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Stratus 17
Seventeenth Setting of the Stratus Ocean Reference Station Cruise On Board RV Cabo de Hornos
April 3 - 16, 2018
Valparaiso - Valparaiso, Chile

by

Sebastien Bigorre,[1] Benjamin Pietro,[1] Alejandra Gubler,[3]
Francesca Search,[4] Emerson Hasbrouck,[1] Sergio Pezoa,[2] Robert A. Weller[1]

[1] Woods Hole Oceanographic Institution, Woods Hole, MA [2] ESRL, NOAA, Univerisity of Boulder, Colorado [3] Univesity Santa Maria, Valparaiso, Chile
[4] Universityu of Valparaiso, Chile

Woods Hole Oceanographic Institution
Woods Hole, MA 02543

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Technical Report

Funding was provided by the National Oceanic and Atmospheric Administration under Grant No. NA14OAR4320158.

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Upper Ocean Processes Group
Woods Hole Oceanographic Institution
Woods Hole, MA 02543
UOP Technical Report 2021-02

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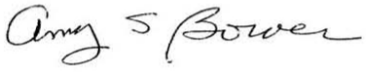

Amy Bower, Chair

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 Chilean research vessel *Cabo de Hornos*.

During the 2018 cruise on the *Cabo de Hornos* to the ORS Stratus site, the primary activities were the recovery of the previous (Stratus 16) WHOI surface mooring, deployment of the new Stratus 17 WHOI surface mooring, in-situ calibration of the buoy meteorological sensors by comparison with instrumentation installed on the ship, CTD casts near the moorings. The Stratus 17 had parted from its anchor site on January 4 2018, so its recovery was done in two separate operations: first the drifting buoy with mooring line under it, then the bottom part still attached to the anchor. Surface drifters and ARGO floats were also launched along the track.

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I. Introduction

I. A. Timeline

Stratus 17 deployment cruise was conducted on the Chilean Navy Research Vessel AGS 61 *Cabo de Hornos*, sailing from Valparaiso, Chile to the Stratus site and ended in Valparaiso, Chile. The ship left Valparaiso, Chile, at 00:10 (local) on the morning of April 3, 2018 and docked in Valparaiso, Chile around 13:00 (local) on April 16, 2018. The track (Figure 1-1) was set to first recover the drifting buoy Stratus 16, then steam to the Stratus site to deploy the Stratus 17 mooring, compare measurements from the new buoy with observations from the ship, then recover the bottom part of the Stratus 16 mooring, and finally return to Valparaiso. WHOI Upper Ocean Processes Group staff left Boston for Chile, on March 25. Thirty-one surface drifters were deployed (twenty-four NOAA AOML, seven for Chilean research group) and six Argo floats were deployed for WHOI ARGO group. An overview of the chronology of the cruise is provided below. Local time during this cruise was 3 hours behind UTC (UTC -3). Ship entered international waters on April 4 in the morning.

March 26: Pre-cruise meeting onboard *Cabo de Hornos*.

March 27-29: Containers delivery delayed as we learn they have been loaded on next reefer following the one initially planned. Second delay because one of the containers is at the bottom of the cargo and port authorities want to deliver them to us together. Science party receives security and safety presentation by port's company. ESRL (Pezoa) personnel arrives in Valparaiso on March 28.

March 30: Containers delivered after 10 am on center pier near building with bathrooms and offices. Security perimeter established with concrete blocks with fences. Unload containers, assemble buoy.

March 31 - April 1: buoy spin, pCO2 installation, burnin.

April 2: ship loading, install cables for GPS and Argos telemetry antennae, lash equipment on deck and in labs.

April 3, Tuesday: Ship *Cabo de Hornos* departs Valparaiso, around 00:00 (local). Transit towards latest position of drifting Stratus 16 buoy site. Drifters deployments every ~ 30 naut. miles.

April 4: Enter international waters. Drifter deployment continues. Launch first Argo float, CTD cast#1 for test to 500 m, followed by second cast to 1,500 m with acoustic releases on Rosette. Deploy Argo float #2. New mooring spliced at sea. Buoy moved from centerline to starboard side and tipped.

April 5: Rewind wire on split net drum. ASIMET data download; zero values inside SWR SA206, so install new flashcard.

April 6: Float #3 deployed and drifters 12 through 16. Surface instrumentation spiked. Subsurface instruments caged. Meeting with captain to review recovery ops.

April 7: Rain overnight. Arrange deck in morning. Deploy drifters 17 through 28. Received WXT decoding script by email and confirmed data is ok. 19:15 local, arrive in sight of Stratus 16 drifting buoy. There is a fishing vessel a few miles away. Drive by buoy for pictures and visual; no apparent damage. Buoy behaves normally, not much bobbing indicating there is quite a bit of weight under it. Start reciprocal tracks, first from West to East and back, then from South to North and back. Trouble shooting ADCP data collection with Alejandra, Francesca, Sergio and Armada folks; we manage to incorporate heading into input, so big improvement with currents that now look more realistic, but we could not find out how to input pitch and roll.

April 8: Recovery Stratus 16. Small boat in water, with Nico, Seb and 4 Armada folks. First small boat gets stranded by buoy after connecting to it, due to fuel line cut. Second small boat in water to help repair first one. First boat repaired and back onboard to start buoy recovery. Recovery ends about 8 hours later, then ship steams at 14 kts for ½ hour to clean engine filters. Launch float #5, drifters 29 through 31.

April 9: Transit towards Stratus 17 target site. Sharp jog during transit to avoid fishing vessel with net in the water. 2300 local, arrive at Stratus 17 target. Wind is 4 kts to the North Northwest. Current is about 0.5 kt to the South. Ship repositions 3 nm North of target and steams slowly South at 1.5-2 kts. After 25 minutes, ship increases speed gradually to 6 kts. This procedure is different from planned instructions (set and drift followed by practice run along drifting course and towards target).

April 10: Overnight, reciprocal track at 5 kts, North to South and back, north of S17 target with 7.5 nm long track on each side of target. 0530 local, wind less than 5 kts and from South, current less than 0.5 kt to the South Southeast. Weather forecast (GFS model in Predict Wind software) indicates wind will increase to 10 kts from the South in afternoon. Swell is 6-7 ft from the South, with ~ 10 s period. Around 0600 local, set and drift test: ship drifts to East-Southeast. Ship repositions 8 nm North of target to start deployment track. During first phase of deployment when the buoy is sent overboard, the ship moves along the track, so when buoy hits the water we are 7 nm from target. Soon, ship departs from track line and goes South-Southeast (with the drift). Split net drum overheats and additional fan is brought in to cool it down. Operations stopped for almost an hour. Ship deviates to the east, making wire angle on the fantail difficult to work with. Once at latitude of target point, ship then turns to the West Northwest towards a point north of target. We are still about 2 hours away from glass balls deployment. Chief scientist goes to the bridge and concerned with entanglement of line behind, establishes a new target site located 1 nm west of initial one. Anchor dropped at 23:24 UTC.

April 11: Overnight, reciprocal tracks with ADCP on near Stratus 17, East-West then North-South. 0600 local, ship on station near Stratus 17 buoy. Wind 15 kts, 135° True. 1000 to 1050 local, CTD

to 1,000 m with SBE 9plus and 19 from SHOA, starting about 0.5 nm from buoy. At 1638 local, CTD to 2,500 m.

April 12: 0600 local, leave Stratus 17 buoy, steam towards Stratus 16 anchor site. 0730 local, reciprocal track above anchor, going North; ADCP current is way too strong and indicates the correction for ship motion is incorrect. ADCP data acquisition corrected for return track going South, indicating there is a southward current at depth. 0830 local, meeting on bridge with Captain. Based on wind (15-20 kts from Southeast) we decide to hold the ship about 200 yards to the Northeast of the anchor for the mooring release. 0920 local, mooring released and rising. 1000 local, glass balls at the surface, 200 yards to the East of the anchor. Two small boats launched. Personnel on first boat make a connection between chain section between the glass balls and a blue spectra line. Second boat then brings line from split net drum on ship to the first small boat and a connection to the spectra line is made. Wire rope recovered; start hauling in some Colmega, but there is a bit of tension and a bad wire angle so we decide to cut the line (1110 local, 19° 25.93'S, 085° 05.15'W). 1300 local, anchor survey for Stratus 17. 1441 local, CTD to 1,000 m, 1 nm North Northwest of Stratus 17 buoy. Then head Southeast to start bathymetry survey on eastern edge of current bathymetry map.

April 13: Bathymetry survey in the morning, then depart Stratus area around 11 am, starting return transit towards Valparaiso.

April 14: Steaming at 14 kts to 132° True. Wind 10-14 kts from 140° True. Memory cards removed from VMCMs, will be processed home. Ship standalones removed from bow (SWR, LWR) and deck below bridge (HRHs).

April 15: Transit towards Valparaiso.

April 16: Ship arrives in Valparaiso. Unload scientific equipment and crew on commercial pier, then ship returns to Navy pier. Loading of scientific equipment into container.

April 17-18: Travel home.

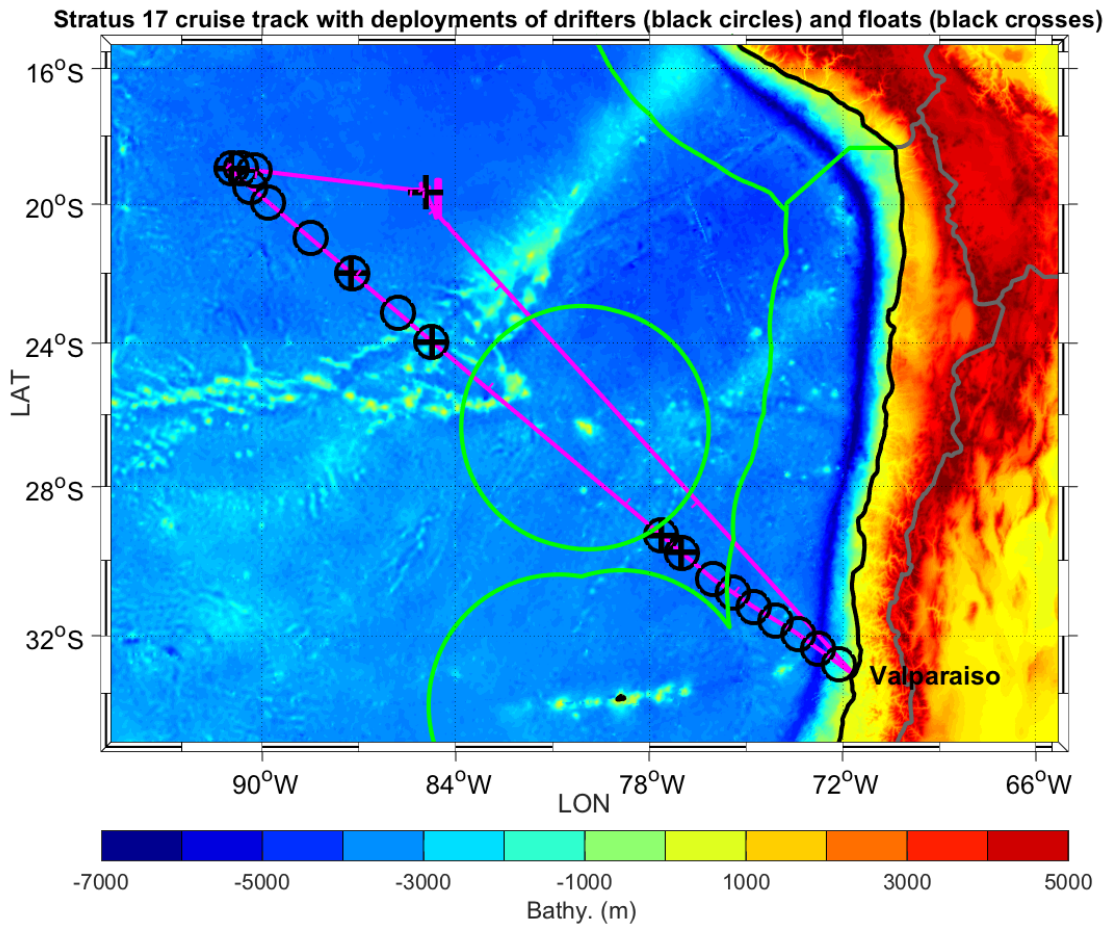

Figure I-1. Stratus 17 cruise itinerary Valparaiso – Stratus 16 and 17 – Valparaiso, Chile. Ship's track (magenta line), EEZ (green line), drifter (black circle) and float (black plus) deployments.

I. 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 16 mooring was deployed in June 2016. Its replacement, Stratus 17 mooring, was installed on April 10 2018 during the Stratus 17 cruise, which is detailed in this report.

During the 2018 Stratus cruise on the NOAA research ship *Cabo de Hornos*, the primary activities were recovery of the drifting WHOI Stratus 16 surface mooring, deployment of the new WHOI Stratus 17 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 floats were launched during the cruise.

The ORS Stratus buoys are equipped with two Improved Meteorological (IMET) systems, which provide surface wind speed and direction, air temperature, relative humidity, barometric pressure, incoming shortwave radiation, incoming longwave radiation, precipitation rate, and sea surface temperature. The 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, except for a few drifters deployed on behalf of University of Valparaiso.

II. Cruise Preparations

II. A. Staging and Loading

On March 26, four WHOI personnel arrived in Valparaiso. On March 27, WHOI personnel met with ship and Chilean Armada's personnel onboard the *Cabo de Hornos* at its berth on the Navy pier. A Broom representative attended this meeting too. Introductions to the ship's officers were made, and details of port operations and mooring operations were discussed.

At 10:00 on Friday, March 30, the two 40-foot containers were delivered on Pier 6 near building with bathrooms and offices. A security perimeter established with concrete blocks and fences. Unloading of the containers started using a forklift and pallet jack. The forklift was then used to assemble the buoy well, tower, halo. The anchor modules were also assembled using the forklift. Some equipment was shuffled back into the containers. One container was set up with tables and chairs to serve as a lab space for preparations. Instruments were mounted on assembled buoy and data collection system was started. In the evening telemetry showed one precipitation did not respond to prior fill and drain and was swapped with spare sensor. On Saturday March 31, the buoy foam was painted, pCO2 system was started and a data download was performed from the buoy meteorological system, resulting in swapping one primary air temperature sensor with the spare sensor. On April 1, anchors were welded and buoy spin was performed, leading to swapping one primary wind sensor with the spare sensor. Pezoa and Bigorre visit ship to plan loading of ESRL's equipment on the bow. Update software (weather forecast, navigation, satellite phone communication).

On April 2, ship docked onto Pier 6 and loading started using port's tall crane. GPS and Iridium antennae were mounted on 02 deck and cabled to the main lab on the 01 deck. Standalone ASIMET meteorological sensors were mounted forward of the ship. Labs were set up and equipment was lashed down. The ship departed the next morning at 00:10 local on April 3 2018.

II. B. Buoy Spin

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 far away 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.

