WHOI-2015-05

Woods Hole Oceanographic Institution

The Northwest Tropical Atlantic Station (NTAS): NTAS-14 Mooring Turnaround Cruise Report

by

Sebastien Bigorre,[1] Ben Pietro,[1] Jason Smith,[1] Ethan Morris,[2] and Al Plueddemann,[1]

Woods Hole Oceanographic Institution
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December 2015

Technical Report

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UOP Technical Report 2015-03

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Approved for Distribution:

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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-13 mooring and deployment of the NTAS-14 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 EN549. The cruise took place between December 5 and 21 December 2014. The NTAS-14 mooring was deployed on December 13, and immediately followed by a 36-hour intercomparison period during which data from the buoy, telemetered through Argos satellite system, and the ship's meteorological and oceanographic data were monitored. The NTAS-13 buoy had parted on September 23 and was recovered on October 28 while drifting freely near Martinique. The rest of the mooring, which had fallen to the seafloor was recovered during EN549, on December 17. 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 EN549 consisted in the recovery and deployment of Pressure Inverted Echo Sounders (PIES) and the acoustic download of data from PIES and subsurface moorings that are part of the Meridional Overturning Variability Experiment (MOVE) array. MOVE is designed to monitor the integrated deep meridional flow in the tropical North Atlantic. Two Argo floats were also deployed during the cruise on behalf of the Argo group at WHOI.

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I. Introduction

A. Timeline

The fourteenth Northwest Tropical Atlantic Station cruise (NTAS-14) cruise originated in Kingstown, Rhode Island on December 5, 2014 and ended in Bridgetown, Barbados on December 21, 2014. The track (Figure 1-1) was arranged to first deploy the NTAS-14 mooring, then recover the NTAS-13 mooring which had fallen to the bottom seafloor after the surface buoy parted from the mooring on September 23 2014. Finally, Pressure Inverted Echo Sounders (PIES) were recovered and redeployed from the Meridional Overturning Variability Experiment (MOVE) array. Data were downloaded from these PIES and additional subsurface moorings that are also part of the MOVE array. On the way down from Rhode Island we also deployed two Argo floats. The WHOI Upper Ocean Processes Group staff arrived in Kingstown on December 2, in preparation of the cruise. An overview of the chronology of the cruise is provided below. Local time on the ship during EN549 cruise was set to UTC minus 4 h during transit to NTAS-14 site.

December 2, Tuesday: WHOI personnel arrive in Kingstown, RI and start unloading equipment from truck and loading ship.

December 3, Wednesday: Ship loading continues. Setting up of NTAS-14 subsurface instrumentation. Install standalone ASIMET units on ship. Load two Argo floats. Ethan Morris from Scripps arrives, has trouble with transducer.

December 4, Thursday: Buoy tipped on its side near aft starboard quarter with vane towards aft. Knuckle boom crane is moved from port to starboard side.

December 5, Friday: Ethan receives spare transducer shipped from Scripps overnight. *Endeavor* leaves dock at 11:20 am EST. Orientation and safety meetings. Ship cruise speed is 10.5 knots, COG 150 T. Slowing down in late afternoon to 9 knots while crossing whale conservation area 40 nm long. In the evening, head winds pick up to ~ 20 knots; ship's speed reduces to 8 knots.

December 6, Saturday: Rewind wire on TSE winch. CTD and acoustic releases on CTD rosette.

December 7, Sunday: Passed Gulf Stream in the morning. Start spiking instruments in ice baths. Storm growing behind us off the Carolinas, ship increases speed to 12 knots.

December 8, Monday: Fire drill. More data spiking in ice baths. Acoustic releases assembled. Subsurface Iridium powered on, followed by deck test.

December 9, Tuesday: We got ahead of the storm and ship returns to cruise speed of 10.5 knots. Height markings on buoy hull. SST and Iridium cables pulled through buoy hull. Universal joint connected to buoy. NDBC emails that WAMDAS data ok. Ship's clock moves ahead one hour to GMT-4 in the evening.

December 10, Wednesday: Argo float #1177 launched, 23° 59.75' N, 57° 19.72' W, 12:44 UTC. Compliant section connected to buoy. Electrical connection to capstan.

December 11, Thursday: Argo float #1134 launched, 20° 35.12' N, 54° 55.97' W, 11:31 UTC. ASIMET logger made ready: cards erased and started. Pre-deployment meeting.

December 12, Friday: Swap SST on logger 16 with spare (#3605). Spike SSTs in ice/salt bucket while connected to loggers. Mooring wire connected from TSE winch, through A-frame block and to bellmouth. IM data do not get updated on UOP webpage. Troubleshooting IM connection looking for electrical resistance (> 1 MOhm, way too high). Open up both ends on EM compliance section and reconnect IM wires that were wrongly crossed between spare and primary wire. Data finally updates on webpage. Ice bag installed on SBE-37IMs at one-hour intervals to check IDs and serial numbers (37IM IDs were reset because setup capture files indicated different IDs from what was identified during burn-in at WHOI). Ship's technician starts a new ship data file for intercomparison period.

December 13, Saturday: Arrive at NTAS-14 site. Set and drift. Deployment of NTAS-14 surface mooring. Drive by buoy. Anchor survey. Intercomparison starts. CTD every 6 hours.

December 14, Sunday: Intercomparison continues. CTD to 500 m every 6 hours until midnight. All NTAS-14 systems updating on website (ASIMET, Xeos, IM, Wamdas). Set up deck for recovery operation. Heavy rain in afternoon due to local convective clouds.

December 15, Monday: Leave NTAS-14 and arrive at NTAS-13 site at 0600 local. One CTD to 500 m and 500 yards downwind of NTAS-13 anchor. Enable release and free mooring from anchor at 0800. Glass balls sighted at surface at 0904. Recovery starts at 0930 (glass balls hooked) and ends at 1445 local. Deck cleanup. Move back to NTAS-14 for drive by to buoy, check waterline and water depth at anchor. Leave NTAS area and sail towards MOVE-1 site.

December 16, Tuesday: Acoustic download of MOVE-1 subsurface mooring data during the night. Recovery of PIES 226 at sunrise. Deployment of PIES 299 near former 266 site. Monitoring of descent and triangulation of PIES 299. Resume acoustic download from subsurface mooring until midnight. Cleanup of sensors recovered from NTAS-13.

December 17, Wednesday: Transit towards MOVE-3 site. SOG 10.5 knots, COG 280° T. Ice bath spiking of temperature sensors recovered from NTAS-13.

B. Background and Purpose

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).

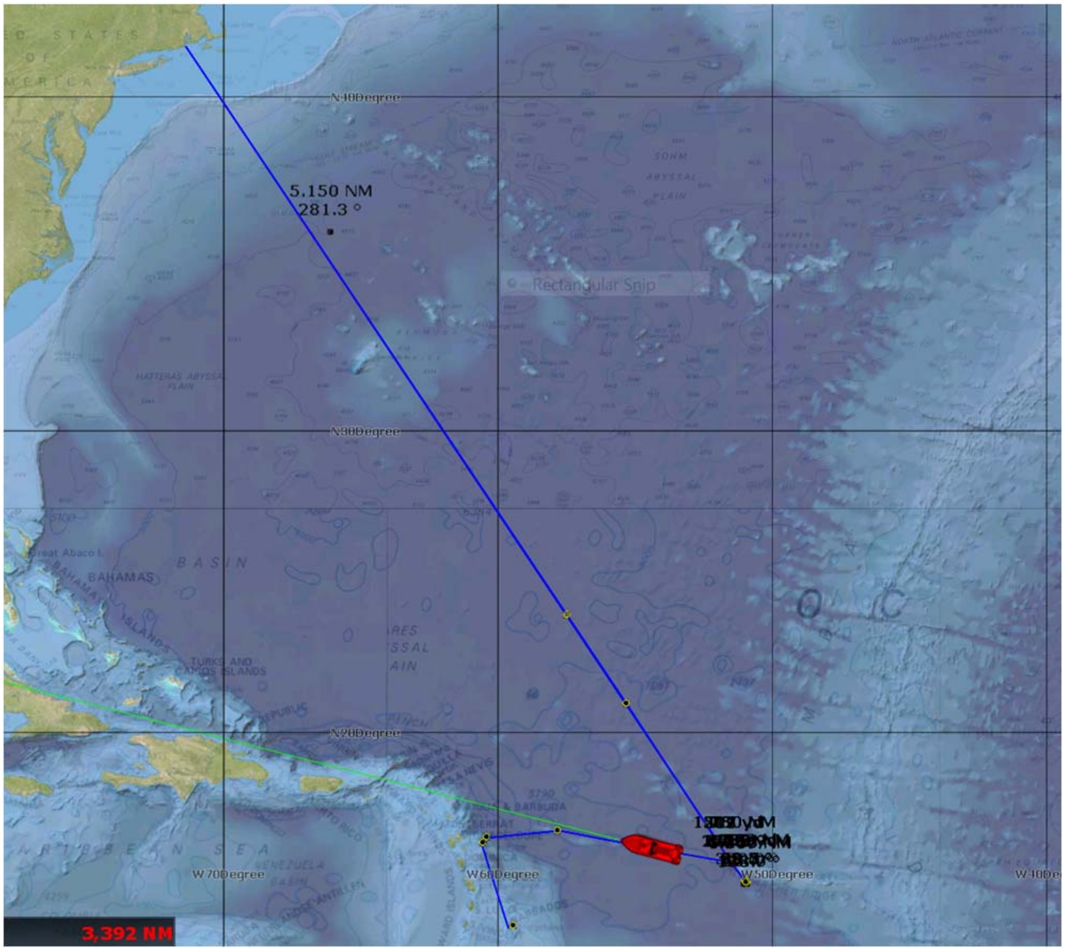


Figure 1-1. NTAS-14 cruise track.

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-14 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). One participant from the Scripps Institution of Oceanography (SIO) was also aboard to service the MOVE array, recover and deploy two Pressure and Inverted Echo Sounder (PIES) devices, and download data from surface moorings and other PIES through acoustic telemetry.

The cruise was completed in 16 days, between December 5 and 21 2014. The cruise originated from Kingstown, Rhode Island and terminated in Bridgetown, Barbados, West Indies. The cruise track is shown in Figure 1-1. The primary objectives were:

- To deploy the NTAS-14 mooring.
- To log data from the NTAS-14 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-13 mooring. The mooring line had parted and the buoy had been recovered. The remaining mooring elements were on the sea floor, to be recovered using backup flotation.
- To recover a PIES, deploy a PIES and retrieve data via acoustic link from PIES and a subsurface mooring at the MOVE-1 site.
- To recover a PIES, deploy a PIES and retrieve data via acoustic link from PIES and a subsurface mooring at the MOVE-3 site.
- To retrieve data via acoustic link from a subsurface mooring at the MOVE-4 site.
- An ancillary objective was to deploy two Argo floats near the latitudes 24° N and 21° N along the track from Rhode Island to NTAS.

Locations of these sites are listed in Table 1-1.

Table 1-1. Waypoints for NTAS-14 cruise.

Selected Waypoints NTAS-14				
Way-point	**Latitude**	**Longitude**	**Expected Date, Time**	**Description**
1	TBD	TBD	06 Dec 0900	Release tests and CTD test cast
	TBD	TBD	13 Dec 0800	NTAS-14 deployment start site
2	14° 45.00' N	50° 57.00' W	13 Dec 1600	NTAS-14 anchor drop site
3	14° 42.00' N	51° 00.00' W	various	NTAS CTD site (nominal location)
4	14° 49.515' N	51° 01.003' W	16 Dec 0400	NTAS-13 anchor location
5	15° 28.00' N	51° 31.00' W	16 Dec 1900	MOVE-1 PIES-226 recovery
6	15° 27.00' N	51° 30.50' W	17 Dec 0100	MOVE-1 mooring data offload
7	15° 27.00' N	51° 31.65' W	17 Dec 0800	MOVE-1 PIES-237 data offload
8	16° 33.00' N	57° 54.00' W	TBD	Dominica EEZ jog
9	16° 21.50' N	60° 30.00' W	19 Dec 1700	MOVE-3 PIES-228 recovery
10	16° 20.30' N	60° 30.30' W	19 Dec 2300	MOVE-3 mooring data offload
11	16° 20.30' N	60° 29.33' W	20 Dec 0600	MOVE-3 PIES-238 data offload
12	16° 20.00' N	60° 36.45' W	20 Dec 1300	MOVE-4 mooring data offload

II. Cruise Preparations

A. Staging and Loading

Pre-cruise operations were conducted at WHOI and Senesco Marine Repair Yard in North Kingstown, RI. On November 20, 2014 when the R/V *Endeavor* was pier side at the WHOI dock (associated with another project), the assembled buoy and anchor were loaded onto the ship using the ship's crane. Both buoy and anchor were put on the centerline of the fantail to ease the ship for her transit back to Rhode Island.

Five UOP representatives arrived at Senesco Marine Repair Yard on December 2, 2014 and began offloading the gear out of a box truck. The 53' box truck held wire reels, synthetics, deck gear, instrument brackets, deck boxes, lab boxes, instruments, glass balls and the UOP capstan. Using a combination of the knuckle boom crane and the main crane, gear was swung from the pier to the 01 deck and the fantail. Loading was completed on the afternoon of December 3rd.

B. Buoy Spin

The NTAS-14 buoy spin was conducted in Woods Hole on October 17 2014. 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 2-1, where compass error is plotted as a function of buoy orientation and the sinusoidal curve is symptomatic of the buoy spin procedure. Compasses on ASIMET wind sensors meet expectations (compass accuracy within ~ 5°) but Vaisala WXT unit has larger errors. See Appendix 1 for the details of the buoy spin.

C. Sensor Evaluation and Burn-in

Testing (burn-in) for the ASIMET units deployed on the NTAS-14 buoy began at WHOI in October 2014 and the data from this burn-in evaluation (see Fig. 2-2 to 2-9) are the one-minute values recorded in primary loggers L12 and L16 and spare logger L6, and standalone sensors when available (WXT Vaisala and SBE-39 AT).

Burn-in data showed LWR #253 on L12 was high and SST #3604 on L16 was questionable. Therefore, during transit these sensors were replaced by spares LWR #209 and SST #3605. SSTs were spiked in a bucket of ice and saltwater the day before deployment.

Just prior to deployment the precipitation sensors were filled and drained with different amounts of water so that each gauge would start with different water levels, and the domes of the radiation domes were cleaned.

See Appendix 1 for details of the NTAS-14 instrumentation setup.

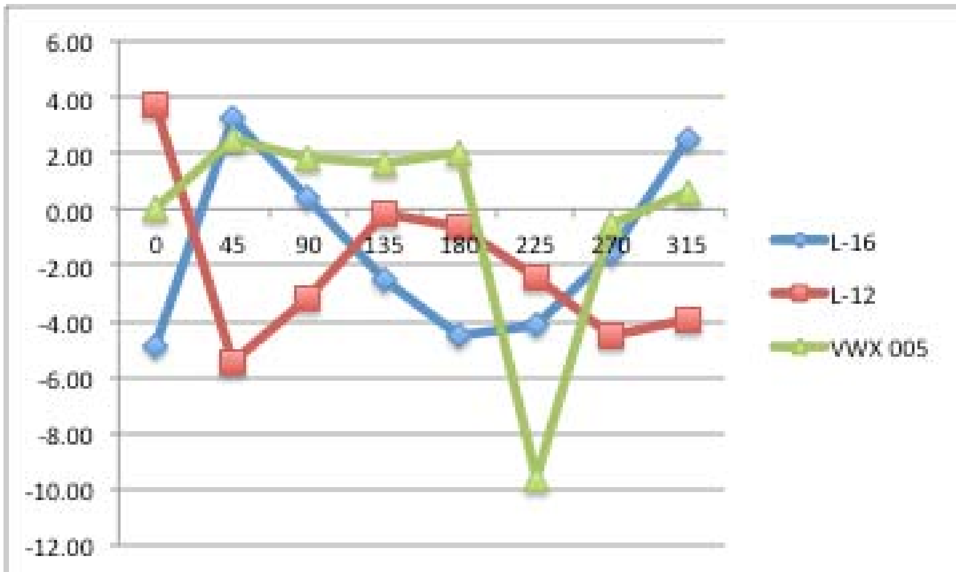


Figure 2-1. Buoy spin of NTAS-14 buoy, in Woods Hole on October 17 2014.

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-14 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. A mixture of Desitin and Biogrease 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 PCV tape was wrapped around instruments down to 40 m to protect them from barnacle growth. Both Norteks and the Workhorse ADCP had a mixture of Desitin and Biogrease applied to the transducers heads.

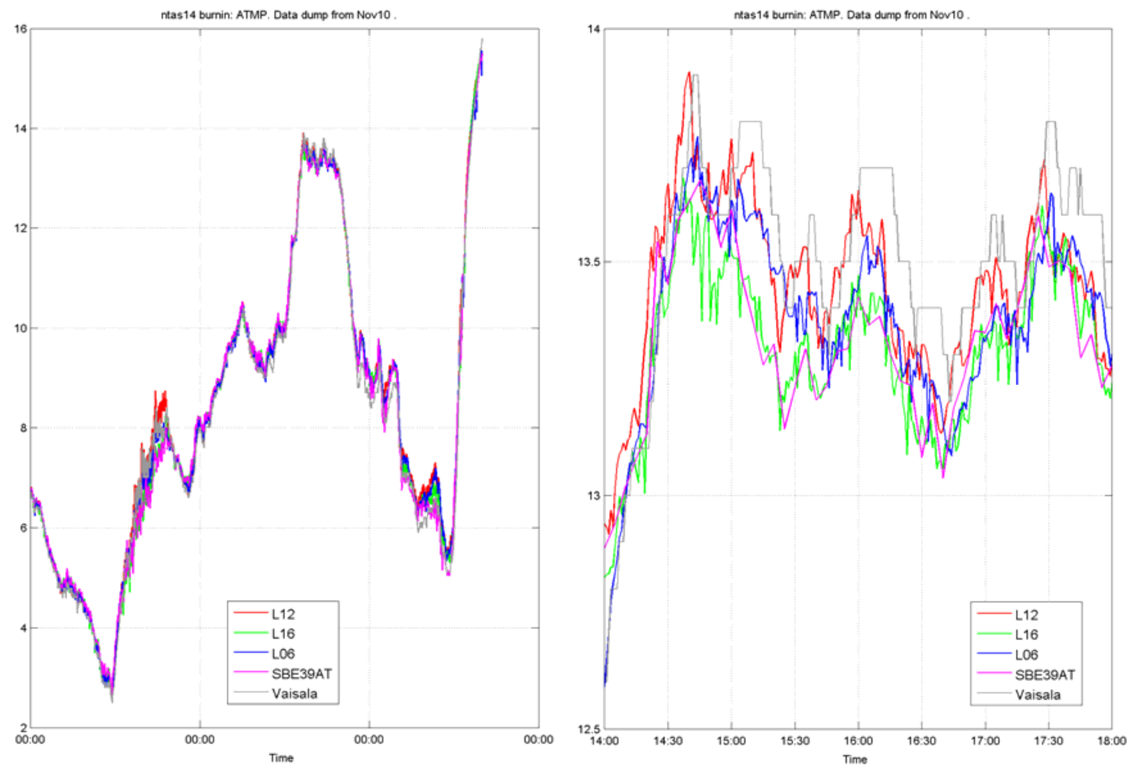


Figure 2-2. Air temperature (°C) for NTAS-14 burn-in data: November 8, 0000 UTC to November 10 1600 UTC (left) and zoom during November 9 1400 to 1800 UTC (right).

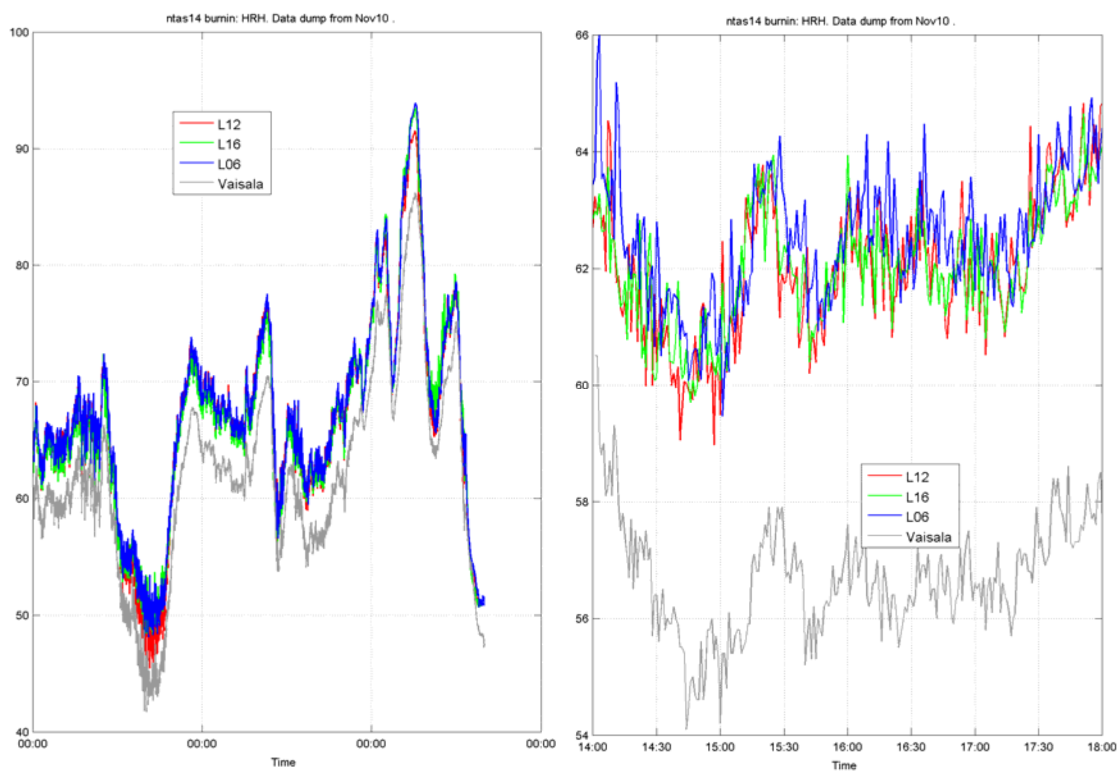


Figure 2-3. Same as Fig. 2-2 but for relative humidity (%RH).

