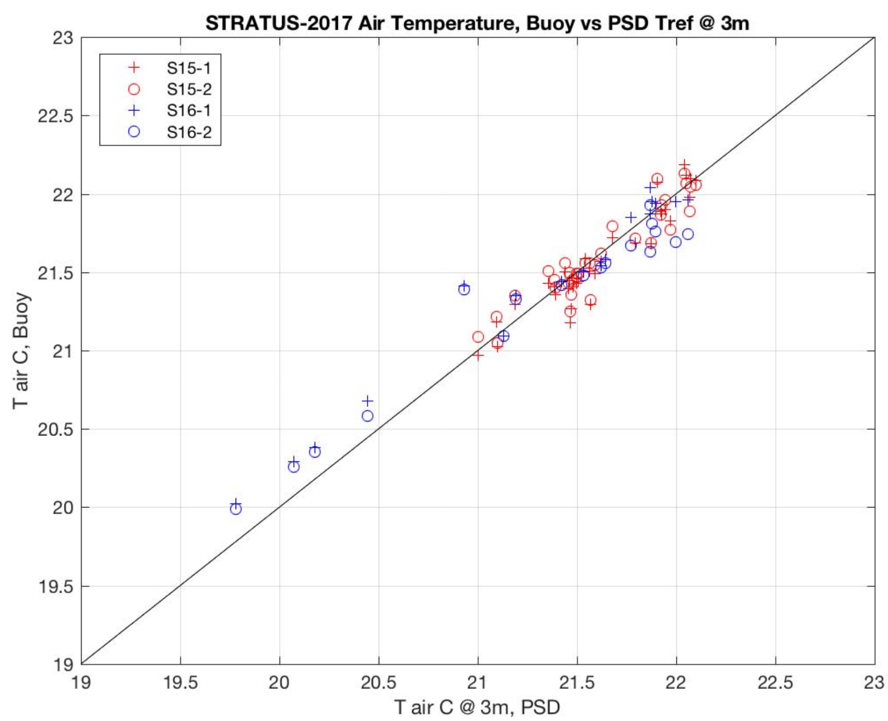


Figure III-20. Scatter plot of air temperature adjusted to 3 m from NOAA ESRL (PSD), versus ship (SCS) and Stratus 15 and 16 ASIMET systems 1 and 2, during inter-comparisons.

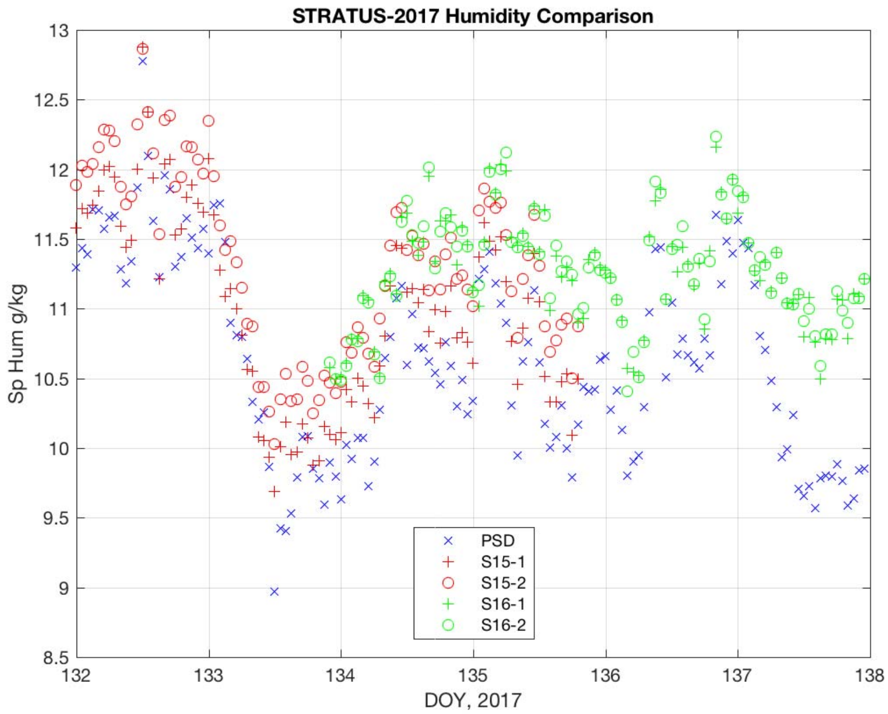


Figure III-21. Time-series of air specific humidity from NOAA ESRL (PSD), ship (SCS) and Stratus 15 and 16 ASIMET systems 1 and 2, from May 12 to 17 2017.

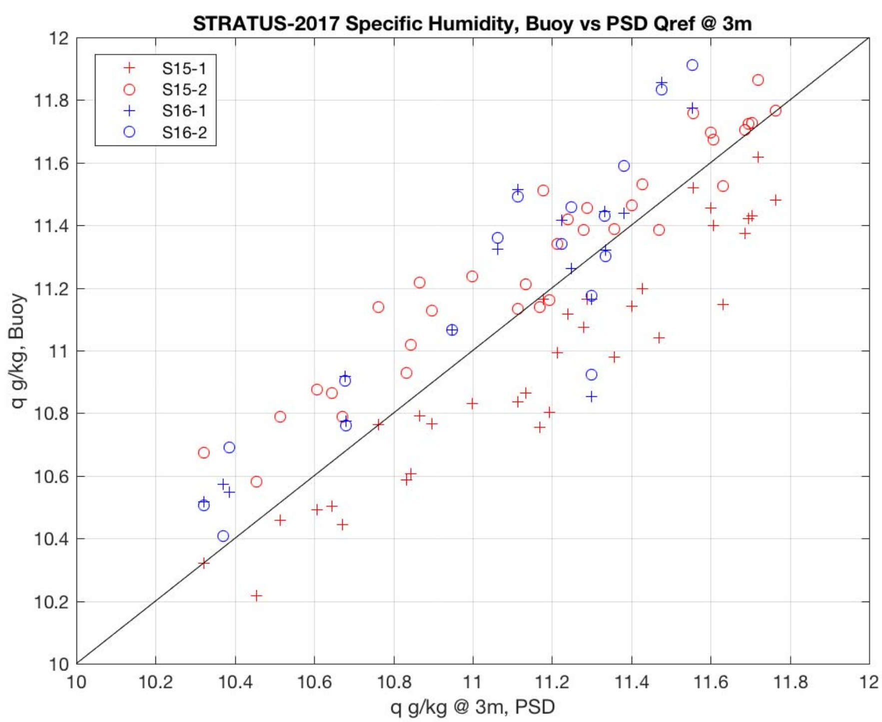


Figure III-22. Scatter plot of air specific humidity adjusted to 3 m from NOAA ESRL (PSD), versus ship (SCS) and Stratus 15 and 16 ASIMET systems 1 and 2, during inter-comparisons.

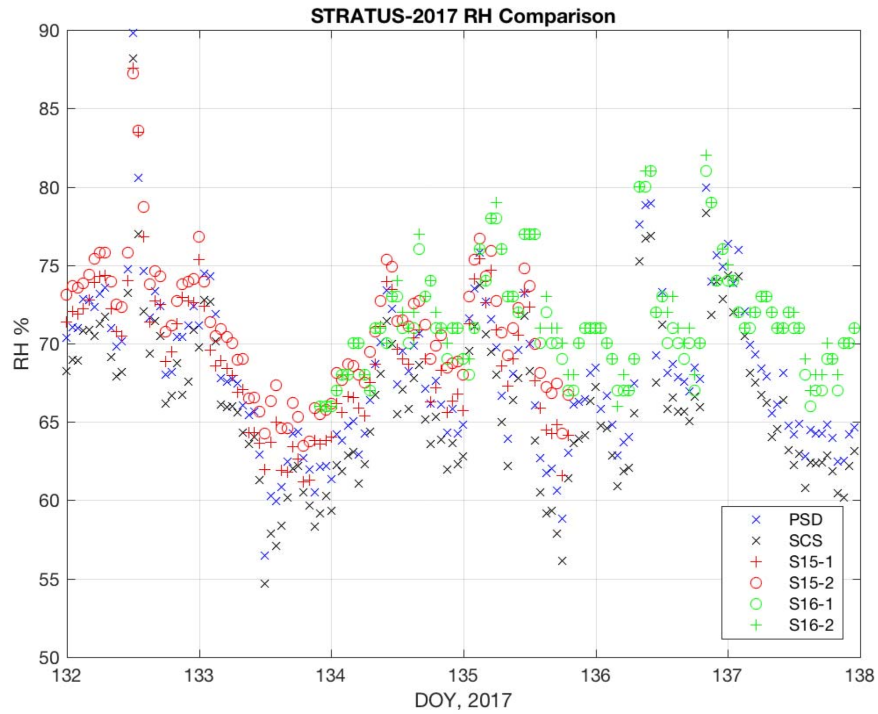


Figure III-23. Time-series of air relative humidity from NOAA ESRL (PSD), ship (SCS) and Stratus 15 and 16 ASIMET systems 1 and 2, from May 12 to 17 2017.

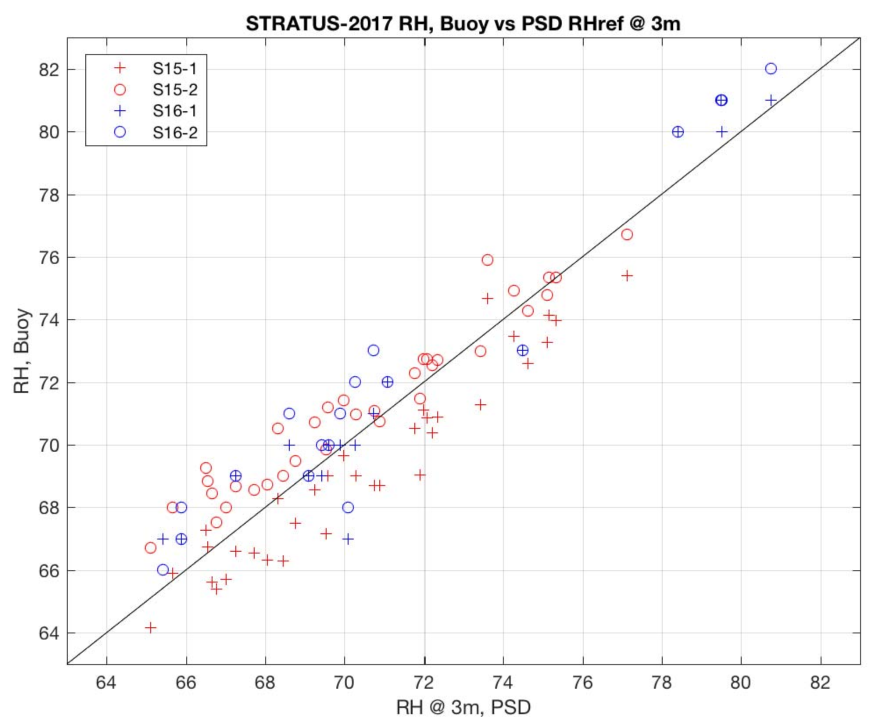


Figure III-24. Scatter plot of air relative humidity adjusted to 3 m from NOAA ESRL (PSD), versus ship (SCS) and Stratus 15 and 16 ASIMET systems 1 and 2, during inter-comparisons.

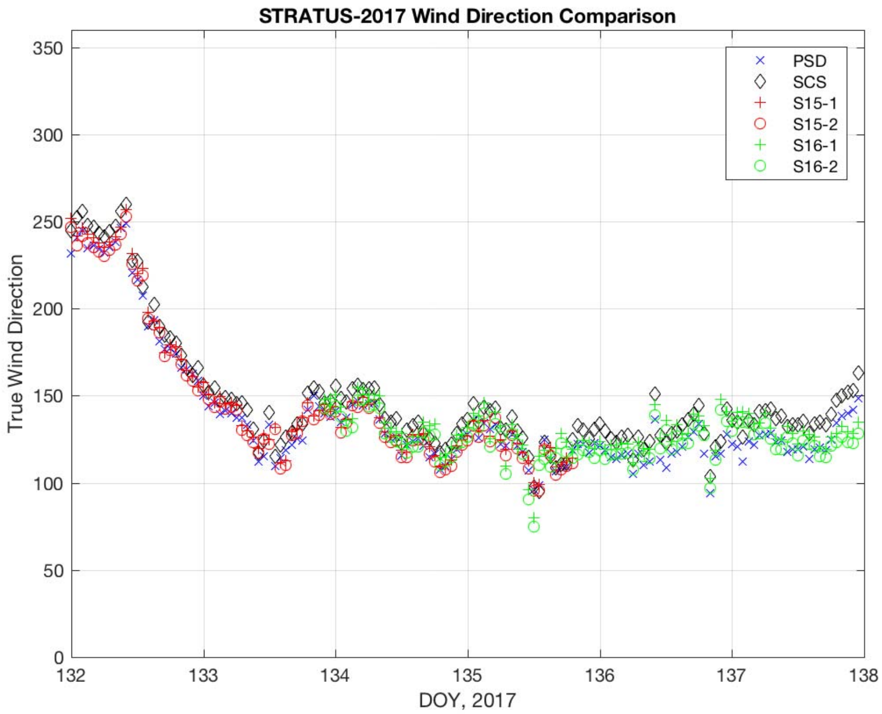


Figure III-25. Time-series of wind direction from NOAA ESRL (PSD), ship (SCS) and Stratus 15 and 16 ASIMET systems 1 and 2, from May 12 to 17 2017.

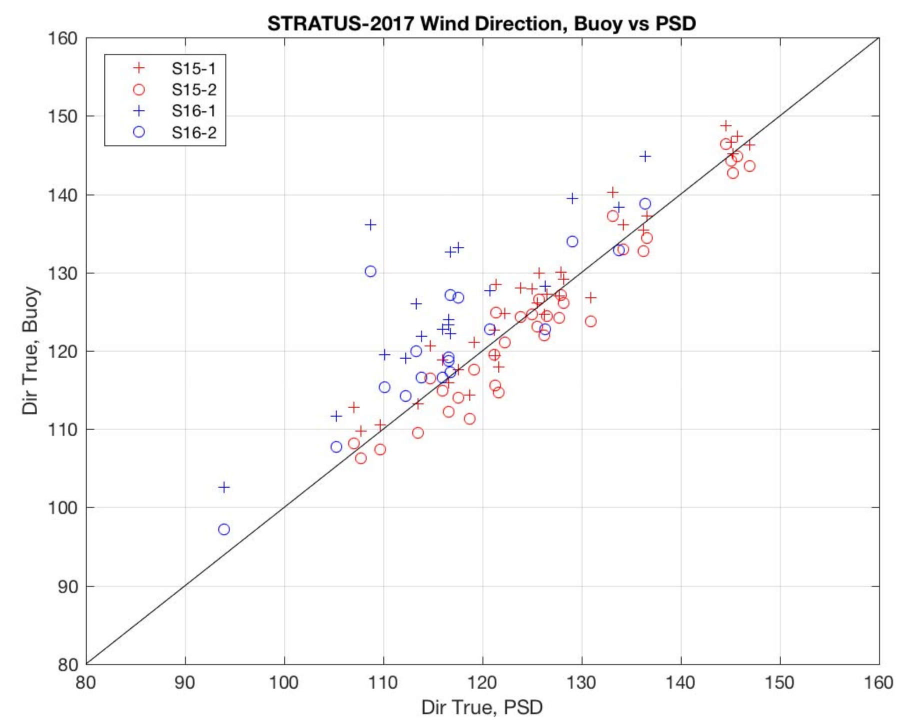


Figure III-26. Scatter plot of wind direction from NOAA ESRL (PSD), versus ship (SCS) and Stratus 15 and 16 ASIMET systems 1 and 2, during inter-comparisons.

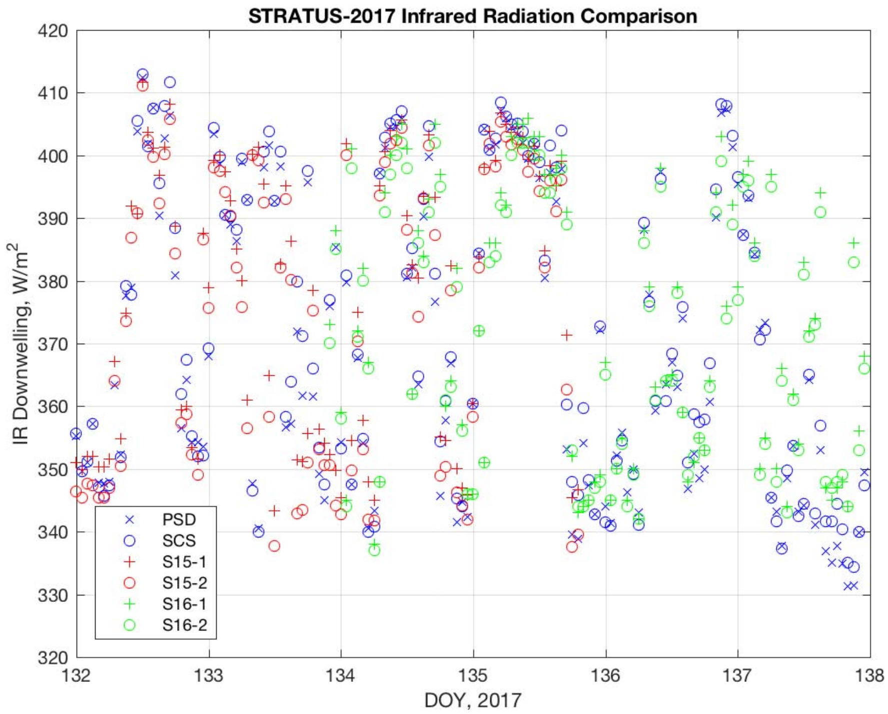


Figure III-27. Time-series of longwave incoming radiation from NOAA ESRL (PSD), ship (SCS) and Stratus 15 and 16 ASIMET systems 1 and 2, from May 12 to 17 2017.