Buoy spin was conducted in port in Woods Hole on October 3 2017 that included a third ASIMET wind sensor, to be used as a spare. A second buoy spin was conducted in port in Valparaiso on March 31 2018, but its results were difficult to interpret to the presence of magnetic disturbances on the pier.

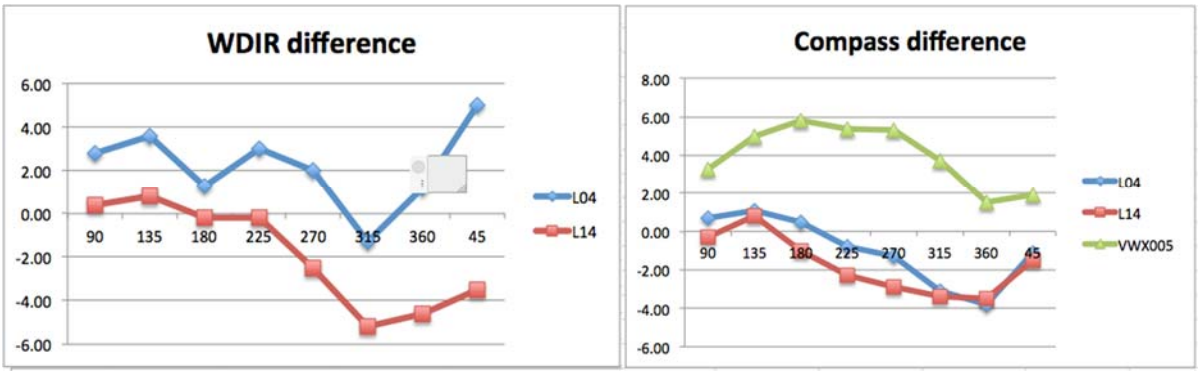

Figure II-1. STRATUS 17 buoy spin on October 3 2017 in Woods Hole. Y-axis: difference between wind direction (L04 and L14), or compass (WXT005), and line-of-sight reference (in degrees). X-axis: angle between buoy and line-of-sight reference (in degrees).

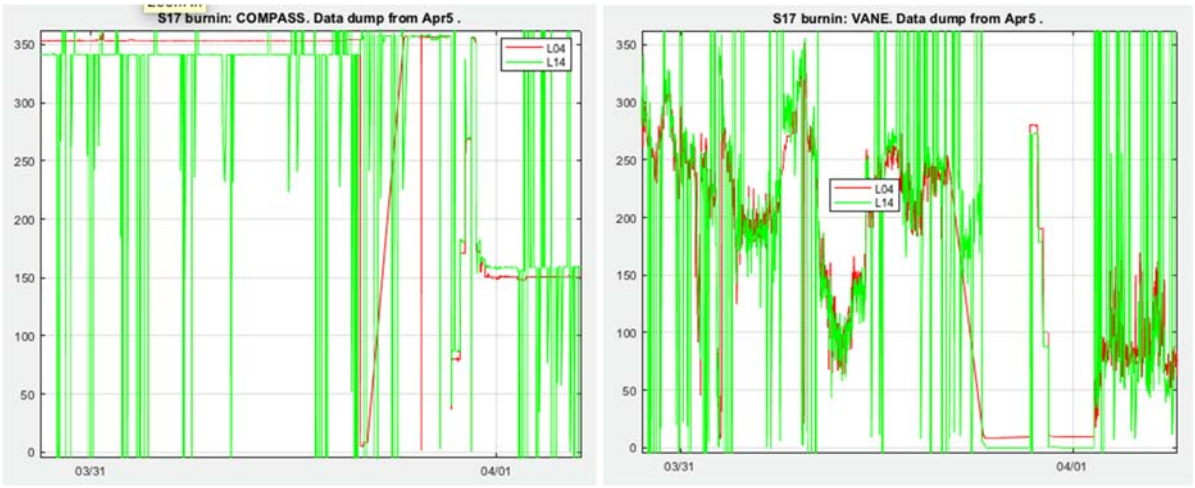

Figure II-2. One-minute data from STRATUS 17 buoy spin on March 31 2018: compass (left) and wind sensor vane (right).

II. 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 17. Every two week or so, the data was downloaded and processed to ensure all instruments were functioning properly and that their measurements were accurate. Some burn-in occurred in the September-October 2017, then buoy systems were turned off to preserve batteries. The buoy was restarted and data was again checked in January 2018.

Data was again downloaded in port on March 31. Wind conditions in port were very low which implies low or no ventilation and diurnal heating on temperature sensors on clear days. Last

download occurred on board *Cabo de Hornos* on April 5 2018, while buoy was upright on back deck, and exposed to large disturbances from the ship's structure (impacting air flow, radiation). Final data evaluation concluded that all data looked good overall, HRH from Logger 4 was about 3 %RH lower than L14 and stand-alone.

II. D. Antifouling

General comments: Experience has shown that the fouling potential at STRATUS is extremely high with high amount of barnacle growth on the upper 80m of instrumentation and buoy. Instruments below 80 m come up with little more than some sea-slime and are easy to clean up. Copper guards on SBE-37s work best when electrically isolated from the instrument case and are now mandatory on any SBE-37 above ~180m. A few years ago, we started to see evidence of birds on the radiometers, so now include bird wire on the tower top.
SBE-37's conductivity cells and transducer heads on the mooring had Desitin painted on. It has proven to be a safe and effective method to keep biofoul from growing.

Tower top:
- An "X" of bird wire between the radiometers, standard bird spikes used for PRC and WXT:
- Additional nonmagnetic bird wire along the forward rail as a deterrent.

SBE 56 in buoy hull:
- Apply Aqualube around and inside the protruding probe covers prior to deployment

SBE-37s on buoy (SST's):
- Tape on body of instrument
- Copper sensor guards. Desitin on conductivity cell inside

SBE-39 on wire or load bars:
- Tape on body of instrument and paint Desitin on temperature probe

Nortek on wire:
- Desitin applied to the transducers

Workhorse in load cage:
- Desitin applied to the transducers

III. Stratus 17 Deployment

III. 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) and standalone sensors. The mooring line below the buoy is equipped with oceanographic instrumentations down to 2009 m and two deep SBE 37s near the bottom (Figure III-2).

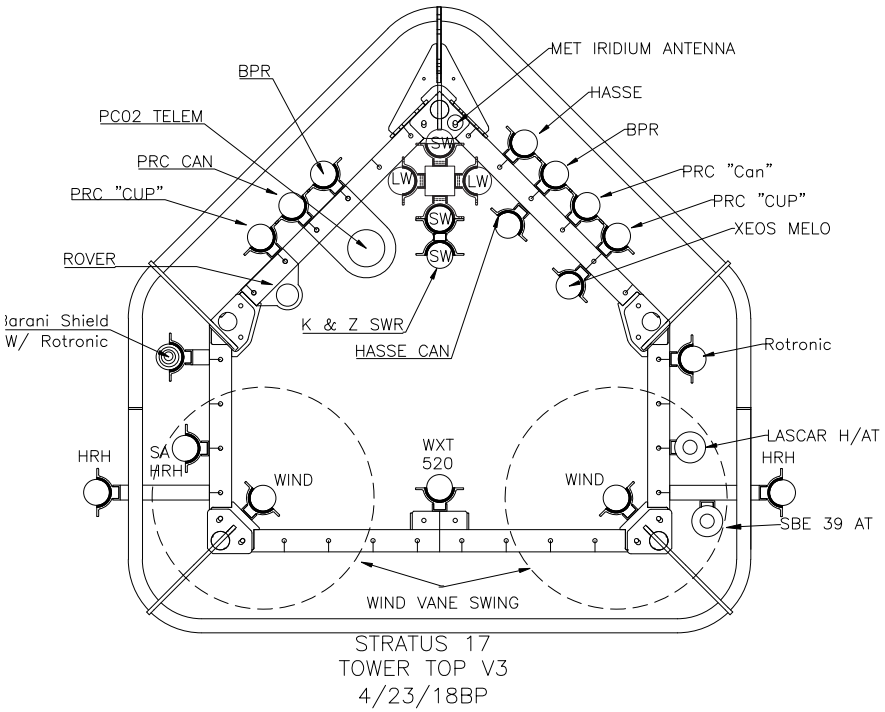

Figure III-1. Top view schematic of the meteorological tower on the STRATUS 17 buoy with the location of the ASIMET and other instruments.

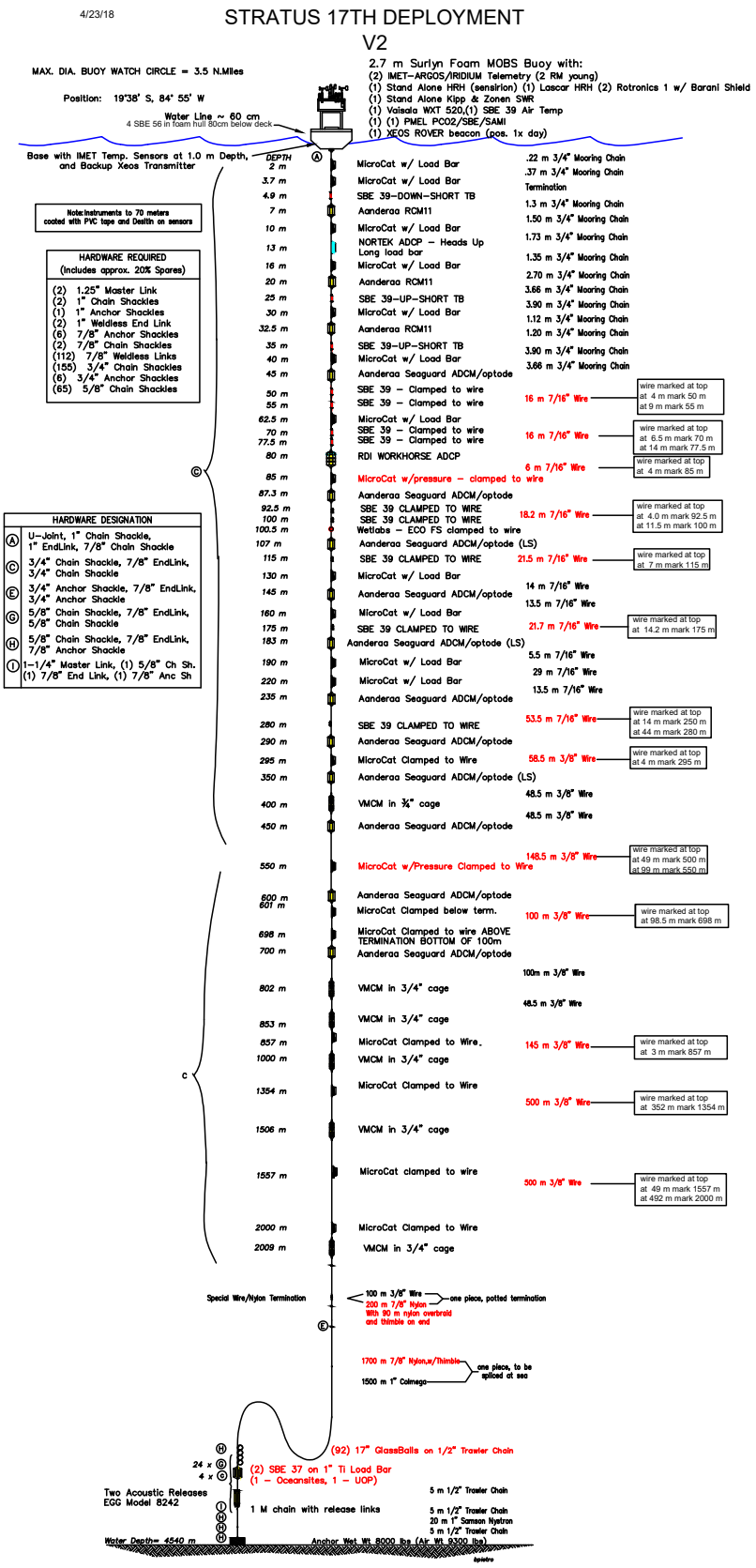

Figure III-2. Stratus 17 mooring diagram.

III. B. Deployment

III. B. 1. Deck Operations

The Stratus 17 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 starboard side of the ship. Phase 2 is the deployment of the remaining mooring components through the A-frame on the stern.

The ship's starboard side net 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:

- 200 m 7/8" nylon with overbraid – 100 m 3/8" wire rope (nylon to wire shot)
- 500 m 3/8" wire
- 500 m 3/8" wire
- 145 m 3/8" wire
- 48.5 m 3/8" wire
- 100 m 3/8" wire
- 148.5 m 3/8" wire
- 48.5 m 3/8" wire
- 48.5 m 3/8" wire
- 58.5 m 7/16" wire
- 53.5 m 7/16" wire
- 16 m 7/16" wire
- 16 m 7/16" wire

Prior to the deployment of the mooring, the wire was passed through the Red German block that was hung from the Gilson winch off the center of the A-frame. Then passed around the aft starboard quarter then forward along the rail to the instrument lowering area. Four wire handlers were stationed around the aft starboard quarter 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 hove to with the bow positioned with the wind slightly on the stern. The cranes 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 on the deck, in order of deployment, 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 or wire.

The first instrument segment to be lowered was an Aanderaa current meter at 45m. This instrument had a 3.66-meter shot of chain shackled to the top of the instrument cage, and a 16-meter shot of 7/16" wire rope shackled to the bottom from the winch. The crane hook, suspended over the instrument deployment area was lowered to approximately 1.3 meters off the deck. A six-foot sling was hooked onto the crane and passed through a ring to the top of the 3.66-meter shot of chain shackled to the top of the current meter.

The crane was raised so the chain and instrument were lifted off the deck. The crane slowly lowered the wire and attached mooring components into the water. The line handlers positioned around the stern eased line over the starboard side, paying out enough to keep the mooring segment vertical in the water. A sling with a snap hook was secured to a deck eye bolt to stop the vertical mooring line and remove it from the crane. 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 7-meter Aanderaa current meter. The load from this instrument array was stopped off using a slip line passed through a pear link shackled into the chain above the instrument cage. The 2, 3.7, and 4.9-meter instruments were shackled to hardware and chain, connecting them to the universal joint on the bottom of the buoy. The vertical instrument array hanging in the water was joined to the two instruments attached to the bottom of the buoy.

The next operation was launching the buoy. Three slip lines were rigged on the buoy to maintain control during the lift. Lines were rigged on the buoy bottom, the tower, and a buoy deck bail. The slip lines were used to stabilize the bottom of the buoy at the start of the lift. Another slip line was rigged to check the tower as the hull swung outboard. Another line on the buoy deck bail slip line was rigged to prevent the buoy from spinning as the buoy settled in the water. The deck slip line was removed just following the release of the buoy.

