WHOI-2025-04

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Stratus 23
Twenty-third Setting of the Stratus Ocean Reference Station
Cruise On Board RV Cabo de Hornos
March 10 - 23, 2025
Valparaiso, Chile - Valparaiso, Chile

by

Sebastien Bigorre[1], Maria Theresa Gatica[2], Ray Graham[1]
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Woods Hole Oceanographic Institution
Woods Hole, MA 02543

May 2025

Technical Report

Funding was provided by the National Oceanic and Atmospheric Administration under Grant No. NA19OAR4320074

Upper Ocean Processes Group
Woods Hole Oceanographic Institution
Woods Hole, MA 02543
UOP Technical Report 2025-04

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Young-Oh Kwon
Physical Oceanography

Abstract

The Ocean Reference Station at 22 °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 from March 10 to 23 on the Chilean research vessel *Cabo de Hornos*.

During the 2025 cruise on the *Cabo de Hornos* to the ORS Stratus site, the primary activities were the recovery of the previous (Stratus 22) WHOI surface mooring, deployment of the new Stratus 23 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 were also launched along the track.

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I. Introduction

A. Timeline

The Stratus 23 cruise departed Valparaiso on March 10 and returned to Valparaiso on March 23. Times below are in local time on board the ship (UTC -3, throughout the cruise).

March 9, 2025
23:00 local (UTC-3), loading ship at commercial port TPS site 1.

March 10, 2025
Ship Cabo De Hornos departs TPS pier at 03:45 am local, start of Stratus 23 cruise. Orientation meeting at 2 pm followed by fire drill. SOG 9 kts, choppy seas, wind from the South.

March 11, 2025
08:25 local deployed drifters #1 and 2, 10 nm outside (west) of Chile EEZ in international waters. Explanation about use of drifters to Captain, XO and a few officers.
10:30 am, crossing 76 W (29 48.7 S, 076 0.9 W), so 9.4 kts average speed over past 2 hours.
Mooring wire wound on split net drum. Set up of subsurface instruments (including Wetlabs), spike of T sensors in walk-in freezer.
14:14:30 (local) CTD#1, start downcast from surface after 5 mn soak at 5 m. Rosette with 12 bottles, 1 acoustic release, SHOA and UOP CTD sensors.
14:45 (local), reaches bottom of cast, 1500 m, soak and trigger bottles, then A-coms with acoustic release.
15:15 CTD#2 in water. 16:37 at bottom, 1500 m. Noisy coms for a while, probably because wind picked up a bit so DP system may be more noisy. 17:14 transducer back onboard after A-coms with releases are good, CTD coming back up. 17:45 back on deck. Launch drifters 3 and 4 when leaving area.
18:30 rinsed SSTs on S23 with freshwater and replaced seawater in bucket. Trying to see if offset that developed yesterday is because of debris in bucket.
20:00 launched drifters 5 and 6 at 29 18.0; S, 76 41’ W, still 45 nm SE from EEZ around San Felix Island.

March 12, 2025, Wednesday
SOG 10 kts. Mooring rope splices at sea. Data download for loggers; conductivity now tracks well (no more offset), but Logger04 had a 30 mn long jump after freshwater rinse.
09:00 local, swapped SST from L04 with spare because of an offset that lasted 30 mn after rinse yesterday, and noise that had developed after ship loading but before rinse.
11:00, CTD test for SHOA sensor (issue with O2 sensor) to 1000 m, back on deck at 11:30 am. We check bottles for leaks. Bottles 1 and 9 didn’t close properly because lanyard too short. Bottles 2, 7, 8, 10, 11, 12. Bottles 3,4,5,6 leaked. SHOA swapped with their other CTD sensor (from SBE19 to SBE9+) and O2 sensor worked well.
14:11 SOG 5 kts, 27 29.8’S, 79 10.9’W.
15:30 new data download for loggers to evaluate COND data from L04 after spare was installed. It shows an offset (0.04 S/m) on spare that is worse than original sensor (0.002 S/m) so we decide to put pack original sensor.

15:45 SOG still about 5 kts (one diesel engine has issues and needed a filter replacement), slows down for CTD to 50 m to test repairs on Niskin bottles.
19:00 buoy tipped.

March 13, 2025, Thursday
08:50, SOG 10.5 kts, COG 305 T. Download of logger data; data looks good, including COND which are within 1/1000 S/m. OK to erase cards, set clocks, restart loggers and close hatch.

March 14, 2025, Friday
14:00, ship arrives near S23 target, 2 nm southwest of it, slows down to 8 kts for Multibeam survey showing seafloor depth 4195 m to 4225 m.
14:20-14:40 set and drift. Drift to 340 T at 1 kt. Wind 300 T. Possibly a northward current.
15:30: start practice run with DP on and all propulsion assets on, going 1-1.2 kt SOG, COG 166 T. Bridge is trying different propulsions means to see which one is the best.
17:45 small boat launch near S22 buoy for inspection. Buoy looks in good shape and not too dirty. No birds on buoy but a few seabirds flying or in water behind ship.
Short bathy survey in the night, to fill gaps past seamounts to the north of Stratus sites.

March 15, 2025, Saturday
Deployment Stratus 23.
06:30 ship has been approaching target site slowly as set and drift. Deployment track will be 9 nm with course 130 T. Based on Stratus 22 telemetry, wind is < 7 m/s and direction 295 T.
07:40 as we are getting ready on deck ship goes dark.
09:45 first instruments go in the water.
18:08, anchor dropped.
19:00-20:00: anchor survey S23.
After anchor survey, transit to Stratus 22 buoy for intercomparison ¼ nm downwind of buoy.

March 16, 2025, Sunday
Intercomparison at Stratus 22.
07:00 ship moves 1 nm downwind of Stratus 22 buoy for CTD.
08:19 CTD#2 at surface after 5 mn soak at 5 m depth. Start downcast to 3000m.
At bottom (3000m), stop for 5 mn (wait 2.5 mn, close 2 bottles, wait 2.5 mn then start going up), and repeat this at 2540m, 550, 350m, 250m and 20m.
09:00, good rain.
11:20 CTD#2 back on deck. Rosette stayed up in the air at recovery for a few mn as J-frame was not responding. All 12 bottles triggered but 7 leaked (not sampled).
13:30 debrief on bridge, planning recovery.
14:00-14:36: CTD#3 to 600 m 500 yards from S22 buoy. No samples.
18:28, rain (drizzle) for 2 mn, sunny though as broken stratus clouds move above ship fast.
20:04, CTD#4, start downcast to 600m, 500 yards from S22 buoy. At bottom at 20:16.
22:00 leave S22 and steam towards S23.

March 17, 2025, Monday
Intercomparison at Stratus 23.
02:00 wind picks up and DP does not hold anymore.

04:00 ship goes dark.
08:00 CTD#5, 1 nm downwind of S23 buoy. At 380 m Rosette comes back to the surface due to a problem with coms from pylon (SBE32). SHOA folks say it is just a problem with the cable, so we decide we can still do CTD but in autonomous mode using UOP's CTD sensor. 08:25, CTD below surface, going back down to 2200m.
09:55, CTD#5 back on deck. Ship 0.8 nm SW of S23 buoy.
14:00 CTD#6 to 2200m, 1 nm WSW of S23 buoy, no samples. It is raining all around us pretty good.
17:00-17:40 CTD#7 to 1000m, 1 nm WSW of S23 buoy.
After CTD back on deck, ship starts doing navigation exercises for training.
19:30 drive by S23 then ship goes to S22.
Overnight: weather patterns at Stratus 22 buoy, ship steams back and forth up and downwind.

March 18, 2025, Monday
Recovery of Stratus 22.
08:10 local, Stratus 22 mooring released; ranging to releases decreases 94 m/mn. Ship is between buoy and anchor, so relocate to ½ nm SE of anchor. From there, ship moves NW towards anchor.
08:53 glass balls at surface, about 200 m on port side of ship.
Ship moves for small boat deployment from bow, WHOI personnel boards small boat from starboard ladder off main deck.
9:50 Start recovery after messenger line to winch leader transmitted between small boat and back deck, and small boat personnel and boat recovered.
15:10 Stratus 22 buoy onboard. When lifting buoy up and forward of transom, the A-frame stops for a couple of minutes (remote control in winch house stopped working) until someone runs to local control up on the ladder by A-frame.
About 16:00, a few minutes after recovery ends and deck is secured, ship moves to Stratus 23 to deploy small boat and do a buoy ride on Stratus 23 buoy to replace equilibrator with spare on the pCO2 system from PMEL.
17:45 leave Stratus work area and start transit back to Valparaiso, deploy 2 drifters on way out.
Bridge says ETA in Valparaiso is 07:25 on March 23. Contact agent in Valparaiso to book berth.
Spiking of eight SBE 37s and download of data overnight in preparation for in-situ calibration CTD tomorrow.

March 19, 2025, Wednesday
07:00, transit SE at 9 kts. Deploy 2 drifters (1mn apart). Same at 8, 9, 10 am
11:00, deploy last drifter.
Resetting 8 microcats for fast sampling (10 s) for calibration CTD.
13:30 CTD#8, after 5 mn soak at 5m start downcast from surface to 3000m. Will stop for 3 bottles at 3000m, 310m, 210m and 30m. 8 microcats from S22 attached to Rosette (SNs 1836 and 2054 (SSTs), 1899 (16.4m), 1902 (62.5m), 8004 (88m), 1905 (160m), 8214 (220m) and 8223 (550m)). Realized too late that record from SN 8223 showed a large bias early in deployment so probably in situ calibration will not be useful.
16:00 CTD#8 back on deck. Ship resumes transit.
Disconnected batteries on bow met sensors as we will reenter EEZ in a short while.
16:30, SOG 9.5 kts, COG 130 T. We are at 24 24.38' S, 83 19.06' W, 9 nm NW of EEZ entry.
Buoy tipped upright during CTD station. Cleaning subsurface instruments.

Heard back from agent that port is congested, available berth at TPS on Monday March 24 at 1400 with offload support at 15:30. No berth at TPV or even in San Antonio.
17:23, 24 29.66'S, 83 12.12'W, enter EEZ around San Felix Island. SOG 9.6 kts, COG 130 T.

March 20, 2025, Thursday
Transiting to Valparaiso, SOG 9 kts.
Removed met sensors from S22. Downloading subsurface data.
17:24, just passed San Felix Islands (two) 29nm on our port side, 26 47.734'S, 080 08.074'W.
PMEL confirms pCO2 data from Stratus 23 looks good.

March 21, 2025, Friday
Transiting to Valparaiso, SOG 8.5 kts.
Checked CTD data, good agreement between SHOA and UOP CTD sensors. Data from last CTD shows O2 data analyzed at sea are in reasonable agreement with SHOA sensor. But O2 values increased during the 5 mn soak at each of the 4 stops we did; might soak for 10 mn in the future.
Packing instruments.
Measured holes for SBE56 in foam of Stratus 22 buoy and updated 2 lower holes on bow as 110 cm and 120 cm below deck (previously listed as 120 and 140 cm).
14:55, 28 47.44' S, 077 25.82' W, 5 nm from EEZ exit, SOG 8.5 kts.

March 22, 2025, Saturday
Transiting to Valparaiso, SOG 7.5 kts. Sea state a bit choppy.
06:47, entering Chilean EEZ, 30 11.20'S, 075 30.41'W.

March 23, 2025, Sunday
08:00, arrive in Valparaiso. Palletize all WHOI equipment, dismantle buoy.

March 24, 2025, Monday
15:00, ship offload, stuffing of containers. Buoy foam and anchor stay onboard for storage at Valpabas. In the evening, WHOI personnel fly back home.

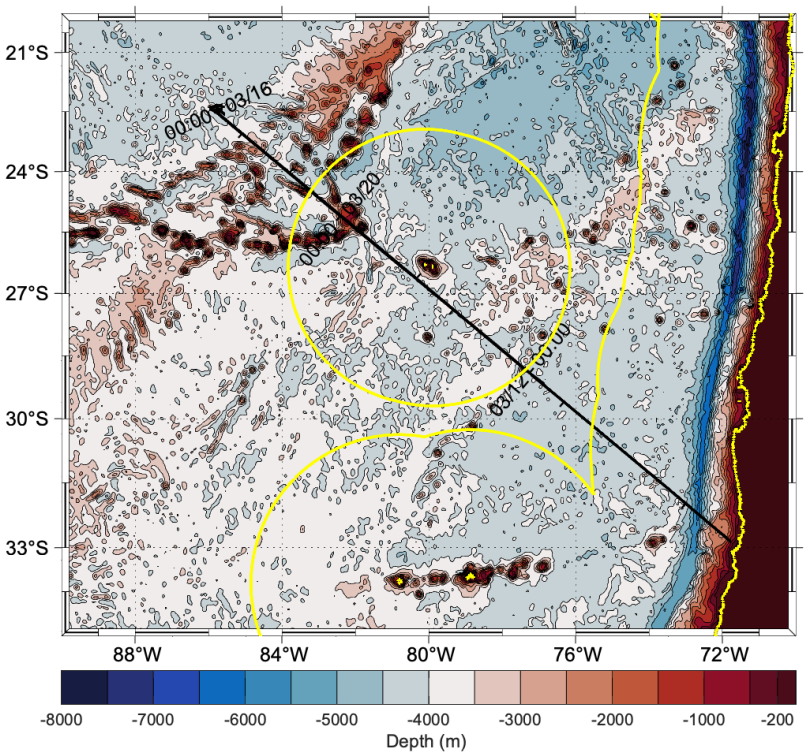


Figure I-1. Stratus 23 cruise itinerary Valparaiso – Stratus 22 and 23 – Valparaiso, Chile: track of ship Cabo De Hornos (black), EEZ and coastline (yellow). Colored contours are bathymetry (contour interval 500 m).

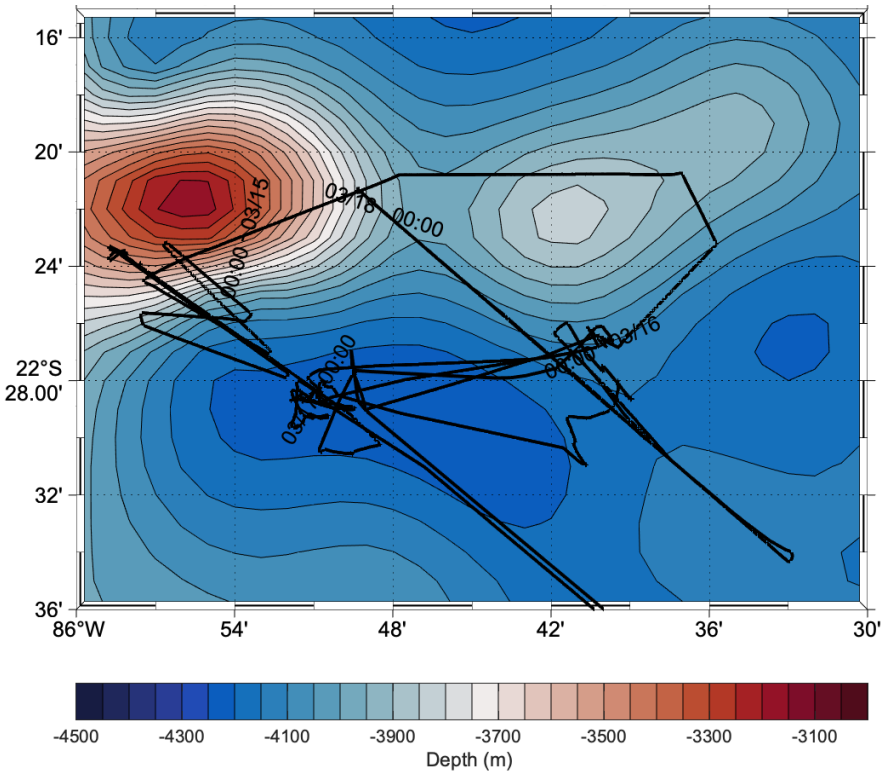


Figure I-2. Stratus 23 cruise: track of ship Cabo De Hornos (black) while in the Stratus mooring area (March 14 – 19 2025). Colored contours are bathymetry (contour interval 50 m).

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. Starting with Stratus 18 in 2019, the nominal position of Stratus has been moved south to 22° S, 85° W. The Stratus 22 mooring was deployed in December 2023 and its replacement, Stratus 23 mooring, was installed on March 15, 2025, during the Stratus 23 cruise, which is detailed in this report.

During the 2025 Stratus cruise on the Chilean research ship *Cabo de Hornos*, the primary activities were recovery of the WHOI Stratus 22 surface mooring, deployment of the new WHOI Stratus 23 surface mooring at a nearby site. At the Stratus mooring, in-situ calibration of the buoy meteorological sensors was done through comparison with WHOI stand-alone meteorological sensors mounted on the ship and a Vaisala weather station that is part of the ship's monitoring system. CTD casts were also done near both moorings for comparison with newly deployed instruments and older Stratus 22 instruments. A calibration CTD cast was also conducted with some of the sensors from the recovered Stratus 22 mounted on the rosette. Water samples were taken at a few CTD casts and analyzed for salinity and oxygen by personnel from the Servicio Hidrográfico y Oceanográfico de la Armada de Chile (SHOA). Finally, surface drifters were launched in international waters 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 and salinity. The buoy is outfitted with a PCO_2 sampling system from Adrienne Sutton (NOAA Pacific Marine Environmental Laboratory, PMEL). The IMET data are made available in near real time using satellite telemetry. The mooring line carries instruments to measure ocean salinity, dissolved oxygen, temperature, and currents.

The Stratus 23 buoy was assembled and tested after shipping and final preparations for its moored instrumentation were carried out. Equipment for Stratus 23 was therefore loaded onto the *Cabo de Hornos* in Valparaiso on March 9-10, 2025, and the ship departed from the port of Valparaiso early in the morning on March 10. The cruise ended in Valparaiso on March 23, where the Stratus gear was unloaded and the science party returned home.

II. Cruise Preparations

A. Staging and loading in port

Two 40 ft containers left Woods Hole on January 3 and were delayed during shipping to Chile, arriving in San Antonio on March 4. WHOI personnel arrived in Chile in the morning of March 5 and had a meeting in the afternoon on the *Cabo de Hornos* at its berth on the Navy pier. Details of port operations were discussed. On March 6, the Broom agent cleared the two WHOI containers through customs and arranged for their transportation by truck to Valparaiso, where they arrived at 03:00 local the next day. On March 7, WHOI personnel visited *Cabo De Hornos* again to ensure readiness for loading and check status of the ship's deck equipment.

At 11:00 on March 7, the two 40-foot containers were delivered to a staging area at the end of the TPS concession of the commercial port, near pier site #1. With the help of a forklift and stevedores, the containers were unstuffed. The buoy tower top, and hull were assembled with the forklift and the meteorology instrumentation was started for testing. The anchor modules were also assembled using the forklift. Some equipment was shuffled back into the containers. The pCO2 system was installed and started for testing. On March 8 the meteorological data was validated and all instrumentation performed well. The next day, VMCMs were prepared, and final cable dressing was done on the buoy. On March 9 at 22:00, berth site # 1 was available and *Cabo De Hornos* tied in; ship load started at about 23:00 until about 03:00 the next morning when all scientific equipment was loaded onboard secured on deck and in the labs. The ship was under way at 03:45 local (UTC-3) on March 10.

B. Instrumentation evaluation

Prior to shipping equipment, the data collection system is tested at WHOI for several weeks, and again in port before loading on the ship. This testing period is called burn-in. During burn-in, the Stratus 23 buoy was mounted with ASIMET (one stand-alone and two primary systems) and other instrumentation in the same configuration as the one planned for deployment and placed outdoors 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 23. Every week or so, the data was downloaded and processed to ensure all instruments were functioning properly and that their measurements were accurate. This burn-in occurred between August 20 and November 14, 2024, and instruments were gradually added to the buoy.

One data download occurred in port in Valparaiso on March 8. Wind conditions in port were very low which implies low or no ventilation and diurnal heating on temperature sensors on clear days. On the ship, the buoy was placed on the back deck and starboard side, tipped on its chamfered hull on March 12 during transit, with tower facing aft. Data was downloaded again while in transit on March 11, 12 and 13 as there was concern about primary conductivity sensor on logger 04.

Wind direction sensor function is confirmed with a "buoy spin". A buoy spin is the process by which the vane and compass are co-varied, such that the sum of their orientation is a known

bearing. Buoy spins were conducted at WHOI on September 3, 2024 (next day for the spare buoy). See Appendix 1for details of the buoy spin.

