WHOI-2016-04

Woods Hole Oceanographic Institution

The Northwest Tropical Atlantic Station (NTAS):

NTAS-15 Mooring Turnaround Cruise Report
Cruise On Board RV Endeavor
January 25 - February 13, 2016
Narragansett RI, USA - San Juan, Puerto Rico

by

Sebastien Bigorre,[1] Jim Ryder,[1] Jason Smith,[1] Matthias Lankhorst,[2]

Woods Hole Oceanographic Institution
Woods Hole, MA 02543

November 2016

Technical Report

Funding was provided by the National Oceanic and Atmospheric Administration
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Upper Ocean Processes Group
Woods Hole Oceanographic Institution
Woods Hole, MA 02543
UOP Technical Report 2016-02

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Approved for Distribution:

Albert J. Plueddemann, Chair

Department of Physical Oceanography

Abstract

The Northwest Tropical Atlantic Station (NTAS) was established to address the need for accurate air-sea flux estimates and upper ocean measurements in a region with strong sea surface temperature anomalies and the likelihood of significant local air–sea interaction on interannual to decadal timescales. The approach is to maintain a surface mooring outfitted for meteorological and oceanographic measurements at a site near 15°N, 51°W by successive mooring turnarounds. These observations are used to investigate air–sea interaction processes related to climate variability. The NTAS Ocean Reference Station (ORS NTAS) is supported by the National Oceanic and Atmospheric Administration's (NOAA) Climate Observation Program.

This report documents recovery of the NTAS-14 mooring and deployment of the NTAS-15 mooring at the same site. Both moorings used Surlyn foam buoys as the surface element. These buoys were outfitted with two Air–Sea Interaction Meteorology (ASIMET) systems. Each system measures, records, and transmits via Argos satellite the surface meteorological variables necessary to compute air–sea fluxes of heat, moisture and momentum. The upper 160 m of the mooring line were outfitted with oceanographic sensors for the measurement of temperature, salinity and velocity.

The mooring turnaround was done by the Upper Ocean Processes Group of the Woods Hole Oceanographic Institution (WHOI), onboard R/V *Endeavor*, Cruise EN573. The cruise took place between January 25 and February 13 2016. The NTAS-15 mooring was deployed on February 2, and the NTAS-14 mooring was recovered on February 4. A 24-hour inter-comparison period was conducted on February 5, during which data from the buoy, telemetered through Argos satellite system, and the ship's meteorological and oceanographic data were monitored while the ship was stationed 0.2 nm downwind of NTAS-15 buoy. A similar procedure was done at NTAS-14 but for only about 10 hours on the morning of February 4. This report describes these operations, as well as other work done on the cruise and some of the pre-cruise buoy preparations.

Other operations during EN573 consisted in the recovery and deployment of the Meridional Overturning Variability Experiment (MOVE) subsurface moorings array (MOVE 1 in the east, and MOVE 3 and 4 in the west near Guadeloupe). Acoustic download of data from Pressure Inverted Echo Sounders (PIES) was also conducted. MOVE is designed to monitor the integrated deep meridional flow in the tropical North Atlantic.

TABLE OF CONTENTS

List of Figures

List of Tables

I. INTRODUCTION

A. Timeline

The NTAS-15 cruise originated in Narragansett, Rhode Island on Monday January 25, 2016 and ended in San Juan, Puerto Rico on February 13, 2016. The track (Figure 1-1) was set to first deploy the NTAS-15 mooring, recover and deploy MOVE 1, then recover the NTAS-14 mooring. After transiting to the west towards Guadeloupe, we recovered and re-deployed the MOVE 3 and 4 array, as well as downloaded data from nearby Pressure Inverted Echo Sounders (PIES) that are also part of the MOVE array. WHOI Upper Ocean Processes Group staff left Cape Cod and arrived in Narragansett on January 15, in preparation of the cruise. An overview of the chronology of the cruise is provided below. Local time on the ship during EN573 cruise started as UTC-5 and was changed to UTC-4 on January 28 for the remainder of the cruise.

January 15-16, Friday-Saturday: WHOI personnel arrive in Narragansett, RI and start unloading equipment from truck and staging warehouse for buoy assembly.

January 18, Monday: Ship at the dock. Labs are made ready: lot of work still needed after long winter maintenance period.

January 19, Tuesday: Scripps team stage warehouse with MOVE equipment. Relief captain arrives, warns about bad weather forecast for planned departure (Friday January 22); Tom Glennon enquires with PIs for next two cruises about possibility of delayed departure.

January 20, Wednesday: Decision to postpone departure to Monday, January 25. Ship loading continues. ASIMET standalones installed on ship. Argos telemetry running. Buoy turned on and on dock next to ship.

January 21, Thursday: Buoy heights taken, then buoy tipped on its side on dock. Labs lashing. Ship preps continue (ADCP transducer installed). WHOI folks return home and Scripps team move in their quarters on the ship.

January 22, Friday: Final preps on ship (ADCP transducer tightened), equipment on fantail secured for incoming storm. SIO folks set up salinometer.

January 25, Monday: Orientation meeting before departure. 14:20 UTC, R/V *Endeavor* leaves dock. 15:15 UTC, orientation and safety meetings. Underway COG 145°T. Slowing down <10 kn in whale protection area.

January 26, Tuesday: Enter Gulf Stream at breakfast time and exit around lunch. SOG 11 kn, winds 20-25 kn SW. CTD#1 with 4 acoustic releases (2 WHOI, 2 SIO) at 20:30 UTC, location (37° 00.2’ N, 67° 45.7’W); 500m stop and won to 1,500m for acoustic release comm. CTD back on deck at 22:20 UTC. SSTs in bucket, EM chain connected to buoy. Sailing at 11 kn.

January 27, Wednesday: Transit continues, wind SW 25 kn. SOG ~10 kn. Crossed eddy during the night. Green water damages wood box on starboard side that contains mooring rope; ship

changes course momentarily for crewmembers to fix box. Still too much weather to open buoy hatch and turn on Iridium transmission.

January 28, Thursday: Advanced clocks onboard 1 hour to UTC-4. Passed Bermuda during the night. Meeting with captain: will increase rpm for better speed and plan arrival next Monday at MOVE 1 for update on mooring status. Splices at sea. Ground loop on EM chain connected and Iridium turned on ~ 20:00 UTC: data shows up on UOP webpage one hour later.

January 29, Friday: Fire drill 14:15 UTC. IM instruments connected to inductive line in staggered manner on deck to checks serial numbers using webpage data listing. Winds 20kn, SOG ~ 10.5 kn.

January 30, Saturday: IM check completed. Ship's marine tech change O2 sensor on CTD with new instrument. Meeting science, bridge and bosun: talk about MOVE 1 recon and NTAS-15 deployment.

January 31, Sunday: Rpm increased to 180, SOG > 12kn. Instrumentation spikes. Hazy sky with Sahara dust. Recovered life ring. MOB drill.

February 1, Monday: SOG > 12 kn, winds 15 kn E. Buoy hatch sealed, waterline marks on hull. 15:00 UTC short science talks in galley. 17:00 UTC: CTD#2 3,500m with bottles for MOVE 1 cal (27 SBE37s attached to Rosette). 20:27 UTC CTD back on deck, resume transit towards MOVE 1. 24:00 UTC first station point for MOVE 1 anchor survey.

February 2, Tuesday: During the night, anchor survey for MOVE 1 followed by acoustic comms to evaluate status of remaining mooring. 05:30 UTC depart MOVE 1 and transit towards NTAS-15 deployment site. 09:34 UTC arrive at NTAS-15 target (14° 49.50'N, 51° 01.00'W). ADCP shows no current, winds are 15 kn. Set and drift 0.8 kn to WNW so we will deploy along 113° COG, 6 nm from target. Final preps (Desitin, instruments clamped to mooring wire on deck down to 55 m mark). Ship sails down deployment line past target and then back up to verify we are in flat area using 12 kHz echo-sounder. After breakfast, walk-through by mooring ops leader. 13:09 UTC buoy set afloat. Speed 0.9 kn along 113° T. 14:20 UTC termination wire/nylon over. 15:25 UTC increase speed to 1.25 kn. 17:10 UTC glassballs over, still 2.3 n from target so increase speed to 1.5 kn. 19:09 UTC anchor NTAS-15 over at 14° 49.429'N, 51° 00.819'W. Secure deck, transit to MOVE 14 for drive-by at 19:50 UTC. 21:05 UTC first station for NTAS-15 anchor survey. 22:00 UTC anchor survey completed. 23:00 UTC CTD#3, 1 nm from NTAS-14. CTD back on deck at 01:00 UTC next morning.

February 3, Wednesday: transit towards MOVE 1. Acoustic comms from previous day show all of the mooring is still there except short top section that washed onshore in Dominican Republic prior to cruise; no drag operation needed. Data download from PIES 299 and 237. 10:50 UTC at MOVE 1 mooring, anchor released at 11:00 UTC. Recovery starts after breakfast and ends at 17:30 UTC. Deck cleanup. Instruments data download starts. Weather forecast for end of week on the edge of limits for crane operation at sea, so postpone MOVE 1-12 deployment and advance NTAS-14 recovery. Transit to NTAS-14.

February 4, Thursday: Arrive at 03:15 UTC at NTAS-14, hold station 0.2 nm downwind of buoy. 10:11-10:46 UTC, CTD#4 to 500m, 0.25nm downwind of NTAS-14 buoy. Deck re-arranged, attempt to repair UOP capstan. 14:08 UTC anchor released. 15:25 UTC glass balls onboard. 23:30 UTC recovery completed. 23:40-01:26 UTC CTD#5 to 1,000m and on the spot for comparison with recovered mooring; includes SBE37s and acoustic release for SIO folks.

February 5, Friday: After CTD, transit towards NTAS-15 mooring. 02:55 UTC arrive at NTAS-15, hold station 0.2 nm downwind of buoy. 04:08-04:40 UTC, CTD#6 to 500m, no bottles. 10:00-10:30 UTC, CTD#7 to 500m, no bottles. 14:30 UTC drive by to NTAS-15 buoy for pictures. 16:28-17:07 UTC, CTD#8 to 500m, no bottles. 22:05-22:34 UTC, CTD#9 to 500m, no bottles. Subsurface instruments from NTAS-14 spiked. Deck preparation for mooring ops.

February 6, Saturday: 03:40 UTC inter-comparison ends depart NTAS-15 towards MOVE 1 site. 07:40 UTC arrive MOVE 1. 07:52-10:52 UTC, CTD#10 to 3,500m at MOVE 1 target site. 11:22 UTC underway to start of MOVE 1 deployment track. 13:37 UTC start MOVE 1-12 deployment, course 067° T, 1.0-1.5 kn STW, 13 nm from target. 23:15 UTC anchor drop. 00:35-02:25 UTC anchor survey followed by acoustic comms to check status of MOVE1-12.

February 7, Sunday: 02:25 UTC, depart for MOVE 3 and 4. Transit SOG ~ 12 kn. Clean instruments and data download continue.

February 8, Monday: Transit to MOVE 3 and 4. 08:20 UTC, enter Guadeloupe EEZ. 11:40-15:24 UTC cross Dominica's EEZ: ship ADCP data acquisition system turned off. 23:15 UTC arrive at MOVE 4: anchor survey and acoustic comms.

February 9, Tuesday: 04:24 UTC, at PIES 300 for acoustic comms. 09:46 UTC anchor released from MOVE 3. 19:10 MOVE 3 recovered, transit to MOVE 4. 20:05 UTC at MOVE 4, recovery from 20:20 to 22:55 UTC. At PIES 300 for acoustic comms.

February 10, Wednesday: drift test at MOVE 4 target, transit to start MOVE 4 deployment track, inspect fishing gear on. 14:43-19:20 UTC deployment MOVE 4. Transit to MOVE 3. 23:00-02:20 UTC, CTD#11 to 3,500m with bottles for post-cal of MOVE 1 instruments, 1.4 nm from MOVE 3. HRH standalone removed from bow mast.

February 11, Thursday: 03:21-04:55 UTC, CTD#12 to 1,000m with one SBE37. Acoustic comms with PIES 238. 07:48-09:50 UTC, anchor survey MOVE 4. 13:08-21:48 UTC, deployment MOVE 3-12. 22:45-22:54 UTC, CTD#13 for test for new O2 sensor on ship's CTD. Anchor survey for MOVE 3-12.

February 12, Friday: 00:38 UTC, scientific operations complete, underway towards San Juan, Puerto Rico.

February 13, Saturday: arrive San Juan. 10:17 UTC pilot onboard. 11:10 UTC last line secured to dock.

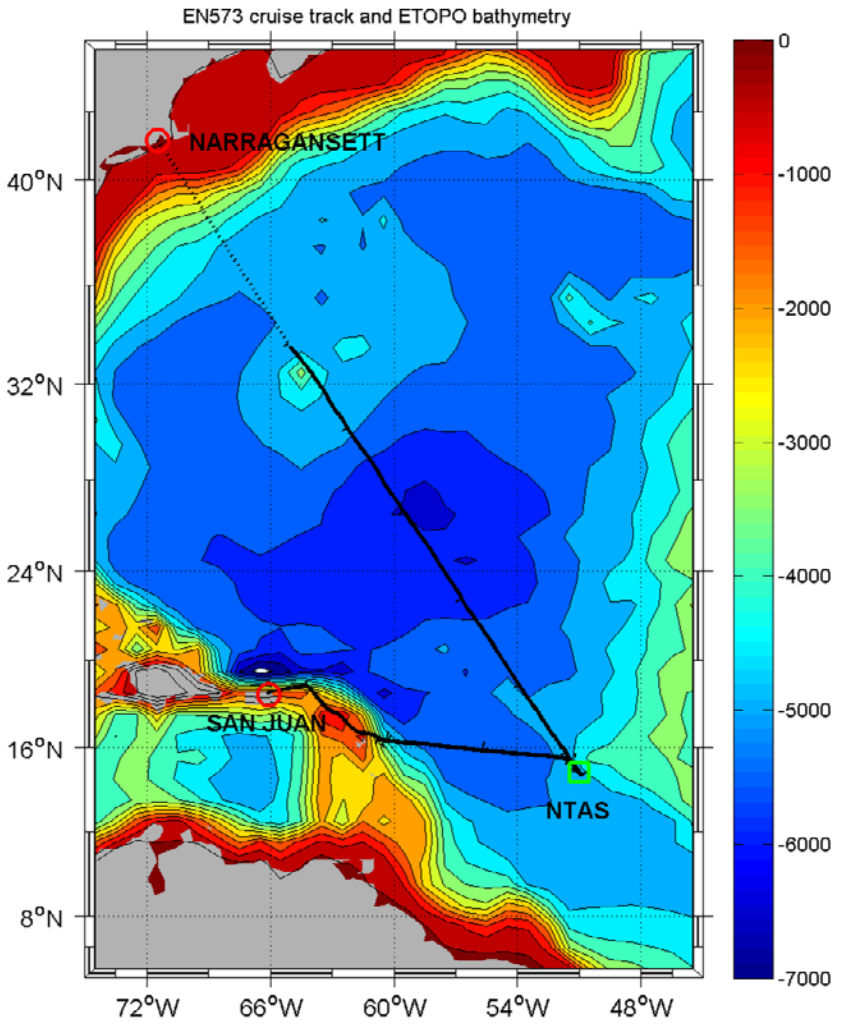


Figure I-1. NTAS-15 cruise track onboard R/V Endeavor (cruise EN573). Dotted line represents missing data and is approximate track.

B. Background and Purpose

The Northwest Tropical Atlantic Station (NTAS) project for air–sea flux measurement was conceived in order to investigate surface forcing and oceanographic response in a region of the tropical Atlantic with strong sea surface temperature (SST) anomalies and the likelihood of significant local air–sea interaction on inter-annual to decadal timescales. Two intrinsic modes of variability have been identified in the ocean–atmosphere system of the tropical Atlantic, a dynamic mode similar to the Pacific El Niño–Southern Oscillation (ENSO) and a thermodynamic mode characterized by changes in the cross-equatorial SST gradient. Forcing is presumed to be due to at least three factors: synoptic atmospheric variability, remote forcing from Pacific ENSO, and extra-tropical forcing from the North Atlantic Oscillation (NAO). Links among tropical SST variability, the NAO, and the meridional overturning circulation, as

well as links between the two tropical modes, have been proposed. At present neither the forcing mechanisms nor links between modes of variability are well understood.

The primary scientific objectives of the NTAS project are to determine the in-situ fluxes of heat, moisture and momentum, to use these fluxes to make a regional assessment of flux components from numerical weather prediction models and satellites, and to determine the degree to which the oceanic budgets of heat and momentum are locally balanced. To accomplish these objectives, a surface mooring with sensors suitable for the determination of air–sea fluxes and upper ocean properties is being maintained at a site near 15° N, 51° W by means of annual "turnarounds" (recovery of one mooring and deployment of a new mooring near the same site).

The surface elements of the moorings are Surlyn foam discus buoys outfitted with two complete Air–Sea Interaction Meteorology (ASIMET) systems. Each system measures, records, and transmits via Argos satellite the surface meteorological variables necessary to compute air–sea fluxes of heat, moisture and momentum. The upper 160 m of the mooring line is outfitted with oceanographic sensors for the measurement of temperature, salinity and velocity. The upper 80 m also contain inductive instruments that transmit their data to a logger inside the surface buoy; this data is then telemetered to a satellite.

The NTAS-15 mooring turnaround was achieved on the research vessel R/V *Endeavor*, Cruise EN549, by the Upper Ocean Processes Group (UOP) of the Woods Hole Oceanographic Institution (WHOI). Five personnel from Scripps Institution of Oceanography (SIO) were also aboard to service the MOVE array, recover and deploy three subsurface moorings and download data from Pressure and Inverted Echo Sounder (PIES) devices through acoustic telemetry.

The cruise was completed in 20 days, between January 25 and February 13 2016. It originated from Naragansett, Rhode Island and terminated in San Juan, Puerto Rico. The planned cruise track and waypoints are shown in Figure I-2 and Figure I-3. The primary objectives were:

- To deploy the NTAS-15 mooring.
- To log data from the NTAS-15 buoy and Endeavor shipboard meteorological sensors during an intercomparison period during which a sequence of CTD casts would also be made.
- To recover the NTAS-14 mooring.
- To do an inter-comparison between the NTAS-14 buoy and Endeavor shipboard data (meteorological sensors and CTD cast).
- To recover MOVE 1-11 and deploy MOVE 1-12 at the same site and with calibrated instruments.
- To retrieve data via acoustic link from PIES near the MOVE-1 site.
- To recover MOVE 3-11 and deploy MOVE 3-12 at the same site and with calibrated instruments.
- To retrieve data via acoustic link from PIES near the MOVE-3 site.
- To recover MOVE 4-11 and deploy MOVE 4-12 at the same site and with calibrated instruments.
- To retrieve data via acoustic link from PIES near the MOVE-4 site.

#	Name	Comment	Latitude	Longitude	Altitude ft	Icon	Distance n. miles
1	WP0001	Narragansett pier	41°27.000'	-71°27.000'		Waypoint	0.0000
2	WP0002	NTAS 15 target	14°49.500'	-51°01.000'		Waypoint	1915.9906
3	WP0003	MOVE 1	15°27.000'	-51°30.500'		Waypoint	1962.9859
4	WP0004	NTAS 14	14°44.640'	-50°57.710'		Waypoint	2015.7637
5	WP0005	jog Dom Rep EEZ	16°30.000'	-58°00.000'		Waypoint	2436.5355
6	WP0006	MOVE 3	16°20.300'	-60°30.300'		Waypoint	2581.3253
7	WP0007	MOVE 4	16°20.000'	-60°36.450'		Waypoint	2587.2467
8	WP0008	San Juan	18°24.383'	-66°03.833'		Waypoint	2923.9416

Figure I-2. List of waypoints used for planning of NTAS-15 cruise.

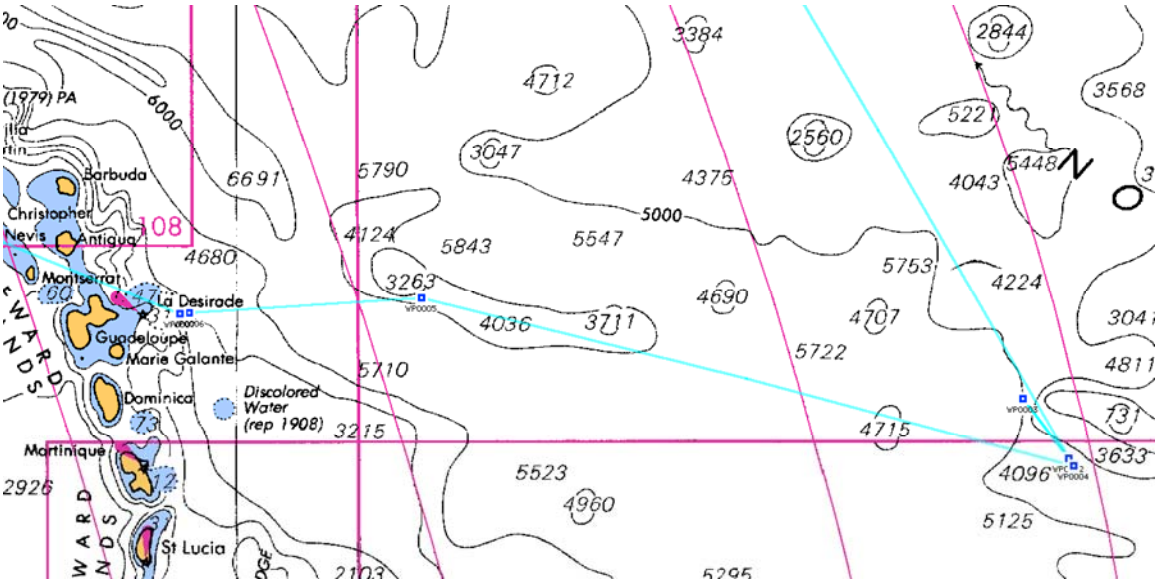


Figure I-3. Planned track for NTAS-15 (EN573) cruise according to waypoints in Figure I-2.

II. Cruise Preparations

A. Staging and Loading

Pre-cruise operations were conducted at WHOI and at the pier in Narragansett, RI. Instrumentation (sensor, telemetry) were tested at WHOI during burn-in then shipped to Rhode Island. On January 15, the WHOI equipment, including NTAS-15 buoy were delivered by truck at a warehouse near the pier in Narragansett. Three WHOI personnel unloaded and staged the equipment in the warehouse to begin assembly of the buoy (hardware, electronics) with some

protection from wind and low temperatures. Buoy was turned on the next day. R/V Endeavor moored at the pier on January 18th. A lot of work was still needed on the ship after spending months at the dock for maintenance and engine overhaul. Scripps folks took reception of their own equipment and staged in a warehouse adjacent to the one used by WHOI. On the ship work was underway to prepare deck, laboratories and install sensors and setup communications systems. On January 19th, WHOI folks installed Argplot system on the ship and started communications with NTAS-15 buoy while ship's loading continued. Captain Steve Beuth arrived in the afternoon and warned about weather system forecast that could delay departure, initially planned for Friday January 22nd. Tom Glennon started enquiries with NOAA and principal investigators for next two cruises about possibility of delayed departure. On January 20th, forecast confirmed incoming storm for end of week and decision was made to delay departure to Monday January 25th. WHOI standalone instruments (HRH on bow mast, SWR and LWR on rail of 01 deck crane) were mounted on ship and buoy was brought on the pier next to the ship. On January 21st, heights of ASIMET instruments were taken on the buoy, after which the buoy loaded on the ship, tipped and secured to the deck on the starboard aft quarter. Equipment in the science laboratories were lashed and WHOI folks returned home while the five Scripps personnel moved into their staterooms on the ship. On January 22nd, ship ADCP, which had been re-installed, was retightened to stop small leaks, salinometer was setup and mooring lines were added to secure ship in prevision of the storm during the weekend. Ship departed for cruise EN573 on January 25th at 09:20 EST.

B. Buoy Spin

Buoy spin was conducted in Woods Hole on November 18 2015. The buoy spin is a procedure to check the compasses in the wind sensors mounted on the buoy. A visual reference direction is first set using an external compass. The buoy is then oriented successively at 8 different angles with respect to the reference and the vanes of the anemometers are visually oriented towards the reference direction, and blocked. Wind is recorded for 15 minutes at the end of which the average compass and wind direction is read. Their sum should correspond to the reference heading, within errors due to approximations in orientation, compass precision, and any deformation of the magnetic field due to the buoy metallic structure that may affect the compass reading. Buoy spin results are shown in Figure II-1, where compass error is plotted as a function of buoy orientation. The WXT does not have a vane so the difference between its compass and the direction of the reference direction is plotted instead. Compasses on ASIMET wind sensors meet expectations (compass accuracy within ~ 5°) but Vaisala WXT unit has larger errors. For this buoy spin, the reference direction was oriented towards 0°. See Appendix 1: NTAS-15 Buoy Spin for details of the buoy spin. Note that an initial buoy spin was conducted on November 9 2015, which showed faulty wind sensors that were replaced with new ones and lead to a second and final buoy spin on November 18 (Figure II-1, Figure II-2).

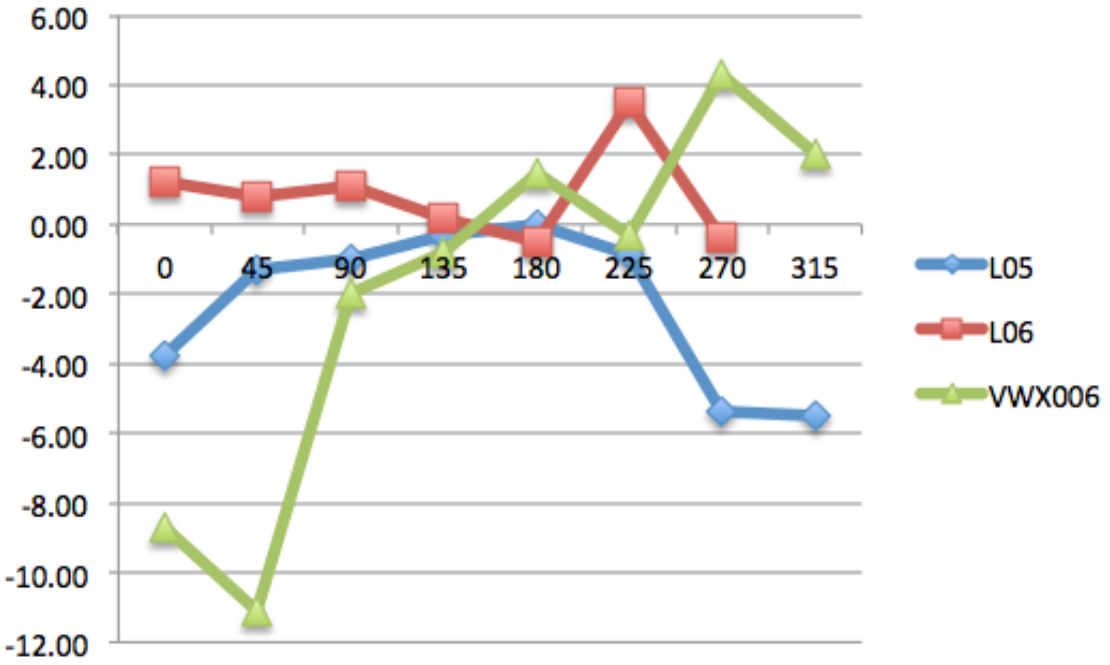


Figure II-1. NTAS-15 buoy spin on November 18 2015 in Woods Hole. Y-axis: difference between wind direction (L05 and L06), or compass (WXT006), and line-of-sight reference (in degrees). X-axis: angle between buoy and line-of-sight reference (in degrees).

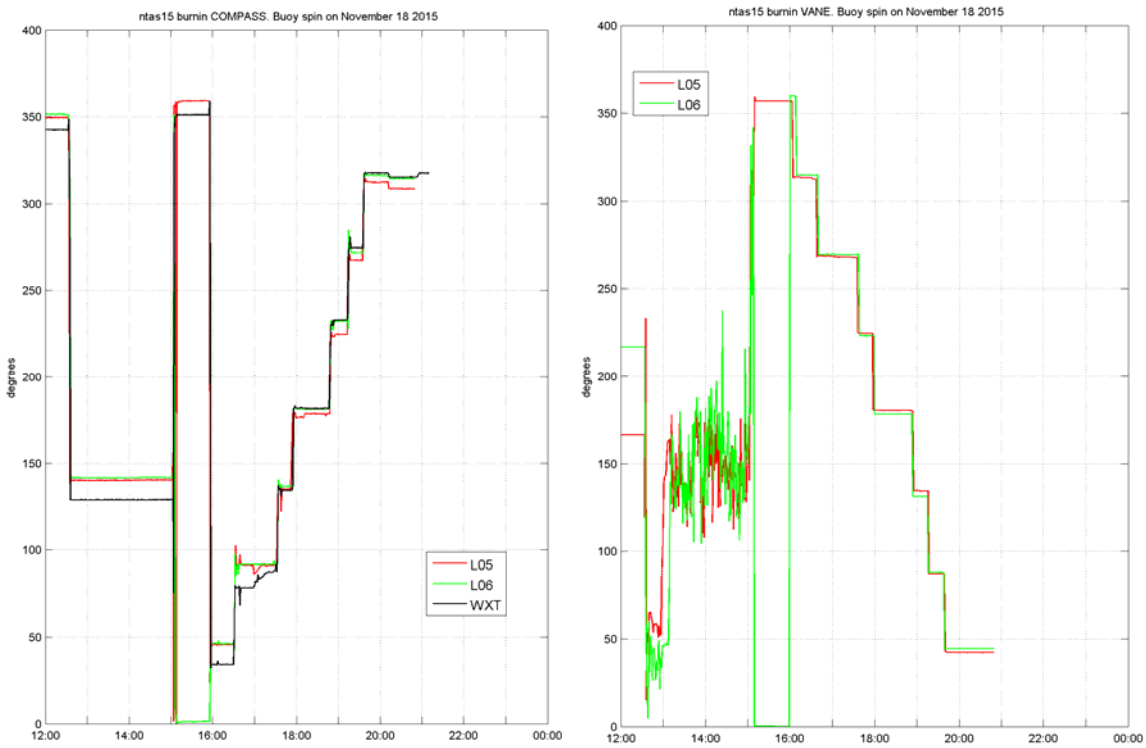


Figure II-2. 1-minute data from NTAS-15 buoy spin on November 18 2015: compass (left) and wind sensor vane (right).