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

The winch operator slowly hauled in the slack wire once the buoy had drifted behind the ship. The ship's speed was increased to .5 knot through the water to maintain a safe distance between the buoy and the ship. The Red German traveling block was suspended from the A-frame using the ships Gilson winch. Two tag lines were then attached to the block to maintain control of the block. The bottom end of the shot of wire was pulled back in so 2-SBE 39 temperature loggers could be clamped onto the wire, then the wire was payed out and stopped off at the transom.

The next instrument, a 62.5-meter depth load bar with SBE 37 (Microcat) and 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 working line. The hauling line 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. Additional instruments were attached to the mooring wire using clamps. 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 2009 meters. 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 20 feet from the transom using a sling though the thimble.

An H-bit cleat was positioned approximately 30 feet from the transom, and secured to the deck. The free end of the 3350-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 overheating.

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 main deck winch tag leader 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 winch payed out the mooring line until all but one meter of the Colmega line was over the transom.

The 12-ton crane was used to lift glass balls out of the open top container. The 92 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 (fore and aft) 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 only one ball remained on the deck. Stopper lines were attached, the winch leader was removed, and two more strings of glass balls were inserted into the mooring line. This process was repeated until all 92 balls were deployed.

A 1" titanium load bar with two SBE 37 C/T loggers was shackled to the last glass ball segment. After that, a five-meter shot of ½" chain was connected to the mooring. The winch took tension on the mooring, stopper lines were removed, and a chain hook connected to the Gilson winch line running through the block on the A-frame lifted the SBE 37s off the deck. The winch payed out with the tugger, and the instruments were eased over the transom. The tugger went slack, and the chain hook was removed. The acoustic releases were shackled to the chain. Another 5-meter chain section was shackled to the releases. A 20-meter Nystron anchor pendant was shackled to that chain, and another 5-meter section of ½" chain was shackled to the anchor pendant. The ship's

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 Gilson winch 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 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 up this segment of chain. A heavy-duty slip line was passed through the link and secured to the winch leader. The winch hauled in until tension was transferred to the slip line. The chain lashings were removed from the anchor. A 3⁄4" sacrificial nylon line was attached to the winch leader using a bowline and fed through the sling link on the 5m chain from the anchor and brought back to the winch leader and tied off with a bowline. The mooring was towed through the water as preparations to tip the anchor were finalized.

The ship's crane was connected to the tip plate bridle to lift the tip plate. A slight strain was applied to the bridle. The sacrificial line transferred the mooring tension to the 1/2" chain and anchor and the line was cut. Once cut the anchor slid off the plate and into the ocean.

III. B. 2. Navigation Operations

Deployment of Stratus 17 occurred on April 10 2018. Overnight, North-South reciprocal tracks were done above the S17 target site, steaming at 5 kts for 7.5 nm North and South of the target. At 0530 local, wind less than 5 kts and from South, the upper ocean current was less than 0.5 kt to the South-Southeast. Weather forecast (GFS model in Predict Wind software) indicated the wind would increase to 10 kts and come from the South-Southeast in afternoon. The sea swell was 6-7 ft with about 10 s period and coming from the South. At around 0600 local, the set and drift test established that the ship drifted to the East-Southeast. During a pre-deployment meeting on the bridge with the Captain, second Captain, Chief scientist and deck lead, it was decided to start the track 8 nm North of the target in order to mitigate swell induced motion and possible wind direction change during the course of the day. Also, the planned drop site was defined to lie within a 3 nm radius circle centered on the nominal target, so that there would be some flexibility in the ship's track in case wind direction departed from expected forecast. The ship repositioned to the start of the deployment track. However, it was realized after the deployment had started that this initial position was in fact 2.5 nm to the East of the planned start point. During the first phase of deployment, the ship progressed southward. When the buoy was deployed overboard, the ship was 7 nm from the nominal target. Early in the deployment, delays occurred caused by confusion on deck regarding clamp size for instruments and later by overheating of split net drum, which required the temporary use of an external fan and interrupted the deployment for almost an hour. Later in the deployment, the wire angle coming out of the fantail kept increasing, so the bridge was asked to maneuver accordingly. At this point the ship was still going southward, but the buoy, probably pushed by the current was on the port side of the ship and there was very little tension on the line. Science party informed the bridge that wire angle needed to be straighter during glass balls deployment. Once at the latitude of target point, ship turned to the West-Northwest towards a point north of target (left-handed hook in **Figure III-3**). We were still about 2 hours away from glass balls deployment. In order to avoid sharp turn later on to hit the nominal target point, the Chief scientist established a new target located 1 nm west of initial one, in agreement with Captain.

Later on, the ship did another sharp turn in order to mitigate wire angle. Once the bathymetry was checked and anchor was rigged for deployment, the anchor was dropped at 23:24 UTC.

Note that the Stratus 17 mooring broke free on August 19 2018. Upon recovery of the Stratus 17 mooring in 2019, the cause of the premature failure was wire chaffing and abrasion. This was most probably caused by lack of tension on the wire during deployment operations, and the natural tendency for the wire to recoil after being stored on wire reels and on the winch. It is therefore paramount that for future deployments the ship does maintain a speed over water that is faster than the wire payout. If this cannot be achieved, the mooring must be recovered and a new deployment must be restarted.

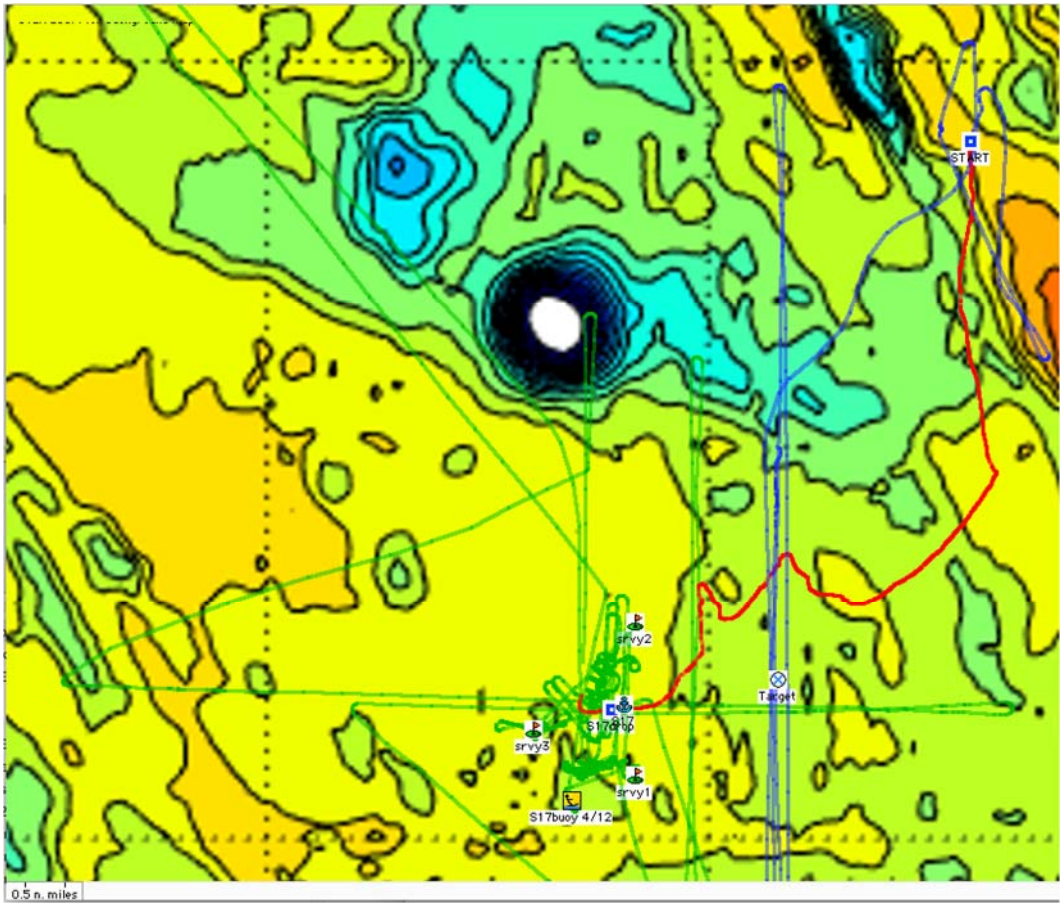

Figure III-3. Stratus 17 deployment track (red), beginning at START location (blue hollow square) and nominal target (blue cross inside circle). Pre-deployment track (blue) shows reciprocal tracks in the morning of April 10 2018. Post-deployment track (green) shows anchor survey sites 1 to 3 (green golf symbols with red flag), anchor location as surveyed (blue anchor symbol), which is slightly to the East of the anchor drop (blue hollow square), and location of buoy 2 days after deployment (yellow symbol). Colored contours show bathymetry from previous cruises' surveys (20 m between contours).

III. C. Anchor Survey

Three survey positions were chosen roughly 1 nm from the anchor drop position (Table III-1). At each position the ship stopped, and a portable hydrophone was deployed over the side to send acoustic signals to the releases on the mooring and near the anchor. A deck box was connected to the hydrophone and displayed the acoustic transmit time between the hydrophone and release. Using a speed of sound, this time was converted to a slant range. Three ranges/travel times were obtained at each survey point to ensure the ranging was repeatable. Based on previous cruises, an average sound speed at Stratus is taken to be 1509 m s^{-1}. The manual for the release box (Edgetech 8011XS deck unit) indicates that its default setting uses 1490 m s^{-1} as sound speed.

Two Matlab programs were used to find the solution of the anchor triangulation. Art Newhall's acoustic survey program, called survey.m, and anchpos2c.m, created by Robert Weller. Survey.m finds the solutions in the horizontal plane, using the intersection of three circles, assuming the anchor depth is known. Anchpos2.m finds a solution in the 3-D space and solves for the anchor position as well as its depth. It also includes a possibility to correct the sound speed used by the deck box to the actual one observed in the ocean. The program also takes into account that the releases' heads are 33 m above the bottom and that the portable transducer is about 5 m below the water surface.

The solutions of the triangulation of Stratus 17 anchor are:

- (19° 38.3242' S, 84° 55.1036' W), using survey.m with first readings at each site (see Figure III-5)
- (19° 38.3238' S, 84° 55.1017' W), using anchpos.m with second readings at each site (see Figure III-6)

However, the official anchor position reported on the mooring log and website is (19° 38.3203' S, 84° 55.0999' W), which is about 5 m from estimates above. The ocean depth at the anchor site was reported as 4565 m. The fallback of the anchor (distance between anchor drop and position on seafloor), which is caused by tension on the mooring line during the 45 minutes long descent of the anchor, is about 320 m (7% of water depth). A visual inspection of the buoy showed the waterline to be about 55 cm below the top of the buoy foam.

Table III-1. Survey points, ranges in meters and travel time. Locations converted for decimal degrees for input into anchor locations. Note that the range is computed using 1500 ms^{-1} for speed of sound.

Site	Latitude (dd mm.mm)	Latitude (dd.ddd)	Longitude (dd mm.mm)	Longitude (dd.ddd)	Range (m)	Time (s)
Survey 1	19° 39.217'S	-19.6536	84° 54.955'W	-84.9159	4788	6.384
Survey 1	19° 39.214'S	-19.6535	84° 54.962'W	-84.9160	4785	6.381
Survey 1	19° 39.213'S	-19.6535	84° 54.967'W	-84.9161	4784	6.379
Survey 2	19° 37.257'S	-19.6209	84° 54.939'W	-84.9156	4979	6.547
Survey 2	19° 37.257'S	-19.6209	84° 54.939'W	-84.9156	4908	6.545
Survey 2	19° 37.257'S	-19.6209	84° 54.939'W	-84.9156	4908	6.544
Survey 3	19° 38.632'S	-19.6438	84° 56.327'W	-84.9387	4997	6.663
Survey 3	19° 38.629'S	-19.6438	84° 56.331'W	-84.9388	5001	6.669
Survey 3	19° 38.628'S	-19.6438	84° 56.331'W	-84.9388	5000	6.669

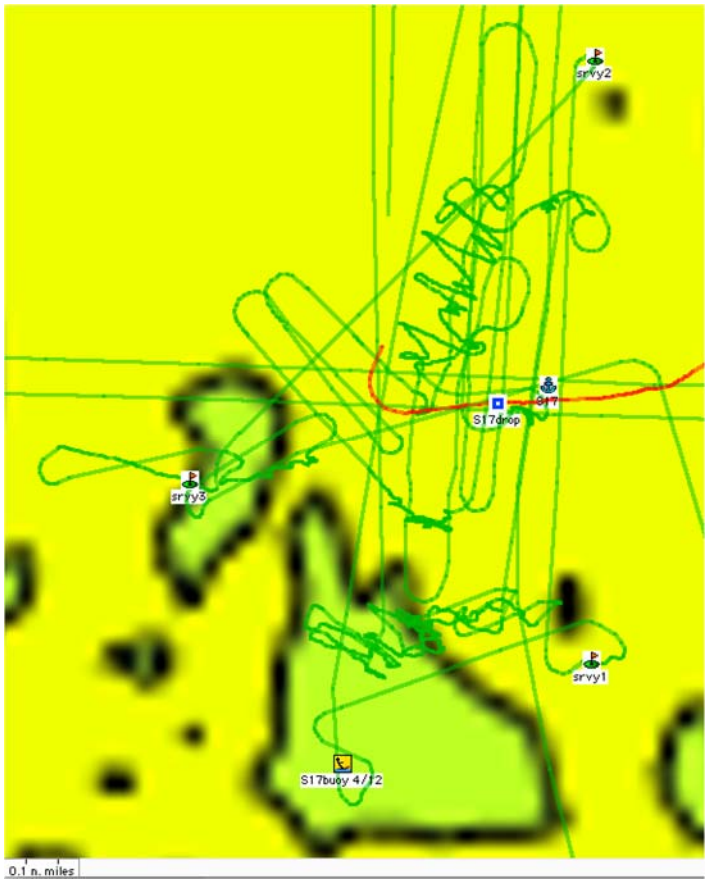

Figure III-4. Ship's track (green line) near Stratus 17. Symbols with labels show the locations of anchor survey sites (srvy1 to 3), anchor drop (S17drop), surveyed anchor (S17) and buoy (S17buoy 4/12) two days after its deployment.