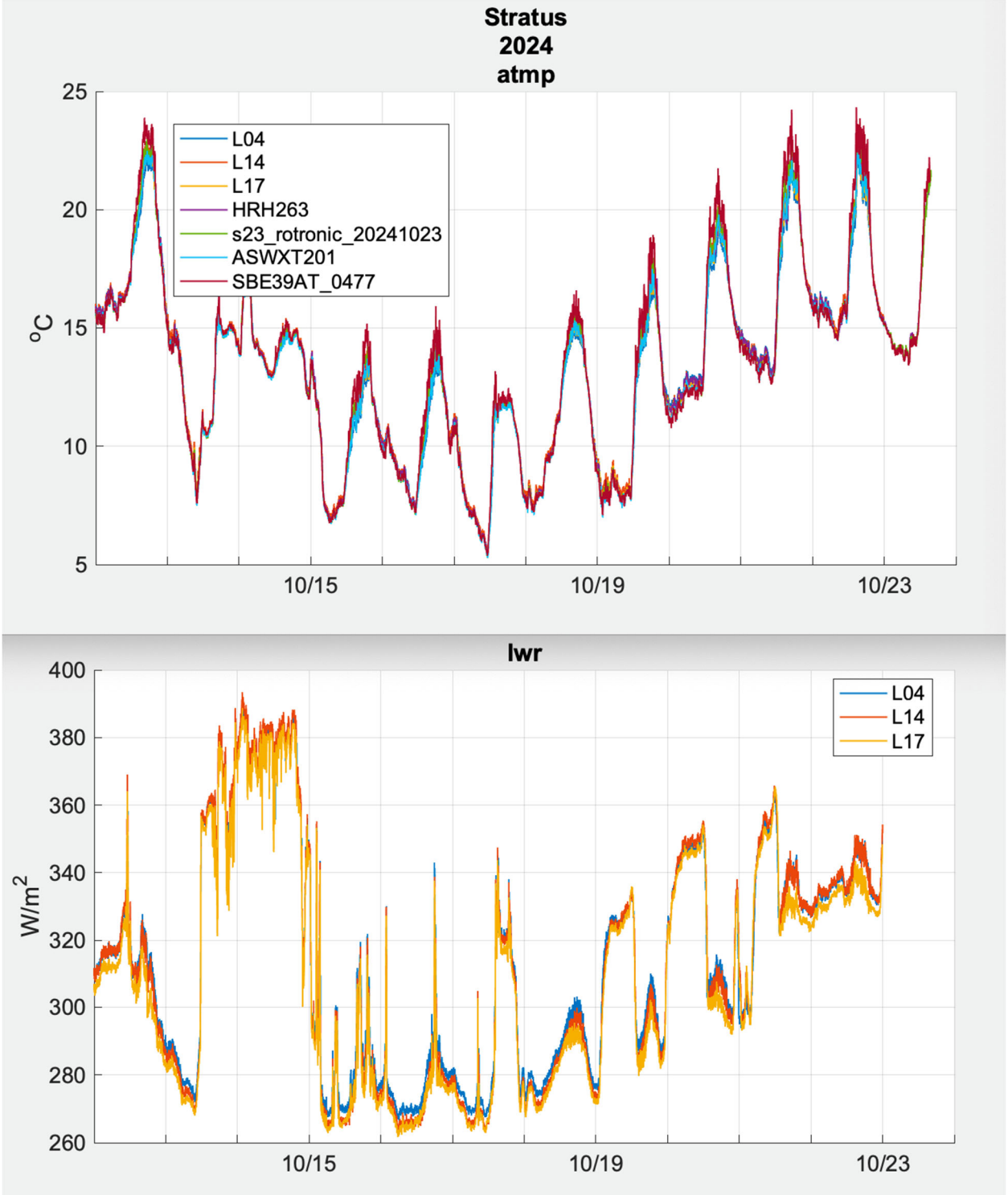


Figure II-1. Burn-in data at end of October 2024 for air temperature (top) and longwave radiation (bottom), from sensors on Stratus 23 buoy (L04 and L14 loggers and standalones) and spare buoy (L17 logger).

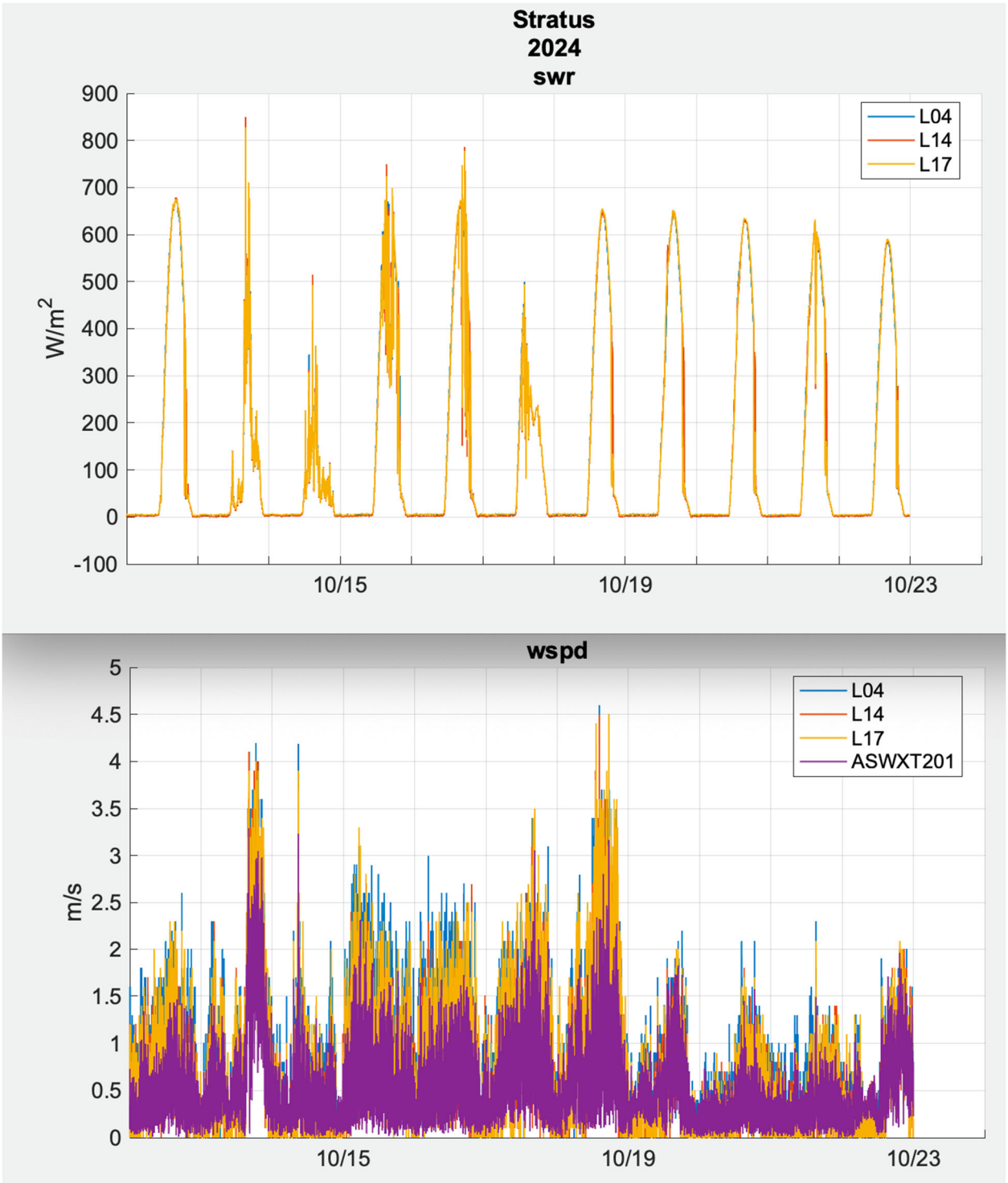


Figure II-2. Burn-in data at end of October 2024 for shortwave radiation (top) and wind speed (bottom), from sensors on Stratus 23 buoy (L04 and L14 loggers and WXT) and spare buoy (L17 logger).

III. Stratus 23 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) and standalone sensors. The mooring line below the buoy is equipped with oceanographic instrumentations down to 2000 m and two deep SBE 37s near the bottom (Figure III-2).

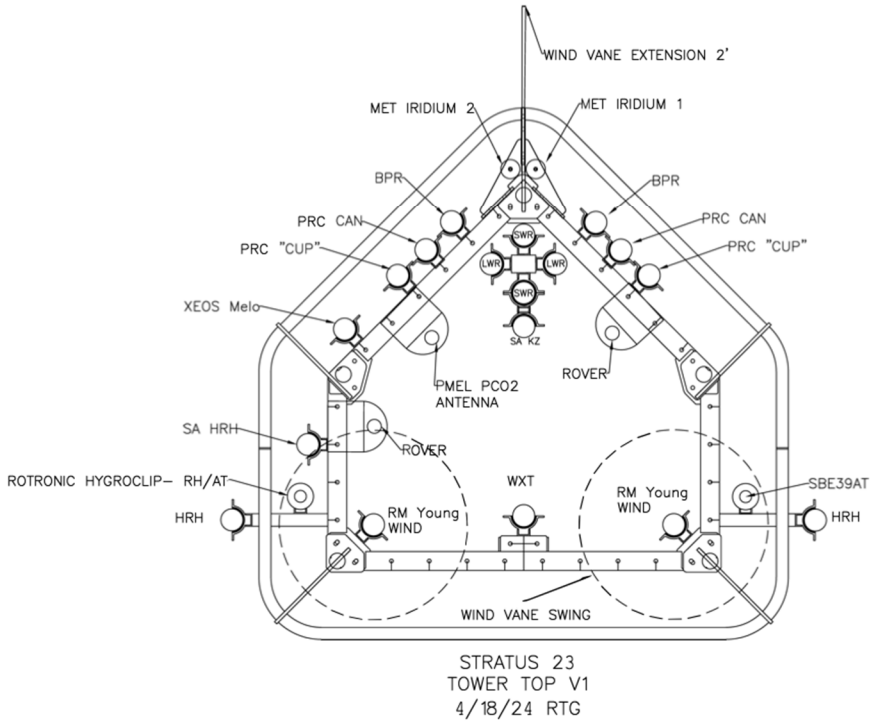
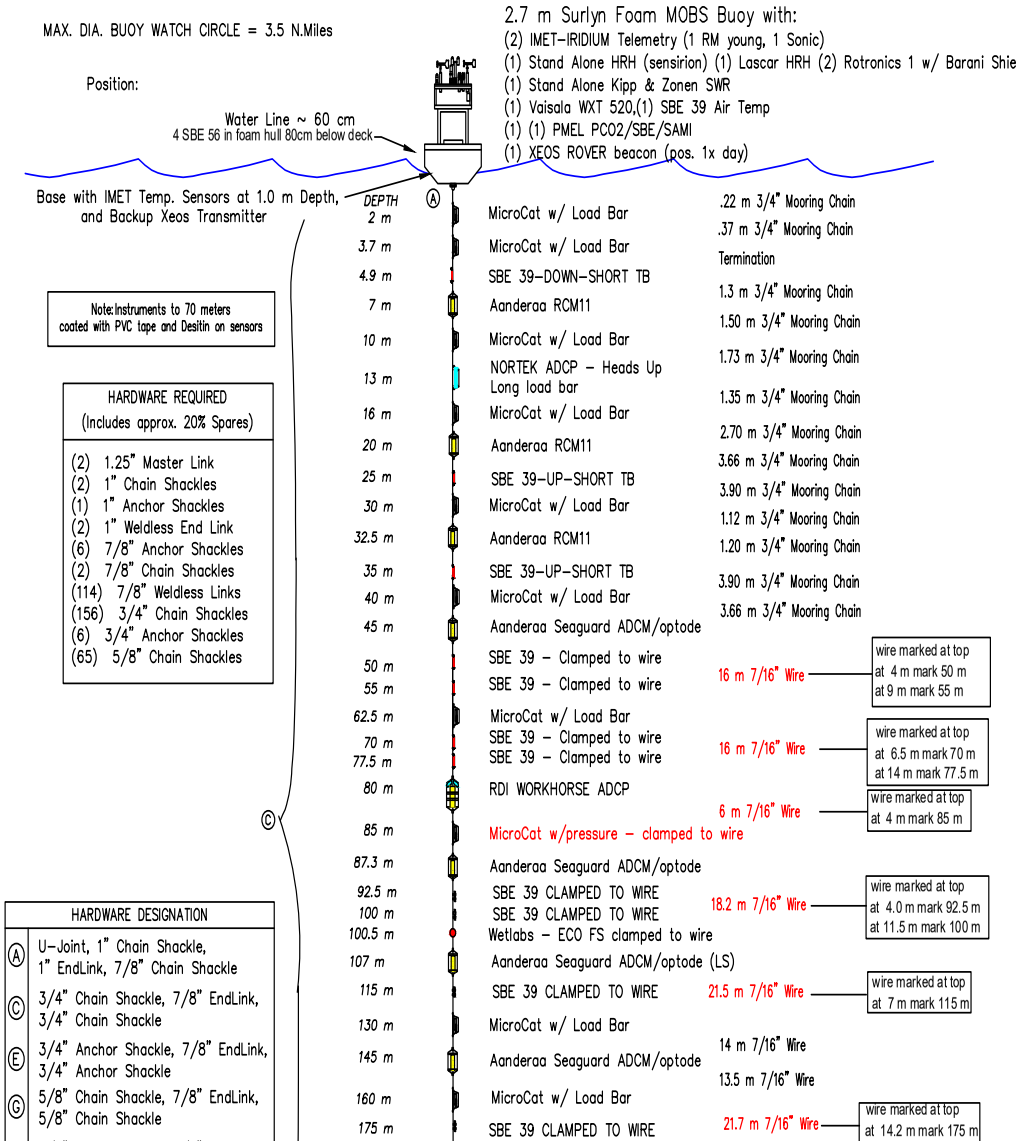


Figure III-1. Top view schematic of the meteorological tower on the STRATUS 23 buoy with the location of the ASIMET and other instruments.

STRATUS 23
V1



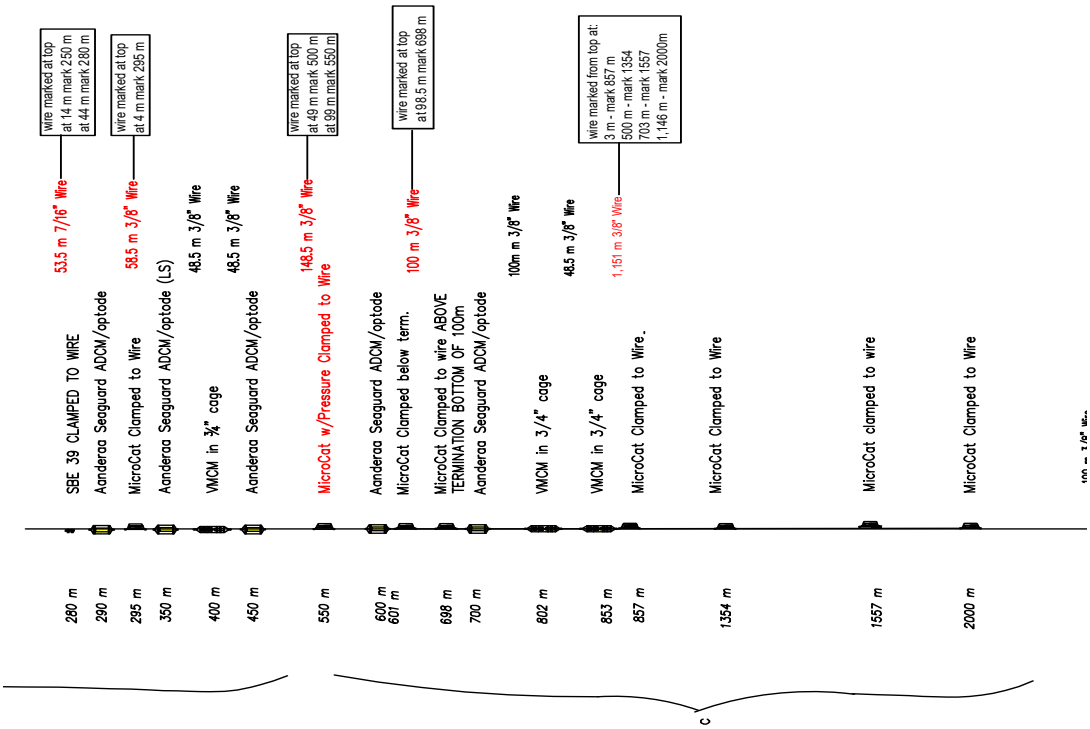


Figure III-2. Stratus 23 mooring diagram.

B. Deployment

1. Navigation

In preparation for the S23 deployment, a practice run was performed in the afternoon on March 14. Prior to the practice run, a set and drift showed the ship had drifted at about 1 knot to 340° T, to the right of the wind which was 10 knots and directed towards 300° T. The small offset between drift and wind direction indicated the presence of a weak northward current in our work area. The practice run was then conducted for a couple of hours as the bridge tested different propulsion methods with the Dynamic Positioning system and were able to establish a slow course (1-1.2 kt) with near constant bearing (115-130° T) towards the S23 target.

The next morning, on March 15, 2025, at 06:30 local, the ship approached the S23 target site slowly as a set and drift method as the wind was 12-15 knots towards 290° T. The conditions were similar to the practice run the day before and to the previous Stratus cruise and we decided on a deployment track of 9 nm mostly downwind of S23 target with bearing 130 T.

As the ship redirected towards the start of the deployment track, we monitored the bathymetry with the Multibeam northwestward of the S23 target; the bathymetry did not change much and was 4189 m as we were 3.8 nm from the target. The day before, as the ship approached the S23 area, we also monitored the bathymetry up to 2 nm from the southeast of the target and saw a small range between 4195 m and 4220 m. This confirmed the bathymetry map based on previous Multibeam surveys and we were confident the seafloor was pretty flat and 4220 m deep in a large area around the S23 target.

At 7:40 local, as we were getting ready on deck and the winches got turned on, the ship lost power. The captain explained that only one diesel engine was online when winches were turned on, which overloaded the system. Luckily, the weather was good, and we drifted gently downwind. After 20 mn, power came back for lights, then another 20 mn and winches were back on. At this point we were 10 nm NW of the S23 target. The ship repositioned to the start of the track, 9 nm away from the target and a course of 125° T to the target. The ship stayed on station there for the initial phase of the deployment where the upper 50 m of instruments were deployed before the buoy. The deployment track is shown in the figure below.

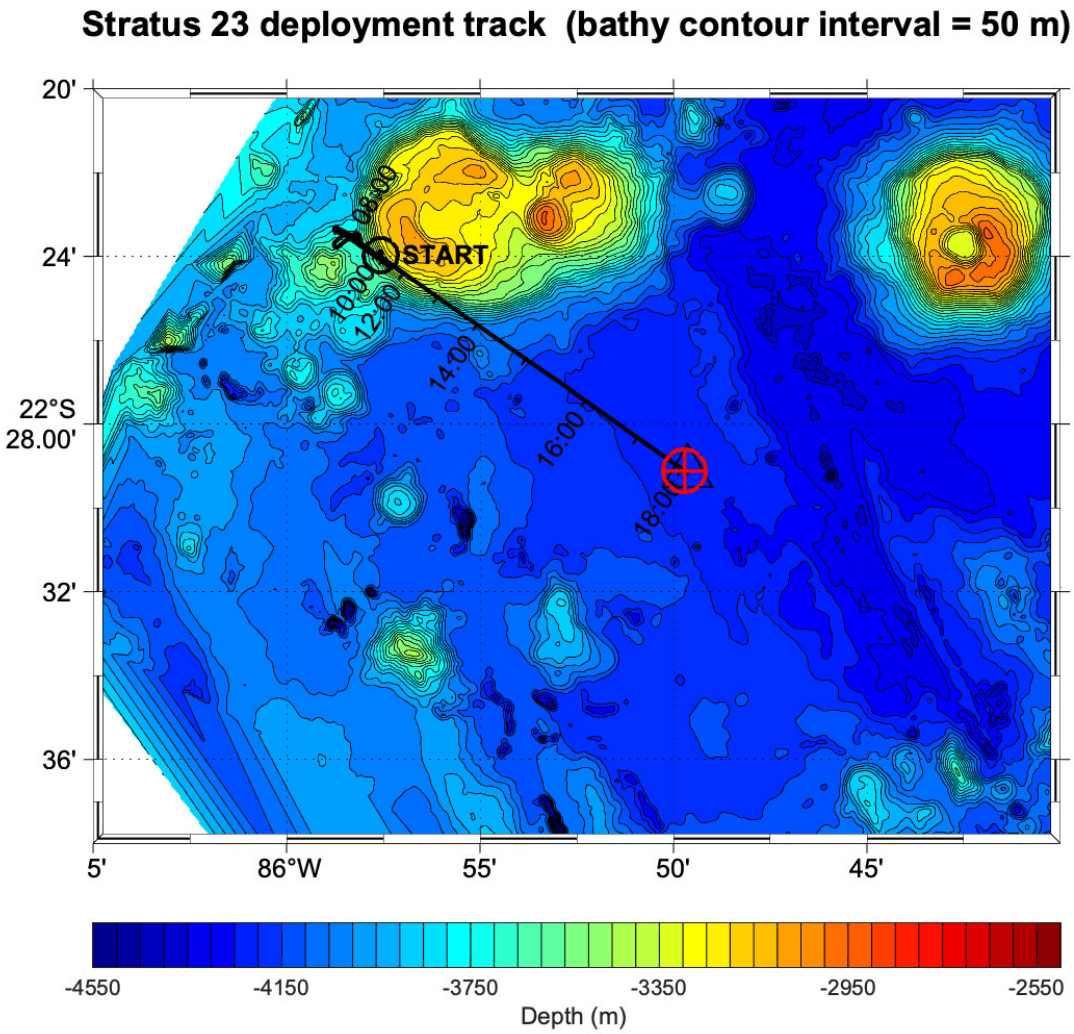


Figure III-3. Track of Cabo de Hornos during the deployment of Stratus 23, with the deployment start (black circle) in the northwest and anchor drop (red circle and cross) 9 nm to the southeast.