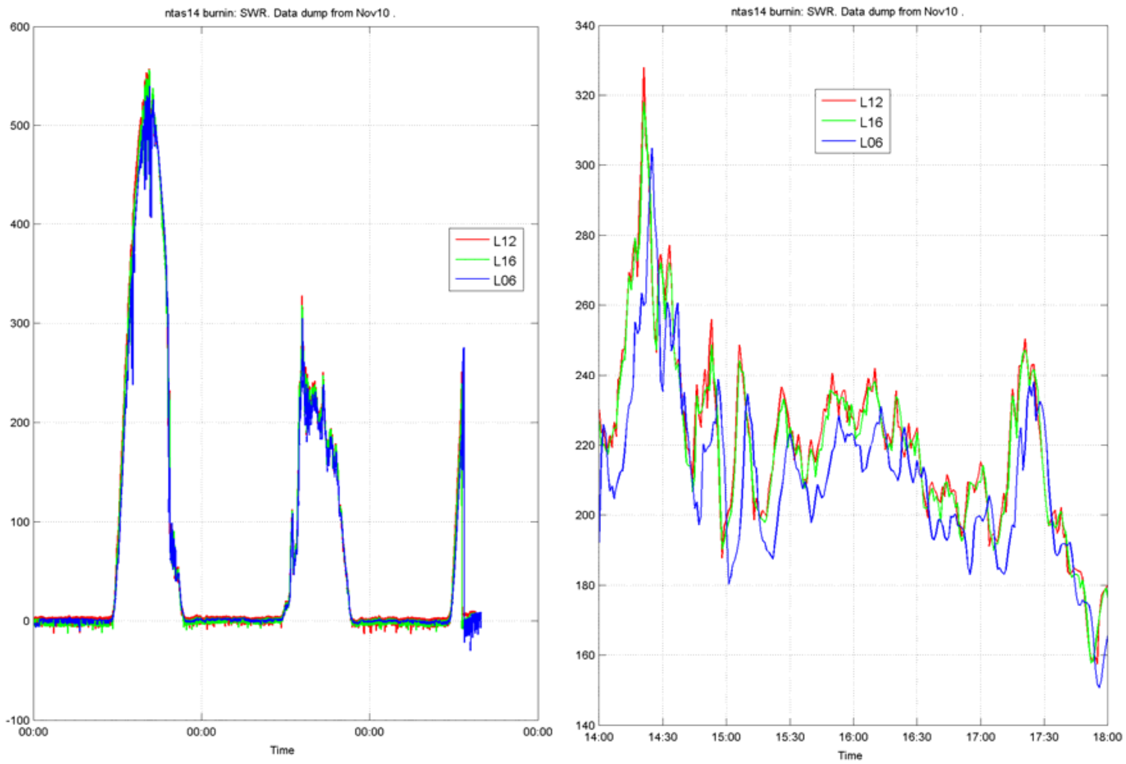


Figure 2-4. Same as Fig. 2-2 but for downwelling shortwave radiation (W m^{-2}).

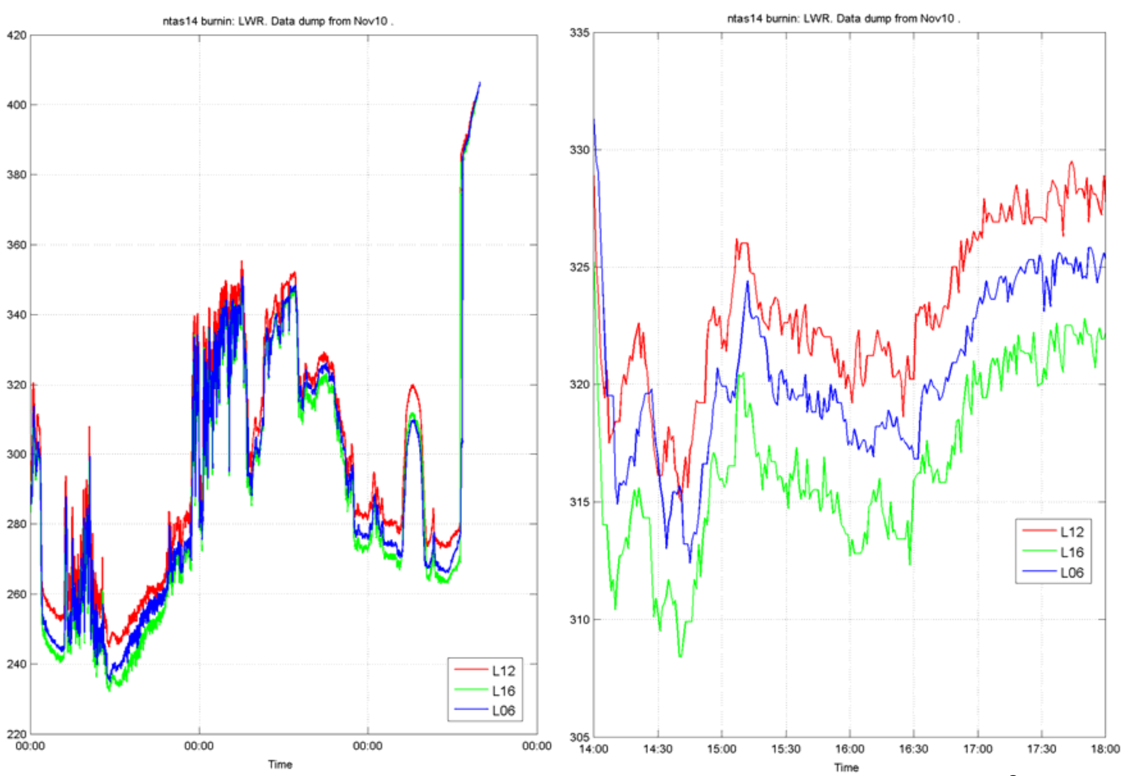


Figure 2-5. Same as Fig. 2-2 but for downwelling longwave radiation (W m^{-2}).

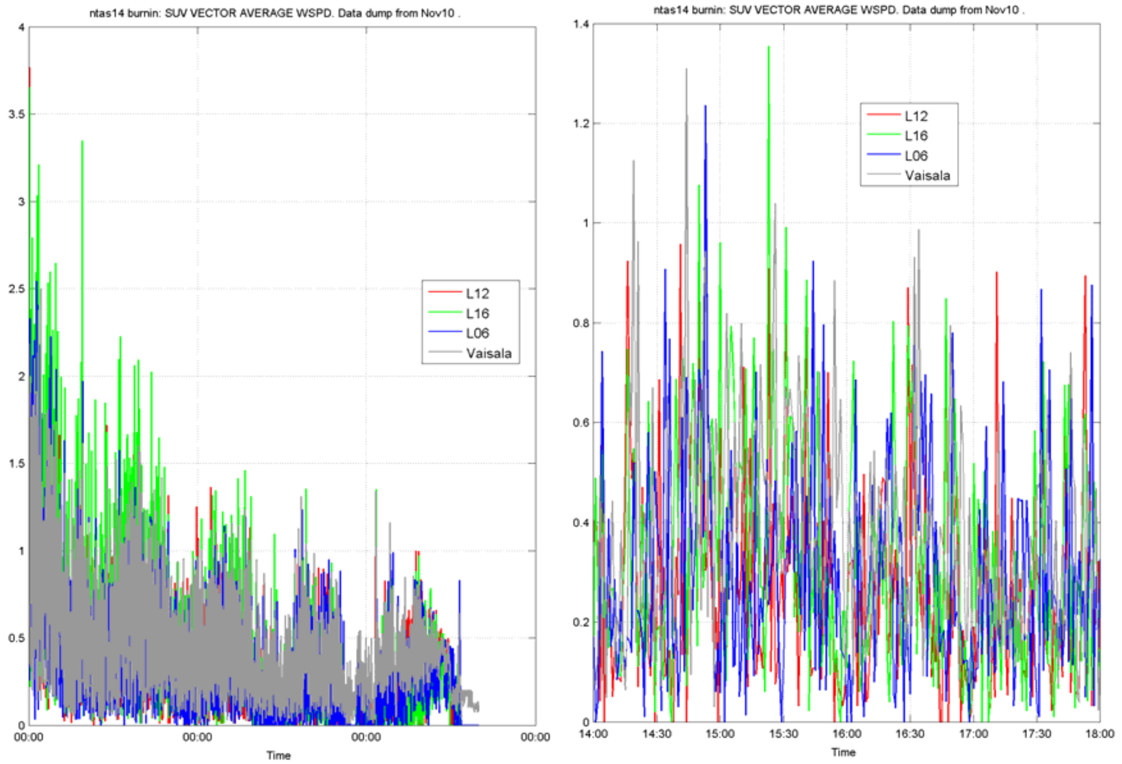


Figure 2-6. Same as Fig. 2-2 but for wind speed from east and north wind components (m s^{-1}).

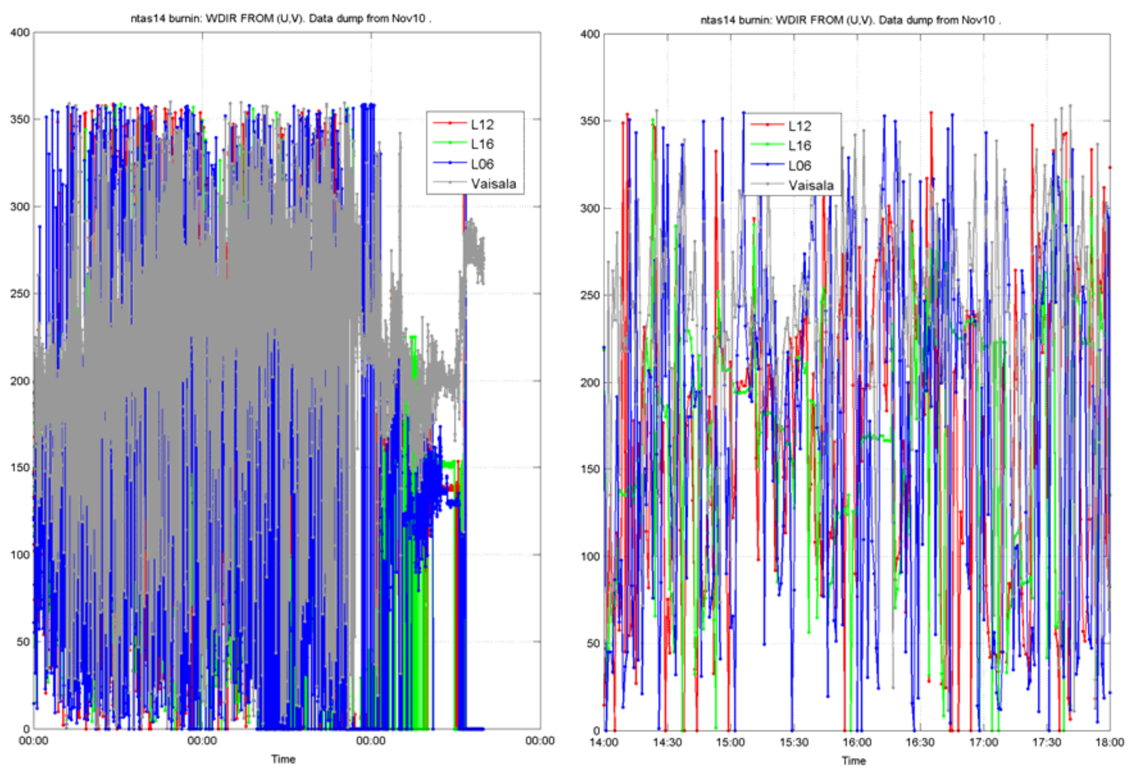


Figure 2-7. Same as Fig. 2-2 but for wind heading from east and north wind components (degrees, positive clockwise from magnetic north).

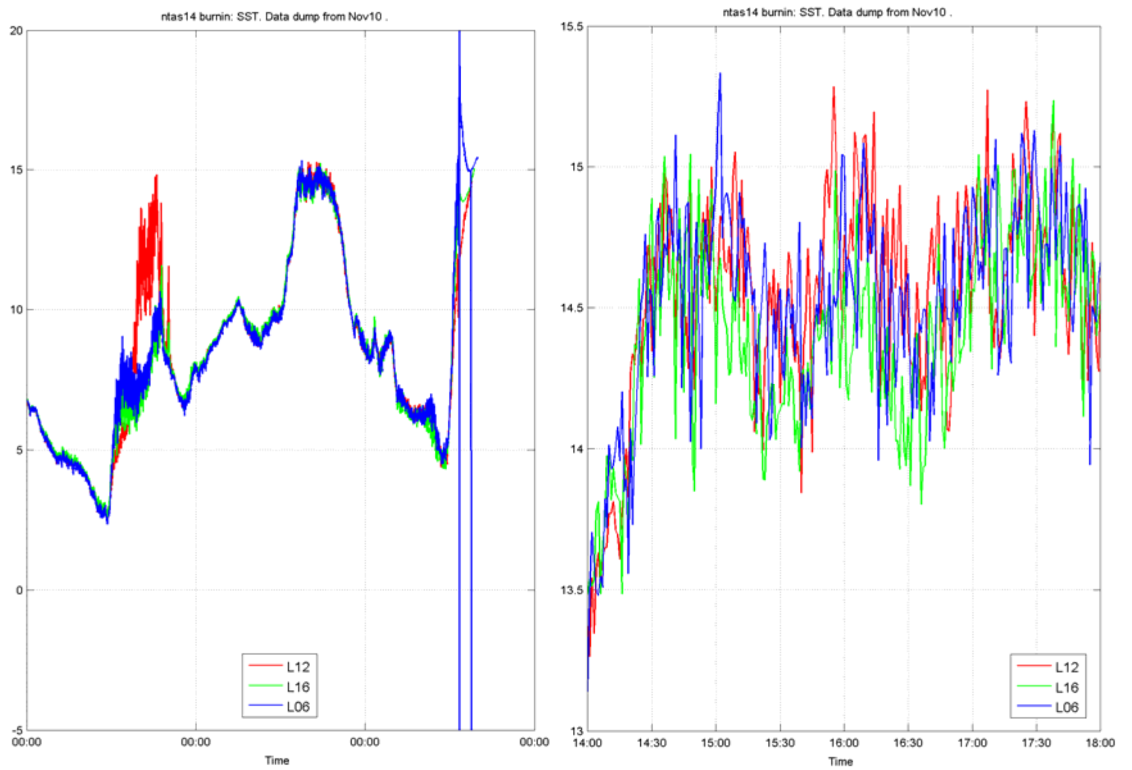


Figure 2-8. Same as Fig. 2-2 but for sea surface temperature sensor (°C).

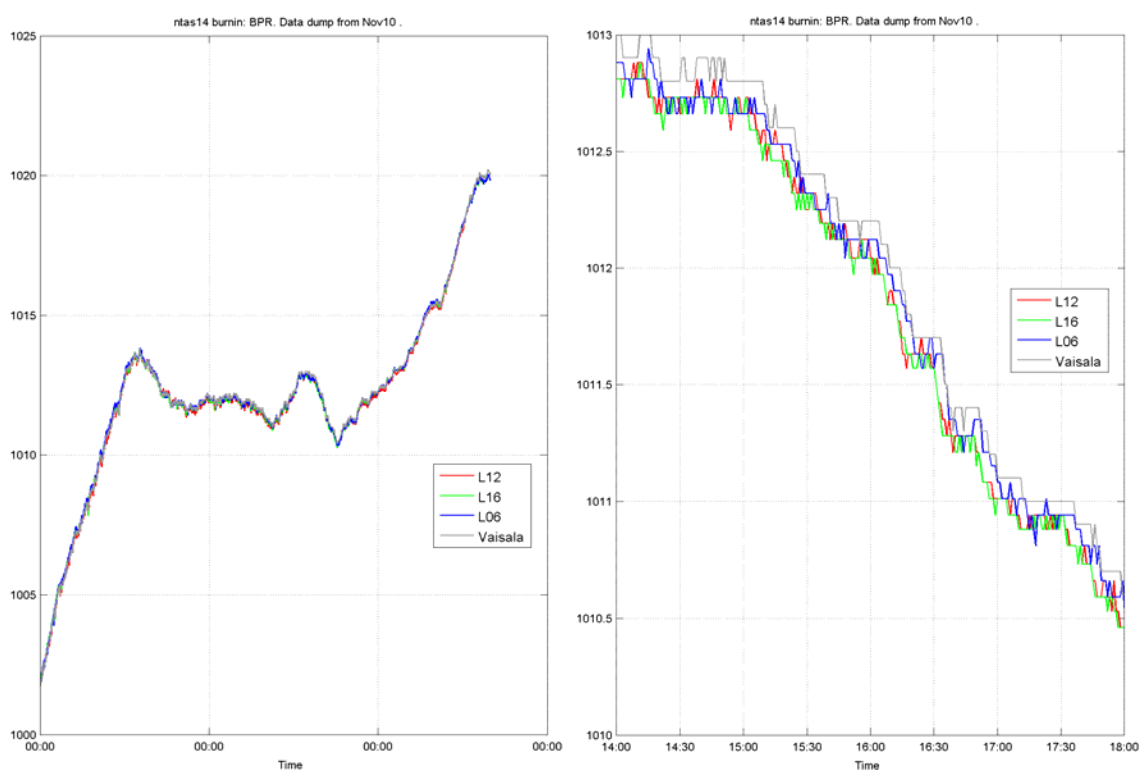


Figure 2-9. Same as Fig. 2-2 but for barometric pressure (mb).

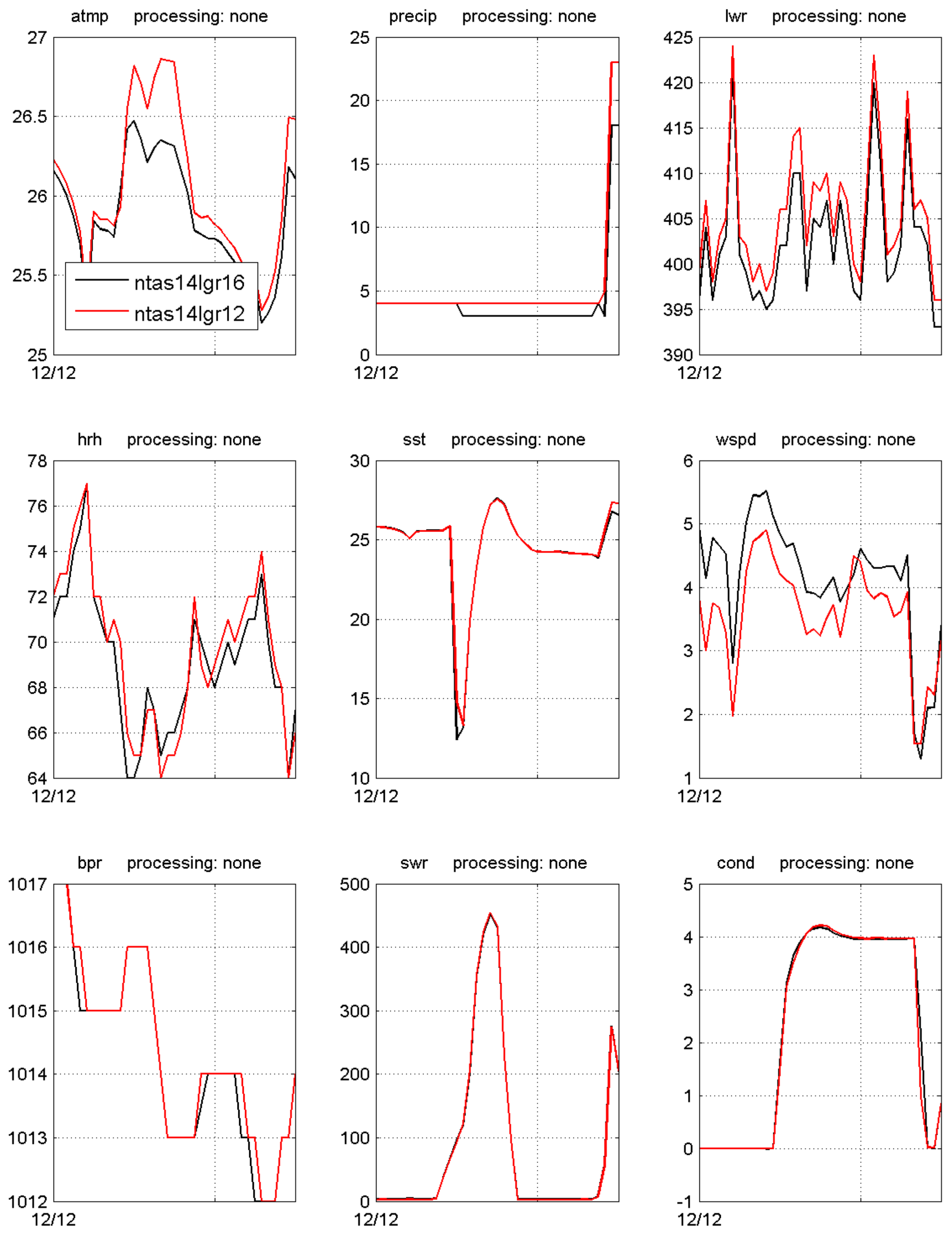


Figure 2-10. Telemetry data from NTAS-14 buoy from December 12 0000 UTC to December 13 1200 UTC while buoy was tipped on fantail of R/V *Endeavor* prior to deployment.

III. NTAS-14 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 3-1). The NTAS-14 surface buoy has a 2.7 m diameter foam buoy with an aluminum tower and rigid bridle. A new buoy wind vane was designed and installed on the NTAS-14 buoy and was larger than previous deployments. Note that NTAS13 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 3-2). 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.

For the NTAS-14 deployment, a 78 m wire section was used below the 5 m EM chain section, whereas a 79 m wire section was desired. The result was that the ADCP and all deeper instruments were actually 1 m shallower than planned. Corrections were made to Figure 3-2 and the NTAS-14 mooring log (Appendix 2)

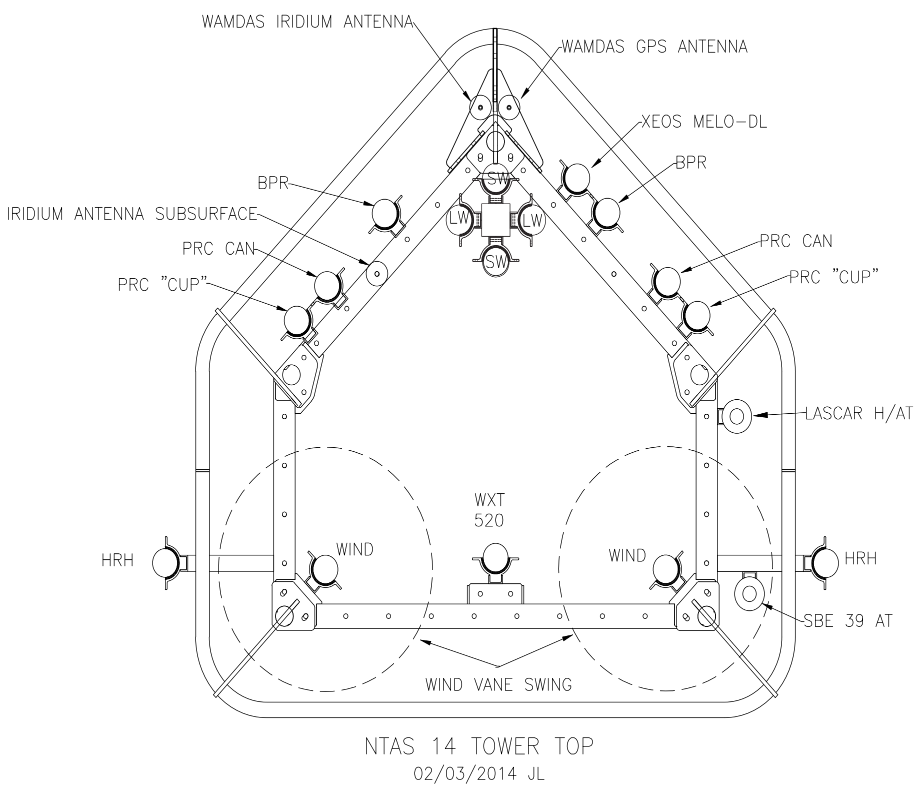


Figure 3-1. Top view schematic of the meteorological tower on the NTAS-14 buoy with the location of the ASIMET and other instruments.