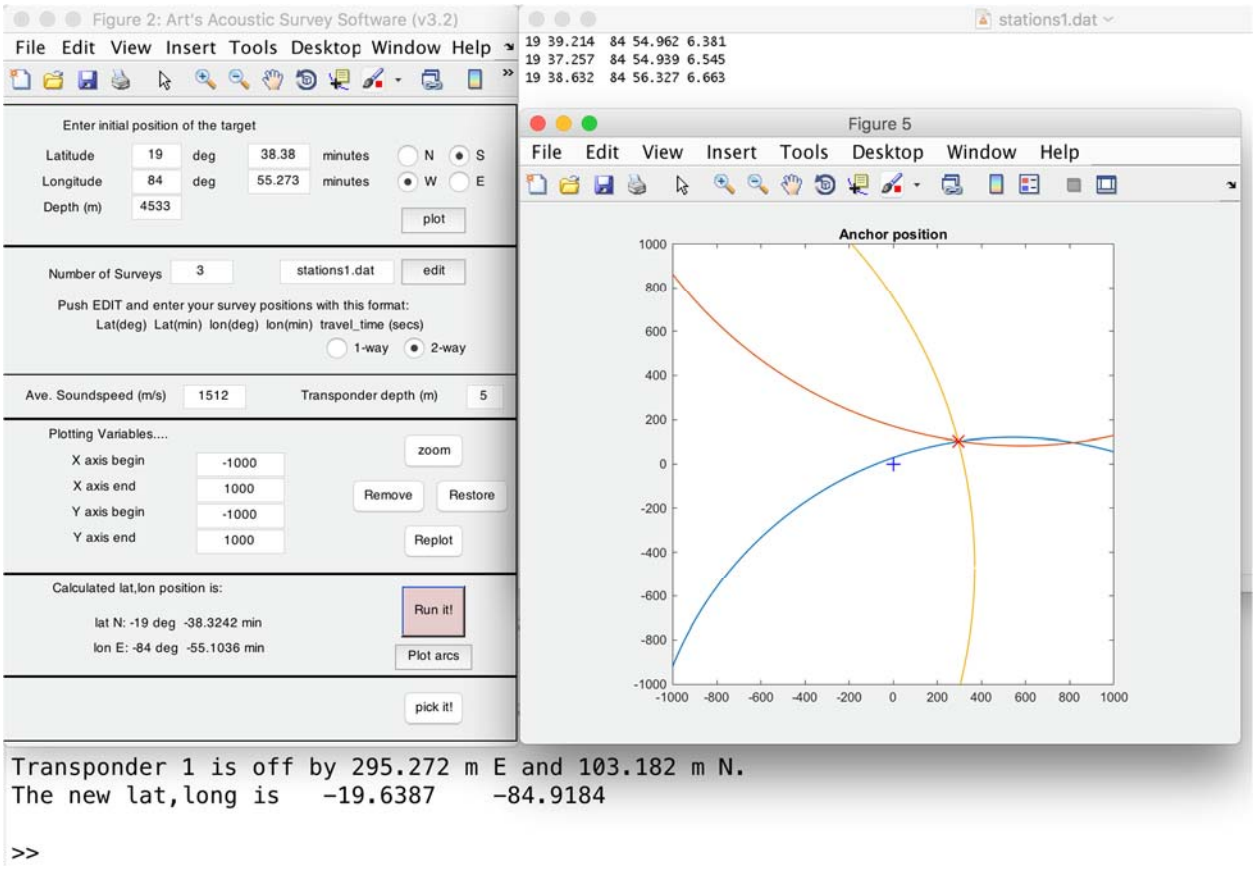

Figure III-5. Stratus 17 anchor triangulation using Art Newhall's survey.m program.

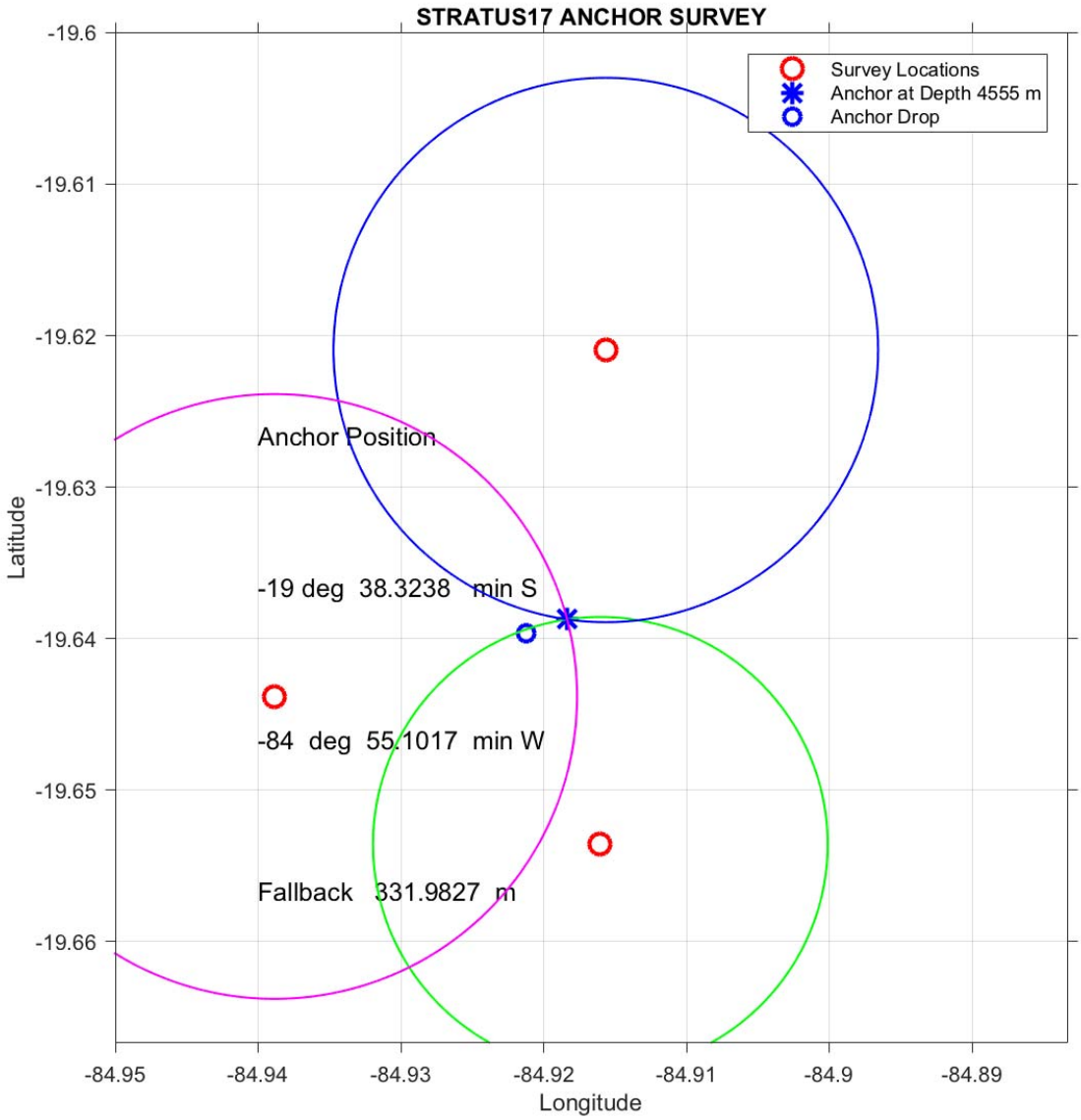

Figure III-6. Stratus 17 anchor triangulation using Bob Weller's anchpos.m program.

IV. Stratus 16 Recovery

IV. A. Drifting mooring recovery

On January 4, 2018 the STRATUS 16 mooring broke free and started drifting westward. See Figure IV-1 for the drifting mooring track.

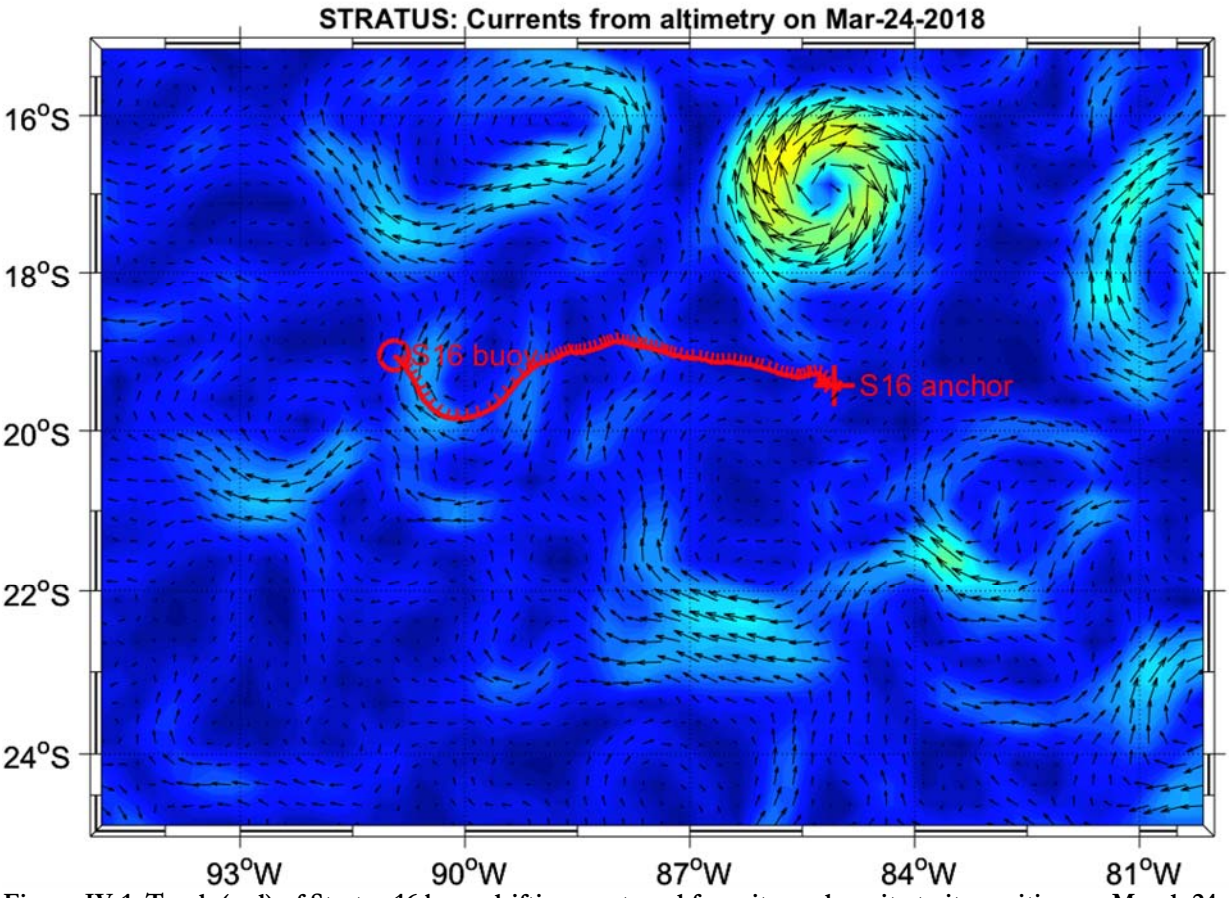

Figure IV-1. Track (red) of Stratus 16 buoy drifting westward from its anchor site to its position on March 24 2018, prior to the recovery cruise. Colored contours and black arrows indicate surface currents speed and direction according to altimetry provided by Copernicus website.

The Stratus 16 buoy was recovered on April 8, 2018. To prepare for recovery of the buoy the geophysical winch and A-frame were the chosen equipment to lift the buoy and instrumentation out of the water. Without knowing how much weight was under the drifting buoy the ship made the decision to use the strongest devices onboard. An approximate 100 m shot of ¾ spectra was shackled to the geophysical winch and fed through the ship's A-frame. The line was faked out on the grating deck and a heaving line was tied into the end. Two small boats were deployed to hook up to the buoy pick up bail using the spectra that was tossed to them from the ship. After crew and scientists were back on the ship, hauling in of the spectra started. The A-frame was positioned outboard and the buoy was elevated in the air. Once the buoy was clear of the transom the A-frame

came in. To stabilize the buoy two tag lines were attached to the buoys D-handles. The A-frame came in and the winch payed out lowering the buoy to the grated deck. Stopper lines were placed on the link just below the 3.7 m MicroCat. To relieve the tension off the buoy and put it on the stopper lines the buoy was picked back up using the A-frame and elevated by moving the A-frame aft. Once tension was on the stopper lines the connection from the mooring chain to the buoy was disconnected. The buoy was then repositioned forward of the grated deck to create a larger working area on the back deck. Three tag lines were positioned in a triangle pattern to keep the buoy from swinging. Once the buoy was moved it was secured to the deck using ratchet straps and the mooring recovery continued.

To recover the remaining instruments and wire a traveling block was hung off the center block. The Rope Master block was hung using the Gilson winch. Two tag lines were attached to the Rope Master it to ease the swinging motion of the block. A winch leader was wound on the port side split net drum and fed through the rope master block. The winch leader was then attached to the mooring chain and the recovery of the mooring line got underway. Instruments on load bars or in cages were stopped about 3 feet below the block. Two stopper lines were hooked into sling links and made fast to the deck cleats. The winch payed out slowly to lower the instruments to the deck. The instruments were 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.

Finally, the broken end of the wire was recovered as part the second 500 m shot (Figure IV-2). There was clear evidence that the mooring was damaged by long line gear. Such line was entangled on the mooring line in multiple spots, and the wire was abraded near the broken section. This damage may have been caused by sawing motion through the 3/8’’ wire. There was also other lacerations and abrasions in the wire associated with long lining gear.

Figure IV-2. Broken 3/8" wire somewhere on the second 500 m wire shot on Stratus 16.

IV. B. Bottom mooring recovery

On April 12, 2018 the *Cabo De Hornos* was positioned roughly 200 m to the northeast of the anchor position. The release command was sent to the acoustic releases to separate the anchor from the mooring line. After about 60 minutes, the glass balls were spotted, about 200 m east of the anchor. A leader line was pre-wound on the split net drum then fed through the Red German block and the line was faked out on deck. The ship deployed two small boats to make a secure connection

on the glass balls. The first boat connected to the buoy while a winch leader line was thrown to the second small boat and the two lines were connected.

The 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 mooring line 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. The ship's winch, on the main deck, was used to stabilize the glass balls as well as haul it forward. When the cluster was clear of the transom; it was lowered to the deck. A stopper line was used to secure the chain hanging over the stern with two SBE 37s and two acoustic releases attached to it. Another stopper line was connected to the thimble on the end of the Colmega line. The winch was disconnected from the glass ball cluster, and shackled to the release chain. The chain was disconnected from the glass ball cluster, and the winch hauled in to get the SBE 37s and releases onto the deck. The acoustic releases and deep SBE 37s sensors did not show any damage. The glass balls were disconnected and hauled forward where the ship's crane lifted them into the open top container. Recovery of the Colmega then started. Due to tension and a strong angle on the line as the ship has difficulty maneuvering, the decision was made to cut the line in the Colmega; the time was 14:10 UTC and location 19° 25.93' S, 85° 05.15' W.

V. Ancillary Work

A. Intercomparisons

The ship was stationed near each buoy (typically ¼ nm downwind of buoy for 24 hours). See Figure V-1 for the ship's tracks near the buoys during intercomparison periods.