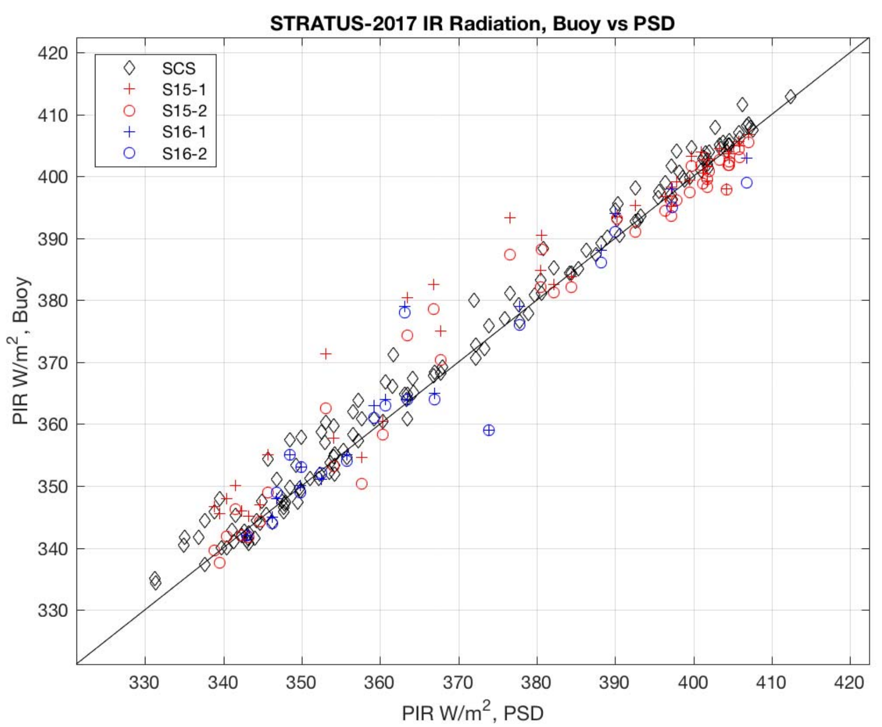


Figure III-28. Scatter plot of longwave incoming radiation from NOAA ESRL (PSD), versus ship (SCS) and Stratus 15 and 16 ASIMET systems 1 and 2, during inter-comparisons.

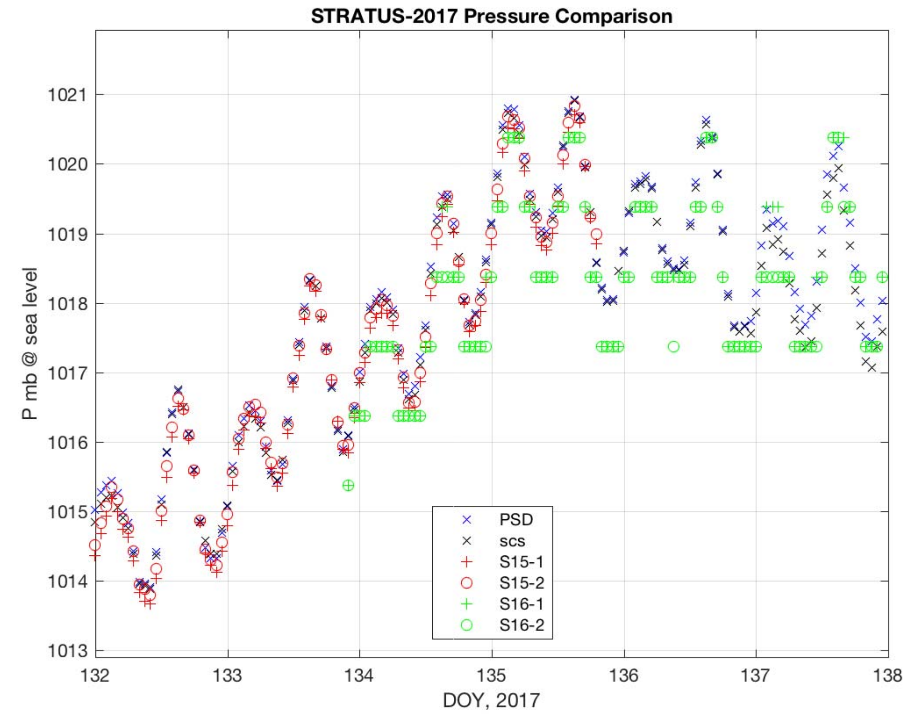


Figure III-29. Time-series of barometric pressure from NOAA ESRL (PSD), ship (SCS) and Stratus 15 and 16 ASIMET systems 1 and 2, from May 12 to 17 2017.

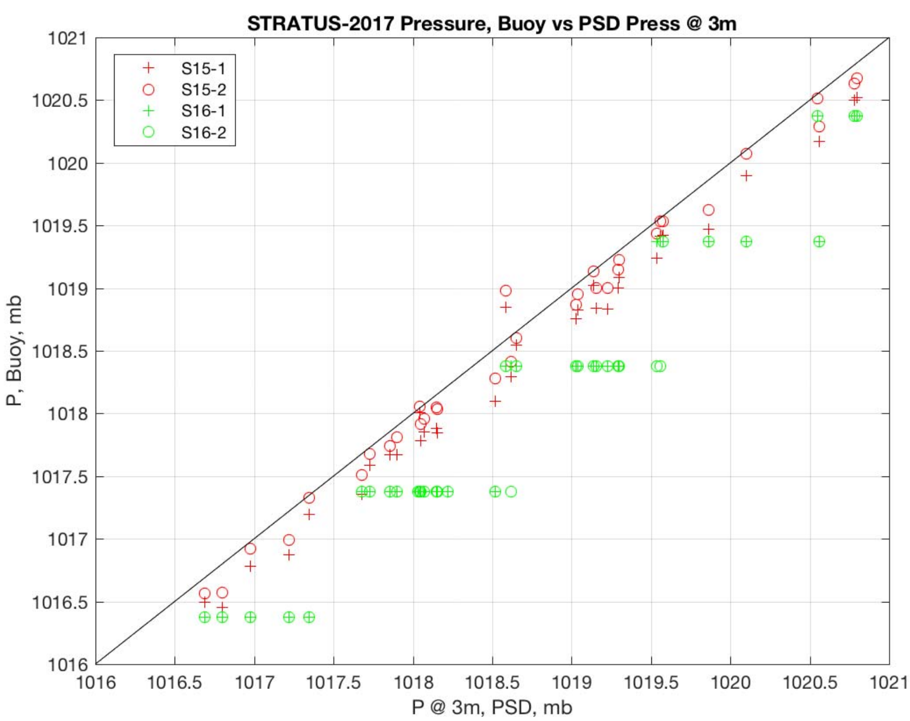


Figure III-30. Scatter plot of barometric pressure adjusted to 3 m from NOAA ESRL (PSD), versus ship (SCS) and Stratus 15 and 16 ASIMET systems 1 and 2, during inter-comparisons.

Table III-2. Statistics of comparison between PSD, ship and Stratus 15 and 16 measurements during period May12-17 and during inter-comparisons.

PSD – Ship, entire period at site								
	T air, C	RH, %	SST, C	Wspd, m/s	Wdir, deg	Rs W/m2	Rl, W/m2	P, mb
mean	0.12	2.02	-0.49	-0.43	-9.03	-0.96	-1.81	0.04
median	0.11	1.98	-0.49	-0.44	-8.87	0.42	-1.09	0.04
std dev	0.06	0.31	0.16	0.30	2.02	11.95	2.83	0.05
PSD – S15-1, entire period at site								
	T air, C	RH, %	SST, C	Wspd, m/s	Wdir, deg	Rs W/m2	Rl, W/m2	P, mb
mean	-0.14	-0.79	0.10	0.53	-2.41	-8.39	-1.74	0.18
median	-0.15	-0.91	0.10	0.54	-2.10	-4.80	-1.40	0.19
std dev	0.16	1.68	0.04	0.53	5.31	59.06	16.22	0.13
PSD – S15-2, entire period at site								
	T air, C	RH, %	SST, C	Wspd, m/s	Wdir, deg	Rs W/m2	Rl, W/m2	P, mb
mean	-0.15	-2.76	0.10	0.60	0.67	-5.86	1.37	0.07
median	-0.17	-2.79	0.10	0.60	1.48	-1.69	1.28	0.07
std dev	0.18	1.78	0.04	0.53	5.29	57.54	16.56	0.10
PSD – S16-1, entire period at site								
	T air, C	RH, %	SST, C	Wspd, m/s	Wdir, deg	Rs W/m2	Rl, W/m2	P, mb
mean	-0.16	-3.14	0.04	0.76	-6.44	-3.25	-1.83	0.56
median	-0.13	-3.14	0.03	0.74	-6.75	-2.63	-0.93	0.56
std dev	0.26	2.71	0.04	0.78	6.61	59.93	18.06	0.29
PSD:S16-2, entire period at site								
	T air, C	RH, %	SST, C	Wspd, m/s	Wdir, deg	Rs W/m2	Rl, W/m2	P, mb
mean	-0.16	-3.49	0.04	0.69	-0.88	-4.79	-0.40	0.61
median	-0.13	-3.53	0.03	0.67	-0.94	-4.49	0.93	0.64
std dev	0.26	2.67	0.04	0.76	6.39	59.99	17.69	0.31
PSD – S15-1, near buoy								
	T air, C	RH, %	SST, C	Wspd, m/s	Wdir, deg	Rs W/m2	Rl, W/m2	P, mb
mean	-0.17	-1.05	0.08	0.62	-1.29	-1.97	-3.33	0.22
median	-0.16	-0.99	0.08	0.64	-1.22	-4.61	-1.26	0.23
std dev	0.11	1.04	0.02	0.33	2.87	40.14	5.72	0.13

PSD – S15-2, near buoy								
	T air, C	RH, %	SST, C	Wspd, m/s	Wdir, deg	Rs W/m2	Rl, W/m2	P, mb
mean	-0.20	-3.05	0.08	0.71	1.91	0.01	-0.25	0.10
median	-0.19	-2.91	0.08	0.70	1.91	-1.42	1.20	0.11
std dev	0.11	1.10	0.02	0.30	2.74	38.19	4.37	0.11
PSD – S16-1, near buoy								
	T air, C	RH, %	SST, C	Wspd, m/s	Wdir, deg	Rs W/m2	Rl, W/m2	P, mb
mean	-0.18	-3.52	0.03	0.94	-5.11	0.63	-1.94	0.59
median	-0.18	-3.75	0.03	1.03	-5.75	-2.25	-1.27	0.60
std dev	0.31	3.19	0.03	0.89	6.86	74.29	19.99	0.28
PSD – S16-2, near buoy								
	T air, C	RH, %	SST, C	Wspd, m/s	Wdir, deg	Rs W/m2	Rl, W/m2	P, mb
mean	-0.18	-3.83	0.03	0.86	0.56	-1.12	-0.29	0.66
median	-0.18	-3.98	0.03	0.93	-0.16	-4.14	1.73	0.66
std dev	0.31	3.18	0.03	0.88	6.53	74.18	19.59	0.29

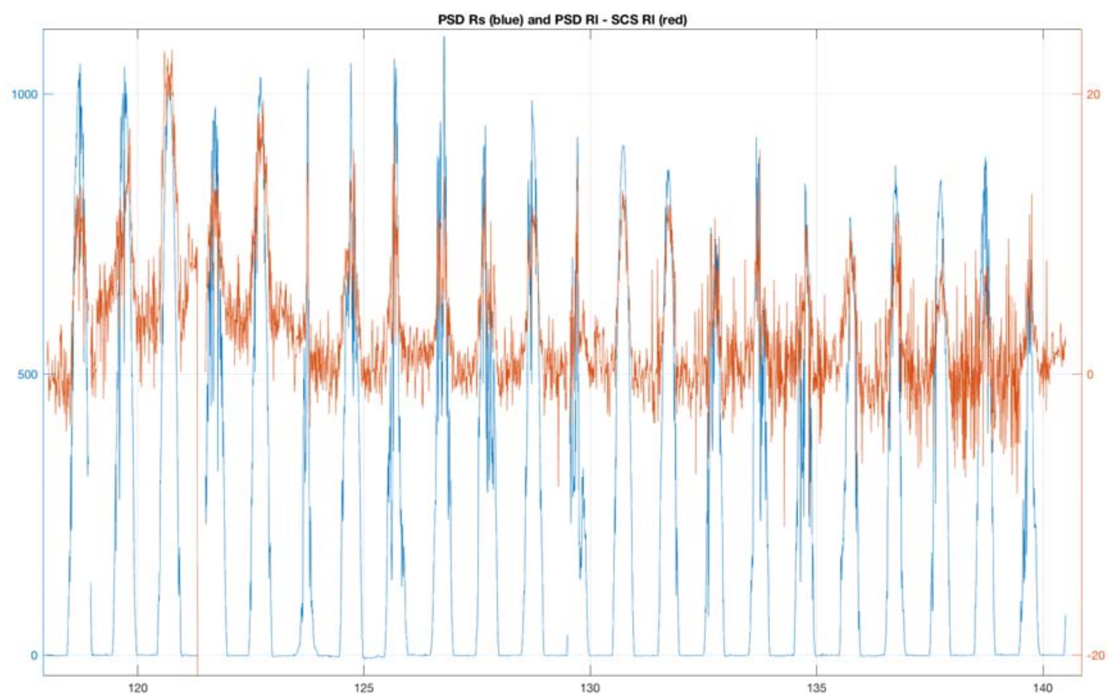


Figure III-31. Time-series of incoming longwave radiation difference between PSD and SCS measurements (red) and raw shortwave radiation from PSD (blue).

While the ship was stationed near Stratus 15 mooring during inter-comparison on May 14 2017, two CTDs (cast 3 and 4) were done to compare with the data collected by instruments deployed on the Stratus 15 mooring. These instruments are Seabird 39 (temperature data only), and Seabird 37 (temperature, conductivity, pressure). Figure III-32 to Figure III-34 show this comparison (using data from the UOP CTD sensor). See Section V. A. for information about CTD casts.

The salinity profiles show that the salinity from SBE37 at 2 m was anomalously low (0.2 psu) compared to the CTD and nearby SBE37s on the mooring.

The SBE37 deployed at 10 m on Stratus 15 showed a high salinity (close to 0.1 psu) compared to nearby SBE37s and the CTD casts.

A similar comparison between ship CTD and Stratus 15 mooring was conducted after the Stratus 15 deployment in June 2016. The high bias from the SBE37 at 10 m was already visible then (not shown), so this instrument may have been biased high from the start. The SBe37 at 2 m showed a very small low bias in June 2016, so this sensor probably drifted low during period that the Stratus 15 was deployed.

Salinity from SBE37s in the mixed layer (upper 65 m) tend to be larger (0.05 to 0.1 psu) than the CTD values from casts 3 and 4. This tendency does not show for deeper instruments, so it is possible this bias may be real and that the upper SBE37s on stratus 15 had a high salinity bias at the end of their deployment.

Similar comparisons are made for temperature data from SBE37s and SBE39s. No obvious bias in temperature was detected with the CTD comparison.

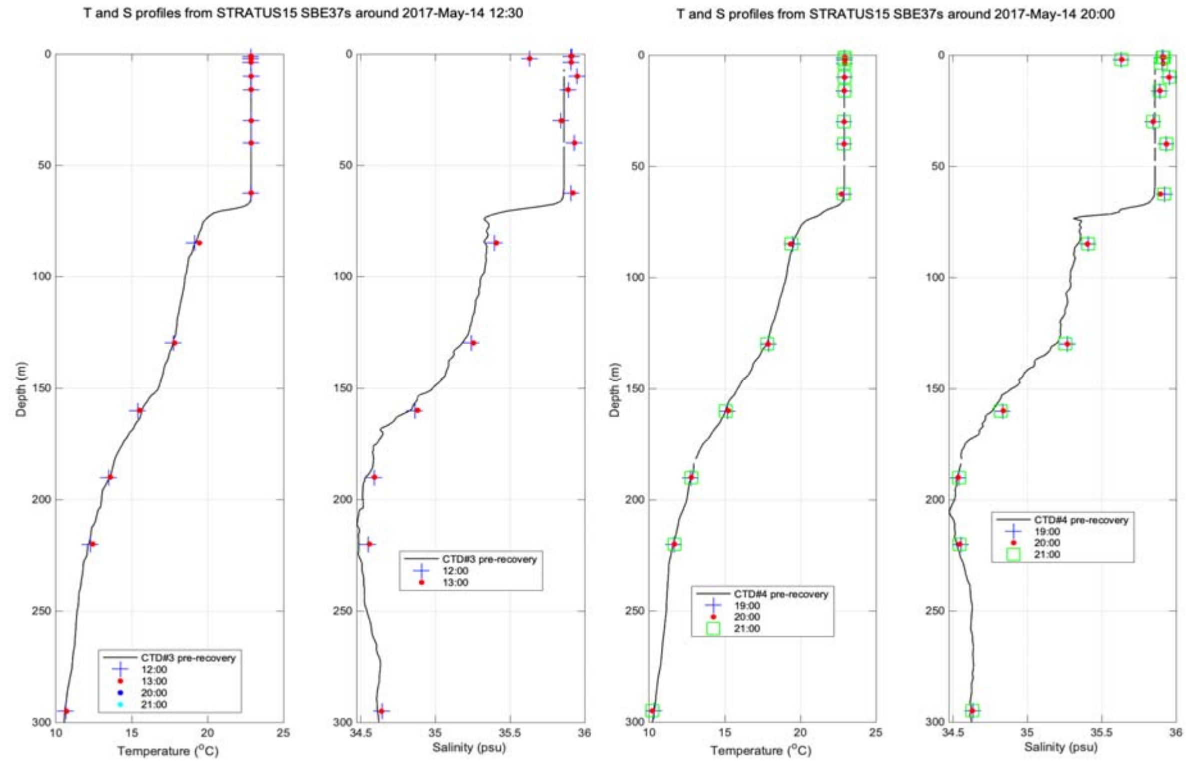


Figure III-32. Temperature and salinity profiles from CTD casts 3 (left) and 4 (right) made on May 14 2017 near Stratus 15 mooring, prior to its recovery. Colored symbols denote concomitant data from SBE37 instruments mounted on Stratus 15.