C. Sensor Evaluation and Burn-in

For burn-in, the buoy was placed outdoors, mounted with instruments and the data collection system, including telemetry, turned on. Data was downloaded (data dumps) on several occasions to evaluate the 1-minute data record, in addition to the continuous monitoring of the hourly telemetry data. Several sensors had to be replaced with new ones during the burn-in. The buoy itself was brought back indoor several times for maintenance or to avoid damage from frost. Burn-in ran for about one month, starting in mid-October.

We present here the data collected during the last data dump, on November 18 2015 and that followed the last buoy spin. The buoy had been outside since November 10 (20:00 UTC), received a new wind (WND) sensor on logger L05 on November 12 (16:40 UTC), a new barometric pressure (BPR) on L06 on November 13 (21:00 UTC), a new air temperature/humidity (ATMP/HRH) on L06 on November 17 (15:45 UTC). Buoy was moved indoor late on November 17 until the next day 12:00 UTC. Buoy spin occurred on November 18 from 14:30 to 19:40 UTC and a fill and drain (150 ml added) to PRCs was done at 20:00 UTC. Data dump occurred at 21:00 UTC.

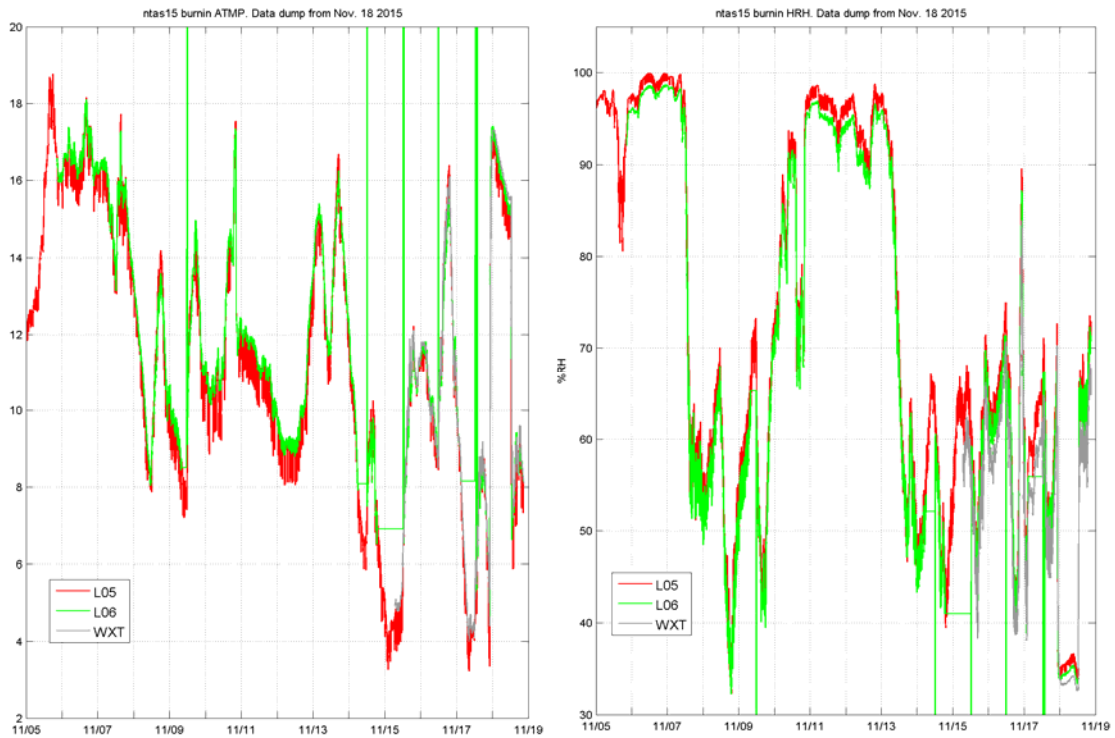


Figure II-3. NTAS-15 burn-in: air temperature ATMP, in °C (left) and relative humidity HRH (right).

Figure II-4. NTAS-15 burn-in: air barometric pressure BPR (left) and precipitation (right).

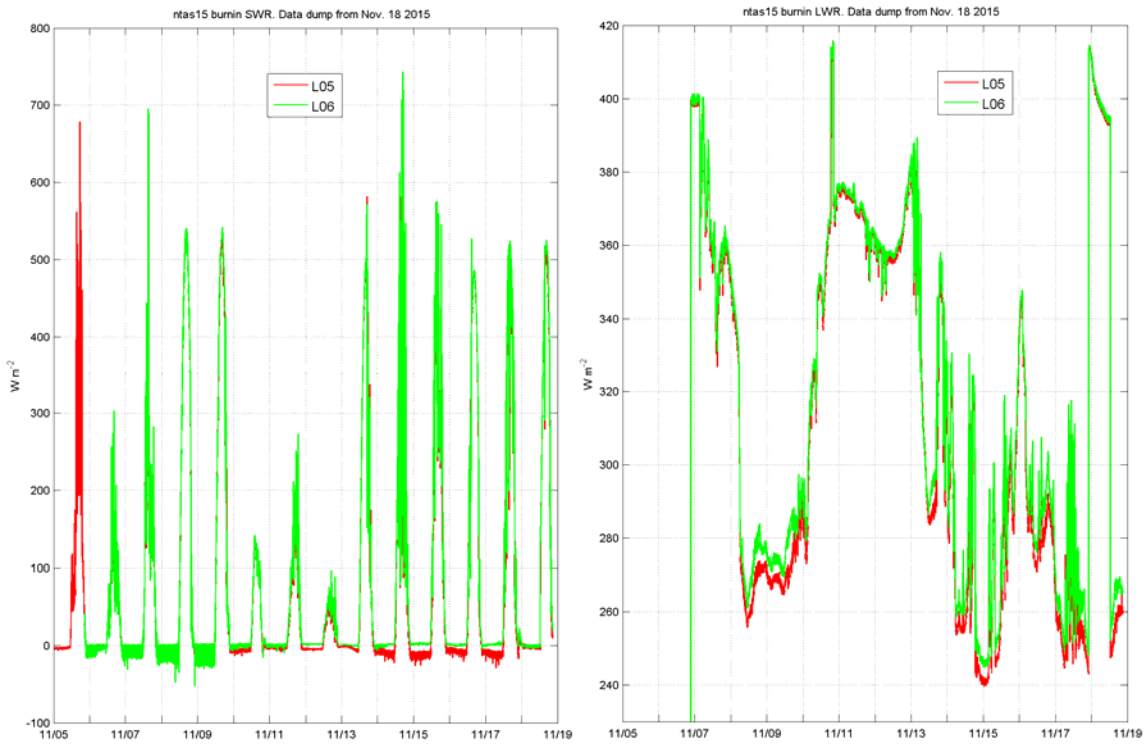


Figure II-5. NTAS-15 burn-in: downwelling radiation, shortwave SWR (left) and longwave LWR (right).

Figure II-6. NTAS-15 burn-in: sea surface temperature SST (left) and conductivity COND (right).

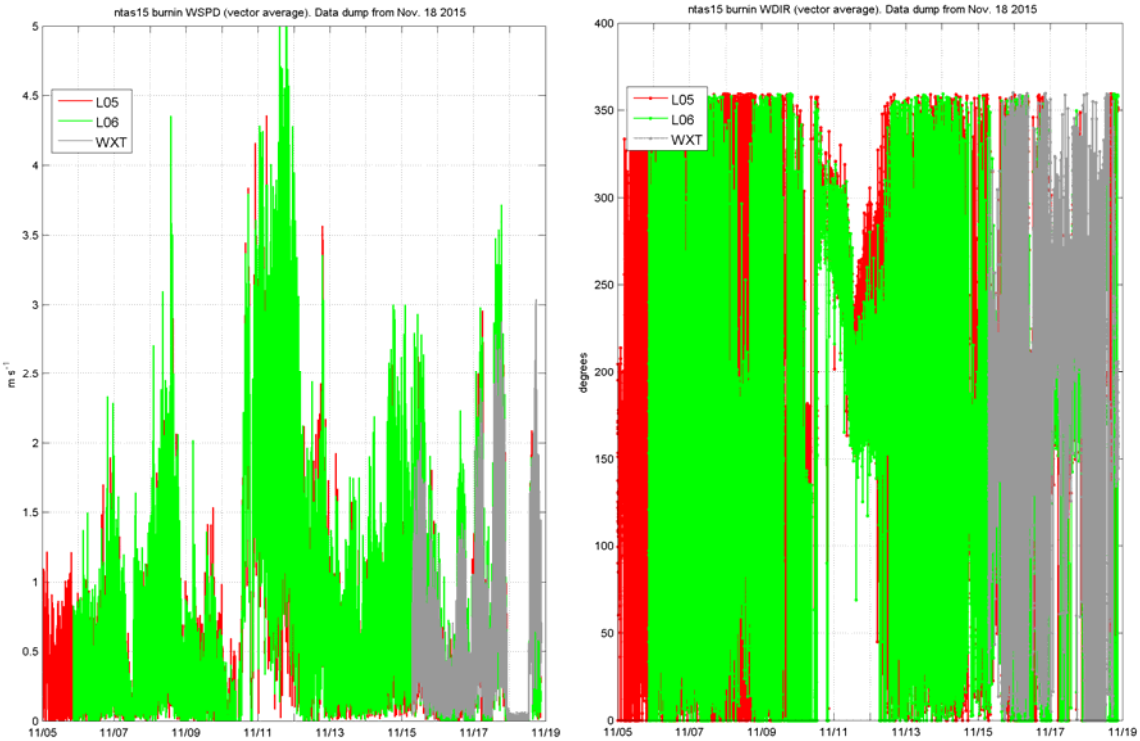


Figure II-7. NTAS-15 burn-in: wind speed WSPD (left) and direction WDIR (right); using vector averages of east and north wind components inside ASIMET sensor.

Using telemetered data, we are able to evaluate the hourly averaged data collected on the NTAS-15 buoy since its deployment on February 2 2016. Figures below show that the two ASIMET on the buoy agree remarkably well since deployment. Precipitation from logger 5 does not show any rain before April but seems to be in line with logger 6 after that.

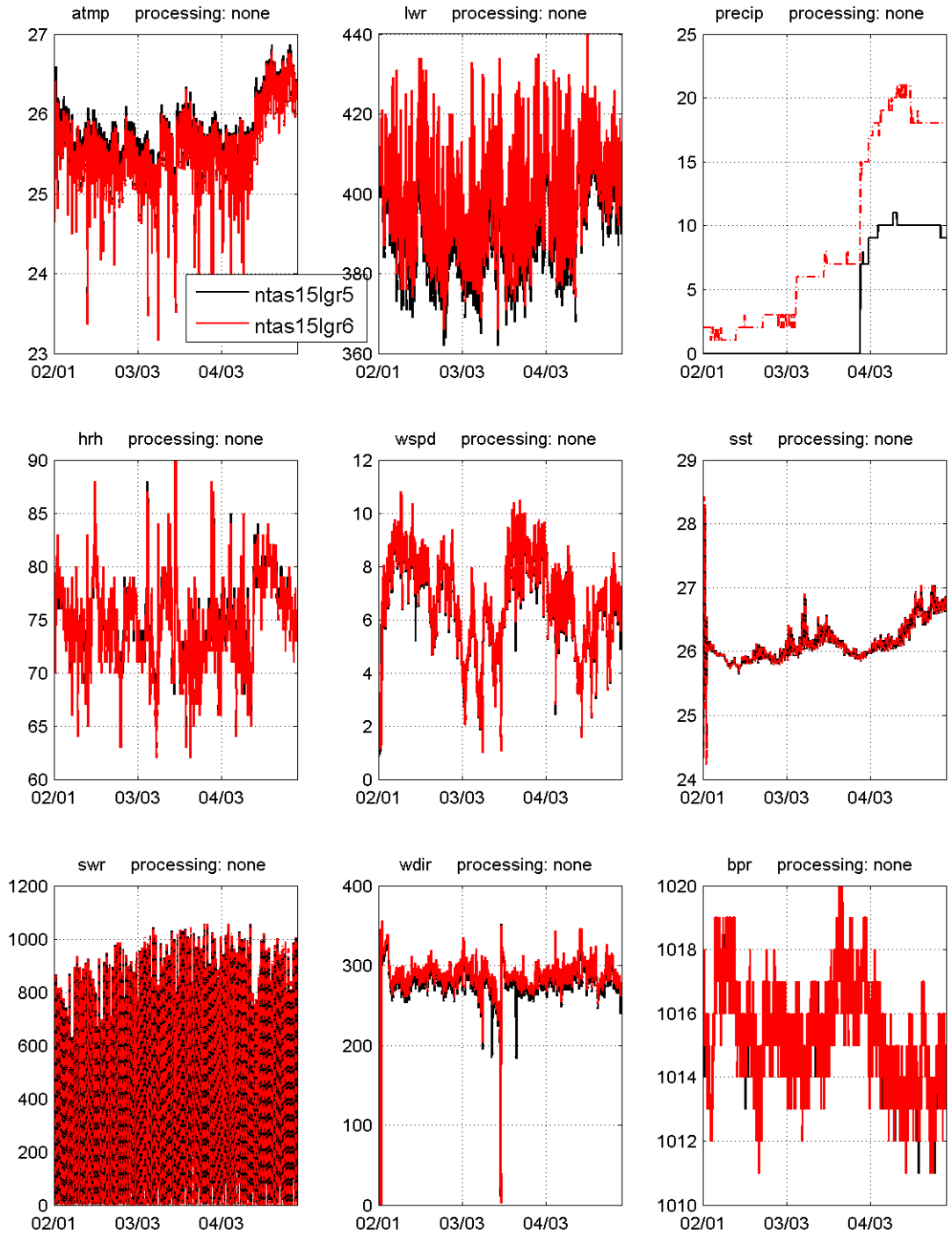


Figure II-8. Hourly averaged telemetered data from NTAS-15, from deployment until May 2016.

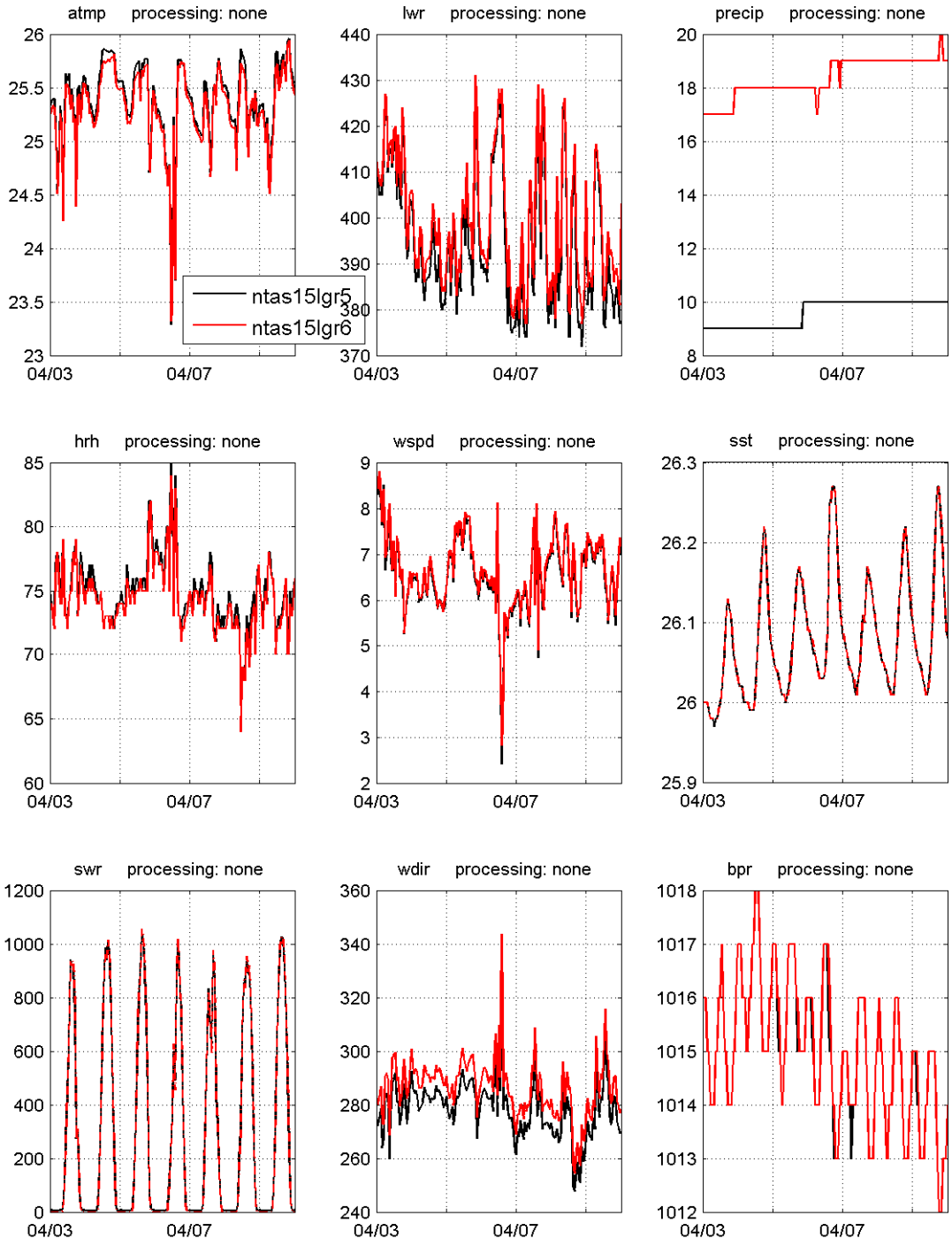


Figure II-9. Same as Figure II-8, but for one week in early April 2016.

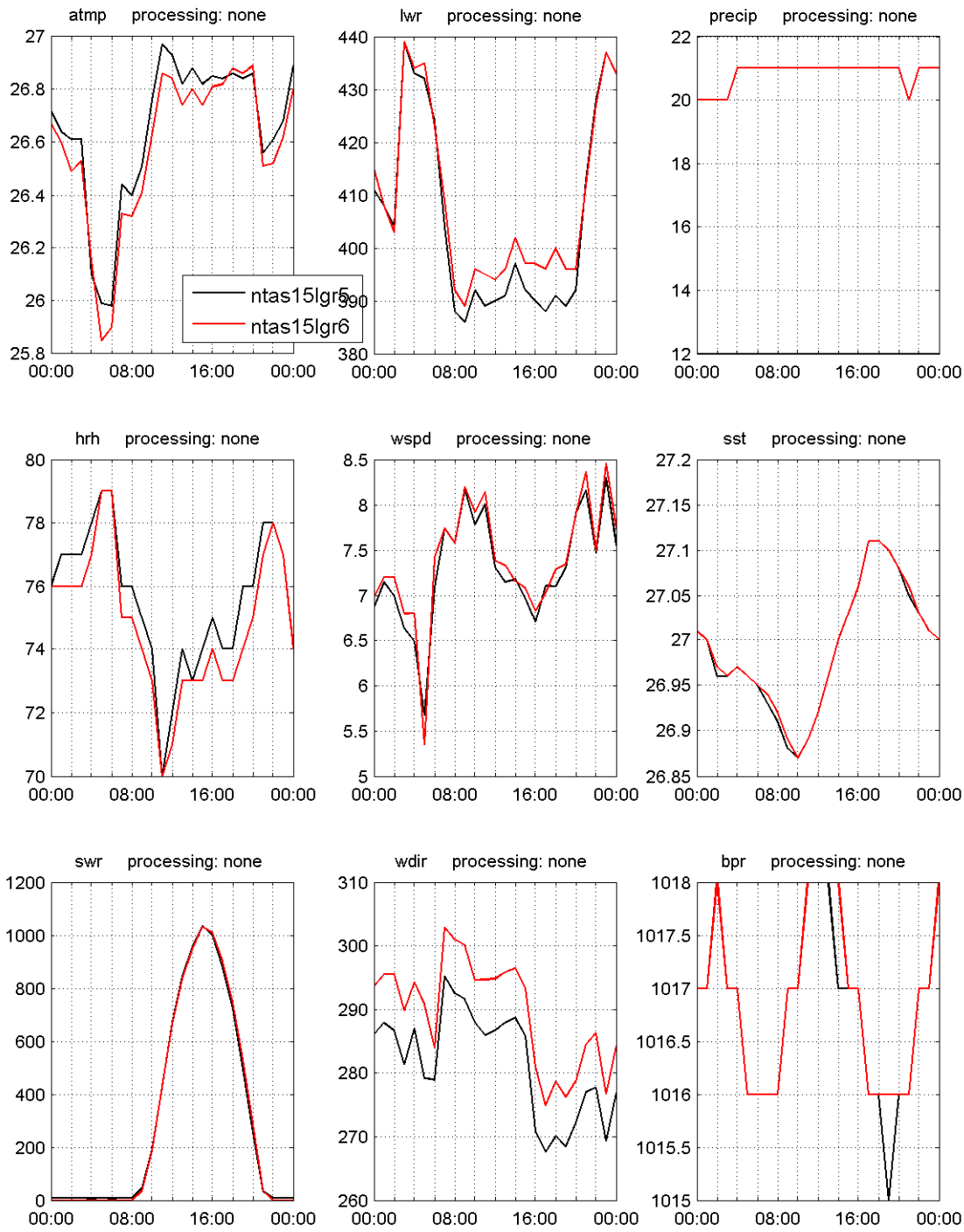


Figure II-10. Same as Figure II-8, but for May 15 2016 only.

Conductivity is shown separately in Figure II-11 and both loggers are reporting similar values at the time of this writing.

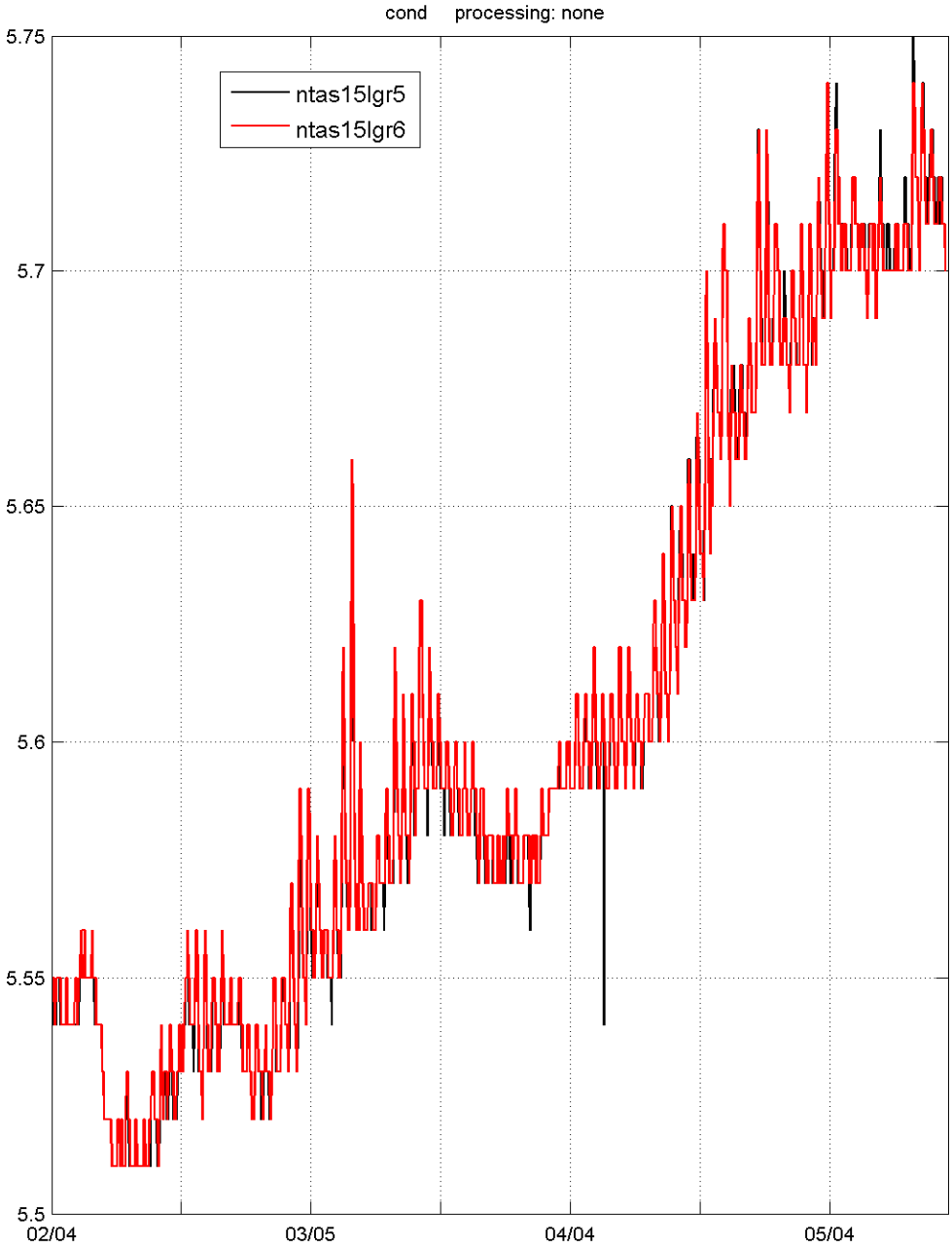


Figure II-11. Hourly averaged telemetered conductivity (in S m^{-1}) from NTAS-15, from deployment until May 2016.

D. Antifouling

E-Paint's products have been refined to best suit WHOI's wishes for effective products that remain relatively safe to apply. Treatment of the NTAS-15 mooring was as follows:
One gallon of grey E-Primer 1000 provided two coats on the Surlyn foam buoy hull, and aluminum bottom plate. One gallon of blue E-Paint Ecominder was applied in the same areas. Pasco PVC tape was wrapped around the housing of the SSTs mounted to the bottom base plate of the buoy. Copper guards were used to protect the cells on the SST's, but not on other SBE37 sensors. Desitin was also used on the cells. Sea surface temperature probes were inserted into the hull and Green Aqua Lube was applied to the heads of the probes. Pasco PVC tape is usually wrapped around instruments down to 40m to protect them from barnacle growth. Without any tape at our disposal, we instead coated these instruments with Desitin. Both Norteks and the Workhorse ADCP had Desitin applied to the transducers heads.

III. NTAS-15 Deployment

A. Mooring Design

The buoys used in the NTAS project are equipped with surface meteorological instrumentation, including two Improved Meteorological (IMET) systems (see Figure III-1). The NTAS-15 surface buoy has a 2.7-meter diameter foam buoy with an aluminum tower and rigid bridle. Starting with NTAS-14, buoys on NTAS include a new wind vane that is larger than previous deployments (Note that NTAS-13 had a wind vane extension, which seemed to improve the alignment of the buoy into the wind).

The WHOI mooring is an inverse catenary design utilizing wire rope, chain, nylon and Colmega line (Figure III-2). The mooring line also carries subsurface instrumentation that measures conductivity and temperature, three acoustic current meters and one profiler. The upper 5 m of the mooring includes a compliance section through which inductive sensors transmit their data to an Iridium logger in the buoy well.

Prior to deployment, instruments were initialized with memory cards erased, clocks reset and time marks set in the data records by plunging instruments at known times in a bath with water and ice (for sensors that include temperature measurement). This information is shown in appendix 4.

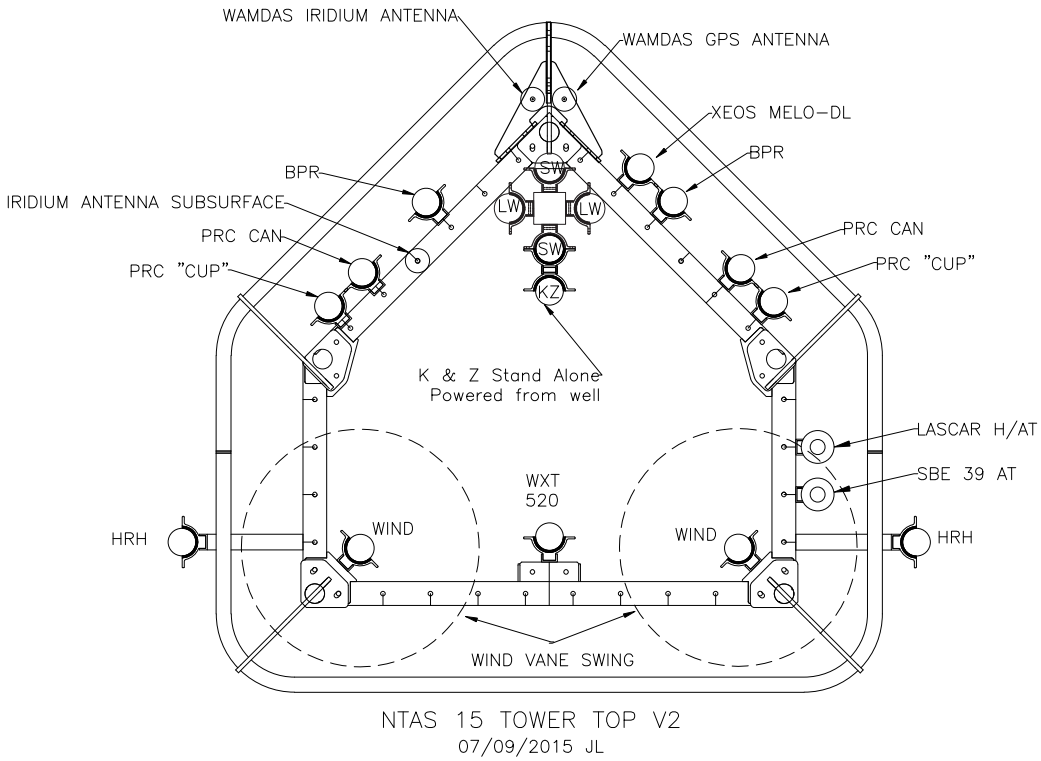


Figure III-1. Top view schematic of the meteorological tower on the NTAS-15 buoy with the location of the ASIMET and other instruments.