One set of three standalone ASIMET sensors (shortwave, longwave radiation, and air temperature and humidity) similar to the ones on the buoys were mounted on the bridge deck on the ship forward and starboard of the bridge. The measurements from stratus 17 used here are telemetered and represent hourly averages. System 1 uses Iridium satellite transmission, which has a higher resolution than system 2, which uses the ARGOS system (thus the quantized signal in system 2 values shown in the plots below). There were also meteorological measurements made by ESRL on the ship but they are not shown in the plots below. Figure V-2 shows the time-series of these measurements while the ship was near Stratus 17 buoy between 2018/04/11 09:00 UTC to 2018/04/12 08:00 UTC. Note that the ship's measurements were made higher than the ones from the buoy, and no height adjustment was made for the following plots. However, similar comparisons made on previous Stratus cruises that included height adjustment using the COARE algorithm show that the height from the bridge height to the buoy height typically warms the air temperature values by 0.2 °C colder and wets the air relative humidity by 3% RH. Thus, the ship's measurements of air temperature and humidity should actually agree with the buoy observations better than what is shown in the figure here. Also, note that solar radiation and heating on the ship's measurements introduces a warm anomaly at mid-day, probably due to the ship's infrastructure near the standalone sensors.

Measurements from the two ASIMET sensor sets on Stratus 17 agree well with each other. There is a bias in wind direction, which is caused by flow distortion as the air flow tends to be divergent around the buoy structure (hull, tower and instruments). The sensor on the buoy port (system 1) measures a wind direction several degrees more clockwise than the identical sensor placed on the starboard side (system 2) of the buoy.

A more limited intercomparison was done at Stratus 16, which was drifting. The ship arrived Stratus 16 on April 7 around 22:00 UTC and the buoy was recovered the next day at 13:25 UTC. The ship conducted reciprocal tracks for ADCP testing during the night, so that it was up to 5 nm away from the buoy at the end of each track (Figure V-1, right panel). Nonetheless, the time-series during this period are shown in Figure V-3.

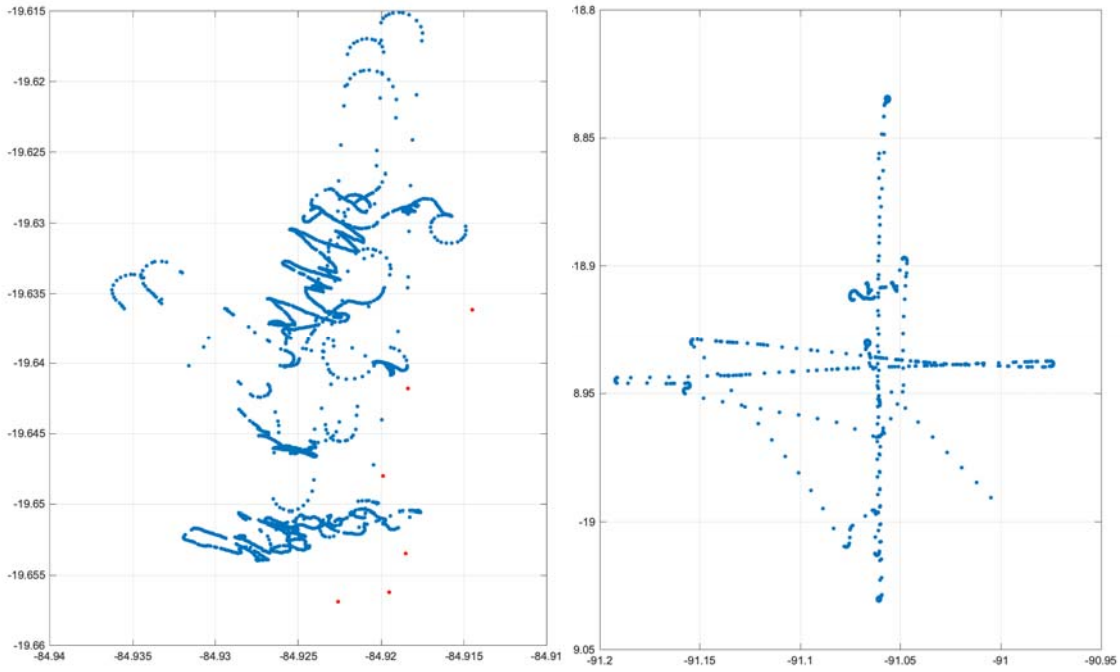

Figure V-1. Ship's track during intercomparisons ship vs buoy. Left: near Stratus 17 newly deployed buoy (red dots), between April 11 09:00 UTC and April 12 2018 07:58 UTC. Right: near Stratus 16 drifting buoy prior to recovery, between April 7 22:00 UTC and April 8 2018 13:19 UTC.

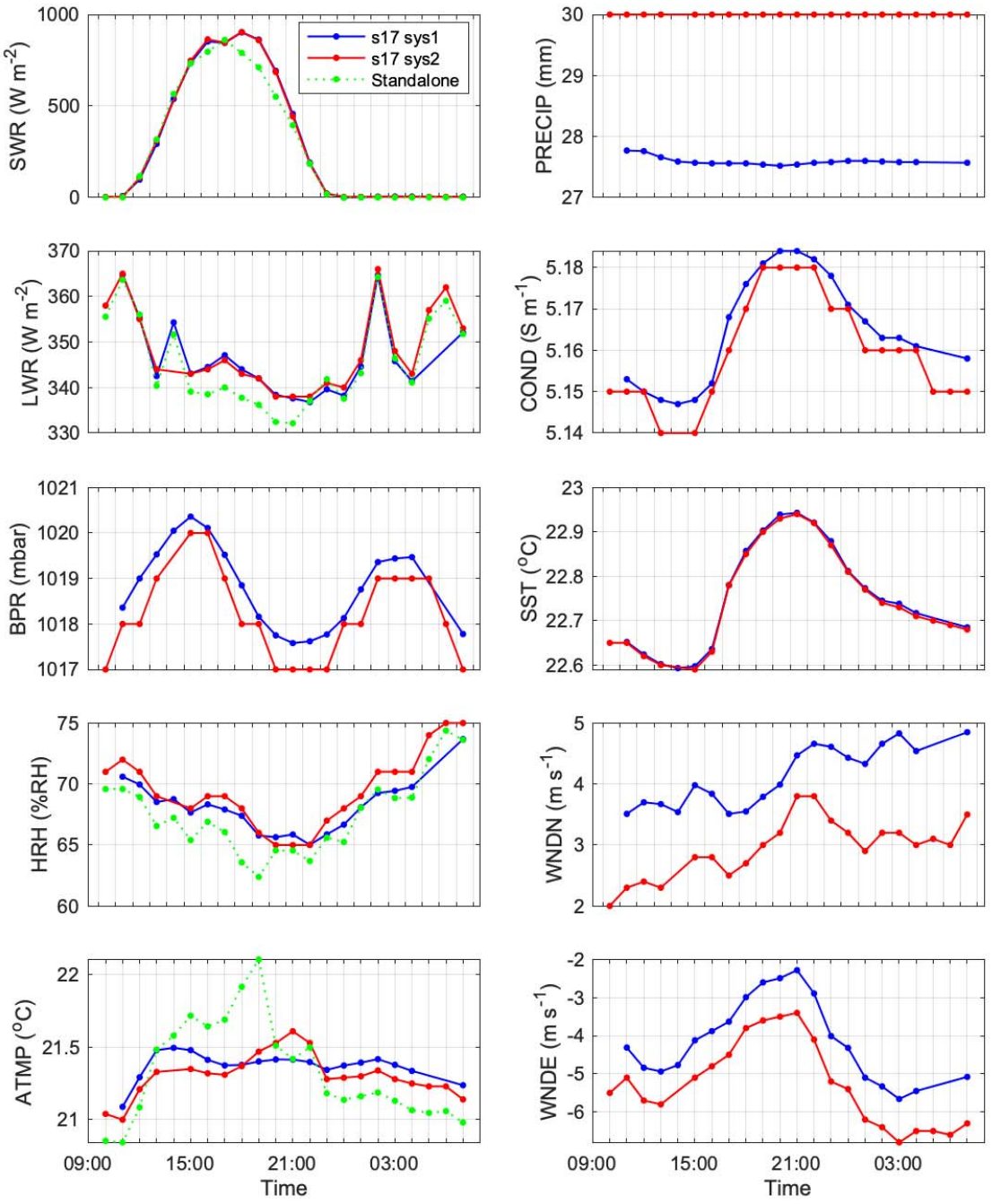

Figure V-2. Time-series of hourly ASIMET meteorological measurements from Stratus 17 buoy and standalones instruments mounted on the ship's bridge deck. Period shown is April 12 2018 10:00 UTC to April 12 08:00 UTC when the ship was near the buoy. The measurements were not adjusted for height in this plot.

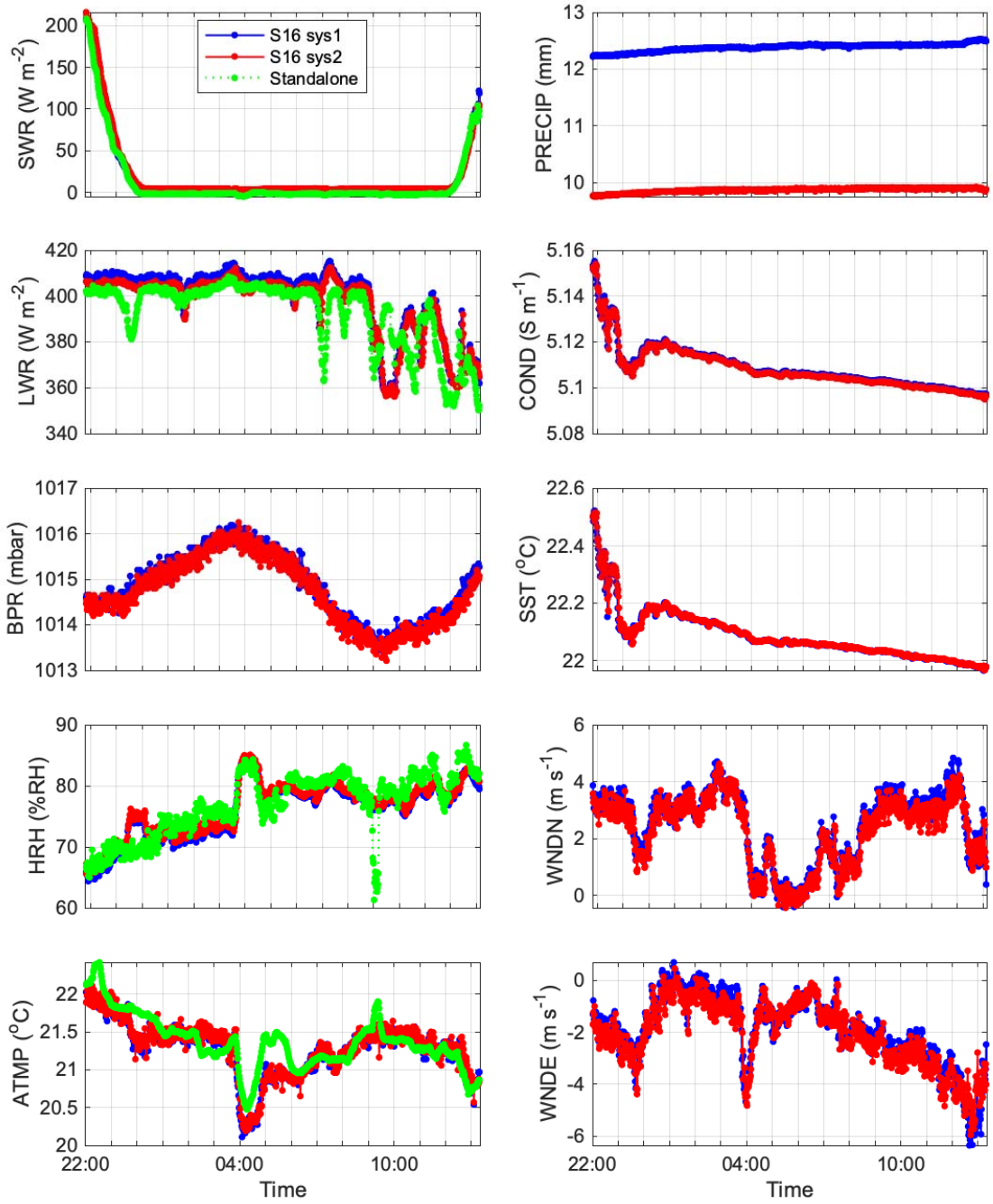

Figure V-3. Same as Figure V-2 but for intercomparison period at Stratus 16 buoy between April 7 2018 22:00 UTC to April 8 13:25 UTC when the ship was near the buoy. The measurements are 1-minute values. The measurements were not adjusted for height in this plot.

B. CTDs

During the Stratus 17 cruise, five CTD casts were operated. The first two were located just outside the Chilean EEZ, and served as tests for the CTD system (using SHOA CTD sensors only) and acoustic releases that were to be deployed on the Stratus 17 mooring. The remaining three CTDs were done at the Stratus 17 buoy and included the UOP CTD sensor. Locations and times of the CTD casts are summarized in Table V-1.

Table V-1. Time and locations of the CTD casts made during the Stratus 17 cruise.

CTD #	Event	Date and Time (UTC)	Latitude	Longitude	Depth (m)
1	Release test	4/4/18 13:00	29° 18.84'S	77° 38.22' W	500
2	Release test	4/4/18 14:30	29° 19.32'S	77° 37.80' W	1,500
3	S17, 0.5 nm from buoy	4/11/18 13:00	84° 55.32'S	19° 38' W	1,000
4	S17, 0.5 nm from buoy	4/11/18 19:38	84° 55.62'S	19° 38.64' W	2,500
5	S17, 1 nm from buoy	4/12/18 17:41	84° 56.22'S	19° 38.62' W	1,000

Two CTD instruments were installed on the Rosette by SHOA. The first set was made of a deck unit SBE 33 (s/n 33-0315), one pilon SBE 32 (s/n 3228755-0415, depth limitation 6800 m), one CTD 19 plus V2 Seacat (s/n 19-7756, depth limitation 3500 m), one pump SBE 5 (s/n 058891, depth limitation 10500 m), one oxygen sensor SBE 43 (s/n 43 -3449, depth limitation 7000 m). Last calibration was 11/09/2016.

The second set included: one SBE 11 Deck Unit (s/n 11P64093-0904), one SBE 9 PLUS CTD underwater unit (s/n 09P64093-1066, depth limitation 6800 m), one SBE 3 PLUS temperature sensor (s/n 03P5386, depth limitation 6800 m), one SBE C 4 conductivity sensor (s/n/ 043944, depth limitation 6800 m), one SBE 5T pump V2 titanium (s/n 056184, depth limitation 10500 m), one SBE 43 dissolver oxygen sensor (s/n 432208, depth limitation 7000 m). Last calibration 03/16/2017.

The CTD instrument used by UOP was a SBE 19 sensor (V3.1, serial number 2361). The sensor was calibrated in 08/23/2017 and sampled every 0.5 s. Figure V-4 below show the T and S profile for CTD cast#5 on 04/12/2018 near Stratus 17, using data from the 3 CTD sensors mentioned above. The UOP CTD sensor has a high bias in conductivity compared to the SHOA instruments. Comparison with some of the SBE37s recovered from the Stratus 17 mooring, indicates this high conductivity bias on the UOP CTD sensor is real.