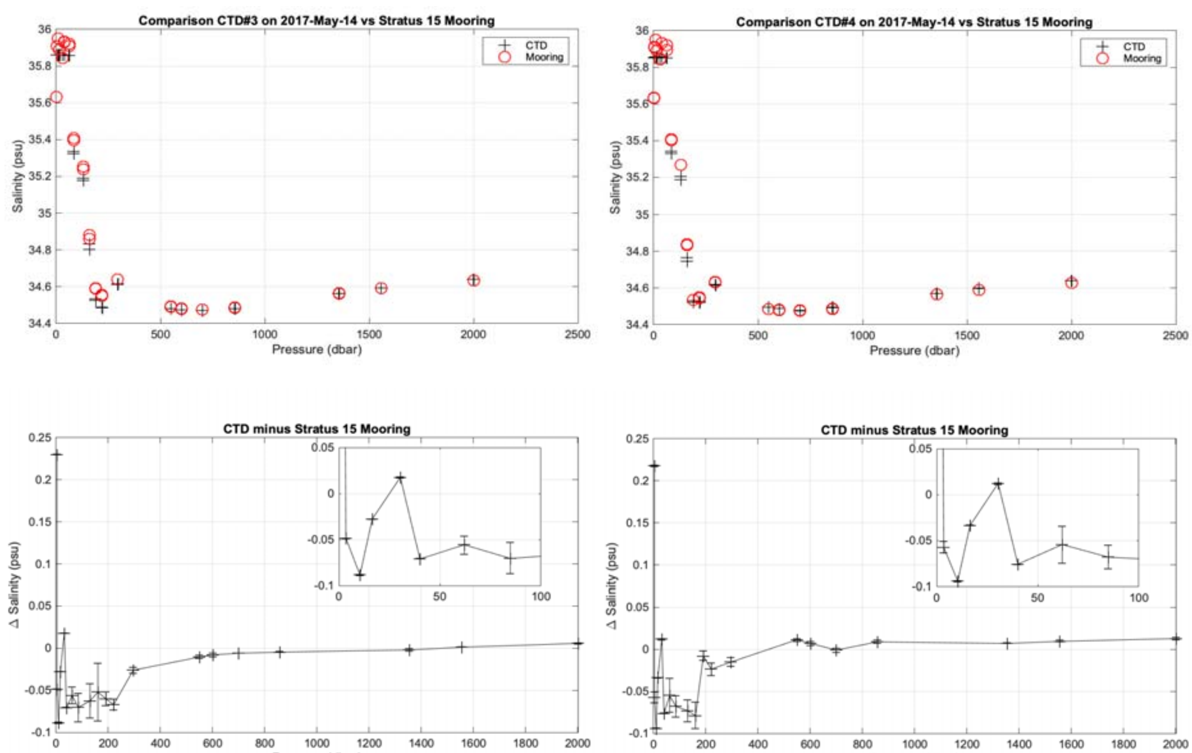


Figure III-33. Difference of salinity CTD minus mooring SBE37s for cast 3 and 4 on May 14 2017.

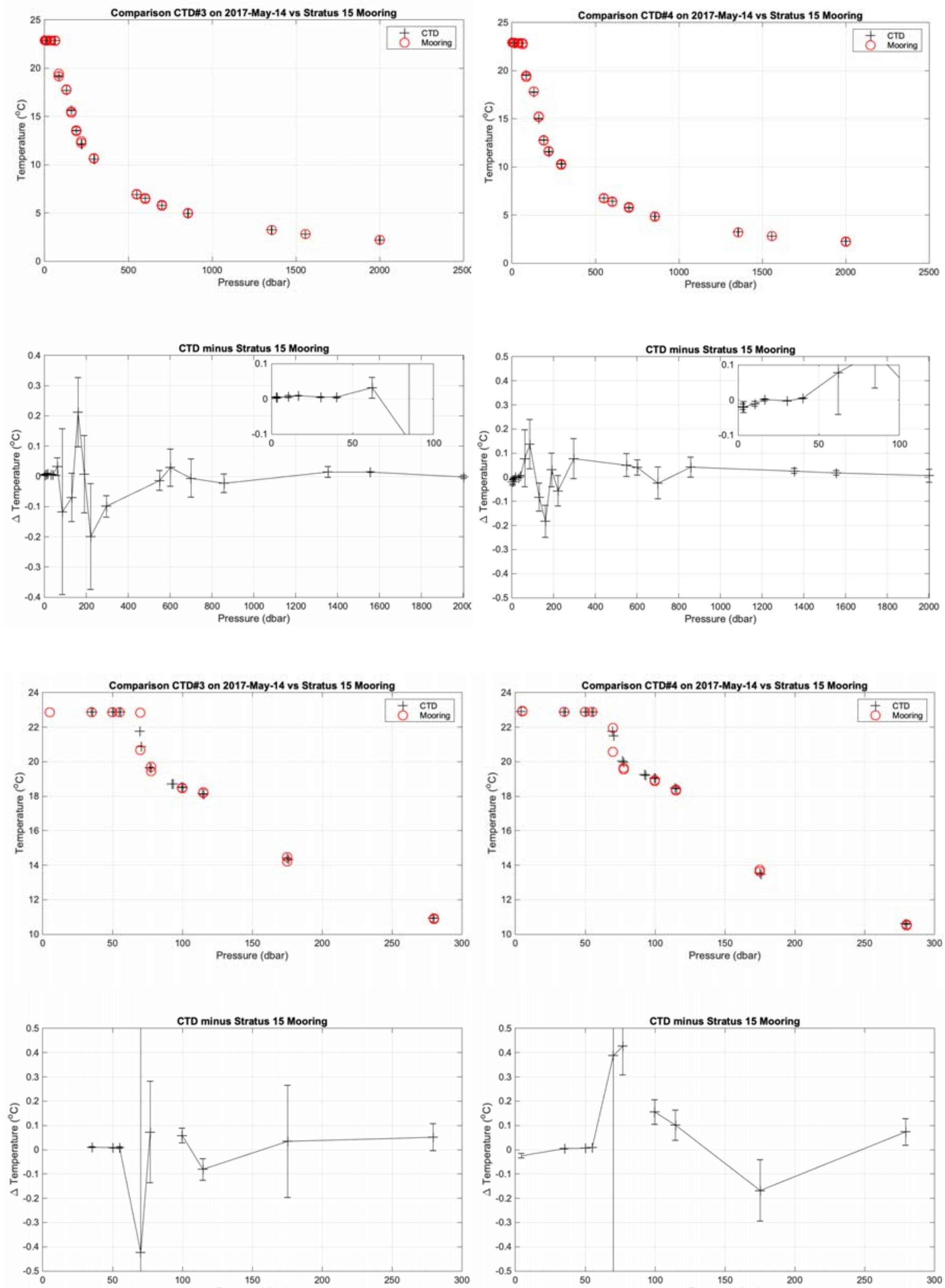


Figure III-34. Difference of temperature CTD minus mooring for cast 3 (left) and 4 (right) on May 14 2017, using mooring data from SBE37s (top) and SBE39s (bottom).

IV. Stratus 15 Recovery

A. Deck operations

The Stratus 15 buoy was recovery in multiple phases. The first operation was to recovery the acoustic release and the bracket. It was needed for the deployment of Stratus 16.

On May 12, 2017 at 07:15 local the release command was sent to the acoustic releases to separate the anchor from the mooring line. After about 55 minutes the glass balls were spotted off the stern quarter about ½ mile away. Once the glass balls were on the surface, the ship's small boat was deployed to connect a lifting sling into the glass ball cluster. A messenger line was used to pass the lifting line from the ship to the small boat; the lifting sling and lifting line were shackled together.

The lifting line on the glass balls was fed through the ship's block on the A-frame and was wound around capstan head. Recovery of the glass balls commenced and the capstan picked up the load of the flotation. As the glass balls reached the peak of the A-frame, stopper lines were put in place at the bottom of the pile to secure the load. The A-frame came inboard and the capstan gently put the cluster on deck. Once the balls where on deck the releases with the bracket and deep SBE 37 instruments were disconnected from the cluster and the reaming glass balls and chain was slipped off the fan tail using a 3/8th blue spectra slip line.

On May 15, 2017 at about 0830 local, the glass ball cluster from Stratus 15 that had been drifting for over 48 hours was successfully grappled from the ship and recovery of the mooring commenced. The TSE winch hauled in as the ship steamed ahead to get the balls lined up behind it. At this point, the ship was towing the glass balls from the winch, with the rest of the mooring trailing behind. With the A-frame positioned outboard, the glass balls were slowly lifted from the water. The A-frame was brought inboard as the winch hauled in, lifting the cluster of glass above the deck. Three air tuggers were used to stabilize the cluster, and haul it forward. When the cluster was clear of the transom, it was lowered to the deck. Stopper lines were used to secure the thimble on the end of the Colmega line. The winch was disconnected from the glass ball cluster and the glass ball strings were disconnected and relocated. The glass balls were dragged forward to be staged for the crane to put them into the open top container.

The ship continued to steam slowly into the wind during this operation. Once the deck was clear, a traveling block was hung from A-frame, using the large air tugger to adjust the height. The port side stopper line that was connected to the thimble on the Colmega line was eased off and wrapped around the ship's capstan head 8 times. Line handlers were used to ensure that the line came off the capstan smoothly and the line was packed into the burlap bags. The capstan hauled in all of the 3200 meters of synthetic line. When the nylon to wire termination came through the block the capstan stopped and the load was transferred to the TSE winch. The remaining nylon and wire were recovered using the winch. All subsurface instruments were removed as they came to the surface.

For instrument recovery, the A-frame was positioned about 4 feet forward of the stern. A traveling block remained in place. Height was adjusted with the large air tugger. The winch hauled in the wire. Instruments on load bars or in cages were stopped about 3 feet above the deck. Two stopper lines were hooked into the sling link and made fast to the deck cleats. The winch payed out slowly, lowering the instrument to the deck. The instrument was disconnected from the hardware and moved to a staging area for pictures. The wire rope from the winch was then shackled to the load. The winch took up the slack and the stopper lines were eased off and then cleared. Hauling continued until the next instrument.

The above procedure was continued throughout the recovery operation until the Aanderaa Seaguard at 45 meters was recovered. A slip line was passed through the link at the bottom of the 3.9 meter chain shot to set the buoy and remaining 45 meters of instruments adrift.

Once the buoy was set adrift from the stern recovery operation, R/V *Ronald H Brown* made an approach on the port side to recover the buoy. A pickup sling with a 50-meter piece of buoyant line and a float had been attached to the buoy pickup bale a day earlier. The crane was positioned above the recovery area. As the ship maneuvered by the buoy, a grappling hook was used to recover the pickup line and connect the lifting sling to the crane hook. The crane lifted the buoy from the water and swung inboard so the buoy would rest on the side of the ship. Air tugger lines were attached to the buoy deck bale and buoy base. The buoy was hoisted up and then swung inboard while the tuggers and line kept the buoy from swinging.

Once the buoy was on deck aircraft straps were used to secure the buoy. A stopper line was used to stop off on the 0.75 m shot of 3/4” chain between the third and fourth instruments. Tugger lines were removed from the buoy. The shackle below the 3.7-meter SBE 37 was removed to disconnect the mooring line from the buoy.

A 6-foot sling was placed through the link at the top of the first instrument and onto the crane’s hook. The crane took the load and the stopper line was eased off and cleared. The crane hoisted the first two instruments. A stopper was attached to the chain below the instruments hanging from the crane. The crane lowered the instruments to the deck transferring the load to the stopper. The instruments were disconnected and the crane was repositioned over the load. The sling was placed through the sling at the top of the remaining instrument array hooked into the crane. The crane took the load and the stopper line was cleared. The crane lifted the next section of instruments and the above procedure was repeated to recover the remaining instruments.

Figure IV-1. Recovery of glass balls from Stratus 15 mooring.

Figure IV-2. Recovery of Colmega rope using capstan.

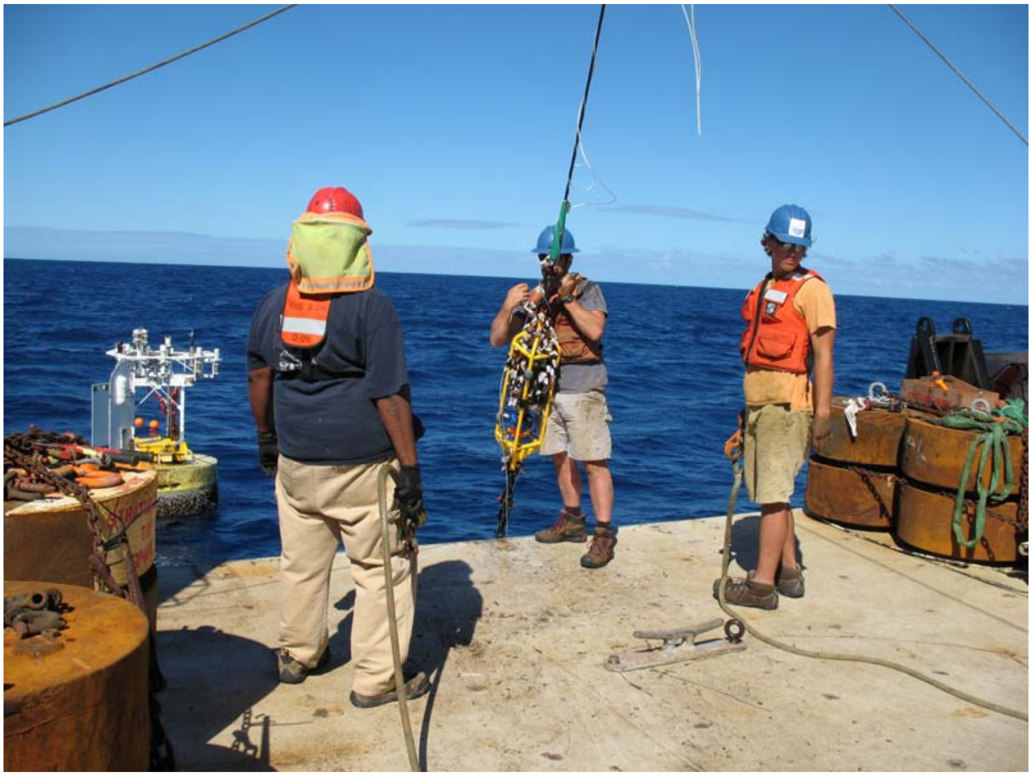


Figure IV-3. Recovery of caged Aanderaa Seaguard below the Stratus 15 buoy, prior to letting the buoy adrift.

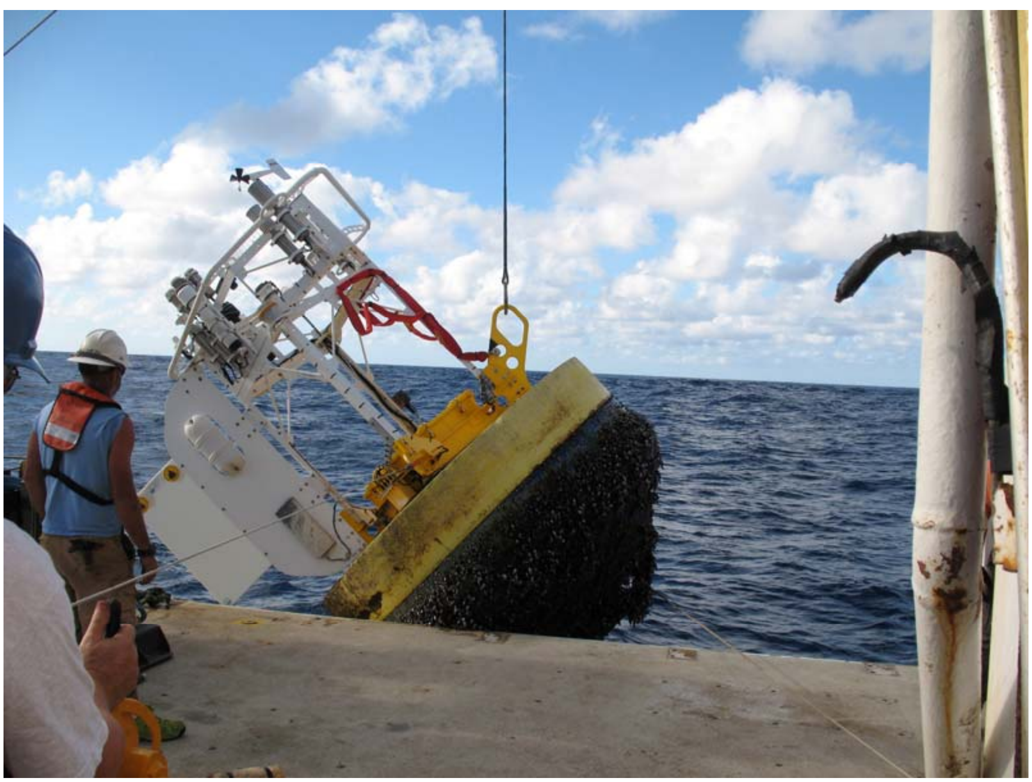


Figure IV-4. Recovery of Stratus 15 buoy on port side of the ship using ship's crane.