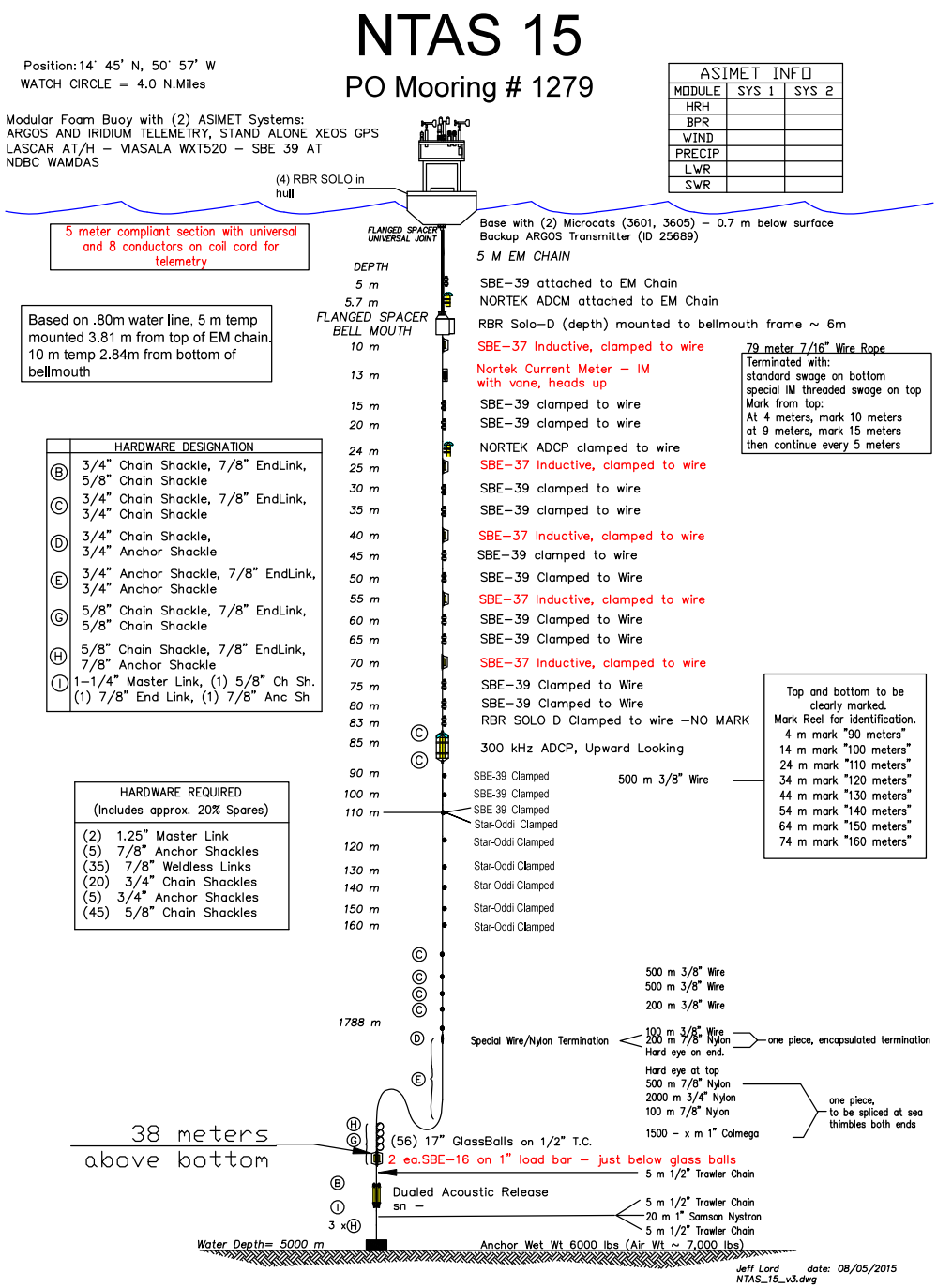


Figure III-2. NTAS-15 mooring diagram and its instrumentation.

B. Deployment

In preparation for the deployment of NTAS-15, the ship ran a set and drift test at the target site (14° 49.50' N, 51° 01.00' W). The drift was about 0.8 kn to WNW and indicated a deployment track along 113°, starting 6 nm downwind of the target. The winds were about 15 kn and the ship ADCP showed no significant current. After the set and drift, the ship sailed upwind of the target for ½ nm to check the bathymetry in case the anchor would have to be deployed slightly past the target. Then the ship turned around and sailed downwind towards the target, slowly at first in order to continue monitoring the bathymetry in the vicinity of the target. Depth from the 12 kHz ship echosounder (set with default speed of sound 1500 m s^{-1}) consistently read 4946 m. Accounting for the different speed of sound in the NTAS area (1511 m s^{-1}), the seafloor depth was therefore 4983 m. In the meantime, last preparations on the fantail were being done, including applying Desitin to the instruments.

Deployment started with buoy pick up after breakfast and buoy was in the water around 09:00 local time. A ½ hour later the last instrument at 160 m was deployed. At 10:20 local the wire-nylon termination was deployed. Glass balls were over at 13:10 local. We were still 2.3 nm from the target and increased the ship speed to 1.5 kn. the anchor was dropped at 15:09 local.

Prior to deployment, three sections of bulwark were removed. The 7/16 wire rope was payed out through the center of the A-frame, around the starboard quarter and along the rail. The wire rope was fair leaded under the 5 meter EM chain. The top of the 7/16 IM wire rope was bolted to the bell mouth frame.

Roughly 50 meters was payed out from the TSE winch and faked out on deck. The upper instrumentation was attached to the wire rope as designated per the mooring design. The 01 crane was used for the deployment of the surface buoy. Roughly 50 feet of boom was needed. The crane was attached to the Peck & Hale release and then attached to the lifting bail of the buoy. Three slip lines were used to control the buoy while deploying, one green (65 feet) and two blue (80 feet). The green slip line was reeved on the lower tag bail on the tower. The two blue slip lines were reeved through the slip bail on the inboard bail on the frame and the other slip was reeved through the frame near the universal.

The bell mouth was eased into the water using a slip line. The EM chain settled aft to the buoy. The crane took up the slack and the remaining aircraft straps securing the buoy were cleared. The crane lifted the buoy roughly one foot off the deck and swung to starboard. When the buoy was clear of the ship, the crane boomed down lowering the buoy to the water. The green slip line was cleared first. The blue line that was reeved through the bail was cleared next. The remaining blue line was used to control the orientation of the buoy. Once the buoy was in the water, the Peck & Hale was released. As the buoy came astern, personnel that were positioned along the starboard rail and starboard quarter slipped the wire rope to the buoy. When the 50 meters faked on the deck were deployed, the wire rope was placed in the red snatch block.

As the winch payed out the wire, instrumentation was clamped onto the wire at designated depths. At the end of the 79-meter shot, the mooring was stopped off and the ADCP cage was shackled to the wire. The winch hauled in taking the load from the stopper line. The stopper was

eased off and cleared. The remaining instruments were clamped onto the upper 500-meter shot of wire rope. The winch continued to pay out the remaining 1,700 meters of wire rope. The wire to nylon boot and remaining nylon was payed out. The stopper line was hooked into the link at the end of the nylon and made fast to the deck cleat. The ship's H-bit was bolted into position and the upper nylon shot from the wire basket was shackled to the link from the 200 meter nylon shot. The H-bit was dressed with 4 turns initially and the stopper line was eased off and cleared. All the nylon and Colmega was payed out using the H-bit. With roughly 10 meters of Colmega remaining in the box, a Yale grip was placed onto the Colmega and the stopper line was attached to the Yale grip and made fast to the deck cleat. The remaining Colmega was removed from the H-bit and wound onto the TSE winch. The stopper line was removed and the remaining line was payed out. At the end of the Colmega the mooring was stopped off and the first section of the 56 glass balls were shackled into place. A stopper line and TSE winch leader were used together to purse out the glass balls. At the end of the glass balls, the load bar was shackled to the end of the chain. A 5-meter shot of chain was shackled to the loadbar. The end of the chain shot was shackled to the winch leader, as the winch took up slack; the stopper line was eased off and cleared. The large airtugger line was reeved through the center block on the A-frame and a chain hook was shackled into place. The chain hook was dipped into a link roughly a meter below the loadbar. The tugger hauled in, lifting the load bar cage off the deck. The A-frame boomed out while the winch payed out keeping the load level. Once the frame was cleared off the stern, the tugger payed out lowering the frame. The hook was removed and the winch payed out the 5-meter shot of chain. The dualed Edge Tech releases were shackled to the bottom of the 5-meter shot. A 5-meter shot of chain was shackled to the master link. The winch tag line was shackled into a link near the bottom of the shot. The tugger line with the hook was now placed on the 5-meter shot below the releases. The tugger hauled in, lifting the releases off the deck. The A-frame was boomed out while the tugger payed out lowering the releases over the stern. The stopper line was shackled into the 5-meter shot and made fast and the winch leader was removed.

A 50-foot ¾" Nystron slip line reeved through the 7/8" link, which was shackled to the 20-meter shot of 1" Samson Nystron. The two ends of the slip line were tied with a bowline knot to the winch leader. The slip line and the 20-meter shot of Nystron were wound on the winch. The 5-meter ½" chain from the releases was shackled to the 20-meter shot of Nystron. The 5-meter shot was shackled to the 7,000 lbs anchor. The chain lashings on the anchor were removed, and an expendable backstay was rigged on the anchor to secure it. With 200 meters to the drop site, the winch payed out slowly. When the end of the 20-meter shot of 1" Nystron was near the ½" chain from the anchor, the winch stopped so the connection could be made between the two. Payout continued until anchor had the load. The ¾" slip line was removed from the winch leader and was slowly slipped out through the 7/8" link. The 9/16" trawl wire was reeved through the starboard block and shackled into the tip plate bridle. As the ship approached the launch site, the backstay was removed, the winch hauled in and the tip plate raised enough to let the anchor slip into the water.

C. Anchor Survey

An acoustic survey of the anchor position of NTAS-15 was carried out about two hours after the anchor drop on February 2 2016. The three triangulating positions were occupied in a triangular pattern (see Table III-1) around the drop site (14° 49.429’ N, 51° 00.819’ W). WHOI’s Edgetech 8011M deck gear was used with portable transducer over the starboard side to range on one of the mooring releases. The releases are about 31 meters above the anchor, which rests on the seafloor. As mentioned in the previous section, corrected water depth at NTAS-15 site is 4983 m.

Triangulation using the horizontal range to the release from the three sites, gave an anchor position of 14° 49.500’ N, 51° 00.978’ W (in decimal convention 14.8250 N, 51.0163 W). Fallback from the drop site was 283 m or 5.7% of the water depth (Table III-2).

Table III-1. Acoustic ranges for NTAS-15 anchor survey.

Waypoint	Latitude	Longitude	Travel time (s)
1	14° 48.856’ N	51° 00.001’ W	7.117
2	14° 49.023’ N	51° 02.026’ W	7.096
3	14° 50.481’ N	51° 01.087’ W	6.975

Table III-2. NTAS-15 anchor coordinates based on acoustic survey.

Anchor Drop	14° 49.429’ N	51° 00.819’ W
Anchor position, Newhall’s code	14° 49.500’ N	51° 00.978’ W
Depth at anchor position	4946 m (12 kHz)	4983 m (corrected)
Fallback	283 m	5.7% water depth

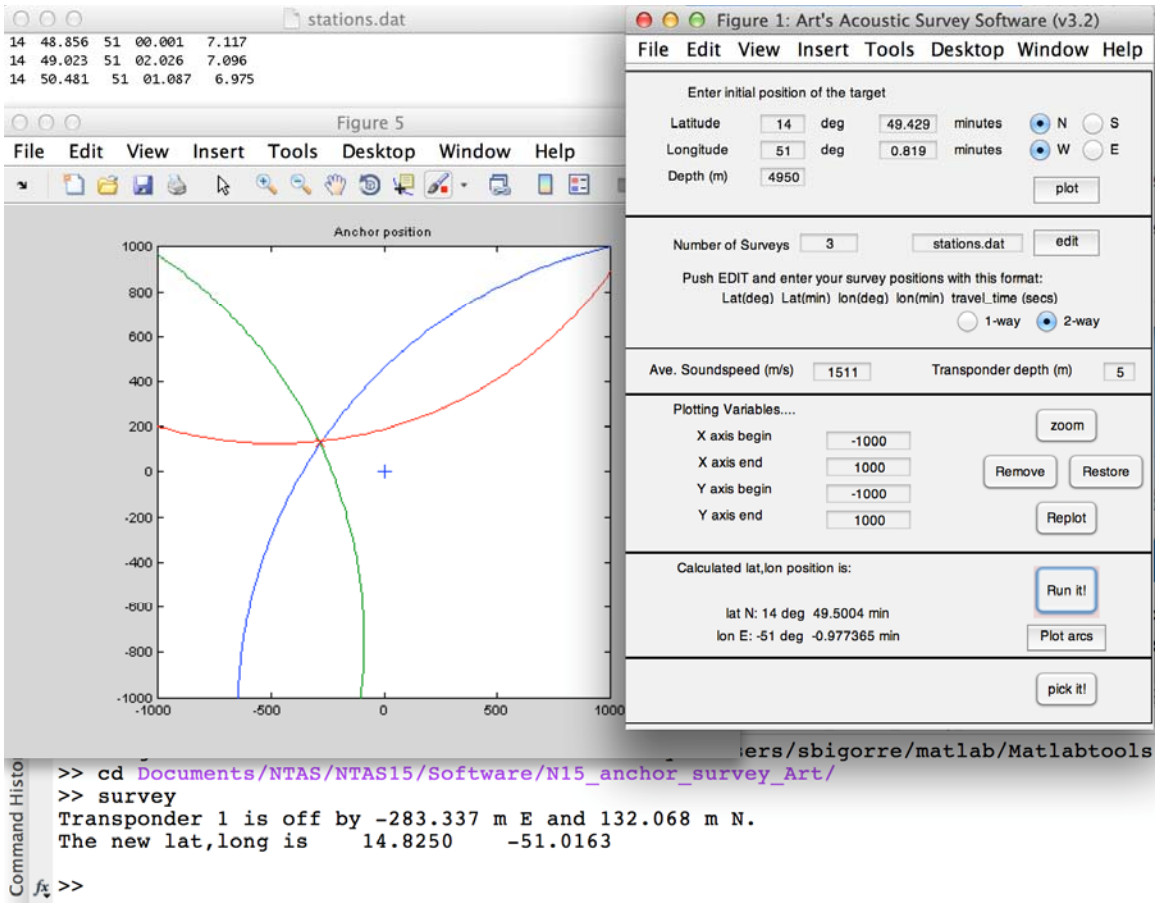


Figure III-3. NTAS-15 anchor survey: screen capture of Art Newhall's code results.

D. NTAS-15 and NTAS-14 Intercomparisons

Following a 1,000m CTD at the site where NTAS-14 was recovered, R/V Endeavor transited towards NTAS-15, arriving there at 23:00 local (03:00 UTC on February 5 2016). The ship held station 0.2 nm downwind of NTAS-15 buoy for the next 24 hours. Four CTDs to 500 m were conducted at approximately 00:00, 06:00, 12:30 and 18:00 UTC on February 5. A drive by next to the buoy was done around 14:00 UTC to inspect visually the buoy. The ship left the NTAS area at 23:30 UTC this same day, sailing towards MOVE 1.

Sensors on the ship did not all function (PRC, primary ATMP/HRH and BPR on bow mast). Secondary sensors were used, namely the ATMP/HRH above the pilot house (rough height estimated as 15 m) and the BPR aft of the main lab (specified in the ship's documentation as being 3.7 m high). Wind speed is from the sonic Gill sensor on the bow mast, 13.4 m above waterline. As for SST, we used the TSG external probe at the seawater inlet and estimate its depth as about 3 m below the waterline (again this is a very rough estimate, between the 5 m hull depth and the surface). UOP had standalone sensors installed on the ship for the duration of the

cruise, in a configuration similar to last year's cruise (EN 549): an ATMP/HRH (ASIMET HRH211) sensor strapped to the bow mast (9 m above waterline) and a SWR (ASIMET SWR211) and LWR (ASIMET LWR255) attached to the rail of the O1 crane. The following plots (Figure III-4 to Figure III-12) show the period of inter-comparison between the ship and NTAS-15, as well as the short inter-comparison at NTAS-14 (from 03:00 to 14:00 UTC on February 4, preceding its recovery). The period shown also covers the time both buoys were in the water, separated by only a few miles, roughly from 1300 UTC on February 2 – when the NTAS-15 buoy was launched over-board, roughly 6 hours prior to anchor drop on its deployment day - to 21:00 UTC on February 4 2016 or 7 hours after anchor release of NTAS-14 and right before the buoy was hauled back on the ship fantail on recovery day). Measurements of air temperature and humidity, wind speed, from the ship were adjusted to the heights of similar sensors on the buoy for comparison. The height adjustment was done using the COARE3.5 bulk algorithm. Note that data from NTAS-15 is based on telemetry, which does not have a very good resolution due to limited bandwidth for data transmissions. This digitization is especially noticeable on BPR and conductivity values and can introduce a bias as values get rounded off.

Measurements of air temperature on both buoys agree within 0.05 °C at night, as well as with the standalone on the ship's bow mast. Relative humidity measurements between the two buoys are within 2%RH; the standalone on the ship is higher by 1 (night) to 3%RH (day). Wind speed measurements are all within 0.5 m s^{-1} in the 6 to 8 m s^{-1} range observed. Wind direction measurements from the buoys are within 10°, and this difference occurs between duplicate sensor on each buoy. This is probably due to the wind flow distortion that is similar on both buoys. The ship's wind direction is between 15 and 20 lower than measurements from the buoys. This is due the magnetic deviation (-17.15° at NTAS in 2016), since ship's values are true wind, whereas buoy values are referenced to magnetic north and uncorrected at this stage of data processing. Barometric pressure was close to ship values, although the latter were smaller, probably due to the higher height of measurements on the ship (no height adjustment was done for pressure). Only one sensor (system 2) on NTAS-14 was giving good BPR data at recovery. Telemetry values from NTAS-15 are not very accurate due to the digitization. Downwelling longwave radiation (LWR) measurements from duplicate sensors on each buoy agree within 5 W m^{-2} and the two buoys are within the same agreement, with measurements from NTAS-14 slightly lower than the ones from NTAS-15. Ship measurements are slightly higher overall and standalone (LWR255) on the ship is slightly lower; spread from all these measurements is about 15 W m^{-2}. Downwelling shortwave radiation (SWR) measurements from duplicate sensors on NTAS-14 buoy agree within better than 10 W m^{-2} and within about 15 W m^{-2} on NTAS-15. There is some difference between the two buoys but this may be due to different cloudiness between the two sites. Ship measurements are higher than both buoy measurements during NTAS-14 inter-comparison but agree well with NTAS-15 buoy during NTAS-15 inter-comparison. Precipitation (PRC) on NTAS-14 showed that system 2 was not collecting good data near recovery. On NTAS-15, PRC from system 1stayed at 0 but this may be real as no good rain was noticed during the inter-comparison. The ship PRC did not record any rain signal during the cruise and is deemed non-functioning for our purpose. Sea surface temperature (SST) measurements from duplicate sensors on each buoy agreed very well. SST from NTAS-15 is consistently 0.03 °C higher than SST from NTAS-14 but this is probably due to the physical separation as the agreement with the ship is much better during NTAS-15 inter-comparison. Sea

surface conductivity (SSC) from NTAS-14 is 0.004 S m^{-1} higher on system 1 than on system 2. Conductivity values in the telemetry data from NTAS-15 is digitized to 0.01 S m^{-1} so we cannot resolve the same kind of bias, however, system 1 tended to be lower than system 2. Ship values are about 0.08 S m^{-1} higher than buoy values; this may be due to the different depth of the ship's sensor or a calibration issue.

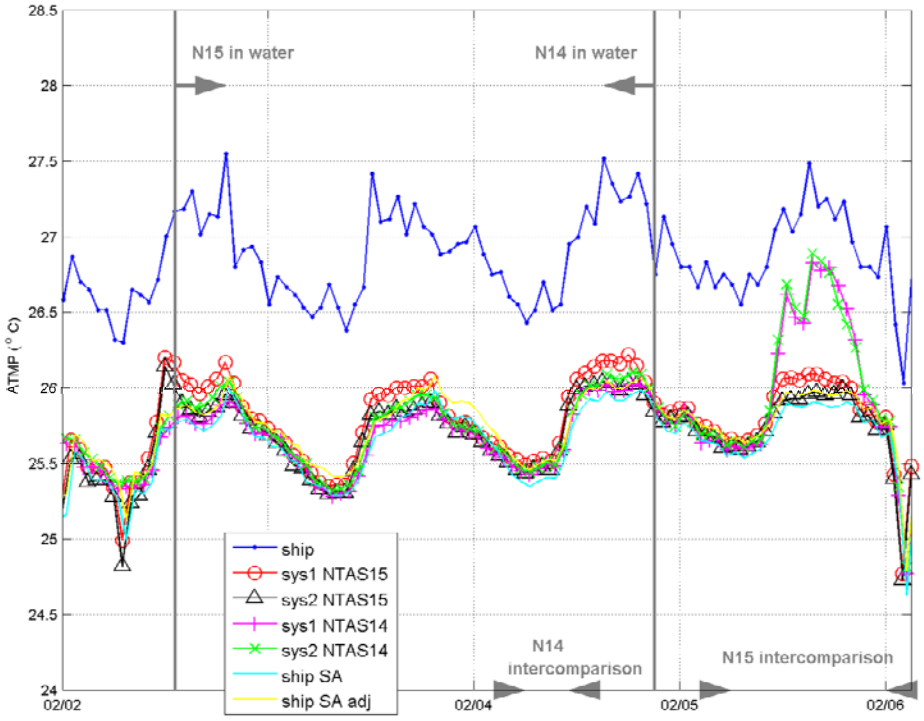


Figure III-4. Ship vs NTAS-15 vs NTAS-14 inter-comparison in February 2016: Air temperature (ATMP). Ship measurement (ship, blue line) was not adjusted for height. The UOP standalone (ship SA, cyan line) was adjusted (ship SA adj, yellow line).

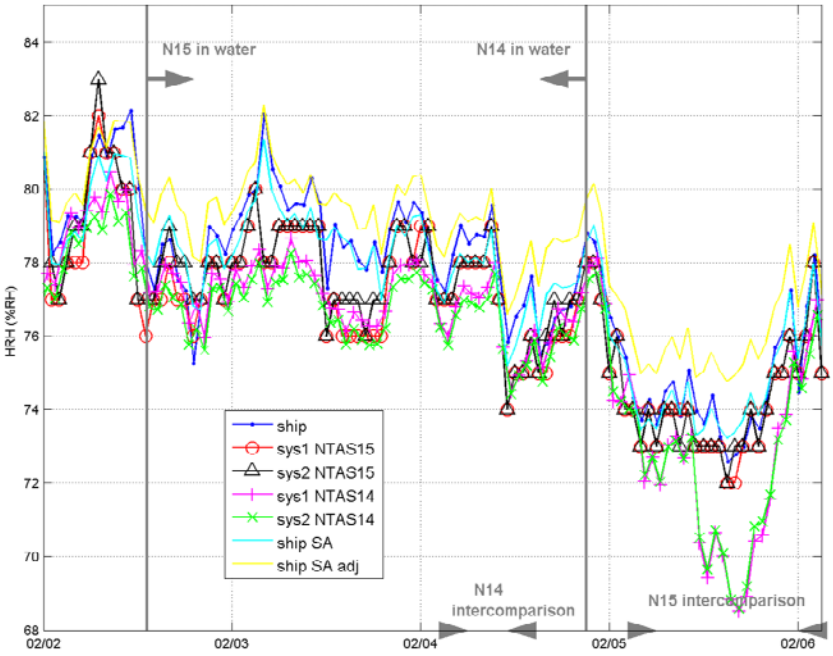


Figure III-5. Same as Figure III-4 but for air relative humidity.

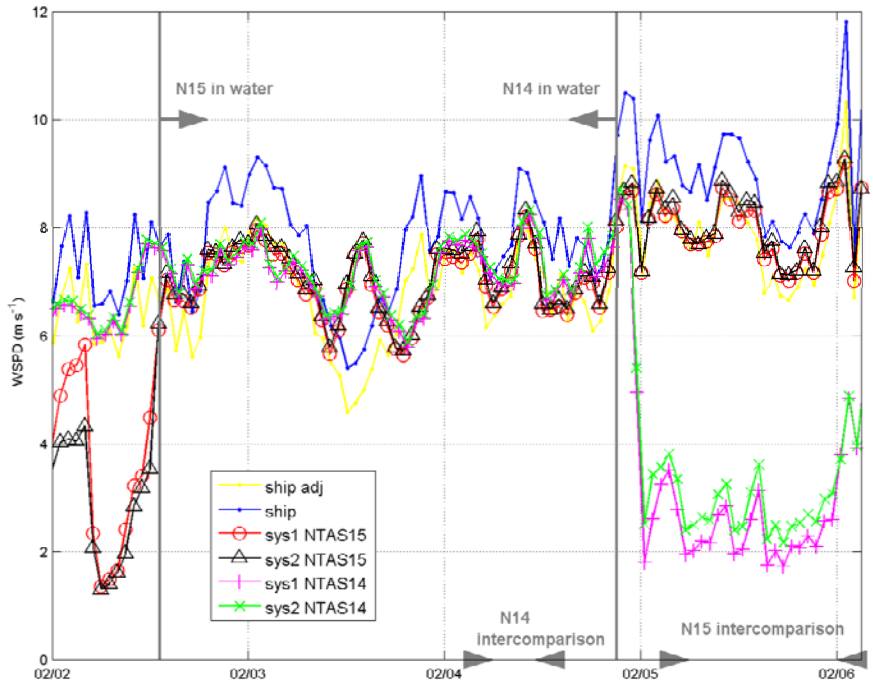


Figure III-6. Same as Figure III-4 but for wind speed. No standalone was installed on ship, so ship measurement (blue) was adjusted to buoy height (yellow).

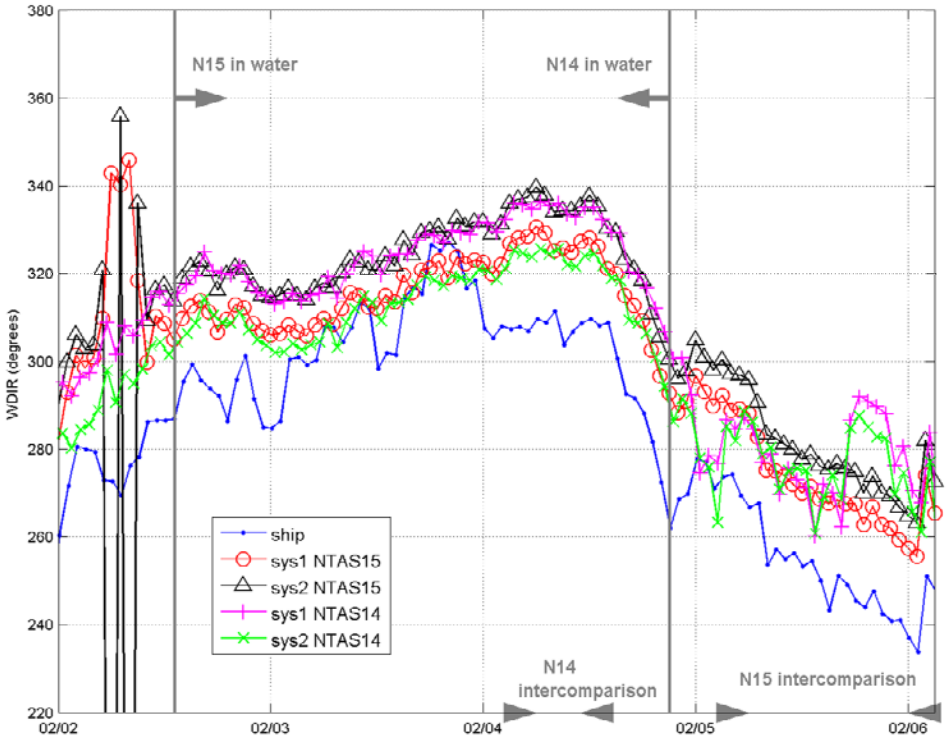


Figure III-7. Same as Figure III-4 but for wind direction. No height adjustment. Ship measurements are true wind and buoy values are referenced to magnetic north.

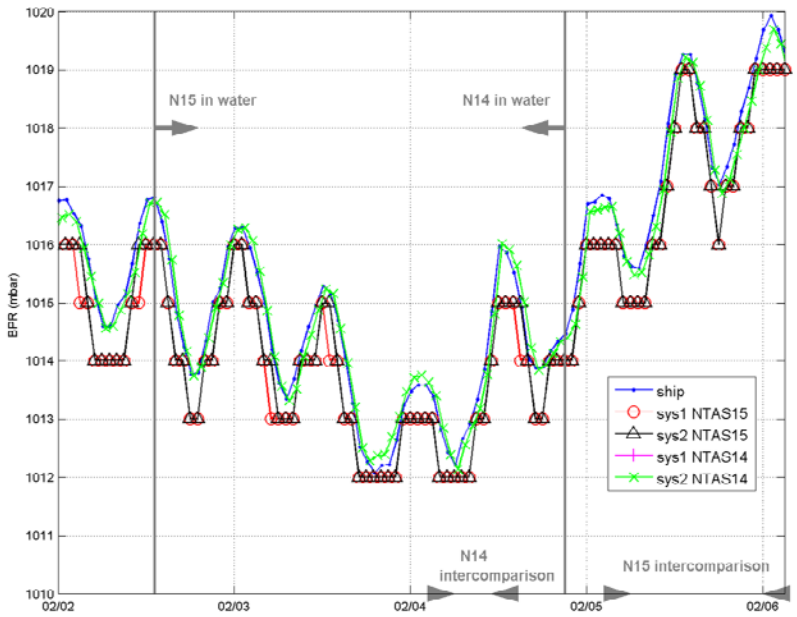


Figure III-8. Same as Figure III-4 but for barometric pressure. No height adjustment was done.

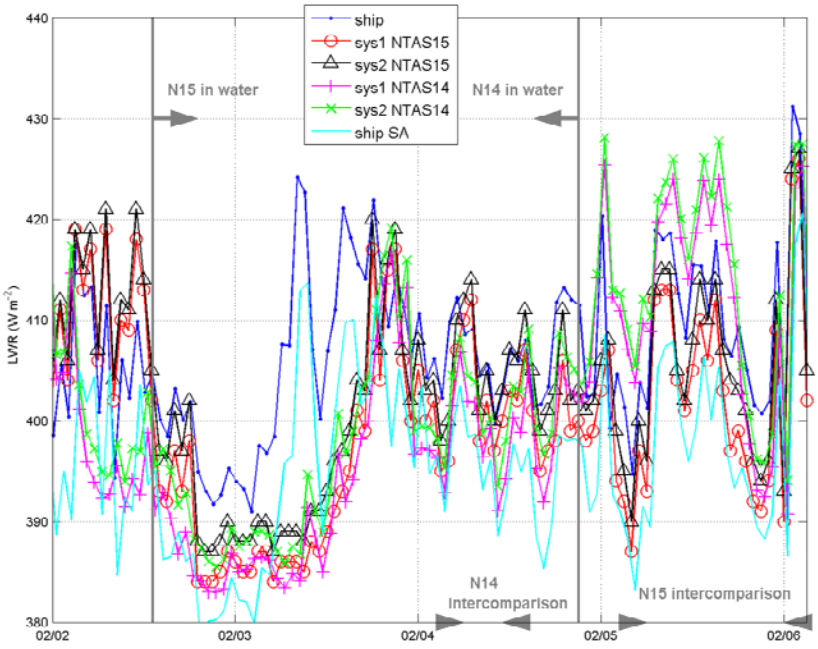


Figure III-9. Same as Figure III-4 but for downwelling longwave radiation LWR.