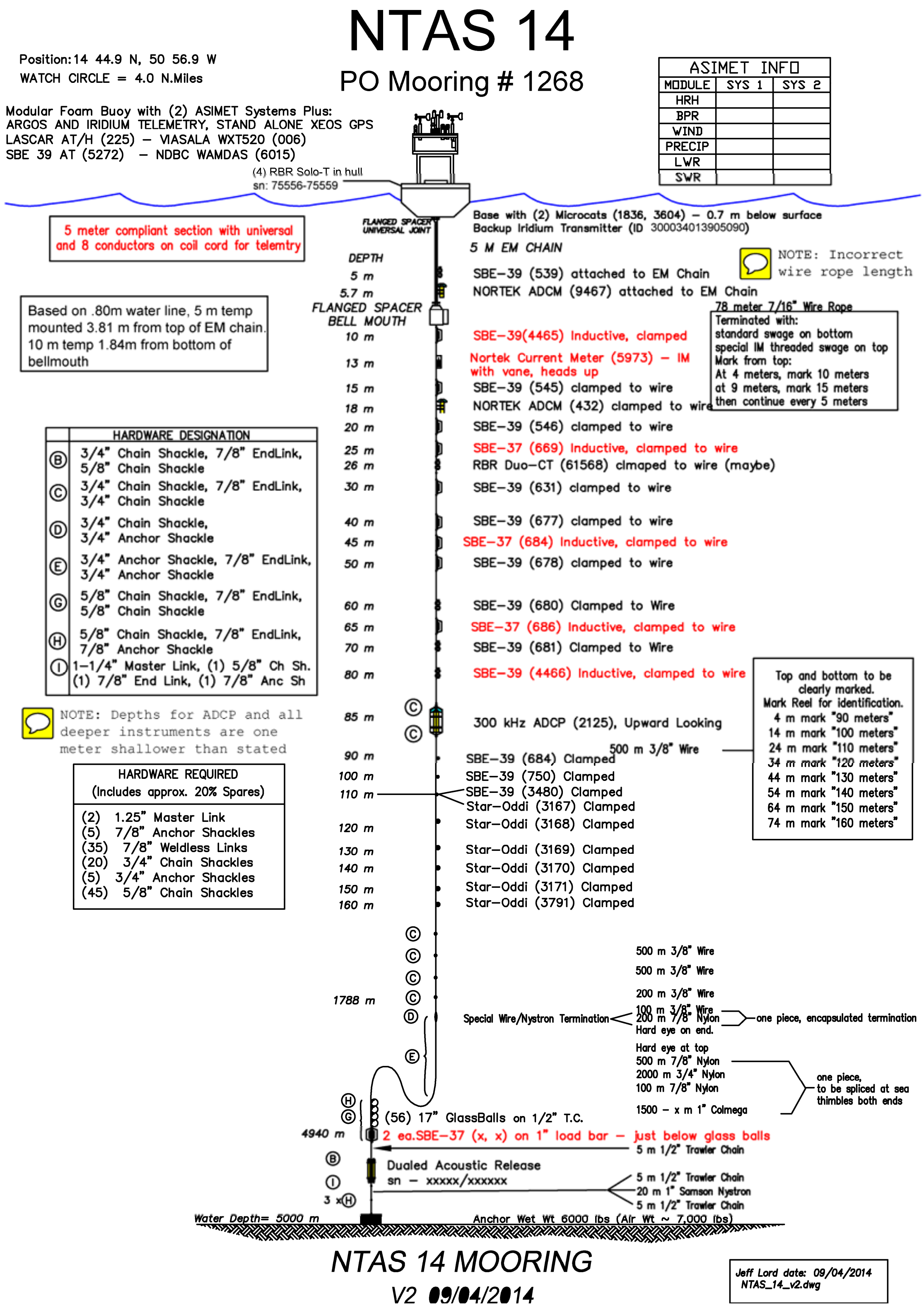


Figure 3-2. NTAS-14 mooring diagram and its instrumentation.

B. Deployment

Preparation for deployment included mounting the hardware for the telemetry interface section and the upper mooring wire section. The first 60 m of the 78 m section of mooring wire was fed from the URI TSE winch through the UOP Gifford block that hung from the ship's snatch block on the A-frame. The wire continued around the starboard quarter, and forward to the wire coupling assembly. The universal joint, flanged spacers, electro-mechanical chain (EM Chain), coupling assembly, and the top of the 78 m mooring wire were assembled and attached to the buoy. A SBE-39 and Nortek current meter were clamped to the compliant section. All other instruments down to 45 meters were clamped to the mooring wire.

Deployment operations began at about 0845 h (local) with the *Endeavor* at a distance of 6 nm from the drop site. The first step of the deployment procedure was the lowering of the assembled telemetry interface section over the starboard side of the ship. As the interface section was lowered, using the ship's knuckle crane and a slip line, the first section of mooring wire with instruments clamped to it was fed over the bulwark into the water by wire handlers stationed at the starboard rails and along the stern quarter rail. Approximately 50 m of mooring wire was lowered in this manner. This formed a loop of wire and instruments hanging below the EM chain, and leading back towards the TSE winch.

The next phase of the operation was to launch the surface buoy. The ship's main crane was positioned above the buoy's lifting bale; the crane's headache ball was then attached to the lifting bale. Slip lines were rigged on the tower top, D-ring, and buoy base to maintain control during the lift. The crane took tension on the buoy and the straps lashing the buoy to the deck were removed. The buoy was then raised up and swung outboard as the slip lines kept the hull stable. The bottom slip line was removed first, followed by the tower slip line then the D-ring slip line. After the lines were released the buoy was then lowered quickly to the water by the crane and released. The ship then maneuvered slowly ahead, and the TSE winch payed out approximately 10 m of mooring wire to provide scope for the buoy to clear the stern. The remainder of the mooring was deployed over the stern.

Once the buoy was behind the ship, speed was increased to 0.5 knots. Approximately 10 m of the 78 m wire shot was hauled back through the Gifford block and the SBE-39 (SN 678) was clamped to the wire. The wire was payed out, instruments were attached at the stern, and the final inductive SBE-39 (SN 4466) was installed at the 80 m mark. The bottom of the 78 m shot of mooring wire was stopped off at the transom and disconnected from the mooring wire on the winch. The RDI ADCP was shackled into the mooring at the transom, and the mooring wire from the winch connected to the bottom of the ADCP cage.

The block was raised in the A-frame to keep instruments and wire off the deck. The mooring tension was pulled up on the winch, and the stopper lines were removed from the mooring. The winch began to pay wire out slowly. Temperature recorders were clamped onto the mooring wire at 10 m increments after it passed through the block.

Once all the instruments were attached the mooring payout continued until the 1900 m of wire rope and 200 m of nylon that had been spooled onto the mooring winch was payed out. The ship continued to steam toward the anchor position at 1.25 knots. The wire and nylon on the winch were payed out approximately 10% slower than the ship's speed through the water.

As the mooring components were being deployed from the winch drum, the glass balls used for backup floatation were removed from wire baskets and laid out on deck. An H-bit was set up on the deck for the next phase of the deployment. The three lined wire baskets containing synthetic line for the mooring were in position for deployment. The line in the three baskets had been spliced together to form one continuous length (4100 m) of synthetic line. The top section of this line had a hard eye thimble spliced into it. Approximately 20 m of this line was pulled from the basket and dressed onto the H-bit with several turns. The thimble was positioned approximately 10 feet from the transom.

The final section of mooring line on the winch was the wire to nylon transition. This consists of a 100 m shot of 3/8" mooring wire and 200 m of 7/8" nylon line. The termination is wrapped and coated to provide a transition from the stiff mooring wire to the flexible nylon line. As the end of the nylon came off the winch, it was payed out slowly until the thimble was about 10 feet from the stern. An endless 4-foot green sling was installed in the thimble on the 7/8" nylon and a stopper line was attached, the load was transferred off the winch to the stopper line. The top of the nylon line from the baskets was shackled into the bottom of the line coming off the winch. At this termination, tie wraps were used to secure the shackles and end link, and tape was wrapped around the cotter pins. These additional steps prevent the shackles and the cotter pins from tangling in the nylon if the mooring goes slack. The stopper line was eased off slowly to pass the mooring tension to the line on the H-bit; the sling was removed and the line was payed out through the H-bit. While the nylon and Colmega line was being payed out, the 56 glass balls were pre-rigged with shackles and links.

With approximately 30 meters of Colmega line behind the H-bit, payout was stopped and the termination was connected to the winch leader. A Yale Grip was wrapped onto the Colmega line, between the bit and the transom. The mooring was stopped off with a stopper line on the Yale Grip. The slack Colmega was removed from the H-bit and moved onto the winch. With tension on the winch, the stopper line and Yale grip were removed, and the remaining Colmega was wound off the winch and stopped off at the transom. The glass balls were then shackled into the mooring line and the winch leader. The stopper was removed and the glass balls were eased over the transom with the winch. The glass balls were parceled over the transom four at a time, using the winch to control deployment, and stopper lines to stop off and connect the four-meter strings of glass balls. Just below the glass balls on a 1" load bar, two SBE-37s were shackled into the mooring to record deep temperature.

The acoustic releases and the two SBE-37s were deployed using an air tugger hauling line led through a block hung in the A-frame, and the winch. A 5 m shot of 1/2” chain was shackled into the 20 m 1” Nystron section then shackled to the next 5 m shot of 1/2” chain and wound onto the winch drum. The tugger line with a chain grab was attached to the chain just below the releases and hauled in. The A-frame was shifted out board with the winch slowly paying out its line. Once the releases cleared the deck, the tugger line was payed out and removed. Payout continued while the chains and 20 meter Samson section were payed out. The bottom 5 m of 1/2” chain was then stopped off about 3 m from the transom using a stopper line. Once the stopper took the load the slack end of the chain was shackled into the anchor eye. A 3⁄4” nylon line was attached to the winch leader using a bowline and fed through a sacrificial pear link on the 5 m chain and brought back to the winch leader and tied off with a bowline. A backstay was also secured to the eye of the anchor and fed through a deck eye directly forward of the anchor tip plate.

With the drop site approaching, the chain binders holding the anchor in place were removed and the 3⁄4” slip line took the load from the stopper line. As the ship approached the launch site, the winch payed out slowly and put the load to the anchor and the nylon backstay. The TSE winch leader was then passed through the ship’s snatch block and attached to the anchor tip plate bridle. When in position the backstay that held the anchor to the deck was removed and the TSE hauled in causing the anchor to go over. The anchor was dropped at 18:27 UTC on 13 December at 14° 44.72’ N, 50° 57.60’ W in water of depth 5027 m (corrected).

Visual observations from the bridge around 20:00 UTC (1.5 hour after the anchor drop), showed the tower top instrumentation intact and the buoy riding smoothly with a nominal waterline about 75 cm below the buoy deck. An anchor survey was done after the buoy settled and is described in more detail in the next section. See Appendix 2 for the NTAS-14 deployment mooring log.

C. Anchor Survey

An acoustic survey of the anchor position of NTAS-14 was carried out on December 13, 2014 at 20:30 UTC, about two hours after the anchor drop, and took about 1.5 hours to complete. Three positions about 1.3 nm away from the drop site (14° 44.72’ N, 50° 57.60’ W) were occupied in a triangular pattern (see Table 3-1). WHOI’s Edgetech 8011M deck gear was used with the ship’s hull transducer to determine the range to one of the mooring releases. The releases are about 31 meters above the anchor, which rests on the seafloor. The Edgetech deck box was set with a sound speed equal to 1511 m s^{-1}.

The depth at the anchor drop was 4989 m according to the ship’s 12 kHz echosounder, which was set with a sound speed of 1500 m s^{-1} and incorporated a 5 m correction for the depth of the ship’s transducer. Matthews tables indicate the correction for bathymetry in the NTAS-14 area is 38 m (this is equivalent to an actual sound speed of 1511 m s^{-1}). Therefore, the corrected depth at the anchor drop site was 5027 m.

Triangulation using the horizontal range to the release from the three sites, gave an anchor position of 14° 44.64’ N, 50° 57.71’ W. Fallback from the drop site was about 230 m or 5% of the water depth (Table 3.2). The track followed by the ship during the end of the deployment, the anchor survey and the beginning of the intercomparison period is shown in Figure 3-4. The anchor acoustic survey circles are also shown there.

Table 3-1. Acoustic ranges for NTAS-14 anchor survey (with sound speed = 1511 m s^{-1}).

Waypoint	Latitude	Longitude	Horizontal range (m)	Travel time (s)
1	14° 45.770’N	50° 58.774’W	2778	7.566
2	14° 45.332’N	50° 56.257’W	2902	7.650
3	14° 43.42’N	50° 57.574’W	2266	7.261

Table 3-2. NTAS-14 anchor coordinates based on acoustic survey.

Anchor Drop	14° 44.72 ’N	50° 57.6 ’W
Anchor position, Newhall’s code	14° 44.65 ’N	50° 57.72 ’W
Depth at anchor position	4989 m (12 kHz)	5027 m (corrected)
Fallback	250 m	5% water depth

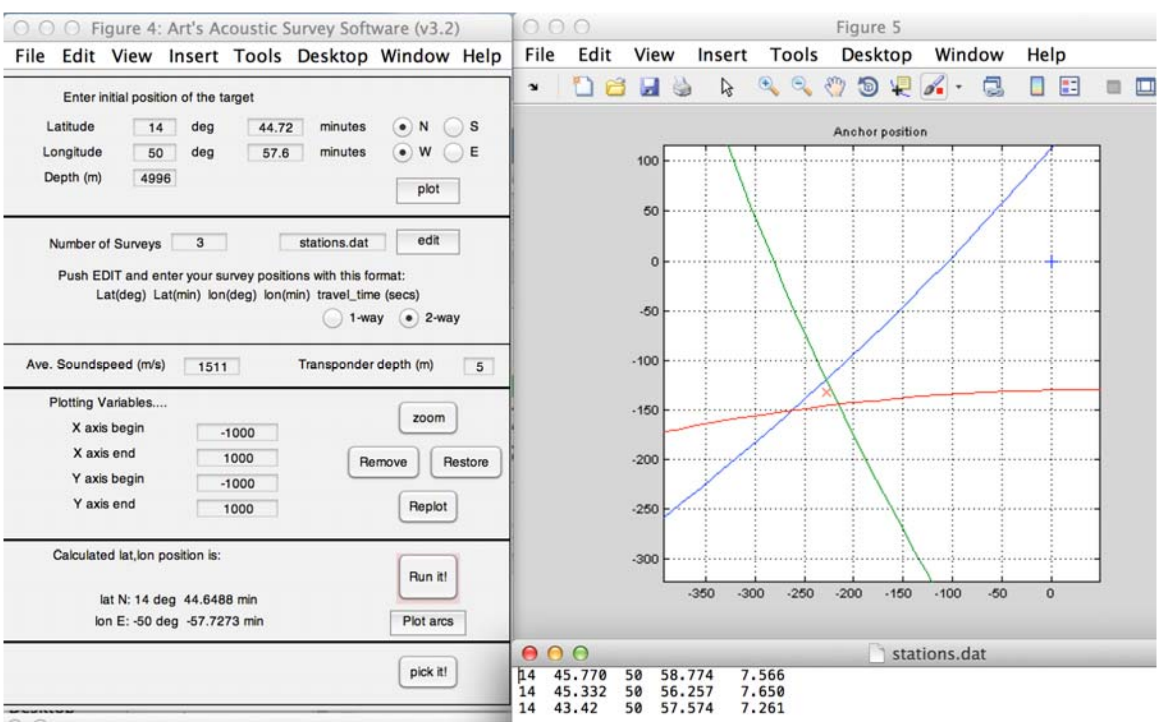


Figure 3-3. NTAS-14 anchor survey: screen capture of Art Newhall’s code results.

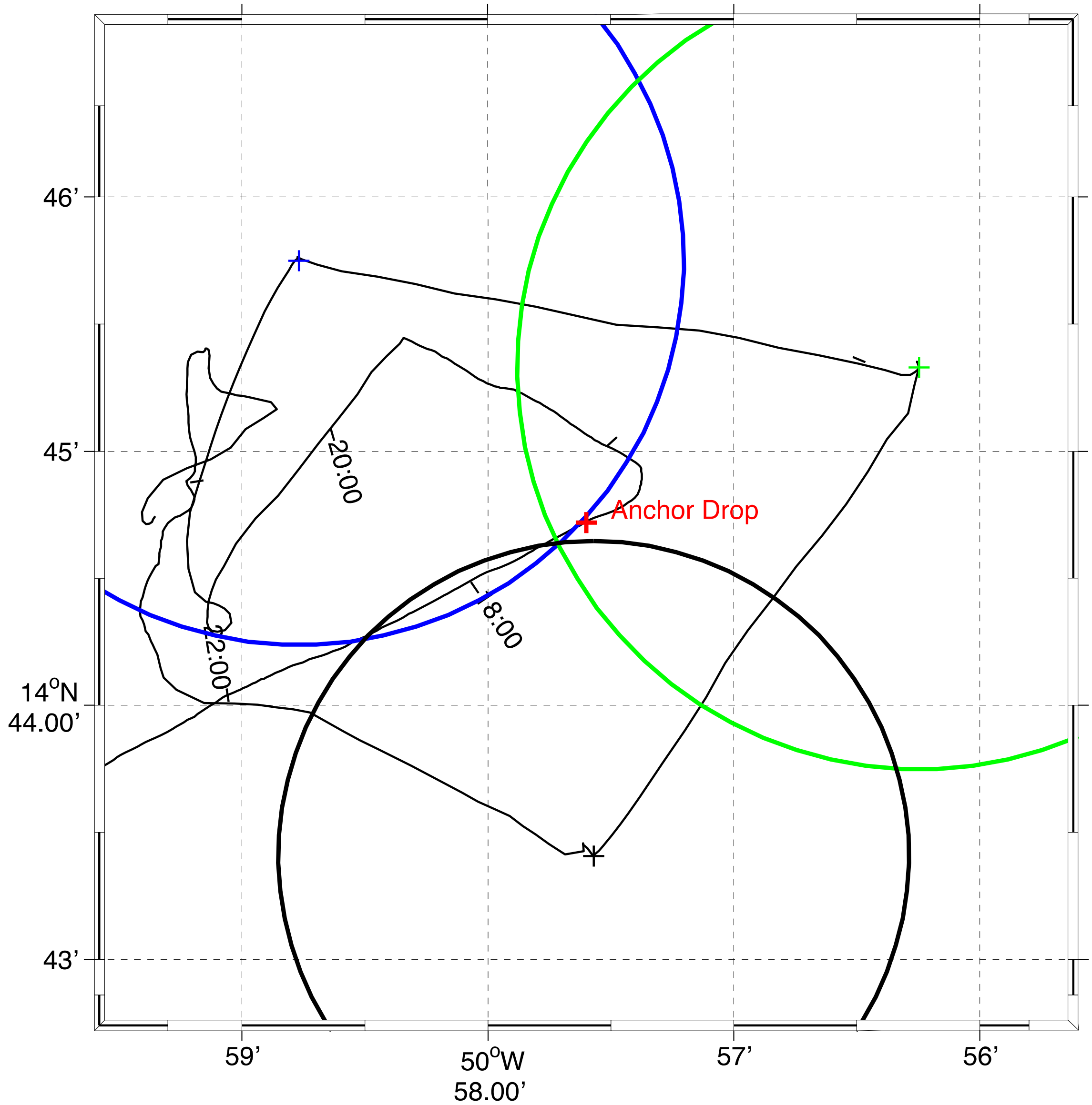


Figure 3-4. Map showing ship's track on December 13 2014, showing the end of the NTAS-14 deployment followed by the anchor survey. Acoustic survey circles are also shown.

D. Intercomparison

The NTAS-14 buoy was in the water at 12:51 UTC and the anchor was dropped at 18:27 UTC on December 13 2014. The intercomparison between ship and buoy started at 20:00 UTC the same day, with the ship hoving to about 500 m downwind of the buoy. Meteorological data collected on R/V *Endeavor* and used for the intercomparison consist of wind measurements from a Gill Windsonic sensor, RM Young sensors for temperature, relative humdity, barometric pressure, and precipitation and PIR and PSP radiation sensors, located on the bow mast (Fig. 3.5). The foredeck at the bow mast is 4.47 m above the waterline. Ship's diagram indicate the instruments on bow mast are 16.85 m above the baseline which is 4.2 m below the waterline. So we estimate that ship's meteorological sensors are about 12.5 m above sea level. Sea surface temperature and salinity are measured from the thermosalinograph system with a SBE-21 and MicroTSG unit with a SBE-45, using water from the water intake at 5 m depth. UOP personel also installed standalone (SA) ASIMET sensors on the ship for the duration of this cruise. SA HRH 248 was placed on the bow mast (see Fig. 3.5), 4.5 m above the forward O1 deck (about 9 m above sea level). The SA radiation sensors (SWR 209, LWR 236) were placed on the back rail of the main crane on the O1 deck aft (see Fig. 3.5, right panel).

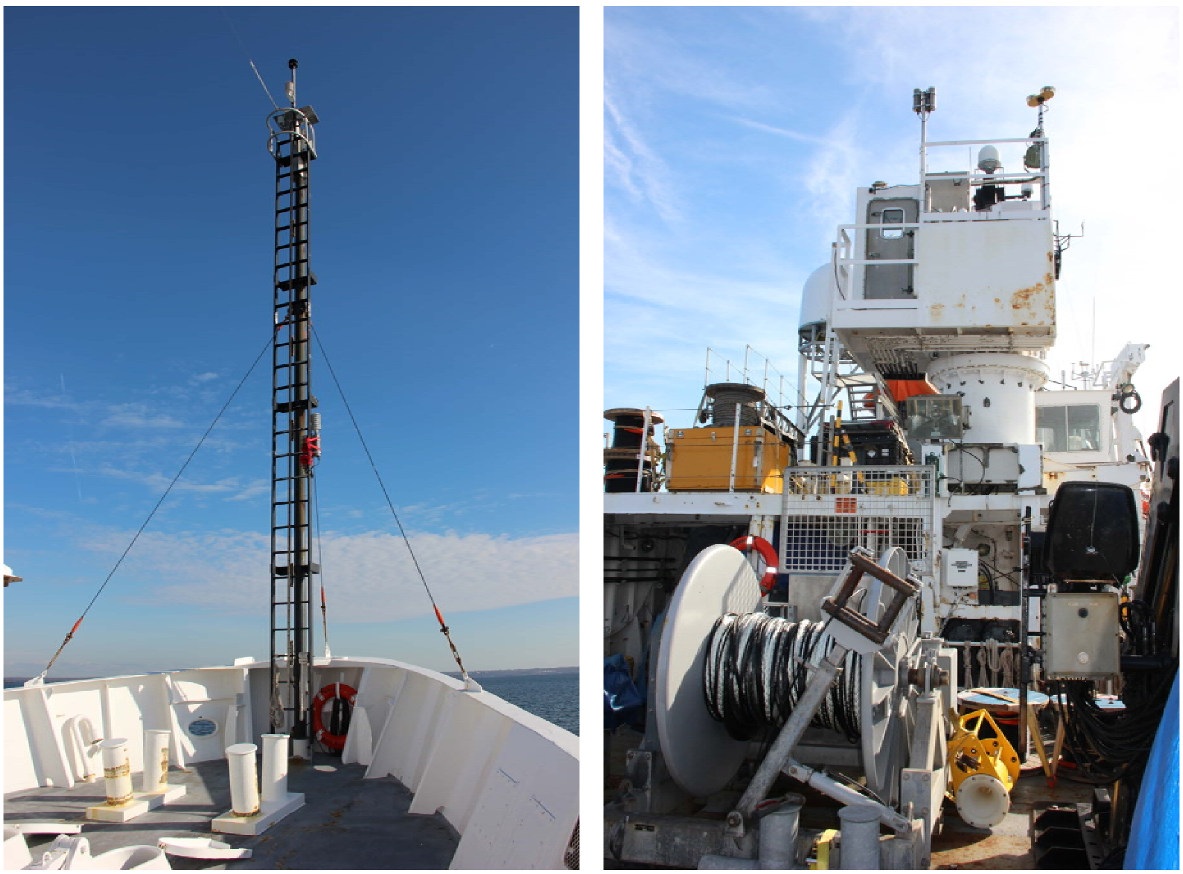


Figure 3-5. Meteorological sensors on R/V *Endeavor* during NTAS-14. Left: bow mast on O1 deck with UOP standalone HRH 248 at mid-height and ship's sensors at top. Right: radiation sensors located above the rail behind the main crane on O1 deck (UOP sensors on the left and ship sensors on the right).