The first instruments (Seaguard at 45 m along with SBE39 clamped on wire below it at 50 m) were deployed at 9:45 local, and the ship remained stationary until the upper instruments closest to the buoy bridle. When the buoy was ready for deployment, the ship gained forward speed (0.5 to 1 kt). Once the buoy was launched (10:51 local), the ship steamed toward the target; the ship's speed was first very low (<1 kt) to avoid tipping the buoy but was increased later when enough weight was under the buoy. The figure below shows the ship distance and speed towards the anchor drop.

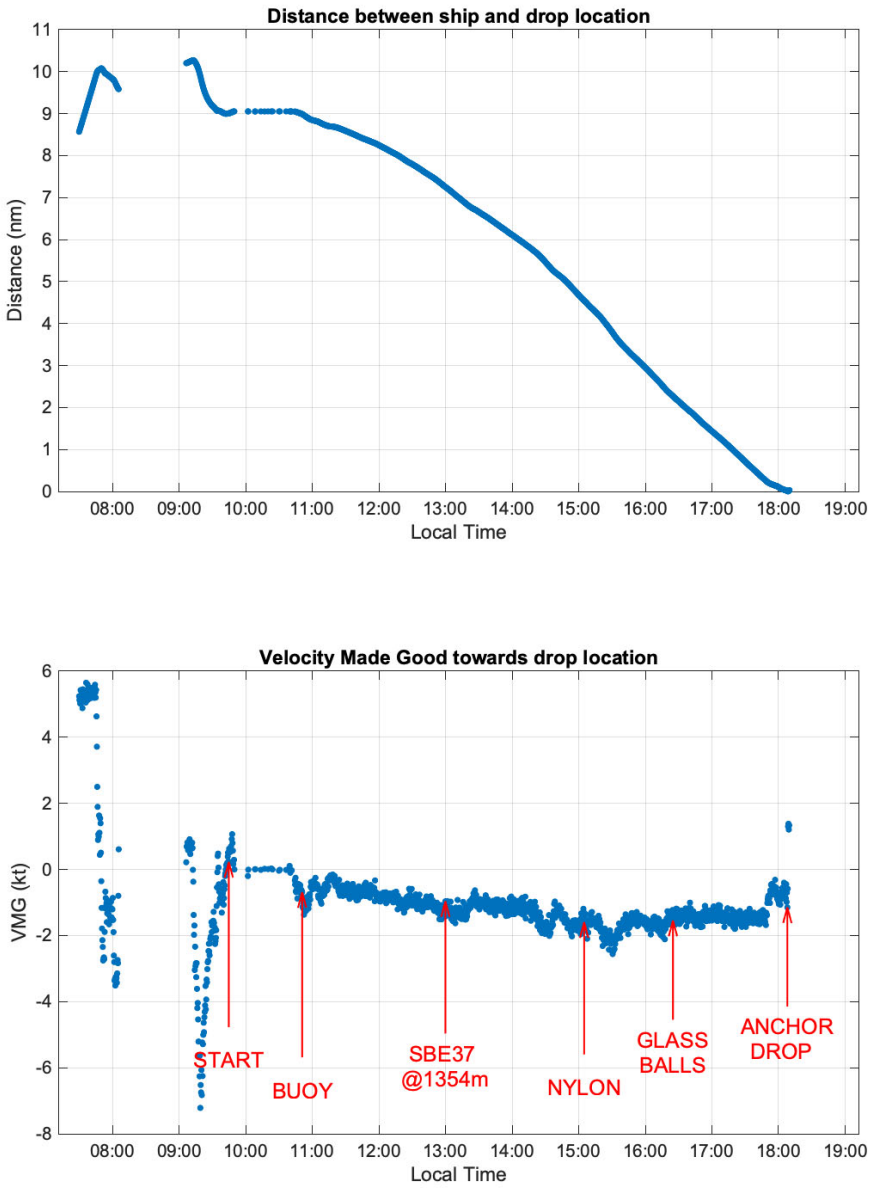


Figure III-4. Timeline of events and ship's position relative to the anchor drop during the deployment of Stratus 23. The data gap between 8 and 9 am was caused by general power loss onboard the ship. For the first part of the deployment (~10 to 11 am), the ship was stationary. After that the maximum speed over ground reached 2 kts during the Nylon and Colmega deployment.

At 13:00 local, SBE37 at 1354 m (500m down the 1151 m wire shot before rope) was deployed and ship was 7.3 nm from target, SOG = 1.3 kts. Between 13:05 and 14:05 the winch stopped due to a burnt electrical circuit (same issue as previous cruise but this time the ship had a spare circuit). At 15:05, we started paying out the Nylon through H-bit and the ship was 4.5 nm from target, SOG 1.7 kts. At 16:25 we started deploying glass balls while the ship was 2.2 nm from target, SOG 1.4 kts. When only two sets of glass balls remained to be deployed, the mini split winch on the main deck stopped, so the mooring lead switched to the split net drum up on 01 deck. A bit earlier, the Gilson winch also stopped working when lifting Colmega out of traveling block. At 18:08 local, after checking the bathymetry on the Multibeam, the anchor was deployed slightly ahead of the

target location. An hour later, the anchor survey was performed using triangulation locations about 1.5 nm away from the anchor drop. The figure below shows the ship's positions during the end of the deployment track and the anchor survey.

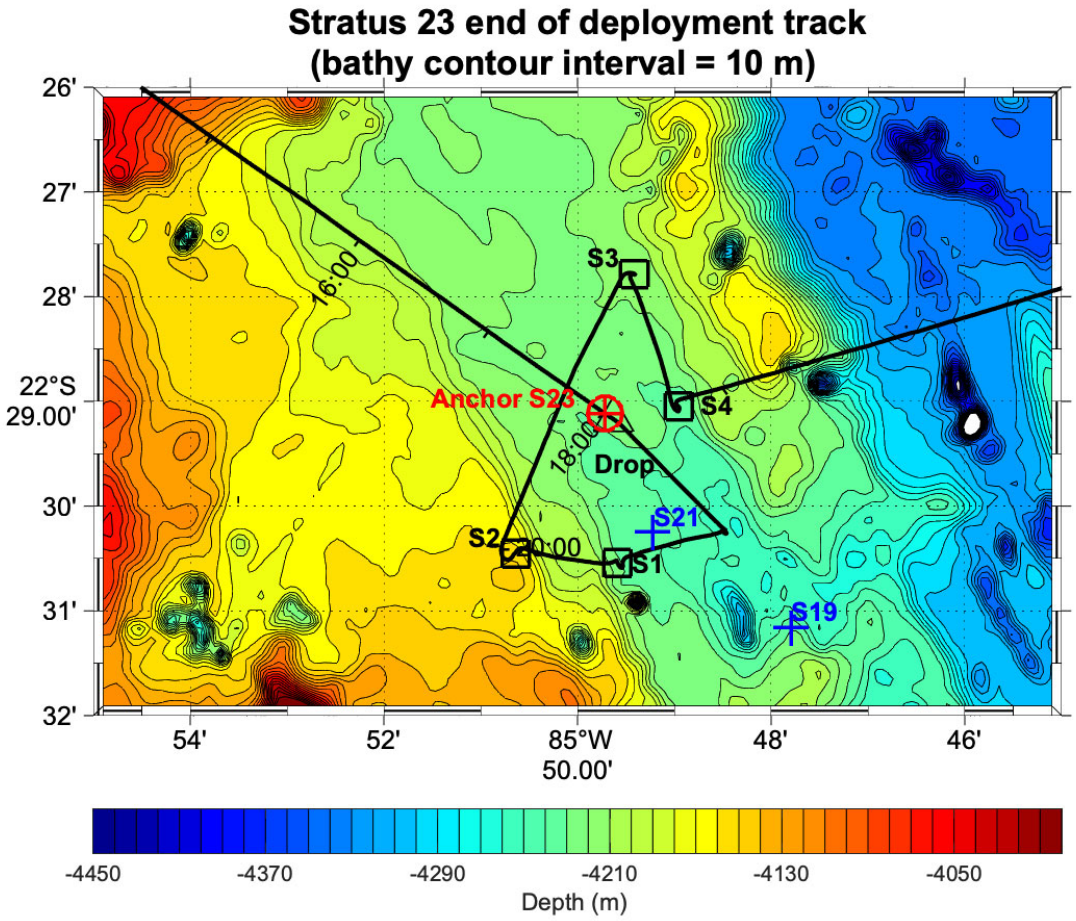


Figure III-5. Track of Cabo de Hornos during the end of Stratus 23 deployment and the anchor survey. The anchor drop (black triangle) and anchor location (red circle and cross) are very close to each other. The 4 survey sites (black squares) are about 1.5 nm from the drop. For comparison, the locations of previous moorings, S21 and S19, are also shown (blue crosses).

2. Deck Operations

Deck preparations the night before, where instruments were brought out on deck, organized by depth, chain mounted on the top of the first 45 meters of instruments and travel block hung with the Gilson winch. The ship's starboard side net drum winch was pre-wound with the following mooring components listed below:

- 180-meter ¾" winch leader
- 200 m 7/8" nylon with special wire to nylon termination, followed by 100 m of 3/8" wire
- 100 meters 3/8" wire
- 1151 meters 3/8" wire

- 48.5 meters 3/8” wire
- 100 meters 3/8” wire
- 100 meters 3/8” wire
- 148.5 meters 3/8” wire
- 48.5 meters 3/8” wire
- 48.5 meters 3/8” wire
- 58.5 meters 3/8” wire
- 53.5 meters 7/16” wire
- 13.5 meters 7/16” wire
- 29 meters 7/16” wire
- 5.5 meters 7/16” wire
- 21.7 meters 7/16” wire
- 13.5 meters 7/16" wire
- 14 meters 7/16" wire
- 21.5 meters 7/16" wire
- 18.2 meters 7/16" wire
- 6 meters 7/16" wire
- 16 meters 7/16" wire
- 16 meters 7/16" wire

On the morning of March 15, 2025, completion of deck preparations started at 6:30 am local. The ship was slowly approaching the start of the deployment track, 9 nm away from the Stratus 23 anchor target. At 7:40 am the winches onboard the ship were started and the ship lost general power (only one diesel engine was online then and the electrical grid was overloaded). Power was restored slowly in stages and winches were started again at 8:20 am. As we had drifted downwind during the power outage, the ship repositioned to the start of the track, and deployment operations started at 9:30 am.

The first 16-meter section of 7/16” wire was lead from the split net drum, through the travelling block, around the starboard quarter and up to the starboard rail next to the buoy. Five wire handlers were spaced out along the starboard rail and aft quarter. The wire handlers’ job was to keep the line from fouling in the ships propeller and to pass the line around the stern after the buoy was deployed. Prior to lowering instruments over the side, the two SBE 39s located at 50 and 55 meters were clamped to the wire. At 9:45 local time, the ship was in DP and was not moving as instruments began to be lowered over the side. Starting with the Seaguard at 45m, the 16-meter shot of wire was attached to the bottom of the instrument cage while the ship’s crane was attached to the top of the 3.66 meters of ¾” mooring chain attached to the top of the instrument cage. The crane was raised so the chain and instruments were lifted off the deck and over the side and the crane slowly lowered the instruments and attached mooring components into the water. The line handlers positioned around the stern eased the line over the starboard side, paying out enough to keep the mooring segment vertical in the water. The crane stopped with about 1 meter of chain above the starboard rail and a 12-foot sling secured on one end to a deck cleat with a shackle was attached to the instrument chain using a screw pin shackle and link. Once stopped off, the crane continued to lower until the load was transferred to the stopper line and the remaining 1 meter of chain was slacked over the starboard rail. The next instrument and chain were brought in; the instrument was secured to the top of the 3.66-meter chain from the Seaguard and the crane was re-attached to the

top of the next segment of mooring chain. The crane was raised until the load was transferred off the stopper line and began to lower the next instrument into the water. This process of lowering instruments and chain into the water was repeated until the SBE39 at 4.9 meters. At this point, the chain attached to the top of the SBE39 at 4.9 meters was stopped off with a slip line and mounted to the first two SBE37s that were pre-mounted to the bottom of the buoy. The crane then got into position to deploy the surface buoy.

Three tag lines were used to stabilize the buoy during the deployment, one on the buoy base, one on the buoy well D-handle and the third on the tower top D-handle. Once the tag lines were secured and crane connected to the buoy using a peck and hale release with two 12' slings to ensure the headache ball was well above the tower, the ship began to move forward in DP at 0.5 knots. The ratchet straps securing the buoy to the deck were removed and the buoy was raised over the bullworks as the crane slued outboard. As the crane moved outboard, the slip lines kept the buoy from swinging and the slip line holding the suspended 45 meters of instrumentation was eased off to allow the buoy to take the hanging load. The tower slip line was removed first, followed by the middle tag line and then the bottom. Once the buoy had settled into the water, the quick release was tripped, and the crane swung forward. As the buoy moved astern, the wire handlers released the wire as the buoy passed each of them.

Once the buoy was directly astern, the split net winch hauled in the mooring wire to the termination at the bottom of the first 16 meter shot of wire. Once at the termination, two stopper lines were secured to the 16-meter shot of wire and the winch was disconnected. The next instrument (a SBE37 in a load cage) was secured to the 16-meter shot and the winch was reconnected with the next 16 meter shot of 7/16" wire secured to the bottom of the instrument cage. The split net winch hauled in until the winch had the load, stopper lines were removed and this process of adding instruments and paying out line continued. During this phase the ship maintained a speed of 0.5 knots, until the 3/8" wire was reached at 290 meters, when the ship's speed was increased to 1.0 knots. At 13:00 the SBE37 clamped to the 1151 m wire at 1354 m depth was deployed. At 13:05, halfway through the deployment of the 1151 meters of 3/8" wire, the starboard split net drum stopped working. While the ship's crew troubleshooted the problem, a leader line was wound on the port side split net drum in case no fix could be found. Fortunately, at 14:05 the starboard split net drum was fixed (burnt electrical circuit was replaced with a spare) and deployment resumed. After the final 100-meter section of 3/8" wire and 200 meters of nylon were payed out, the hard-eye at the end of the 200-m section of nylon attached to the wire-to-nylon termination was stopped off using two stopper lines. At this time, the H-bit was positioned mid ship, and the nylon rope from the dura-green boxes was wrapped around the H-bit. The two ends of nylon were secured thimble to thimble with two ¾" anchor shackles and a 7/8" end link. Zip-ties were used to stabilize the connection and ensure the nylon could not huckle. A line handler held onto the nylon coming out of the box, while another person used the fire hose to wet the line as it moved through the H-bit to lower friction and heat. The remaining 1700 meters of nylon and 1200 meters of Colmega were payed out through the H-bit.

When the end of the Colmega line was reached, the line was stopped, and a Yale grip was secured with two stopper lines to take the tension off the H-bit. The thimble at the end of the Colmega was secured to the net drum winch and the H-bit and travel block were removed. The Gilson winch failed when lifting the Colmega up to remove the travel block. The net drum payed out until the

end of the Colmega was a few meters from the transom and the two stopper lines were resecured. The next phase was to attach the 24 sets of glass balls to the Colmega line. Three sets of glass balls were brought in, the first was secured to the Colmega and the third back to the net drum winch. The net drum winch pulled up the slack, stopper lines removed and slowly payed out the balls over the transom. This process was repeated until all sets of glass balls were deployed. While two sets remained to be deployed, the net drum winch failed with no indication it could be fixed. The line was stopped off and the split net drum on the 01 deck was used for the remaining two sets of glass balls and instruments. A 1" titanium load bar with two SBE 37s were shackled to the last glass ball segment and a five-meter shot of ½" chain was connected to the bottom of the instruments and was secured to the split net drum. Using a chain hook attached to the Gilson winch, the two SBE 37s were lifted off the deck as the net drum payed out. Once over the transom, the Gilson came down until the chain hook was slacked, and the hook was removed. Two stopper lines were secured to the 5-meter section of chain below the SBE 37s and the net drum was disconnected. The acoustic releases were attached to the bottom of the 5-meter section of chain, and the next 5 meter shot of chain and 20 meters of 1" Nystrom was secured to the net drum winch using a 20-meter bull rope slip line. A chain hook attached to the Gilson was used to lift the releases off the deck as the net drum payed out. The end of the 20-meter Nystrom was attached to the 5-meter shot of chain above the anchor, and the load was transferred to the anchor using the bull rope slip line. The crane was then positioned over the anchor and connected to the tip plate. The bathymetry was checked again on the Multibeam, which confirmed that the area had adequate depth and that anchor drop could proceed slightly ahead of the initial target. The back stay on the anchor was cut, the crane lifted the tip plate and the anchor immediately slid off the deck. Anchor was deployed at 18:08 local time (21:08 UTC). The deck was cleaned up and secured and an anchor survey was performed in the evening.

C. Anchor Survey

The anchor of Stratus 23 mooring was dropped at 21:08 UTC at 22° 29.171' S, 085° 49.627' W on March 15, 2025. The same day, anchor survey was conducted from 22:00 to 23:30 UTC. The 3 triangulation points were selected by the bridge, 1.5 nm away from the drop point. The first point was the southeast corner of the triangulation. The portable hydrophone was lowered by hand on the starboard of the ship, and the ship's propulsion was turned off, as well as Multibeam echosounder, to keep noise level to a minimum. Acoustic communications could not be established so the ship repositioned to a new location half-way to the second survey point in the southwest corner. Acoustic communications there were also initially not possible until we switched to a different transducer and control box. At this point the communications were very clear. We added a fourth station in order to get a converging solution from the triangulation. The survey sites nominal locations, locations of successful acoustic communications and ranging 2-way times are in the table below.

The input parameters for survey.m Matlab program were:
Depth = 4193 m (Multibeam read at anchor drop location was 4225 m, height of releases above seafloor = 32 m).
Depth of transducer below ship = 5 m (actual depth was perhaps a few meters different).
Speed of sound = 1500 ms^{-1}(this is also the default SoS used by EdgeTech control box).

Table III-1. Survey points locations and sound travel time in during Stratus 23 anchor survey.

Survey site #	Longitude W (dd mm.mmm)	Latitude S (dd mm.mmm)	Two-way travel time (s)
1	85 49.527	22 30.565	
	85 49.590	22 30.547	6.619
	85 49.591	22 30.544	6.617
	85 49.594	22 30.536	6.605
2	85 50.638	22 30.451	
	85 50.641	22 30.453	6.805
	85 50.644	22 30.455	6.810
	85 50.647	22 30.457	6.814
3	85 49.416	22 27.780	
	85 49.419	22 27.781	6.463
	85 49.413	22 27.783	6.462
	85 49.409	22 27.786	6.460
4	85 48.950	22 29.047	
	85 48.951	22 29.046	5.840
	85 48.953	22 29.044	5.840
	85 48.954	22 29.043	5.837

The solution given by the Matlab survey.m program created by Art Newhall is based on sites 1,2 and 4:

Stratus 23 anchor position from survey.m Matlab:
22.4853° S, 85.8287° W or 22° 29.117’ S, 85° 49.720’ W.