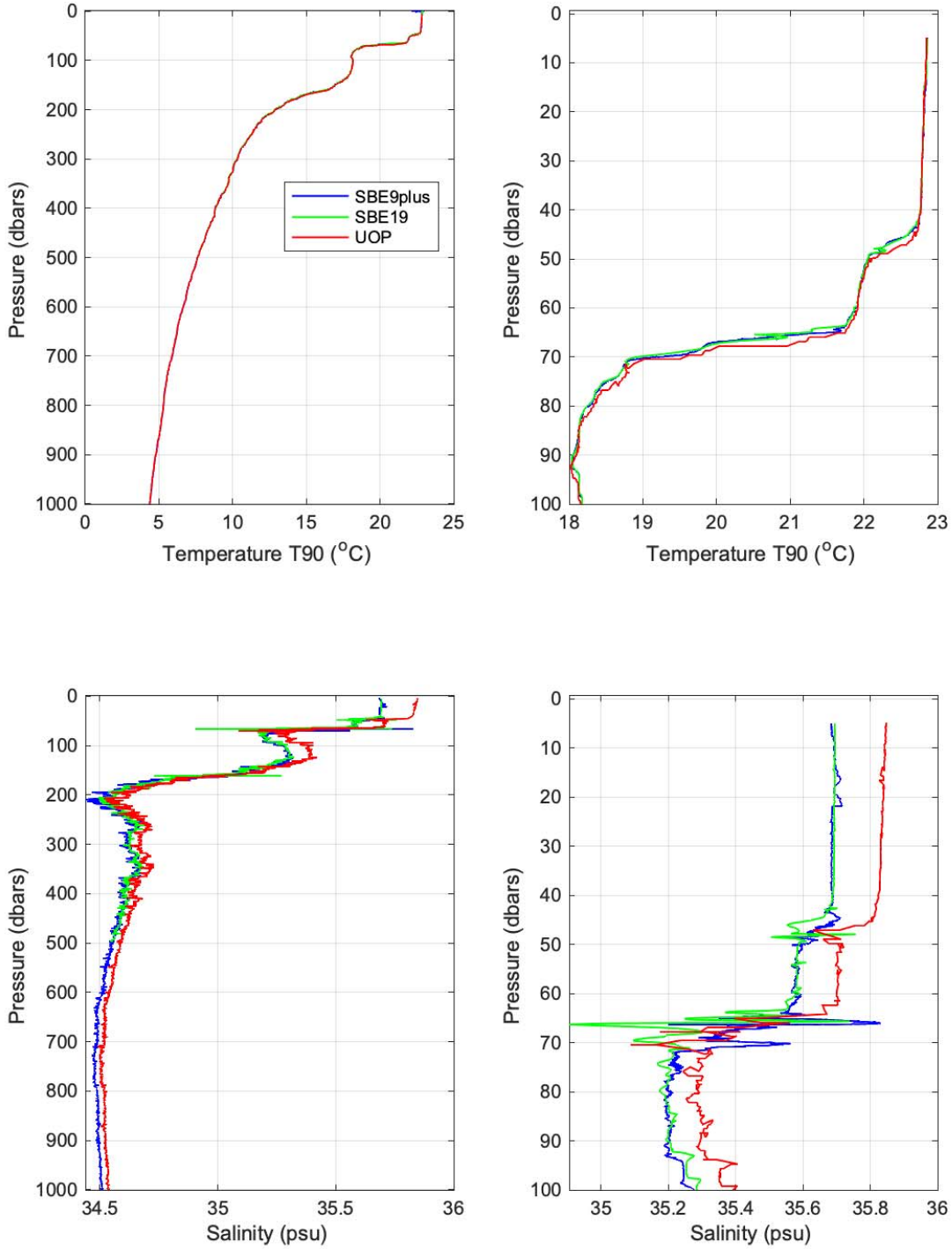

Figure V-4. CTD cast #5 done on April 12 2018, 1 nm from newly deployed Stratus 17 buoy. Data from three instruments (two SHOA, one UOP).

C. Surface Drifters and Argo Floats

During the Stratus 17 cruise, 31 surface drifters and 6 Argo profiling floats were launched. The six Argo floats were deployed in international waters (Table V-2) on behalf of the Argo group at WHOI.

Seven drifters were provided by professor Mario Caceres (University of Valparaiso) and deployed in Chilean waters. The remaining surface drifters, provided by NOAA AOML (Atlantic Oceanographic and Meteorological Laboratories, Miami, Florida) for the NOAA Global Surface Drifter Program, were deployed in international waters (Table V-3).

Table V-2. Locations of Argo floats deployments during Stratus 17 cruise.

Float ID	Date	Time (UTC)	Latitude (S)	Longitude (W)
7464	4/4/2018	09:10	29° 46.61’	77° 00.19’
7444	4/4/2018	17:15	29° 19’	77° 38’
7469	4/6/2018	09:45	23° 57’2	84° 44.3’
7475	4/7/2018	00:26	21° 59.820’	87° 14.240’
7445	4/8/2018	18:55	18° 56.322	90° 57.755’
7476	4/12/2018	18:48	19° 38.518	84° 56.100’

Table V-3. Locations of surface drifter deployments during Stratus 17 cruise.

Drifter ID	Date (mm/dd/yy)	Time (UTC)	Latitude	Longitude	Notes
64702590	4/3/18	6:31	32°44.8’ S	72°06.9’ W	UV drifter
64703760	4/3/18	9:53	32°20.2’ S	72°44.7’ W	UV drifter
64702720	4/3/18	13:51	31°56.9’ S	73°23’ W	UV drifter
64702740	4/3/18	16:19	31°35.8’ S	74°04.3’ W	UV drifter
64704580	4/3/18	20:27	31°14.0’ S	74°46’ W	UV drifter
64702610	4/3/18	23:50	30°51.8’ S	75°23.3’ W	UV drifter
64703670	4/4/18	3:17	30°29.5’ S	76°01.4’ W	UV drifter
64737970	4/4/18	9:00	29°47.8’ S	76°59.6’ W	
64338820	4/4/18	9:01	29°47.5’ S	72°59.7’ W	
64738830	4/4/18	17:15	29°19’ S	77°38’ W	Magnet was still attached
64737830	4/4/18	17:15	29°19’ S	77°38’ W	
64873160	4/6/18	9:47	23°56.9’ S	84°44.8’ W	-1
64873100	4/6/18	9:47	23°56.9’ S	84°44.8’ W	
64873090	4/6/18	15:52	23°07.96’ S	85°47.5’ W	
64738150	4/6/18	15:52	23°07.96’ S	85°47.5’ W	
64828030	4/6/18	15:52	23°07.96’ S	85°47.5’ W	
64828450	4/6/18	0:14	22°59.60’ S	87°13.41’ W	
64828460	4/6/18	0:14	22°59.60’ S	87°13.41’ W	
64828040	4/6/18	0:14	22°59.60’ S	87°13.41’ W	
64827540	4/7/18	8:01	20°59.6’ S	88°30.25’ W	
64828400	4/7/18	8:01	20°59.6’ S	88°30.25’ W	
64827510	4/7/18	8:01	20°59.6’ S	88°30.25’ W	
65157530	4/7/18	15:38	19°57.28’ S	89°48.49’ W	
65036080	4/7/18	15:38	19°57.28’ S	89°48.49’ W	
65155920	4/7/18	15:38	19°57.28’ S	89°48.49’ W	
65035080	4/7/18	18:37	19°30.20’ S	90°22.1’ W	
65052180	4/7/18	18:37	19°30.20’ S	90°22.1’ W	
64827560	4/7/18	18:37	19°30.20’ S	90°22.1’ W	
65158530	4/8/18	18:53	18°56.32’ S	90°57.90’ W	
65159530	4/8/18	20:48	19°57.7’ S	90°39.6’ W	
65156630	4/8/18	23:29	19°00.74’ S	90°13.58’ W	

Acknowledgements

The Upper Ocean Processes group at WHOI is thankful for the crew of the research vessel *Cabo de Hornos*, the Chilean Navy and its Hydrographic Services (SHOA). Finally, thanks go to the National Ocean and Atmospheric Administration (NOAA) for its continued support and funding. The Stratus program work is funded by the Climate Observation Division, Climate Program Office (FundRef number 100007298), National Oceanic and Atmospheric Administration, U.S. Department of Commerce, under grant NA14OAR43201.

Appendix 1: Stratus 17 instrument setup

Aanderaa RCM-11s:
20180409 S17 RCM 11 Set-up

SN:13 - 30 minute interval, 7 channels, burst mode ON: 18:59:00z (DSU: 1:4261) spike IN: 19:07z OUT: 20:08z

SN:78 - 30 minute interval, 6 channels, (NO BURST) ON: 18:59:45z (DSU: 98142) spike IN: 19:05z OUT: 20:08z

SN: 79 - 30 minute interval, 6 channels, (NO BURST) ON: 19:00:45z (DSU: 98202) spike IN:19:03z OUT: 20:08z

Aanderaa Seaguards:
sampling interval: 300 seconds / 1500 seconds - repeat 2x per hour = 5 minute averages every 30 minutes
pings: 300 pings per sampling interval (1 Hz)
blanking distance: 1m
cell size: 2.5m

Nortek ADCP SN 357:
Deployment : STRA17
Current time : 1/8/18 12:49:10 AM
Start at : 3/26/18 1:00:00 AM
Comment:
S17 / 2Mhz Profiler / 3 Li batteries / 13m depth - head up

Profile interval (s) : 1800
Number of cells : 15
Cell size (m) : 1.00
Blanking distance (m) : 1.02
Measurement load (%) : 4
Average interval (s) : 300
Power level : HIGH
Wave data collection : DISABLED
Compass upd. rate (s) : 1
Coordinate System : ENU
Speed of sound (m/s) : MEASURED
Salinity (ppt) : 35
Analog input 1 : NONE
Analog input 2 : NONE
Analog input power out : DISABLED
File wrapping : OFF
TellTale : OFF
Acoustic modem : OFF

Serial output : OFF
Baud rate : 38400

Assumed duration (days) : 440.0

Battery utilization (%) : 89.0
Battery level (V) : 11.2
Recorder size (MB) : 25
Recorder free space (MB) : 24.973
Memory required (MB) : 3.4
Vertical vel. prec (cm/s) : 0.3
Horizon. vel. prec (cm/s) : 0.9

Instrument ID : AQD 0357
Head ID : AQP 0274
Firmware version : 1.17

AquaPro Version 1.37.04

TRDI SN 1218:
Instrument S/N: 1218
Frequency: 307200 HZ
Configuration: 4 BEAM, JANUS
Match Layer: 10
Beam Angle: 20 DEGREES
Beam Pattern: CONVEX
Orientation: UP
Sensor(s): HEADING TILT 1 TILT 2 TEMPERATURE
Temp Sens Offset: -0.13 degrees C

CPU Firmware: 50.40 [0]
Boot Code Ver: Required: 1.16 Actual: 1.16
DEMOD #1 Ver: ad48, Type: 1f
DEMOD #2 Ver: ad48, Type: 1f
PWRTIMG Ver: 85d3, Type: 4

Board Serial Number Data:
E4 00 00 02 48 9F C4 09 PIO727-3000-04C
4F 00 00 06 F6 08 BE 09 REC727-1000-04E
77 00 00 02 67 9C C5 09 CPU727-2000-00H
96 00 00 02 67 90 33 09 DSP727-2001-04F

>rr?

Recorder Directory:
Volume serial number for device #0 is 0000-0161

Bytes used on device #0 = 0
Volume serial number for device #1 is 0000-0110

Bytes used on device #1 = 0
Total capacity = 52168704 bytes
Total bytes used = 0 bytes in 0 files
Total bytes free = 52168704 bytes

>rn?
Current deployment name = STR17

>tt?
TT 2018/01/08,01:19:15 - Time Set (CCYY/MM/DD,hh:mm:ss)
>CR1
[Parameters set to FACTORY defaults]
>CF11101
>EA0
>EB0
>ED800
>ES35
>EX11111
>EZ1111101
>WA50
>WB0
>WD111100000
>WF200
>WN45
>WP300
>WS200
>WV175
>RNSTR17
>TE01:00:00.00
>TP00:01.00
>TF18/03/26 01:00:00
>CK
[Parameters saved as USER defaults]
>CS

<u>Vector Measuring Current Meters (VMCM):</u>
VM001
Model: STAR ENGINEERIN
SerNum: VM2017
CfgDat: 08APR02
Firmware: VMCM2 v3.24
RTClock: 2018/04/05 20:39:04
Logging Interval: 60; Current Tick: 4
Compass Ontime=2 Offtime=13
EDI Intel-compatible 20MB PCMCIA CARD present - CARD OK!
FLASH card capacity: 20840436
Records used: 0; available: 612954
Main Battery Voltage: 0.00
TPOD Firmware: VMTPOD53 v3.00
TPOD Info: VMTPOD VMT004 11OCT17 THERM004
Sampling GO

VMCM2 - Firmware VMCM2 v3.24
Waiting to Sync...Running

VM001
Model: STAR ENGINEERIN
SerNum: VM2001
CfgDat: 09APR02
Firmware: VMCM2 v3.24
RTClock: 2018/04/05 20:52:35
Logging Interval: 60; Current Tick: 22
Compass Ontime=2 Offtime=13
EDI Intel-compatible 20MB PCMCIA CARD present - CARD OK!
FLASH card capacity: 20840436
Records used: 1; available: 612953
Main Battery Voltage: 0.00
TPOD Firmware: VMTPOD53 v3.00
TPOD Info: VMTPOD VMT002 11OCT17 THERM002
Sampling STOPPED
Sampling GO - synchronizing...