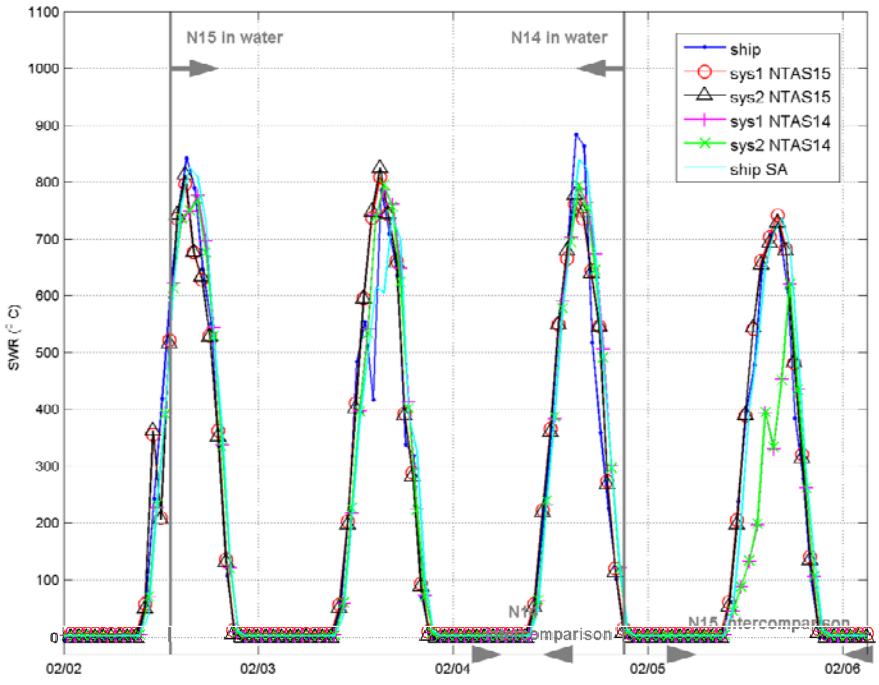


Figure III-10. Same as Figure III-4 but for downwelling shortwave radiation SWR.

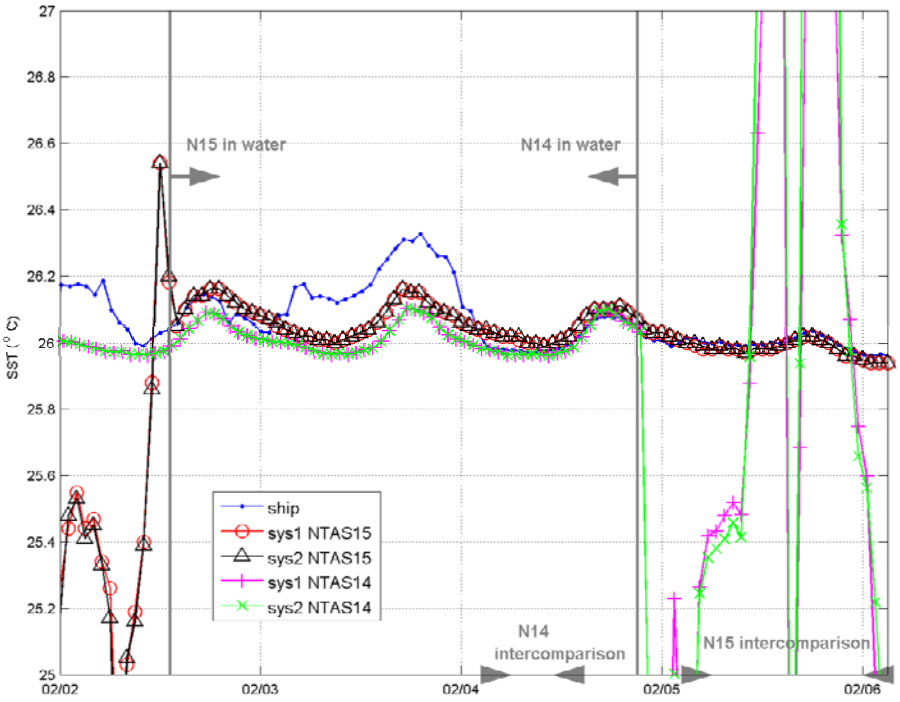


Figure III-11. Same as Figure III-4 but for sea surface temperature (SST). No depth adjustment.

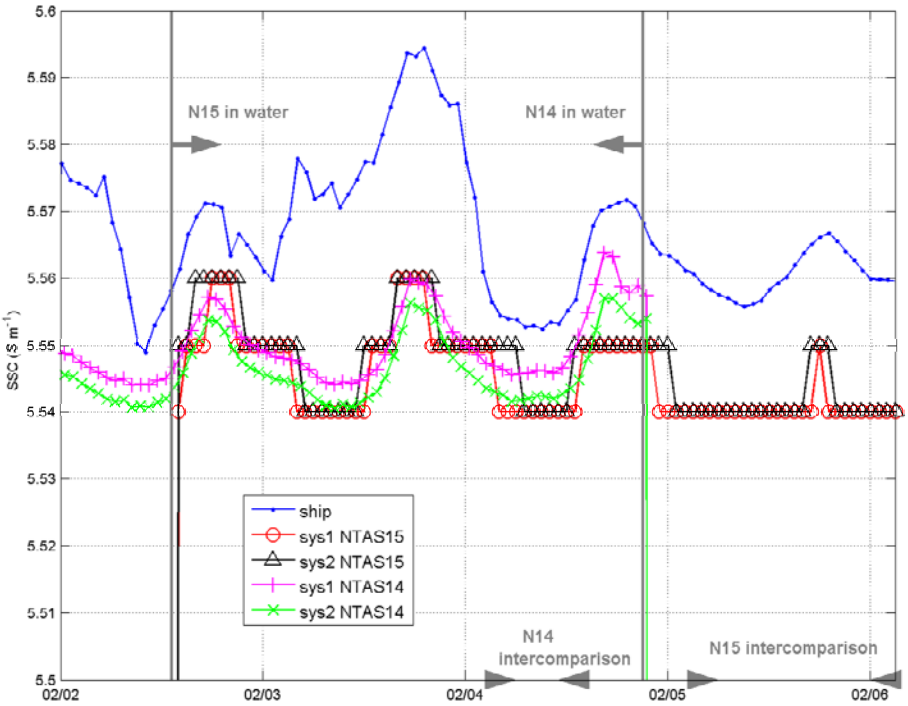


Figure III-12. Same as Figure III-4 but for sea surface conductivity. No depth adjustment.

Subsurface hourly data from NTAS-14 and 15 are telemetered using inductive telemetry. This data was compared to the CTDs done nearby each of these moorings. The figures below show the comparisons between the temperature and salinity profiles from moorings and CTDs.

The data from NTAS-15 agree well with CTDs nearby. Temperatures telemetered from the mooring are all bracketed by CTD data. Salinities at 25, 40 and 55 m are slightly higher on the mooring than the CTD values (0.01 to 0.02 psu, increasing with depth). This is a rather small difference. Some of this may be accounted for by spatial heterogeneity, since the ship was about ½ nm downwind of the buoy. In fact, during the inter-comparison the ship drove by the buoy for a visual inspection and the near-surface salinity and temperature measured by sensors on the ship's hull measured slightly saltier (+0.004 psu) and colder (-0.01 °C) conditions as we approached the buoy.

Data from NTAS-14 agrees well with CTDs, except salinity at 25 m, which is 0.2 psu low on the NTAS-14 mooring compared to CTDs# 3, 4, 5.

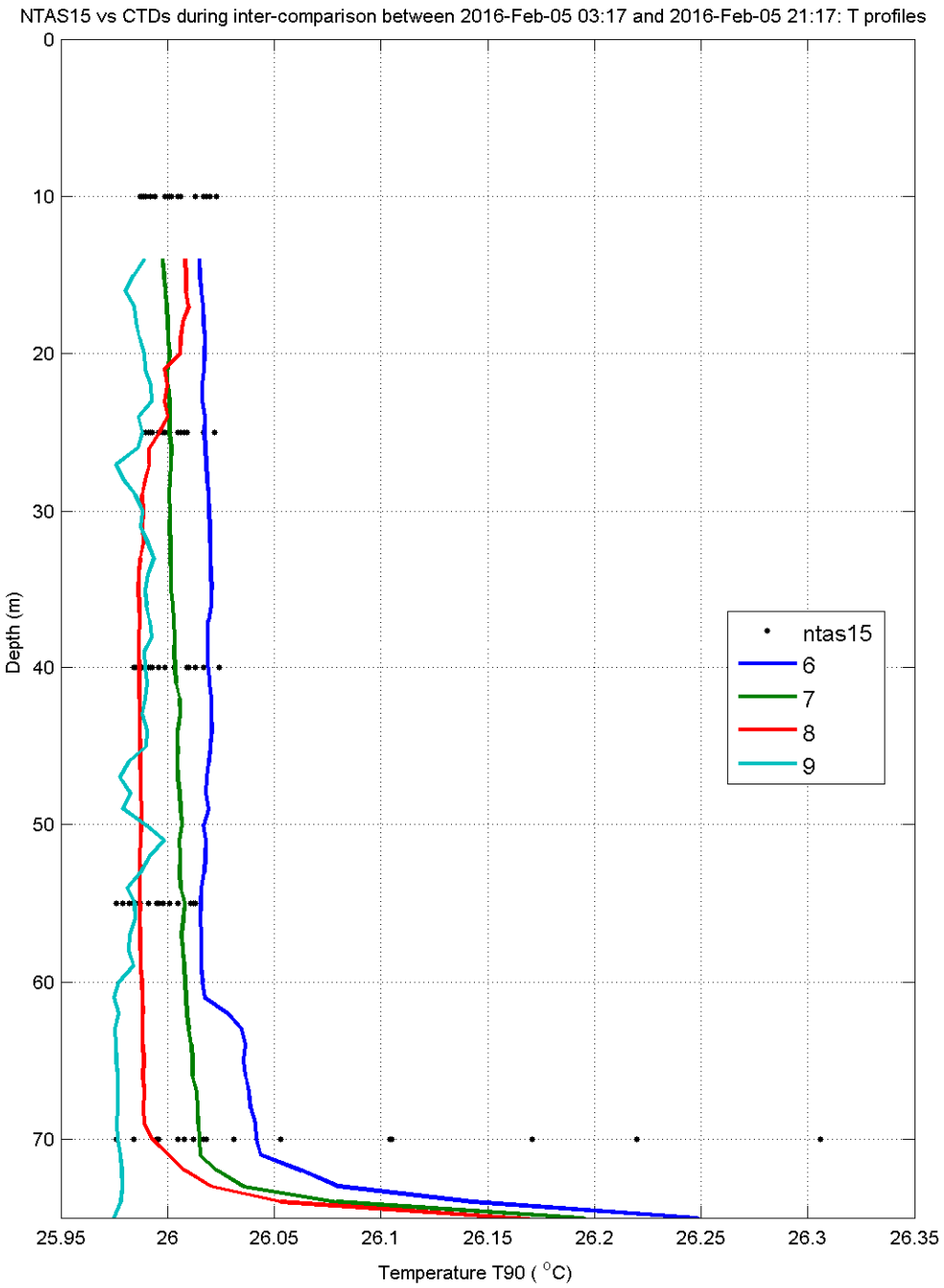


Figure III-13. CTD temperature profiles (color lines) done near NTAS-15 and concomitant (from February 5 2016, during inter-comparison period at NTAS-15) data from NTAS-15 (black dots). Legend indicates the CTD cast number plotted.

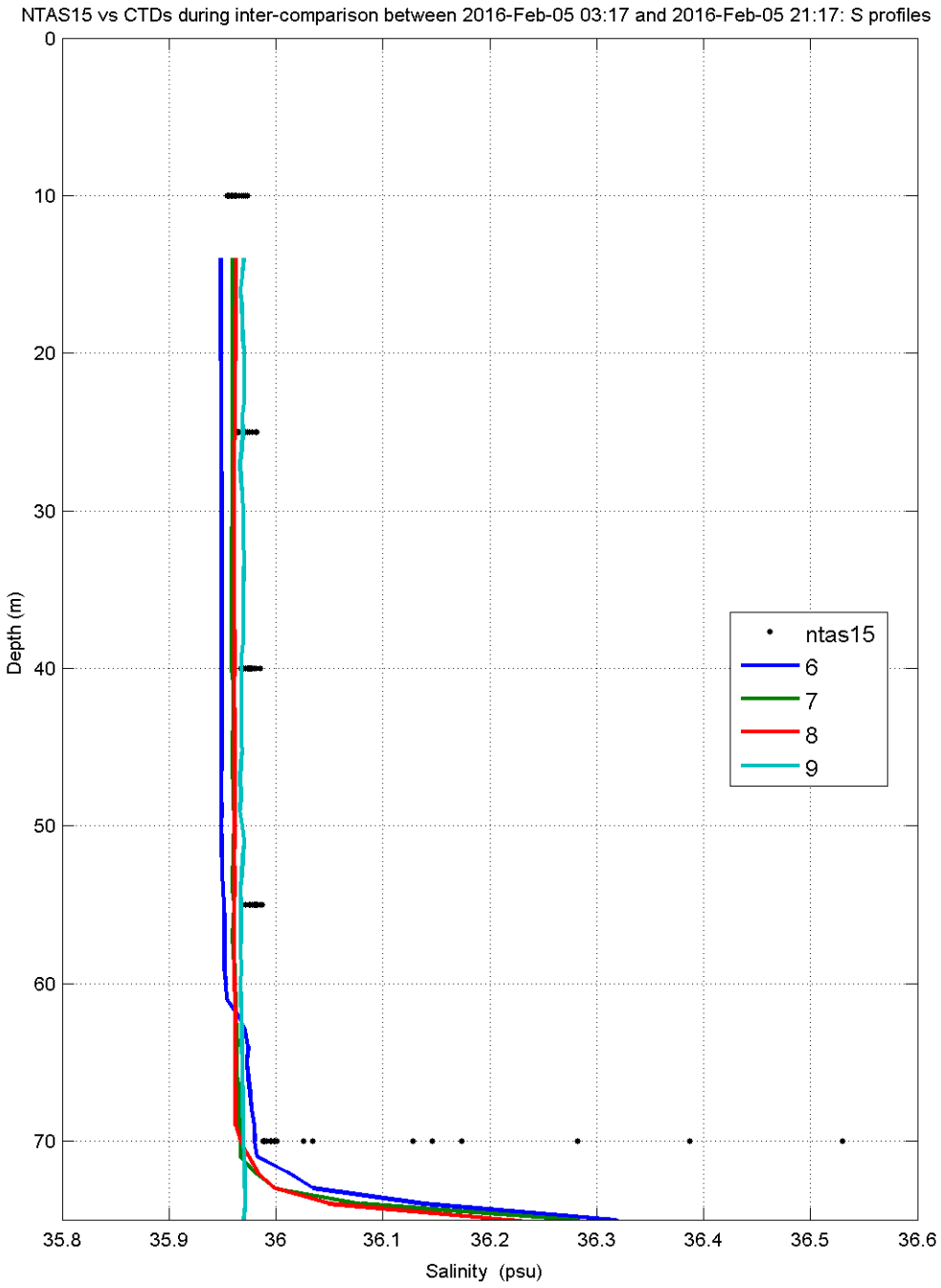


Figure III-14. Same as Figure III-13 but for salinity.

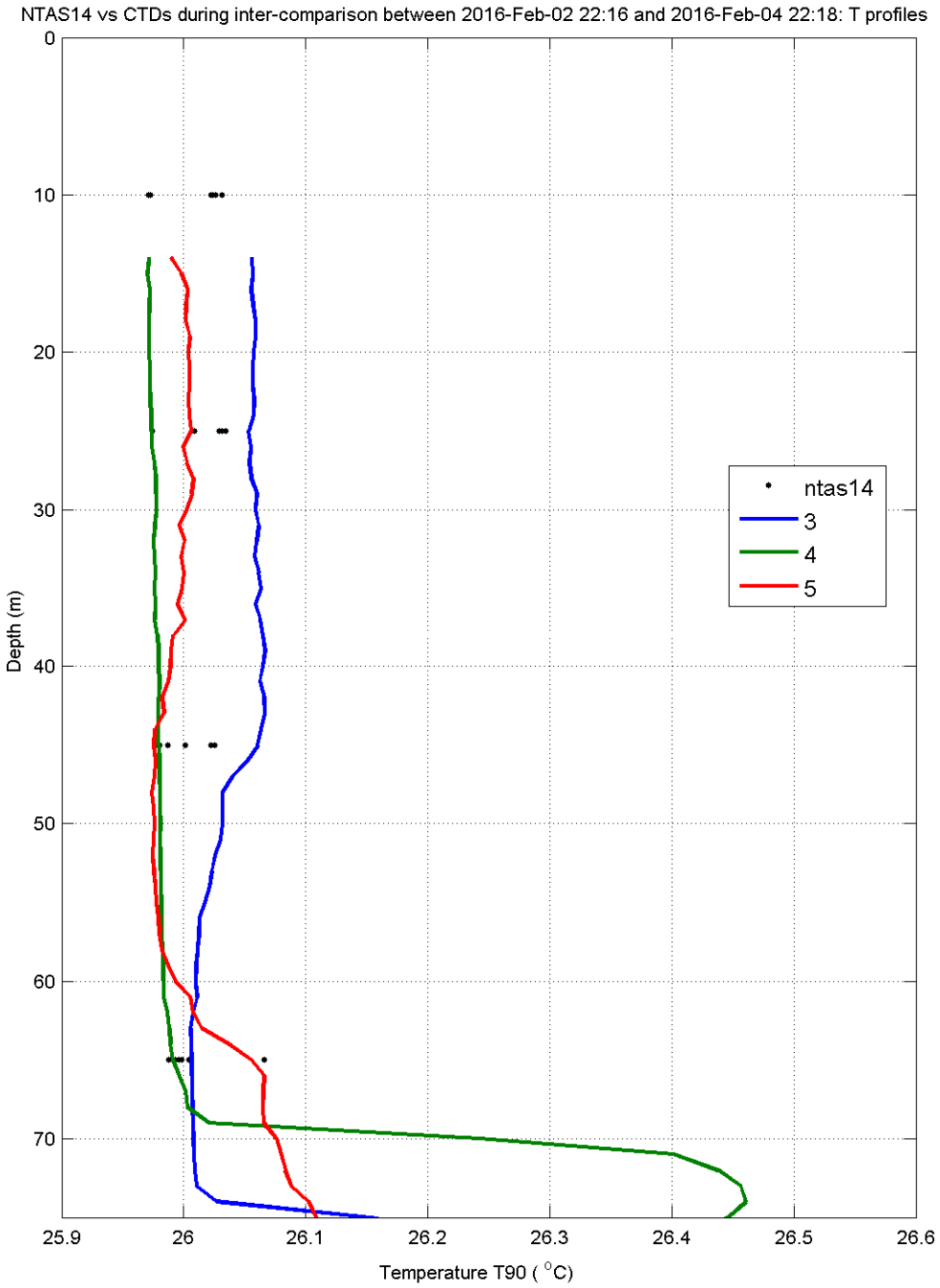


Figure III-15. CTD temperature profiles (color lines) done near NTAS-14 and concomitant (within 1 to 3 hours of CTD #3,4,5) data from NTAS-14 (black dots). Legend indicates the CTD cast number plotted.

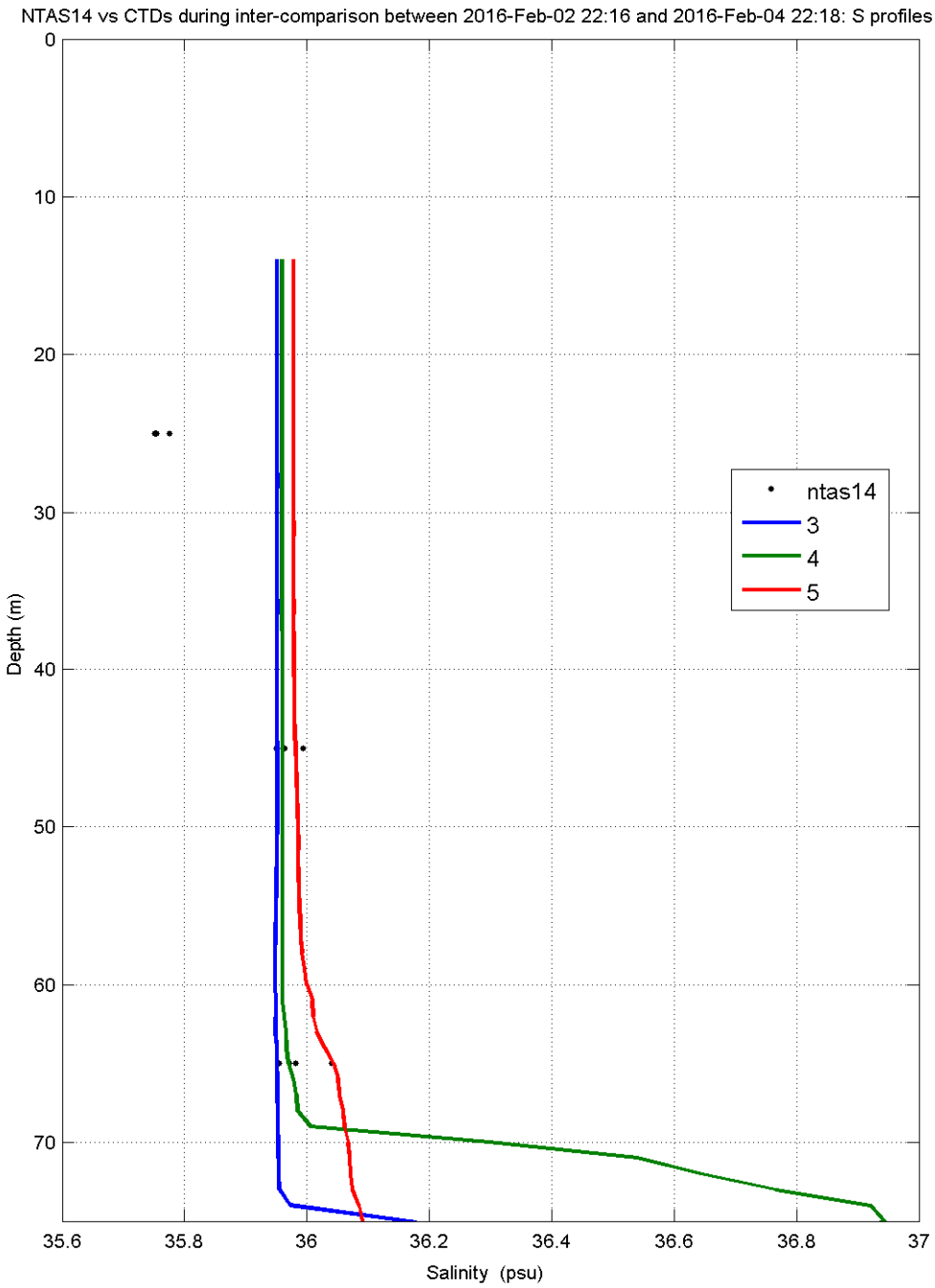


Figure III-16. Same as Figure III-15 but for salinity.

IV. NTAS-14 Recovery

A. Mooring Recovery

Recovery was initiated with R/V Endeavor positioned approximately ¼ mile upwind of the anchor position while the acoustic release was fired. It took about 1 hour for the glass balls to surface. The ship maneuvered to the cluster of balls. The TSE winch leader was reeved through the center block and passed forward along the starboard rails. The 5-ton titanium hook pendent was shackled to the leader. With the cluster of balls along the starboard side, the titanium hook snapped into a section of chain. The ship moved ahead slowly allowing the cluster to come astern. When the cluster was centered behind the ship, hauling began. As the balls came on board, stopper lines were attached to the chain. The TSE lowered the balls on deck. The cluster of balls were disconnected and placed into the wire baskets. The TSE was used to recover the pair of Microcats deep sensors on the load bar and the dualed releases. The large snatch block was raised off the deck using the large air tugger. The TSE leader was reeved through the block and shackled to the Colmega. The winch hauled in and the stopper line was eased and cleared. The winch recovered approximately 20 meters of Colmega and a Yale grip was attached to the Colmega. The stopper line was attached to the Yale grip and made fast to the cleat. The winch payed out the Colmega which was then wound with 6 wraps on the ship's capstan. The capstan took up the slack and the stopper and Yale grip were removed. The capstan recovered the majority of the Colmega and then had mechanical issues. It was decided to recover the remaining synthetics using the TSE. The recovered line filled the winch drum and had to be removed once. Once cleared, the remaining line and wire rope were recovered. The winch continued the recovery of the remaining 200 meters of nylon and 1700 meters of wire rope. The hauling operation was stopped periodically to remove instruments that were clamped onto the mooring wire. At the ADCP section of the mooring, the ADCP was removed and a slip line was rigged through the 7/8'' link and made fast to the deck cleat. The stopper line was removed allowing the slip line to have the load. When the ship was ready, the line was slipped allowing to mooring to be free. It took roughly 15 minutes to arrange the deck for the buoy recovery. The ship re-positioned to have the buoy come along the starboard side. The crane had roughly 20 feet of boom extension out. The 5-ton hook snapped into the lifting bail of the buoy and the softeye of the pendent was hooked to the crane. The crane hauled in lifting the buoy out of the water. Air tuggers were attached to tagline bails to reduce movement while recovering. The crane swung the buoy inboard and once on deck, the buoy was secured to the deck. The crane swung back to recover the 5-meter EM chain and bell mouth. After the bell mouth was on board, a Yale grip was placed on the 79-meter shot. The wire rope from the TSE winch was brought through the A-frame and around the starboard quarter. It was then shackled to the Yale grip. The wire rope was cut just above the Yale grip allowing the TSE to recover the remaining 79 meters of wire and instrumentation.

B. Instrumentation Recovery

As instruments were recovered, their status was documented in the mooring log (Appendix 2 and Appendix 5 for recovery time marks) and pictures were taken (see Figure IV-1 through Figure IV-3Figure IV-2). Details and more information about all instruments recovered are contained in the document *NTAS14InitialDataProcessing.docx*. Post-recovery procedures such as temperature spikes and power down times are documented in *NTAS14_Recovery.xlsx* (latest version at time of writing is actually *NTAS14_Recovery20160524.xlsx*).

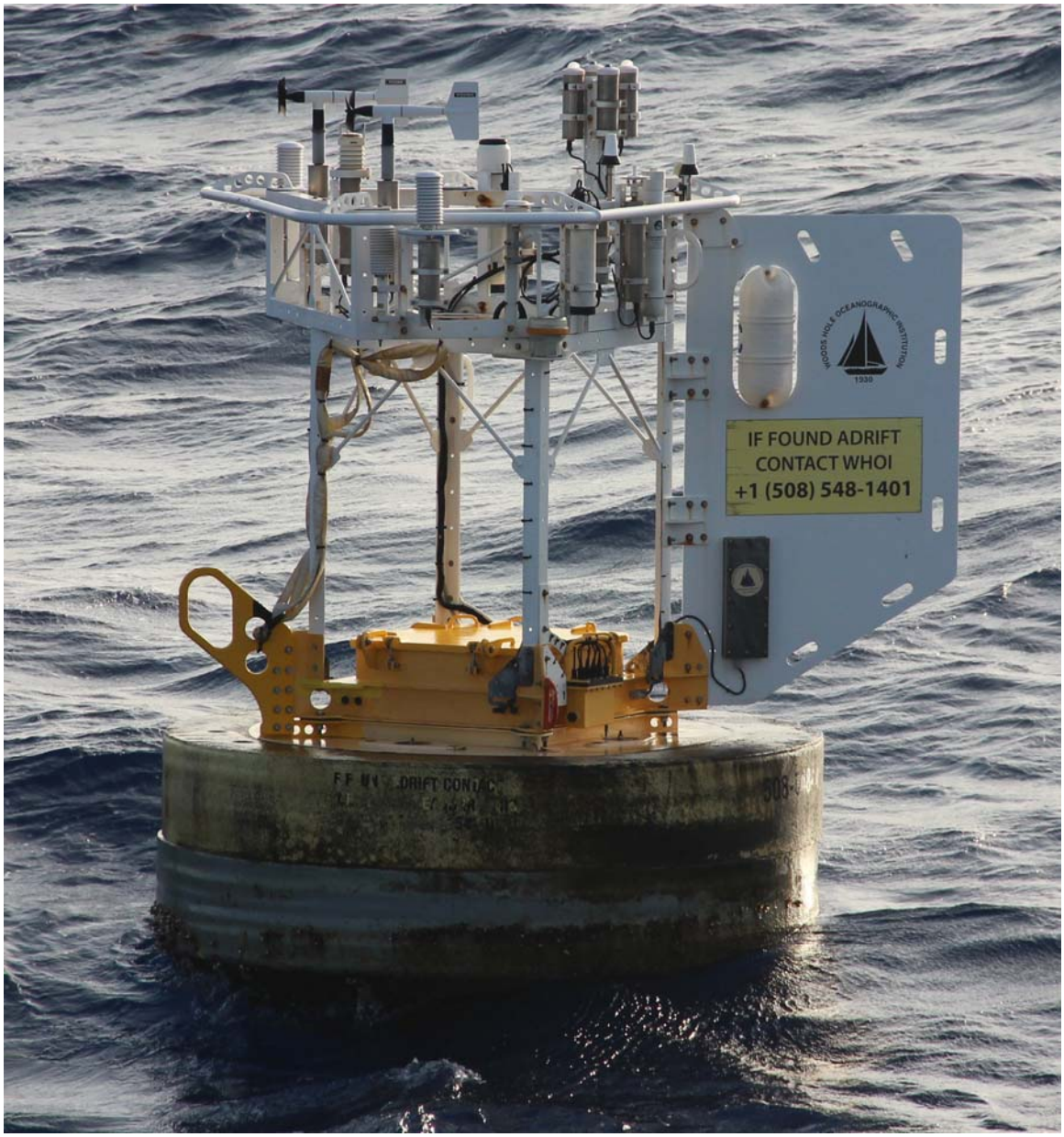


Figure IV-1. NTAS-14 buoy during drive by on February 2 2016, two days before recovery.