Based on seafloor map obtained from bathymetry surveys in previous Stratus cruises, the seafloor depth at this location is indeed 4225 m.

The fall back of the anchor as it descended the water column is 187 m to the Northwest (4.4% of water column).

A visual inspection of the buoy showed the waterline to be about 60 cm below the top of the buoy foam.

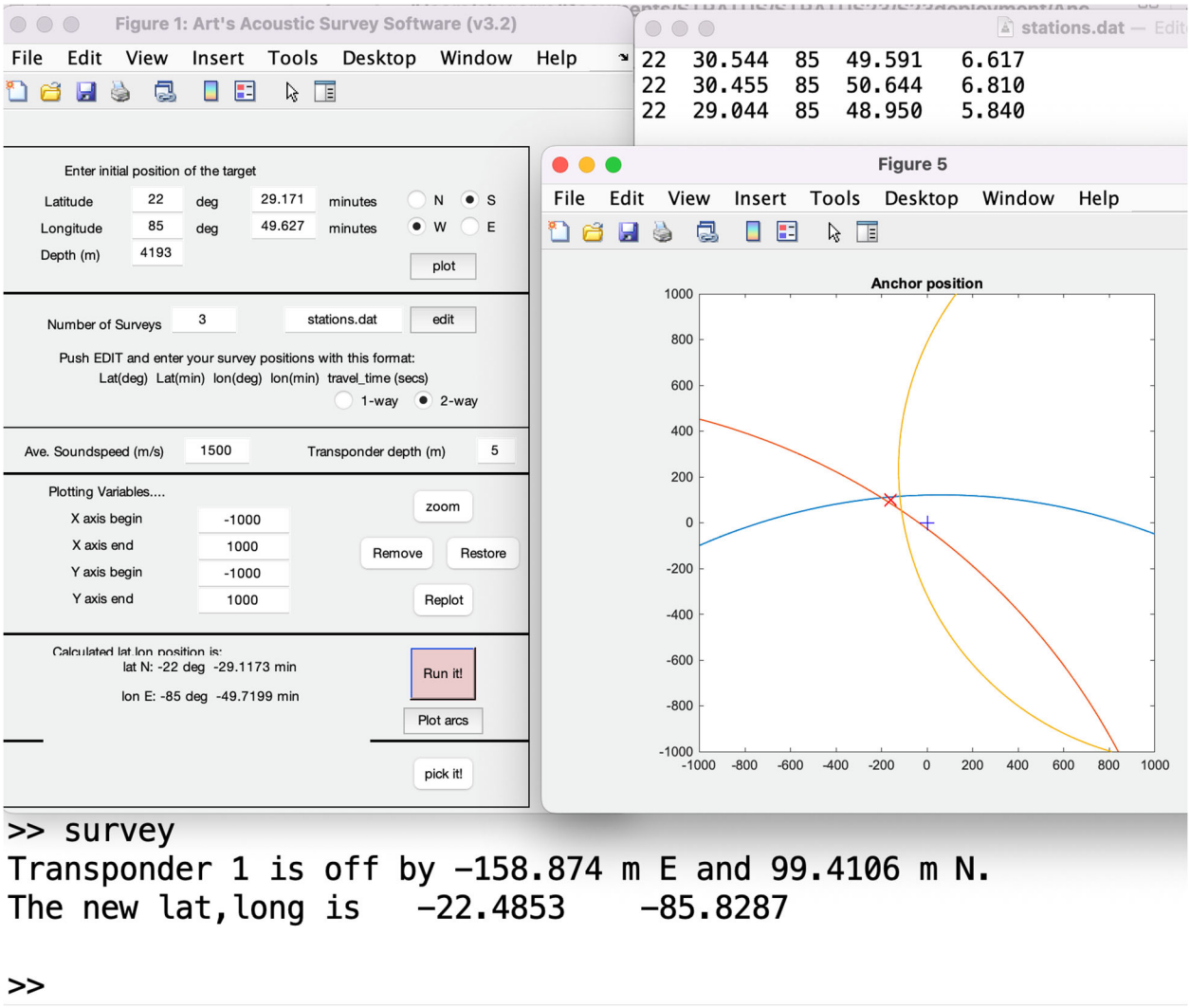


Figure III-6. Anchor survey results using survey.m code from Art Newhall.

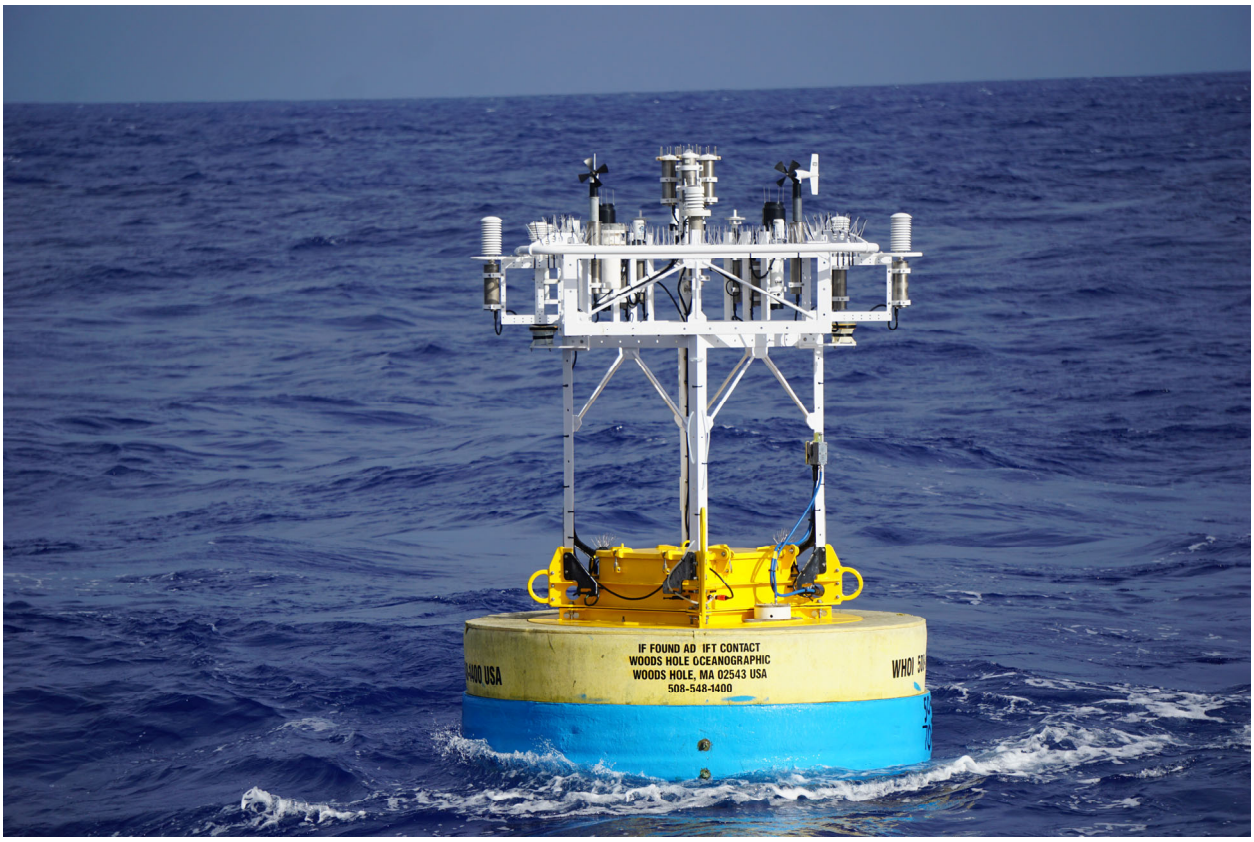


Figure III-7. Picture of Stratus 23 buoy during its deployment, as seen from the stern of *Cabo De Hornos* on March 15, 2025.

IV. Stratus 22 Recovery

To begin the Stratus 22 mooring recovery, the ship was positioned 1 nm northwest (downwind) of the anchor location. On March 18, 2025, at 08:10 am local, the mooring was released using an over-the-side transducer and Edgetech deck unit. Being between the anchor and the buoy, the ship then repositioned out of the way of any mooring element, about ½ nm to southeast (upwind) of the Stratus 22 anchor. The ship then approached slowly towards the anchor and at 08:53 am local the glass balls surfaced, about 200 m on our port side and within approximately 200 m of the anchor location. During the rest of the recovery the ship steamed slowly (0.5 to 1 kt) to the south, then west and southeast (see Figure below).

The ship maneuvered to deploy the small boat deployment on the forward deck starboard side. Once deployed, two WHOI and two Armada personnel boarded the small boat from the main deck using the Jacob's ladder on the starboard side. The small boat then drove to the glass balls to carefully hook up into the chain and to check for the presence of the floating Colmega line. Once the Colmega was identified and its direction relayed to the bridge, a 4-foot green sling was basketed through an endlink in the middle of the glass ball cluster and secured with a screw pin shackle to the end of a 110 meter, ¾" spectra line. The ship then began to approach the small boat until it was about 100 meters away from the glass balls. At that time, the small boat drove with the grey spectra line to the Cabo. Once at the transom, a messenger line was passed from the ship to the small boat and secured to the grey spectra. At 9:34 am, the messenger line was hauled in until the end of the grey spectra could be connected to the winch leader on the starboard side split net winch. At 9:45 am, the small boat and its personnel were back onboard, the ship proceeded at 1 knot southward, into the wind and seas, as the winch began hauling in the glass balls around 9:50 am.

As the glass ball cluster was lifted over the transom, the A-frame came in lowering the cluster onto the deck. A stopper line was secured to the hard eye at the end of the Colmega line and the glass balls were disconnected from the mooring line. With a few strings of glass balls and acoustic releases still hanging over the side, a stopper line was secured to the glass balls at the end of the transom before disconnecting them from the main cluster. The winch was then disconnected from the large clump of glass balls and secured to the string hanging over the side. Once secured, the winch took up tension, the stopper line was removed, and A-frame moved back out. Once clear of the transom the winch hauled up, lifting the final glass balls and releases over the side before the A-frame was brought back in, lowering them to the deck at 10:05 am local. At this time, the glass ball cluster was broken down and all strings were put back into wire baskets by hand and with the crane. Once the deck was cleared from glass balls, the split net winch was secured to the Colmega line and hauled in 1300 meters of Colmega, 1850 meters of Nylon and the wire to Nylon termination which consists of 200 meters of Nylon and 100 meters of 3/8" wire. At 11:50 am local, the winch started hauling in the first 500-meter shot of 3/8" wire. At 12:10 pm local, the second 500-meter wire shot started to be hauled in. At the end of the next 340-meter shots of wire was a VMCM, which was recovered at 12:34 pm. Two stopper lines were secured to the front of the VMCM cage, the winch slowly payed out, transferring tension to the stopper lines, and lowering the VMCM to the deck. After the VMCM was removed the termination from the 340-meter wire was reconnected to the next 160-meter wire shot termination, the winch took up tension, stopper lines were removed, and the winch continued to haul in the mooring wire. This process of removing

instruments continued until the final section of wire was recovered and the VMCM at 45m was recovered at 14:01 local. At this point, instead of reconnecting the winch to the chain above the VMCM, a ½" spectra slip line was secured to a cleat on one end, fed through an end link, and secured to another cleat on the other end. Once secured, stopper lines slowly let out, transferring the load to the slip line. A line handler slowly slipped out the chain until the tension was off the line, meaning the chain was straight below the surface buoy. Once there was no tension, the line was pulled through, setting the buoy adrift.

To recover the surface buoy and remaining 45 meters of chain and instruments, the small boat was relaunched with two WHOI personnel who were tasked with securing a 5-ton titanium hook with ¾" spectra line to the buoy pick-up bale. To do so, WHOI personnel boarded the buoy, connected the titanium hook the pick-up bale and taped the latch to ensure it did not come off. Once the hook was secure, the 3/4" spectra line attached to the hook was secured to a 180-meter ¾" winch leader using a screw-pin shackle. At this time, the ship approached the small boat, again until it was about 100 meters away, before the small boat drove the 180-meter winch leader to the ship. Once at the transom, a messenger line was again passed to the small boat, connected to the winch leader, hauled in, and secured to the final shot of wire wound on the port side winch. Once connected to the surface buoy, the small boat was recovered. Once all personnel were on board, the ship slowed to 0.5 knots and the winch began to haul in the surface buoy. The A-frame was positioned all the way out to try and keep the buoy away from the transom as it was lifted out of the water. As the buoy continued to come up, two tag lines were secured to the well D-handles, using snap hooks, to control the buoy as it was brought on board at 15:10 local. Once over the transom, the A-frame was brought in, but stopped functioning as remote control from the winch house stopped functioning. The buoy remained lifted in the air until ship's personnel reached the local control up on the ladder by the A-frame. The buoy was then lowered to the deck. Once on the deck, the net drum winch on the main deck was connected to the buoy using a 12-foot sling and used to pull the buoy further on deck to recover the remaining instruments and chain. Once there was enough working space behind the buoy, the buoy was strapped to the deck, and a stopper line was secured to the chain on the bottom of the first SBE37 located at 2 meters. Once stopped off, the first SBE37 and surface buoy were disconnected from the remaining instruments and chain. At this time, the port side split net winch was disconnected from the surface buoy and secured to the chain over the transom. The winch hauled in, taking up tension and the stopper line was removed. The winch hauled up until the chain was at the edge of the travelling block and the stopper line was reconnected to the chain just above the transom. The winch then payed out, transferring the load to the stopper line and lowering the chain and instruments above the stopper line to the deck. This section of instruments and chain were removed before reconnecting the winch to the stopped off chain. This process of using stopper lines and the starboard side split net winch were repeated to recover the final 45 meters of instruments and chain. The last section of chain was recovered at 15:36 local time, marking the end of the Stratus 22 recovery. The deck was cleaned and secured for transit to Stratus 23 for a buoy ride and from there, transit back to Valparaiso, which started at 17:45 local.

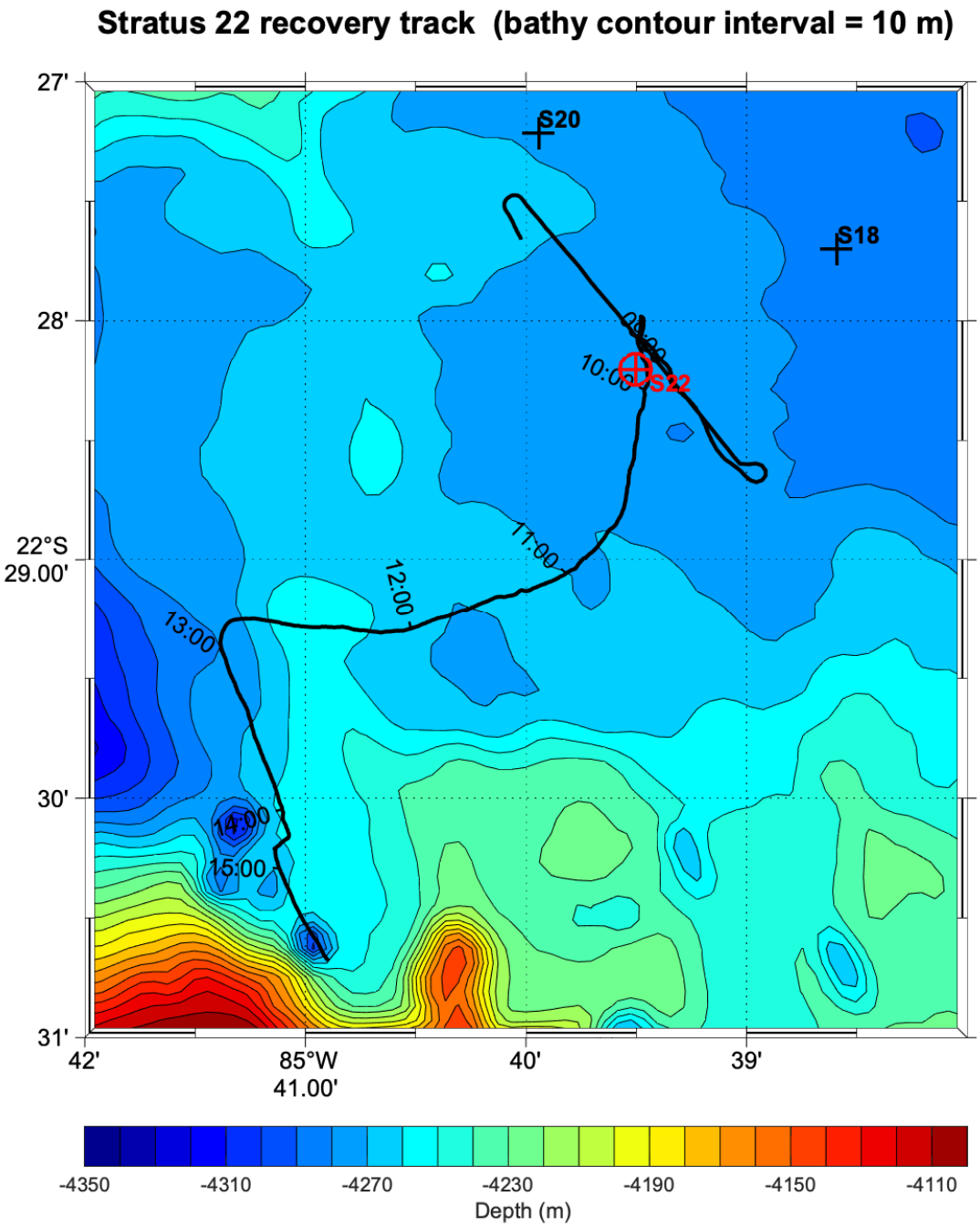


Figure IV-1. Track of Cabo De Hornos on March 18, 2025, between 8:10 and 15:50 local during the recovery of Stratus 22. The most northwestern point is when the mooring was released, then the ship repositions to the southeast of the Stratus 22 anchor (red circle and cross) and approached the anchor to connect to the glass balls that surfaced there. The ship then steamed southward. Locations of previous Stratus 18 and 20 anchors are shown for comparison. Bathymetry contours every 10 m are in colors.

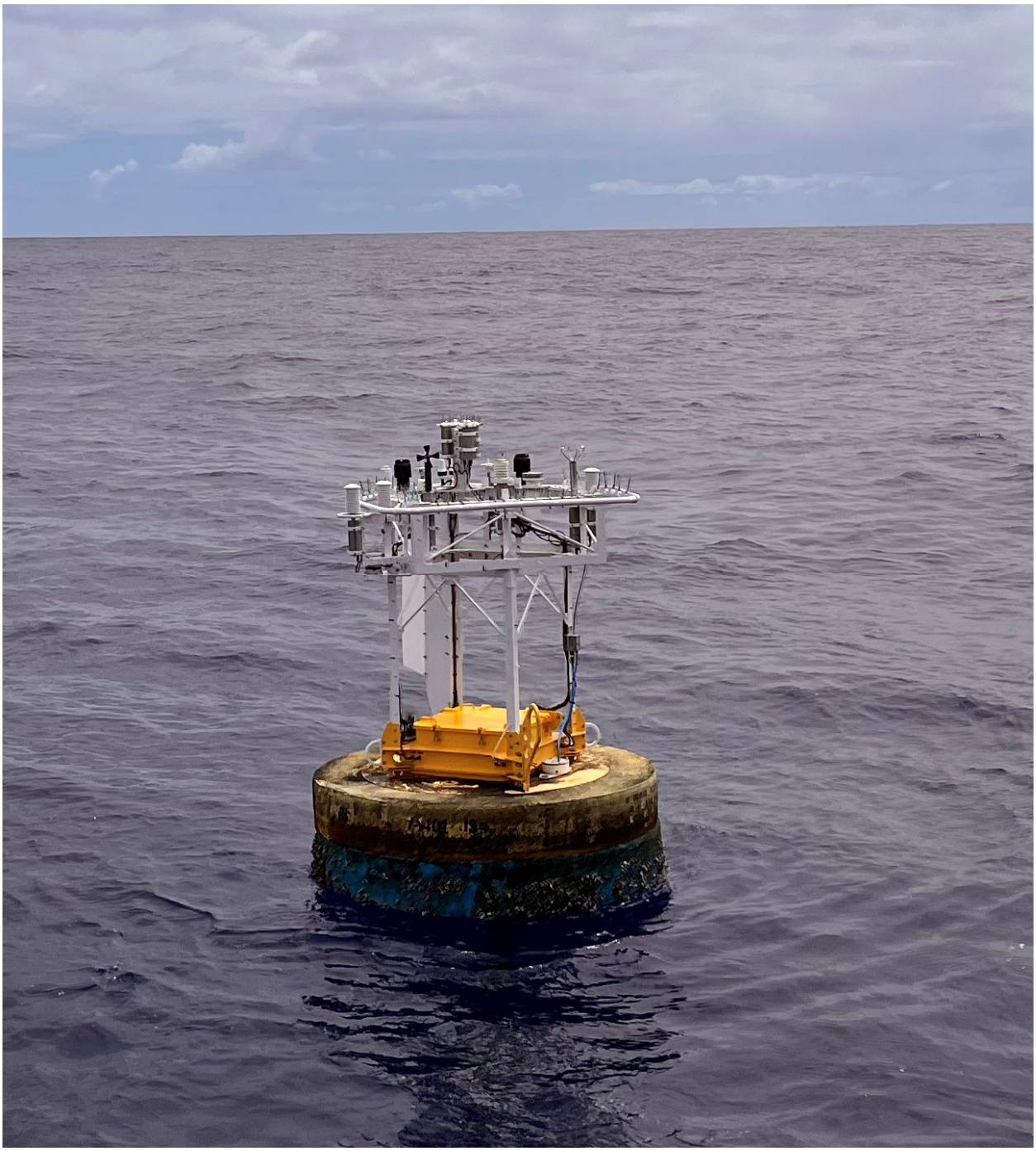


Figure IV-2. Picture of Stratus 22 right before its recovery as seen from the stern of *Cabo De Hornos* on March 18, 2025. Note missing outboard bracket on port (far) side of the buoy where standalone HRH and SBE39AT were installed at deployment.