VM001
Model: STAR ENGINEERIN
SerNum: VM2080
CfgDat: 16APR02
Firmware: VMCM2 v3.24
RTClock: 2018/04/05 21:11:23
Logging Interval: 60; Current Tick: 53
Compass Ontime=2 Offtime=13
EDI Intel-compatible 20MB PCMCIA CARD present - CARD OK!
FLASH card capacity: 20840436
Records used: 15; available: 612939

Main Battery Voltage: 0.00
TPOD Firmware: VMTPOD53 v3.00
TPOD Info: VMTPOD VMT012 11OCT17 THERM012
Sampling GO

VM001
Model: STAR ENGINEERIN
SerNum: VM2053
CfgDat: 15APR02
Firmware: VMCM2 v3.24
RTClock: 2018/04/05 21:51:04
Logging Interval: 60; Current Tick: 4
Compass Ontime=2 Offtime=13
EDI Intel-compatible 20MB PCMCIA CARD present - CARD OK!
FLASH card capacity: 20840436
Records used: 0; available: 612954
Main Battery Voltage: 0.00
TPOD Firmware: VMTPOD53 v3.00
TPOD Info: VMT068 28DEC16 THERM068
Sampling GO

VM001
Model: STAR ENGINEERIN
SerNum: VM2091
CfgDat: 17APR02
Firmware: VMCM2 v3.24
RTClock: 2018/04/05 22:15:03
Logging Interval: 60; Current Tick: 18
Compass Ontime=2 Offtime=13
EDI Intel-compatible 20MB PCMCIA CARD present - CARD OK!
FLASH card capacity: 20840436
Records used: 6; available: 612948
Main Battery Voltage: 0.00
TPOD Firmware: VMTPOD53 v3.00
TPOD Info: VMTPOD VMT075 02FEB18 THERM075
Sampling GO

VM001
Model: STAR ENGINEERIN
SerNum: VM2020
CfgDat: 08APR02
Firmware: VMCM2 v3.24
RTClock: 2018/04/05 22:29:30
Logging Interval: 60; Current Tick: 45
Compass Ontime=2 Offtime=13
EDI Intel-compatible 20MB PCMCIA CARD present - CARD OK!
FLASH card capacity: 20840436
Records used: 2; available: 612952
Main Battery Voltage: 0.00
TPOD Firmware: VMTPOD53 v3.00
TPOD Info: ^^^^^^^^^^^^^^ VMT017 02FEB18 THERM017
Sampling GO

SBE37s:

SBE37SM-RS232 v3.1 SERIAL NO. 12258 04 Apr 2018 20:36:19
vMain = 6.96, vLith = 3.09
samplenumber = 0, free = 838860
not logging, waiting to start at 05 Apr 2018 01:00:00
sample interval = 300 seconds
data format = converted engineering
transmit real-time = no
sync mode = no
pump installed = no
reference pressure = 0.0 decibars

SBE37SM-RS232 v3.1 SERIAL NO. 8212 04 Apr 2018 20:38:35
vMain = 6.90, vLith = 3.10
samplenumber = 0, free = 838860
not logging, waiting to start at 05 Apr 2018 01:00:00
sample interval = 300 seconds
data format = converted engineering
transmit real-time = no
sync mode = no
pump installed = no
reference pressure = 0.0 decibars

SBE37SM-RS232 v3.1 SERIAL NO. 8218 04 Apr 2018 20:41:30
vMain = 6.96, vLith = 3.12
samplenumber = 0, free = 838860
not logging, waiting to start at 05 Apr 2018 01:00:00
sample interval = 300 seconds
data format = converted engineering
transmit real-time = no
sync mode = no
pump installed = no
reference pressure = 0.0 decibars

SBE37SM-RS232 v3.1 SERIAL NO. 8220 04 Apr 2018 17:44:05
vMain = 6.90, vLith = 3.14
samplenumber = 0, free = 838860
not logging, waiting to start at 05 Apr 2018 01:00:00
sample interval = 300 seconds
data format = converted engineering
transmit real-time = no
sync mode = no
pump installed = no
reference pressure = 0.0 decibars

SBE37SM-RS232 v3.1 SERIAL NO. 8219 04 Apr 2018 17:46:21
vMain = 6.99, vLith = 3.14
samplenumber = 0, free = 838860
not logging, waiting to start at 05 Apr 2018 01:00:00
sample interval = 300 seconds
data format = converted engineering
transmit real-time = no
sync mode = no
pump installed = no
reference pressure = 0.0 decibars

SBE37SM-RS232 v3.1 SERIAL NO. 8224 04 Apr 2018 17:49:38
vMain = 7.02, vLith = 3.16
samplenumber = 0, free = 838860
not logging, waiting to start at 05 Apr 2018 01:00:00
sample interval = 300 seconds
data format = converted engineering
transmit real-time = no
sync mode = no
pump installed = no
reference pressure = 0.0 decibars

SBE37SM-RS232 v3.1 SERIAL NO. 8221 04 Apr 2018 17:52:15
vMain = 6.98, vLith = 3.15
samplenumber = 0, free = 838860
not logging, waiting to start at 05 Apr 2018 01:00:00
sample interval = 300 seconds
data format = converted engineering
transmit real-time = no
sync mode = no
pump installed = no
reference pressure = 0.0 decibars

SBE37SM-RS232 v3.1 SERIAL NO. 8215 04 Apr 2018 18:01:27
vMain = 7.02, vLith = 3.18
samplenumber = 0, free = 838860
not logging, waiting to start at 05 Apr 2018 01:00:00
sample interval = 300 seconds
data format = converted engineering
transmit real-time = no
sync mode = no
pump installed = no
reference pressure = 0.0 decibars

SBE37SM-RS232 v3.1 SERIAL NO. 12256 04 Apr 2018 18:09:13
vMain = 7.00, vLith = 3.10
samplenumber = 0, free = 838860
not logging, waiting to start at 05 Apr 2018 01:00:00
sample interval = 300 seconds
data format = converted engineering
transmit real-time = no
sync mode = no
pump installed = no
reference pressure = 0.0 decibars

SBE37SM-RS232 v3.1 SERIAL NO. 8211 04 Apr 2018 18:11:58
vMain = 6.92, vLith = 3.11
samplenumber = 0, free = 838860
not logging, waiting to start at 05 Apr 2018 01:00:00
sample interval = 300 seconds
data format = converted engineering
transmit real-time = no
sync mode = no
pump installed = no
reference pressure = 0.0 decibars

SBE37SM-RS232 v3.1 SERIAL NO. 8216 04 Apr 2018 18:14:08
vMain = 6.98, vLith = 3.11
samplenumber = 0, free = 838860
not logging, waiting to start at 05 Apr 2018 01:00:00
sample interval = 300 seconds
data format = converted engineering

transmit real-time = no
sync mode = no
pump installed = no
reference pressure = 0.0 decibars

Deep SBE37:
SBE37SM-RS232 v3.1 SERIAL NO. 12257 04 Apr 2018 17:35:20
vMain = 6.98, vLith = 3.08
samplenumber = 0, free = 838860
not logging, waiting to start at 05 Apr 2018 01:00:00
sample interval = 300 seconds
data format = converted engineering
transmit real-time = no
sync mode = no
pump installed = no
reference pressure = 0.0 decibars

SBE37SM-RS232 v3.1 SERIAL NO. 11394 04 Apr 2018 17:37:42
vMain = 6.94, vLith = 3.07
samplenumber = 0, free = 559240
not logging, waiting to start at 05 Apr 2018 01:00:00
sample interval = 300 seconds
data format = converted engineering
transmit real-time = no
sync mode = no
pump installed = no

Wetlabs Fluorometer:
Ser FLSB-2866
Ver FL 4.06
Ave 65
Pkt 4
Cal 1
Asv 1
Set 7870
Rec 1
Int 01:39:52
Dat 04/09/18
Clk 23:03:26
Mem 1

mvs 1
04/09/18 23:03:43 1.07 695 193 526
04/09/18 23:03:44 1.07 695 193 526
04/09/18 23:03:45 1.06 695 192 526
04/09/18 23:03:46 1.03 695 188 526
mvs 0

Appendix 2: Stratus 17 Surface and Subsurface Instrumentation Configuration

Surface:

	SYSTEM 1			SPIKE		
Module	Serial	Height Cm	DATE	Start Time	End Time	Notes
Logger PORT	L04					
HRH	213	240				
BPR	210	242				
WND	343	264	20180409	22:31	23:24	spike is removal of nose cone (prop)
PRC	506	252	20180409	23:17	23:17	spike with 250 ml
LWR	208	284	20180409	22:30	23:22	
SWR	349	285	20180409	22:30	23:22	
SST	1725	142				no spike - no ice available
IR	J10CJ1					
IMEI	300234063167110					
	SYSTEM 2			SPIKE		
Logger STARBOARD	L14					
HRH	249	243				
BPR	219	236				
WND	346	264	20180409	22:31	23:24	spike is removal of nose cone (prop)
PRC	219	253	20180409	23:18	23:18	spike with 300ml
LWR	243	284	20180409	22:30	23:22	
SWR	216	285	20180409	22:30	23:22	
SST SBE37	1839	142				no spike - no ice available
PTT	18171					
IDs	27919, 27920, 27921					

STAND ALONES MODULES		SPIKE				
Module	Serial	Height Cm	DATE	Start Time	End Time	Notes
VWX	201	240 (top of white ring)				
Lascar AT/RH	10031713	210				
SBE-39-AT	477	235				
SA HRH	269	238				
SA SWR	206	284				
XEOS KILO	300234062943610					
XEOS Mello	300034013701980					
XEOS Rover	300434061508050					

Stratus 17 Sea Surface Temperature Array				
		CM	CM	Orientation
Instrument	Serial	Below Deck	below waterline	Degrees
SBE56	2065	90	30	PORT 270
SBE56	2066	90	30	BOW 180
SBE56	2067	120	60	BOW 180
SBE56	2068	90	30	STBD 90

In hull SSTs orientation convention has bow (pick-up bale) a 0* positive degrees go clockwise so STBD is 90* wind vane is 180* and port is 270*

Subsurface:

Instrument	Serial	Depth Meters	Sample rate (s)	START		SPIKE			NOTES
				date	time	date	start time	stop time	
Nortek 2 MHZ Profiler	357	13	300/1800	20180326	0100	20180406	14:10	16:13	
RCM11	78	7	1800	20180409	18:59:45	20180409	19:05	20:08	
RCM11p	79	20	1800	20180409	19:00:45	20180409	19:03	20:08	
RCM11p	13	32.5	1800	20180409	18:59:00	20180409	19:07	20:08	
RDI 300 KHZ	1218	80	3600	20180326	0100	20180406	14:11	16:12	
SBE37	11394	4503	300	20180405	0100	20180406	14:11	14:33	
SBE37	12257	4503	300	20180405	0100	20180406	14:11	14:33	
SBE37	1325	2	300	20180326	0100	20180406	14:10	14:33	
SBE37	1326	3.7	300	20180326	0100	20180406	14:10	14:33	
SBE37	1328	10	300	20180326	0100	20180406	14:09	14:34	
SBE37	1329	16	300	20180326	0100	20180406	14:10	14:33	
SBE37	1330	30	300	20180326	0100	20180406	14:09	14:34	
SBE37	8211	40	300	20180405	0100	20180406	14:10	14:33	
SBE37	8212	62.5	300	20180405	0100	20180406	14:09	14:34	
SBE37	1909	85	300	20180326	0100	20180406	14:08	14:35	
SBE37	8215	130	300	20180405	0100	20180406	14:10	14:33	
SBE37	8216	160	300	20180405	0100	20180406	14:10	14:33	
SBE37	12258	190	300	20180405	0100	20180406	14:09	14:34	

SBE37	12256	220	300	20180405	0100	20180406	14:10	14:33	
SBE37	1906	295	300	20180326	0100	20180406	14:08	14:35	
SBE37	3733	550	300	20180326	0100	20180406	14:10	14:33	
SBE37	1908	601	300	20180326	0100	20180406	14:08	14:35	
SBE37	8218	698	300	20180405	0100	20180406	14:08	14:35	
SBE37	8219	857	300	20180405	0100	20180406	14:11	14:32	
SBE37	8220	1354	300	20180405	0100	20180406	14:11	14:32	
SBE37	8221	1557	300	20180405	0100	20180406	14:11	14:32	
SBE37	8224	2000	300	20180405	0100	20180406	14:11	14:32	
SBE39	35	4.9	300	20180326	0100	20180406	14:09	14:32	
SBE39	38	25	300	20180326	0100	20180406	14:09	14:32	
SBE39	44	35	300	20180326	0100	20180406	14:09	14:32	
SBE39	48	50	300	20180326	0100	20180406	14:09	14:32	
SBE39	49	55	300	20180326	0100	20180406	14:09	14:32	
SBE39	102	70	300	20180326	0100	20180406	14:09	14:32	
SBE39	103	77.5	300	20180326	0100	20180406	14:09	14:32	
SBE39	203	92.5	300	20180326	0100	20180406	14:09	14:32	
SBE39	276	100	300	20180326	0100	20180406	14:09	14:32	
SBE39	284	115	300	20180326	0100	20180406	14:09	14:32	
SBE39	719	175	300	20180326	0100	20180406	14:09	14:32	
SBE39	720	280	300	20180326	0100	20180406	14:09	14:32	
SBE56	2065	.9	60	20180405	0100	20180405	18:46	18:46	PORT (90*)
SBE56	2066	.9	60	20180405	0100	20180405	18:44	18:44	BOW HIGH (180*)
SBE56	2067	1.2	60	20180405	0100	20180405	18:45	18:45	BOW LOW (180*)
SBE56	2068	.9	60	20180405	0100	20180405	18:43	18:43	STBD (90*)

Seaguard	138	45	300/1500	20180326	0100	20180406	14:45	16:10	
Seaguard	140	87.3	300/1500	20180326	0100	20180406	14:41	16:11	
Seaguard	141	145	300/1500	20180326	0100	20180406	14:46	16:09	
Seaguard	142	235	300/1500	20180326	0100	20180406	14:46	16:09	
Seaguard	143	290	300/1500	20180326	0100	20180406	14:43	16:10	
Seaguard	144	700	300/1500	20180326	0100	20180406	14:44	16:10	
Seaguard	181	450	300/1500	20180326	0100	20180406	14:42	16:11	
Seaguard	182	600	300/1500	20180326	0100	20180406	14:44	16:10	
Seaguard (LS)	961	107	300/3300	20180326	0100	20180406	14:42	16:11	
Seaguard (LS)	964	183	300/3300	20180326	0100	20180406	14:46	16:09	
Seaguard (LS)	969	350	300/3300	20180326	0100	20180406	14:46	16:09	
VMCM	2017	802	60	20180405	20:37:14	20180410	17:13	17:14	CHECK SN# WHEN RECOVERED: 2 SN#17 - hard prop spin prior to deployment
VMCM	2001	853	60	20180405	20:52:35	20180410	17:46	17:47	hard prop spin prior to deployment
VMCM	2080	1506	60	20180405	21:07:13	20180410	18:16	18:17	hard prop spin prior to deployment
VMCM	2053	400	60	20180405	21:51:04	20180410	16:57	16:58	hard prop spin prior to deployment
VMCM	2091	853	60	20180405	22:08:29	20180410	17:46	17:47	hard prop spin prior to deployment
VMCM	2020	2009	60	20180405	22:25:58	20180410	18:50	1/0/0 0 18:51	CHECK SN# WHEN RECOVERED: 2 SN#17 and no SN# 20 hard prop spin prior to deployment
wetlabs FLSB	2866	100.5	1:39:52	20180409	23:03:43				no spike
SBE37_SST	1725	-152	300	20180326	0100				no spike - no ice available
SBE37_SST	1839	-152	300	20180326	0100				no spike - no ice available

Appendix 3: Mooring Log Stratus 16, as recovered

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 8242 XS 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 344214	Release 127413

Recovery (release fired)

Date (day-mon-yr) Mooring broke 1/4/18 (January 4 2018) Recovered April 8 2018 (Top part) Time April 12 2018 12:20 UTC