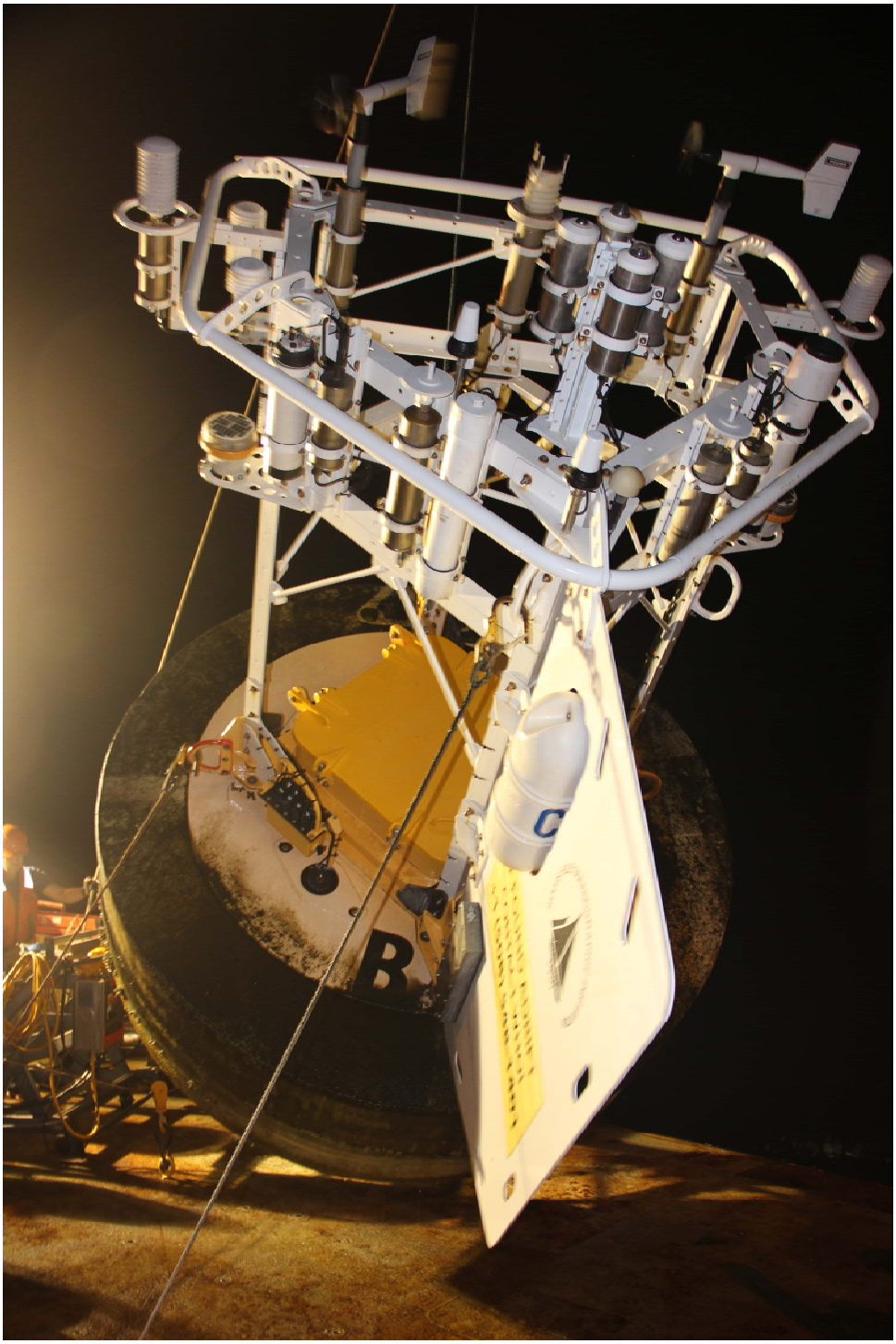


Figure IV-2. NTAS-14 buoy upon recovery

Figure IV-3. Instruments are, from left to right, top to bottom:
110 m, 100m, 80 m, 6 m, 13 m, 18 m, 26 m, 65 m.

1. Depths of subsurface sensors on NTAS-14 mooring

The NTAS-14 mooring was designed with a 79 m inductive wire shot under the buoy. However, the mooring diagram incorrectly reported this length as being 78 m. Upon recovery, the wire shot was checked as being labeled 79 m as read on the wire end-boot. Further length measurements were made after recovery to ensure the correct instruments depths. The universal joint's height is 0.3 m, the EM chain (including the top and bottom flange, each 0.1m long is 5 m long). Two flanges, each 0.2 m high, are added to the EM chain; one at the top below the universal joint and one at the bottom, above the bell mouth spacer. With a water line of 0.75 m for the NTAS-14 buoy, the bottom of the EM chain is therefore at a depth of 6.4 m. Finally, we measured the distance from the deepest SBE 39 on this wire shot: it was 4.85 m from the swage's eye. Its depth was therefore estimated as 80.55 m (0.7+0.3+0.2+5+0.2+79-4.85), which is quite close to its intended nominal depth of 80 m. We can therefore assume all the sensors clamped on the 79 m inductive wire shot were also correctly deployed at their intended depth.

The pictures below (Figure IV-4 and Figure IV-5) show the EM chain and instrumentation clamped to it prior to deployment in December 2014, and Figure IV-6 shows the current meter instrument near the bottom of the EM chain right after recovery on February 4 2016. The current meter nominal depth is 5.7 m and the pictures are consistent with this. Pressure from this instrument also confirms this (pressure was close to 6.35 dbar during deployment and the values in air were 0.65 dbar). On the contrary, the SBE 39 deployed above was installed about 1.5 m above the current meter (based on Figure IV-4 and scale of surrounding objects, like the base of the knuckle boom crane). The actual depth of the SBE 39 (SN539) was therefore 4.2 m instead of its 5 m target depth. Note that for NTAS-15 we followed the mooring diagram indication to clamp the SBE at 3.81 m from the top of the EM chain, so the 5 m target will be reached.

Figure IV-4. Picture of instruments (current meter and SBE 39) clamped to compliance section prior to deployment of NTAS-14 on December 13 2014.

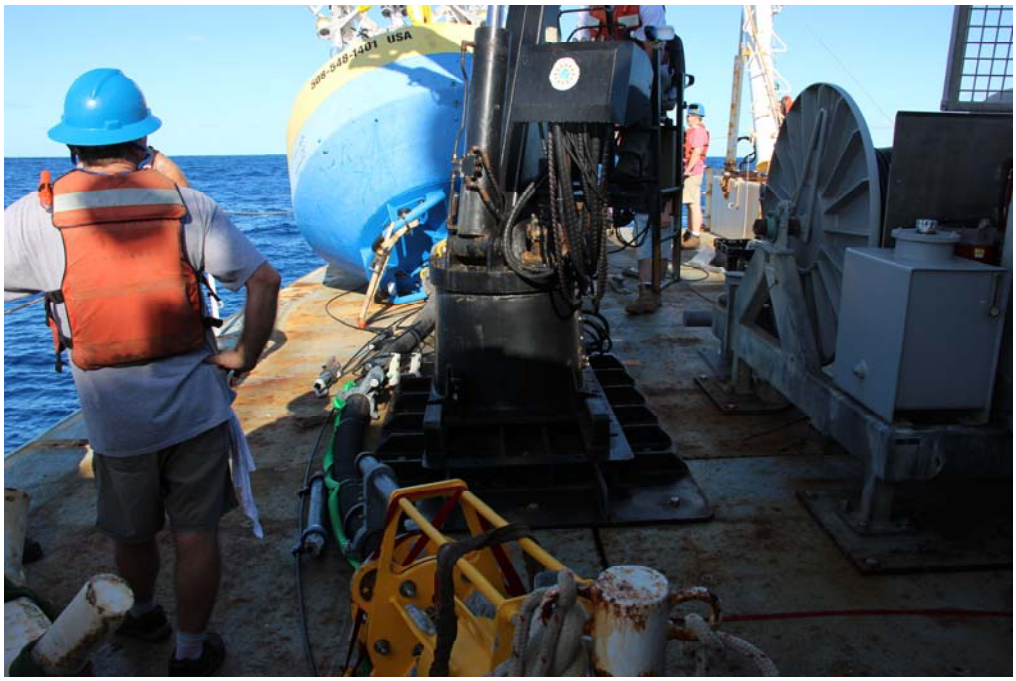


Figure IV-5. Picture of instruments (current meter and SBE 39) clamped to compliance section prior to deployment of NTAS-14 on December 13 2014.

Figure IV-6. Picture of current meter clamped to bottom of compliance section on NTAS-14 during its recovery on February 4 2016.

V. Ancillary Work

A. CTD casts

Twelve Conductivity Temperature Depth (CTD) casts were done. First CTD was made during transit to the NTAS site when the ship exited the warm side of the Gulf Stream and was used to test the CTD and a few acoustic releases. A very short CTD was done at end of cruise (CTD#13, on 2/11) to validate a new ship O2 sensor. Information about CTD casts is in Table V-1 and plots are in Figure V-1 and Figure V-2. Water samples were taken by the SIO group and information about these is in Appendix 6.

Table V-1. CTD casts operated during EN573 cruise in January/February 2016, including start time and locations.

CTD #	Date	Time	Latitude N (dd mm.mm)	Longitude W (dd m.mm)	Cast depth (db)	Comment
		(UTC)				
1	1/26	20:33	37 00.15	67 45.71	1530	Test cast. 4 acoustic releases attached rosette. Two O2 sensors disagree. Collect O2 samples for 100% saturation control.
2	2/1	17:06	13 53.917	51 49.953	3494	29 SBE37s attached to Rosette for cal/val MOVE. 12 bottles (#8 seemed warm; maybe fired at wrong depth). Spare O2 sensor installed.
3	2/2	22:57	14 45.803	50 59.884	998	Near NTAS14 buoy. 4 releases and 3 SBE37s attached. 12 bottles (#9 did not fire).
4	2/4	10:16	14 45.57	50 59.50	507	Near NTAS14, prior to recovery.
5	2/4	23:40	14 41.22	50 54.43	1000	Near NTAS14, after recovery. 1 release + 1 SBE37 attached.
6	2/5	4:13	14 50.31	51 03.19	515	Near NTAS15. No bottles.
7	2/5	10:03	14 50.07	51 02.95	504	Near NTAS15. No bottles.
8	2/5	16:34	14 49.64	51 03.17	506	Near NTAS15. No bottles.
9	2/5	22:07	14 49.69	51 03.09	505	Near NTAS15. No bottles.
10	2/6	7:53	15 27.11	51 31.63	3514	Near MOVE1 target. Forgot 20 cm tubes on both CTDs.
11	2/10	23:02	16 19.69	60 28.53	3501	Near MOVE3. 18 SBE37s from MOVE3-11 on Rosette for post cal/val.
12	2/11	3:24	16 20.19	60 28.19	1003	One SBE37 attached, from MOVE3-11.

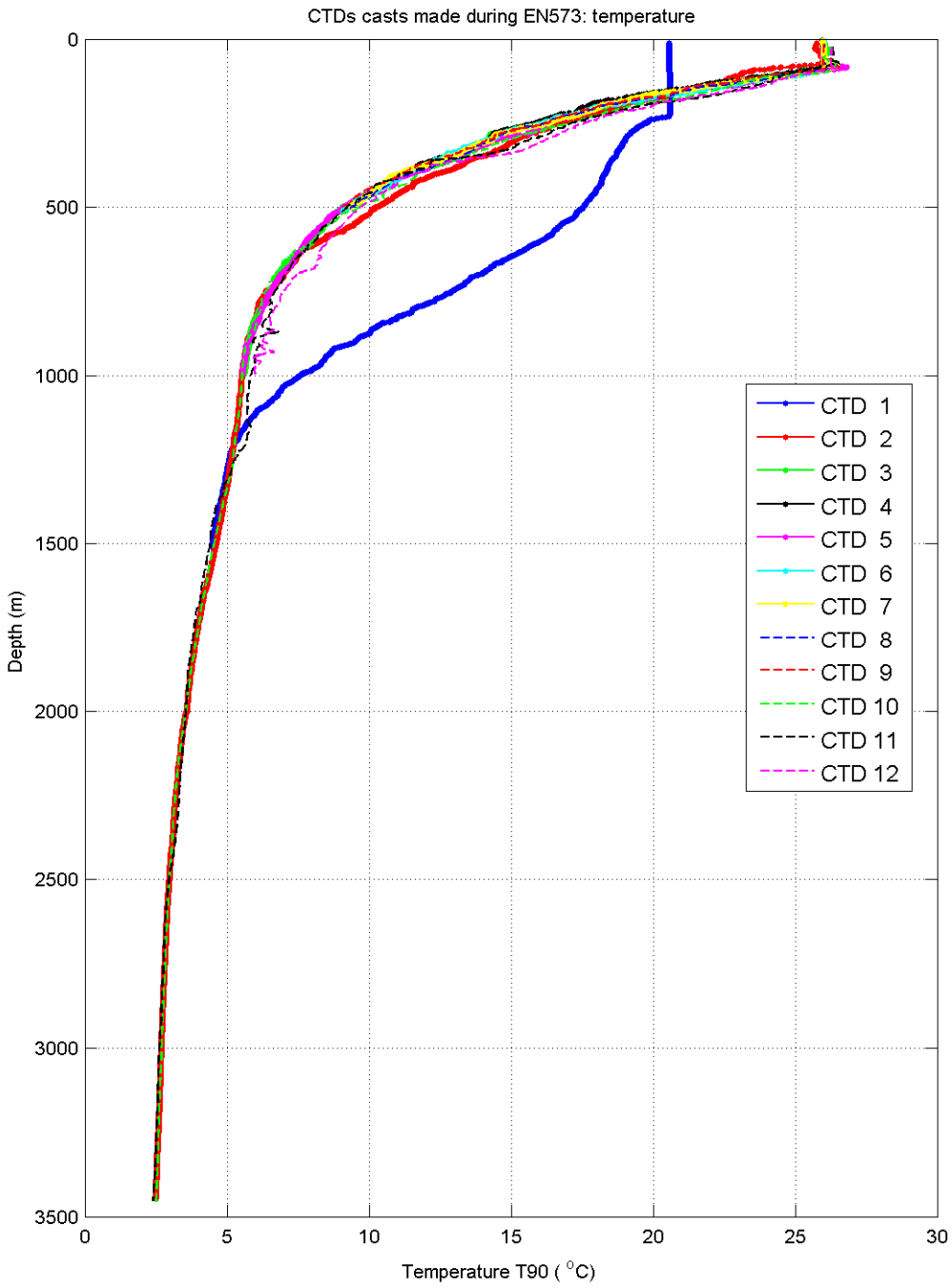


Figure V-1. All CTD casts made during EN573 cruise: temperature vs depth.

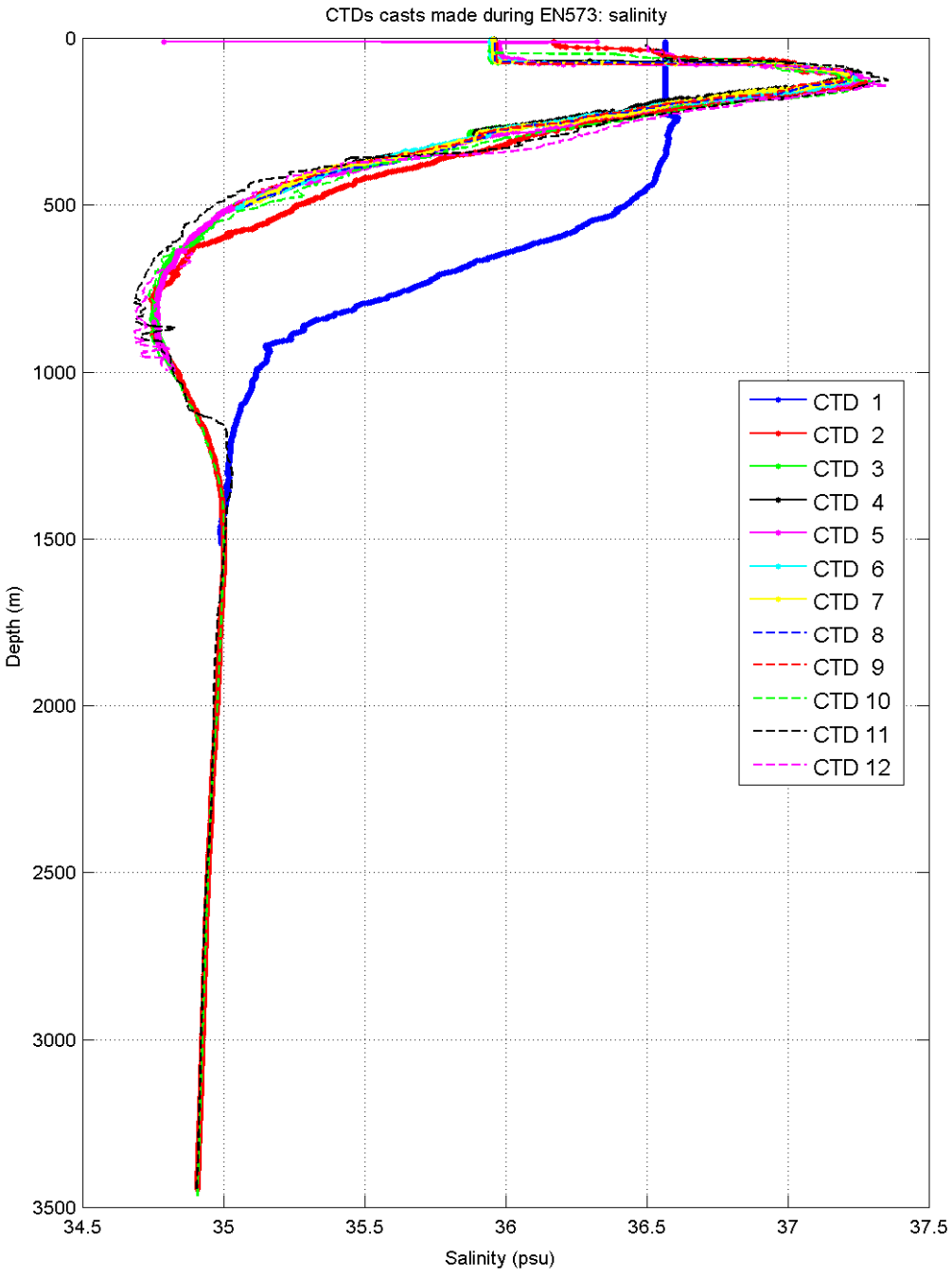


Figure V-2. All CTD casts made during EN573 cruise: salinity vs depth.

B. MOVE mooring operations

As quoted from the Meridional Overturning Variability Experiment (MOVE) website (http://mooring.ucsd.edu/index.html?/projects/move/move_results.html):

The meridional overturning circulation in the Atlantic Ocean carries much of the meridional heat flux, and speculations are abundant about variability, slowing, or potential collapse of this system, with the ensuing impacts on northern hemisphere climate. Figure V-3 shows the path of the southward branch (or "cold limb") of this regime (i.e. the Deep Western Boundary Current, DWBC, formed by North Atlantic Deep Water, NADW) in the North Atlantic. No monitoring system has existed until recently for the transports of this overturning circulation, thus all evidence of variability came from instantaneous estimates based on hydrography, or from numerical models.

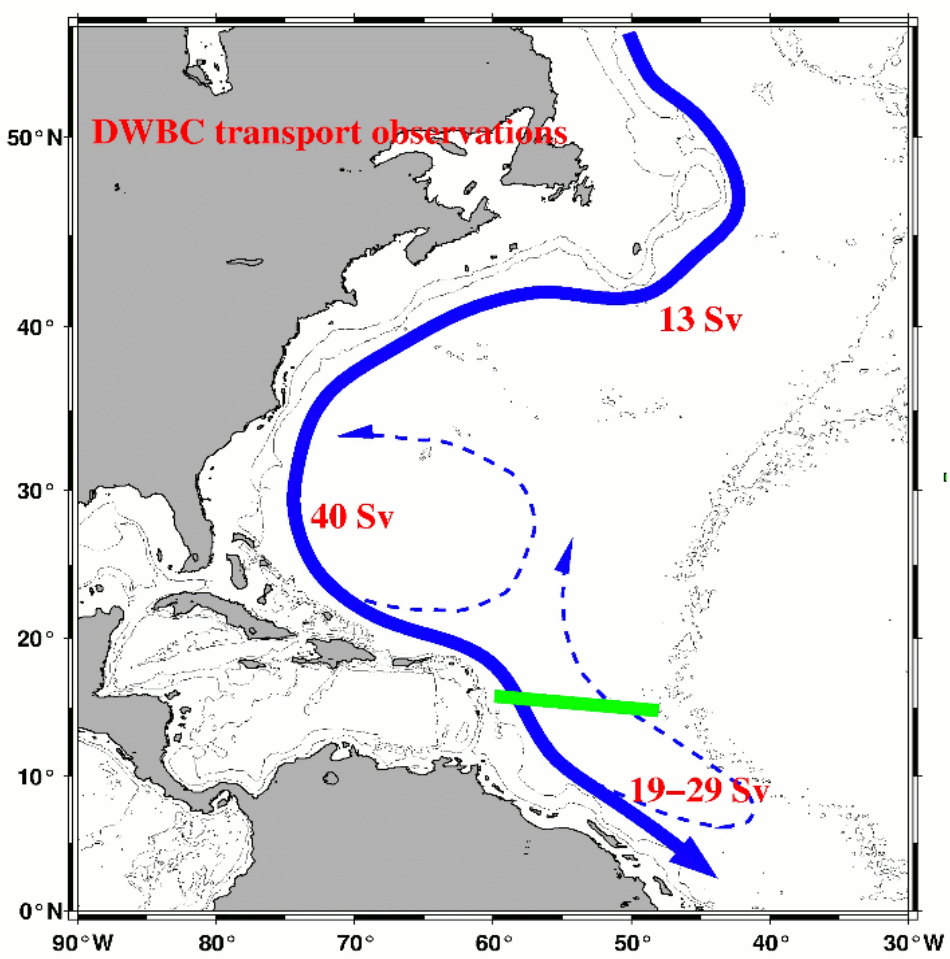


Figure V-3. Path of DWBC and estimated transports of the NADW, including indirectly inferred recirculation. MOVE measures the flow of water in the NADW depth range across the green line.

In the original configuration, three "geostrophic end-point moorings" (MOVE1, MOVE2, MOVE3) plus one traditional current meter mooring on the slope (MOVE4) have been used to cover the section between the Lesser Antilles (Guadeloupe) and the Mid-Atlantic Ridge. The goal is to determine the transport fluctuations across this section, using dynamic height and bottom pressure differences between the moorings for estimates of the geostrophic transport. The core system of moorings has occasionally been augmented with additional measurements, including acoustic thermometry, RAFOS floats, and more bottom pressure sensors for comparison with GRACE satellite data.

The MOVE moorings were first deployed in 2000, and have measured temperature, salinity, and currents ever since. The goal of the project is to observe the volume of water transported across the section covered by the array. There are multiple components to this volume transport, documented by Kanzow et al (2006).

The MOVE program is ran by a team from Scripps Institution of Oceanography. Five personnel from SIO participated in the EN573 cruise to support work for MOVE. All three MOVE subsurface moorings (MOVE1, 3 and 4) were turned over during the EN573 cruise. Acoustic communication was also conducted using over the board transducer to check the status of subsurface moorings and recover data from some of the PIES deployed last year (see NTAS-14 cruise report). CTD casts (Table V-1) were also conducted with MOVE instruments attached to the Rosette for calibration of their conductivity, temperature and oxygen sensors. During these CTD casts, the winch was stopped at a few depths below the main thermocline for a few minutes until the instruments had equilibrated to the environmental temperature and the Rosette motion was minimized. At the end of each stop, a water sample was taken in a Niskin bottle on the Rosette, for calibration of salinity (made onboard using salinometer Guildline Autosal 8400B) and oxygen (post-cruise).

MOVE 1-12 deployment track was about 15 nm WSW of the target position. MOVE 3 and 4 are in a fishing area and several fishing gear (floats with nets) were spotted during deployment and recovery operations. MOVE 3-12 deployment track was 10.5 nm away from target. Due to time constraints and communications problems with acoustic releases, the anchor survey was replaced by a triangulation of the modem on MOVE 3-12.

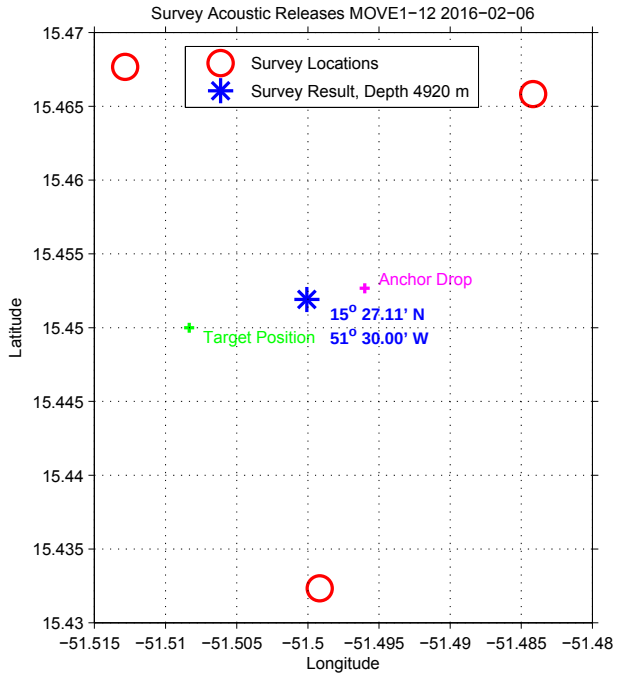


Figure V-4. Anchor survey for MOVE 1-12 deployed on February 6 2016 (anchor drop 23:15 UTC).

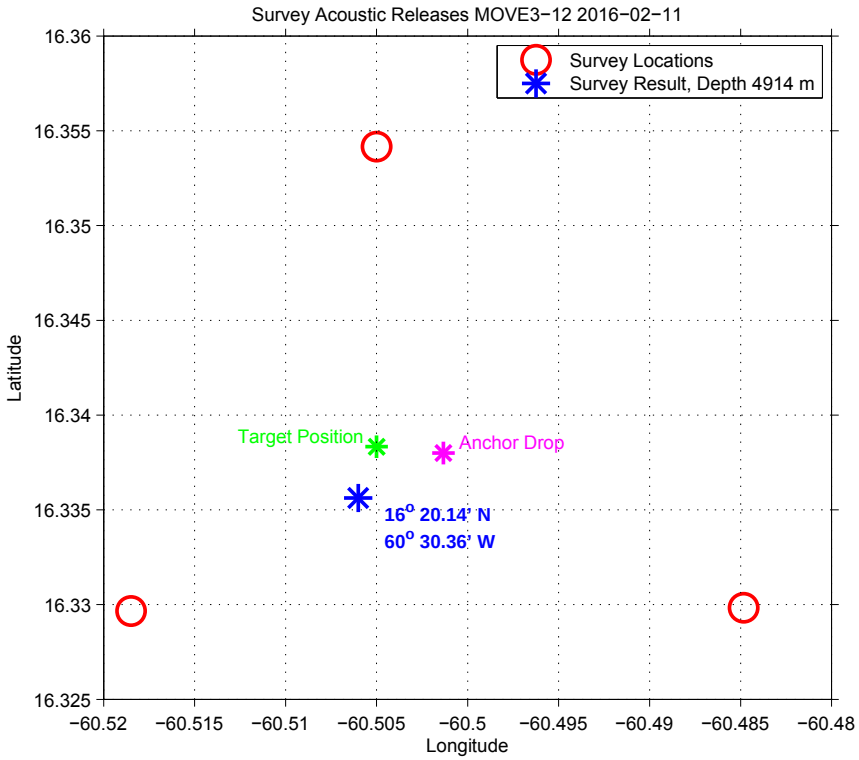


Figure V-5. Anchor survey for MOVE 3-12 deployed on February 11 2016 (anchor drop 21:47 UTC).

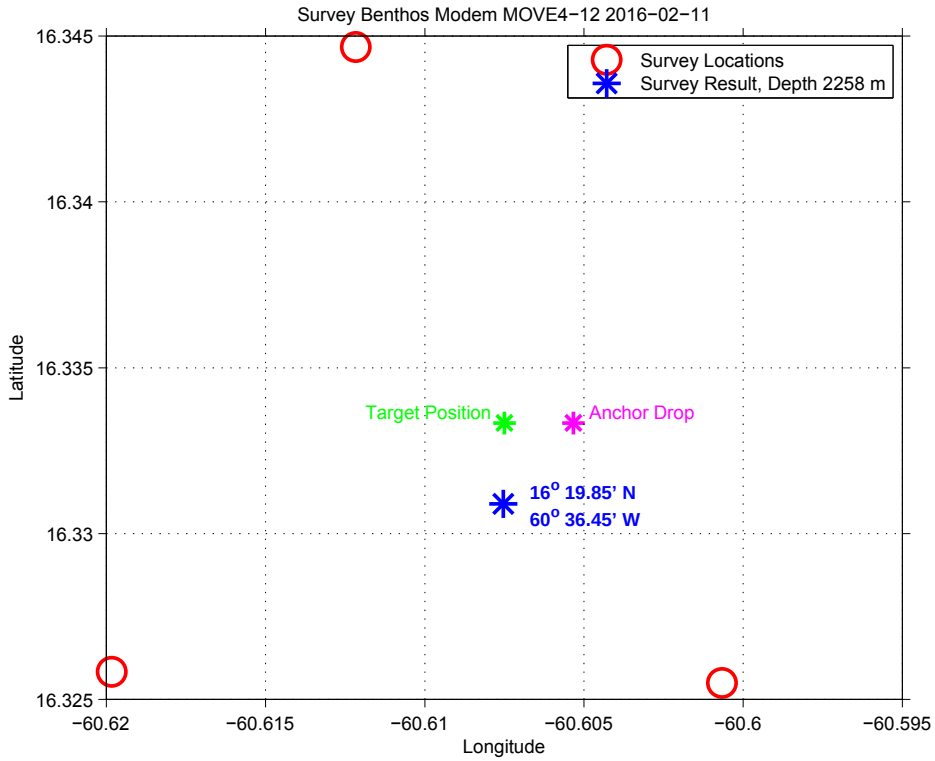


Figure V-6. Anchor survey for MOVE 4-12 deployed on February 10 2016 (anchor drop 19:18 UTC).

Table V-2. MOVE subsurface moorings deployed during EN573 cruise.