Figure IV-3. Stratus 22 buoy being recovered on March 18, 2025. Note missing outboard bracket on port (left) side of the buoy where standalone HRH and SBE39AT were installed at deployment

V. Ancillary Work

A. CTDs

During the Stratus 23 cruise, 8 CTD casts were operated. The first one was located just outside the Chilean EEZ and served as a test for the acoustic releases that were to be deployed on the Stratus 23 mooring. Three CTDs were done at the Stratus 22 and 23 sites each. The last CTD was done during transit back to Valparaiso and included eight of the SBE 37s recovered from Stratus 22 for in-situ calibration using water samples for salinity and oxygen. Locations and times of the CTD casts are summarized in Table V-1. A test cast, which is not reported here, was done at the same location as cast #1 and included one acoustic release, but the data for that cast was not saved.

On cast #1, the SHOA CTD instrument was a SBE 19+ (SN#4208, O_2 SBE43 #77) with sampling interval 0.25 s. There was an issue with the O_2 sensor so for next casts, SHOA swapped to their spare CTD sensor, a CTD 9+ (SN #5386 (T), #3944 (C) and SBE43 2208 (O_2)), which had been calibrated in February 2023, and used a sampling interval 0.04167 s (24 Hz). A second CTD sensor, provided by the UOP group was also used on all casts: SBE19 #2361, calibrated in July 2024, with sampling every 0.5 s.

Table V-1. Time and locations of the CTD casts made during the Stratus 23 cruise.

CTD Station #	Date (mm/dd/yy)	Time UTC (HH:MM)	Latitude S (dd mm.mm)	Longitude W (dd mm.mm)	Max depth (m)	Notes
1	3/11/25	17:00	29 29.127	76 24.986	1500	Outside EEZ. Test cast with SHOA SBE19plus and 2 WHOI acoustic releases
2	3/16/25	11:20	22 26.100	85 40.620	3000	**Water samples for S and O2 (at 3000, 2540, 550 and 350 m).** Bottle #7 did not close. 1 nm downwind of S22 buoy. SHOA CTD switched to 9+.
3	3/16/25	17:00	22 26.118	85 40.625	600	500 yards from S22 buoy
4	3/16/25	23:04	22 26.790	85 40.215	600	500 yards from S22 buoy
5	3/17/25	11:25	22 28.348	85 51.487	2200	1 nm from S23 buoy. Cast started at 11:00 but had to come back to surface due to connection issue on SHOA sensor.
6	3/17/25	17:00	22 28.413	85 51.826	2200	1 nm from S23 buoy
7	3/17/25	20:00	22 28.348	85 51.829	1000	1 nm from S23 buoy
8	3/19/25	16:30	24 21.282	83 23.365	3000	15 nm NW of San Felix EEZ. **Water samples (at 3000, 310, 210, 30 m)**

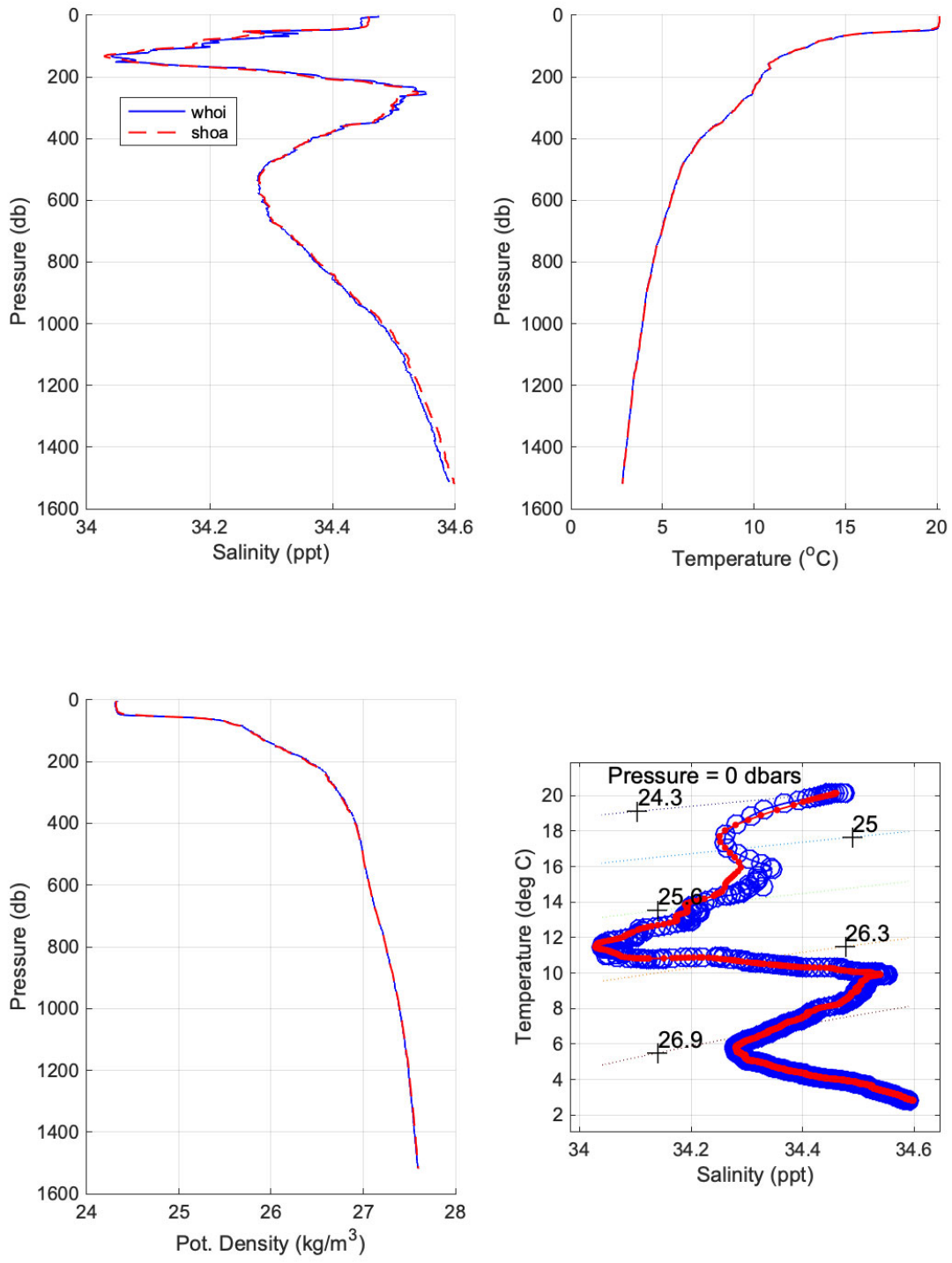


Figure V-1. CTD cast #1 data collected on March 11, 2025, for acoustic releases test.

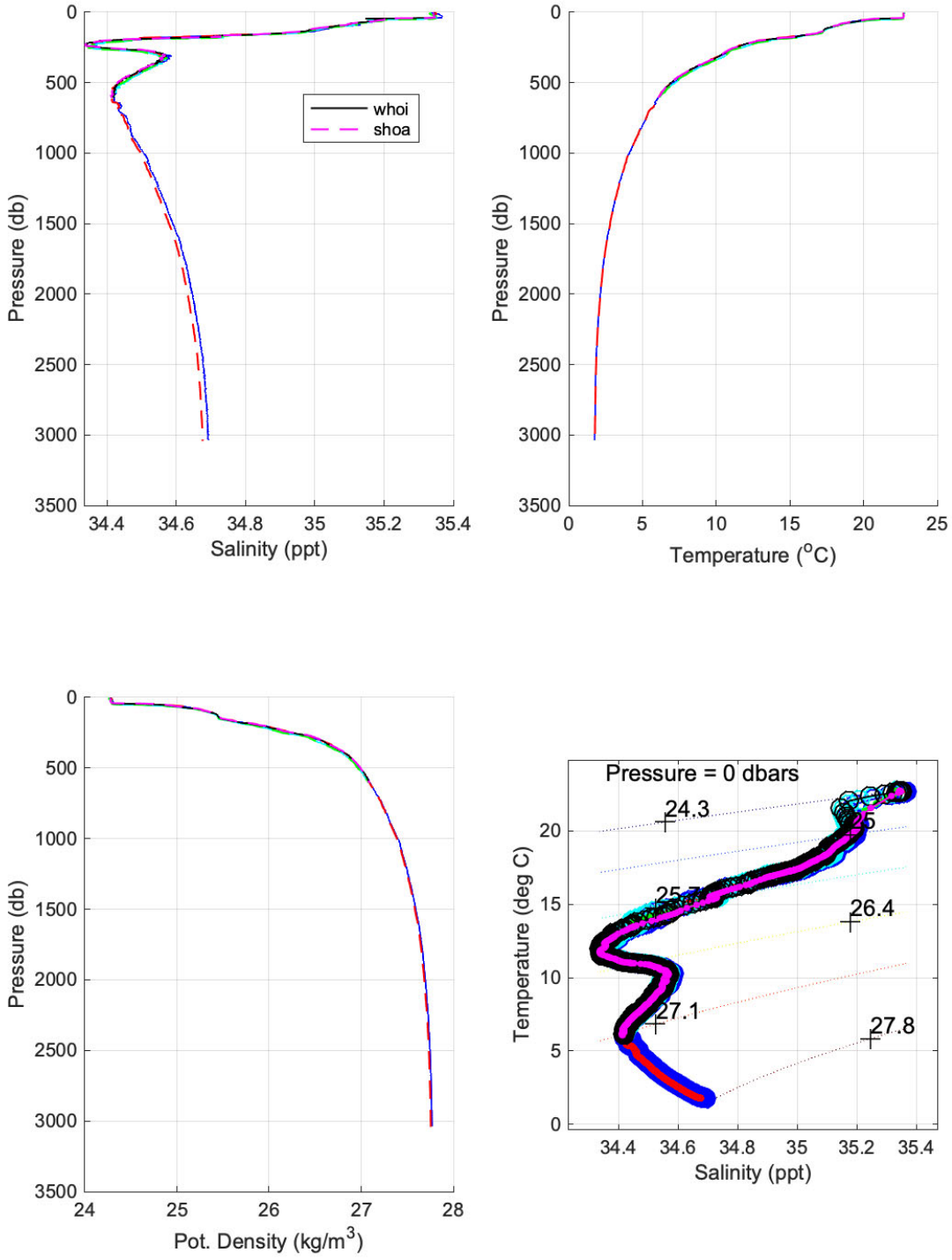


Figure V-2. CTD casts #2,3,4 data collected on March 16, 2025, near Stratus 22 mooring.

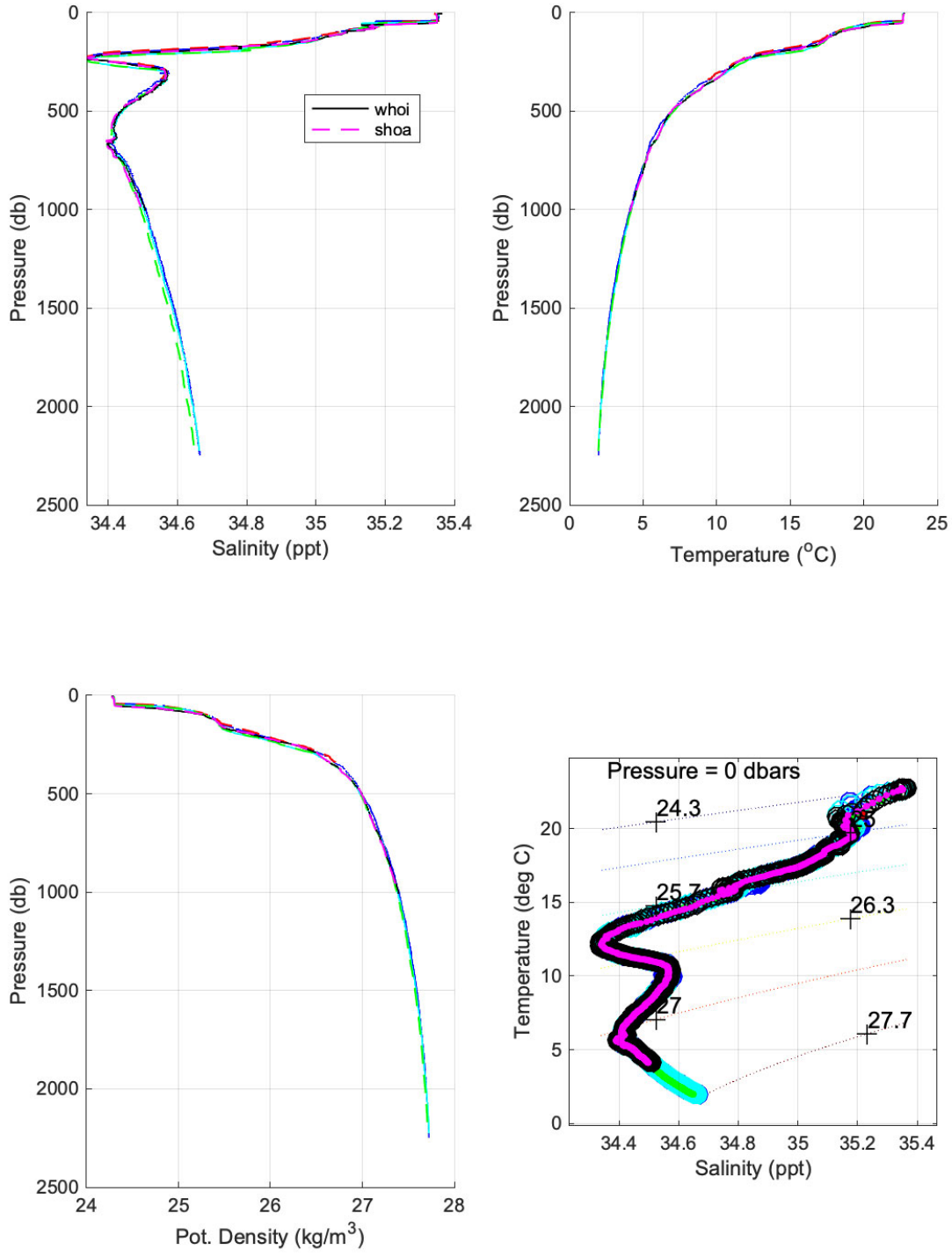


Figure V-3. CTD casts #5,6,7 data collected on March 17, 2025, near Stratus 23 mooring.

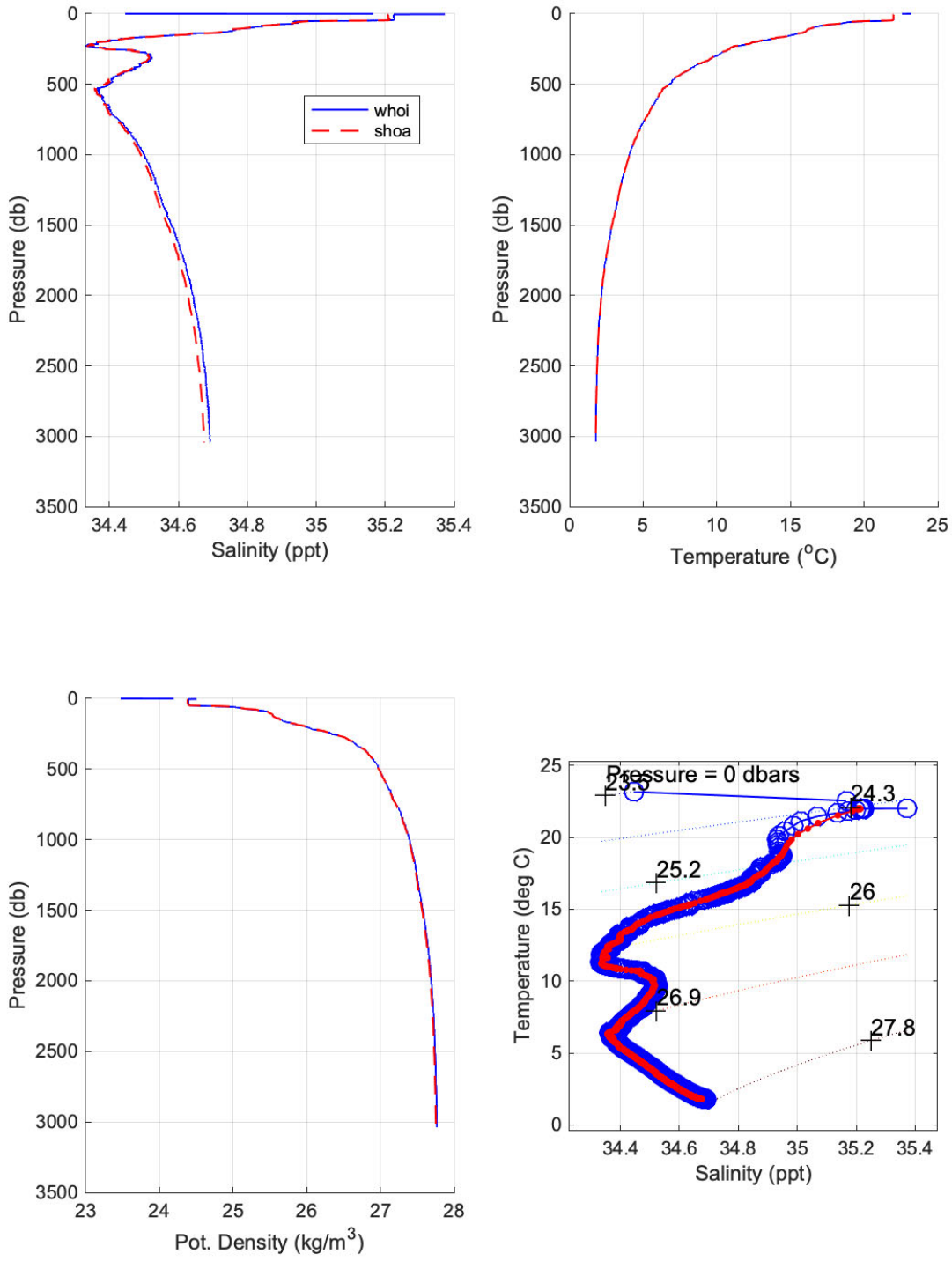


Figure V-4.CTD cats #8 data collected on March 19, 2025, during transit back to Valparaiso Error! Reference source not found..