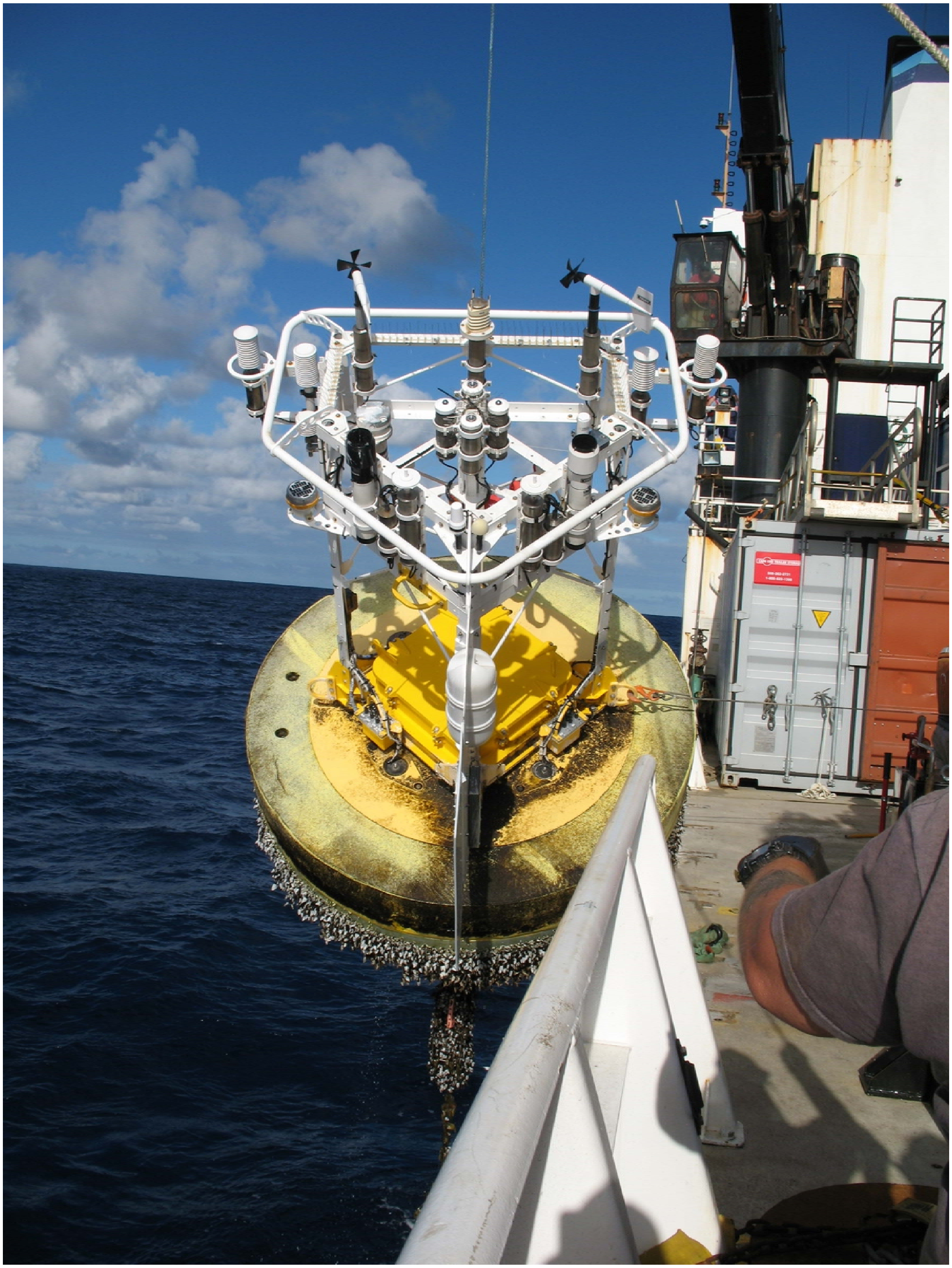


Figure IV-5. Recovery of Stratus 15 buoy on port side using ship's crane.

B. Instrument and Data Return

Figure IV-6 to Figure IV-15 show a good data return from instrumentation recovered from Stratus 15. Figure IV-16 shows that offsets between measurements from identical longwave sensors recovered on Stratus 15 are correlated with incoming shortwave. A similar trend was seen in Figure III-31 between PSD and SCS sensors on the ship.

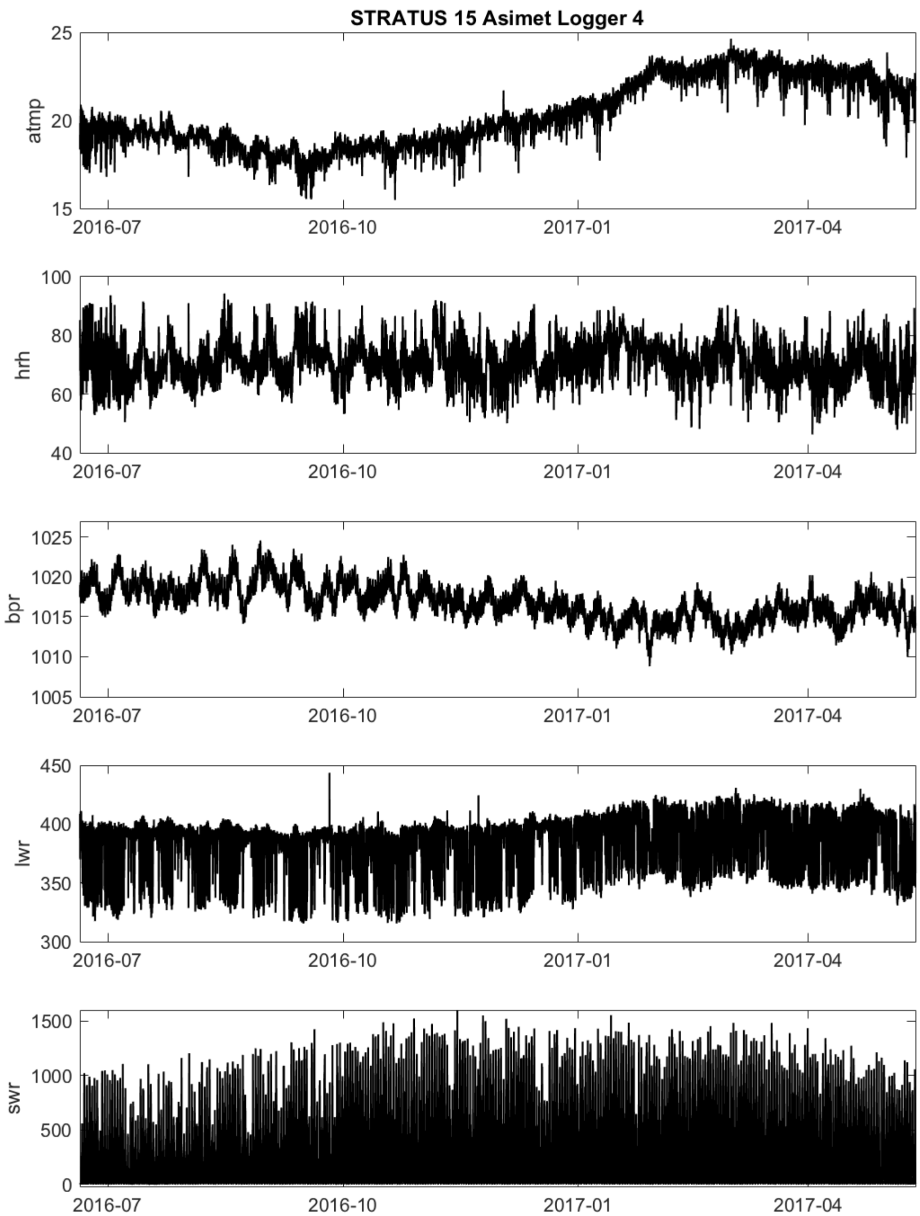


Figure IV-6. 1-minute data recovered from logger 4 (system 1) on Stratus 15: air temperature, air humidity, barometric pressure, incoming longwave radiation, incoming shortwave radiation

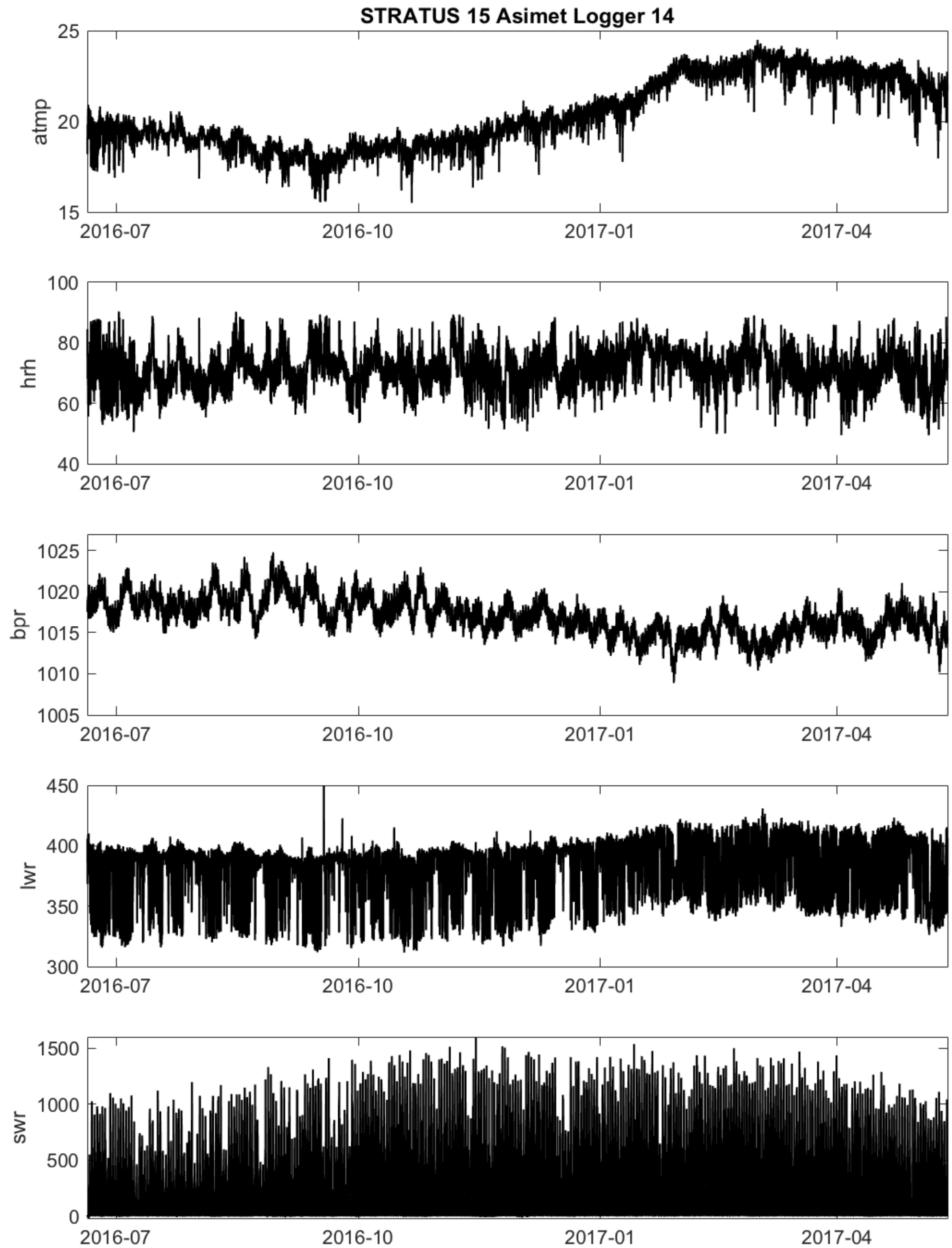


Figure IV-7. 1-minute data recovered from logger 14 (system 2) on Stratus 15: air temperature, air humidity, barometric pressure, incoming longwave radiation, incoming shortwave radiation

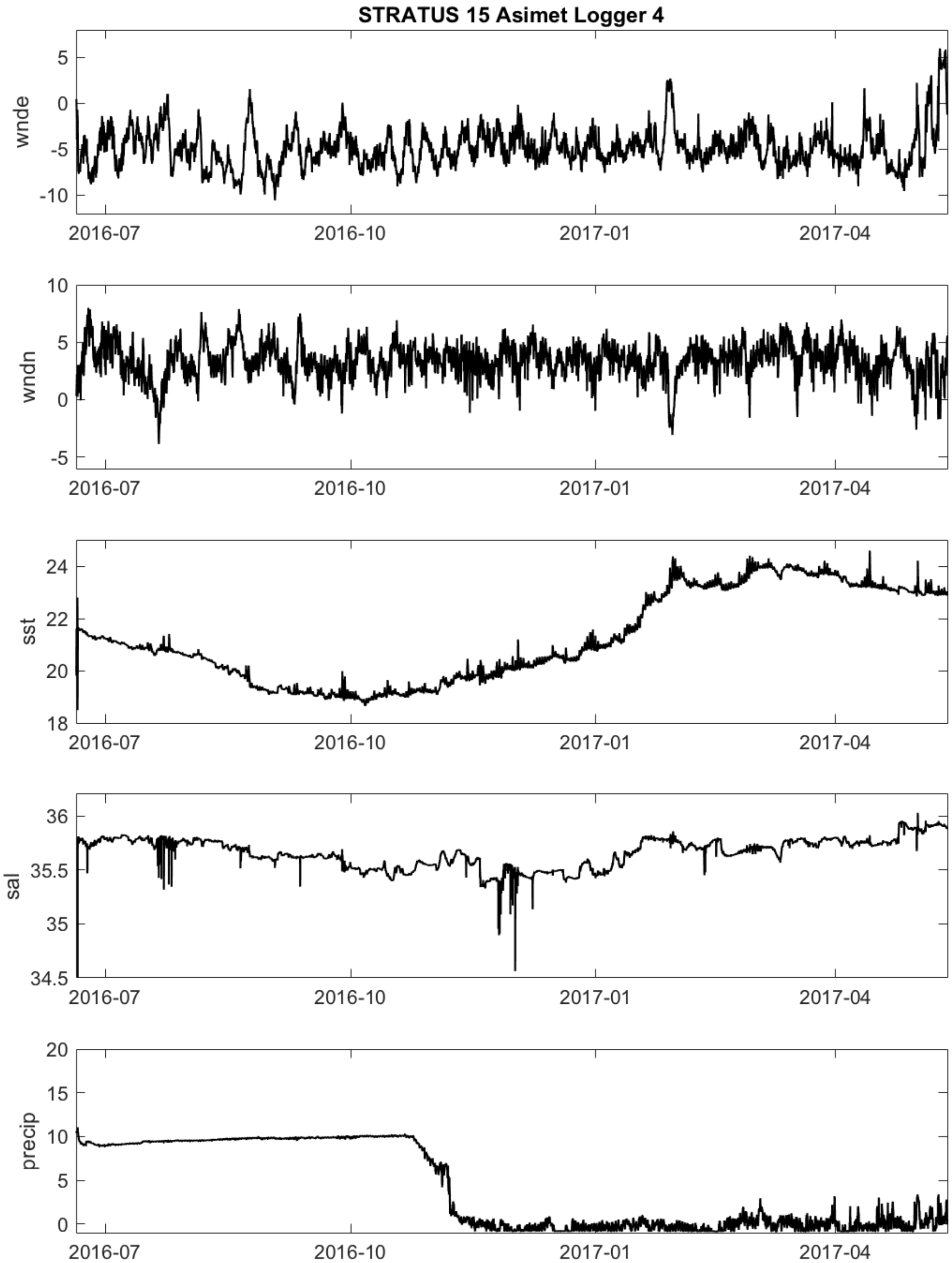


Figure IV-8. 1-minute data recovered from logger 4 (system 1) on Stratus 15: wind east, wind north, sea surface temperature, sea surface salinity, precipitation.