Mooring	Anchor Drop: Date/Time	Anchor Drop: Lat	Anchor Drop: Lon	Anchor Lat	Anchor Lon	Approximate Depth (m)
MOVE 1-12	2/6/2016 23:15	15 27.16‘	51 29.76’	15 27.11’	51 30.00’	4960
MOVE 3-12	2/11/2016 21:47	16 20.16‘	60 36.72’	16 20.14’	60 30.36’	4914
MOVE 4-12	2/10/2016 19:18	16 20.00‘	60 36.32’	16 19.85’	60 36.45’	2258

* Coordinates of modem, about 700m above anchor.

Acknowledgements

The help and professionalism of the crew of the R/V Endeavor during the EN573 cruise is greatly appreciated. The Marine Operations office at the University of Rhode Island was also instrumental in the logistics pre and post-cruise.

Thanks to the National Ocean and Atmospheric Administration for its continuing support of the NTAS and MOVE projects. The projects are funded by the Climate Observation Division, Climate Program Office (FundRef number 100007298), National Oceanic and Atmospheric Administration, U.S. Department of Commerce, under grants NA14OAR4320158 (NTAS) and NA15OAR4320071 (MOVE).

Appendix 1: NTAS-15 Buoy Spin

Woods Hole Buoy Spin

Heading 0
Turn 0

	Time	Date
Vanes Secured UTC	15:14:00	18-Nov-15

System 1		VANE	Compass	Direction	Sample Time
Logger	**L05**				
WND	**241**	356.90	359.30	-3.80	15:51:00
System 2		**Vane**	**Compass**	**Direction**	**Sample Time**
Logger	**L06**				
WND	**239**	0.00	1.20	1.20	15:48:00
		VANE	**Compass**	**Direction**	**Sample Time**
VWX006	Stand Alone	N/A	351.30	N/A	15:53:00

Heading 0
Turn 45

	Time	Date
Vanes Secured UTC	16:07:00	18-Nov-15

System 1		VANE	Compass	Direction	Sample Time
Logger	**L05**				
WND	**241**	313.30	45.40	-1.30	16:24:00
System 2		**Vane**	**Compass**	**Direction**	**Sample Time**
Logger	**L06**				
WND	**239**	314.80	46.00	0.80	16:27:00
		VANE	**Compass**	**Direction**	**Sample Time**
VWX 06	Stand Alone	N/A	33.90	N/A	16:29:00

Heading 0
Turn 90

	Time	Date
Vanes Secured UTC	16:39:00	18-Nov-15

System 1		VANE	Compass	Direction	Sample Time
Logger	**L05**				
WND	**241**	268.10	90.90	-1.00	17:08:00
System 2		**Vane**	**Compass**	**Direction**	**Sample Time**
Logger	**L06**				

WND	**239**	269.40	91.70	1.10	17:17:00
		VANE	**Compass**	**Direction**	**Sample Time**
VWX 06	Stand Alone	N/A	88.00	N/A	17:31:00

Heading	**0**				
Turn	**135**				
	Time	**Date**			
Vanes Secured UTC	17:38:00	18-Nov-15			
System 1		**VANE**	**Compass**	**Direction**	**Sample Time**
Logger	**L05**				
WND	**241**	224.60	135.10	-0.30	17:53:00
System 2		**Vane**	**Compass**	**Direction**	**Sample Time**
Logger	**L06**				
WND	**239**	223.30	136.90	0.20	17:52:00
		VANE	**Compass**	**Direction**	**Sample Time**
VWX 06	Stand Alone	N/A	134.20	N/A	17:50:00

Heading	**0**				
Turn	**180**				
	Time	**Date**			
Vanes Secured UTC	17:59:00	18-Nov-15			
System 1		**VANE**	**Compass**	**Direction**	**Sample Time**
Logger	**L05**	180.30	178.50	-1.20	18:17
WND	**241**				
System 2		**Vane**	**Compass**	**Direction**	**Sample Time**
Logger	**L06**				
WND	**239**	178.10	181.40	-0.50	18:54:00
		VANE	**Compass**	**Direction**	**Sample Time**
VWX 06	Stand Alone	N/A	181.50	N/A	18:46:00

Heading	**0**				
Turn	**225**				
	Time	**Date**			
Vanes Secured UTC	18:54:00	18-Nov-15			
System 1		**VANE**	**Compass**	**Direction**	**Sample Time**
Logger	**L05**				
WND	**241**	134.40	224.70	-0.90	19:11:00
System 2		**Vane**	**Compass**	**Direction**	**Sample Time**
Logger	**L06**				
WND	**239**	131.10	232.40	3.50	19:09:00
		VANE	**Compass**	**Direction**	**Sample Time**
VWX 005	Stand Alone	N/A	233.40	N/A	19:08:00

Heading	**0**				
Turn	**270**				
	Time	**Date**			
Vanes Secured UTC	19:16:00	18-Nov-15			
System 1		**VANE**	**Compass**	**Direction**	**Sample Time**
Logger	**L05**				
WND	**241**	87.10	267.50	-5.40	19:32:00
System 2		**Vane**	**Compass**	**Direction**	**Sample Time**
Logger	**L06**				
WND	**239**	87.80	271.80	-0.40	19:33:00
		VANE	**Compass**	**Direction**	**Sample Time**
VWX 06	Stand Alone	N/A	274.30	N/A	19:35:00

Heading	**0**				
Turn	**315**				
	Time	**Date**			
Vanes Secured UTC	19:40:00	18-Nov-15			
System 1		**VANE**	**Compass**	**Direction**	**Sample Time**
Logger	**L05**				
WND	**241**	42.20	312.30	-5.50	19:58:00
System 2		**Vane**	**Compass**	**Direction**	**Sample Time**
Logger	**L06**	44.50	316.40		19:57
WND	**239**			-360.00	
		VANE	**Compass**	**Direction**	**Sample Time**
VWX 06	Stand Alone	N/A	317.00	N/A	19:56:00

Appendix 2: NTAS-14 mooring log

Moored Station Log

(fill out log with black ball point pen only)

ARRAY NAME AND NO. NTAS 14 MOORED STATION NO. 1268

Launch (anchor over)

Date (day-mon-yr) 13-12-14 Time 18:27 UTC

Deployed by Ben Pietro Recorder/Observer Sebastien Bigorre

Ship and Cruise No. Endeavor EN549 Intended Duration 12 months

Depth Recorder Reading 4989 (12kHz) m Correction Source MaHews table

Depth Correction + 38 m m

Corrected Water Depth 5027 m Magnetic Variation (E/W)

Anchor Drop Lat. (N/S) 14° 44.72' Lon. (E/W) 50° 57.6'

Surveyed Pos. Lat. (N/S) 14° 44.64' Lon. (E/W) 50° 57.71'

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

Acoustic Release Model Edgetech 8242 Tested to 500 m

Release No. 1 (sn) 32483	Release No. 2 (sn) 33036
Interrogate Freq. 11 kHz	Interrogate Freq. 11 kHz
Reply Freq. 12 kHz	Reply Freq. 12 kHz
Enable 114703	Enable 314022
Disable 114720	Disable 314047
Release 132174	Release 332111

Recovery (release fired)

Date (day-mon-yr) 4-Feb-2016 Time 1408 UTC

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

Recovered by Ryder / Smith Recorder/Observer Bigorre

Ship and Cruise No. Endeavor EN573 Actual duration 418 days

Distance from waterline to buoy deck 75 cm

1

ARRAY NAME AND NO. NTAS 14 MOORED STATION NO. 1268

Surface Components

Buoy Type HDB Color(s) Hull Tower blue hull, yellow deck, white tower

Buoy Markings If found adrift contact Woods Hole Oceanographic Woods Hole, MA 02543 U 508-548-1401

Surface Instrumentation

Item	ID #	Height*	Comments
ASIMET Lgr	L16	buoy well	port side
HRH	231	233	
BPR	217	237	
WND	206	268	
PRC	214	239	
LWR	254	280	
SWR	212	280	
SST	3605		
PTT	18128		
ASIMET Lgr	L12	buoy well	stbd side
HRH	221	233	
BPR	219	237	
WND	207	268	
PRC	210	239 ~~270~~	
LWR	209	280	
SWR	214	280	
SST	1836		
PTT	67720		
VWX	5	250	
Lascar	10021813	226	
SBE 39AT	5272	212	
XEOS Melo			IMEI 300034013207760

*Height above buoy deck in centimeters

ARRAY NAME AND NO. NTAS 14 MOORED STATION NO. 1268

Subsurface Instrumentation on Buoy and Bridle			
Item	ID #	Depth†	Comments
SST	75556	95	RBR solo, 120° (port)
SST	75557	85	RBR solo, 180° (fwd)
SST	75558	95	RBR solo, 180° (fwd)
SST	75559	95	RBR solo, 240° (stbd)
WAMDAS	6015	buoy hull	IMET: 300124000010620
			SIM: 89881 69312 00205 1328
			NDBC #: 41NT0
S:S/Sable			XEOS IMEI 300034013905090
Iridium(SS) ↳ LIG	43720		IMEI 3002 2401 0043 720
Iridium			
†Depth below buoy deck in centimeters			

ARRAY NAME AND NO. NTAS 14 MOORED STATION NO. 1268

Item No.	Length (m)	Item	Depth	Inst No.	Time Over	Time Back	Notes
1		buoy	0		12:50	2230	
2	5m	EM chain			12:48		
3		SBE 39	5	539	12:48	2238	
4		Nortek ADCM	5.7	9467	1248	~~2300~~	heads up growth on 2 outside eyes
5		SBE 39	10	4465	1248	2258	IM
6		Nortek ADCM	13	5973	1248	2300	IM heads up fuzzy growth on eyes
7		SBE 39	15	545	1252	2304	
8		Nortek ADCM	18	432	1252	2307	heads up no desitin left on center beam
9		SBE 39	20	546	1252	2308	
10		SBE 37	25	669	1252	2309	IM
11		RBR Duo CT	26	61568	1252	2310	
12		SBE 39	30	631	1252	2311	
13		SBE 39	40	677	1252	2313	
14		SBE 37	45	684	1252	2314	IM
15		SBE 39	50	678	12:~~59~~ 55	2316	
16		SBE 39	60	680	12:59	2318	
17		SBE 37	65	686	1301	2319	IM
18		SBE 39	70	681	1303	2320	
19		SBE 39	80	4466	1305	~~2324~~ ~~2258~~	IM wrong ~~SN 4466~~
20		RDI ADCP	85	2125	1312	2144	heads up light covering of fuzz algae, incl always heads
21	78	7/16 wire					wire length marked 78
22	500	3/8 wire					
23		SBE 39	90	684	1315	2144	
24		SBE 39	100	750	1317	2143	
25		SBE 39	110	3480	1319	2141	

4

ARRAY NAME AND NO. NTAS 14 MOORED STATION NO. 1268

Item No.	Length (m)	Item	Depth	Inst No.	Time Over	Time Back	Notes
26		Starmon	110	3167	1319	2141	
27		Starmon	120	3168	1320	2140	
28		Starmon	130	3169	1320	2139	
29		Starmon	140	3170	132130	2138	
30		Starmon	150	3171	132245	2137	
31		Starmon	160	3791	132310	2136	
32	500	3/8 wire		14033	1335		
33	500	3/8 wire		13079-2	1352		
34	200	3/8 wire		121044	1409		
35	100	3/8 wire		121045	1417		encapsulated termination
36	200	7/8 nylon			1423	2045	
37	500	7/8 nylon			1459	1935	unspool TSE @ recovery
38	2000	3/4 nylon			1515	~~1935~~	
39	100	7/8 nylon					
40	1500	1" Colmega			1615		end colmega 16:45 recovery: start 1615, end 1740 (includes 30 min stop)
41		glassballs (56)		start end	1741	1533	4 4 4 1 2 broken @ recovery
42		SBE 37	4989	11392	1750	1555	
43		SBE 37	4989	11393	1750	1555	
44	5	1/2" chain					
45		release		32483	1800	1557	
46		release		33036	1800	1557	
47	5	1/2" chain					
48	20	1" nystrap					
49	5	1/2" chain					
50		Anchor			~~1424~~ 1427 5		14° 44.72 50° 57.6' depth ~~4992~~ m (+38) 1827 UTC

ARRAY NAME AND NO._____ MOORED STATION NO._____

Item No.	Length (m)	Item	Depth	Inst No.	Time Over	Time Back	Notes
51							
52							
53							
54							
55							
56							
57							
58							
59							
60							
61							
62							
63							
64							
65							
66							
67							
68							
69							
70							
71							
72							
73							
74							
75							

Appendix 3: NTAS-15 mooring log

Moored Station Log

(fill out log with black ball point pen only)

ARRAY NAME AND NO. NTAS 15 MOORED STATION NO. _____

Launch (anchor over)

Date (day-mon-yr) 2-2-2016 Time 1909 UTC

Deployed by Ryder / Smith Recorder/Observer Bigorre

Ship and Cruise No. Endeavor EN573 Intended Duration 365 days

Depth Recorder Reading 4945 (12kHz) m Correction Source Mattews table

Depth Correction +38m m _____

Corrected Water Depth 4983 m Magnetic Variation (E/W) _____

Anchor Drop Lat. (N/S) 14° 49.429' Lon. (E/W) 51° 00.819'

Surveyed Pos. Lat. (N/S) 14° 49.50' Lon. (E/W) 51° 00.978'

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

Acoustic Release Model Edgetech 8242 XS Tested to 1,500 m

Release No. 1 (sn) 35321 Release No. 2 (sn) 35322

Interrogate Freq. 11 kHz Interrogate Freq. 11 kHz

Reply Freq. 12 kHz Reply Freq. 12 kHz

Enable 111552 Enable 111613

Disable 111571 Disable 111630

Release 127524 Release 127541

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 75 cm

1

ARRAY NAME AND NO. NTAS 15 MOORED STATION NO. _____

Surface Components

Buoy Type MOB Color(s) Hull Tower blue hull, yellow deck, white tower

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	05		Starboard's J-box
HRH	232	235	
BPR	216	244	
WND	241	270	
PRC	213	235	
LWR	205	280	
SWR	213	280	
SST	3601	-153	forward stbd
PTT	14623		
ASIMET logger	06		Port's J-box
HRH	257	237	
BPR	212	244	
WND	239	270	
PRC	219	235	
LWR	208	280	
SWR	503	280	
SST	3604	-153	forward port
PTT	67720		
SBE 39AT	5270	225	
LASCAR		208	
VWX	006	258	
XEOS Relo			300034013709960

*Height above buoy deck in centimeters

2

ARRAY NAME AND NO. NTAS 15 MOORED STATION NO. _____

Subsurface Instrumentation on Buoy and Bridle			
Item	ID #	Depth†	Comments
SST SOLO-T	10035	95	60° Port
SST SOLO-T	10036	85	0° Forward
SST SOLO-T	10037	95	0° Forward
SST SOLO-T	10038	95	60° Starboard
WAMDAS	6017	buoy well	300224010103770 IMEI
			8988 1693 1200 2051 229 SIM
			Iridium ID 25719
			NDBC# 28560
XEOS	kilo		300234062643350
Iridium	0432	buoy well	(Logger 05) 300224010237100
†Depth below buoy deck in centimeters			

ARRAY NAME AND NO. NTAS 15 MOORED STATION NO. _____

Item No.	Length (m)	Item	Depth	Inst No.	Time Over	Time Back	Notes
1		buoy	0		1308		
2	5	EM chain					
3		SBE 39	5	3479	1308		
4		NORTEK ADCM	5.7	12688	1308		
5		RBR SOLO-D	6	78197	1306		
6	79	7/16 wire					15187-7
7		SBE 37 IM	10	13409	1306		NO copper guard
8		NORTEK ADCM-IM	13	12309	1306		looks up with vane
9		SBE 39	15	7680	1306		
10		SBE 39	20	7681	1306		
11		NORTEK ADCP	24	12393	1306		
12		SBE 37 IM	25	13410	1306		no copper guard
13		SBE 39	30	7682	1306		
14		SBE 39	35	7683	1306		
15		SBE 37 IM	40	13411	1306		no copper guard
16		SBE 39	45	7684	1306		
17		SBE 39	50	7687	1306		
18		SBE 37 IM	55	13412	1306		no copper guard
19		SBE 39	60	7688	1314		
20		SBE 39	65	7689	1315		
21		SBE 37 IM	70	13413	1317		no copper guard
22		SBE 39	75	7690	1318		
23		SBE 39	80	7691	1325		
24		RBR SOLO-D	83	78198	1325		
25		RDI ADCP	85	23281	1328		looks up

4

ARRAY NAME AND NO. NTAS 15 MOORED STATION NO. _____

Item No.	Length (m)	Item	Depth	Inst No.	Time Over	Time Back	Notes
26	500	3/8 wire					15187-2
27		SBE 39	90	7692	1329		
28		SBE 39	100	7693	1329		
29		SBE 39	110	7694	1330		paired with star-oddi
30		Starmon Oddi	110	5275	1330		
31		Starmon Oddi	120 ~~110~~	5276	1331		
32		Starmon Oddi	130	5277	1331		
33		Starmon Oddi	140	5278	1331		
34		Starmon Oddi	150	5279	1333		
35		Starmon Oddi	160	5280	1334		
36	500	3/8 wire					14032-2
37	500	3/8 wire					15187-3
38	200	3/8 wire					14032-4
39	100	3/8 wire			1420		encapsulated termination 14032-6
40	200	7/8 nylon					
41	500	7/8 nylon					
42	2000	3/4 nylon					
43	100	7/8 nylon					
44	1500	1" Colmega					
45		glassballs (56)			1710		~~HHT~~ ~~HHT~~ IIII 14
46		SBE 16	38 m above	2323	1721		paired
47		SBE 16	bottom	2324	1721		
48	5	1/2" chain					
49		release		35321			paired
50		release		35322			

ARRAY NAME AND NO. NTAS 15 MOORED STATION NO. _____

Item No.	Length (m)	Item	Depth	Inst No.	Time Over	Time Back	Notes
51	5	1/2" chain					
52	20	1" nystron					
53	5	1/2" chain					
54		anchor					
55							
56							
57							
58							
59							
60							
61							
62							
63							
64							
65							
66							
67							
68							
69							
70							
71							
72							
73							
74							
75							

Appendix 4: NTAS-15 instrument setup

NTAS 15 2016 Deploy					
	System 1				
Module	Serial	Firmware Version	HeightAbove Deck (cm)	START (UTC)	Transit SPIKE
Logger (Starboard)	L05			2016/1/25 20:01	
PTT	14623	15441, 15442, 15444			
HRH	232		235	2016/1/25 20:01	
BPR	216		244	2016/1/25 20:01	
WND	241		270	2016/1/25 20:01	2016/1/30 1757 props blocked, 1923 props free
PRC	213		235 screen height	2016/1/25 20:01	2016/1/30 1639 first fill, 1915 second fill
LWR	205		280	2016/1/25 20:01	2016/1/30 1646 covers on, 1922 covers off
SWR	213		280	2016/1/25 20:01	2016/1/30 1646 covers on, 1922 covers off
SST	3601		153	2016/1/25 20:01	2016/1/26 21:06 in bucket, 21:23 connected to logger
SIM	0432	IMEI - 300224010237100			
	System 2				
Module	Serial	Firmware Version	HeightAbove Deck (cm)	START (UTC)	Transit SPIKE
Logger (Port)	L06			2016/1/25 21:16	
PTT	67720	15446, 15447, 26272			
HRH	257		237	2016/1/25 21:16	
BPR	212		244	2016/1/25 21:16	
WND	239		270	2016/1/25 21:16	2016/1/30 1757 props blocked, 1923 props free
PRC	219		235 screen height	2016/1/25 21:16	2016/1/30 1641 first fill, 1916 second fill
LWR	208		280	2016/1/25 21:16	2016/1/30 1646 covers on, 1922 covers off
SWR	503		280	2016/1/25 21:16	2016/1/30 1646 covers on, 1922 covers off
SST SBE37	3604		153	2016/1/25 21:16	2016/1/26 21:06 in bucket, 21:23 connected to logger
STAND ALONES					
SBE-39-AT	5270		225	2016/1/30 1501	
LASCAR	yes		208	2016/1/29 1700	
VWX	006		258		
SIM IMEI	300224010237100				
XEOS Melo	300034013709960				
XEOS Kilo	300234062644350				
WAMDAS				2016/1/31	
SN:	6017				
NDBC#	28560				
3DM-GX1	8713				
Magnetic variation	-17				
Iridium ID	25719				
IMEI #	300224010103770				
SIM#	8988 169312				

NTAS 15 Subsurface

Instrument	Serial	IM Address	Depth Meters	Sample Rate	Start Date	Start Time	Date Spike Start	Time Spike Start (UTC	Date Spike Stop	Time Spike Stop
NORTEK										
Aquadopp Current Meter	AQD 12688		5.7	1200	20150118	01:00	1/31/16	15:31:00	1/31/16	18:15:00
Aquadopp IM Current Meter	AQD 12309	041	13	1200	20150118	01:00	1/31/16	13:52:00	1/31/16	15:15:00
Aquadopp Profiler-2mhz	AQD 12393		24	3600	20150118	01:00	1/31/16	15:31:00	1/31/16	18:15:00
RBR										
Solo-D	78197		6	21600	20150118	01:00	1/31/16	13:52:00	1/31/16	15:21:00
Solo-D	78198		83	21600	20150118	01:00	1/31/16	13:52:00	1/31/16	15:21:00
Solo-T	100035		0.95	60	20150118	01:00	1/31/16	13:52:00	1/31/16	15:21:00
Solo-T	100036		0.85	60	20150118	01:00	1/31/16	13:52:00	1/31/16	15:21:00
Solo-T	100037		0.95	60	20150118	01:00	1/31/16	13:52:00	1/31/16	15:21:00
Solo-T	100038		0.95	60	20150118	01:00	1/31/16	13:52:00	1/31/16	15:21:00
SBE										
SBE16	2323		4962	1800	20150118	01:00	1/31/16	16:02:00	1/31/16	18:18:00
SBE16	2324		4962	1800	20150118	01:00	1/31/16	16:02:00	1/31/16	18:18:00
SST										
SBE37-SM	3601		SST	300	20150118	01:00	1/26/16	21:23:00	N/A	N/A
SBE37-SM	3604		SST	300	20150118	01:00	1/26/16	21:23:00	N/A	N/A
SBE37-IM	13409	3	10	600	20150105	01:00	1/31/16	13:52:00	1/31/16	15:17
SBE37-IM	13410	4	25	600	20150105	01:00	1/31/16	13:52:00	1/31/16	15:17
SBE37-IM	13411	5	40	600	20150105	01:00	1/31/16	13:52:00	1/31/16	15:17
SBE37-IM	13412	7	55	600	20150105	01:00	1/31/16	13:52:00	1/31/16	15:17
SBE37-IM	13413	8	70	600	20150105	01:00	1/31/16	13:52:00	1/31/16	15:17
SBE39	3479		5	300	20150118	01:00	1/31/16	13:52:00	1/31/16	15:21:00
SBE39	7680		15	300	20150118	01:00	1/31/16	13:52:00	1/31/16	15:21:00
SBE39	7681		20	300	20150118	01:00	1/31/16	13:52:00	1/31/16	15:21:00
SBE39	7682		30	300	20150118	01:00	1/31/16	13:52:00	1/31/16	15:21:00
SBE39	7683		35	300	20150118	01:00	1/31/16	13:52:00	1/31/16	15:21:00
SBE39	7684		45	300	20150118	01:00	1/31/16	13:52:00	1/31/16	15:21:00
SBE39	7687		50	300	20150118	01:00	1/31/16	13:52:00	1/31/16	15:21:00
SBE39	7688		60	300	20150118	01:00	1/31/16	13:52:00	1/31/16	15:21:00
SBE39	7689		65	300	20150118	01:00	1/31/16	13:52:00	1/31/16	15:21:00
SBE39	7690		75	300	20150118	01:00	1/31/16	13:52:00	1/31/16	15:21:00
SBE39	7691		80	300	20150118	01:00	1/31/16	13:52:00	1/31/16	15:21:00
SBE39	7692		90	300	20150118	01:00	1/31/16	13:52:00	1/31/16	15:21:00
SBE39	7693		100	300	20150118	01:00	1/31/16	13:52:00	1/31/16	15:21:00
SBE39	7694		110	300	20150118	01:00	1/31/16	13:52:00	1/31/16	15:21:00
STARR										
Starmon Mini	5275		110	600	20150118	01:00	1/31/16	13:52:00	1/31/16	15:21:00
Starmon Mini	5276		120	600	20150118	01:00	1/31/16	13:52:00	1/31/16	15:21:00
Starmon Mini	5277		130	600	20150118	01:00	1/31/16	13:52:00	1/31/16	15:21:00
Starmon Mini	5278		140	600	20150118	01:00	1/31/16	13:52:00	1/31/16	15:21:00
Starmon Mini	5279		150	600	20150118	01:00	1/31/16	13:52:00	1/31/16	15:21:00
Starmon Mini	5280		160	600	20150118	01:00	1/31/16	13:52:00	1/31/16	15:21:00
Teledyne RDI										
WH 300KHZ	23281		85	3600	20150118	01:00				

The inductive string is sampled every 10 minutes by the SIM controller, then 24 samples are sent to the Iridium box every 4 hours and are processed into 1-hour averages for transmiss

NTAS 14 Sea Surface Temperature Array

Instrument	Serial		Location	Cm Below Deck	Orientation Degrees
RBR SoloT	10035		PORT	95	60
RBR SoloT	10036		FORWARD	85	0
RBR SoloT	10037		FORWARD	95	0
RBR SoloT	10038		STARBOARD	95	60

Note: for post-cruise spike, SSTs were put in seawater bucket (no ice) at 21:06 and connected to loggers at 21:23 UTC.

NORTEKS:

Aquadopp 12309:
Deployment : N15
Current time : 12/6/15 3:24:32 PM
Start at : 1/18/16 1:00:00 AM
Comment:
AQD-12309, NTAS 15, 13m, SIM ID# 041,
Measurement interval (s) : 1200
Average interval (s) : 180
Blanking distance (m) : 0.35
Measurement load (%) : 4
Power level : HIGH-
Diagnostics interval(min) : 1440:00
Diagnostics samples : 50
Compass upd. rate (s) : 1
Coordinate System : ENU
Speed of sound (m/s) : MEASURED
Salinity (ppt) : 36
Analog input 1 : NONE
Analog input 2 : NONE
Analog input power out : DISABLED
File wrapping : OFF
TellTale : OFF
AcousticModem : OFF
Serial output : OFF
Baud rate : 9600
Assumed duration (days) : 540.0
Battery utilization (%) : 85.0
Battery level (V) : 11.1
Recorder size (MB) : 9
Recorder free space (MB) : 8.894
Memory required (MB) : 2.7
Vertical vel. prec (cm/s) : 1.4
Horizon. vel. prec (cm/s) : 0.8
Instrument ID : AQD12309
Head ID : ALD 7062
Firmware version : 3.36
Inductive modem : ENABLED
Device ID : 41
Transmit power level : HIGH
Data format : ASCII

Aquadopp 12393:
Deployment : N15
Current time : 12/8/15 11:15:12 PM
Start at : 1/18/16 1:00:00 AM
Comment:
600kHz, 24m, AQD 12393, N15
Profile interval (s) : 3600
Number of cells : 15
Cell size (m) : 2.00
Blanking distance (m) : 0.50
Measurement load (%) : 25
Average interval (s) : 240
Power level : HIGH
Wave data collection : DISABLED
Compass upd. rate (s) : 1
Coordinate System : ENU
Speed of sound (m/s) : MEASURED
Salinity (ppt) : 36
Analog input 1 : NONE
Analog input 2 : NONE
Analog input power out : DISABLED
File wrapping : OFF
TellTale : OFF
Acoustic modem : OFF
Serial output : OFF
Baud rate : 9600
Assumed duration (days) : 540.0
Battery utilization (%) : 98.0
Battery level (V) : 11.1
Recorder size (MB) : 3773
Recorder free space (MB) : 3772.972
Memory required (MB) : 2.1
Vertical vel. prec (cm/s) : 0.5
Horizon. vel. prec (cm/s) : 1.6
Instrument ID : AQD12393
Head ID : AQP 7429
Firmware version : 3.40
ProLog ID : 1131
ProLog firmware version : 4.22
SD Card Inserted : YES
SD Card Ready : YES
SD Card Write protected : NO
SD Card Type : SDHC
SD Card Supported : YES

Aquadopp 12688:
Deployment : N15
Current time : 12/8/15 11:58:29 PM
Start at : 1/18/16 1:00:00 AM
Comment:
AQD 12688, 5.7m, N15
Measurement interval (s) : 1200
Average interval (s) : 180
Blanking distance (m) : 1.01
Measurement load (%) : 4
Power level : HIGH-
Diagnostics interval(min) : 1440:00
Diagnostics samples : 100
Compass upd. rate (s) : 1
Coordinate System : ENU
Speed of sound (m/s) : MEASURED
Salinity (ppt) : 36
Analog input 1 : NONE
Analog input 2 : NONE
Analog input power out : DISABLED
File wrapping : OFF
TellTale : OFF
AcousticModem : OFF
Serial output : OFF

Baud rate : 9600
Assumed duration (days) : 540.0
Battery utilization (%) : 84.0
Battery level (V) : 11.2
Recorder size (MB) : 9
Recorder free space (MB) : 8.973
Memory required (MB) : 3.7
Vertical vel. prec (cm/s) : 1.4
Horizon. vel. prec (cm/s) : 0.8
Instrument ID : AQD12688
Head ID : AQD 7357
Firmware version : 3.36

SEABIRD

SBE37IM#13409
S>#03ds
SBE37-IM v3.1 SERIAL NO. 13409 06 Dec 2015 20:45:55
vMain = 6.92, vLith = 3.15
samplenumber = 0, free = 838860
not logging, waiting to start at 05 Jan 2016 01:00:00
sample interval = 600 seconds
data format = converted engineering
compatible mode enabled
do not transmit sample number
do not transmit sample HEX time
pump installed = no
reference pressure = 0.0 decibars
PC baud rate = 9600

SBE37IM#13410:
S>#04ds
SBE37-IM v3.1 SERIAL NO. 13410 06 Dec 2015 20:52:34
vMain = 6.97, vLith = 3.16
samplenumber = 0, free = 838860
not logging, waiting to start at 05 Jan 2016 01:00:00
sample interval = 600 seconds
data format = converted engineering
compatible mode enabled
do not transmit sample number
do not transmit sample HEX time
pump installed = no
reference pressure = 0.0 decibars
PC baud rate = 9600

SBE37IM#13411:
S>#05ds
SBE37-IM v3.1 SERIAL NO. 13411 06 Dec 2015 21:03:27
vMain = 6.96, vLith = 3.15
samplenumber = 0, free = 838860
not logging, waiting to start at 05 Jan 2016 01:00:00
sample interval = 600 seconds
data format = converted engineering
compatible mode enabled
do not transmit sample number
do not transmit sample HEX time
pump installed = no
reference pressure = 0.0 decibars
PC baud rate = 9600