B. Intercomparison

During the work at the Stratus mooring site, intercomparison was done to validate the measurements from each buoy. For the evaluation of the meteorological data, the ship stayed on station about ¼ nm downwind from each buoy for 24 hours. From March 15 22:30 local (UTC -3) to March 16 20:00 local, the ship *Cabo De Hornos* was near the Stratus 22 mooring (it moved 1 nm downwind of the buoy for CTD #2 between 07:00 and 12:00 local). From March 16 23:30 local to March 17 19:00 the ship was downwind from Stratus 23, but on many occasions pulled back 1 nm from the mooring because of issues with DP during the night and ship losing general power (~ 02:00 to 04:00) and for CTDs (08:00 to 10:00, 14:00 to 16:00 and 17:00 to 17:40).

Two ASIMET sensors (HRH #249 and LWR #256) were placed on a pole on main deck at the bow (Figure V-5). The data collected between March 15 22:00 and March 18 15:00 UTC for the 2 ship sensors and for the buoys (hourly averages telemetered through Iridium) are shown in Figure V-6 and Figure V-7).

Figure V-5. LWR and HRH ASIMET sensors on the bow of Cabo De Hornos.

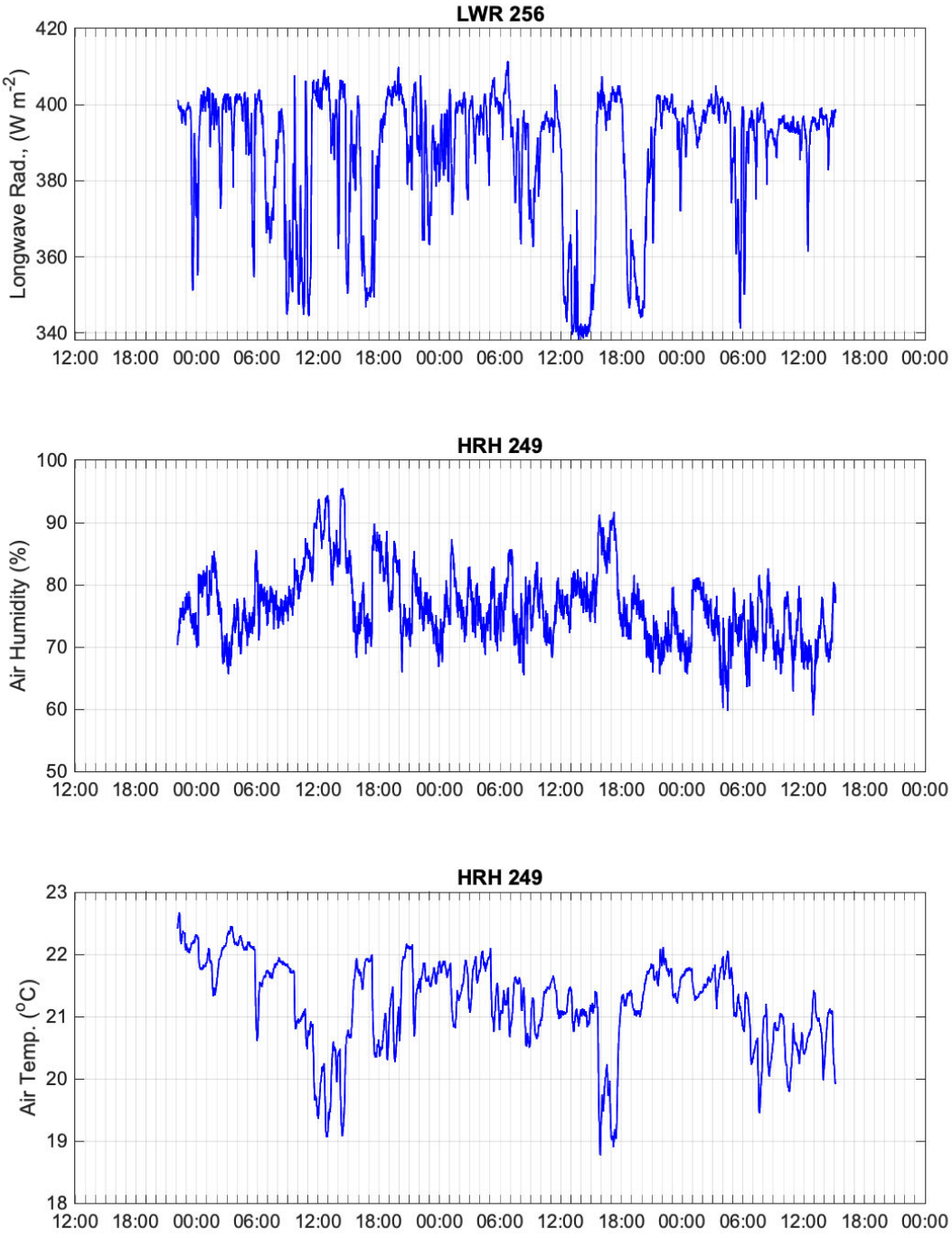


Figure V-6. Data from standalones ASIMET mounted on the ship bow, between March 15 22:00 and March 18 15:00 UTC.

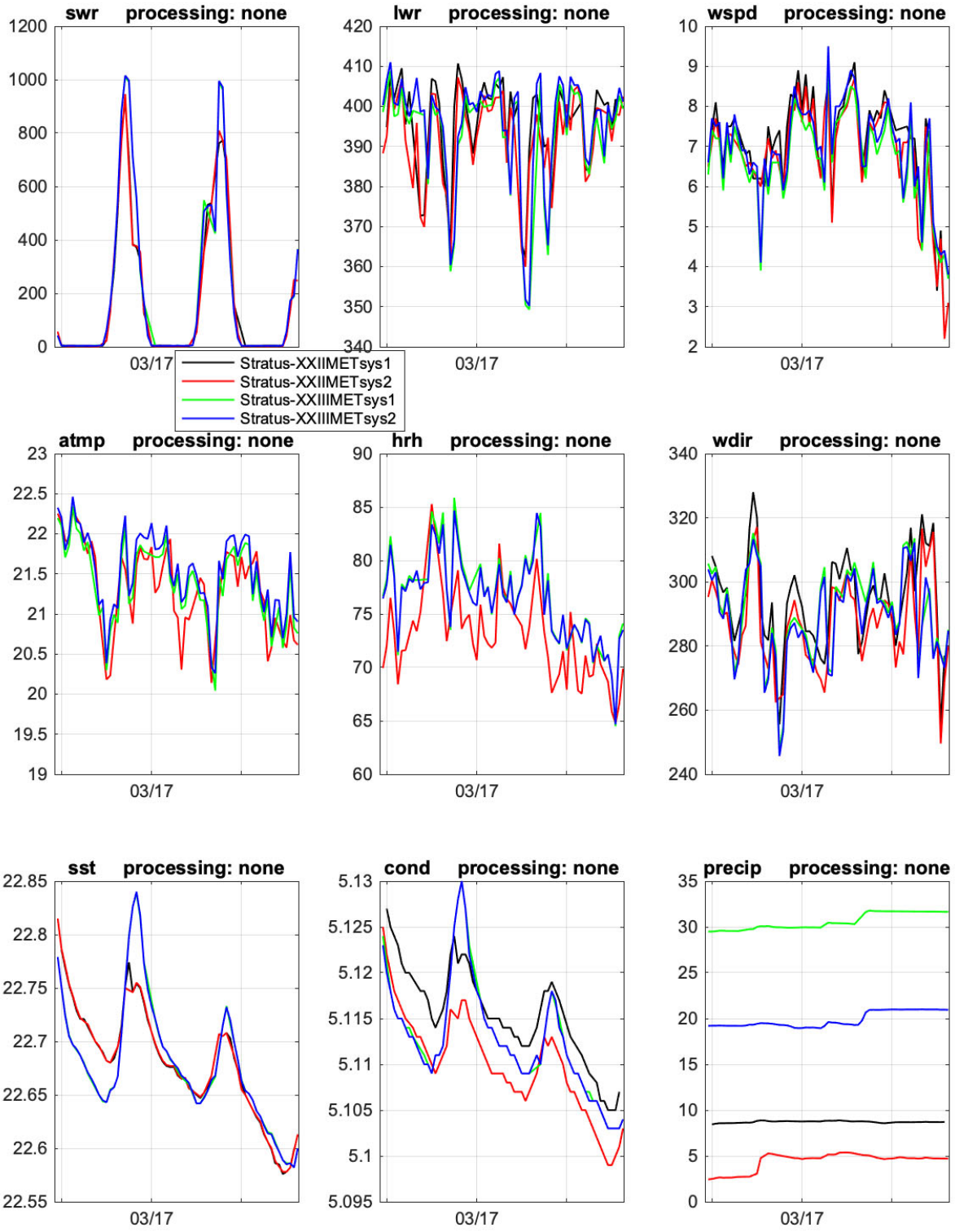


Figure V-7. Hourly data telemetered from Stratus 22 (black, red lines) and Stratus 23 (green, blue lines) buoys between March 15 22:00 and March 18 15:00 UTC.

C. Surface Drifters

During the Stratus cruise 21surface drifters were launched in international waters. The surface drifters were provided by NOAA AOML (Atlantic Oceanographic and Meteorological Laboratories, Miami, Florida) by the NOAA Global Surface Drifter Program. The Stratus program contacted the Global Surface Drifter Program and volunteered to deploy drifters.

The surface drifter deployments were done (1-8) on the outbound leg, with numbers 9 and 10 going in just as the ship departed the Stratus 23 mooring site, and remaining drifters (11 to 21) deployed between Stratus and the Chilean EEZ to the northwest of San Felix Island.

Figure V-8 shows the deployments; international waters are located between Valparaiso and the San Felix Islands region and then again to the northwest of the San Felix Islands.
Table V-2 provides a tabular summary of surface drifter deployments.

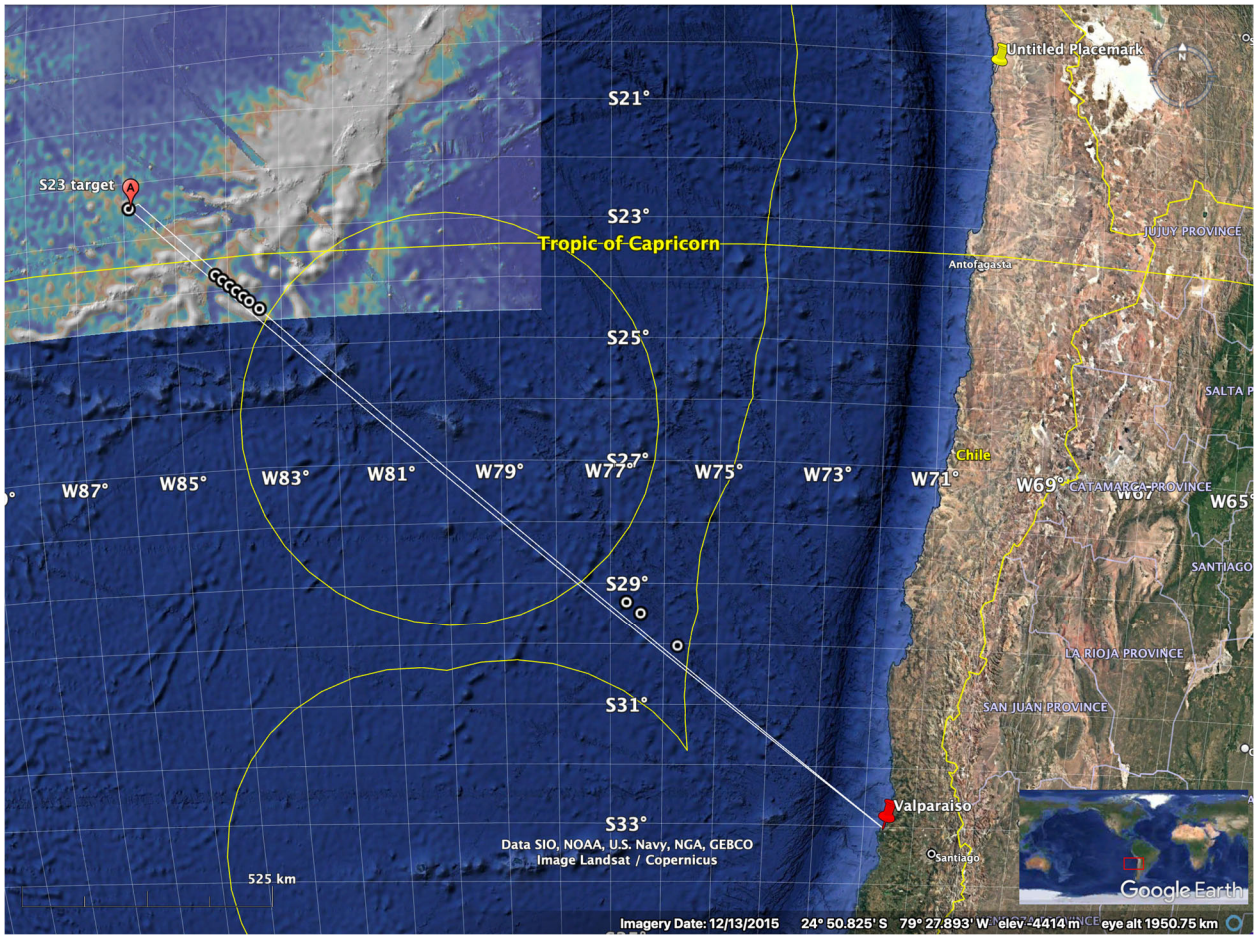


Figure V-8.Stratus 23 planned route (grey line). Locations of surface drifter deployments (grey circles).

Table V-2. Surface drifter deployment summary for Stratus 23 cruise.

Drifter launch	ID	Date (mm/dd/yyyy)	Time UTC	Lat S (dd mm.mm)	Lon W (dd mm.mm)	Ship speed (knots)
D1	300534065373780	3/11/25	11:25:03	30 01.23	75 43.5	9.8
D2	300534065373970	3/11/25	11:25:50	30 01.1	75 43.6	9.8
D3	300534065373960	3/11/25	20:57:03	29 28.8	76 25.29	6
D4	300534065373920	3/11/25	20:57:36	29 28.8	76 25.3	6
D5	300534065374940	3/11/25	23:03:57	29 18.063	76 41.081	10
D6	300534065373770	3/11/25	23:05:08	29 17.941	76 41.258	10
D7	300534065374770	3/13/25	23:43:27	24 21.472	83 22.087	10
D8	300534065375940	3/13/25	23:45:03	24 21.4295	83 22.321	10
D9	300534065375950	3/18/25	20:44:00	22 28.347	85 50.842	6
D10	300534065374960	3/18/25	20:45:00	22 28.461	85 50.869	6
D11	300534065474020	3/19/25	9:53:00	23 44.399	84 11.425	9
D12	300534065474010	3/19/25	9:54:00	23 44.473	84 11.326	9
D13	300534065473210	3/19/25	10:55:00	23 50.2	84 03.7	9
D14	300534065473100	3/19/25	10:56:00	23 50.3	84 03.6	9
D15	300534065474100	3/19/25	11:57:20	23 56.293	83 55.880	9
D16	300534065473170	3/19/25	11:59:24	23 56.394	83 55.749	9
D17	300534065475010	3/19/25	12:55:49	24 02.013	83 48.396	9
D18	300534065475090	3/19/25	12:57:06	24 02.137	83 48.233	9
D19	300534065475040	3/19/25	13:59:20	24 08.039	83 40.508	9
D20	300534065476120	3/19/25	14:00:33	24 08.168	83 40.340	9
D21	300534065474150	3/19/25	14:53:15	24 13.278	83 33.644	9

D. Eddies from satellite data

This section presents the results of the analysis of oceanic eddies along the southeastern Pacific coast using data obtained from the NOAA CoastWatch ERDDAP platform. The objective is to characterize the dynamics of eddies on different dates and evaluate their temporal evolution. The data used in this analysis were obtained from the NOAA CoastWatch platform through ERDDAP, using two different datasets:

- Mesoscale Energy Index (MESI): Provides information on the intensity of mesoscale eddies in terms of relative vorticity and ocean circulation patterns. Available at: NOAA CoastWatch ERDDAP MESI.

- U and V velocity components of ocean currents: Represent the direction and magnitude of surface water flow, allowing the identification of dynamic ocean structures. Available at: NOAA CoastWatch ERDDAP Currents.

Data were obtained for four specific days: February 15, 2025, March 1, 2025, March 15, 2025, March 18, 2025. The last two correspond to the deployment day of the Stratus23 buoy and the recovery of the Stratus22 buoy, respectively. These data were extracted at a daily resolution and used to generate comparative maps of oceanic eddies in the study region. The data were processed in MATLAB to generate comparative maps of oceanic eddies on two sets of dates:

- February 15, 2025, and March 1, 2025
- March 15, 2025, and March 18, 2025.

The Mesoscale Energy Index (MESI) was plotted as a base layer, over which the U and V velocity components were overlaid using vector arrows to visualize oceanic flow direction. Subsequently, the total velocity magnitude was added, represented on a color map to identify regions of higher and lower velocity. Finally, the U and V components' arrows were overlaid again on this map, providing an integrated visualization of ocean flow dynamics. In every picture, the green point represents the location of the Stratus buoy, near 22.5 °S, 85.5 °W.

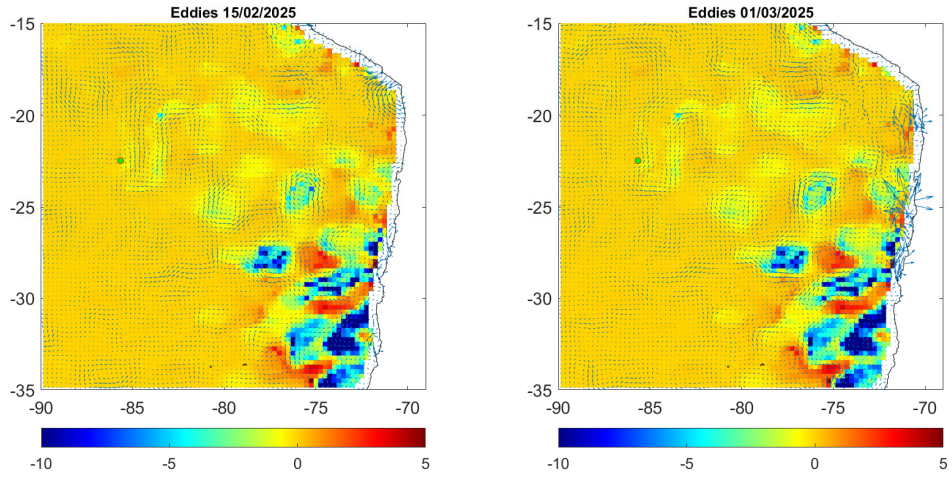


Figure V-9. Mesoscale Energy Index (MESI) – February 15 and March 1, 2025

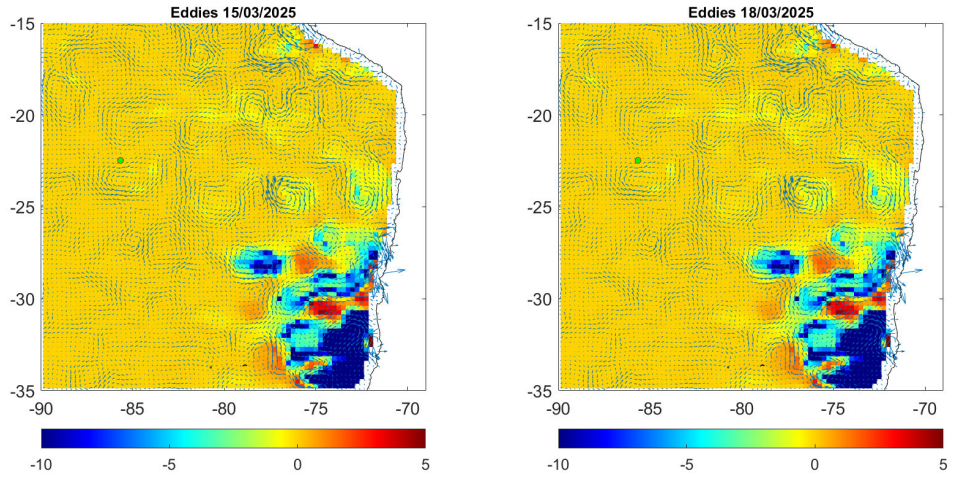


Figure V-10. Mesoscale Energy Index (MESI) – March 15 and March 18, 2025

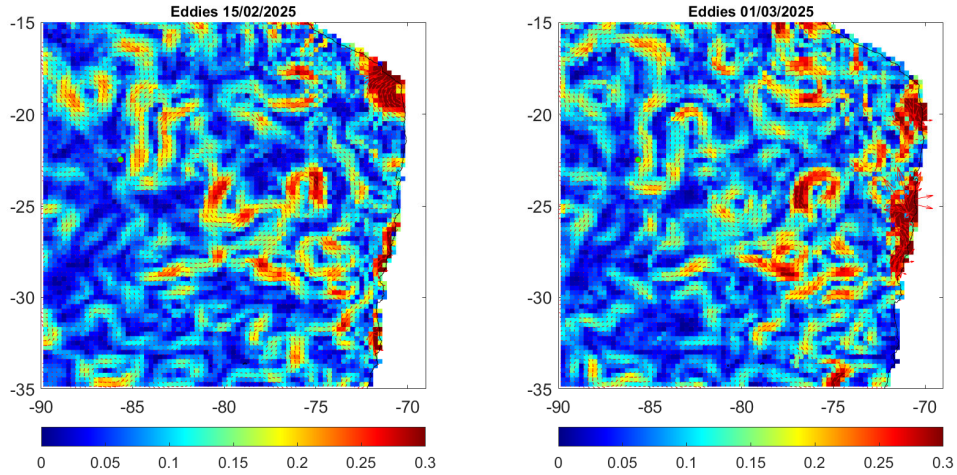


Figure V-11. Eddy Distribution (MESI) and Velocity Vectors – February 15 and March 1, 2025