Air-sea fluxes during the intercomparison period were computed using the COARE 3.5 algorithm (Fairall 2003, Edson 2014) and are shown in Figure 3-6. Figures 3-7 to 3-18 show the hourly averaged data from buoy (using telemetry output), ship sensors and UOP SA sensors. For some variables (ATMP, BPR, WSPD), the correction for height is also included. This correction is computed using the COARE 3.5 bulk algorithm.

SWR measurements from sensors on the buoy are within about 5 W m^{-2} of each other (Figs. 3-7 and 3-8). Measurements from the ship are about 20 W m^{-2} lower than on the buoy. Some of the differences occur due to differences in attitude of the sensors, which may be different from one platform to the other, obstruction from other objects, and calibration offsets. This dataset is too short to identify and quantify these effects.

AT measurements (Fig. 3-9) from the buoy are within 0.1 °C of each other and track measurements from the sensors on the ship, after adjusting values for the different sensor heights.

RH is shown in Figures 3-10 and 3.11. The ASIMET sensors on the buoy are within 0.1g kg^{-1} of each other. With the height correction the buoy measurements get closer to ship's sensor measurement, although they are still higher than ship's measurements on the second day of the intercomparison by 0.1 to 0.2 g kg^{-1}.

LWR measurements from the buoy are within 4 W m^{-2} of each other and within 2 W m^{-2} of the ship's measurement on the second day, although 10 W m^{-2} lower than the ship's measurement on the first day (Fig. 3-12).

SST measurements from the buoy are consistent and typically different from the ship's measurement by about 0.15 °C (Fig. 3-13), which may be due to spatial inhomogeneity in the ocean but also from the different depth sampled by buoy and ship's sensors.

WSPD measurements are consistent and typically lower than the ship's measurement by about 0.2 m s^{-1} after correction for the difference in sensors heights (Fig. 3-14).

WDIR measurements from the buoy are offset by about 10° and one of these sensors gives similar wind direction to the ship's sensor (Fig. 3-15). This may be due to flow distortion on the buoy itself and will need to be further assessed at recovery (checking in particular the proper mounting of the wind vanes).

BPR in Figure 3-16 shows very good agreement between buoy and ship measurement.

Salinity measurements (Fig. 3-17) from the buoy are very consistent with each other. The difference with the ship's measurement is within 0.05 psu and may be the result of issues similar to those described for SST.

Precipitation (PRC) measurements from the buoy track each other very well (Fig. 3-18). The rain event with 5 mm accumulation on December 14 around 17:00 UTC is seen in both the buoy and ship measurements, although ship's values are closer to 4 mm. The initial increase in buoy PRC values on December 13 around 12:00 UTC are an artifact of the buoy loggers being turned on just prior to deployment.

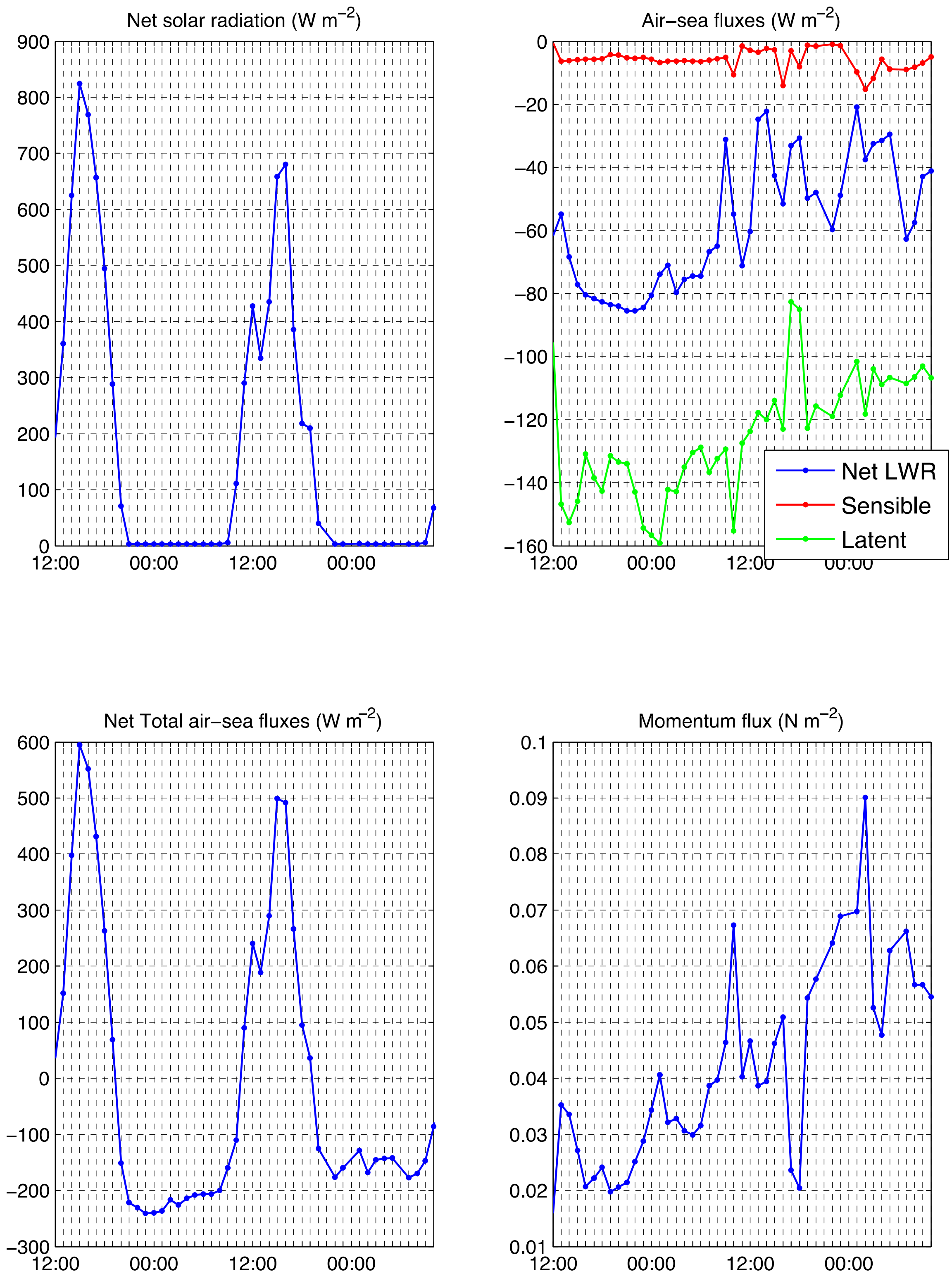


Figure 3-6. Air-sea fluxes during intercomparison between NTAS-14 and R/V Endeavor on December 13 and 14 2014. Radiation is positive for input into ocean.

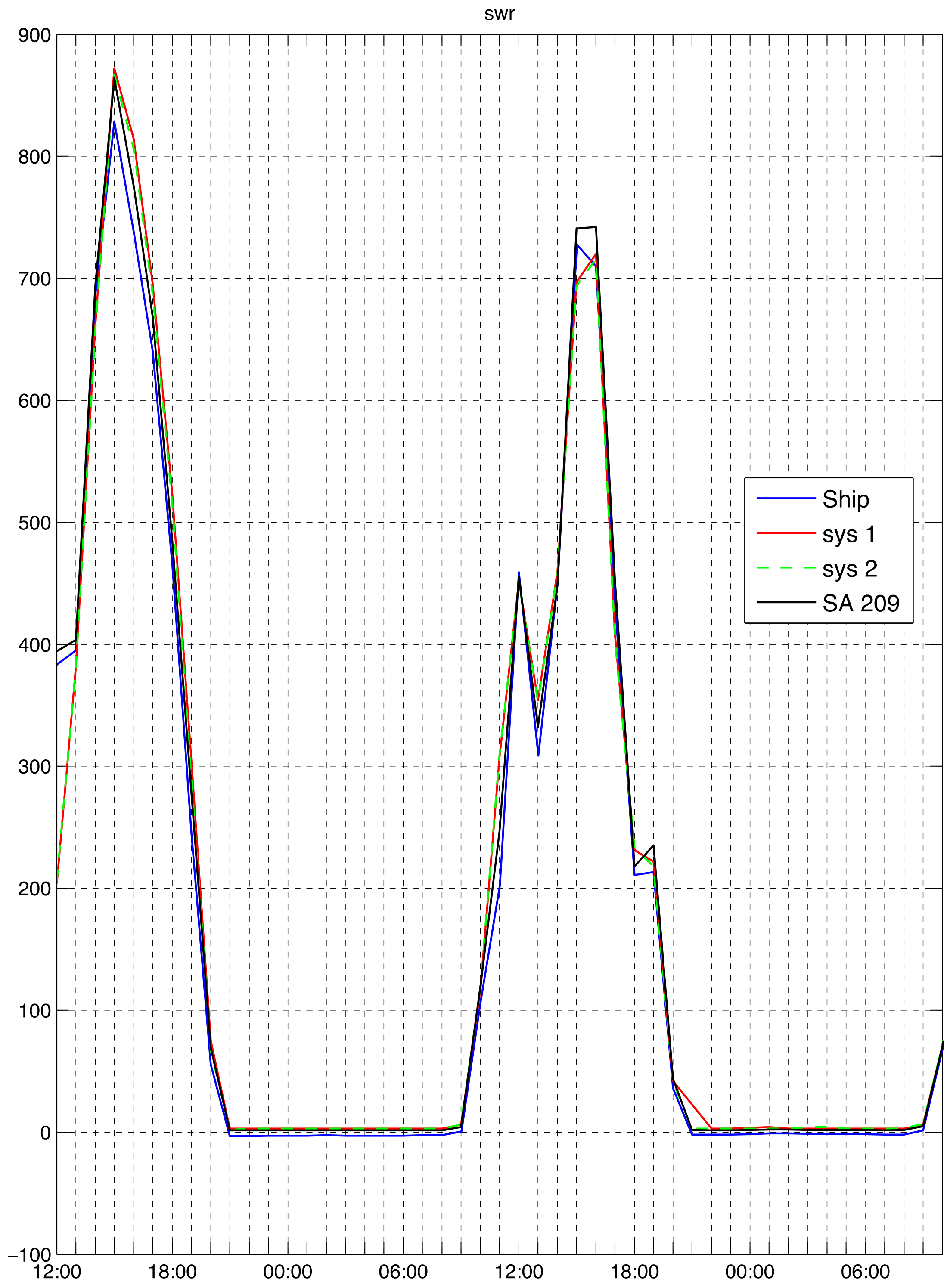


Figure 3-7. Intercomparison NTAS-14 - ship on December 13-14 2014: downwelling shortwave radiation (SWR, Wm^{-2}).

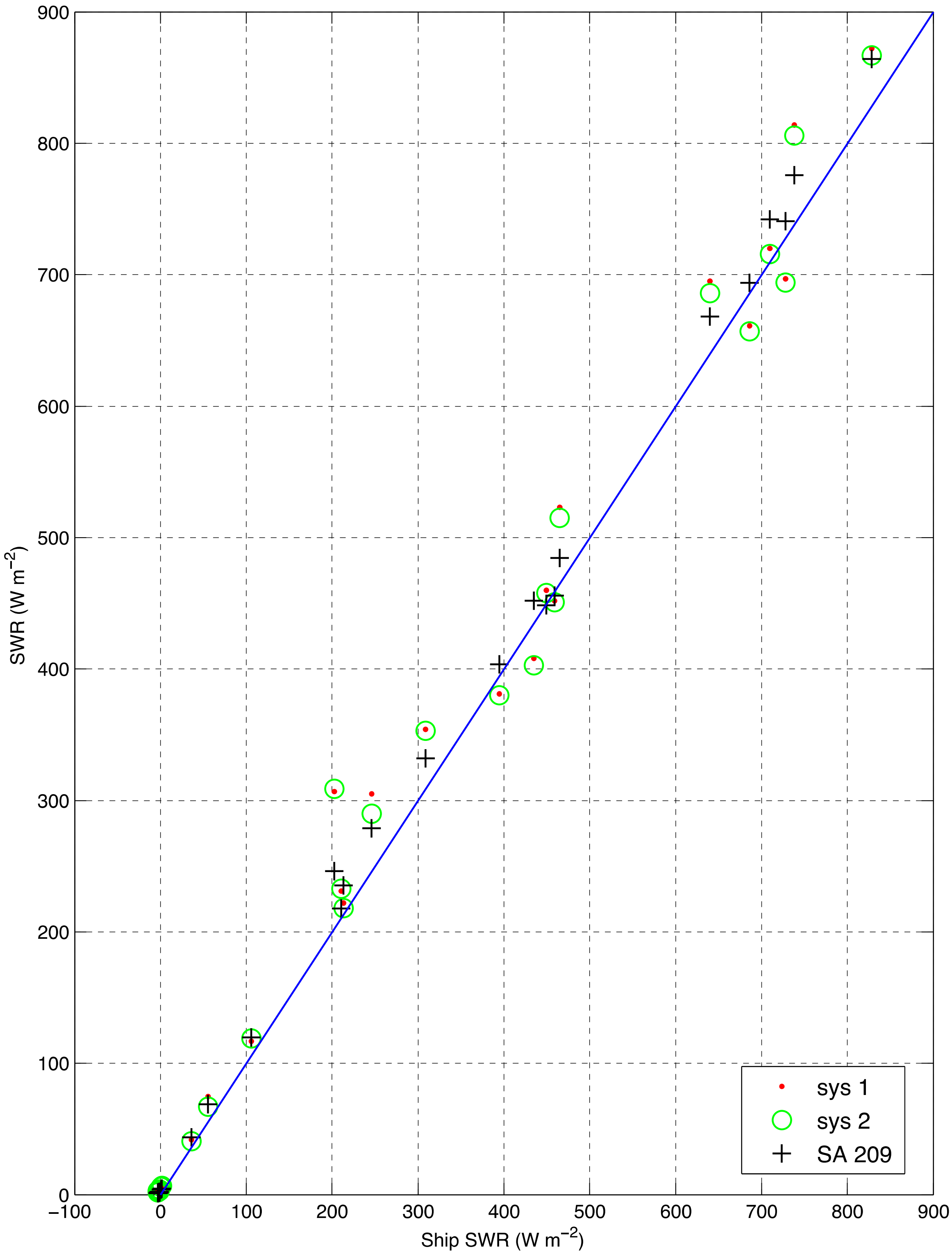


Figure 3-8. Scatter plot of downwelling shortwave radiation (SWR, Wm^{-2}), using data shown in Fig. 3.7.

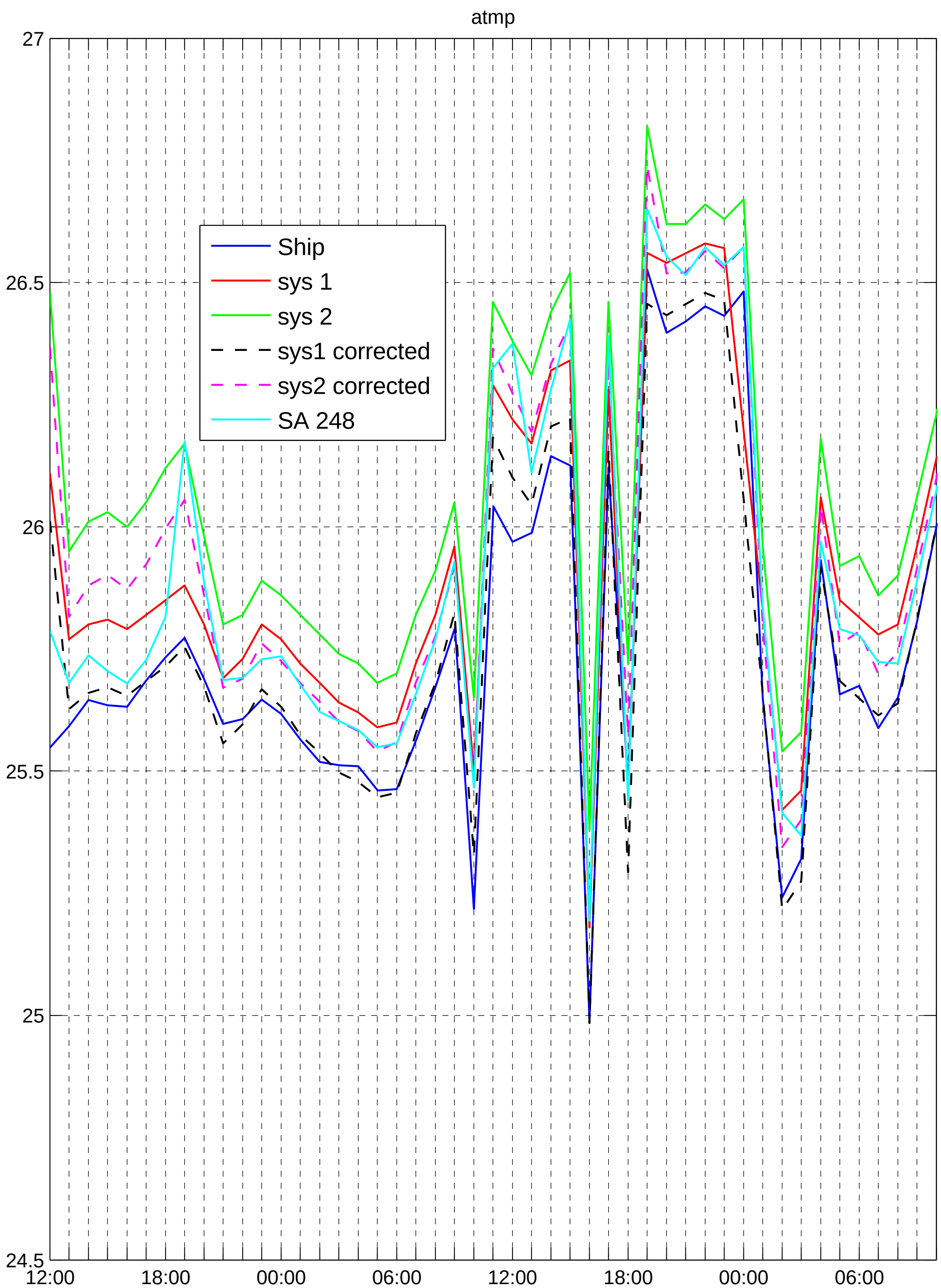


Figure 3-9. Same as Fig. 3.7 but for in-situ air temperature (ATMP, °C). Dashed lines are ATMP adjusted to height of ship's sensor. SA-248 is standalone sensor installed by UOP on bow mast.

Figure 3-10. Same as Fig. 3.7 but for air relative humidity (HRH, %RH).

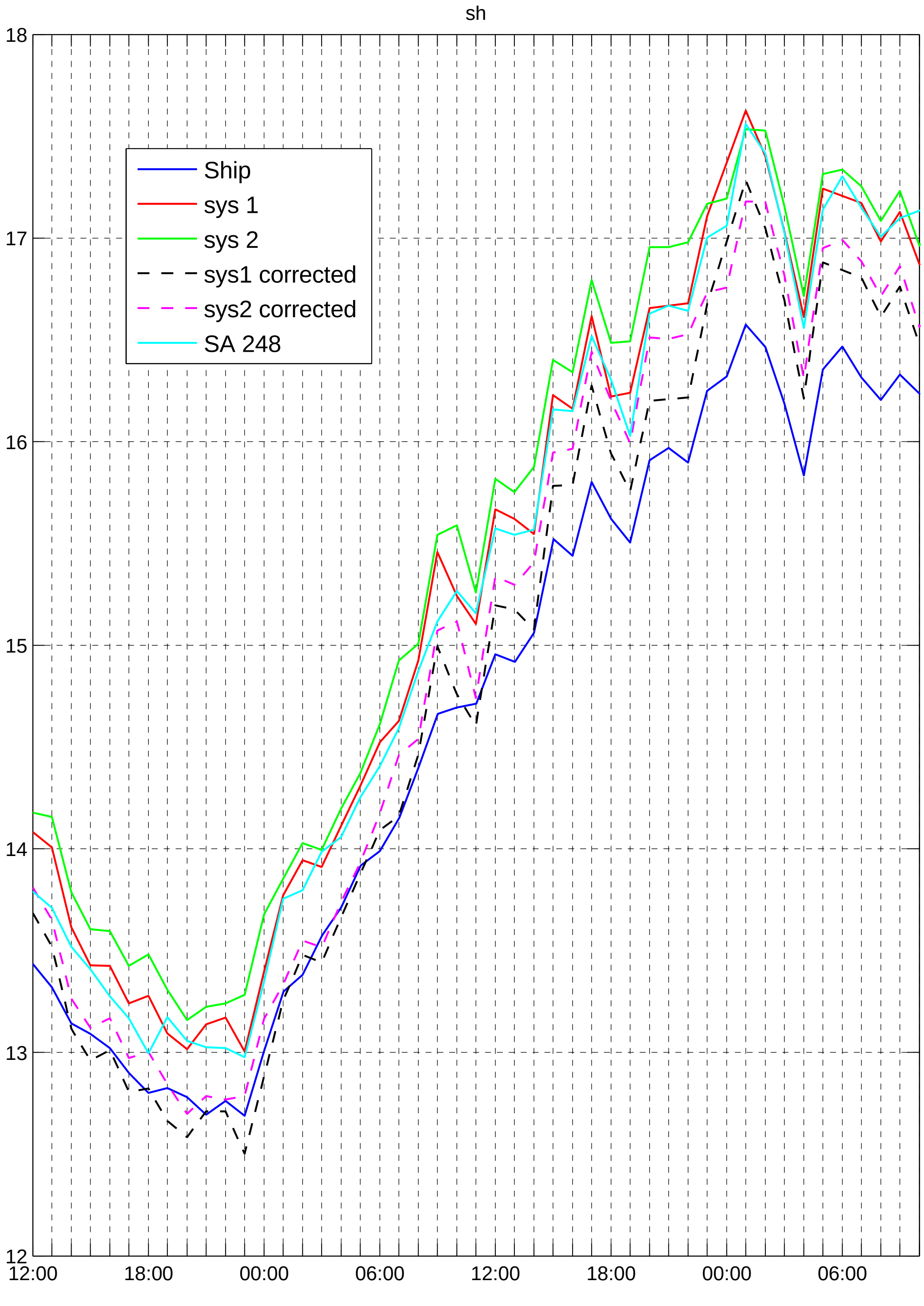


Figure 3-11. Same as Fig. 3.10 but for air specific humidity (HRH, %RH). Dashed lines are buoy values adjusted to the height of ship's sensor.