SBE37IM#13412:
S>#07ds
SBE37-IM v3.1 SERIAL NO. 13412 06 Dec 2015 21:07:43
vMain = 7.04, vLith = 3.12
samplenumber = 0, free = 838860
not logging, waiting to start at 05 Jan 2016 01:00:00
sample interval = 600 seconds
data format = converted engineering
compatible mode enabled
do not transmit sample number
do not transmit sample HEX time
pump installed = no
reference pressure = 0.0 decibars
PC baud rate = 9600

SBE37IM#13413:
S>#$08ds
SBE37-IM v3.1 SERIAL NO. 13413 06 Dec 2015 20:39:17
vMain = 7.03, vLith = 3.14
samplenumber = 0, free = 838860
not logging, waiting to start at 05 Jan 2016 01:00:00
sample interval = 600 seconds
data format = converted engineering
compatible mode enabled
do not transmit sample number
do not transmit sample HEX time
pump installed = no
reference pressure = 0.0 decibars
PC baud rate = 9600

SBE16#2323:
S>time out sds
#S>ds
SEACAT V4.1a SERIAL NO. 2323 12/06/15 13:38:10.993
clk = 32768.070, iop = 102, vmain = 8.9, vlith = 5.4
at 01/18/16 01:00:00.000 sample interval = 1800 sec
start time = 01/18/16 01:00:00.000
samples = 0, free = 260821, lwait = 0 msec

SW1 = C0H, battery cutoff = 5.6 volts
no. of volts sampled = 0
mode = normal
logdata = NO

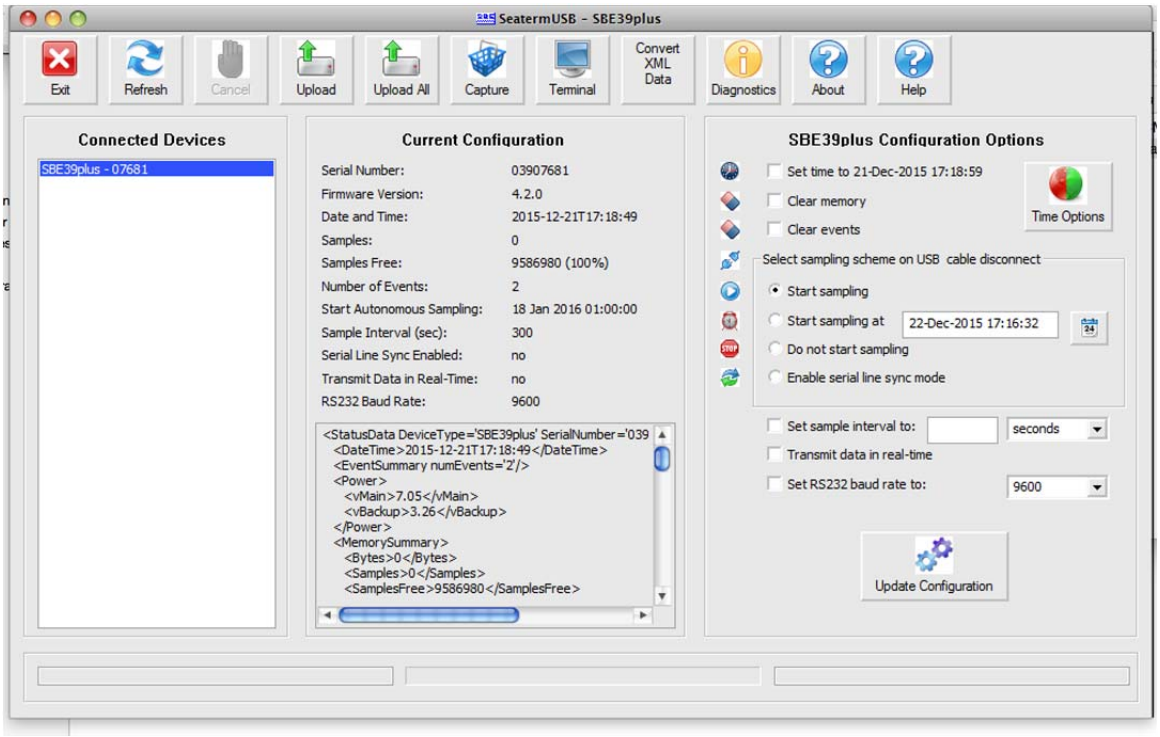
SBE16#2324:

S>ds
SEACAT V4.1a SERIAL NO. 2324   12/06/15 18:03:06.865
clk = 32768.063, iop = 95, vmain = 8.9, vlith = 4.7
at 01/18/16 01:00:00.000 sample interval = 1800 sec
start time = 01/18/16 01:00:00.000
samples = 0, free = 260821, lwait = 0 msec
SW1 = C0H, battery cutoff = 5.6 volts
no. of volts sampled = 0
mode = normal
logdata = NO

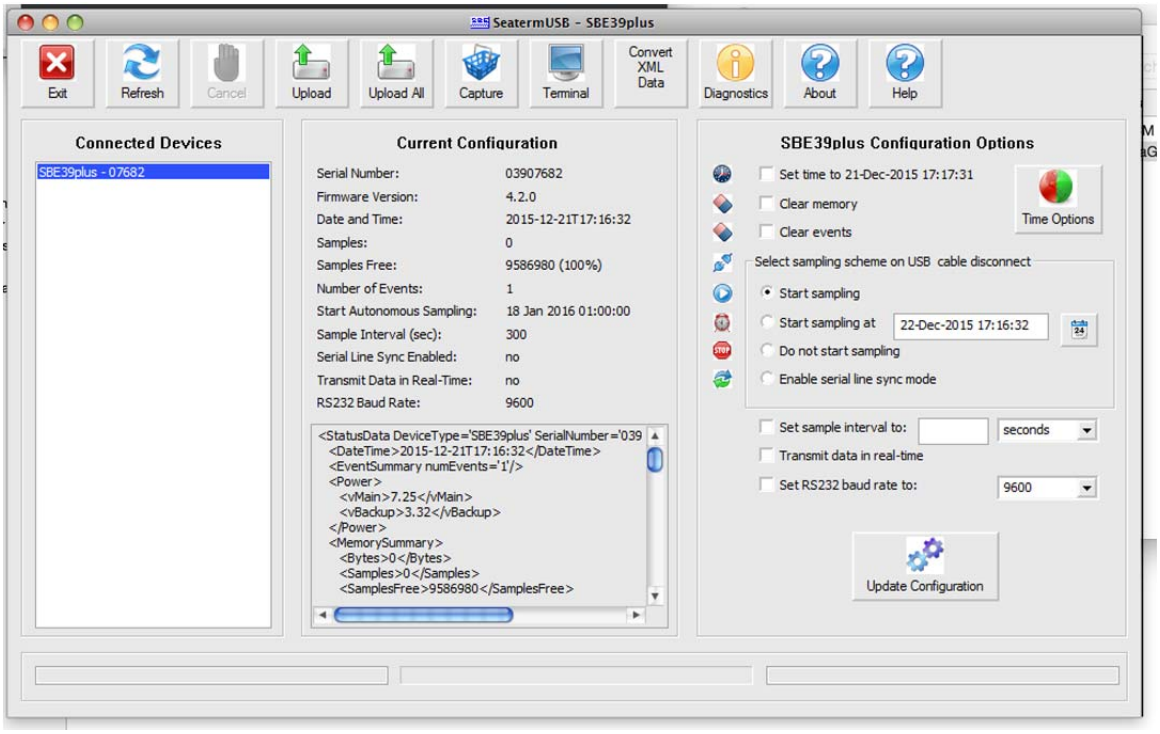
SBE39#3479:

S>ds
SBE 39 V 3.0b   SERIAL NO. 3479   03 Dec 2015 20:26:35
battery voltage = 8.5
not logging: waiting to start at 18 Jan 2016 01:00:00
sample interval = 300 seconds
samplenumber = 0, free = 599186
serial sync mode disabled
real-time output disabled
SBE 39 configuration = temperature only
binary upload does not include time
temperature = 22.66 deg C
S>
timeout

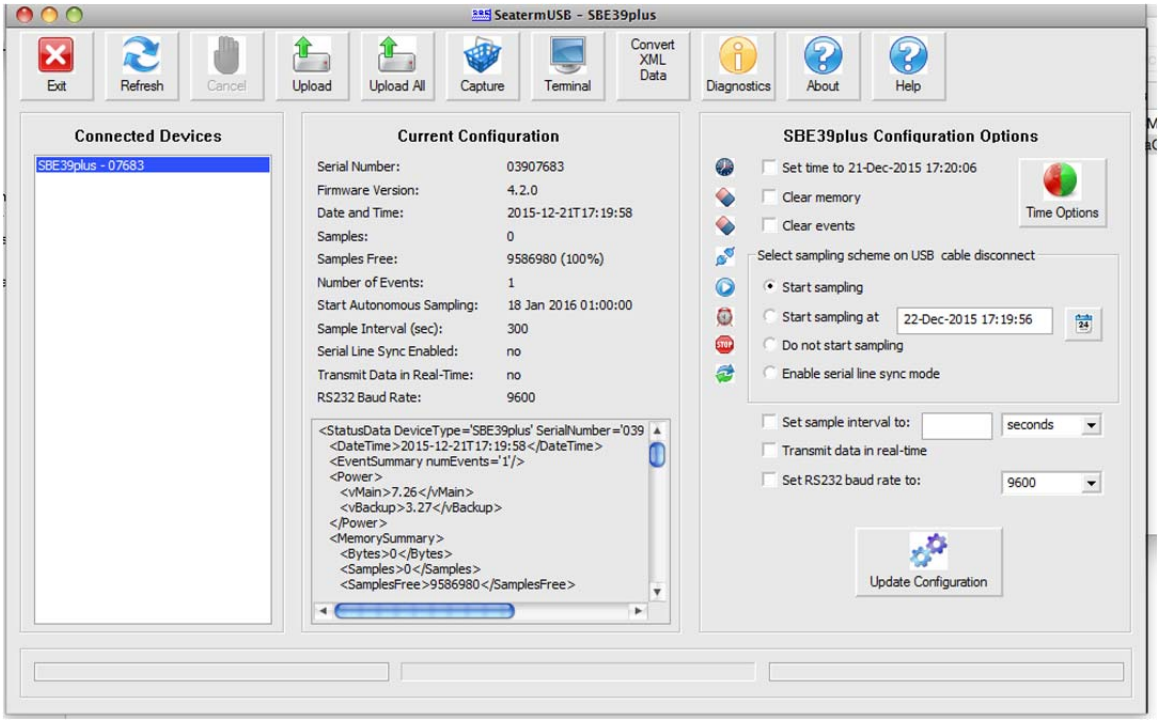
SBE39#7681:



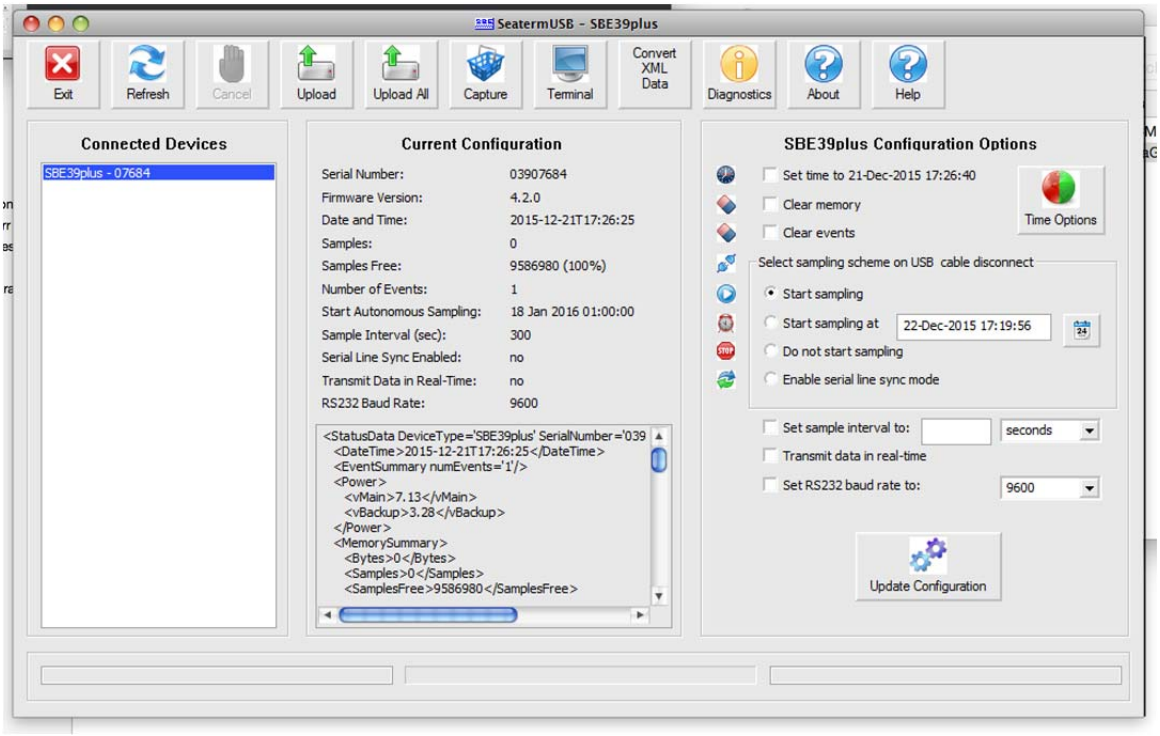
SBE39#7682:



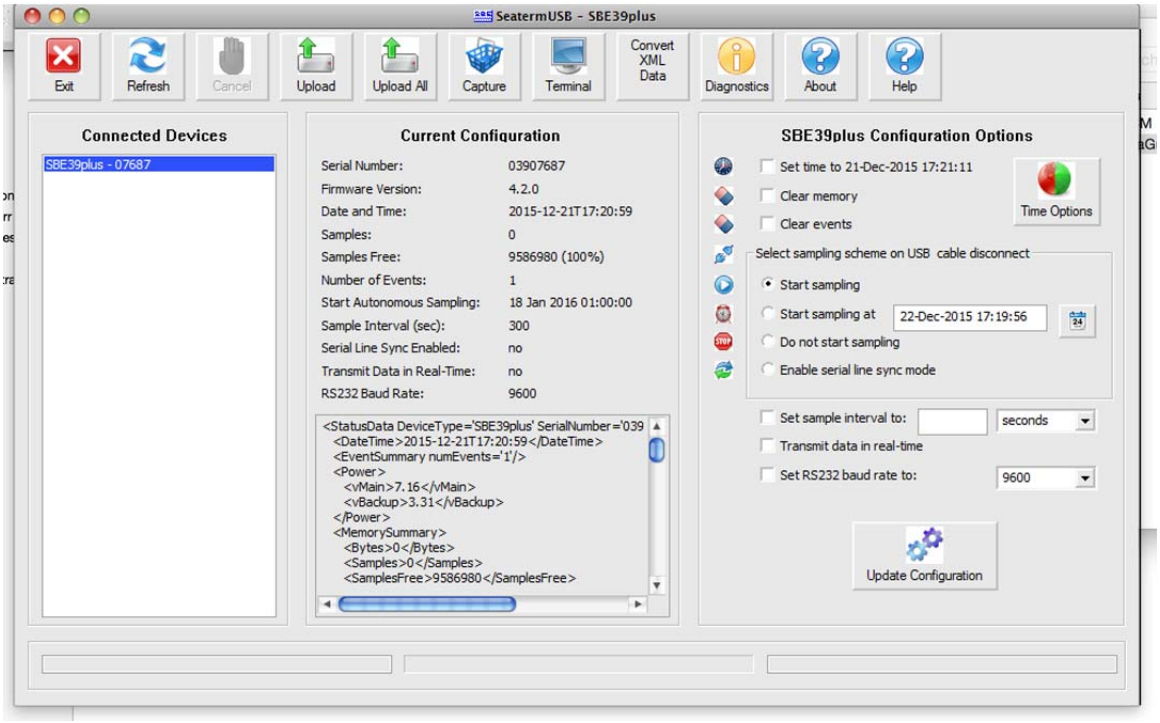
SBE39#7683:



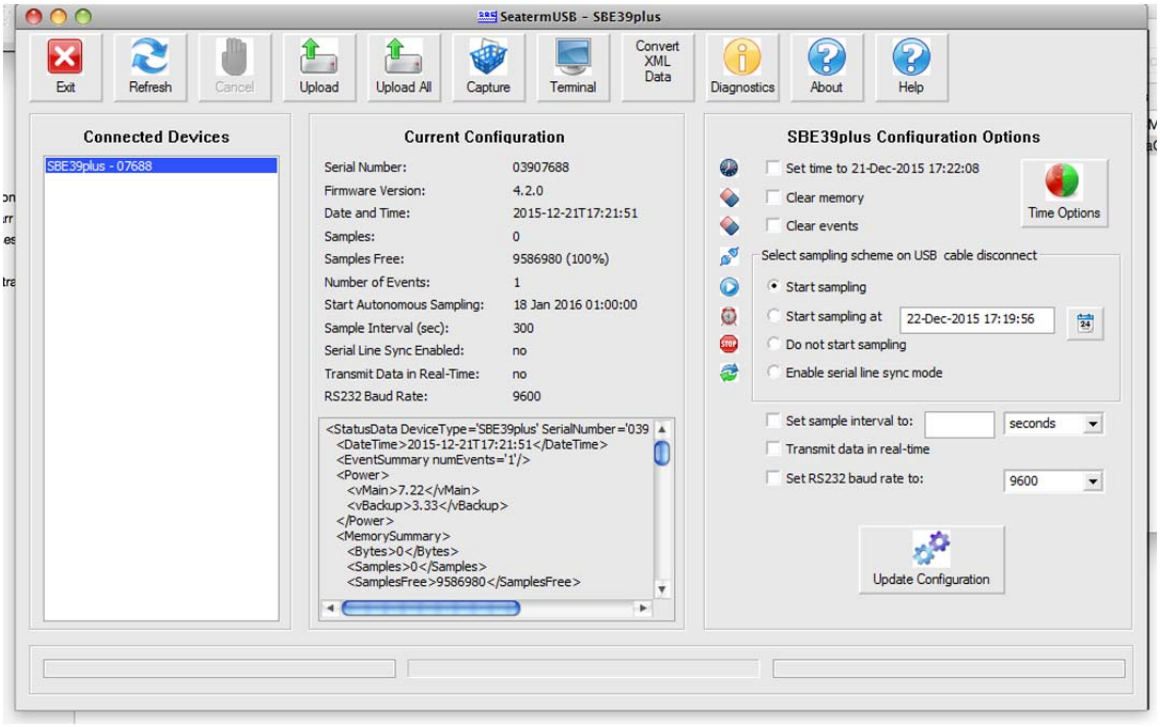
SBE39#7684:



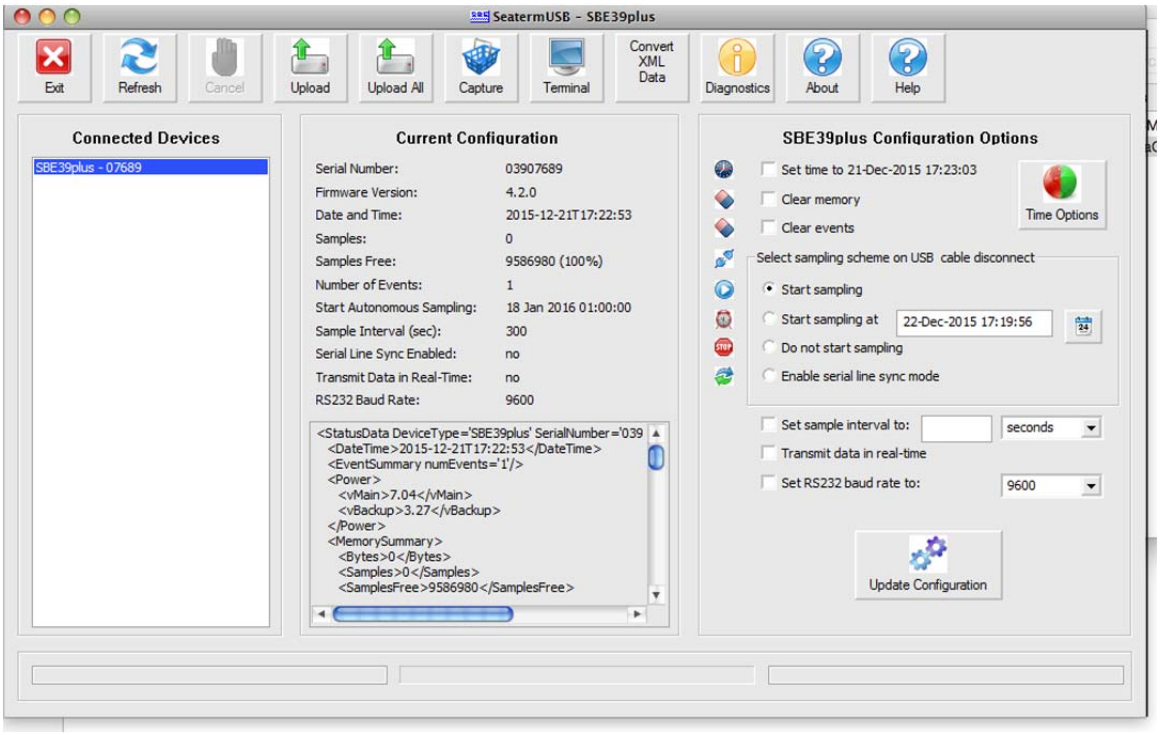
SBE39#7687:



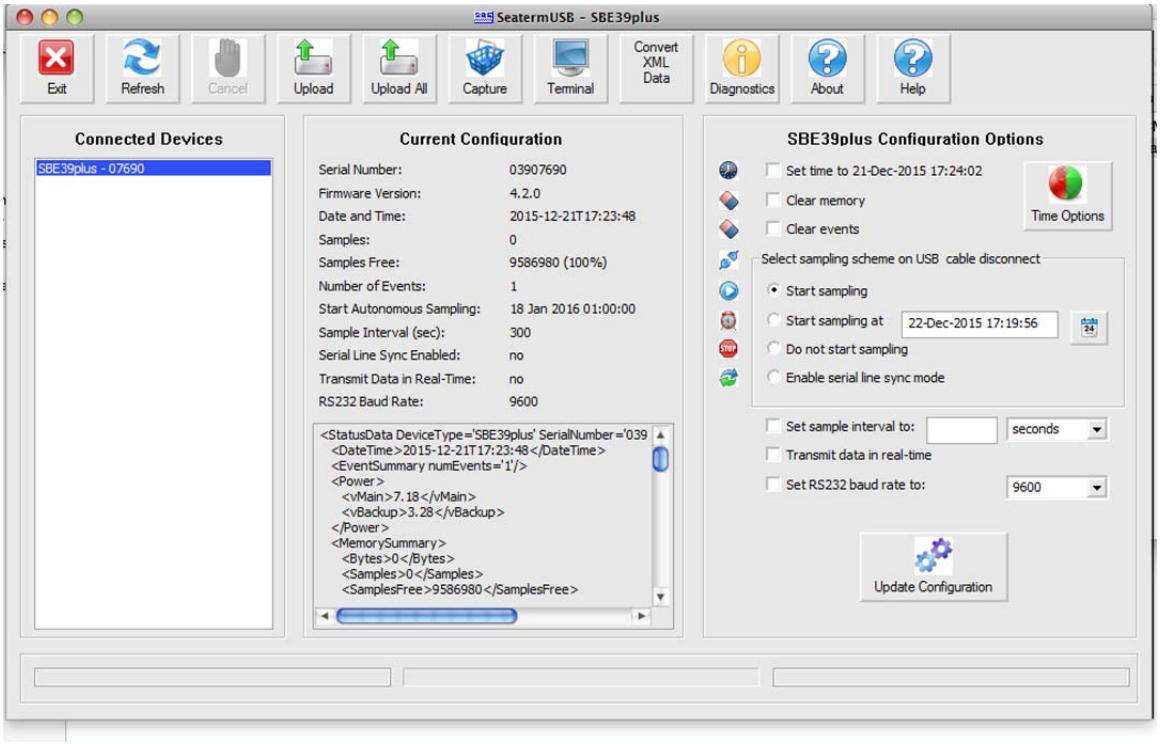
SBE39#7688:



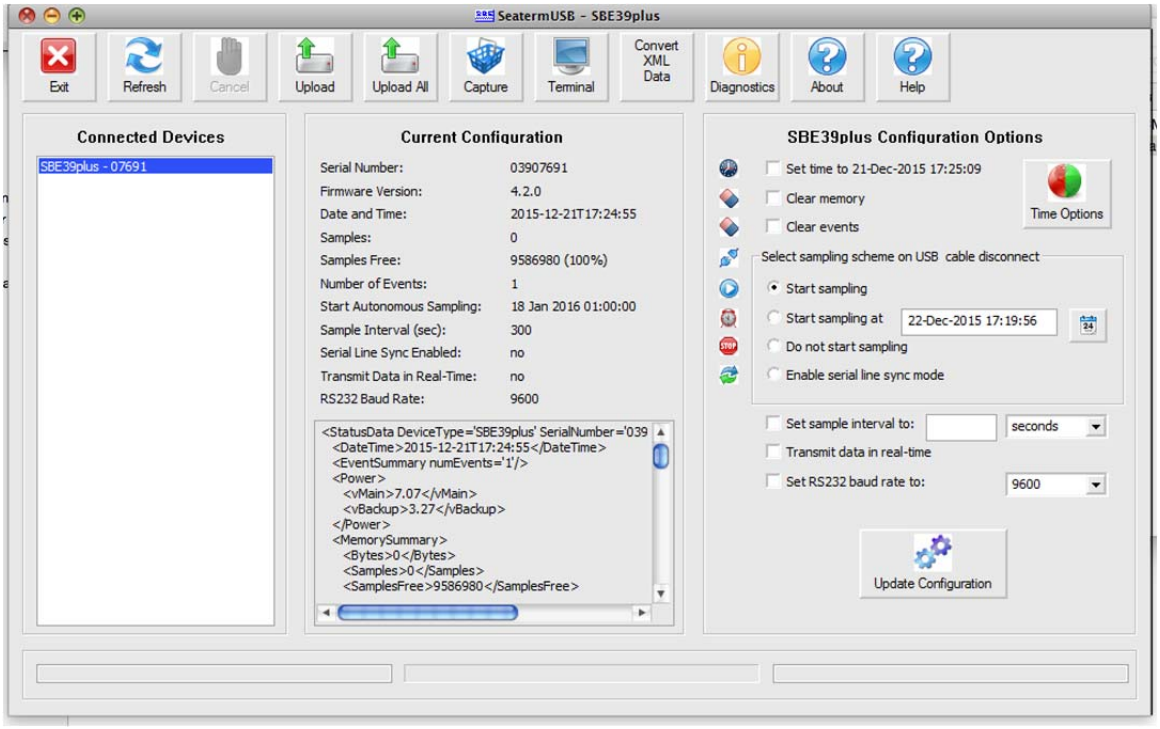
SBE39#7689:



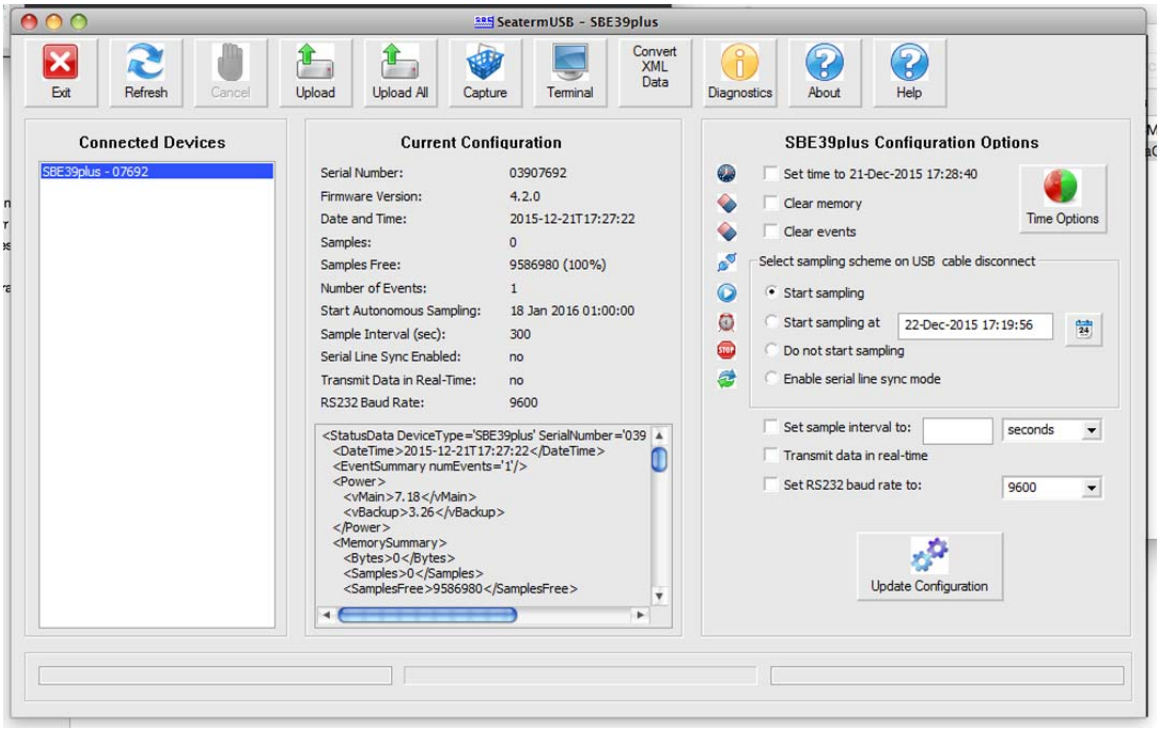
SBE39#7690:



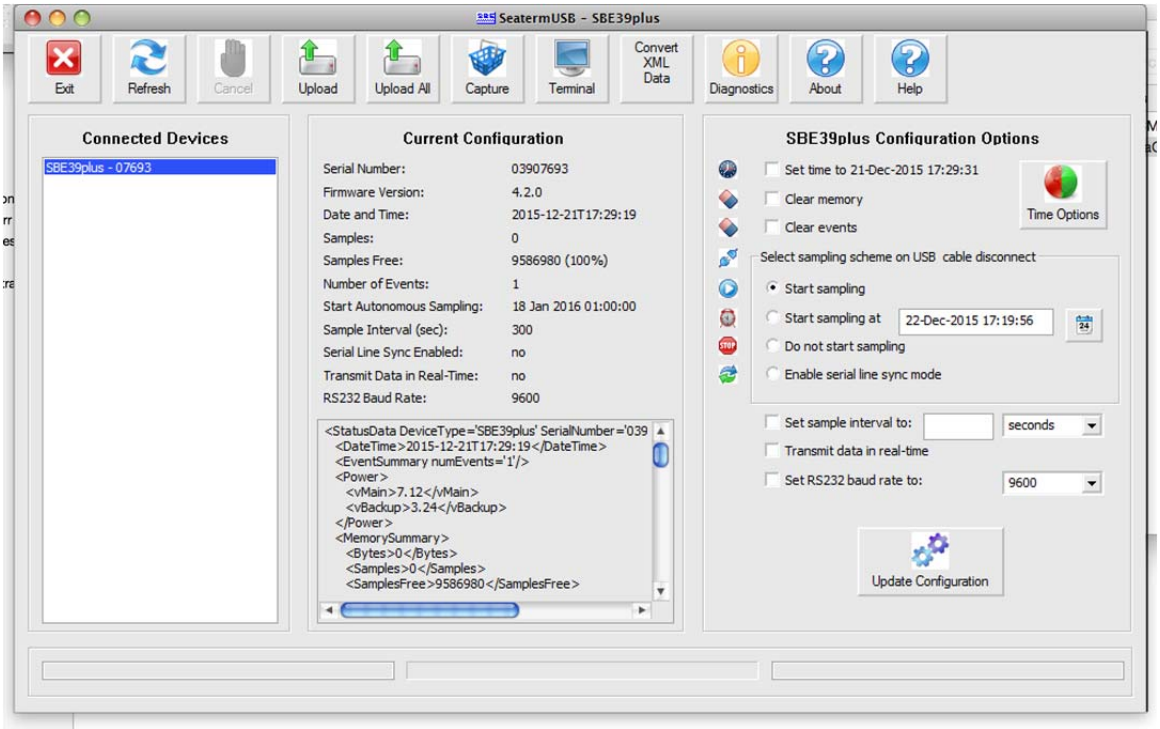
SBE39#7691:



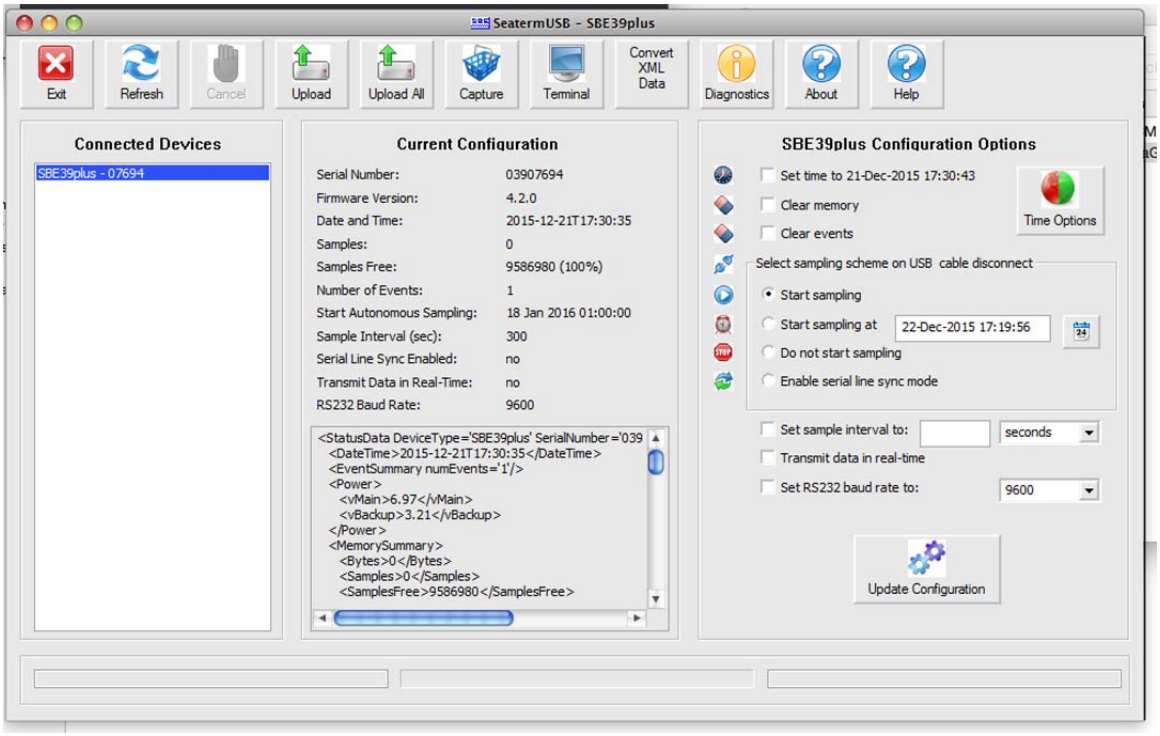
SBE39#7692:



SBE39#7693:



SBE39#7694:



STARMON:

Starmon#5275:

Filename: C:\SeaStar\Starmon mini\T5275\T5275.RDT
SeaStar 7.21
Recorder type : Starmon mini
Recorder number : T5275
Recorder version : 23 CRC8/38400/HighRes
Recorder measures : Temperature
Recorder memory(byte/meas.) : 524063 / 349375
Measurement sequence number : 1
Recorder started from PC : 12/13/2015 6:17:35 PM
Measurement interval def. : Single interval = 00:10:00
Measurement start time : 1/18/2016 1:00:00 AM
Measurement settings: [dd:hh:mm:ss] x number
Start delay : 35:06:42:25
1. interval period : 00:10:00 x 65535
2. interval period : 00:10:00 x 65535
Estimated time duration and battery usage for NMS
Battery energy at start (%): 98.0

Cycle 1			Meas.taken	
Seq/Inr	Date&Time	Batt.used(%)	Mem.used(%)	Temp
1/1	4/17/2017 3:30:00 AM	5	25	65535
2/2	7/16/2018 6:00:00 AM	11	50	131070

Cycle 2 Meas.taken
Seq/Inr Date&Time Batt.used(%) Mem.used(%) Temp
1/1 10/14/2019 8:30:00 AM 16 75 196605
Memory full : 1/10/2021 5:00:00 PM
After (days:hours) : 1819:16
In Cycle : 2
In sequence : 2
In Interval : 1
In measurement : 65427
Total meas. taken : 262032
Battery used (%) : 22.2
Battery left (%) : 75.8

Starmon#5276:
Filename: C:\SeaStar\Starmon mini\T5276\T5276.RDT
SeaStar 7.21
Recorder type : Starmon mini
Recorder number : T5276
Recorder version : 23 CRC8/38400/HighRes
Recorder measures : Temperature
Recorder memory(byte/meas.) : 524063 / 349375
Measurement sequence number : 1
Recorder started from PC : 12/13/2015 6:19:10 PM
Measurement interval def. : Single interval = 00:10:00
Measurement start time : 1/18/2016 1:00:00 AM
Measurement settings: [dd:hh:mm:ss] x number
Start delay : 35:06:40:50
1. interval period : 00:10:00 x 25700
2. interval period : 00:10:00 x 100
Estimated time duration and battery usage for NMS
Battery energy at start (%): 98.0

Cycle 1 Meas.taken
Seq/Inr Date&Time Batt.used(%) Mem.used(%) Temp
1/1 4/17/2017 3:30:00 AM 5 25 65535
2/2 7/16/2018 6:00:00 AM 11 50 131070
Cycle 2 Meas.taken
Seq/Inr Date&Time Batt.used(%) Mem.used(%) Temp
1/1 10/14/2019 8:30:00 AM 16 75 196605
Memory full : 1/10/2021 5:00:00 PM
After (days:hours) : 1819:16
In Cycle : 2
In sequence : 2
In Interval : 1
In measurement : 65427
Total meas. taken : 262032
Battery used (%) : 22.2
Battery left (%) : 75.8

Starmon#5277:
Filename: C:\SeaStar\Starmon mini\T5277\T5277.RDT
SeaStar 7.21
Recorder type : Starmon mini
Recorder number : T5277
Recorder version : 23 CRC8/38400/HighRes
Recorder measures : Temperature

Recorder memory(byte/meas.) : 524063 / 349375
Measurement sequence number : 1
Recorder started from PC : 12/13/2015 6:20:37 PM
Measurement interval def. : Single interval = 00:10:00
Measurement start time : 1/18/2016 1:00:00 AM
Measurement settings: [dd:hh:mm:ss] x number
Start delay : 35:06:39:23
1. interval period : 00:10:00 x 25700
2. interval period : 00:10:00 x 100
Estimated time duration and battery usage for NMS
Battery energy at start (%): 98.0

Cycle 1			Meas.taken	
Seq/Inr	Date&Time	Batt.used(%)	Mem.used(%)	Temp
1/1	4/17/2017 3:30:00 AM	5	25	65535
2/2	7/16/2018 6:00:00 AM	11	50	131070

Cycle 2			Meas.taken	
Seq/Inr	Date&Time	Batt.used(%)	Mem.used(%)	Temp
1/1	10/14/2019 8:30:00 AM	16	75	196605

Memory full : 1/10/2021 5:00:00 PM
After (days:hours) : 1819:16
In Cycle : 2
In sequence : 2
In Interval : 1
In measurement : 65427
Total meas. taken : 262032
Battery used (%) : 22.2
Battery left (%) : 75.8

Starmon#5278:

Filename: C:\SeaStar\Starmon mini\T5278\T5278.RDT
SeaStar 7.21
Recorder type : Starmon mini
Recorder number : T5278
Recorder version : 23 CRC8/38400/HighRes
Recorder measures : Temperature
Recorder memory(byte/meas.) : 524063 / 349375
Measurement sequence number : 1
Recorder started from PC : 12/13/2015 6:21:37 PM
Measurement interval def. : Single interval = 00:10:00
Measurement start time : 1/18/2016 1:00:00 AM
Measurement settings: [dd:hh:mm:ss] x number
Start delay : 35:06:38:23
1. interval period : 00:10:00 x 25700
2. interval period : 00:10:00 x 100
Estimated time duration and battery usage for NMS
Battery energy at start (%): 98.0

Cycle 1			Meas.taken	
Seq/Inr	Date&Time	Batt.used(%)	Mem.used(%)	Temp
1/1	4/17/2017 3:30:00 AM	5	25	65535
2/2	7/16/2018 6:00:00 AM	11	50	131070

Cycle 2			Meas.taken	
Seq/Inr	Date&Time	Batt.used(%)	Mem.used(%)	Temp
1/1	10/14/2019 8:30:00 AM	16	75	196605

Memory full : 1/10/2021 5:00:00 PM
After (days:hours) : 1819:16
In Cycle : 2
In sequence : 2

In Interval : 1
In measurement : 65427
Total meas. taken : 262032
Battery used (%) : 22.2
Battery left (%) : 75.8

Starmon#5279:

Filename: C:\SeaStar\Starmon mini\T5279\T5279.RDT
SeaStar 7.21
Recorder type : Starmon mini
Recorder number : T5279
Recorder version : 23 CRC8/38400/HighRes
Recorder measures : Temperature
Recorder memory(byte/meas.) : 524063 / 349375
Measurement sequence number : 1
Recorder started from PC : 12/13/2015 6:22:47 PM
Measurement interval def. : Single interval = 00:10:00
Measurement start time : 1/18/2016 1:00:00 AM
Measurement settings: [dd:hh:mm:ss] x number
Start delay : 35:06:37:13
1. interval period : 00:10:00 x 25700
2. interval period : 00:10:00 x 100
Estimated time duration and battery usage for NMS
Battery energy at start (%): 98.0

Cycle 1			Meas.taken	
Seq/Inr	Date&Time	Batt.used(%)	Mem.used(%)	Temp
1/1	4/17/2017 3:30:00 AM	5	25	65535
2/2	7/16/2018 6:00:00 AM	11	50	131070

Cycle 2			Meas.taken	
Seq/Inr	Date&Time	Batt.used(%)	Mem.used(%)	Temp
1/1	10/14/2019 8:30:00 AM	16	75	196605

Memory full : 1/10/2021 5:00:00 PM
After (days:hours) : 1819:16
In Cycle : 2
In sequence : 2
In Interval : 1
In measurement : 65427
Total meas. taken : 262032
Battery used (%) : 22.2
Battery left (%) : 75.8

Starmon#5280:

Filename: C:\SeaStar\Starmon mini\T5280\T5280.RDT
SeaStar 7.21
Recorder type : Starmon mini
Recorder number : T5280
Recorder version : 23 CRC8/38400/HighRes
Recorder measures : Temperature
Recorder memory(byte/meas.) : 524063 / 349375
Measurement sequence number : 1
Recorder started from PC : 12/13/2015 6:23:46 PM
Measurement interval def. : Single interval = 00:10:00
Measurement start time : 1/18/2016 1:00:00 AM
Measurement settings: [dd:hh:mm:ss] x number
Start delay : 35:06:36:14
1. interval period : 00:10:00 x 25700
2. interval period : 00:10:00 x 100

Estimated time duration and battery usage for NMS
Battery energy at start (%): 98.0

Cycle 1			Meas.taken	
Seq/Inr	Date&Time	Batt.used(%)	Mem.used(%)	Temp
1/1	4/17/2017 3:30:00 AM	5	25	65535
2/2	7/16/2018 6:00:00 AM	11	50	131070

Cycle 2			Meas.taken	
Seq/Inr	Date&Time	Batt.used(%)	Mem.used(%)	Temp
1/1	10/14/2019 8:30:00 AM	16	75	196605

Memory full : 1/10/2021 5:00:00 PM
After (days:hours) : 1819:16
In Cycle : 2
In sequence : 2
In Interval : 1
In measurement : 65427
Total meas. taken : 262032
Battery used (%) : 22.2
Battery left (%) : 75.8

RDI#23281:

```
>ps0
  Instrument S/N:  23281
       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  DEPTH  TEMPERATURE  PRESSURE
Pressure Sens Coefficients:
            c3 = -1.522438E-169
            c2 = -1.833885E-07
            c1 = +3.232684E-01
        Offset = -9.553367E+00
Temp Sens Offset:  0.15 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:   6
>tt?
TT 2015/12/11,17:06:40 - Time Set (CCYY/MM/DD,hh:mm:ss)
>c deploy?
Deployment Commands:
CF = 11101 ---------- Flow Ctrl (EnsCyc;PngCyc;Binry;Ser;Rec)
CK ---------- Keep Parameters as USER Defaults
CR # ---------- Retrieve Parameters (0 = USER, 1 = FACTORY)
CS ---------- Start Deployment
EA = +00000 ---------- Heading Alignment (1/100 deg)
EB = +00000 ---------- Heading Bias (1/100 deg)
ED = 00085 ---------- Transducer Depth (0 - 65535 dm)
ES = 36 ---------- Salinity (0-40 pp thousand)
EX = 11111 ---------- Coord Transform (Xform: Type,Tilts,3 Bm,Map)
EZ = 1111101 ---------- Sensor Source (C,D,H,P,R,S,T)
RE ---------- Recorder ErAsE
RN ---------- Set Deployment Name
TE = 01:00:00.00 --------- Time per Ensemble (hrs:min:sec.sec/100)
```

TF = 16/01/18,01:00:00 --- Time of First Ping (yr/mon/day,hour:min:sec)
TP = 00:01.00 ---------- Time per Ping (min:sec.sec/100)
TS = 15/12/11,17:08:26 --- Time Set (yr/mon/day,hour:min:sec)
WD = 111 100 000 --------- Data Out (Vel,Cor,Amp; PG,St,P0; P1,P2,P3)
WF = 0300 ---------- Blank After Transmit (cm)
Press any key to continue
WN = 025 ---------- Number of depth cells (1-128)
WP = 00180 ---------- Pings per Ensemble (0-16384)
WS = 0400 ---------- Depth Cell Size (cm)
WV = 175 ---------- Mode 1 Ambiguity Vel (cm/s radial)
>cz
Powering Down

Appendix 5: NTAS-14 Recovery Instrumentation Documentation

NTAS 14

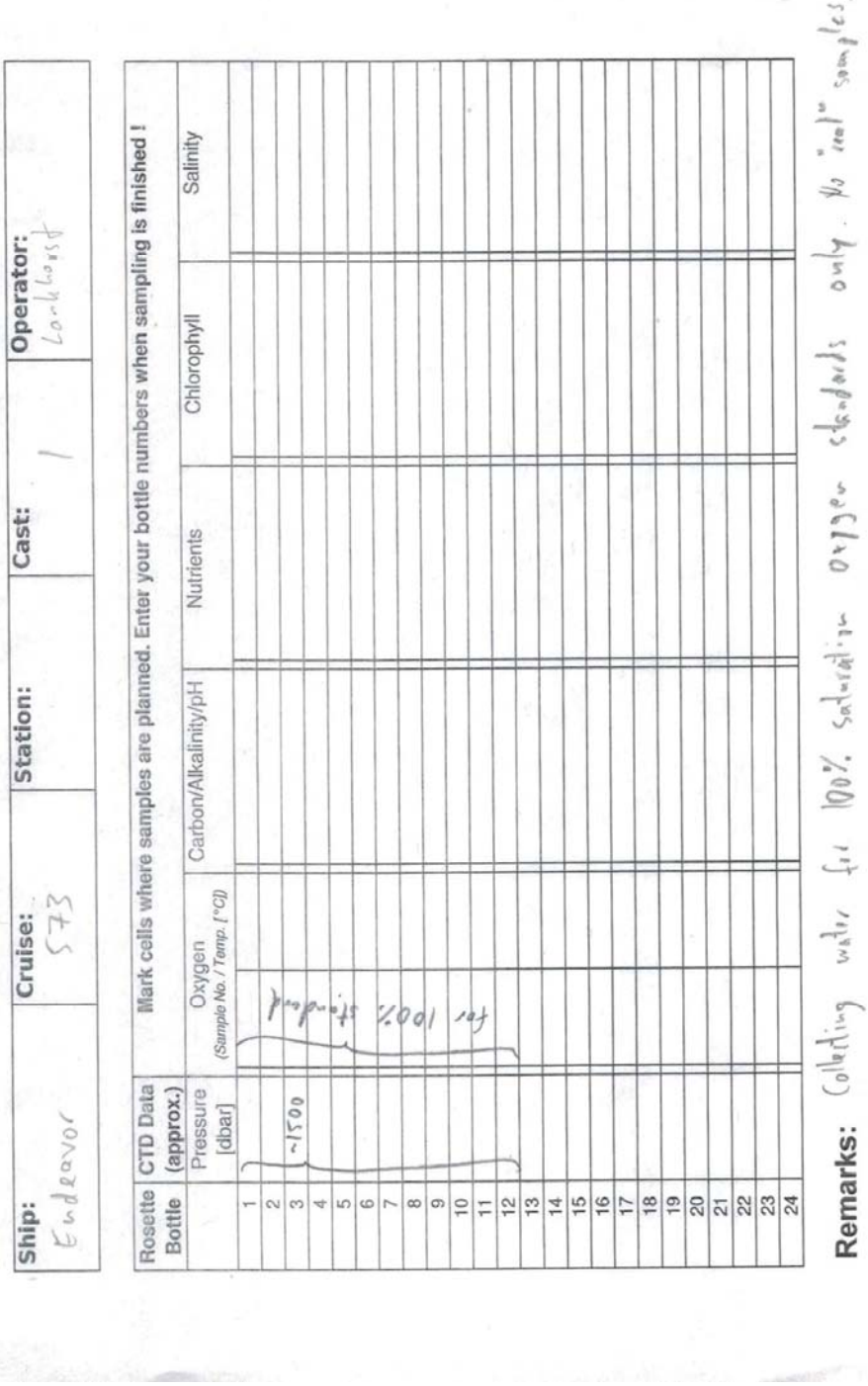
Instrument	Serial	Depth (m)	UTC Time	UTC Date	Internal Time	Internal Date	Stop Sampling	Last timestamp	Records	Start Time	Start Date	Stop Time	Stop Date
			[------------------TIME CHECK--------------]						[-------DATA-------]	[--------------------------------Po st Recovery Spike--------------------------------]			
Logger	16								39365120 bytes	N/A	N/A	N/A	N/A
Logger	12								39367040 bytes	N/A	N/A	N/A	N/A
SBE37__SST	3605	0.75		2/7/2016					121712				
SBE37__SST	1836	0.75		2/7/2016					123843				
SBE39	539	5							118657				
Nortek ADCM	9467	5.7	14:27:38	2/7/2016	14:28:30	2/7/2016	14:30:00	2/7/16 14:20	31001 samples / 3127758 bytes				
SBE39_IM	4465	10		2/7/2016					62026	10:30:00	26-Oct-2013	11:42:00	26-Oct-2013
Nortek-IM	5973	13	unknown	2/7/2016	unknown	unknown	21:31:00	11/9/15 21:59	24533				no battery (
SBE39	545	15		2/6/2016					123787				
Nortek ADCM	432	18	unknown	2/7/2016	unknown	unknown	20:23:00	7/2/15 17:40	15171				no battery
SBE-39	546	20		2/6/2016					123735				
SBE37_IM	669	25		2/9/16					62341				
RBR DUO	61568	26											
SBE-39	631	30											
SBE-39	677	40		2/6/2016					123779				
SBE37_IM	684	45		2/7/2016					62012				
SBE-39	678	50		2/6/2016					123760				
SBE-39	680	60		2/6/2016					123821				
SBE37_IM	686	65		2/9/2016					62266				
SBE-39	681	70		2/8/2016					124291				
SBE39_IM	4466	80		2/10/2016					62423				
RDI ADCP	2125	85		2/11/2016			0:20:35		6812064 bytes	17:43	2/9/16	22:03	2/9/16
SBE-39	684	90		2/6/2016					123716				
SBE-39	750	100		2/6/2016					123739				
SBE-39	3480	110		2/6/2016					123800				
Starmon	3167	110		2/10/2016		2/10/2016	14:24:00		62288 samples / 93430 bytes				
Starmon	3168	120		2/10/2016		2/10/2016	17:32:00		62308 / 93462				
Starmon	3169	130		2/10/2016		2/10/2016	18:45:00		62315 / 93471				
Starmon	3170	140		2/10/2016		2/10/2016	18:51:00		62314 / 93471				
Starmon	3171	150		2/10/2016		2/10/2016	18:59:00		62316 / 93474				
Starmon	3791	160		2/10/2016		2/10/2016	19:05:00		62316 / 93474				
RBR SOLO	75556	0.2	23:26:00	2/10/2016	23:23:49	2/10/2016	23:27:00		624865				
RBR SOLO	75557	0.15		2/10/2016		2/10/2016	22:40:30						
RBR SOLO	75558	0.2		2/10/2016		2/10/2016	23:07:00						
RBR SOLO	75559	0.2	23:16:30	2/10/2016	23:14:15	2/10/2016	23:16:00		624854				
SBE37	11392	4989											
SBE37	11393	4989											

NTAS 14 Sea Surface Temperature Array

Instrument	Serial		Location	Cm below deck	Orientation Degrees
RBR SOLO	75556		Hole #1	95	
RBR SOLO	75557		Hole #2	85	
RBR SOLO	75558		Hole #3	95	
RBR SOLO	75559		Hole #4	95	

note: vane=0 degrees; clockwise

Appendix 6: Water samples during CTD casts



Rosette Water Sampling Log Sheet

Ship:	Cruise:	Station:	Cast:	Operator:
Endeavor	573		1	Lockhart

Rosette Bottle	CTD Data (approx.)	Mark cells where samples are planned. Enter your bottle numbers when sampling is finished !					
	Pressure [dbar]	Oxygen (Sample No. / Temp. [°C])	Carbon/Alkalinity/pH	Nutrients	Chlorophyll	Salinity
1						
2						
3	~1500					
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						

Remarks: Collecting water for 100% saturation oxygen standards only. No "real" samples.

Rosette Water Sampling Log Sheet

Ship:	Cruise:	Station:	Cast:	Operator:
Endeavor	573		2	Lankhorst

Rosette Bottle	CTD Data (approx.)	Mark cells where samples are planned. Enter your bottle numbers when sampling is finished !					
	Pressure [dbar]	Oxygen (Sample No. / Temp. [°C])		~~Carbon/Alkalinity/pH~~	~~Nutrients~~ Carousel stop #	~~Chlorophyll~~	Salinity
1	3458	1693	11.7		1		6
2	3430				3		24
3	3430	1155	10.4		5		
4	2509	1754	10.2		7		17
5	2508				9		5
6	2500	1775	11.1		11		
7	1535	1706	12.3		13		11
8	1535				15		22
9	1545	1667	13.1		17		
10	845	1575	13.1		19		23
11	855				21		18
12	875	1060	13.4		23		
13							
14							
15							
16							
17							
18							
19							
20							
21							
22							
23							
24							

felt too warm to be from depth

Remarks: 12 bottles on 24-rosette; bottle and carousel counters mismatch.

Rosette Water Sampling Log Sheet

Ship:	Cruise:	Station:	Cast:	Operator:
Endeavor	573		3	Laukhorst/Kölling

Rosette Bottle	CTD Data (approx.)	Mark cells where samples are planned. Enter your bottle numbers when sampling is finished !					
	Pressure [dbar]	Oxygen (Sample No. / Temp. [°C])		Carbon/Alkalinity/pH	~~Nutrients~~ Carousel Stop #	Chlorophyll	Salinity
1	998				1		16
2	998				3		10
3	998				5		
4	858				7		4
5	858				9		15
6	858				11		
7	703				13		9
8	703				15		20
9	702				17		
10	33				19		21
11	33				21		3
12	33				23		
13							
14							
15							
16							
17							
18							
19							
20							
21							
22							
23							
24							

1 2 3 4 5 6 7 8 9 10 11 12

Remarks: Requested ship ops to keep wire angle steadier than cast 2.
12 bottles labeled 1-12 on 24-place rosette, using odd number stops.

Rosette Water Sampling Log Sheet

Ship:	Cruise:	Station:	Cast:	Operator:
Endeavor	573		5	Kölling

Rosette Bottle	CTD Data (approx.)	Mark cells where samples are planned. Enter your bottle numbers when sampling is finished !						Niskin #
	Pressure [dbar]	Oxygen (Sample No. / Temp. [°C])		Carbon/Alkalinity/pH	~~Nutrients~~ Carousel Stop #	Chlorophyll	Salinity	
1	994				1		2	1
2	995				3		1	2
3	997				5			3
4	818				7		4	4
5	818				9		19	5
6	819				11			6
7	731				13		/	7
8	730				15		7	8
9	729				17			9
10	23				19		8	10
11	23				21		13	11
12	23				23			12
13								
14								
15								
16								
17								
18								
19								
20								
21								
22								
23								
24								

Remarks: 12 Bottles on 24-position carousel, using only odd-numbered stops.

Rosette Water Sampling Log Sheet

Ship:	Cruise:	Station:	Cast:	Operator:
R/V Endeavor	EN 573		10	Kilting

Rosette Bottle	CTD Data (approx.)	Mark cells where samples are planned. Enter your bottle numbers when sampling is finished !						Niskin #
	Pressure [dbar]	Oxygen (Sample No. / Temp. [°C])		Carbon/Alkalinity/pH	~~Nutrients~~ Carousel #	Chlorophyll	Salinity	
1	3508				1		92	1
2	3507				3		88	2
3	3502				5			3
4	3013				7			4
5	3013				9		36	5
6	3013				11		94	6
7	860				13			7
8	860				15		85	8
9	855				17		95	9
10	25				19		93	10
11	26				21		35	11
12	24				23			12
13								
14								
15								
16								
17								
18								
19								
20								
21								
22								
23								
24								

Remarks: #7 leaked on last 2 casts
didn't close

Rosette Water Sampling Log Sheet

Ship:	Cruise:	Station:	Cast:	Operator:
Endeavor	573		11	Lankhorst

Rosette Bottle	CTD Data (approx.)	Mark cells where samples are planned. Enter your bottle numbers when sampling is finished !					
	Pressure [dbar]	Oxygen (Sample No. / Temp. [°C])		Carbon/Alkalinity/pH	~~Nutrients~~ 24-stop Carousel #	Chlorophyll	Salinity
1	3495				1		~~73~~
2	3495				3		80
3	3495				5		
4	2730				7		~~74~~
5	2730				9		81
6	2730				11		
7	2025				13		96
8	2025				15		82
9	2025				17		
10	21				19		76
11	21				21		89
12	21						
13							
14							
15							
16							
17							
18							
19							
20							
21							
22							
23							
24							

Remarks: 12 bottles on 24-rosette, using odd numbers only

50272-101

REPORT DOCUMENTATION PAGE	1. REPORT NO. WHOI-2016-04	2.	3. Recipient's Accession No.

4. Title and Subtitle
The Northwest Tropical Atlantic Station (NTAS): NTAS-15 Mooring Turnaround Cruise Report Cruise on Board RV Endeavor January 25 - February 13, 2016 Narragansett RI, USA - San Juan, Puerto Rico

5. Report Date
November 2016

6.

7. Author(s) Sebastien Bigorre, Jim Ryder, Jason Smith, Matthias Lankhorst

8. Performing Organization Rept. No.

9. Performing Organization Name and Address
Woods Hole Oceanographic Institution
Woods Hole, Massachusetts 02543

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16. Abstract (Limit: 200 words)
The Northwest Tropical Atlantic Station (NTAS) was established to address the need for accurate air-sea flux estimates and upper ocean measurements in a region with strong sea surface temperature anomalies and the likelihood of significant local air-sea interaction on interannual to decadal timescales. The approach is to maintain a surface mooring outfitted for meteorological and oceanographic measurements at a site near 15°N, 51°W by successive mooring turnarounds. These observations are used to investigate air-sea interaction processes related to climate variability. The NTAS Ocean Reference Station (ORS NTAS) is supported by the National Oceanic and Atmospheric Administration's (NOAA) Climate Observation Program. This report documents recovery of the NTAS-14 mooring and deployment of the NTAS-15 mooring at the same site. Both moorings used Surlyn foam buoys as the surface element. These buoys were outfitted with two Air-Sea Interaction Meteorology (ASIMET) systems. Each system measures, records, and transmits via Argos satellite the surface meteorological variables necessary to compute air-sea fluxes of heat, moisture and momentum. The upper 160 m of the mooring line were outfitted with oceanographic sensors for the measurement of temperature, salinity and velocity.

17. Document Analysis a. Descriptors

Upper Ocean Processed Group - Ocean Reference Station
The Northwest Tropical Atlantic Station (NTAS)
Turnaround Cruise Report - San Juan, Puerto Rico

b. Identifiers/Open-Ended Terms

c. COSATI Field/Group

18. Availability Statement
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