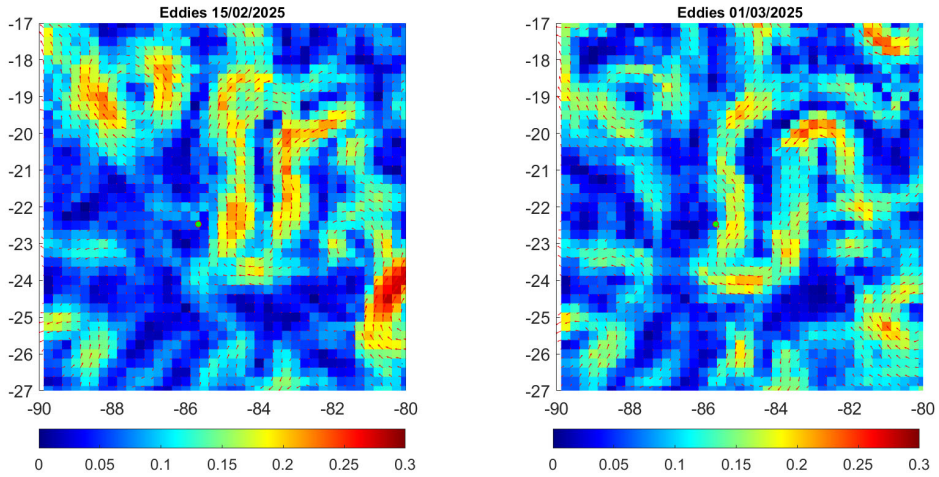


Figure V-12. Eddy Distribution (MESI) and Velocity Vectors – February 15 and March 1, 2025

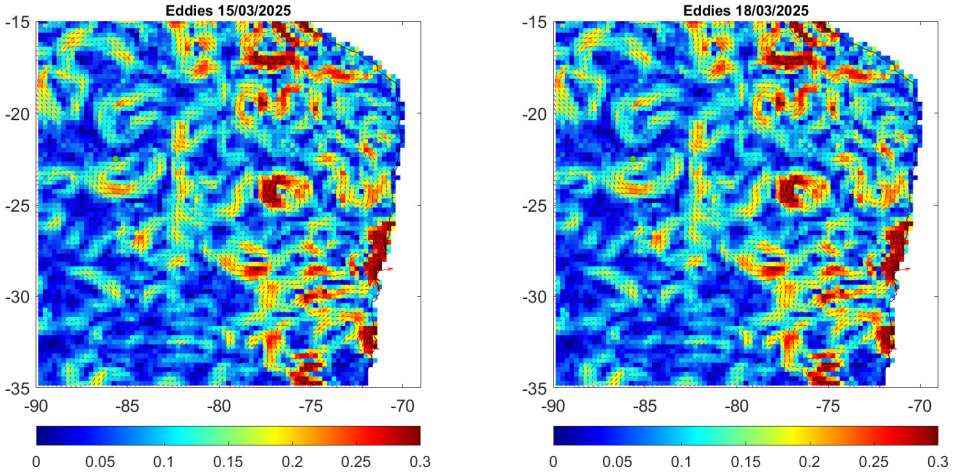


Figure V-13. Eddy Distribution (MESI) and Velocity Vectors – March15 and 18, 2025.

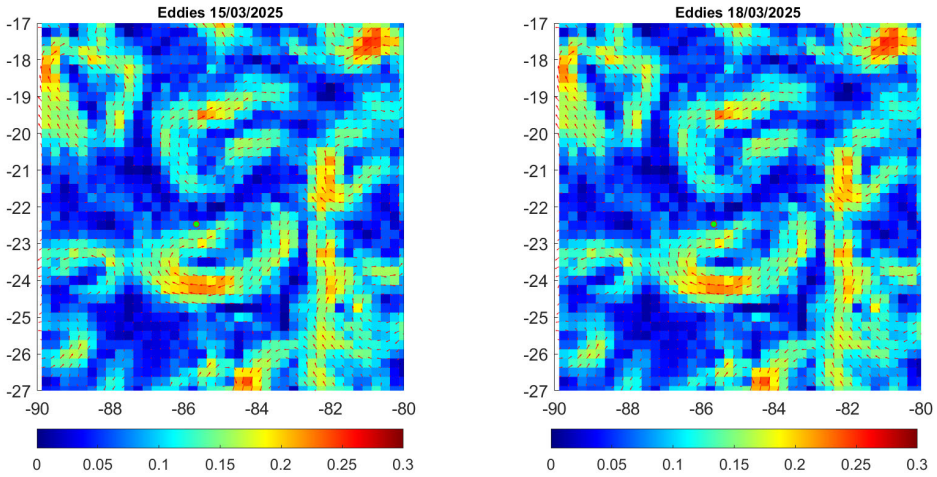


Figure V-14. Eddy Distribution (MESI) and Velocity Vectors – March15 and 18, 2025

These plots show a large cyclonic eddy, elongated in the latitudinal direction, approaching the Stratus area from the east and splitting in two eddies by March 15. The translational speed of this large eddy was roughly 2 km per day as it travelled about 0.5 degree (~ 52 km) west between February 15 and March 3. The western side of this eddy had a northward flow, which might have been associated with the northward drift of the ship during the set and drift tests performed on March 14 and 15 in preparation for the mooring deployment. The MESI index shows that the coastal area near 30 °S is a hot spot for the formation of eddies.

This analysis provides insight into the evolution of oceanic eddies in the study area, offering valuable information for understanding oceanographic dynamics. It is recommended to extend the analysis over a longer period to assess seasonal trends and potential relations with the coastal circulation.

Acknowledgements

The Upper Ocean Processes group at WHOI is very thankful for the crew of the research vessel *Cabo de Hornos*. The help and welcome from the Chilean Navy and its Hydrographic Services (SHOA) are also very much appreciated. 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, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, under grant NA19OAR4320074.

Appendix 1: Stratus 23 Buoy Spin

Heading	**90**
Turn	**0**

	Time	Date
Vanes Secured UTC	14:40:00	20240903

System 1		VANE	Compass	Direction	Sample Time
Logger	**L04**				
WND	**222**	3.10	89.80	92.90	14:51:00
System 2		**Vane**	**Compass**	**Direction**	**Sample Time**
Logger	**L14**				
WND	**344**	1.60	90.00	91.60	14:52:00
		VANE	**Compass**	**Direction**	**Sample Time**
WXT	201	N/A	90.80	N/A	14:53:00

Heading	**135**
Turn	**45**

	Time	Date
Vanes Secured UTC	15:01:00	20240903

System 1		VANE	Compass	Direction	Sample Time
Logger	**L04**				
WND	**222**	317.40	134.90	92.30	15:11:00
System 2		**Vane**	**Compass**	**Direction**	**Sample Time**
Logger	**L14**				
WND	**344**	318.80	133.70	92.50	15:13:00
		VANE	**Compass**	**Direction**	**Sample Time**
WXT	201	N/A	136.50	N/A	15:14:00

Heading	**180**
Turn	**90**

	Time	Date
Vanes Secured UTC	15:22:00	20240903

System 1		VANE	Compass	Direction	Sample Time
Logger	**L04**				
WND	**222**	269.80	180.00	89.80	15:32:00
System 2		**Vane**	**Compass**	**Direction**	**Sample Time**
Logger	**L14**				

WND	**344**	275.00	179.50	94.50	15:41:00
		VANE	**Compass**	**Direction**	**Sample Time**
WXT	201	N/A	180.30	N/A	15:34:00

Heading **225**
Turn **135**

	Time	**Date**
Vanes Secured UTC	15:48:00	20240903

System 1		**VANE**	**Compass**	**Direction**	**Sample Time**
Logger	**L04**				
WND	**222**	224.10	224.90	89.00	16:01:00
System 2		**Vane**	**Compass**	**Direction**	**Sample Time**
Logger	**L14**				
WND	**344**	229.90	224.10	94.00	16:00:00
		VANE	**Compass**	**Direction**	**Sample Time**
WXT	201	N/A	223.60	N/A	16:00:00

Heading **270**
Turn **180**

	Time	**Date**
Vanes Secured UTC	16:08:00	20240903

System 1		**VANE**	**Compass**	**Direction**	**Sample Time**
Logger	**L04**				
WND	**222**	179.40	269.70	89.10	16:20:00
System 2		**Vane**	**Compass**	**Direction**	**Sample Time**
Logger	**L14**				
WND	**344**	185.70	269.00	94.70	16:21:00
		VANE	**Compass**	**Direction**	**Sample Time**
WXT	201	N/A	266.50	N/A	16:22:00

Heading **315**
Turn **225**

	Time	**Date**
Vanes Secured UTC	16:30:00	20240903

System 1		**VANE**	**Compass**	**Direction**	**Sample Time**
Logger	**L04**				
WND	**222**	135.40	313.20	88.60	16:43:00

System 2		Vane	Compass	Direction	Sample Time
Logger	L14				
WND	344	139.90	313.80	93.70	16:43:00
		VANE	Compass	Direction	Sample Time
WXT	201	N/A	310.70	N/A	16:42:00

Heading	0
Turn	270

	Time	Date
Vanes Secured UTC	16:51:00	20240903

System 1		VANE	Compass	Direction	Sample Time
Logger	L04				
WND	222	93.10	358.90	92.00	17:04:00
System 2		Vane	Compass	Direction	Sample Time
Logger	L14				
WND	344	94.00	0.20	94.20	17:04:00
		VANE	Compass	Direction	Sample Time
WXT	201	N/A	357.20	N/A	17:05:00

Heading	45
Turn	315

	Time	Date
Vanes Secured UTC	17:13:00	20240903

System 1		VANE	Compass	Direction	Sample Time
Logger	L04				
WND	222	48.50	44.30	92.80	17:28:00
System 2		Vane	Compass	Direction	Sample Time
Logger	L14				
WND	344	48.40	46.10	94.50	17:24:00
		VANE	Compass	Direction	Sample Time
WXT	201	N/A	44.30	N/A	17:23:00

Heading	90
Turn	360

	Time	Date
Vanes Secured UTC	17:34:00	20240903

System 1	VANE	Compass	Direction	Sample Time

Logger	**L04**				
WND	**222**	3.20	89.50	92.70	17:44:00
System 2		**Vane**	**Compass**	**Direction**	**Sample Time**
Logger	**L14**				
WND	**344**	3.70	90.20	266.10	17:44:00
		VANE	**Compass**	**Direction**	**Sample Time**
WXT	201	N/A	90.40	N/A	17:45:00

Appendix 2: Stratus 23 Surface and Subsurface Instrumentation Configuration

Surface:

STRATUS 23 Deploy

	SYSTEM 1		SPIKE				
Module	Serial	Firmware Version	Height Cm	DATE	Start Time	End Time	Notes
Logger PORT	L04	V 4.38-1 CF 256 MB SD CARD					
HRH	211		234				
BPR	501		243				
WND	222	CF CARD	267	20250313	17:49	19:43	SPIKE= NOSE CONE REMOVED, WSPD=0
PRC	319	SD CARD	252	20250313	17:52	17:54	SPIKE START TIME= FILL UNTIL DRAINS, SPIKE END TIME= FILL WITH 300 ML
LWR	265	CF CARD	281	20250313	17:51	19:44	SPIKE= CAP OVER DOME
SWR	210	SD CARD	281	20250313	17:51	19:44	SPIKE= CAP OVER DOME
SST	1306	2.3B		20250313	17:42	19:46	SPIKE=BAG OF ICE AROUND TEMP PROBE
Met IR	300234063341510						

SYSTEM 2				SPIKE			
Module	Serial	Firmware Version	Height Cm	DATE	Start Time	End Time	Notes
Logger STARBOARD	L14	V 4.38-1 CF 256 MB					
HRH	221	SD CARD	234				
BPR	506	SD CARD	243				
WND	344	CF CARD	267	20250313	17:49	19:43	SPIKE= NOSE CONE REMOVED, WSPD=0
PRC	235	SD CARD	252	20250313	17:52	17:54	SPIKE START TIME= FILL UNTIL DRAINS, SPIKE END TIME= FILL WITH 200 ML
LWR	261	CF CARD	281	20250313	17:51	19:44	SPIKE= CAP OVER DOME
SWR	207	SD CARD	281	20250313	17:51	19:45	SPIKE= CAP OVER DOME
SST SBE37	1839	2.3B		20250313	17:42	19:46	SPIKE=BAG OF ICE AROUND TEMP PROBE
Met IR	300234063441050						

STAND ALONES MODULES				SPIKE			
Module	Serial		Height Cm	DATE	Start Time	End Time	Notes
WXT	201	WXT530 v5.65,ASIPIC24 REV A, SD CARD	267	20250313	17:48	19:43	SPIKE= BAG OVER SENSOR HEAD, WSPD=0
SA-SWR (EPPLEY)	352	CF CARD	281	20250313	17:51	19:44	SPIKE= CAP OVER DOME
SA-HRH	263	SD CARD	234				SPIKE= POWER ON
SBE-39-AT	477	V1.7a	234	20250313	130000		SPIKE TIME = LOGGING INITIALIZED
Rotronic	C210DF/12718303	LOG-HC2-RC-US	234	20250313	123000		SPIKE TIME = LOGGING INITIALIZED

BEACONS

Module	Serial	IMEI
XEOS KILO		300234062945460
XEOS Mello		300034013701980
XEOS ROVER	725	300434063443730
XEOS ROVER	726	300434063448720

PCO2

Module	Serial
ANTENNA	25
SBE16	6885
ECO	2843
SBE63	3209
SAMI	P0018
SPAN GAS	JB03188
MAPCO2 ELECTRONICS	CGA-889
BATTERY	101

Stratus 23 Sea Surface Temperature Array

Instrument	Serial	CM Below Deck	CM below waterline	Orientation Degrees
SBE56	6239	95		Port 90
SBE56	6410	65		Bow 0
SBE56	6412	85		Bow 0
SBE56	6983	95		Bow 0
SBE56	7211	95		Starboard 270

Subsurface:

Stratus 23 Subsurface									
				START		SPIKE Started at ~13 deg C, settled			
Instrument	Serial	Depth Meters	Sample rate (s)	date	time	date	start time	to stop time	STOP DATE
Nortek 2 MHZ Profiler	AQD 17784	13	300/1200	20250305	010000	20250311	1130	15:50	20250311
RCM11	78	7	1800	20250310	233000	20250311	1130	15:50	20250311
RCM11p	79								
RCM11p	13								

RDI 300 KHZ	1218	80	300/3600	20250305	010000	20250311	1130	15:50	20250311
SBE37	3605	SST							
SBE37	1838	SST							
SBE37	1325	2 (LB)	300	20250311	010000	20250311	1130	15:50	20250311
SBE37	1326	3.7 (LB)	300	20250311	010000	20250311	1130	15:50	20250311
SBE37	1328	10 (LB)	300	20250311	010000	20250311	1130	15:50	20250311
SBE37	1329	16 (LB)	300	20250311	010000	20250311	1130	15:50	20250311
SBE37	1330	30 (LB)	300	20250311	010000	20250311	1130	15:50	20250311
SBE37	8211	40 (LB)	300	20250311	010000	20250311	1130	15:50	20250311
SBE37	8212	62.5 (LB)	300	20250311	010000	20250311	1130	15:50	20250311
SBE37	1909	85 (CL)	300	20250311	010000	20250311	1130	15:50	20250311
SBE37	8215	130 (LB)	300	20250311	010000	20250311	1130	15:50	20250311
SBE37	8216	160 (LB)	300	20250311	010000	20250311	1130	15:50	20250311
SBE37	12258	190 (LB)	300	20250311	010000	20250311	1130	15:50	20250311
SBE37	12256	220 (LB)	300	20250311	010000	20250311	1130	15:50	20250311
SBE37	1906	295 (CL)	300	20250311	010000	20250311	1130	15:50	20250311
SBE37	10602	550 (CL)	300	20250311	010000	20250311	1130	15:50	20250311
SBE37	11392	600 (LB)	300	20250311	010000	20250311	1130	15:50	20250311
SBE37	1908	601(CL)	300	20250311	010000	20250311	1130	15:50	20250311
SBE37	8218	698(CL)	300	20250311	010000	20250311	1130	15:50	20250311
SBE37	11393	700(LB)	300	20250311	010000	20250311	1130	15:50	20250311
SBE37	8219	857 (CL)	300	20250311	010000	20250311	1130	15:50	20250311
SBE37	2012	1354(CL)	300	20250311	010000	20250311	1130	15:50	20250311
SBE37	8222	1557(CL)	300	20250311	010000	20250311	1130	15:50	20250311
SBE37	7218	2000(CL)	300	20250311	010000	20250311	1130	15:50	20250311
SBE37	11379	4503	300	20250311	010000	20250311	1130	15:50	20250311
SBE37	11394	4503	300	20250311	010000	20250311	1130	15:50	20250311

SBE39	5275	4.9 (LB)	300	20250311	010000	20250311	1130	15:50	20250311
SBE39	38	25 (LB)	300	20250311	010000	20250311	1130	15:50	20250311
SBE39	3439	35 (LB)	300	20250311	010000	20250311	1130	15:50	20250311
SBE39	48	50 (CL)	300	20250311	010000	20250311	1130	15:50	20250311
SBE39	49	55 (CL)	300	20250311	010000	20250311	1130	15:50	20250311
SBE39	102	70 (CL)	300	20250311	010000	20250311	1130	15:50	20250311
SBE39	103	77.5 (CL)	300	20250311	010000	20250311	1130	15:50	20250311
SBE39	203	92.5 (CL)	300	20250311	010000	20250311	1130	15:50	20250311
SBE39	276	100 (CL)	300	20250311	010000	20250311	1130	15:50	20250311
SBE39	284	115 (CL)	300	20250311	010000	20250311	1130	15:50	20250311
SBE39	719	175 (CL)	300	20250311	010000	20250311	1130	15:50	20250311
SBE39	720	280 (CL)	300	20250311	010000	20250311	1130	15:50	20250311
SBE56	6239		60	20250311	010000	20250311	1130	15:50	20250311
SBE56	6410		60	20250311	010000	20250311	1130	15:50	20250311
SBE56	6412		60	20250311	010000	20250311	1130	15:50	20250311
SBE56	6983		60	20250311	010000	20250311	1130	15:50	20250311
SBE56	7211		60	20250311	010000	20250311	1130	15:50	20250311
Seaguard w/ O2 optode	138	45	300/1500	20250311	010000	20250311	1130	15:50	20250311
Seaguard w/ O2 optode	140	87.3	300/1500	20250311	010000	20250311	1130	15:50	20250311
Seaguard w/ O2 optode	141	145	300/1500	20250311	010000	20250311	1130	15:50	20250311
Seaguard w/ O2 optode	142	235	300/1500	20250311	010000	20250311	1130	15:50	20250311
Seaguard w/ O2 optode	143	290	300/1500	20250311	010000	20250311	1130	15:50	20250311
Seaguard w/ O2 optode	144	20 (700)	300/1500	20250311	010000	20250311	1130	15:50	20250311

Seaguard w/ O2 optode	181	450	300/1500	20250311	010000	20250311	1130	15:50	20250311
Seaguard w/ O2 optode	182	32.5 (600)	300/1500	20250311	010000	20250311	1130	15:50	20250311
Seaguard (LS)w/ O2, C,T,P	961	107	300/3300	20250311	010000	20250311	1130	15:50	20250311
Seaguard (LS)w/ O2, C,T,P	964	183	300/3300	20250311	010000	20250311	1130	15:50	20250311
Seaguard (LS)w/ O2, C,T,P	969	350	300/3300	20250311	010000	20250311	1130	15:50	20250311
VMCM	2019/T POD69	400	60	20250308	121600				
VMCM	2062/T POD17	802	60	20250308	130200				
VMCM	2065/T POD09	853	60	20250308	124700				
Wetlabs	2866	100.5	1 hz for 4 seconds every 99.9 min for 18 mo						

Appendix 3: Mooring Log Stratus 22

Moored Station Log

(fill out log with black ball point pen only)

ARRAY NAME AND NO. Stratus 22 MOORED STATION NO. _____

Launch (anchor over)

Date (day-mon-yr) 06 Dec 2023 Time 0116 UTC

Deployed by Llanos / Graham Recorder/Observer J. Kuzik

Ship and Cruise No. AGS61 Cabo de Hornos Intended Duration 365

Depth Recorder Reading 4276 m Correction Source _____

Depth Correction 0 m Multibeam survey from past cruise

Corrected Water Depth 4276 m Magnetic Variation (E/W) 6.85°

Anchor Drop Lat. (N/S) 22 28.350 Lon. (E/W) 85 39.392

Surveyed Pos. Lat. (N/S) 22 28.205 Lon. (E/W) 85 39.502

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

Acoustic Release Model Edgetech 8242XS Tested to 1500 m

Release No. 1 (sn) 51917 Release No. 2 (sn) 51915

Interrogate Freq. 11 kHz Interrogate Freq. 11 kHz

Reply Freq. 12 Reply Freq. 12

Enable 340011 Enable 337703

Disable 340032 Disable 337720

Release 335364 Release 335322

Recovery (release fired)

Date (day-mon-yr) 18-Mar-25 Time 11:10 UTC

Latitude (N/S) 22° 27.66' Longitude (E/W) 85° 40.01'

Recovered by Llanos / Graham Recorder/Observer Jorquera / Bigorre

Ship and Cruise No. AGS61 - Stratus 23 Actual duration 468 days

Distance from waterline to buoy deck 60 cm

Recovery Cruise: Valparaiso - Stratus - Valparaiso; 2025/3/10 - 23.