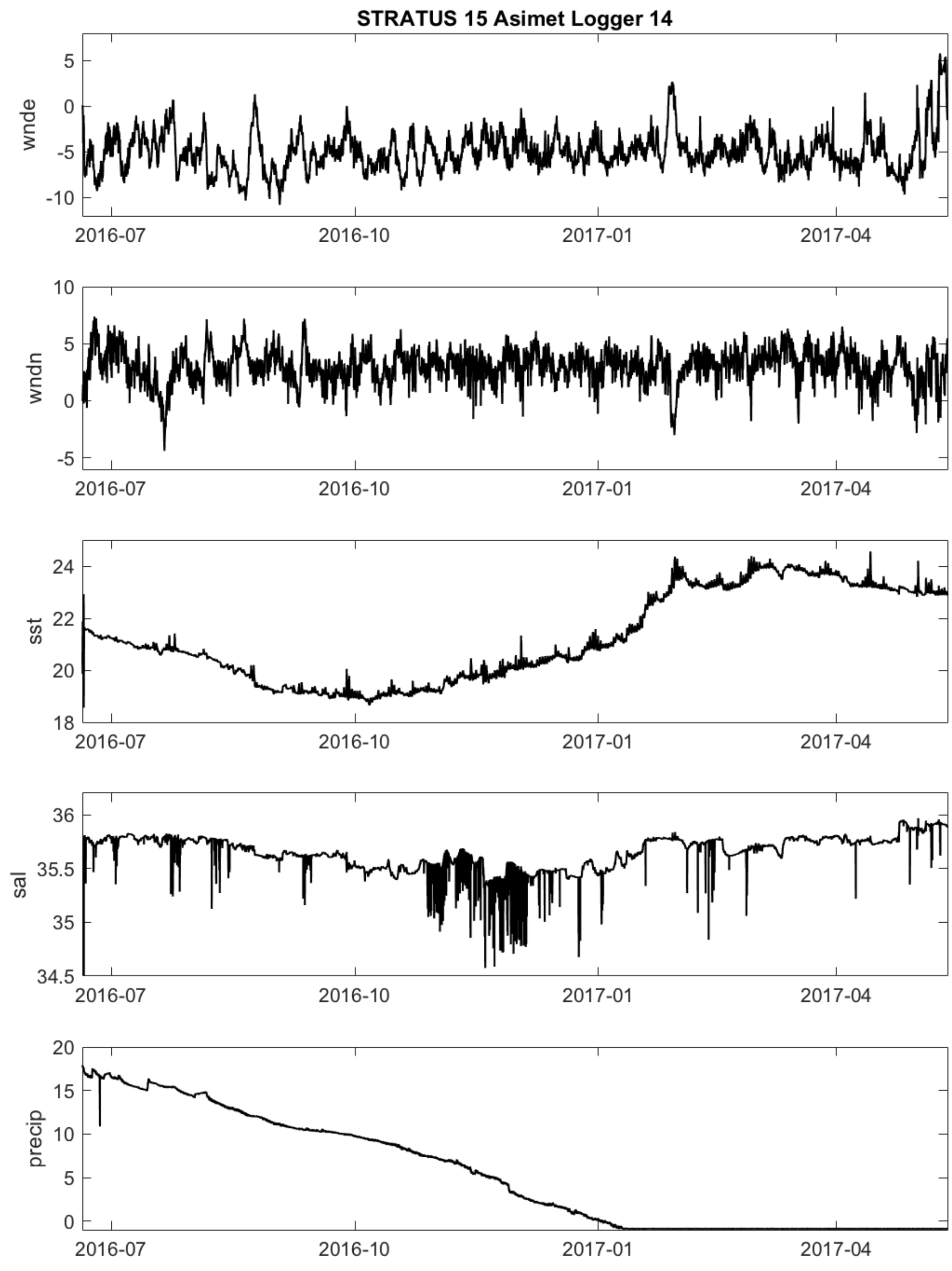
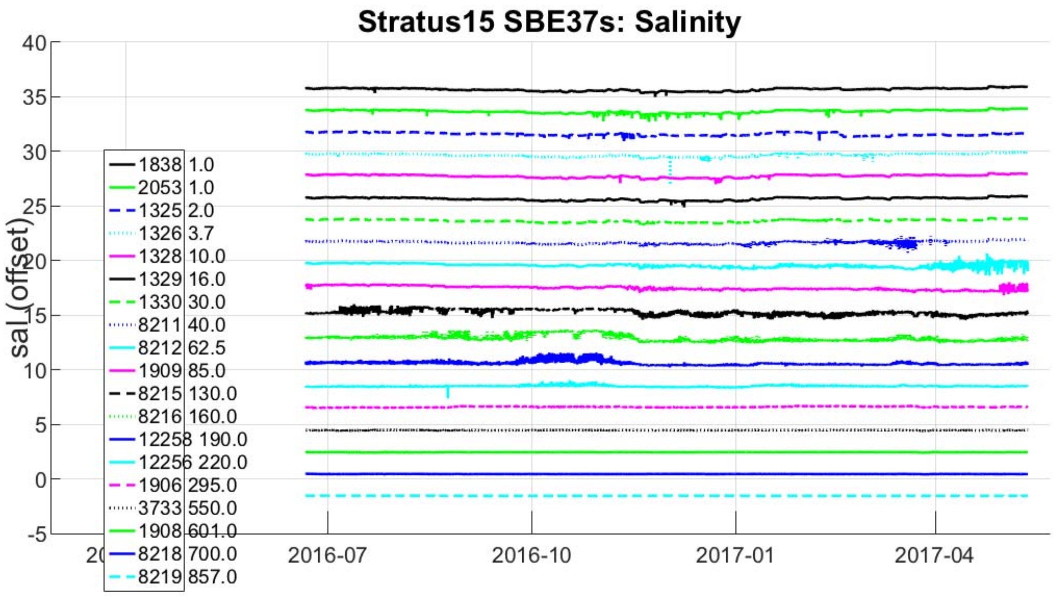


Figure IV-9. 1-minute data recovered from logger 14 (system 2) on Stratus 15: wind east, wind north, sea surface temperature, sea surface salinity, precipitation.



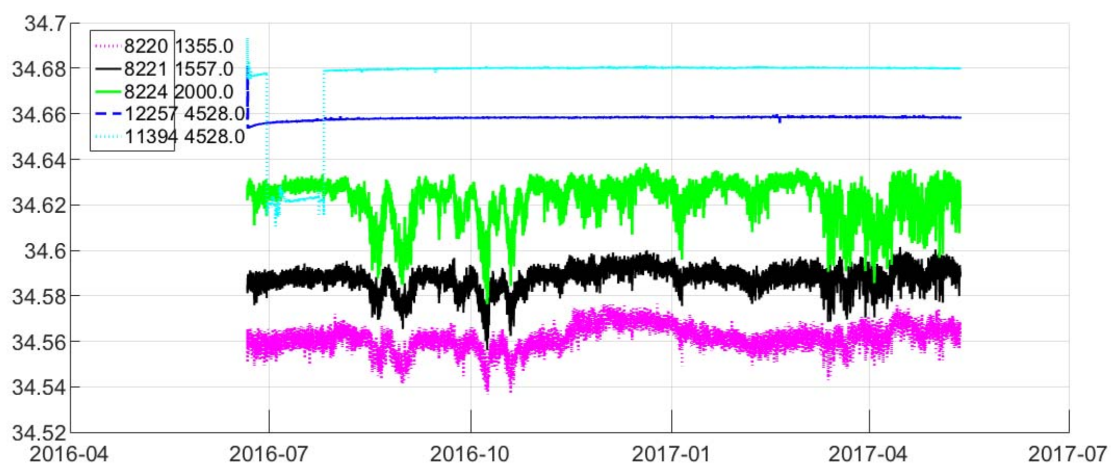
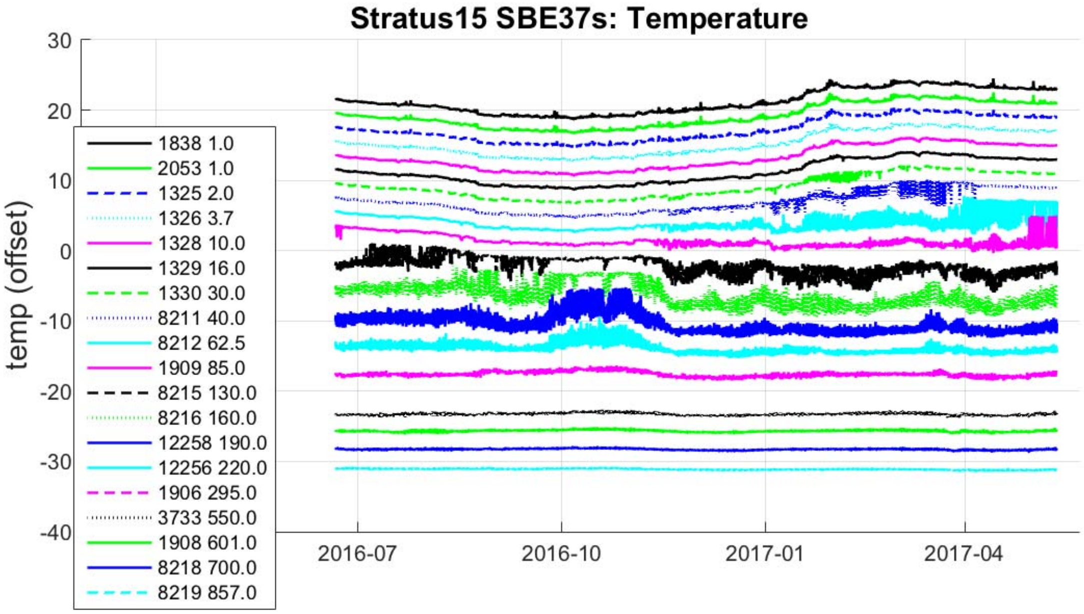


Figure IV-10. Salinity data (with offset for readability) from SBE37s recovered from Stratus 15. Legend indicates serial number and nominal depth of each instrument.



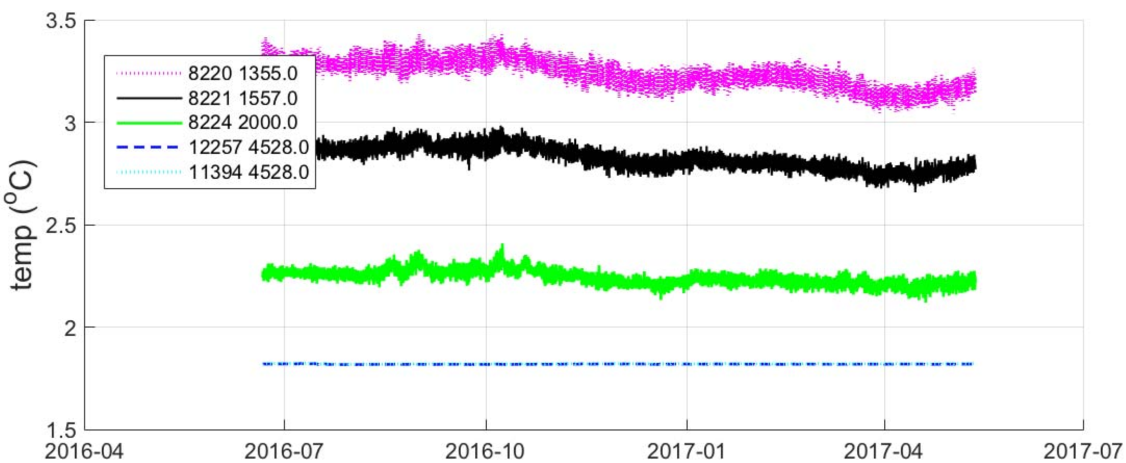


Figure IV-11. Temperature data (with offset for readability) from SBE37s recovered from Stratus 15. Legend indicates serial number and nominal depth of each instrument.

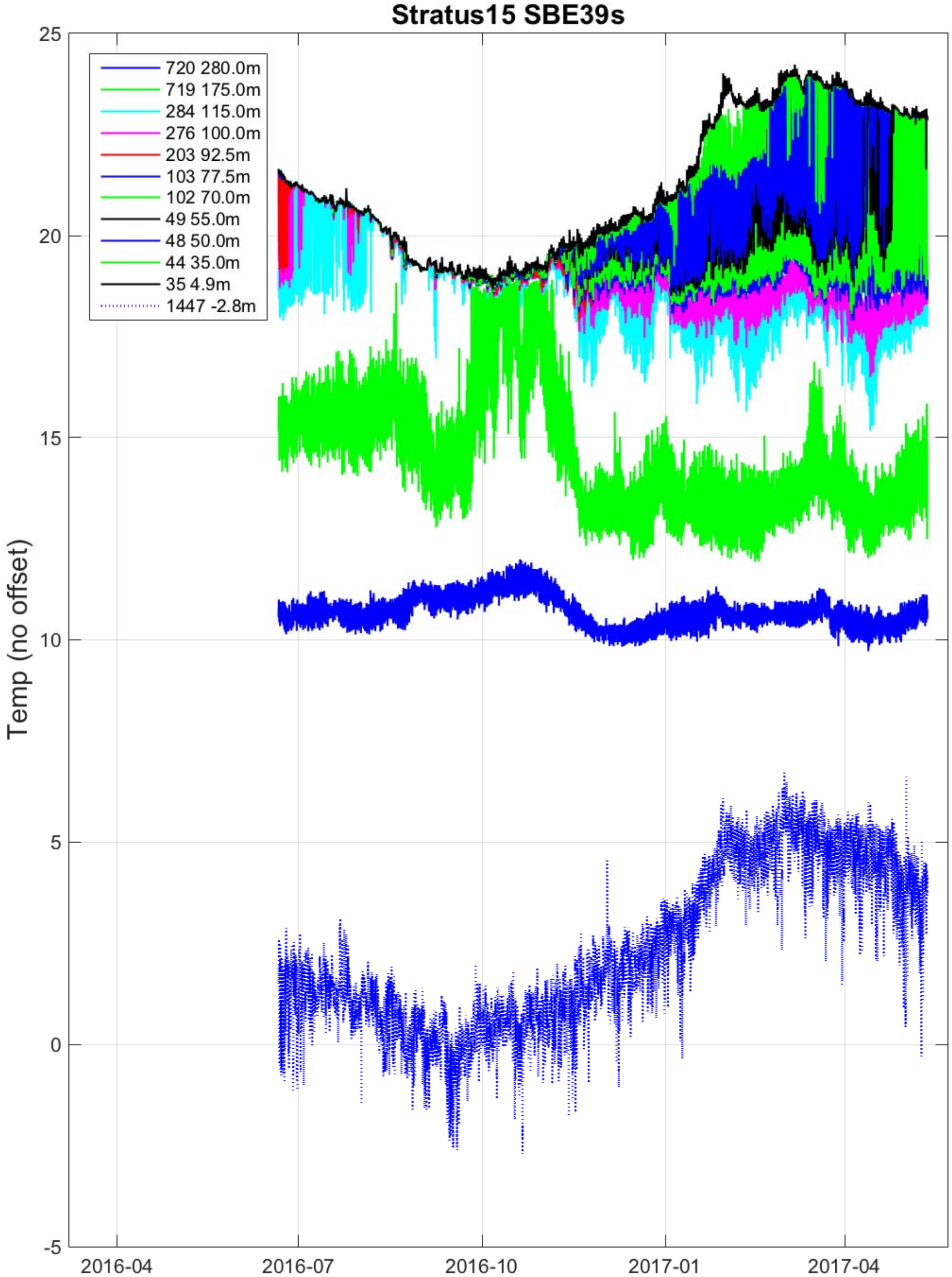


Figure IV-12. Temperature data (with offset for readability) from SBE39s recovered from Stratus 15. Legend indicates serial number and nominal depth of each instrument.

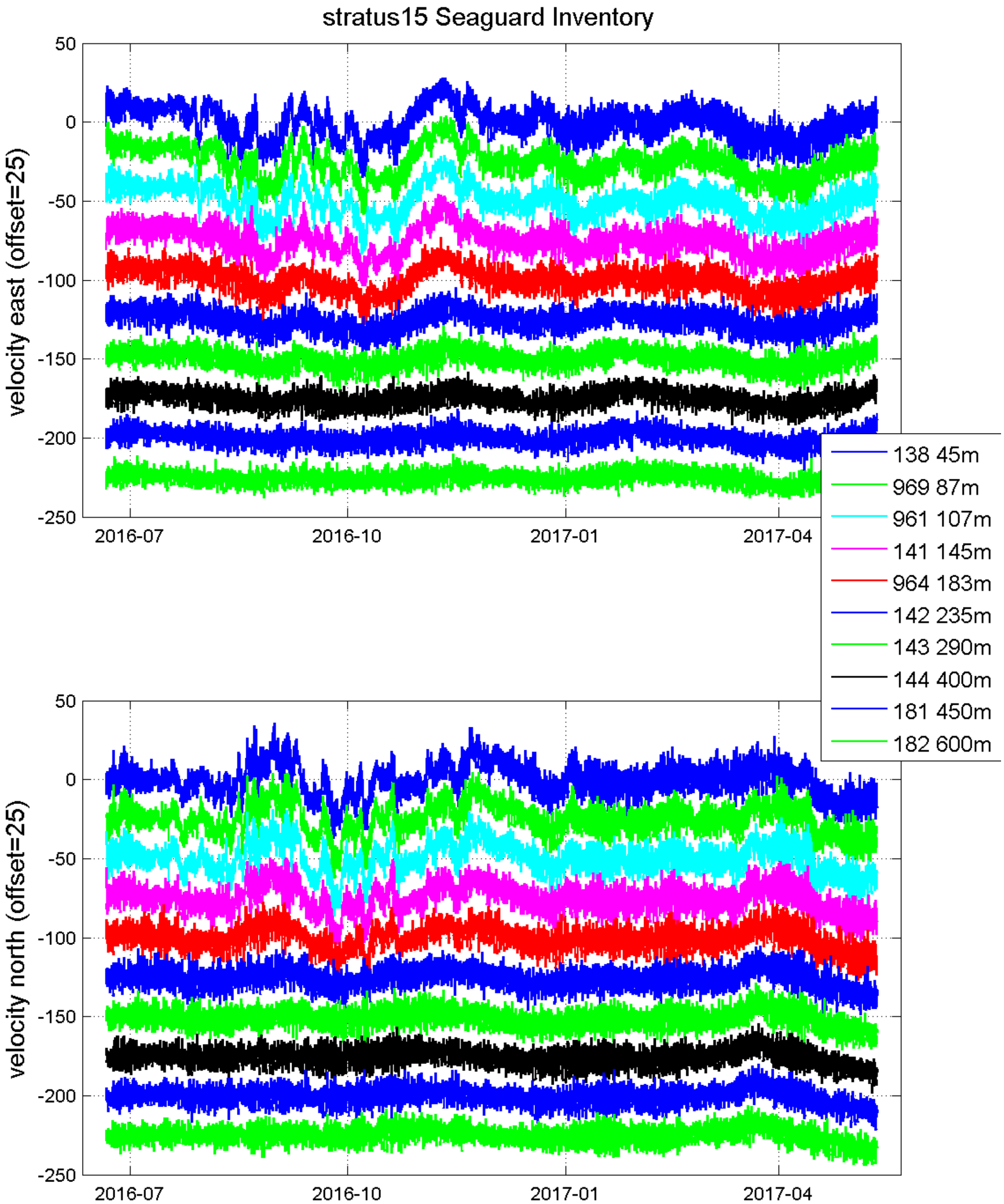


Figure IV-13. Current data (with offset for readability) from Aanderaa Seaguards current meters recovered from Stratus 15. Legend indicates serial number and nominal depth of each instrument.