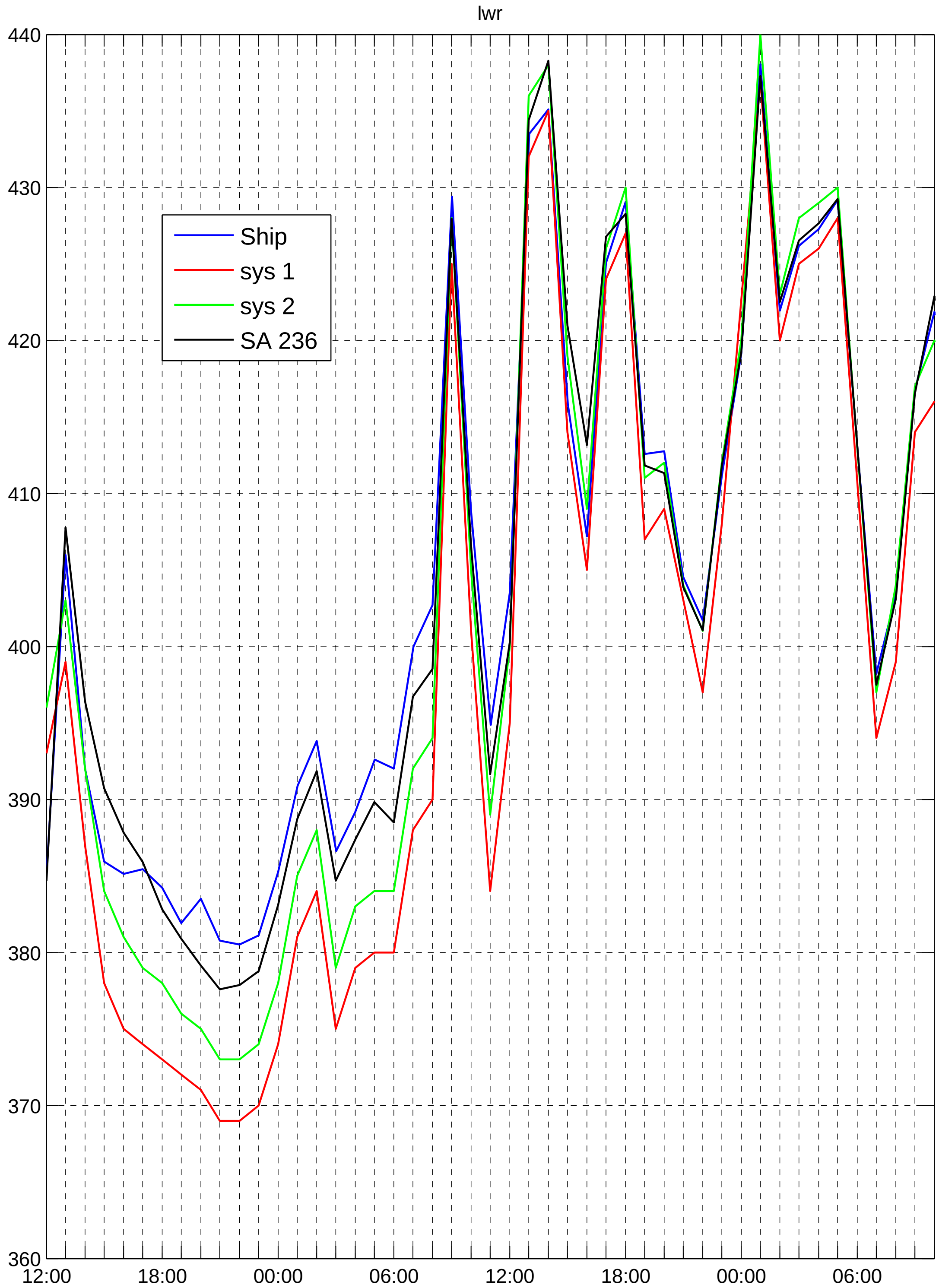


Figure 3-12. Same as Fig. 3.7 but for downwelling longwave radiation (LWR, W m^{-2}).

Figure 3-13. Same as Fig. 3.7 but for sea surface temperature (SST, °C).

Figure 3-14. Same as Fig. 3.7 but for wind speed (WSPD, m s^{-1}). Dashed lines are buoy ASIMET adjusted to height of ship's sensor.

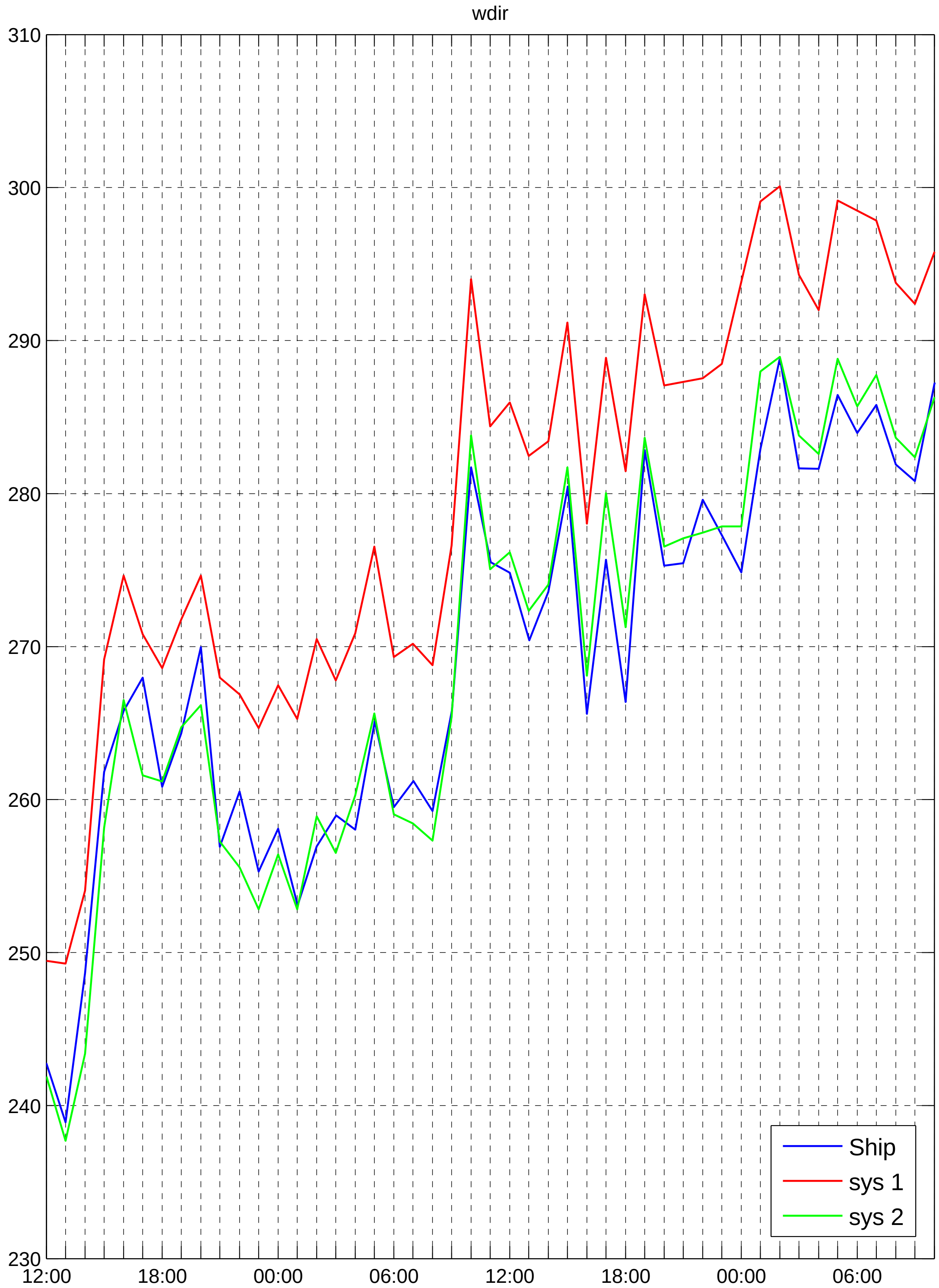


Figure 3-15. Same as Fig. 3.7 but for wind direction (WDIR, degrees).

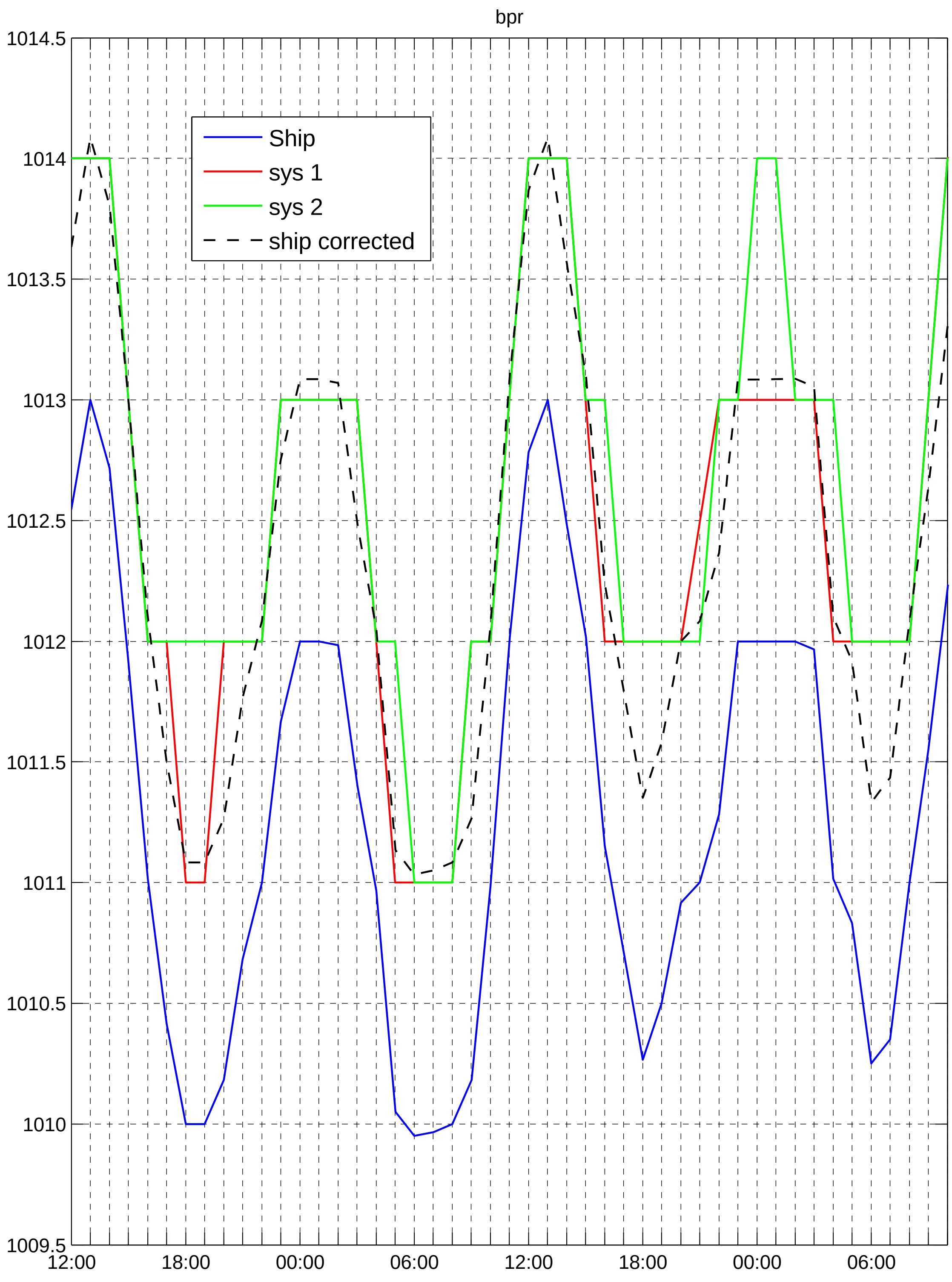


Figure 3-16. Same as Fig. 3.7 but for air barometric pressure (BPR, mb). Black line is ships measurement adjusted to height of buoy sensors.

Figure 3-17. Same as Fig. 3.7 but for sea surface salinity (SSS, psu).

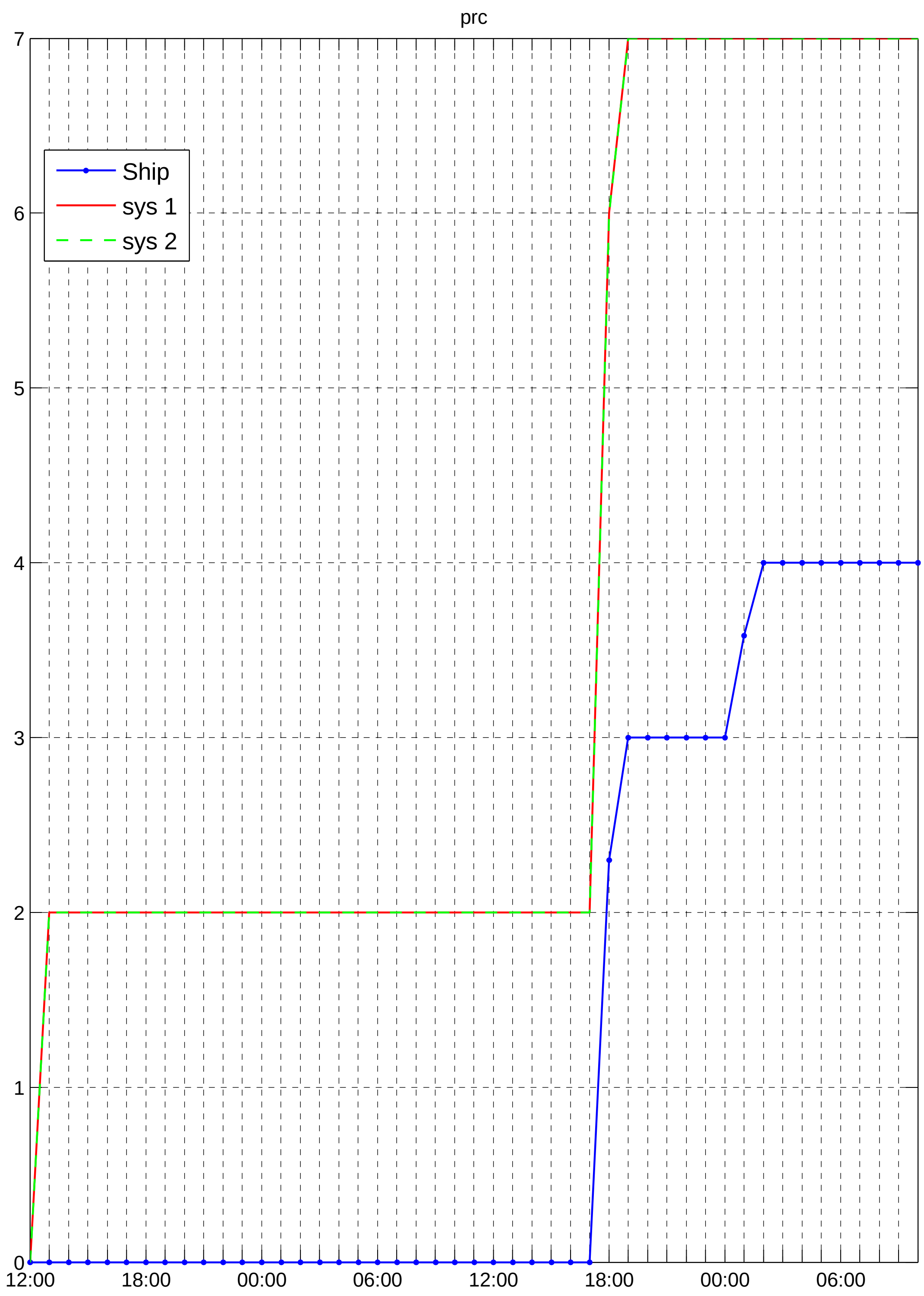


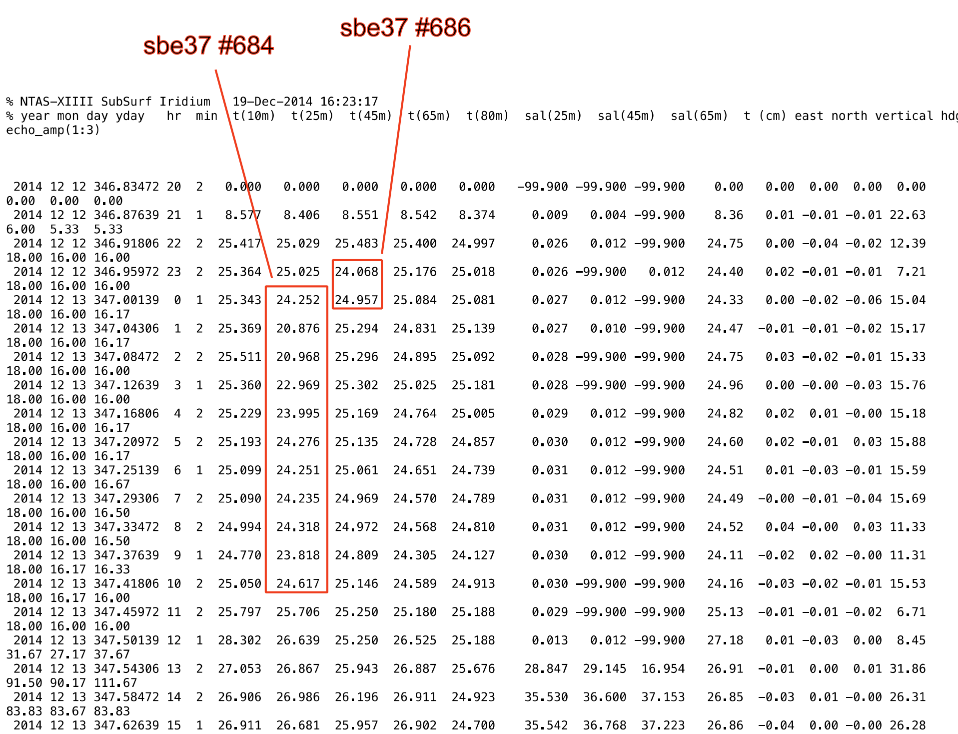
Figure 3-18. Same as Fig. 3.7 but for precipitation accumulation (PRC, mm).

The data from the inductive sensors on the mooring are telemetered through an inductive modem (IM) using unique identification numbers (IDs) for each sensor. The IDs assigned to the three IM-SBE-37s were reset before deployment. To make sure we could match IDs with instrument serial numbers (and therefore depth), we performed a temperature spike (using ice bags strapped on sensor) before deployment on SBE-37s #686 and #684 (SBE-37 #669 was identified as the remaining instrument). The final configuration of inductive sensors' IDs, serial numbers and depths is shown in Table 3.3, as well as times of ice bags spikes when applicable.

Table 3-3. Configuration of inductive sensors serial numbers and inductive modem IDs. Time of cold temperature spikes applied to inductive SBE-37, prior to deployment.

Type	Serial Number	ID	Depth	Time ice applied
SBE 37	686	5	65	22:45 Dec 12
SBE 37	684	4	45	00:18 Dec 13
SBE 37	669	3	25	N/A
SBE 39	4465	7	10	N/A
SBE 39	4466	8	80	N/A
Nortek	5973		13	N/A

Figure 3-19 shows an example of telemetered data where the two spikes in Table 3.3 are shown. In this case the heading of the text file shown is incorrect and in fact the 5 columns with temperature values should be organized with the following depth order: 25m, 45m, 65m, 10m, 80m.




```
% NTAS-XIIII SubSurf Iridium    19-Dec-2014 16:23:17
% year mon day yday   hr  min  t(10m)  t(25m)  t(45m)  t(65m)  t(80m)  sal(25m)  sal(45m)  sal(65m)  t (cm) east north vertical hdg
echo_amp(1:3)

 2014 12 12 346.83472 20  2   0.000   0.000   0.000   0.000   0.000   -99.900 -99.900 -99.900    0.00   0.00  0.00  0.00  0.00
0.00  0.00  0.00
 2014 12 12 346.87639 21  1   8.577   8.406   8.551   8.542   8.374     0.009   0.004 -99.900    8.36   0.01 -0.01 -0.01 22.63
6.00  5.33  5.33
 2014 12 12 346.91806 22  2  25.417  25.029  25.483  25.400  24.997     0.026   0.012 -99.900   24.75   0.00 -0.04 -0.02 12.39
18.00 16.00 16.00
 2014 12 12 346.95972 23  2  25.364  25.025  24.068  25.176  25.018     0.026 -99.900   0.012   24.40   0.02 -0.01 -0.01  7.21
18.00 16.00 16.00
 2014 12 13 347.00139  0  1  25.343  24.252  24.957  25.084  25.081     0.027   0.012 -99.900   24.33   0.00 -0.02 -0.06 15.04
18.00 16.00 16.17
 2014 12 13 347.04306  1  2  25.369  20.876  25.294  24.831  25.139     0.027   0.010 -99.900   24.47  -0.01 -0.01 -0.02 15.17
18.00 16.00 16.17
 2014 12 13 347.08472  2  2  25.511  20.968  25.296  24.895  25.092     0.028 -99.900 -99.900   24.75   0.03 -0.02 -0.01 15.33
18.00 16.00 16.00
 2014 12 13 347.12639  3  1  25.360  22.969  25.302  25.025  25.181     0.028 -99.900 -99.900   24.96   0.00 -0.00 -0.03 15.76
18.00 16.00 16.00
 2014 12 13 347.16806  4  2  25.229  23.995  25.169  24.764  25.005     0.029   0.012 -99.900   24.82   0.02  0.01 -0.00 15.18
18.00 16.00 16.17
 2014 12 13 347.20972  5  2  25.193  24.276  25.135  24.728  24.857     0.030   0.012 -99.900   24.60   0.02 -0.01  0.03 15.88
18.00 16.00 16.17
 2014 12 13 347.25139  6  1  25.099  24.251  25.061  24.651  24.739     0.031   0.012 -99.900   24.51   0.01 -0.03 -0.01 15.59
18.00 16.00 16.67
 2014 12 13 347.29306  7  2  25.090  24.235  24.969  24.570  24.789     0.031   0.012 -99.900   24.49  -0.00 -0.01 -0.04 15.69
18.00 16.00 16.50
 2014 12 13 347.33472  8  2  24.994  24.318  24.972  24.568  24.810     0.031   0.012 -99.900   24.52   0.04 -0.00  0.03 11.33
18.00 16.00 16.50
 2014 12 13 347.37639  9  1  24.770  23.818  24.809  24.305  24.127     0.030   0.012 -99.900   24.11  -0.02  0.02 -0.00 11.31
18.00 16.17 16.33
 2014 12 13 347.41806 10  2  25.050  24.617  25.146  24.589  24.913     0.030 -99.900 -99.900   24.16  -0.03 -0.02 -0.01 15.53
18.00 16.17 16.00
 2014 12 13 347.45972 11  2  25.797  25.706  25.250  25.180  25.188     0.029 -99.900 -99.900   25.13  -0.01 -0.01 -0.02  6.71
18.00 16.00 16.00
 2014 12 13 347.50139 12  1  28.302  26.639  25.250  26.525  25.188     0.013   0.012 -99.900   27.18   0.01 -0.03  0.00  8.45
31.67 27.17 37.67
 2014 12 13 347.54306 13  2  27.053  26.867  25.943  26.887  25.676    28.847  29.145  16.954   26.91  -0.01  0.00  0.01 31.86
91.50 90.17 111.67
 2014 12 13 347.58472 14  2  26.906  26.986  26.196  26.911  24.923    35.530  36.600  37.153   26.85  -0.03  0.01 -0.00 26.31
83.83 83.67 83.83
 2014 12 13 347.62639 15  1  26.911  26.681  25.957  26.902  24.700    35.542  36.768  37.223   26.86  -0.04  0.00 -0.00 26.28
86.33 86.17 85.83
```

Figure 3-19. Excerpt from telemetered subsurface data. The period shown corresponds to time of spiking of SB-37s #686 and 684, a few hours before deployment of NTAS-14.