Latitude (N/S) 18° 54.7' Longitude (E/W) 091° 04'

Recovered by Ben Pietro Recorder/Observer S. Bigorre

Ship and Cruise No. Cabo de Hornos AGS 61 Actual duration 236 (break) 330 (recovery) 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	unplugged 1615 on 4/8/18
PRC	275	253	
LWR	206	285	
SWR	254	286	
SST	3605	-142	
PTT	14709		09805, 09807, 09811
Standalones			
WXT	8	245 top white ring	unplugged @ 1616 on 4/8/18
Lascar	10023643	223	
SBE39AT	5275	223	
HRH	221	240	
SWR	207	286	

*Height above buoy deck in centimeters

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 (32STΦ)
XEOS			
Kilo			3002 3406 2644 350
Hello			3008 4013 2077 60
Rover			3004 3406 0447 400
SBE 56	1206	90	Port 90°
SBE 56	1208	120	Port 90°
SBE 56	1210	140	Port 90°
SBE 56	1211	90	Forward 180°
SBE 56	2069	90	Starboard 270°
PCO2	0132		
SAMI	P62		
SBE 16	7260		pump# 1780
Fluor	2401		
†Depth below buoy deck in centimeters			

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	1325	Halo & instruments damaged at recovery
2	0.22	3/4 chain					
3		SBE 37	2	1304	1346	1448	
4	0.37	3/4 chain					
5		SBE 37	3.7	3821	1346	1449	Copper guard damaged prior to recovery
6	0.53	chain					
7		SBE 39	5	39	1346	1449	
8	0.9	3/4 chain					
9		SBE 37	7	3824	~~1314~~ 1346	1452	
10	4	3/4 chain					
11		SBE 39	12.2	41	1257	1452	
12		termination					
13		Aanderaa ADCP	13	235	1256	1454	
14	1.95	3/4 chain					
15		SBE 37	16.4	1899	1256	1510	
16	2.1	3/4 chain					
17		SBE 39	20	53	1252	1529	
18	4.05	3/4 chain					
19		SBE 39	25	101	1247	1532	
20	3.97	3/4 chain					
21		SBE 37	30	1900	1245	1536	long fishing lines
22	1.13	3/4 chain					
23		Aanderaa ADCP	32.5	238	1245	1545	
24	1.13	3/4 chain					
25		SBE 39	35	721	1241	1545	T probe bent inside guard

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	1554	fishing gear
28	3.23	3/4 chain					
29		VMCM	45	3	1231	1559	spin @ 1230 Heavy barnacles Heavy; props not spinning + fishing gear
30	15.3	7/16" wire					
31		SBE39	52	1502	1400	1604	clamped. Copper guard broken on both ends
32		SBE37	62.5	1902	1405	1609	load bar
33	21.2	7/16" wire					
34		SBE39	70	1509	1406	1613	clamped
35		SBE39	77.5	1511	1407	1616	clamped
36		SBE37	85	8004	1417	1619	load bar
37		termination					
38		RDI ADCP	88	12254	1417	1619	
39	9.5	7/16" wire					
40		SBE39	92.5	3423	1419	1622	
41		VMCM	100	9		1624	spin @ 1419. A few small barnacles on rotors
42	28	7/16" wire					
43		SBE39	115	3434	1427	1629	clamped
44		SBE37	130	1903	1435	1630	
45	3	3/4 chain					
46		VMCM	135	10	1440	1631	spin @ 1431. Fishing line in props (not turning)
47	23.5	7/16 wire					
48		SBE39	145	3435	1442	1640	clamped. Fuzz.
49		SBE37	160	1905	1446	1642	load bar. Heaving fish gear.
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	1647	clamped. Fishing gear (line)
52		VMCM	183	11	1500	1651	spin @ 1452, Lots of fishing line, Props not turning. Bottom anode gone
53	4.8	7/16 wire					
54		SBE37	190	1907	1504	1705	load bar clean
55	28.5	7/16 wire					
56		SBE37	220	8214	1511	1710	load bar clean
57	13	7/16 wire					
58		VMCM	235	38	1516	1713	spin @ 1510. Clean - Bottom anode gone.
59	53	3/8 wire					
60		SBE37	250	2011	1521	1719	clamped
61		VMCM	290	59	1524	1723	Spin @ 15:20z Bottom anode gone
62	160	3/8 wire					
63		SBE37	310	7836	1529	1728	clamped
64		SBE39	400	3438	1534	1731	clamped
65		VMCM	450	61	1540	1734	spin @ 1534
66	340	3/8 wire					
67		SBE37	550	8223	1546z	1741	clamped
68	500	3/8 wire			1555z		wuzzleat 500-500m termination
69	500	3/8 wire			1616		
70	100	3/8 wire			1636		
71	100	3/8 wire			1642		} one piece, wrapped termination
72	200	7/8 nylon			1646		
73	1850	7/8 nylon			1702		} spliced at sea
74	1500	1" Colmega			1725		
75		glassballs (84)			1810		4 glassballs broken on recovery

6

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	13:59 4/12/18	} doubled load bar
77		SBE37		10601	1925	13:59 4/12/18	
78	5	1/2 chain					
79		acoustic releases			1925	14:00 4/12/18	
80	1	chain					
81	5	1/2 chain					
82	20	1" Samson	Nystron				marking on thimble says 25m
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							

7

Appendix 4: Mooring Log Stratus 17, as deployed

Moored Station Log

(fill out log with black ball point pen only)

ARRAY NAME AND NO. STRATUS 17 MOORED STATION NO. _____

Launch (anchor over)

Date (day-mon-yr) 10 - April - 2018 Time 23 : 24 UTC

Deployed by Ben Pietro Recorder/Observer Sebastien Bigorre

Ship and Cruise No. Cabo de Hornos Intended Duration 365 days

Depth Recorder Reading _____ m Correction Source Bathymetry map

Depth Correction _____ m (based on Multibeam surveys)

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

Anchor Drop Lat. (N/S) 19 38.38 ' Lon. (E/W) 084° 55.273 '

Surveyed Pos. Lat. (N/S) 19° 38.3203 ' Lon. (E/W) 084° 55.099 '

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

Acoustic Release Model _____ Tested to 1,500 m

Release No. 1 (sn) 48274 Release No. 2 (sn) 35319

Interrogate Freq. 11 Interrogate Freq. 11

Reply Freq. 12 Reply Freq. 12

Enable 567 402 Enable 111 446

Disable 567 421 Disable 111 465

Release 551 071 Release 127 476

Recovery (release fired)

Date (day-mon-yr) _____ Time _____ UTC

Latitude (N/S) _____ Longitude (E/W) _____

Recovered by _____ Recorder/Observer _____

Ship and Cruise No. _____ Actual duration _____ days

Distance from waterline to buoy deck 60 cm

1

ARRAY NAME AND NO. STRATUS A7 MOORED STATION NO. _____

Surface Components			
Buoy Type ~~NOB~~ 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	L04		Port side
HRH	213	240	
BPR	210	242	
WND	343	264	
PRC	506	252	
LWR	208	284	
SWR	349	285	
SST	1725		
Tridium	J10CJ1		3002 3406 3167 110
ASIMET logger	L14		Starboard side
HRH	249	243	
BPR	219	236	
WND	346	264	
PRC	219	253	
LWR	243	284	
SWR	216	285	
SST	1839		
PTT	18171		Ids: 27919, 27920, 27921
Standalones			
WXT	201	240	
Lascar	10031713	210	
SBE39 AT	477	235	
HRH	269	238	
SWR	206	284	
*Height above buoy deck in centimeters			

ARRAY NAME AND NO. STRATUS 17 MOORED STATION NO. _____

Subsurface Instrumentation on Buoy and Bridle			
Item	ID #	Depth†	Comments
Surface GPS	beacons:		
XEOS ~~Light~~ Mariner Kilo			3002 3406 2943 610
XEOS Delo			3000 3401 3701 980
Subsurface			
XEOS ~~Recover~~ Marmaver			300 434 061 50 80 50
SBE56	2065	90	Port, 270°
SBE56	2066	90	Bow, ~~180°~~ 0°
SBE56	2067	120	Bow, ~~180°~~ 0°
SBE56	2068	90	Stbd, 90°
PCO2			
†Depth below buoy deck in centimeters			

ARRAY NAME AND NO. STRATUS 17 MOORED STATION NO. _____

Item No.	Length (m)	Item	Depth	Inst No.	Time Over	Time Back	Notes
1		Buoy			13:36		
2	0.22	3/4 chain					
3		SBE37	2	1325	13 36		
4	0.37	3/4 chain					
5		SBE37	3.7	1326	13 36		
6							
7		SBE39	4.9	35	13 36		Down, short TB.
8	1.3	3/4 chain					
9		Aanderaa RCM 11*	7	78	13 36		
10	1.5	3/4 chain					
11		SBE37	10	1328	13:32		
12	1.73	3/4 chain					
13		Nortek ADCP	13	357	13:06		Heads up
14	1.35	3/4 chain					
15		SBE37	16	1329	13:01		
16	2.7	3/4 chain					
17		Aanderaa RCM 11(P)	20	79	12:57		
18	3.66	3/4 chain					
19		SBE39	25	38	12:55		Up, short TB.
20	3.9	3/4 chain					
21		SBE37	30	1330	12:51		
22	1.12	3/4 chain					
23		Aanderaa RCM 11(P)	32.5	13	12:48		
24	1.2	3/4 chain					
25		SBE39	35	44	12:48		Up, short TB.

* was out of water for [illegible] until 13:30

ARRAY NAME AND NO. STRATUS17 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	12:42		
28	3.66	3/4 chain					
29		Aanderaa Seaguard	45	138	12:29		w optode.
30	16	7/16 wire					
31		SBE39	50.	48	13:51		clamped.
32		SBE39	55	49	13:53		clamped.
33		SBE37	62.5	8212	13:58		lead bar.
34	16	7/16 wire					
35		SBE39	70	102	14:04		clamped
36		SBE39	77.5	103	14:18		clamped
37		RDI ADCP	80	1218	14:25		
38	6	7/16 wire					
39		SBE37(P)	85	1909	14:29		clamped
40		Aanderaa Seaguard	87.3	140	14:33		w optode.
41	18.2	7/16 wire					
42		SBE39	92.5	203	14:33		clamped.
43		SBE39	100	276	15:40		clamped. (without clacle) 14:30 things) + 151
44		Fluorometer Wetlabs	~~104~~ ~~100.5~~	2866	15:41		clamped. ** depth 104 m
45		Aanderaa Seaguard	107	961	15:41		lobar Stranmark. w optode.
46	21.5	7/16 wire					
47		SBE39	115	284	15:44		clamped.
48		SBE37	130	8215	15:52		lead bar.
49	14	7/16 wire					
50		Aanderaa Seaguard	145	141	15:58		w optode

ARRAY NAME AND NO. STRATUS17 MOORED STATION NO. _____

Item No.	Length (m)	Item	Depth	Inst No.	Time Over	Time Back	Notes
51	13.5	7/16 wire					
52		SBE37	160	8216	16:05		load bar.
53	21.7	7/16 wire					
54		SBE39	175	719	16:06		clamped.
55		Aanderaa Seaguard	183	964	16:11		Lothar Stramma's. w optode.
56	5.5	7/16 wire					
57		SBE37	190	12258	16:17		load bar.
58	29	7/16 wire					
59		SBE37	220	12256	16:24		load bar.
60	13.5	7/16 wire					
61		Aanderaa Seaguard	235	142	16:29		w optode.
62	53.5	7/16 wire					
63		SBE39	280	720	16:36		clamped.
64		Aanderaa Seaguard	290	143	16:42		w optode.
65	58.5	3/8 wire					
66		SBE37	295	1906	16:47		clamped.
67		Aanderaa Seaguard	350	969	16:56		Lothar Stramma's. w optode.
68	48.5	3/8 wire					
69		VMCM	400	053	17:05		16:57 blade spun
70	48.5	3/8 wire					
71		Aanderaa Seaguard	450	181	17:11		w optode.
72	148.5	3/8 wire	*				Oxygen no cast.
73		SBE37 (P)	550	3733	17:18		clamped.
74		Aanderaa Seaguard	600	182	17.26		w optode.
75	100	3/8 wire					

wire out of water

ARRAY NAME AND NO. STRATUS 17 MOORED STATION NO. _____

Item No.	Length (m)	Item	Depth	Inst No.	Time Over	Time Back	Notes
76		SBE37	601	1908	17:26		clamped below top term.
77		SBE37	696	8218	17:36		clamped above bottom term. * Change depth to 696
78		Aandera Seaguard	700	144	17:36		in optode
79	100	3/8 wire					
80		VMCM	802	17	17:44		17:37 blade spun
81	48.5	3/8 wire					
82		VMCM	853	1	17:53		17:46 blade spun
83	145	3/8 wire					
84		SBE37	857	8219	17:53		clamped.
85		VMCM	1000	16	18:02		17:56 blade spun
86	500	3/8 wire					
87		SBE37	1354	8220	18:15		clamped.
88		VMCM	1506	80	18:25		18:16 blade spun
89	500	3/8 wire					
90		SBE37	1557	8221	18:28		clamped.
91		SBE37	2000	8224	18:48		clamped.
92		VMCM	2009	172	18:53		* there is another 17 above 18:50 blade spun.
93	100	3/8 wire			18:59		one piece termination (potted)
94	200	7/8 Nylon			19:35		
95	1700	7/8 Nylon			[redacted]		spliced area
96	1500	Colmega			20:05		
97		glassballs (92)			21:21		[redacted] IIII IIII IIII IIII III Grp of 4
98		SBE37		11394	23:14		doubled
99		SBE37		12257	23:14		
100	5	1/2 chain					

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ARRAY NAME AND NO. STRATUS 17 MOORED STATION NO. _____

Date/Time			Comments			
Item No.	Item	Depth	Int. No	Time Over	Time Back	Notes
101	Acoustic releases			23:14		
102	chain (1m)					
103	1/2 chain (5m)					
104	1" Samson (20m)					
105	1/2 chain (5m)					
106	Anchor			23:24		
			* 19 38,39 S			
			84 55,41 W			

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6.

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Sebastien Bigorre, Benjamin Pietro, Alejandra Gubler, Francesca Search, Emerson Hasbrouck, Sergio Pezoa, Robert A. Weller

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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 Chilean research vessel Cabo de Hornos.

During the 2018 cruise on the Cabo de Hornos to the ORS Stratus site, the primary activities were the recovery of the previous (Stratus 16) WHOI surface mooring, deployment of the new Stratus 17 WHOI surface mooring, in-situ calibration of the buoy meteorological sensors by comparison with instrumentation installed on the ship, CTD casts near the moorings. The Stratus 17 had parted from its anchor site on January 4 2018, so its recovery was done in two separate operations: first the drifting buoy with mooring line under it, then the bottom part still attached to the anchor. Surface drifters and ARGO floats were also launched along the track.

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