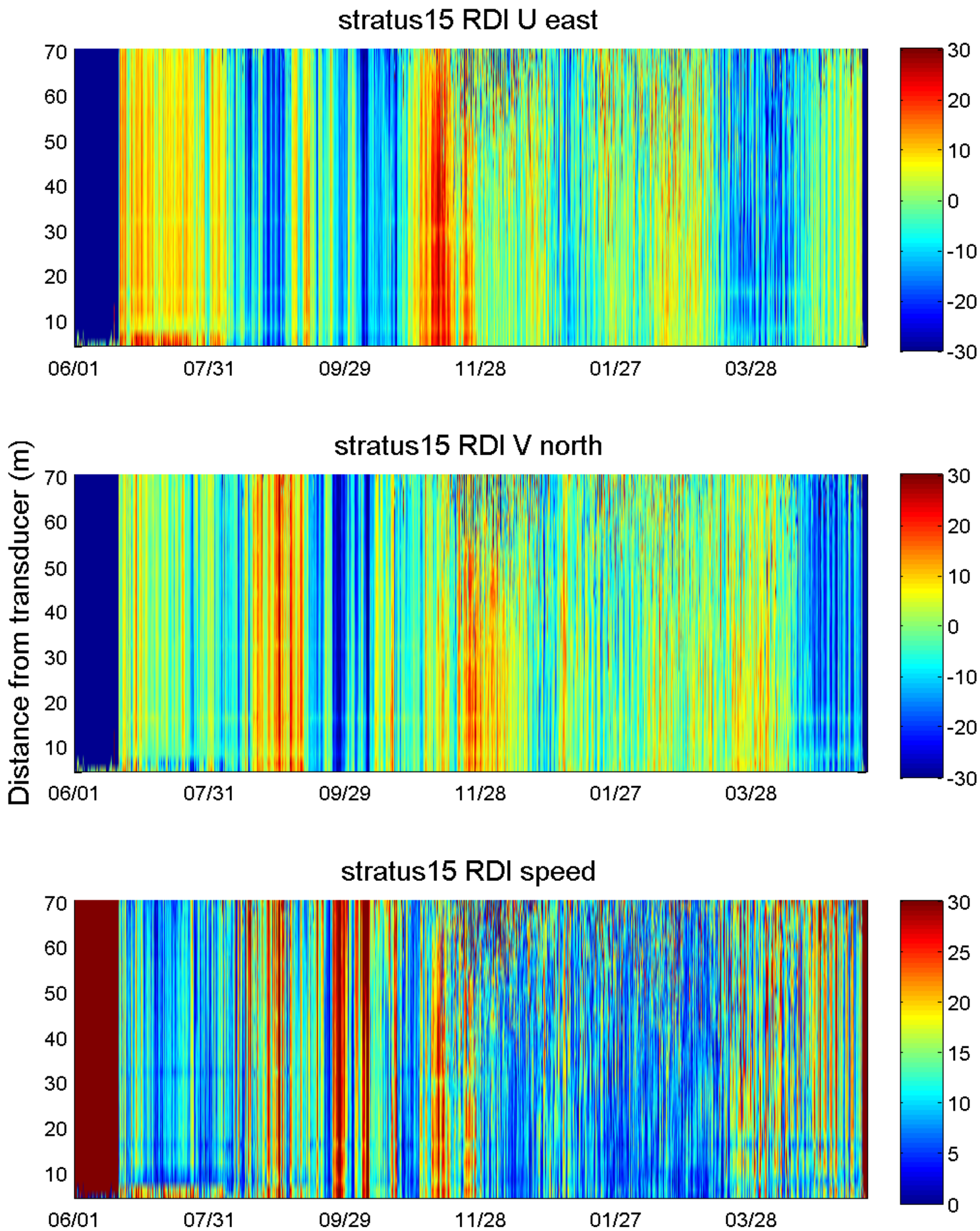


Figure IV-14. Current data from RDI Workhorse ADCP recovered from Stratus 15.

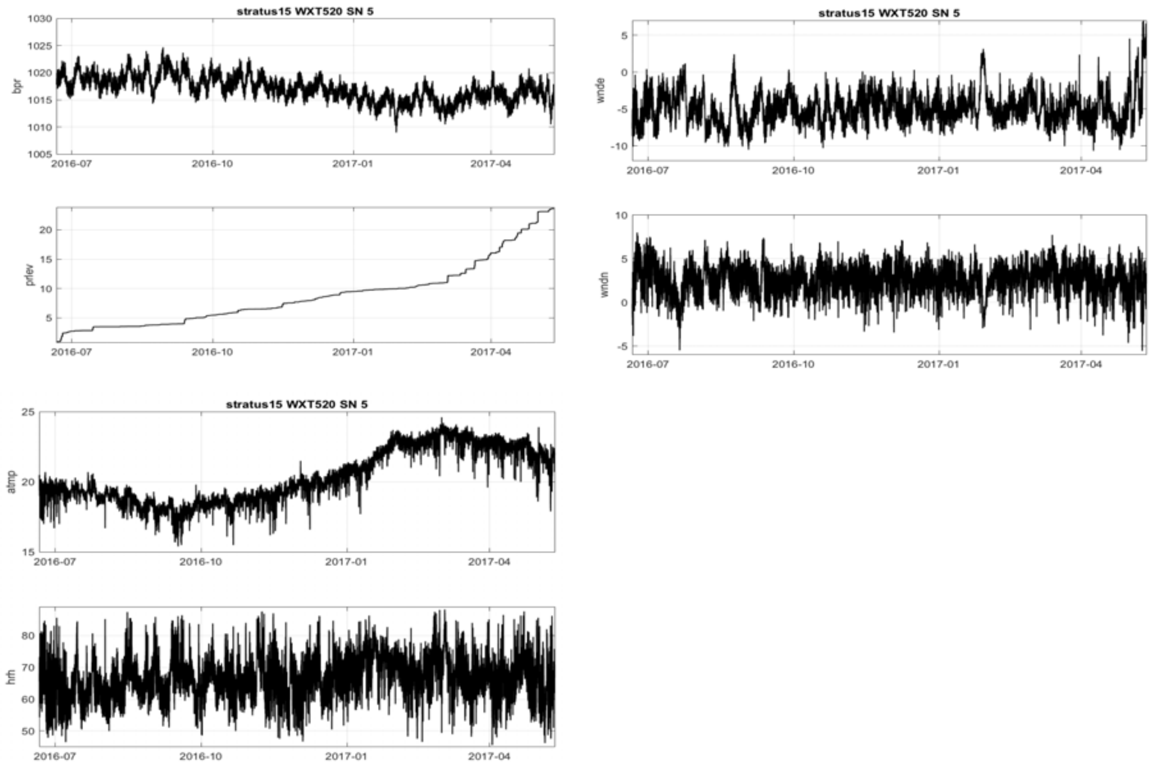


Figure IV-15. Data from Vaisala WXT recovered from Stratus 15.

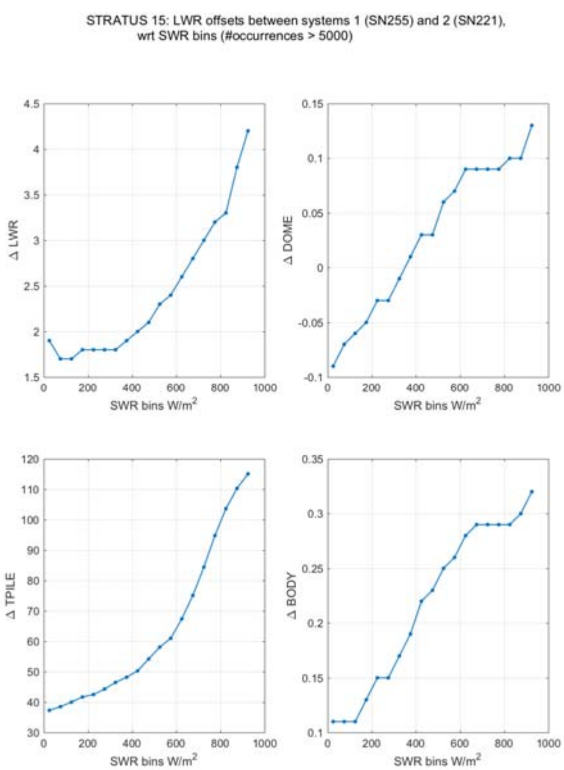


Figure IV-16. Offsets (median from all deployment) between longwave sensor on system 1 and 2 recovered from Stratus 15 as a function of concomitant shortwave radiation also measured on Stratus 15.

V. Ancillary Projects

A. CTDs

Six CTD casts were done during the Stratus 16 cruise. Two were done as a test on May 9 2017, 2 were done at Stratus 15 on May 14 and two at Stratus 16 on May 16.

The ship's CTD instrument was a Sea-Bird SBE19 (Temperature 1 SN = 31713, Conductivity 1 SN = 41473, Temperature 2 SN = 2866, Conductivity 2 SN = 43847; Pressure SN = 09P16228-0489; all sensors calibrated Oct 6 2016) which sampled at 20Hz. The UOP CTD was a Sea-Bird SBE19 (Temperature SN = 2361, Conductivity SN = 2361, both calibrated Sept 9 2015; Pressure SN = 2361 calibrated Sept 3 2015), which sampled at 2Hz.

Table V-1. List of CTD casts operated during Stratus 16 cruise.

CTD #	Event	Date and Time (UTC)	Latitude	Longitude	Depth (m)
1	CTD test	5/9/2017 16:53	9° 12.15'S	83° 24.35' W	500
2	Releases test	5/9/2017 18:10 Bottom 20:00	9° 12.15'S	83° 24.35' W	1,493
3	S15 intercomparison	5/14/2017 12:34 Bottom 14:00 Recovery 15:00	19° 40.18'S	84° 54.64' W	4,000
4	S15 intercomparison	5/14/2017 19:20 Bottom 21:30 Recovery 22:00	19° 40.74'S	84° 53.81' W	4,000
5	S16 intercomparison	5/16/2017 12:29	19° 24.18'S	85° 06.06' W	
6	S16 intercomparison	5/16/2017 16:40	19° 23.61'S	85° 06.06' W	

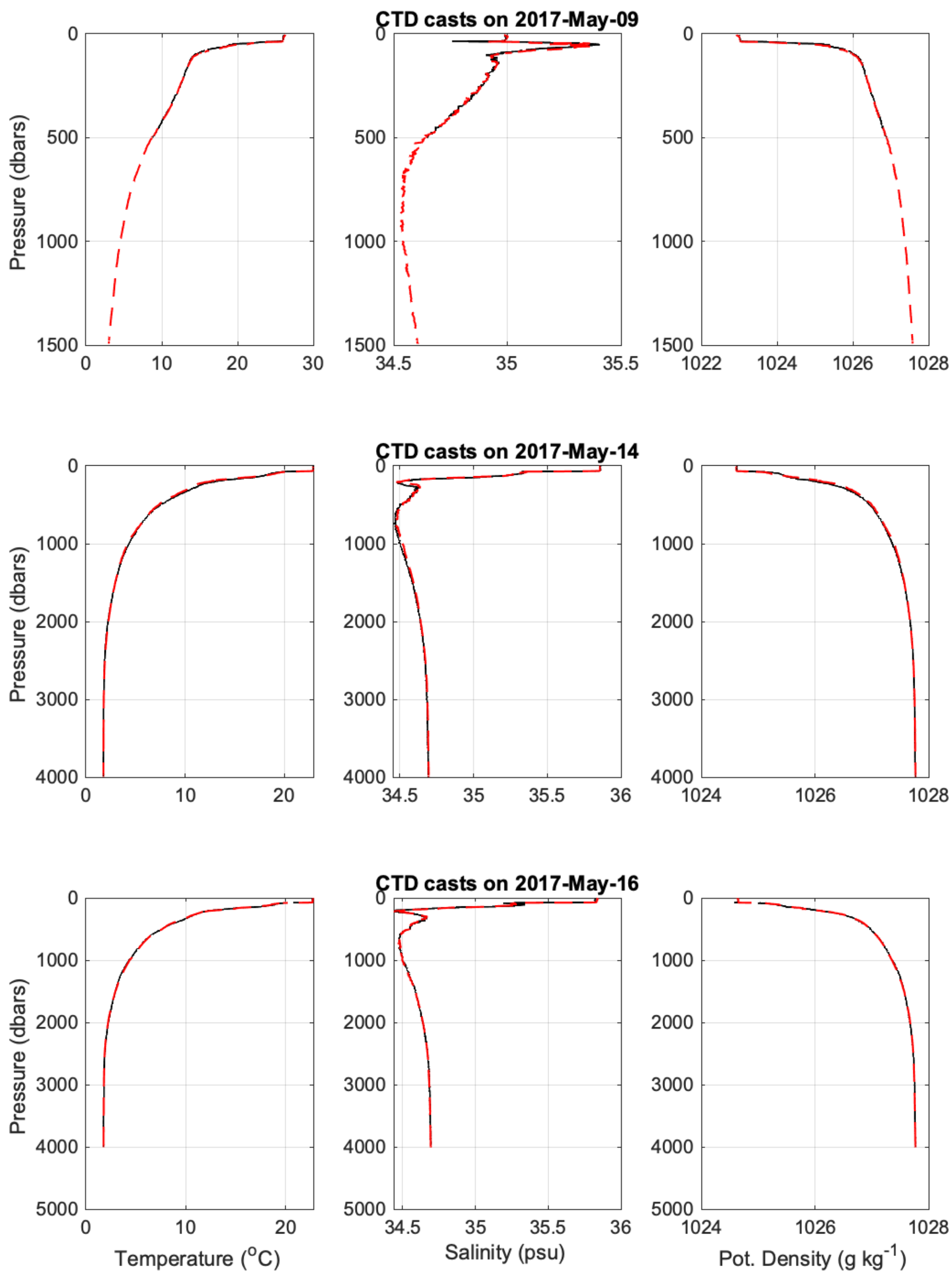


Figure V-1. Profiles from CTD casts conducted during Stratus 16 cruise in May 2017.

B. Drifters and Argo Floats

During the Stratus 16 cruise, surface drifters and Argo profiling floats were launched (see Figure V- for locations). The surface drifters were provided by NOAA AOML (Atlantic Oceanographic and Meteorological Laboratories, Miami, Florida) by the NOAA Global Surface Drifter Program. The ARGO floats were provided by WHOI ARGO group. The Stratus program contacted both AOML and the ARGO float group and volunteered to deploy their drifters and floats in international waters. Table V-1 and Table V-2 provide a tabular summary of surface drifter and Argo deployments.

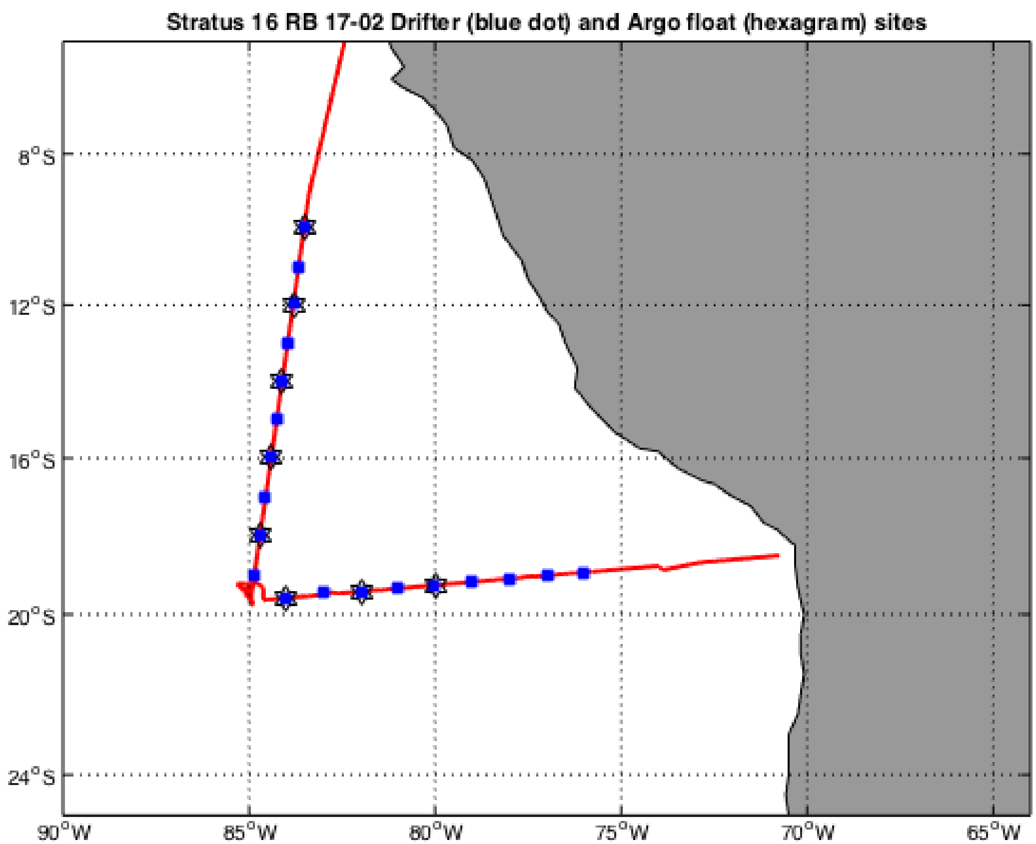


Figure V-2. Locations of drifters and Argo floats deployments during. Stratus 16 cruise in May 2017.