Deployment Cruise: Valparaiso to Valparaiso: 2023/11/29 to 2023/12/14.

ARRAY NAME AND NO. Stratus 22 MOORED STATION NO. _____

Surface Components			
Buoy Type NOAA Color(s) Hull Tower Blue / Yellow / White			
Buoy Markings _____			
Surface Instrumentation			
Item	**ID #**	**Height***	**Comments**
Logger	L01	v	Port side. V4.38-1 CF 256MB
HRH	705	232	SD card.
BPR	211	244	SD card.
SWND	216	262	CF card
PRC	213	253	SD card.
LWR	254	281	CF card
SWR	351	281	SD card.
SST	1836		
Net Iridium	300234063269 360		
Logger	L02		Starboard side.
HRH	339	231	SD card
BPR	216	244	CF card
WND	343	263	SD card
PRC	320	252	SD card.
LWR	212	281	CF card
SWR	214	281	CF card
~~Net Iridium~~ SST	2054		
Net Iridium	300234063166 220		
Standalones:			
WXT	202	263	SD card
SWR	221	281	CF card. Kipp & Zonen
HRH	365	232	SD card
HRH	12718504	233	Hygroclips CZ10E0
SBE 39AT	3800	229	
*Height above buoy deck in centimeters			

ARRAY NAME AND NO. Stratus 22 MOORED STATION NO. _____

Subsurface Instrumentation on Buoy and Bridle			
Item	ID #	Depth†	Comments
SBE56	1207		Port 90° (90 cm)
SBE56	1208		FWD 180°
SBE56	1209		FWD 180°
SBE56	1211		FWD 180°
SBE56	2069		Starboard 225° (135cm)
XeosKilo	619		300 234 061 853 510
XeosDelo			300 034 013 709 960
XeosRover	111		300 434 060 447 400
XeosRover	1032		300 434 064 537 420
PCO2			
NAPCO2	208		
Antenna	208		
GasCylinder	JJ17487		Concentration 444 41 , 1950 751
Sami			
SBE16			
†Depth below buoy deck in centimeters			

ARRAY NAME AND NO. Stratus22 MOORED STATION NO._____

Item No.	Length (m)	Item	Depth	Inst No.	Time Over	Time Back	Notes
1		buoy				1810	Aframe stops when buoy in the air.
2	0.22	3/4 chain					
3		SBE37	2	1304 ✓	1431	1810	
4	0.37	3/4 chain					
5		SBE37	3.7	3821 ✓	1431	1810	
6	0.525	chain					shackle on each end
7		SBE39	5	39 ✓	1431	1810	
8	0.9	3/4 chain					
9		SBE37	7	3824 ✓	1408	1820	
10	4	3/4 chain					
11		SBE39	12.2	41 ✓	1405	1823	
12		Aanderaa ADCP	13	0235 ✓	1404	1823	Heads up
13	1.95	3/4 chain					
14		SBE37	16.4	1899 ✓	1403	1823	
15	2.1	3/4 chain					
16		SBE39	20	~~3480~~ ✓	1400	1826	SN: 3480
17	4.05	3/4 chain					
18		SBE39	25	0539 ✓	1358	1829	
19	3.97	3/4 chain					
20		SBE37	30	1900 ✓	1355	1829	
21	1.125	3/4 chain					
22		Aanderaa ADCP	32.5	0238 ✓	1354	1831	Heads up
23	1.125	3/4 chain					
24		SBE 39	35	0721 ✓	1352	1831	
25	3.97	3/4 chain					

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ARRAY NAME AND NO. Stratus 22 MOORED STATION NO. _____

Item No.	Length (m)	Item	Depth	Inst No.	Time Over	Time Back	Notes
26		SBE37	40	1901 ✓	1349	1836	
27	3.23	3/4 chain		✓			
28		VMCM	45	2064 ✓ TRDR 10	1347	1701	spike = 1345 Recovery Spike 17:06:32
29	15.3	7/16 wire					23053-6 TOP
30		SBE39	52	1502 ✓	1431	1658	clamped covered in barnacles
31		SBE37	62.5	1902 ✓	~~1434~~	1654	load bar TO: 1441 23059-5 A dozen barnacles
32	21.2	7/16 wire					
33		SBE39	70	1509 ✓	1443	1652	1 clamp broken @ recovery
34		SBE39	77.5	1511 ✓	1445	1651	
35		RDI ADCP	85	~~14444~~	1455	1646	SN: 13254 ✓
36		SBE37	88	8004 ✓	1455	1646	load bar
37	9.5	7/16 wire					
38		SBE39	92.5	3423 ✓	1455	1645	clamped
39		VMCM	100	2053 ✓ TRDR 10	1500	1641	SPIKE: 1459 Recovery Spike 16:42:25
40	28	7/16 wire					
41		SBE39	115	1498 ✓	1504	1639	clamped
42		SBE37	130	1903 ✓	1512	1637	load bar 23053-3
43	3	3/4 chain					
44		VMCM	135	2004 ✓ TRDR 13	1514	1633	SPIKE 1513 Recovery Spike 16:33:30
45	23.5	7/16 wire					23053-3
46		SBE39	145	3435 ✓	1516	1632	clamped
47		SBE37	160	1905 ✓	1520	1628	2 small barnacles
48	21.3	7/16 wire					23053-4
49		SBE39	175	45 ✓	1522	1622	clamped
50		VMCM	183	2059 ✓ TRDR 14	1527	1618	SPIKE: 1526 Spike Recovery 16:18:30

s 23053-9 →

I let go @ Recovery

Barna on props + 1 rotop blade missing

ARRAY NAME AND NO. Stratus 22 MOORED STATION NO._____

Item No.	Length (m)	Item	Depth	Inst No.	Time Over	Time Back	Notes
51	4.8	7/16 ✓ wire					23053-9
52		SBE37	190	1907✓	1531		load bar → Missing at Recovery → load bar & clamps OK
53	22.5	7/16 ✓ wire					23053-1
54		SBE37	220	8214✓	1537	1611	load bar
55	13	7/16 ✓ wire					23053-7
56		VMCM	235	2061✓ TBD 33	1543	1607	SPIKE - 15:41 Recovery Spike 16:07:15
57	53	3/8 ✓ wire					23053-18
58		SBE37	250	2011✓	1545	1605	clamped
59		VMCM	290	2062✓ TBD 68	1554	1544	SPIKE - 1552 Recovery Spike 15:45:06 → Tpod 1abo/89
60	160	3/8 ✓ wire					23053-24
61		SBE37	310	7836✓	1557	1543	clamped
62		SBE39	400	3438✓	1607	1540	clamped
63		VMCM	450	2083✓ TBD 34	1616	1534	SPIKE: 16:13 Recovery Spike 15:34:45
64	340	3/8 ✓ wire				1525 start	23053-13
65		SBE37	550	8223✓	1625	1530	clamped
66	500	3/8 ✓ wire				1510	23053-11
67	500	3/8 ✓ wire				1450	23053-10 Winch broke @ 1730 - re
68	100	3/8 ✓ wire	23053-17				other winch w/2m SUBm + 10m wire + 100m + 200m nylon - rest + 21
69	100	3/8 ✓ wire	23053-15			1440	one piece, wrapped termination
70	200	7/8 ✓ nylon					
71	1850	7/8 ✓ nylon	?		2215	1555	spliced at sea
72	1300	1" ✓ Colmega					broken @ B 1111
73		Glass ✓ Balls (24)			0103	1305	IIII IIII IIII IIII 21 sets OK 4
74		SBE37	4238	10600✓	0103	1310	one had case
75		SBE37	4238	10601✓	0103	1310	

6

ARRAY NAME AND NO. Stratus 22 MOORED STATION NO. _____

Item No.	Length (m)	Item	Depth	Inst No.	Time Over	Time Back	Notes
76	5	1/2 chain					
77		Acoustic Release			0104	1313	with 1/2 chain
78		Acoustic Release			0104	1313	
79	1	chain					
80	5	1/2 chain					
81	20	Samson					
82	5	1/2 chain					
83		Anchor			0116		wet weight 8000 lbs dry " 9300 "
84							
85							
86							
87							
88							
89							
90							
91							
92							
93							
94							
95							
96							
97							
98							
99							
100							

7

ARRAY NAME AND NO._____ MOORED STATION NO._____

Date/Time	Comments
12/5/2022 17:30	Split out down stop working during deployment (brake is locked).
" 17:15	Wire transferred by hand to other split out down, using some 100 m wire shots (×2) and some braided Nylon 200 m shot.

Appendix 4: Mooring Log Stratus 23

Moored Station Log

(fill out log with black ball point pen only)

ARRAY NAME AND NO. Stratus 23 MOORED STATION NO. _____

Launch (anchor over)

Date (day-mon-yr) 16-Mar-25 Time 2108 UTC

Deployed by Hanes / Graham / Smith Recorder/Observer Bigorre / Torquera

Ship and Cruise No. AGS61 - Stratus 23 Intended Duration 365

Depth Recorder Reading 4225 m Correction Source local SoS

Depth Correction 0 m Multibeam surveys from past cruises

Corrected Water Depth 4225 m Magnetic Variation (E/W) _____

Anchor Drop Lat. (N/S) 20° 29.171' Lon. (E/W) 085° 49.627'

Surveyed Pos. Lat. (N/S) 20° 29.117' Lon. (E/W) 085° 49.720'

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

Acoustic Release Model EdgeTech Tested to 1500 m

Release No. 1 (sn) 33036	Release No. 2 (sn) 54688
Interrogate Freq. 11 kHz	Interrogate Freq. 11 kHz
Reply Freq. 12 kHz	Reply Freq. 12 kHz
Enable 314 022	Enable 272 474
Disable 314 047	Disable 272 505
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 60 cm

Deployment cruise: Valparaiso to Valparaiso; 2025/3/10 to 23.

1

ARRAY NAME AND NO. Stratus 23 MOORED STATION NO. _____

Surface Components

Buoy Type NOB Color(s) Hull Tower Blue / Yellow / White

Buoy Markings _____

Surface Instrumentation

Item	ID #	Height*	Comments
Logger	04		Port side. (aft = buoy vane). Sys 1
HRH	211	234	SD card
BPR	501	243	SD
WND	222	267	CF card.
PRC	319	252	SD
LWR	265	281	CF
SWR	210	281	SD
SST	1306		SBE37.
Net Iridium	300234060341510		
Logger	14		Starboard side. Sys 2
HRH	221	234	SD card
BPR	506	243	SD
WND	344	267	CF
PRC	235	252	SD
LWR	261	281	CF
SWR	207	281	SD
SST	1839		SBE 37.
Net Iridium	300234060341 0510		
Standalones:			
WXT	201	267	SD
SWR	352	281	CF. Epiley
HRH	263	234	SD
ATMP	477	234	SBE39 AT
Rotronic	12718303	234	

*Height above buoy deck in centimeters

2

ARRAY NAME AND NO. Stratus 23 MOORED STATION NO. _____

Subsurface Instrumentation on Buoy and Bridle			
Item	ID #	Depth† below deck	Comments
SBE 56	6239		95 cm below deck. Port 90°
SBE 56	6410		65cm below deck. Bow 0°
SBE 56	6412		85cm below deck. Bow 0°
SBE 56	6983		95cm below deck. Bow 0°
SBE 56	7211		95 cm below deck. Starboard 270°
Xeos Kilo	3002 3406 2945 460		
Xeos Melo			3000 3401 3701 980
Xeos Rover	725		3004 3406 3443 730
Xeos Rover	726		3004 3406 3448 720
pCO_2:			PMEL system
antena	25		
SBE 16	6885		
ECO	2843		
SBE 63	3209		
SAMI	P0018		
SPAN gas	JB03188		
NAP CO_2	CGA-889		
Battery	101		

†Depth below buoy deck in centimeters

ARRAY NAME AND NO. Stratus 23 MOORED STATION NO. _____

Item No.	Length (m)	Item	Depth (m)	Inst No.	Time Over	Time Back	Notes
1		buoy			13:51		
2	0.22	chain 3/4"					
3		SBE37	2	1325	13:51		with load bar.
4	0.37	chain 3/4"					
5		SBE 37	3.7	1326	13:51		with load bar.
6		SBE39	4.9	5275	13.51		Down, short TB · (UP)
7	1.3	chain 3/4"					
8		Aanderaa RCM 11	7	78 ✓	13 16		Looking up
9	1.5	chain 3/4"					
10		SBE37	10	1328 ✓	13 06		with load bar.
11	1.73	chain 3/4"					
12		ADCP Nortek	13	17784 ✓	13:01		with long load bar. Looking up
13	1.35	chain 3/4"					
14		SBE37	16	1329 ✓	13:01		with load bar.
15	2.7	chain 3/4"					
16		Aa Seaguard	20	144 ✓	13.00		with Optode. with load barrage.
17	3.66	chain 3/4"					
18		SBE39	25	38 ✓	12:57		Up, short TB
19	3.90	chain 3/4"					
20		SBE37	30	1330 ✓	12:54		with load bar.
21	1.12	chain 3/4"					
22		Seaguard	32.5	182 ✓	12:52		with load cage
23	1.2	chain 3/4"					
24		SBE39	35	3439 ✓	12:50		Up, short TB
25	3.9	chain 3/4"					

ARRAY NAME AND NO. Strahw 23 MOORED STATION NO. _____

Item No.	Length (m)	Item	Depth	Inst No.	Time Over	Time Back	Notes
26		SBE37	40	8211	12:48		with lead bar.
27	3.66	chain 3/4"					
28		Seaguard	45	138	12:45		with Optode, with cage
29	16	wire 7/16"					
30		SBE39	50	48	12:45		clamped.
31		SBE39	55	49	12:50		clamped.
32		SBE37	62.5	8212	13:57		with lead bar.
33	16	wire 7/16"					
34		SBE39	70	102	14:00		clamped (WiN mark missing)
35		SBE39	77.5	103	14:04		clamped (send 203)
36		ADCP RDI	80	1218	14:08		looking up,
37	6	wire 7/16"					
38		SBE37	85	1909	14:08		with Pressure. clamped
39		Seaguard	87.3	140	14:10		with Optode. Caged
40	18.2	wire 7/16"					
41		SBE39	92.5	203	14:14		clamped. (Send 103)
42		SBE39	100	276	14:15		clamped
43		Wetlabs	100.5	2866	14:17		clamped. (14:14 TURN ON)
44		Seaguard	107	961	14:20		with Optode, GTP (LS).
45	21.5	wire 7/16"					
46		SBE39	115	284	14:22		clamped.
47		SBE37	130	8215	14:24		with lead bar.
48	14	wire 7/16"					
49		Seaguard	145	141	14:27		with Optode
50	13.5	wire 7/16"					

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ARRAY NAME AND NO. Stratus 23 MOORED STATION NO. _____

Item No.	Length (m)	Item	Depth	Inst No.	Time Over	Time Back	Notes
51		SBE37	160	8216	14:34		with load bar.
52	21.7	wire 7/16					
53		SBE39	175	719	14:38		Clamped.
54		Seaguard	183	964	14:40		with Optode, C,T,P(LS).
55	5.5	wire 7/16					
56		SBE37	190	12258	14:43		with load bar.
57	29	wire 7/16					~~with load~~
58		SBE37	220	12256	14:49		with load bar.
59	13.5	wire 7/16					
60		Seaguard	235	142	14:51		with Optode.
61	53.5	wire 7/16					
62		SBE39	280	720	~~14:55~~ ~~14:55~~		Clamped.
63		Seaguard	290	143	14:58		with Optode.
64	58.5	wire 3/8"					
65		SBE37	295	1906	15:00		Clamped
66		Seaguard	350	969	15:04		with Optode, C,T,P (LS).
67	47.5	wire 3/8					
68		VMCM	400	2019	15:09		Tped 69. 15:09:30 (SP186)
69	48.5	wire 3/8					
70		Seaguard	450	181	15:15		with Optode.
71	148.5	wire 3/8					
72		SBE37	550	10602	15:21		with Pressure. Clamped. Use second mark
73		~~Seaguard~~ SBE37	600	11392	15:28		with load bar.
74	100	wire 3/8					24130-15
75		SBE37	601	1908	15:28		Clamped

6

12-21-16

ARRAY NAME AND NO. ~~Stratus 23~~ MOORED STATION NO. _____

Item No.	Length (m)	Item	Depth	Inst No.	Time Over	Time Back	Notes
76		SBE37	698	8218	15:37		clamped. Taped due to loose clamp
77		SBE37	700	16393 ~~[illegible]~~	15:37		with load bar
78	100	wire 3/8					24130 - 18
79		VMCM	802	2062	15:42		Tpod 17. 15:42:00
80	48.5	wire 3/8					24130 - 20
81		VMCM	853	2065	15:46		Tpod 09. 15:46:03
82	1151	wire 3/8					22105 - 15
83		SBE37	857	8219	15:49		clamped.
84		SBE37	1354	2012	16:04		clamped.
85		SBE37	1557	8222	17:18		clamped
86		SBE37	2000	7218	17:40		clamped
87	100	wire 3/8					) potted termination 19172 - 24
88	200	Nylon 7/8					
89	1700	Nylon 7/8			18:03		) spliced at sea
90	1200	Colmega 1 inch					
91		glassballs (92)					~~HHH HH HH~~ HHIII = 96
92		SBE37	4187	11379	20:47		) dualed on Ti Loadbar
93		SBE37	4187	11394	20:47		)
94	5	chain 1/2					
95		Releases	4193	33036	20:50		) dualed
96		Release	4193	54688	20:50		)
97	1	chain					
98	5	chain 1/2					
99	20	Samson 1"					
100	5	chain 1/2					
101		Anchor			21:08		

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6.

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16. Abstract (Limit: 200 words)

The Ocean Reference Station at 22 °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 from March 10 to 23 on the Chilean research vessel Cabo de Hornos.

During the 2025 cruise on the Cabo de Hornos to the ORS Stratus site, the primary activities were the recovery of the previous (Stratus 22) WHOI surface mooring, deployment of the new Stratus 23 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 were also launched along the track.

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17. Document Analysis

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