During the intercomparison period, six CTDs were done to 500 m depth, while the ship was ½ mile downwind of the NTAS-14 buoy. CTDs were done every 6 hours, with the first one on December 13 at 2200 UTC, and last one was on December 15 at 0400 UTC. Another CTD was done on December 15 at 1100 UTC near the NTAS-13 anchor position (about 3 nm from NTAS-14 buoy).

The comparison between the CTD measurements and conductivity and temperature data that was telemetered from the inductive sensors on the mooring are shown in Figures 3-20 and 3-21. The telemetered data consists of hourly averages and the plot shows data that were within one hour of the CTD. No obvious bias is observed. Agreement is especially good in the mixed layer. Differences are seen below the mixed layer but may be caused by natural variability of the ocean. The full profile of CTD data is shown in Figures 3-22 to 3-24. A temperature-salinity including all the CTD profiles is shown in Figure 3-25.

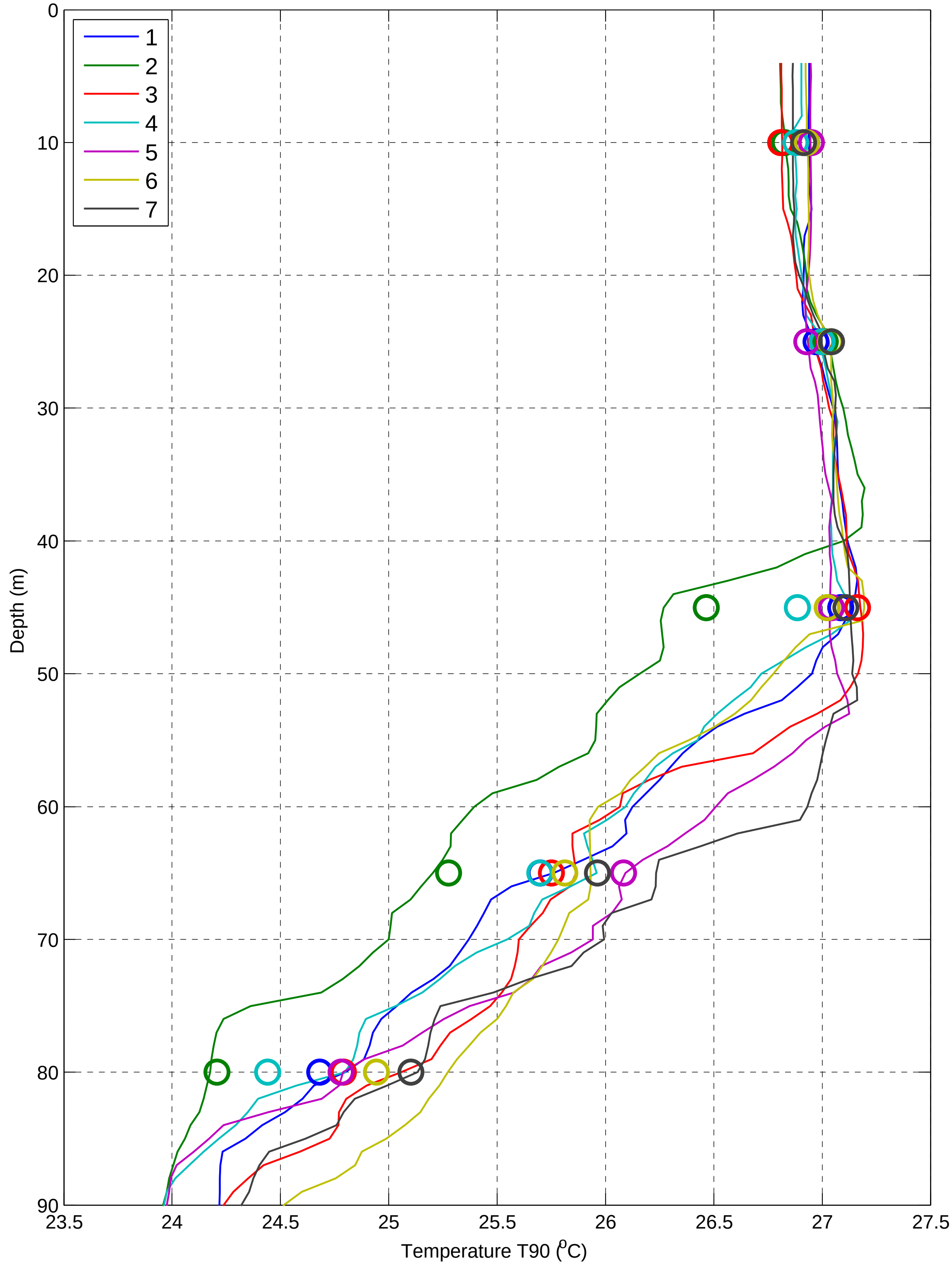


Figure 3-20. Comparison of temperature measurements between CTD profiles (lines) and the NTAS-14 subsurface inductive sensors (circles). Colors are used to distinguish between the times of the CTD which are 6 hours apart.

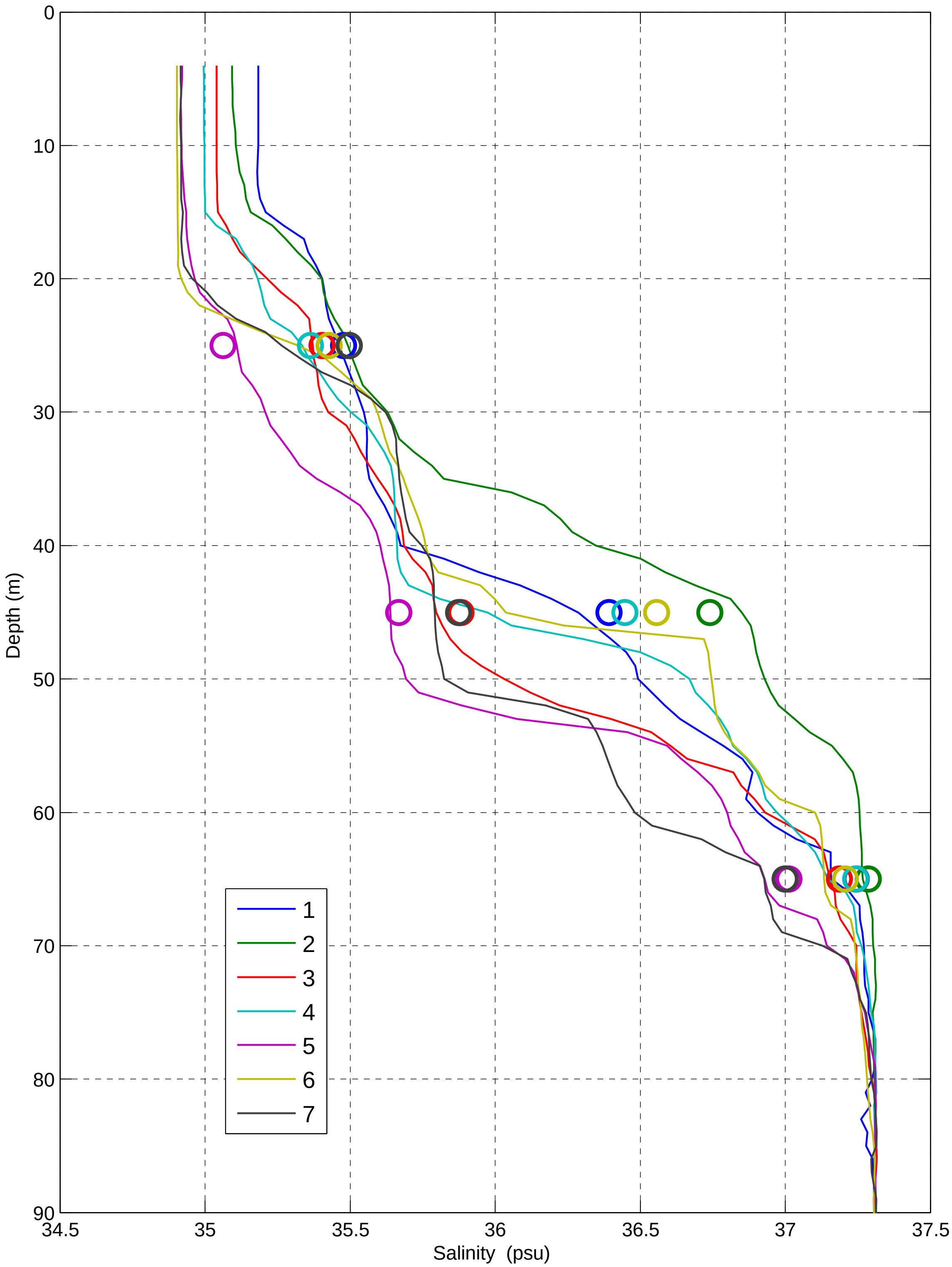


Figure 3-21. Same as Fig. 3-20 but for salinity.

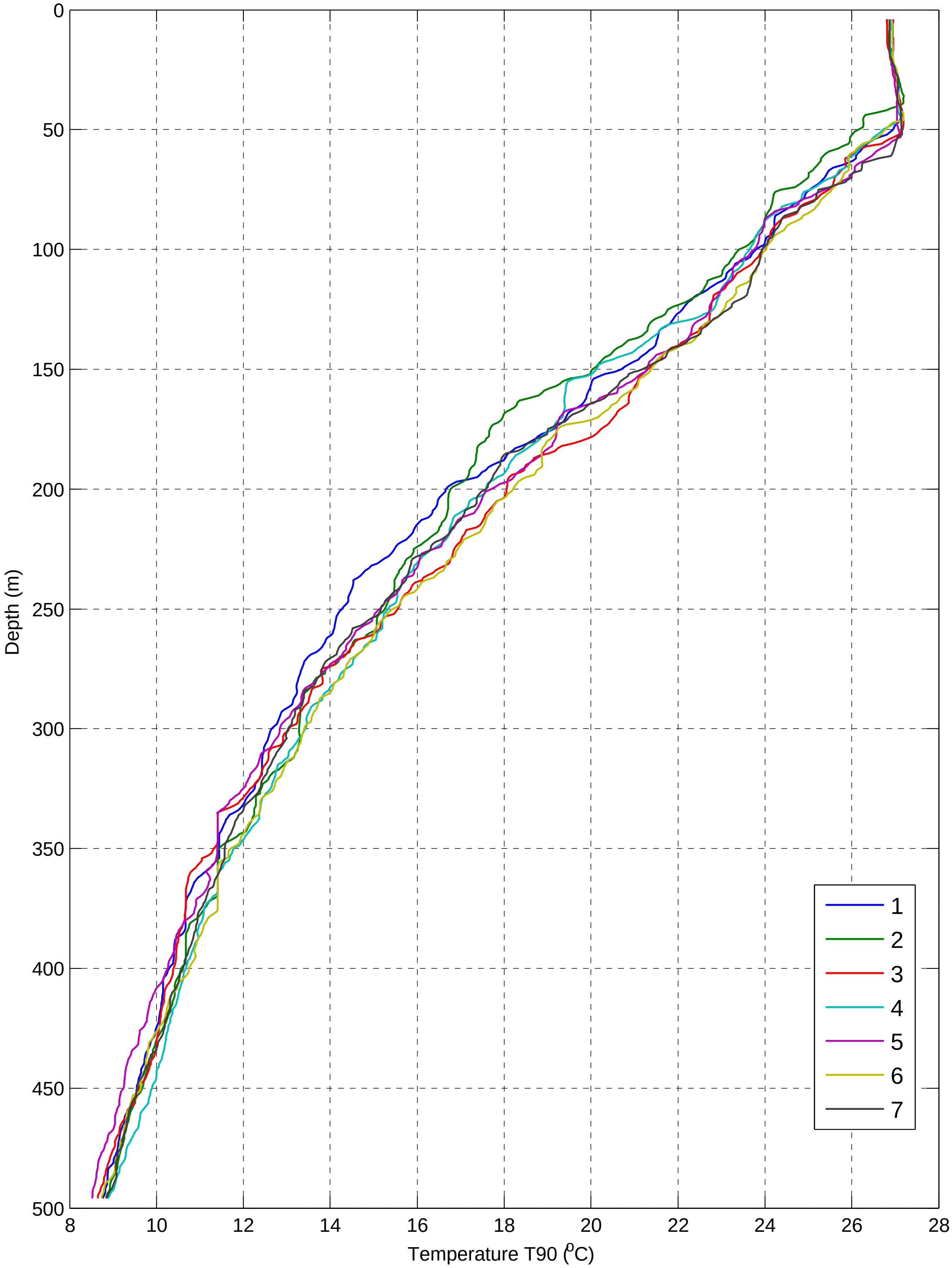


Figure 3-22. Temperature profile from 500 m CTD casts done near NTAS-14 (casts 1 to 6) and NTAS-13 (cast 7).

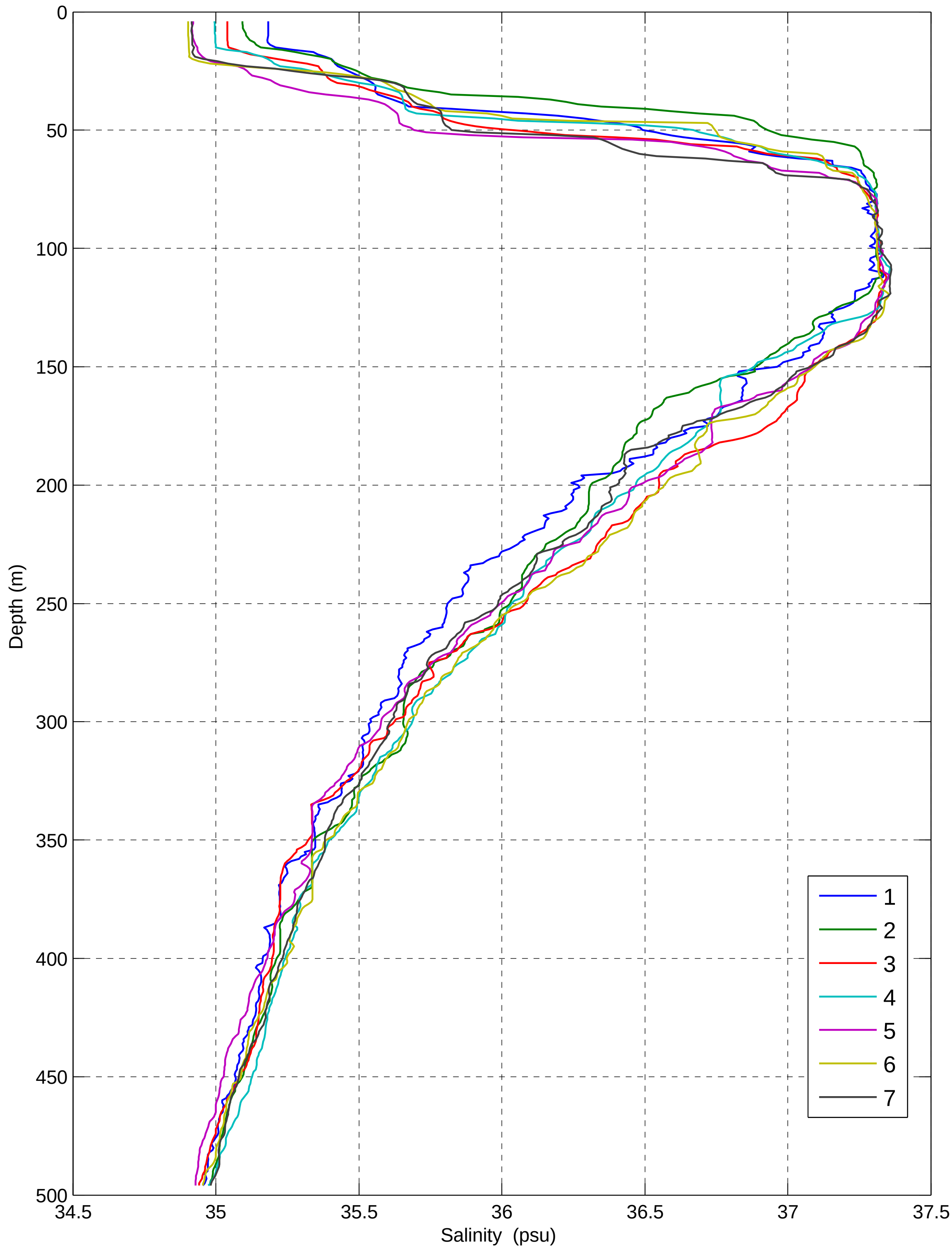


Figure 3-23. As in Fig. 3-22 but for salinity.

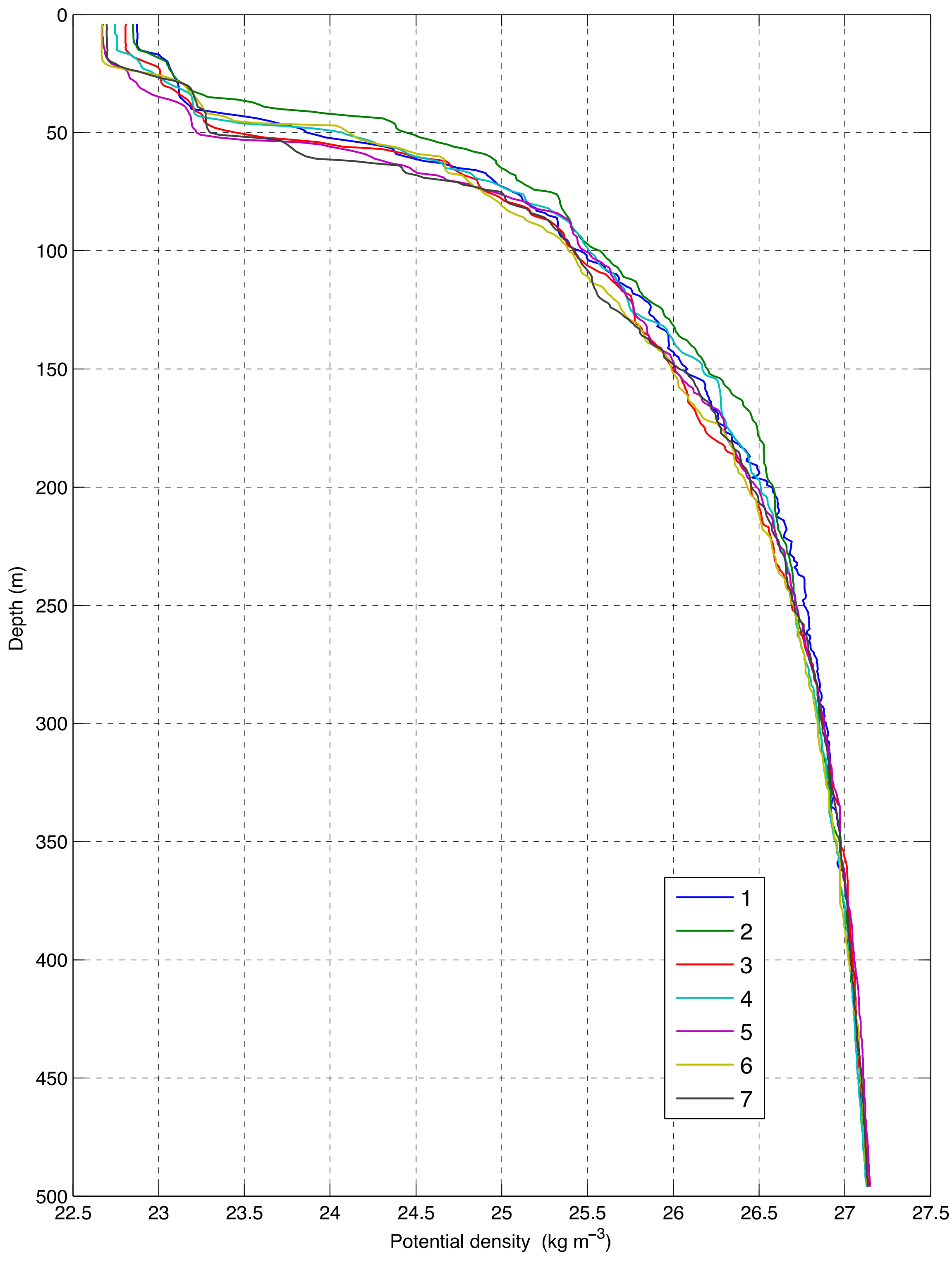


Figure 3-24. As in Fig. 3-22 but for potential density.

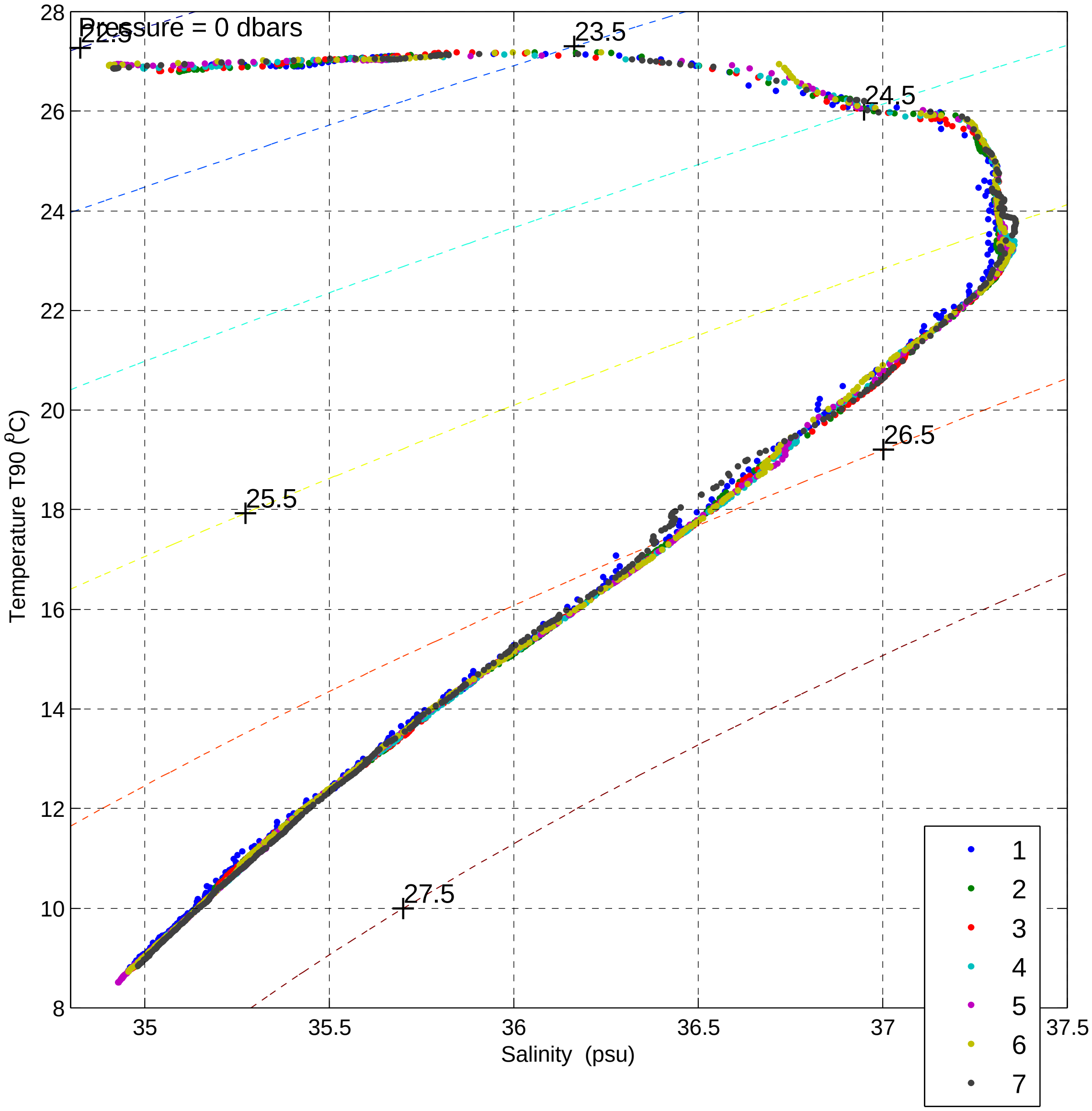


Figure 3-25 T-S data from CTD casts shown in Fig. 3-22 to 3-24.