Table V-2. Locations of drifter deployments during Stratus 16 cruise.

	DRIFTER ID	Latitude South (dd mm.mmm)	Longitude West (dd mm.mmm)	Date (mm/dd/yyyy)	Time UTC
1	64732970	9 55.732	83 30.598	5/10/2017	0:17
2	64730150	11 00.0	83 39.9	5/10/2017	6:24
3	64730820	11 58.704	83 48.564	5/10/2017	11:44
4	64730840	11 58.904	83 48.590	5/10/2017	11:45
5	64731160	12 59.596	83 57.460	5/10/2017	17:21
6	64731840	13 59.476	84 06.229	5/10/2017	22:39
7	64731150	14 59.697	84 15.135	5/11/2017	3:56
8	64731810	14 59.757	84 15.143	5/11/2017	3:57
9	64732150	15 59.5	84 24.0	5/11/2017	9:05
10	64731830	16 59.890	84 33.050	5/11/2017	14:30
11	64731820	17 59.499	84 41.995	5/11/2017	19:45
12	64731950	17 59.649	84 42.013	5/11/2017	19:46
13	64732160	19 00.600	84 51.226	5/12/2017	1:22
14	64732570	19 35.040	84 00.312	5/17/2017	8:16
15	64732980	19 26.020	83 00.894	5/17/2017	13:37
16	64730830	19 26.026	83 00.782	5/17/2017	13:37
17	64732250	19 25.248	81 59.246	5/17/2017	19:00
18	64730970	19 20.372	80 59.606	5/18/2017	0:03
19	64730890	19 15.657	80 01.561	5/18/2017	4:57
20	64730960	19 15.640	80 01.221	5/18/2017	4:59
21	64733150	19 10.623	79 00.086	5/18/2017	10:21
22	64733790	19 05.798	78 00.444	5/18/2017	15:27
23	64733560	19 00.795	76 59.240	5/18/2017	20:55
24	64730130	18 56.038	76 00.711	5/18/2017	22:09

Table V-2. Locations of Argo floats deployments during Stratus 16 cruise.

	FLOAT ID	Latitude South (dd mm.mmm)	Longitude West (dd mm.mmm)	Date (mm/dd/yyyy)	Time UTC
1	7409	9 56.208	83 30.667	5/10/2017	0:23
2	7411	11 59.444	83 48.669	5/10/2017	11:50
3	7415	13 59.899	84 06.351	5/10/2017	22:43
4	7412	15 59.9	84 24.1	5/11/2017	9:10
5	7413	18 00.023	84 42.054	5/11/2017	19:49
6	7414	19 35.008	83 59.859	5/17/2017	8:20
7	7416	19 25.235	81 59.090	5/17/2017	19:03
8	7410	19 15.598	80 00.182	5/18/2017	5:08

CHARLESTON S16 Buoy Spin

Heading	10				
Turn	0				
	Time	Date			
Vanes Secure	15:45:00	20-Apr-17			
System 1		VANE	Compass	Direction	Sample Time
Logger	L01				
WND	230	7.40	3.10	10.50	16:43:00
System 2		Vane	Compass	Direction	Sample Time
Logger	L02				
WND	231	8.80	2.60	11.40	16:38:00
		VANE	Compass	Direction	Sample Time
VWX008	Stand Alone	N/A	4.00	N/A	16:42:00

Heading	0				
Turn	45				
	Time	Date			
Vanes Secured UTC					
System 1		VANE	Compass	Direction	Sample Time
Logger	L01				
WND	230	277.00	97.00	14.00	17:14:00
System 2		Vane	Compass	Direction	Sample Time
Logger	L02				
WND	231			0.00	
		VANE	Compass	Direction	Sample Time
VWX008	Stand Alone	N/A		N/A	

Heading	10				
Turn	90				
	Time	Date			
Vanes Secure	17:00:00	20-Apr-17			
System 1		VANE	Compass	Direction	Sample Time
Logger	L01				
WND	230	277.20	97.00	14.20	17:14:00
System 2		Vane	Compass	Direction	Sample Time
Logger	L02				
WND	231	274.60	98.40	13.00	17:17:00
		VANE	Compass	Direction	Sample Time
VWX008	Stand Alone	N/A	97.30	N/A	17:19:00

Heading	0				
Turn	135				
	Time	Date			
Vanes Secured UTC					
System 1		VANE	Compass	Direction	Sample Time
Logger	L01				
WND	230			0.00	
System 2		Vane	Compass	Direction	Sample Time
Logger	L02				
WND	231			0.00	
		VANE	Compass	Direction	Sample Time
VWX008	Stand Alone	N/A		N/A	

Heading	0				
Turn	180				
	Time	Date			
Vanes Secured UTC					
System 1		VANE	Compass	Direction	Sample Time
Logger	L01				
WND	230	185.00	176.20	1.20	17:49
System 2		Vane	Compass	Direction	Sample Time
Logger	L02				
WND	231	184.10	180.00	4.10	17:47:00
		VANE	Compass	Direction	Sample Time
VWX008	Stand Alone	N/A	178.80	N/A	17:46:00

Heading	0				
Turn	225				
	Time	Date			
Vanes Secured UTC					
System 1		VANE	Compass	Direction	Sample Time
Logger	L01				
WND	230			0.00	
System 2		Vane	Compass	Direction	Sample Time
Logger	L02				
WND	231			0.00	
		VANE	Compass	Direction	Sample Time
VWX008	Stand Alone	N/A		N/A	

Heading	0				
Turn	270				
	Time	Date			
Vanes Secure	17:50:00	20-Apr-17			
System 1		VANE	Compass	Direction	Sample Time
Logger	L01				
WND	230	95.40	267.50	2.90	18:10:00
System 2		Vane	Compass	Direction	Sample Time
Logger	L02				
WND	231	93.60	270.90	4.50	18:12:00
		VANE	Compass	Direction	Sample Time
VWX008	Stand Alone	N/A	271.00	N/A	18:13:00

Moored Station Log

(fill out log with black ball point pen only)

ARRAY NAME AND NO. STRATUS 15 MOORED STATION NO.________

Launch (anchor over)

Date (day-mon-yr) 20-06-16 Time 21:48 UTC

Deployed by Lord / Pietro Recorder/Observer Bigorre

Ship and Cruise No. AGS61 Cabo de Hornos Intended Duration 1 year

Depth Recorder Reading 4600 (12kHz) m Correction Source Mathews table + past CTDs (sound velocity = 1509 m/s)

Depth Correction -35 m m

Corrected Water Depth 4565 m Magnetic Variation (E/W)________

Anchor Drop Lat. (N/Ⓢ) 19° 37.627' Lon. (E/Ⓦ) 84° 56.687'

Surveyed Pos. Lat. (N/Ⓢ) 19° 37.5734' Lon. (E/Ⓦ) 84° 56.818'

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

Acoustic Release Model Edgetech Tested to 500 m

Release No. 1 (sn) 48274 ✓ Release No. 2 (sn) 48281

Interrogate Freq. 11 kHz Interrogate Freq. 11 kHz

Reply Freq. 12 kHz Reply Freq. 12 kHz

Enable 567402 Enable 567743

Disable 567421 Disable 567760

Release ~~?~~ 551071 Release 551241

Recovery (release fired)

Date (day-mon-yr) 12-05-17 * Time 11:16 UTC

Latitude (N/Ⓢ) 19° 37' 24.2" Longitude (E/Ⓦ) 85° 56' 34.5"

Recovered by B. Pietro Recorder/Observer S. Bigorre

Ship and Cruise No. RB 17-02 Actual duration________ days

Distance from waterline to buoy deck 55 cm

* see comments on last page

1

ARRAY NAME AND NO. STRATUS 15 MOORED STATION NO.________

Surface Components

Buoy Type HOBS Color(s) Hull Tower Yellow (top), Blue (bottom), white (tower)

Buoy Markings If found adrift contact Woods Hole Oceanographic Woods Hole, MA 02543 USA. 508-457-1401

Surface Instrumentation

Item	ID #	Height* cm, above deck	Comments
ASIMET logger	L04		Port side . System 1
HRH	299	230	
BPR	218	245	
WND	217	271	
PRC	214	253	
LWR	255	278	
SWR	212	279	
SST	1838	-152	
PTT	12789		27916, 27917, 27918
ASIMET logger	L14		Starboardside . System 2
HRH	256	230	
BPR	210	243	
WND	210	271	
PRC	501	253	
LWR	221	278	
SWR	214	279	
SST	2053	-152	
PTT	18171		27919, 27920, 27921
WXT	5	250 (245 at top of white collar)	Center front
LASCAR	~~243~~ 356	205	port
SBE39	1447	223	port
HRH	216	230	starboard
XEOS Rover			300434060815350
PCO2			

*Height above buoy deck in centimeters

ARRAY NAME AND NO. STRATUS 15 MOORED STATION NO.________

Subsurface Instrumentation on Buoy and Bridle			
Item	**ID #**	**Depth†**	**Comments**
WAMDAS	6014		3002 2401 0100 810
XEOS Kilo			3002 3406 2945 460
SBE 56	2065	-80	bow
SBE 56	2066	-80	starboard
SBE 56	2067	-80	stern
SBE 56	2068	-80	port
PCO2	112		
SAMI	P0044		
SBE 16	6566		
WAMDAS	6014		SIM # 89881 69312 00205 1278
			3DM-GX1 # 2470
			NDBC wave station 32012
			32ST0

†Depth below buoy deck in centimeters

ARRAY NAME AND NO. STRATUS 15 MOORED STATION NO.

Item No.	Length (m)	Item	Depth	Inst No.	Time Over	Time Back	Notes
1		Buoy			1347	2105	guano on port PRC (no birdwire here)
2	.22	3/4 chain					
3		SBE37	2	1325	1346	2105	
4	.37	3/4 chain					
5		SBE 37	3.7	1326	1346	2105	
6		termination					
7		SBE39	4.9	35	1346	2105	down. Thermistor bent by fishing rope.
8	1.3	3/4 chain					
9		RCM 11	7	78	1346	2123	
10	1.5	3/4 chain					
11		SBE 37	10	1328	1326	2123	
12	1.73	3/4 chain					
13		Nortek ADCP	13	357	1324	2130	Heads up. 2 MHz
14	1.35	3/4 chain					
15		SBE37	16	1329	~~1316~~ 1319	2130	
16	2.70	3/4 chain					
17		RCM 11	20	79	1316	2135	
18	3.66	3/4 chain					
19		SBE 39	25	38	1310	2138	up. Battery loose inside, no data. Fill gap in pressure case for future deploy
20	3.90	3/4 chain					
21		SBE 37	30	1330	1306	2141	
22	1.12	3/4 chain					
23		RCM 11	32.5	13	1305	2141	One barnacle on edge of Xducer eye.
24	1.2	3/4 chain					
25		SBE39	35	44	1303	2141	up

4

ARRAY NAME AND NO. STRATUS 15 MOORED STATION NO. ____

Item No.	Length (m)	Item	Depth	Inst No.	Time Over	Time Back	Notes
26	3.9	3/4 chain					
27		SBE37	40	8211	1300	2145	
28	3.66	3/4 chain					
29		Seaguard ADCM	45	138	1259	1904	with optode
~~30~~		~~SBE39~~	~~50~~	~~48~~			~~clamped~~
31	16m	7/16 wire					
32		SBE39	50	48	1259	1900	clamped
33		SBE39	55	49	1408	1859	clamped . ~~[illegible] thermistor and~~ fishing tape.
34		SBE37	62.5	8212	1413	1857	load bar. Fishing line under it.
35	16m	7/16 wire					
36		SBE39	70	102	1416	1855	clamped
37		SBE39	77.5	103	1421	1853	clamped
38		RDI ADCP	80	1218	1426	1852	
39	6	7/16 wire					
40		SBE37	85	1909	1432	1851	clamped. with pressure
41		Seaguard ADCM	87.3	969	1432	1848	with optode (LS)
42	18.2	7/16 wire					
43		SBE39	92.5	203	1434	1846	clamped
44		SBE39	100	276	1439	1844	clamped
45		Fluorometer FLSB	100.5	2866	1439	1844	clamped, cap off. moved above SBE39#276 , Loose clamp
46		Seaguard ADCM	107	961	1445	1841	with optode. (LS)
47	21.5	7/16 wire					
48		SBE39	115	284	1445	1840	clamped
49		SBE37	130	8215	1449	1837	with load bar.
50	14	7/16 wire					

ARRAY NAME AND NO. STRATUS 15 MOORED STATION NO.______

Item No.	Length (m)	Item	Depth	Inst No.	Time Over	Time Back	Notes
51		Seaguard ADCM	145	141	1456	1831	with optode
52	13.5	7/16 wire					
53		SBE 37	160	8216	1501	1828	load bar
54	21.7	7/16 wire					
55		SBE 39	175	719	1503	1824	clamped
56		Seaguard ADCM	183	964	1509	1821	with optode (LS)
57	5.5	7/16 wire					
58		SBE37	190	12258	1515	1817	load bar · No plug
59	29	7/16 wire					
60		SBE37	220	12256	1520	1812	load bar
61	13.5	7/16 wire					
62		Seaguard ADCM	235	142	1526	1809	with optode
63	53.5	7/16 wire					
64		Optode	250	~~691~~ 943	1530	1807	clamped (LS)
65		SBE39	280	720	1534	1804	clamped
66		Seaguard ADCM	290	143	1539	1800	with optode
67	58.5	3/8 wire					
68		SBE37	295	1906	1542	1800	clamped
69	1	3/4 chain					
70	48.5	3/8 wire					
71		Seaguard ADCM	400	144	1555	1749	with optode
72	48.5	3/8 wire					
73		Seaguard ADCM	450	181	1559	1745	with optode
74	148.5	3/8 wire					
75		Optode	500	~~943~~ 691	1603	1735	(LS)

ARRAY NAME AND NO. STRATUS 15 MOORED STATION NO. ________

Item No.	Length (m)	Item	Depth	Inst No.	Time Over	Time Back	Notes
76		SBE37	550	3733	1607	1731	clamped, with pressure
77		Seaguard ADCM	600	182	1615	1726	with optode
78	200	3/8 wire					
79		SBE37	601	1908	1617	1726	clamped. No plug (for test)
80		SBE37	700	8218	1612	1721	clamped
81		VMCM	802	1	1625	1716	1618 rotors spunned up; top shackle hackled recently
82	48.5	3/8 wire					
83		VMCM	853	17	1631	1710	1626 spin up
84	500	3/8 wire					
85		SBE37	857	8219	1637	1709	clamped
86		SBE37	1355	8220	1706	1656	clamped. small depth change during deployment (initially 1354 m)
87	150	3/8 wire					
88		VMCM	1506	80	1717	1645	1712 spin up
89	500	3/8 wire					
90		SBE37	1557	8221	1721	1643	clamped
91		SBE37	2000	8224	1740	1626	clamped
92		VMCM	2009	91	1744	1613	1739 spin up. 2 blades missing on top rotor.
93	100	3/8 wire					} potted termination
94	200	7/8 nylon				1610	}
95	1700	7/8 nylon			1815 (start)	1600 end	} spliced at sea
96	1500	1" Colmega					}
97		glassballs (92)			2048	1305 to 1400	卌 卌 卌 卌 III (23) (one ball broken) 3 glass balls broken at recovery
98		SBE37	4528	~~2053~~ 12257	~2125	1422 5/12/17	} on same load bar 37m above bottom
99		SBE37	4528	~~1832~~ 11394	~2125	1422 5/12/17	}
100	5	1/2 chain					

One glass balls broken @ deployment and removed (near top).
Three more balls broken at 7 recovery.

ARRAY NAME AND NO. STRATUS 15 MOORED STATION NO.________

Date/Time		Comments				
Item no	Length	Item	Depth	Inst. No.	Time Over	Time Back
101		Acoustic Releases		48274 48281	~2130	1426 5/12/17
102	1m chain 5	1/2 chain				
103	20	1" Nystron				
104	5	1/2 chain				
105		Anchor			2148	
		Depth at anchor drop 4600 m				
5/12/2017		glassballs surface 46 min after release				
		* Recovery occurred in two steps:				
		1) anchor released on 5/12/2017 with				
		recovery of releases and two deep SBE37s.				
		2) recovery of glass balls and all ~~remaining~~				
		instrumentation above deep CTDs on 5/15/2017				
		Buoy and mooring were adrift between May 12 and 15 2017.				
		This was done on purpose in order to retrieve				
		strongback on releases for new mrg S16.				