IV. NTAS-13 Recovery

A. Buoy Recovery

The NTAS-13 mooring broke on September 23 and the buoy drifted freely westward at an average speed of 1 knot. On October 26 2014, buoy position was close to Martinique and it was decided that two people would go to Martinique for recovery of the drifting buoy. Arrangements were made to hire the Alliance (SOMARA company) tugboat. The Alliance departed Fort-de-France, Martinique, on October 28 (1740 local), with B. Pietro onboard in charge of the buoy recovery. Alliance was in sight of buoy on October 29 1205 (local) with position 14°57’06 N, 59°23’0 W (about 100 nm east of Martinique).

The tug pulled up to the buoy for a visual inspection. Initial impressions indicated the buoy had parted right under the EM chain. The decision was made to launch the small raft to board the buoy and dismount all of the tower instrumentation. The operation was in three steps and took over 3 hours to complete. One instrument at a time was handed down from the buoy to the raft. After half of the instruments were on the raft it was determined that the raft was getting too heavy. A judgment call was made for the raft to row back to the tug and remove all instruments. Once all instruments were off the buoy and in the raft, it was decided again to go back to the ship and offload for safety of personnel and instrumentation. The next step in rescuing the buoy was a call made by the captain of the tugboat. It was his firm decision to tow the buoy instead of lashing the buoy to the rail. The raft was thrown a leader line that was attached to the towline. After the connection was made using a 1” anchor shackle to the buoy pickup bail all personnel got back in the raft and rowed back to the tug. The tug then (1425 local) started to steam forward at approximately 2 knots. Within 2 minutes of towing the buoy capsized. Calling an all stop to the operation the tug made a loop back towards the buoy to inspect the damage. After a visual assessment, there was no clear evidence of any major destruction. The decision was made not to flip the buoy back due to not having the proper equipment on board. The tug then adjusted its track to head back to the Martinique with the buoy in tow (upside down) traveling at an average speed of 5 knots.

Tugboat Alliance was back in port in Fort-de-France on October 30 at 0640 (local). The same day, a crane lifted the buoy on the dock, the buoy hatch was safely opened and no damage was visible inside the well (only a few drops of water on top of logger box). Only the compliant section remained under the buoy, with the bellmouth and the boot of the cable hanging from it but no cable inside the boot could be seen.

The SST instruments (SNs 2054 and 3601) were unplugged at 17:03:20 UTC. Using the terminal emulator Procomm and RS232 communications, the loggers’ clocks were checked against known time and then stopped (see Table 4.1 for details). Power cables were pulled out at 19:45:45 UTC.

Table 4-1. NTAS-13 buoy recovery shutdown procedure on October 30 2014, Fort-de-France, Martinique.

Logger	Time UTC	Logger Time	Stop time	Capture file
05	19:35:30	19:46:14	19:37:20	ntas13recovery_LGR5.cap
03	19:41:30	20:10:15	19:42:45	ntas13recovery_LGR3.cap

B. Mooring Recovery

The bottom part of the mooring, which had fallen to the seafloor back in September, was recovered on December 15, 2014 on R/V *Endeavor*. On that day, we departed the NTAS-14 site and sailed towards NTAS-13 anchor site. Once there we did one CTD cast to 500 m depth. In addition to the data collection, this operation also gave the navigating crew an idea of the current and drift which would be valuable information for the recovery operation.

To prepare for recovery the ship was positioned roughly 0.4 nm downwind (west) of the anchor position. The release command was sent to the acoustic release (#31270) to separate the anchor from the mooring line at 0800 local. We continued to range on the release to make sure it was ascending. The ship then moved into position for recovery, drifting north northeast but heading toward southeast, due to east southeast wind and northward current. The glass balls were spotted at the surface at 0904 local, about 200 m on the starboard bow. The position of the ship at this time was 14° 49.57' N, 51° 01.16' W or about 300 m northwest of anchor, consistent with local current and wind. Once the glass balls were on the surface, the ship slowly approached the glass ball cluster.

A connection was made using a 5-ton titanium hook and spectra line that was attached to the TSE winch leader. After securing the hook into the chain the ship slowly maneuvered ahead and the winch hauled in. When the mooring was trailing behind the ship, the winch hauled up to bring the cluster of glass balls up over the stern. Two air tuggers were used to control the glass balls as they were pulled forward and lowered to the deck. Once all of the glass balls were on board, a stopper line was hooked into a link that was fed through the Colmega thimble and then made fast to a deck cleat. As a backup a Yale grip was also wrapped around the Colmega at the stern and made fast to a deck eye. The winch leader was attached to the shot of chain above the SBE-16s, and they were hauled aboard. The pair of releases that hung below the SBE-16s were hauled up by hand.

The next step was the disassembly and removal of the glass balls from the working area. The small knuckle crane was used to pick the glass balls up and place them in the wire baskets on the port side. Once the glass balls were cleared off the deck, a working line was tied to the Colmega thimble and wrapped onto the capstan. The capstan took the load of the mooring, and the stopper line was removed. The capstan was used to haul in approximately 4300 m of Colmega and nylon line on the mooring. This line was rolled up into wood-lined wire baskets on the starboard side that had burlap bags inserted into them as it came off the capstan. Approximately 5 m before the shackled termination that connected the 300 m wire to nylon transition, the mooring was stopped off using a Yale grip.

At this point, the winch leader was connected to the Yale grip to recover the remainder of the mooring line and wire. The winch continued to pull in the remaining synthetic line and mooring wire. The mooring wire came up with multiple parallel strands, sometimes as many as 16 strands were pulled through the UOP block at once. All of the instruments on the upper 160 ms without deepwater housings had imploded. About 25% of the instruments clamps had been cracked or broken. The final portion of wire was pulled on board at 1445 local.

Inspection showed that the mooring broke at the top of the 78 m IM threaded swage. The wire appeared to have parted at the base of the swage (see Figure 4-1).

Figure 4-1. Breakup of NTAS-13 mooring, as recovered on December 15 2014.

The following instruments were recovered from NTAS-13 mooring: two acoustic releases, two SBE-16s and three SBE-37s. Some of these sensors could not communicate and will need to be sent to the manufacturer for evaluation. A few of the Starmon temperature sensors were also recovered but their housing was deformed and will need to be evaluated further. All other instruments were imploded and destroyed by the sea pressure. See Appendix 3 for NTAS-13 recovery mooring log.

V. Ancillary projects

A. MOVE 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 5-1 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.

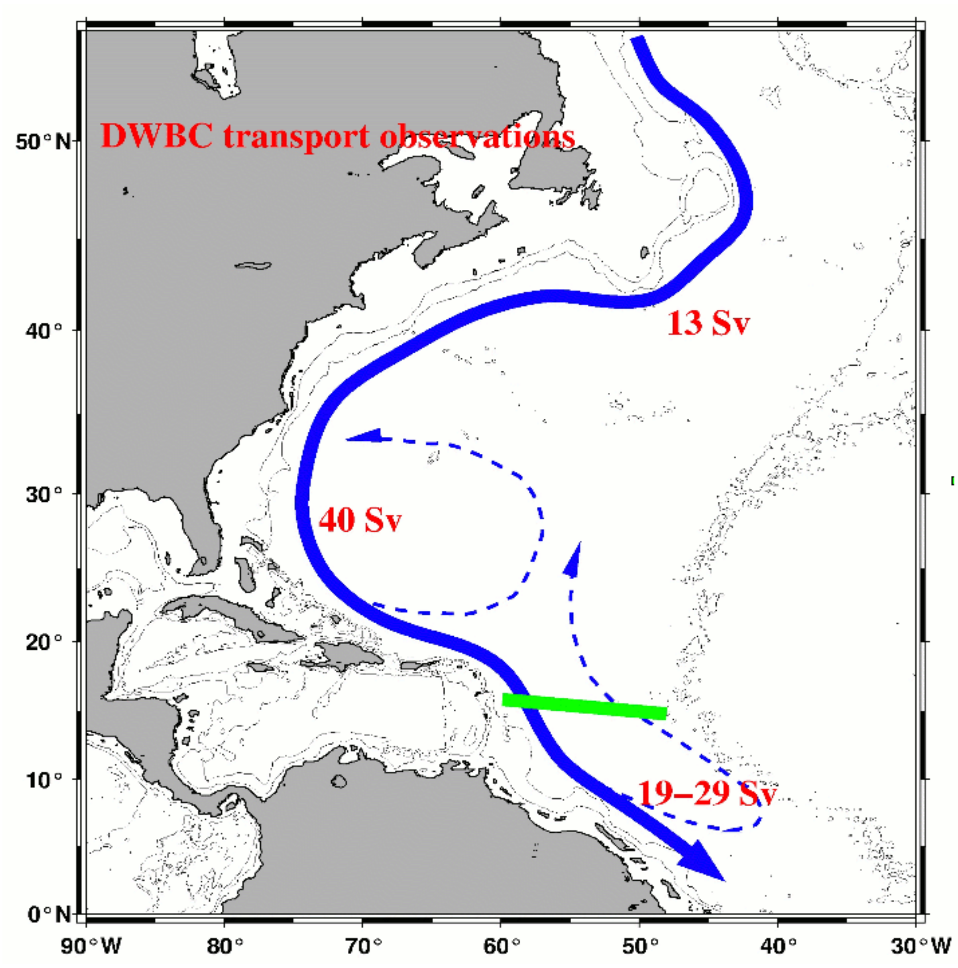


Figure 5-1. Path of DWBC and estimated transports of the NADW, including indirectly inferred recirculation. MOVE measures the flow of water in the NADW depth range across the green line.

In the original configuration, three "geostrophic end-point moorings" (MOVE-1, MOVE-2, MOVE-3) plus one traditional current meter mooring on the slope (MOVE-4) 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 run by a team from Scripps Institution of Oceanography and Ethan Morris was their representative onboard R/V *Endeavor* during the NTAS-14 cruise. In support of MOVE, several operations were conducted to recover and deploy inverted echo sounders with pressure (PIES), and to download acoustically the data from subsurface moorings.

On December 16 0300 UTC we arrived at the MOVE-1 site which comprises two PIES and one subsurface mooring, forming roughly an equilateral triangle (Fig. 5-2). Acoustic downloads from the subsurface mooring started right away. Earlier attempts to use the ship’s transducer for acoustic communications with MOVE assets had proved unsuccessful, maybe due to ship’s noise, so a portable transducer hanging over the side was used from that point on. For recovery we had planned on a 90 minutes ascent time for the PIES and floating glass ball after release. First light being around 0515 local (UTC -4), we had planned to release PIES 226 at 0330 local. However, a problem with the transducer caused a 45 minute delay of the planned release of the PIES. In addition, we learned afterward that the release mechanism is a burn wire with a burn time of about 15 to 30 minutes. Eventually, the release command was issued on December 16 0817 UTC. The winds then were 10 to 15 knots from the south-southeast. The PIES was spotted at the surface at 1032 UTC, thanks to the red flag still attached to its frame. At this time the ship was only about 240 yards from the PIES anchor site, 4950 m below the surface, so the drift during ascent was less than 5%. At this time, the sun was up and there was no chance to see the strobe lights, although they still worked. A few minutes before the visual contact, the RF beacon on the PIES had been received on the radio on the bridge, which allowed us to get closer to the PIES location. PIES 226 was back onboard at approximately 1100 UTC.

PIES 300 was then supposed to be deployed at the same site, but a final check before deployment showed that codes for release and transpond commands were similar to PIES 237 that was still on the seafloor in the southwest corner of MOVE-1. It was then decided to use PIES 299 instead of PIES 300. Morris then prepared PIES 299, which was deployed at 1637 UTC. The ship stayed on station to monitor the descent. At 1806 UTC it was determined that PIES 299 had reached the seafloor so we started the anchor survey (Tables 5-1 and 5-2).

After the anchor survey, Morris checked that the number of records on PIES 299 was increasing. Several attempts to download data acoustically from PIES 237 proved difficult and there was concern about battery depletion on PIES 237. Changes to the PIES 237 settings were done acoustically. Finally, acoustic downloads from the subsurface mooring resumed, with the ship declutched and drifting to the north-northwest towards the subsurface mooring. When acoustic communications became spotty again (about 3.6 nm from PIES 237), the ship returned within 1.2 nm of PIES 237 and started drifting again NNW towards the mooring. This sequence was repeated several times.

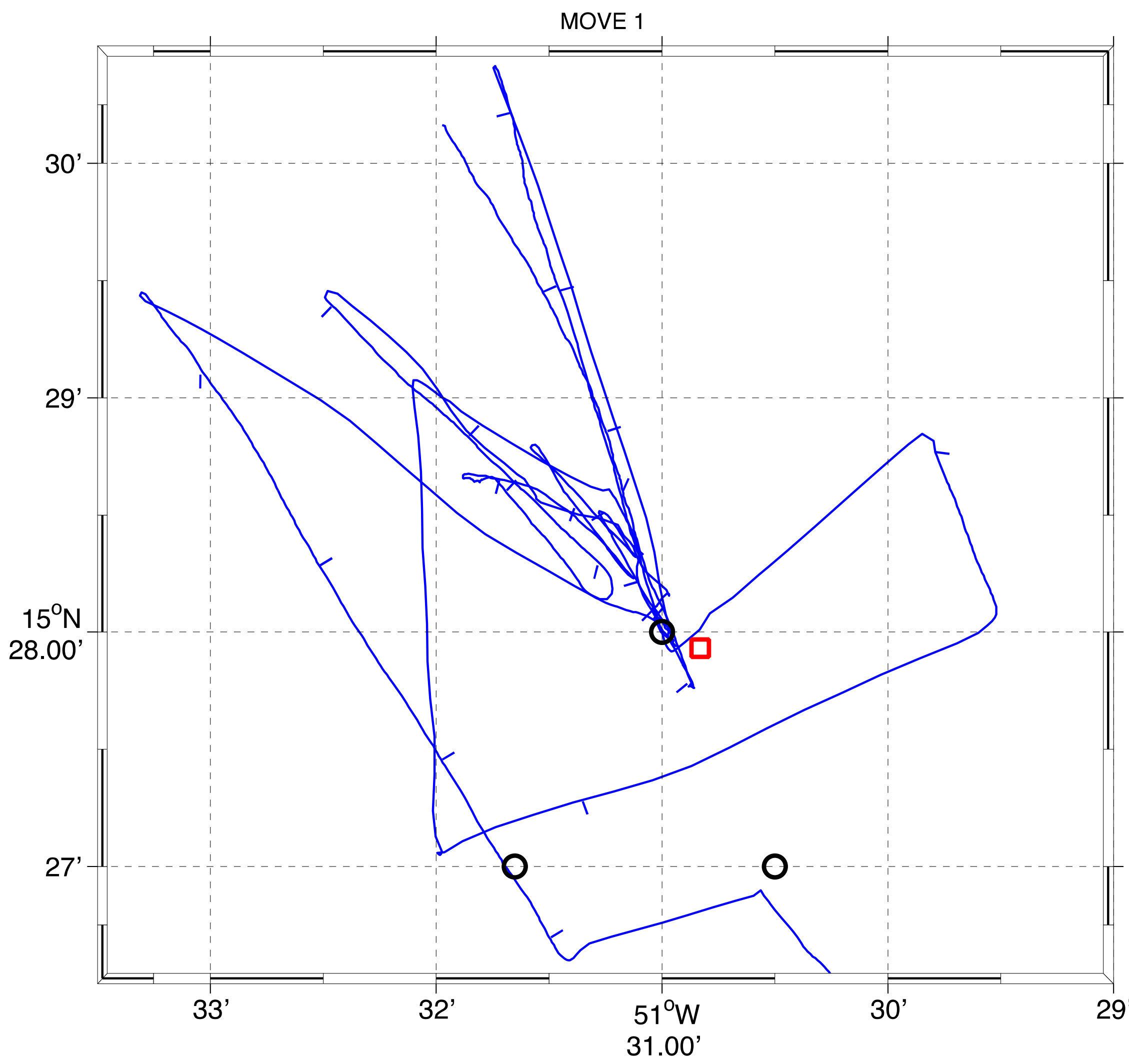


Figure 5-2. MOVE -1 PIES and subsurface mooring locations and ship track on December 16.

Table 5-1. PIES 299 deployment at MOVE 1 site.

PIES	Seafloor position	Depth (m) *	Drop position	Drop time UTC
299	15° 27.93'N, 51° 30.83'W	4969	15°27.921'N, 51° 30.938'W	12/16/2014 16:37

* Depth includes +38 m correction from Matthews table (added to 12 kHz reading set with speed of sound 1500 m s^{-1}).

Table 5-2. Acoustic ranges for PIES 299 anchor survey (with sound speed = 1511 m s^{-1}). Locations are from UOP's GPS unit with antenna located on O1 deck aft portside.

Waypoint	Latitude	Longitude	Time UTC	2-way time (s)
1	15° 29.057'N	51° 32.045'W	18:31	7.653
2	15° 27.060'N	51° 31.977'W	18:51	7.425
3	15° 28.063'N	51° 29.537'W	19:13	7.247

We departed MOVE-1 early on December 17 and transited towards MOVE-3, near Guadeloupe. We arrived at MOVE-3 on December 19 around 0400 UTC. The ship declutched near PIES 228 and Morris started acoustic downloads from mooring located about 1 nm away. At 0745 UTC, PIES 228 was released. Again, RF signal was detected when PIES reached the surface and a visual contact of the strobe light was made at 1012 UTC, when ship was about 0.85 nm from anchor site. PIES 300 was then deployed at same site at 1042 UTC. Descent was monitored and after about 88 minutes, the PIES reached the bottom, about 880 yards from the drop location (Fig. 5-3). See Tables 5-3 and 5-4 for the deployment of PIES 300.

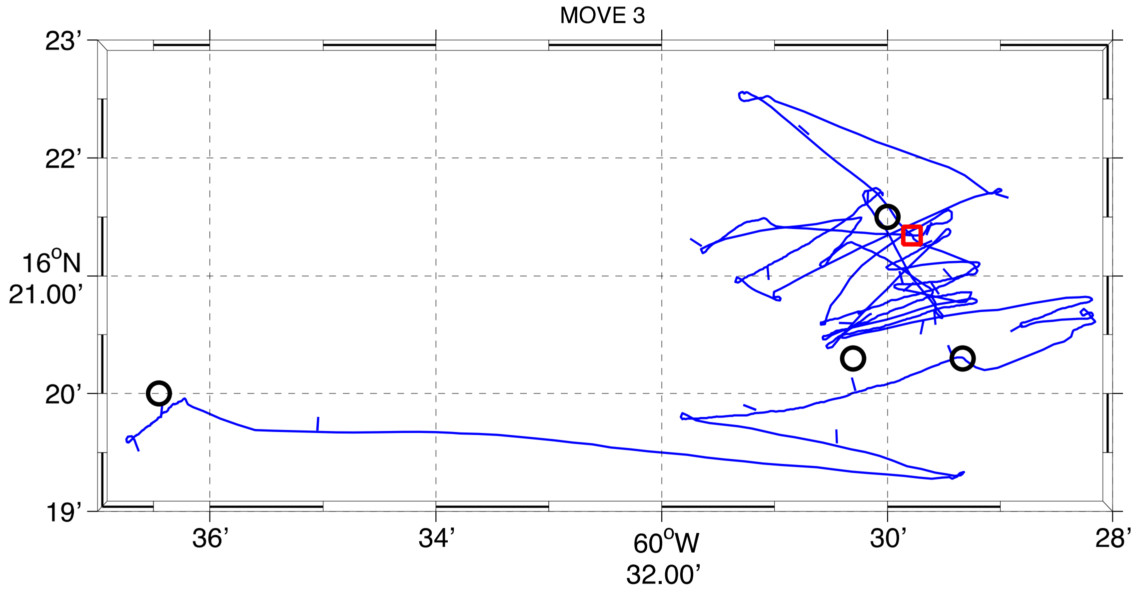


Figure 5-3. MOVE 3 PIES and subsurface mooring locations and ship track on December 19.

Table 5-3. PIES 300 deployment at MOVE 3 site.

PIES	Seafloor position	Depth (m) *	Drop position	Drop time UTC
300	16° 21.34'N, 60° 29.78'W	4975	16° 21.73'N, 60° 30.071'W	12/19/2014 10:42

* Depth includes +44 m correction from Matthews table (added to 12 kHz reading with speed of sound 1500 m s^{-1}).

Table 5-4. Acoustic ranges for PIES 300 anchor survey (with sound speed = 1513 m s^{-1}). Locations are from UOP's GPS unit with antenna located on O1 deck aft portside.

Waypoint	Latitude	Longitude	Time UTC	2-way time (s)
1	16° 20.823'N	60° 30.961'W	12:33	7.231
2	16° 21.697'N	60° 29.083'W	13:03	6.821
3	16° 22.519'N	60° 31.078'W	13:21	7.773

After PIES 300 was deployed, acoustic data download from the subsurface mooring resumed and finished. A similar download from nearby PIES 238 started, but proved very difficult despite multiple attempts with different download settings (block size, signal amplitude) and ship positions. We were getting one successful download every 100 attempts. Finally, after having managed to download about a week of data, we decided to abandon downloading data from PIES 238 and instead sail towards nearby MOVE-4 site. We arrived at MOVE-4 at 0100 UTC on December 20 and started download from subsurface mooring. Download was apparently successful, but when was data provided to colleagues at Scripps (who parsed it), they asked for a second download as data quality was faulty. During a second attempt Morris retained only data records with transfer messages PASS (previous attempt had occasional FAIL messages). All MOVE 4 mooring data was finally successfully downloaded and we departed for Barbados early on December 20.

B. Argo Floats

During transit from Rhode Island to NTAS-14, we deployed two Argo floats near previously determined target positions (24° N and 21° N) shown in Figure 5-4. One of these floats contained a dissolved oxygen (DO) sensor. The actual deployments were:

- Argo #1177 at (23° 59.75'N, 57° 19.72'W) on December 10 2014 12:44 UTC, with swell and 10 knots wind from southeast.