09G0135

Moored Station Log

(fill out log with black ball point pen only)

ARRAY NAME AND NO. STRATUS 16 MOORED STATION NO. ________

Launch (anchor over)

Date (day-mon-yr) 13 - 05 - 17 Time 19:40 UTC

Deployed by Ben Pietro Recorder/Observer S. Bigorre

Ship and Cruise No. Ron Brown RB-17-02 Intended Duration 365 days

Depth Recorder Reading 4523 m Correction Source Multibeam with

Depth Correction +11 m local speed of sound

Corrected Water Depth 4534 m Magnetic Variation (E/W) ________

Anchor Drop Lat. (N/(S)) 19° 25.894' Lon. (E/(W)) 85° 04.361'

Surveyed Pos. Lat. (N/(S)) 19° 25.8101' Lon. (E/(W)) 85° 04.4254'

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

Acoustic Release Model 8242XS Tested to 1,500 m

Release No. 1 (sn) 31270 Release No. 2 (sn) 35316

Interrogate Freq. 11 kHz Interrogate Freq. 11 kHz

Reply Freq. 12 kHz Reply Freq. 12 kHz

Enable 360042 Enable 111273

Disable 360061 Disable 111302

Release ________ Release ________

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 55 cm

1

ARRAY NAME AND NO. STRATUS 16 **MOORED STATION NO.**________

Surface Components

Buoy Type MOB **Color(s) Hull Tower** Yellow (top), Blue (bottom).

Buoy Markings If found adrift contact woods hole oceanographic Woods Hole, MA 02543 USA 508-457-1401

Surface Instrumentation

Item	ID #	Height*	Comments
ASIMET logger	L01		Port side
HRH	230	240	
BPR	221	245	
WND	344	271	
PRC	220	253	
LWR	231	285	
SWR	268	286	Kipp & Zonen
SST	1305	-142	
PTT	99538		14644, 14652, 14653
ASIMET logger	L02		Starboard side
HRH	231	240	
BPR	504	245	
WND	225	271	
PRC	275	253	
LWR	206	285	
SWR	254	286	
SST	3605	-142	
PTT	14709		09805, 09807, 09811
Standalones			
WXT	8	245 top white ring	
Lascar	10023643	223	
SBE39AT	5275	223	
HRH	221	240	
SWR	207	286	

***Height above buoy deck in centimeters**

2

ARRAY NAME AND NO. STRATUS 16 MOORED STATION NO.________

Subsurface Instrumentation on Buoy and Bridle			
Item	**ID #**	**Depth†**	**Comments**
WAMDAS	6017		NDBC # 28560
			IMEI 300 224 01010 3770
			SIM 8988 169312 00205 1229
			3DM GX1 8713
			IR 24537
			NDBC station 32012 (32STØ)
XEOS			
Kilo			3002 3406 2644 350
Mello			3008 4013 2077 60
Rover			3004 3406 0447 400
SBE56	1206	90	Port 90°
SBE56	1208	120	Port 90°
SBE56	1210	140	Port 90°
SBE56	1211	90	Forward 180°
SBE56	2069	90	Starboard 270°
PCO2	0132		
SAMI	P62		
SBE16	7260		pump# 1780
Fluor	2401		

†Depth below buoy deck in centimeters

3

ARRAY NAME AND NO. STRATUS 16 **MOORED STATION NO.**_________

Item No.	Length (m)	Item	Depth	Inst No.	Time Over	Time Back	Notes
1		Buoy			1346		
2	0.22	3/4 chain					
3		SBE 37	2	1304	1346		
4	0.37	3/4 chain					
5		SBE 37	3.7	3821	1346		
6	0.53	chain					
7		SBE 39	5	39	1346		
8	0.9	3/4 chain					
9		SBE 37	7	3824	~~1314~~ 1346		
10	4	3/4 chain					
11		SBE 39	12.2	41	1257		
12		termination					
13		Aanderaa ADCP	13	235	1256		
14	1.95	3/4 chain					
15		SBE 37	16.4	1899	1256		
16	2.1	3/4 chain					
17		SBE 39	20	53	1252		
18	4.05	3/4 chain					
19		SBE 39	25	101	1247		
20	3.97	3/4 chain					
21		SBE 37	30	1900	1245		
22	1.13	3/4 chain					
23		Aanderaa ADCM	32.5	238	1245		
24	1.13	3/4 chain					
25		SBE 39	35	721	1241		

ARRAY NAME AND NO. STRATUS16 MOORED STATION NO.________

Item No.	Length (m)	Item	Depth	Inst No.	Time Over	Time Back	Notes
26	3.97	3/4 chain					
27		SBE37	40	1901	1237		
28	3.23	3/4 chain					
29		VMCM	45	3	1231		spin @ 1230
30	15.3	7/16" wire					
31		SBE39	52	1502	1400		clamped
32		SBE37	62.5	1902	1405		load bar
33	21.2	7/16" wire					
34		SBE39	70	1509	1406		clamped
35		SBE39	77.5	1511	1407		clamped
36		SBE37	85	8004	1417		load bar
37		termination					
38		RDI ADCP	88	12254	1417		
39	9.5	7/16" wire					
40		SBE39	92.5	3423	1419		
41		VMCM	100	9			spin @ 1419
42	28	7/16" wire					
43		SBE 39	115	3434	1427		clamped
44		SBE37	130	1903	1435		
45	3	3/4 chain					
46		VMCM	135	10	1440		spin @ 1431
47	23.5	7/16 wire					
48		SBE39	145	3435	1442		clamped
49		SBE37	160	1905	1446		load bar
50	21.3	7/16 wire					

ARRAY NAME AND NO. STRATUS 16 MOORED STATION NO.________

Item No.	Length (m)	Item	Depth	Inst No.	Time Over	Time Back	Notes
51		SBE39	175	3437	1450		clamped
52		VMCM	183	11	1500		spin @ 1452
53	4.8	7/16 wire					
54		SBE37	190	1907	1504		load bar
55	28.5	7/16 wire					
56		SBE37	220	8214	1511		load bar
57	13	7/16 wire					
58		VMCM	235	38	1516		spin @ 1510
59	53	3/8 wire					
60		SBE37	250	2011	1521		clamped
61		VMCM	290	59	1524		Spin @ 15:20z
62	160	3/8 wire					
63		SBE37	310	7836	1529		clamped
64		SBE39	400	3438	1534		clamped
65		VMCM	450	61	1540		spin @ 1534
66	340	3/8 wire					
67		SBE37	550	8223	1546z		clamped
68	500	3/8 wire			1555z		
69	500	3/8 wire			1616		
70	100	3/8 wire			1636		
71	100	3/8 wire			1642		} one piece,
72	200	7/8 nylon			1646		} wrapped termination
73	1850	7/8 nylon			1702		} spliced at sea
74	1500	1" Colmega			1725		}
75		glass balls (84)			1810		~~IIII~~ ~~IIII~~ ~~IIII~~ ~~IIII~~ I

ARRAY NAME AND NO. STRATUS 16 MOORED STATION NO.________

Item No.	Length (m)	Item	Depth	Inst No.	Time Over	Time Back	Notes
76		SBE37		10600	1925		} dualed load bar
77		SBE37		10601	1925		
78	5	1/2 chain					
79		acoustic releases			1925		
80	1	chain					
81	5	1/2 chain					
82	20	1" Samson Nystron					marking on thimble says 25 m
83	5	1/2 chain					
84		Anchor			1940		9,300 lbs dry. Multibeam @ drop site 4523 m
85							
86							
87							
88							
89							
90							
91							
92							
93							
94							
95							
96							
97							
98							
99							
100							

Aanderaa:

sn 235——————————————
system config:
dcs 455:
ping-300
sos-1500m/s
start distance - 1m
cell size 2.5m
burst - no
use fixed heading - no
tilt compensation - yes
z-pulse active - yes
x-axis: 1+3
y-axis: 2+4
forward ping - yes

optode 2514:
enable air saturation - yes
enable raw data - yes
enable temperature - yes
enable humidity comp - yes
enable svuformula - yes

deployment settings:
vertical position: 13m
seq no.1 -
    300/1/300
    1500/1/1500
internal storage - yes

recorder:
4/18/17 - 01:00:00 - arm
clock check good

sn 238——————————————
system config:
dcs 451:
ping-300
sos-1500m/s
start distance - 1m
cell size 2.5m
burst - no
use fixed heading - no
tilt compensation - yes
z-pulse active - yes
x-axis: 1+3
y-axis: 2+4
forward ping - yes

deployment settings:
vertical position: 32.5m
seq no.1 -
    300/1/300
    1500/1/1500
internal storage - yes

recorder:
4/18/17 - 01:00:00 - arm
clock check good

RDI:

```
;
CR1
CF11101
EA0
EB0
ED850
ES35
EX11111
EZ1111101
WA50
WB0
WD111100000
WF200
WN45
WP300
WS200
WV175
RNSTR16
TE01:00:00.00
TP00:01.00
TF17/04/18 01:00:00
CK
CS
;
```

;Instrument = Workhorse Sentinel
;Frequency = 307200
;Water Profile = YES
;Bottom Track = NO
;High Res. Modes = NO
;High Rate Pinging = NO
;Shallow Bottom Mode= NO
;Wave Gauge = NO
;Lowered ADCP = YES
;Ice Track = NO
;Surface Track = NO
;Beam angle = 20
;Temperature = 18.00
;Deployment hours = 10560.00
;Battery packs = 1
;Automatic TP = NO
;Memory size [MB] = 256
;Saved Screen = 3
;
;Consequences generated by PlanADCP version 2.06:
;First cell range = 4.44 m
;Last cell range = 92.44 m
;Max range = 74.91 m
;Standard deviation = 0.40 cm/s
;Ensemble size = 1054 bytes
;Storage required = 10.61 MB (11130240 bytes)
;Power usage = 1204.17 Wh
;Battery usage = 2.7
;
; WARNINGS AND CAUTIONS:
; There are not enough battery packs for the deployment. (1 battery pack(s) will last 164 days).
; Advanced settings have been changed.
; Expert settings have been changed.

VMCM:

VM001
Model: STAR ENGINEERIN
SerNum: VM0061
CfgDat: 09APR02
Firmware: VMCM2 v3.24
RTClock: 2017/05/10 13:06:25
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: VMTPOD53 v3.00
TPOD Info: VMTPOD VMT037 17NOV16 THERM037
Sampling GO

VM001
Model: STAR ENGINEERIN
SerNum: VM2009
CfgDat: 08APR02
Firmware: VMCM2 v3.24
RTClock: 2017/05/09 22:15:10
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: VMTPOD53 v3.00
TPOD Info: VMTPOD VMT009 17NOV16 THERM009
Sampling GO

VM001
Model: STAR ENGINEERIN
SerNum: VM2010
CfgDat: 10APR02
Firmware: VMCM2 v3.24
RTClock: 2017/05/08 21:06:10
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: VMTPOD53 v3.00
TPOD Info: VMTPOD VMT010 17NOV16 T

Sampling GO

VM001
Model: STAR ENGINEERIN
SerNum: VM2011
CfgDat: 16APR02
Firmware: VMCM2 v3.24
RTClock: 2017/05/09 12:11:25
Logging Interval: 60; Current Tick: 10
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 VMT011 17NOV16
THERM011
Sampling GO

VM001
Model: STAR ENGINEERIN
SerNum: VM2038
CfgDat: 09APR02
Firmware: VMCM2 v3.24
RTClock: 2017/05/08 22:54:55
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: VMTPOD53 v3.00
TPOD Info: ˇˇˇˇˇˇˇˇˇˇˇˇˇˇˇˇ VMT038
17NOV16 THERM038
Sampling GO

VM001
Model: STAR ENGINEERIN
SerNum: VM2059
CfgDat: 15APR02
Firmware: VMCM2 v3.24
RTClock: 2017/05/09 14:38:10
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: VMTPOD53 v3.00
TPOD Info: VMTPOD VMT059 28DEC16
THERM059
Sampling GO

VM001
Model: STAR ENG.
SerNum: VM2003
CfgDat: 05APR02
Firmware: VMCM2 v3.24
RTClock: 2017/05/09 20:16:06
Logging Interval: 60; Current Tick: 5
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 VMT003 17NOV16
THERM003
Sampling GO

Stratus 16 Subsurface								
				START		**SPIKE**		
Instrument	**Serial**	**Depth Meters**	**Sample rate (s)**	**date**	**time**	**date**	**start time**	**stop time**
AANDERAA ADCM	235	13.0	300/1500	20170418	0100	20170506	18:55	20:05
AANDERAA ADCM	238	32.5	300/1500	20170418	0100	20170506	18:55	20:05
MicroCat	1304	2	300	20170418	0100	20170506	19:05	19:20
MicroCat	3821	3.7	300	20170418	0100	20170506	19:05	19:20
MicroCat	3824	7	300	20170418	0100	20170506	19:05	19:20
MicroCat	1899	16.4	300	20170418	0100	20170506	19:05	19:20
MicroCat	1900	30	300	20170418	0100	20170506	19:05	19:20
MicroCat	1901	40	300	20170418	0100	20170506	19:05	19:20
MicroCat	1902	62.5	300	20170418	0100	20170506	19:05	19:20
MicroCat	8004	85	300	20170418	0100	20170506	19:05	19:20
MicroCat	1903	130	300	20170418	0100	20170506	19:05	19:20
MicroCat	1905	160	300	20170418	0100	20170506	19:05	19:20
MicroCat	1907	190	300	20170418	0100	20170506	19:05	19:20
MicroCat	8214	220	300	20170418	0100	20170506	19:05	19:20
MicroCat	2011	250	300	20170418	0100	20170506	19:05	19:20
MicroCat	7836	310	300	20170418	0100	20170506	19:05	19:20
MicroCat	8223	550	300	20170418	0100	20170506	19:05	19:20
MicroCat	10600	4496	300	20170418	0100	20170506	19:05	19:20
MicroCat	10601	4496	300	20170418	0100	20170506	19:05	19:20
RDI ADCP	12254	88	180/3600	20170418	0100	20170506	18:55	21:05
SBE 39	39	5	300	20170418	0100	20170506	19:05	19:20
SBE 39	41	12.2	300	20170418	0100	20170506	19:05	19:20
SBE 39	53	20	300	20170418	0100	20170506	19:05	19:20
SBE 39	101	25	300	20170418	0100	20170506	19:05	19:20
SBE 39	721	35	300	20170418	0100	20170506	19:05	19:20
SBE 39	1502	52	300	20170418	0100	20170506	19:05	19:20

SBE 39	1509	70	300	20170418	0100	20170506	19:05	19:20
SBE 39	1511	77.5	300	20170418	0100	20170506	19:05	19:20
SBE 39	3423	92.5	300	20170418	0100	20170506	19:05	19:20
SBE 39	3434	115	300	20170418	0100	20170506	19:05	19:20
SBE 39	3435	145	300	20170418	0100	20170506	19:05	19:20
SBE 39	3437	175	300	20170418	0100	20170506	19:05	19:20
SBE 39	3438	400	300	20170418	0100	20170506	19:05	19:20
SBE 56	1206		60	20170418	0100	20170506	19:05	19:10
SBE 56	1208		60	20170418	0100	20170506	19:05	19:10
SBE 56	2069		60	20170418	0100	20170506	19:05	19:10
SBE 56	1210		60	20170418	0100	20170506	19:05	19:10
SBE 56	1211		60	20170418	0100	20170506	19:05	19:10
VMCM	3	45	60					
VMCM	9	100	60					
VMCM	10	135	60					
VMCM	11	183	60					
VMCM	38	235	60					
VMCM	59	290	60					
VMCM	61	450	60					
Stratus 16 Sea Surface Temperature Array								
		CM	CM	Orientation				
Instrument	Serial	Below Deck	below waterline	Degrees				
SBE56	1208	90	30cm	PORT 90				
SBE56	1210	90	30cm	FORWARD 180				
SBE56	1211	120	60cm	FORWARD 180				
SBE56	2069	140	80cm	FORWARD 180				
SBE56	1206	90	30cm	STARBOARD 225				
	* water line = 60cm							

STRATUS 16 BURN						
	SYSTEM 1			SPIKE		
Module	Serial	Firmware Version	Height Cm	DATE	Start Time	End Time
Logger PORT	L01					
HRH	230		240			
BPR	221		245			
WND	344		271	20170506	15:53	16:44
PRC	220		253	20170506	15:56	15:57
LWR	231		285	20170506	15:52	16:43
SWR-KZ	268		286	20170506	15:52	16:43
SST	1305		142			
PTT	99538	14644, 14652, 14653				
	SYSTEM 2			SPIKE		
Module	Serial	Firmware Version	Height Cm	DATE	Start Time	End Time
Logger STARBOARD	L02					
HRH	231		240			
BPR	504		245			
WND	225		271	20170506	15:53	16:44
PRC	275		253	20170506	15:56	15:57
LWR	206		285	20170506	15:52	16:43
SWR	254		286	20170506	15:52	16:43
SST SBE37	3605		142			
PTT	14709	09805, 09807, 09811				

STAND ALONES MODULES			SPIKE			
Module	Serial	NDBC #	Height Cm	DATE	Start Time	End Time
WAMDAS:	6017	28560				
IMEI #	300 224 01010 3770					
SIM #	8988 169312 00205 1229					
3DM-GX1 #	8713	N/A				
IR		24537				
NDBC station #	32012 (32ST0)					
VWX	8		245 (top of white ring)			
Lascar AT/RH	10023643		223			
SBE-39-AT	5275		223			
SA HRH	221		240			
SA SWR	207		286	20170506	15:52	16:43
XEOS KILO		300234062644 350				
XEOS Mello		300034013207 760				
XEOS Rover		300434060447 400				

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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 May. This cruise was conducted on the NOAA research vessel Ronald H. Brown. During the 2017 cruise on the Ronald H. Brown to the ORS Stratus site, the primary activities were the recovery of the previous (Stratus 15) WHOI surface mooring, deployment of the new Stratus 16 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 ARGO floats were also launched along the track.

17. Document Analysis

a. Descriptors
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Ocean Reference Station
Cruise - Arica, Chile

b. Identifiers/Open-Ended Terms

c. COSATI Field/Group

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