- Argo #1134 DO at (20° 35.12'N, 54° 55.97'W) on December 11 2014 11:31 UTC, with 15 knots wind from northeast and swell from east.

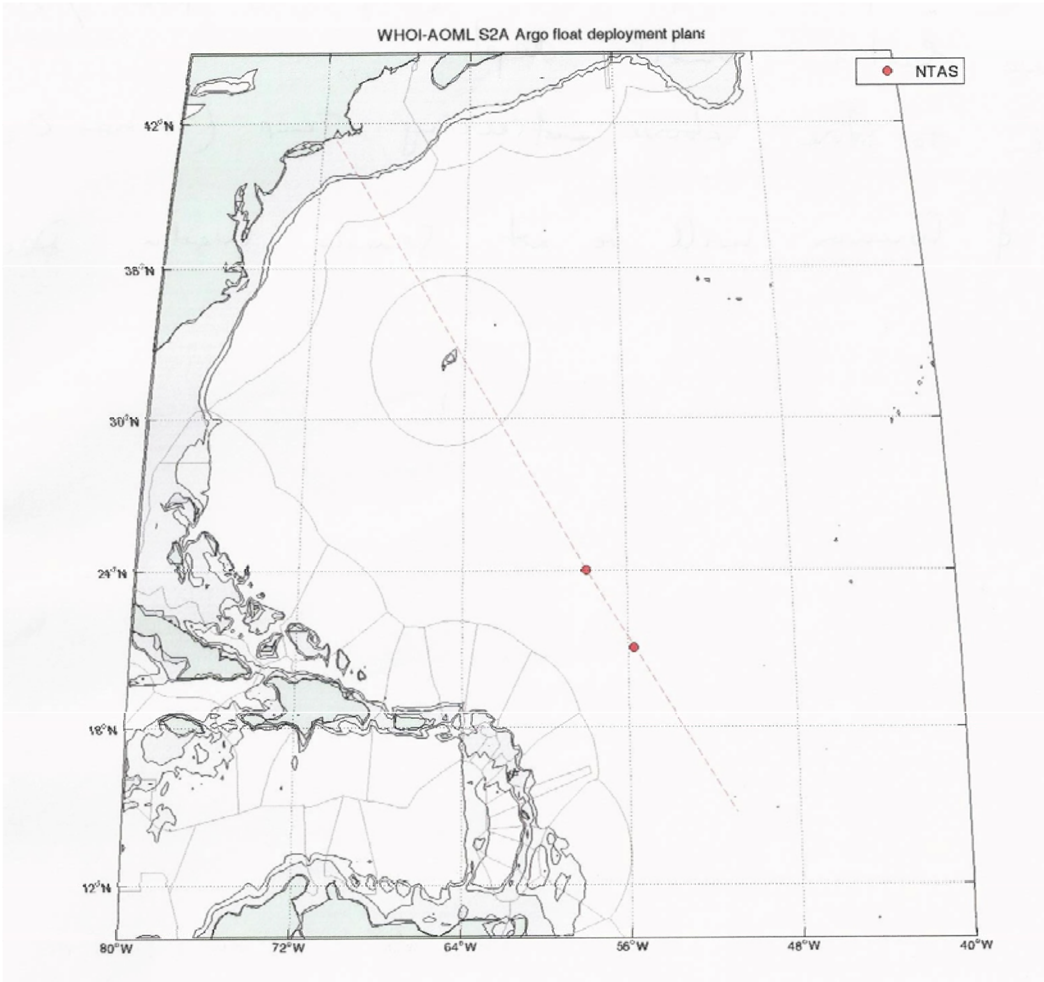


Figure 5-4. Target locations for Argo floats deployments during NTAS-14 cruise. Actual drop locations were slightly different (see text).

Thanks and Acknowledgements

We wish to thank the crew of the *R/V Endeavor* who helped to make this cruise successful and ensured safe operations. Many thanks to the ship's science technician, Lynne Butler, for her dedication to the acquisition and quality of the scientific data collected during the cruise. Special thanks to the people at the Rigging Shop at WHOI for their professionalism in making the mooring components, the Upper Ocean Processes Group personnel for their patience and long efforts to make sure we collect the best data possible and to the NTAS Principle Investigator Albert Plueddemann for overseeing this project and planning the cruise.

The science party on this cruise was composed of Ben Pietro, Jason Smith, George Tupper, Andrew Davies and Sebastien Bigorre, all from Woods Hole Oceanographic Institution, as well as Ethan Morris from Scripps Institution of Oceanography.

References

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Appendix 1: NTAS-14 instrument setup, as deployed.

SYSTEM 1			
Module	**Serial**	**Firmware Version**	**Height Cm**
Logger PORT	L-16		
PTT	18128	20956, 20957, 20959	
HRH	231		233
BPR	217		237
WND	206		268
PRC	214		239
LWR	254		280
SWR	212		280
SST	3605		-150
SS IR	43720	IMEI 300224010043720	
SYSTEM 2			
Logger STARBOARD	L-12		
PTT	67720	20741, 20892, 20898	
HRH	221		233
BPR	219		237
WND	207		268
PRC	210		239
LWR	209		280
SWR	214		280
SST SBE37	1836		-150
STAND ALONES			
WAMDAS:	6015		
IMEI #	300124000010620		
SIM #	89881 69312 00205 1328		
3DM-GX1 s/n:			
NDBC station #	Station 41NT0		
SIS/SABLE			
XEOS Melo	300034013207760	Memory Zeroed and Setup Sent	
VWX	5		250
Lascar	10021813		226
SBE-39-AT	5272	set to start at 12/4/2014 01:00, new battery	212

SPARE			
Module	**Serial**	**Firmware Version**	
Logger	L-06	4.11CF 256 card	
HRH	215		
BPR	218		
WND	215		
PRC	205		
LWR	253		
SWR	207		
SST SBE37	5997		
PTT	67720	15446, 15447, 26272	
MET/SS IR (Spare)	325130	IMEI 300 224 010 325 130	

NTAS-14 Buoy Spin in Woods Hole:

Heading	**0**				
Turn	**0**				
	Time	**Date**			
Vanes Secured UTC	14:25:00	17-Oct-14			
System 1		**VANE**	**Compass**	**Direction**	**Sample Time**
Logger	**L-16**				
WND	**206**	358.50	356.60	-4.90	14:47:00
System 2		**Vane**	**Compass**	**Direction**	**Sample Time**
Logger	**L-12**				
WND	**207**	6.00	357.70	3.70	14:45:00
		VANE	**Compass**	**Direction**	**Sample Time**
VWX 005	Stand Alone	N/A	0.00	N/A	14:48:00

Heading	**0**				
Turn	**45**				
	Time	**Date**			
Vanes Secured UTC	14:50:00	17-Oct-14			
System 1		**VANE**	**Compass**	**Direction**	**Sample Time**

Logger	**L-16**				
WND	**206**	320.40	42.90	3.30	15:12:00
System 2		**Vane**	**Compass**	**Direction**	**Sample Time**
Logger	**L-12**				
WND	**207**	312.60	41.90	-5.50	15:10:00
		VANE	**Compass**	**Direction**	**Sample Time**
VWX 005	Stand Alone	N/A	47.50	N/A	15:20:00

Heading **0**

Turn **90**

	Time	**Date**
Vanes Secured UTC	15:19:00	17-Oct-14

System 1		**VANE**	**Compass**	**Direction**	**Sample Time**
Logger	**L-16**				
WND	**206**	274.40	86.00	0.40	15:33:00
System 2		**Vane**	**Compass**	**Direction**	**Sample Time**
Logger	**L-12**				
WND	**207**	267.50	89.30	-3.20	15:35:00
		VANE	**Compass**	**Direction**	**Sample Time**
VWX 005	Stand Alone	N/A	91.80	N/A	15:37:00

Heading **0**

Turn **135**

	Time	**Date**
Vanes Secured UTC	15:50:00	17-Oct-14

System 1		**VANE**	**Compass**	**Direction**	**Sample Time**
Logger	**L-16**				
WND	**206**	228.70	128.80	-2.50	16:51:00
System 2		**Vane**	**Compass**	**Direction**	**Sample Time**
Logger	**L-12**				
WND	**207**	223.50	136.30	-0.20	16:49:00
		VANE	**Compass**	**Direction**	**Sample Time**
VWX 005	Stand	N/A	136.60	N/A	16:59:00

	Alone				

Heading	**0**				
Turn	**180**				
	Time	**Date**			
Vanes Secured UTC	16:56:00	17-Oct-14			
System 1		**VANE**	**Compass**	**Direction**	**Sample Time**
Logger	**L-16**				
WND	**206**	183.40	172.10	-4.50	18:12:00
System 2		**Vane**	**Compass**	**Direction**	**Sample Time**
Logger	**L-12**				
WND	**207**	179.90	179.50	-0.60	18:09:00
		VANE	**Compass**	**Direction**	**Sample Time**
VWX 005	Stand Alone	N/A	182.00	N/A	18:20:00

Heading	**0**				
Turn	**225**				
	Time	**Date**			
Vanes Secured UTC	18:18:00	17-Oct-14			
System 1		**VANE**	**Compass**	**Direction**	**Sample Time**
Logger	**L-16**				
WND	**206**	140.50	215.40	-4.10	18:35:00
System 2		**Vane**	**Compass**	**Direction**	**Sample Time**
Logger	**L-12**				
WND	**207**	137.70	219.90	-2.40	18:36:00
		VANE	**Compass**	**Direction**	**Sample Time**
VWX 005	Stand Alone	N/A	224.70	N/A	18:38:00

Heading	**0**	
Turn	**270**	
	Time	**Date**
Vanes Secured UTC	18:52:00	17-Oct-14

System 1		VANE	Compass	Direction	Sample Time
Logger	L-16				
WND	206	96.30	262.10	-1.60	19:05:00

System 2		Vane	Compass	Direction	Sample Time
Logger	L-12				
WND	207	91.40	264.10	-4.50	19:03:00

		VANE	Compass	Direction	Sample Time
VWX 005	Stand Alone	N/A	269.50	N/A	19:11:00

Heading 0
Turn 315

	Time	Date
Vanes Secured UTC	19:12:00	17-Oct-14

System 1		VANE	Compass	Direction	Sample Time
Logger	L-16				
WND	206	51.20	311.30	2.50	19:30:00

System 2		Vane	Compass	Direction	Sample Time
Logger	L-12				
WND	207	44.50	311.60	-3.90	19:34:00

		VANE	Compass	Direction	Sample Time
VWX 005	Stand Alone	N/A	315.60	N/A	19:37:00

Turn Angle (deg)	Wind direction difference		Compass difference
	L-16	L-12	VWX 005
0	-4.90	3.70	0.00
45	3.30	-5.50	2.50
90	0.40	-3.20	1.8
135	-2.50	-0.20	1.60
180	-4.50	-0.60	2.0
225	-4.10	-2.40	-9.6
270	-1.60	-4.50	-0.5
315	2.50	-3.90	0.6

Capture files of subsurface instrument setup and SBE39AT:

#01ds
SBE37-SM 485 V 2.3b SERIAL NO. 3605
11 Dec 2014 21:31:47
logging data
sample interval = 300 seconds
samplenumber = 6, free = 233010
store time with each sample
do not output salinity with each sample
do not output sound velocity with each sample
reference pressure = 0.0 db
do not output density with each sample
do not output depth with each sample
A/D cycles to average = 4
internal pump not installed
temperature = 24.27 deg C
S>#01stop
S>#01samplenum=0
S>#01mmddyy=121114
S>#01hhmmss=213345
S>#01ds
SBE37-SM 485 V 2.3b SERIAL NO. 3605   11 Dec 2014 21:33:51
not logging: received stop command
sample interval = 300 seconds
samplenumber = 0, free = 233016
store time with each sample
do not output salinity with each sample
do not output sound velocity with each sample
reference pressure = 0.0 db
do not output density with each sample
do not output depth with each sample
A/D cycles to average = 4
internal pump not installed
temperature = 24.22 deg C
S>#01startmmddyy=121114
S>#01startmmhhmmss=213500
start time = 11 Dec 2014 21:35:00
S>#01startlater
start time = 11 Dec 2014 21:35:00
S>#01ds
SBE37-SM 485 V 2.3b SERIAL NO. 3605   11 Dec 2014 21:35:04
logging data
sample interval = 300 seconds
samplenumber = 1, free = 233015
store time with each sample
do not output salinity with each sample
do not output sound velocity with each sample
reference pressure = 0.0 db
do not output density with each sample
do not output depth with each sample
A/D cycles to average = 4
internal pump not installed
temperature = 24.34 deg C
S>#01ts
 03605, 24.3757,-0.00034, 11 Dec 2014, 21:35:25
S>qs

S>#01ds
SBE37-SM 485 V 2.3b SERIAL NO. 1836
26 Nov 2014 17:57:54
not logging: waiting to start at 04 Dec 2014 01:00:00
sample interval = 300 seconds
samplenumber = 0, free = 233016
store time with each sample
do not output salinity with each sample
do not output sound velocity with each sample
reference pressure = 0.0 db
do not output density with each sample
do not output depth with each sample
A/D cycles to average = 4
internal pump not installed
temperature = 21.43 deg C
S>pwroff

S>#03ds
SBE37-IM V 1.4 SERIAL NO. 0669   11 Dec 2014 17:31:18
logging data
sample interval = 600 seconds
samplenumber = 1108, free = 112214
store time with each sample
do not transmit sample number
A/D cycles to average = 4
reference pressure = 0.0 db
temperature = 23.61 deg C
S>S>qs

S>#04ds
SBE37-IM V 1.4 SERIAL NO. 0684   11 Dec 2014 17:09:59
not logging: waiting to start at 11 Dec 2014 18:00:00
sample interval = 600 seconds
samplenumber = 1106, free = 93474
store time with each sample
do not transmit sample number
A/D cycles to average = 4
temperature = 23.29 deg C
S>S>#04ts
 00684, 23.2907, 0.00049,   0.061, 11 Dec 2014, 17:10:12
S>qs

S>#05ds
SBE37-IM V 1.4 SERIAL NO. 0686   11 Dec 2014 17:18:21
logging data
sample interval = 600 seconds
samplenumber = 1106, free = 114492
store time with each sample
do not transmit sample number
A/D cycles to average = 4
reference pressure = 0.0 db
temperature = 24.01 deg C
S>S>#05mmddyy=121114
cmd not allowed while l#ogging
S>05hhmmss=#05hhmmss=171910
cmd not allowed while logging
S>##05ts
 00686, 23.9089, 0.00000, 11 Dec 2014, 17:20:38
S>qs

ds
SBE37SM-RS232 v3.1 SERIAL NO. 11392
25 Nov 2014 19:53:31
vMain = 6.98, vLith = 2.82
samplenumber = 0, free = 559240
not logging, waiting to start at 04 Dec 2014 01:00:00
sample interval = 600 seconds
data format = converted engineering
transmit real-time = no
sync mode = no
pump installed = no
<Executed/>
qs

ds
SBE37SM-RS232 v3.1 SERIAL NO. 11393
25 Nov 2014 21:13:13
vMain = 6.88, vLith = 2.81
samplenumber = 0, free = 559240
not logging, waiting to start at 04 Dec 2014 01:00:00
sample interval = 600 seconds
data format = converted engineering
transmit real-time = no
sync mode = no
pump installed = no
<Executed/>

SBE 39 AT:
S>ds
SBE 39 V 3.1b   SERIAL NO. 5272   03 Dec 2014 20:36:17
battery voltage = 8.8
not logging: waiting to start at 04 Dec 2014 01:00:00
sample interval = 300 seconds
samplenumber = 0, free = 4699867
serial sync mode disabled
real-time output disabled
SBE 39 configuration = temperature only
binary upload does not include time
temperature = 20.31 deg C
S>qs

S>ds
SBE 39 V 3.0b   SERIAL NO. 3480   03 Dec 2014 13:43:22
battery voltage = 9.0
not logging: waiting to start at 04 Dec 2014 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 = 19.06 deg C
S>qs

S>ds
SBE 39 V 3.1b   SERIAL NO. 0545   03 Dec 2014 13:59:21
battery voltage = 9.0
not logging: waiting to start at 04 Dec 2014 01:00:00
sample interval = 300 seconds
samplenumber = 0, free = 4699867
serial sync mode disabled
real-time output disabled
SBE 39 configuration = temperature only
binary upload does not include time
temperature = 18.24 deg C
S>qs

S>ds
SBE 39 V 3.1b   SERIAL NO. 0750   03 Dec 2014 14:12:40
battery voltage = 9.1
not logging: waiting to start at 04 Dec 2014 01:00:00
sample interval = 300 seconds
samplenumber = 0, free = 4699867
serial sync mode disabled
real-time output disabled
SBE 39 configuration = temperature only
binary upload does not include time
temperature = 18.57 deg C
S>qs

S>ds
SBE 39 V 3.1b SERIAL NO. 0678 03 Dec 2014 14:23:55
battery voltage = 9.1
not logging: waiting to start at 04 Dec 2014 01:00:00
sample interval = 300 seconds
samplenumber = 0, free = 4699867
serial sync mode disabled
real-time output disabled
SBE 39 configuration = temperature only
binary upload does not include time
temperature = 19.26 deg C
S>qs

S>ds
SBE 39 V 3.1b SERIAL NO. 0681 03 Dec 2014 14:37:19
battery voltage = 9.1
not logging: waiting to start at 04 Dec 2014 01:00:00
sample interval = 300 seconds
samplenumber = 0, free = 4699867
serial sync mode disabled
real-time output disabled
SBE 39 configuration = temperature only
binary upload does not include time
temperature = 20.27 deg C
S>qs

S>ds
SBE 39 V 3.1b SERIAL NO. 0684 03 Dec 2014 14:44:48
battery voltage = 9.1
not logging: waiting to start at 04 Dec 2014 01:00:00
sample interval = 300 seconds
samplenumber = 0, free = 4699867
serial sync mode disabled
real-time output disabled
SBE 39 configuration = temperature only
binary upload does not include time
temperature = 19.41 deg C
S>qs

S>ds
SBE 39 V 3.1b SERIAL NO. 0546 03 Dec 2014 14:53:25
battery voltage = 9.0
not logging: waiting to start at 04 Dec 2014 01:00:00
sample interval = 300 seconds
samplenumber = 0, free = 4699867
serial sync mode disabled
real-time output disabled
SBE 39 configuration = temperature only
binary upload does not include time
temperature = 19.88 deg C
S>qs

S>ds
SBE 39 V 3.1b SERIAL NO. 0631 03 Dec 2014 15:01:58
battery voltage = 9.0
not logging: waiting to start at 04 Dec 2014 01:00:00
sample interval = 300 seconds
samplenumber = 0, free = 4699867
serial sync mode disabled
real-time output disabled
SBE 39 configuration = temperature only
binary upload does not include time
temperature = 20.47 deg C
S>SBE 39

S>ds
SBE 39 V 3.1b SERIAL NO. 0680 03 Dec 2014 15:11:13
battery voltage = 9.0
not logging: waiting to start at 04 Dec 2014 01:00:00
sample interval = 300 seconds
samplenumber = 0, free = 4699867
serial sync mode disabled
real-time output disabled
SBE 39 configuration = temperature only
binary upload does not include time
temperature = 20.80 deg C
S>qs

S>ds
SBE 39 V 3.1b SERIAL NO. 0677 03 Dec 2014 15:18:51
battery voltage = 9.1
not logging: waiting to start at 04 Dec 2014 01:00:00
sample interval = 300 seconds
samplenumber = 0, free = 4699867
serial sync mode disabled
real-time output disabled
SBE 39 configuration = temperature only
binary upload does not include time
temperature = 20.74 deg C
S>qs

S>ds
SBE 39 V 3.1b SERIAL NO. 0539 03 Dec 2014 15:25:42

battery voltage = 8.7
not logging: waiting to start at 04 Dec 2014 01:00:00
sample interval = 300 seconds
samplenumber = 0, free = 4699867
serial sync mode disabled
real-time output disabled
SBE 39 configuration = temperature only
binary upload does not include time
temperature = 20.73 deg C
S>qs

S>#07ds
SBE 39-IM V 1.05 SERIAL NO. 4465 03 Dec 2014 18:26:34
battery voltage = 6.9
not logging: waiting to start at 04 Dec 2014 01:00:00
sample interval = 600 seconds
samplenumber = 0, free = 599186
SBE 39-IM configuration = temperature only
transmit sample number
temperature = 15.60 deg C
S>pwroff
transmitter is disabled
S>

S>#08ds
SBE 39-IM V 1.05 SERIAL NO. 4466 03 Dec 2014 18:19:57
battery voltage = 7.4
not logging: waiting to start at 04 Dec 2014 01:00:00
sample interval = 600 seconds
samplenumber = 0, free = 599186
SBE 39-IM configuration = temperature only
transmit sample number
temperature = 17.52 deg C
S>pwro#08ts
command not enabled while logging
S>pwroff
transmitter is disabled
S>

====================================
Deployment : NTAS14
Current time : 10/29/2014 6:48:32 PM
Start at : 12/4/2014 1:00:00 AM
Comment:
SN 0432, 18 Meter Depth

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) : 11.0
Recorder size (MB) : 5
Recorder free space (MB) : 4.973
Memory required (MB) : 3.7
Vertical vel. prec (cm/s) : 1.4
Horizon. vel. prec (cm/s) : 0.8

Instrument ID : AQD 0432
Head ID : AQD 2273
Firmware version : 1.21

Aquadopp Version 1.40.01
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====================================
Deployment : NTAS14
Current time : 10/29/2014 7:24:57 PM
Start at : 12/4/2014 1:00:00 AM
Comment:
SN 9467, 5.7 Meter Depth

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 : AQD 9467
Head ID : AQD 4852
Firmware version : 3.35

Aquadopp Version 1.40.01
Copyright (C) Nortek AS

====================================
Deployment : NTAS14
Current time : 10/28/2014 3:24:42 PM
Start at : 12/4/2014 1:00:00 AM
Comment:
SN 5973, 13 Meter depth, Inductive

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) : 10.9
Recorder size (MB) : 9
Recorder free space (MB) : 8.973
Memory required (MB) : 2.7
Vertical vel. prec (cm/s) : 1.4
Horizon. vel. prec (cm/s) : 0.8

Instrument ID : AQD 5973
Head ID : ALD 3619
Firmware version : 3.35

Inductive modem : ENABLED
Device ID : 41
Transmit power level : HIGH
Data format : ASCII
Coupler impedance : Z = 1768

RDI Workhorse ADCP:

```
>TT?
TT = 2014/10/30,20:56:18 - Time Set (CCYY/MM/DD,hh:mm:ss)
>CR1
[Parameters set to FACTORY defaults]
>TT?
TT = 2014/10/30,20:57:16 - Time Set (CCYY/MM/DD,hh:mm:ss)
>CF11101
>EA00000
>EB00000
>ED0085
>ES36
>EX11111
>EZ1011101
>TG2014/12/04,01:00:00
>TP00:01.00
>WB0
>WD111100000
>WF0300
>WN025
>WP00180
>WS0400
>WV175
>CK
[Parameters saved as USER defaults]
>RNNTA13
>RE ErAsE  erasing...
Recorder erased.
>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 = 1011101 ------------- Sensor Source (C,D,H,P,R,S,T)
RE ----------------------- Recorder ErAsE
RN ----------------------- Set Deployment Name
TE = 01:00:00.00 --------- Time per Ensemble (hrs:min:sec.sec/100)
TF = 14/12/04,01:00:00 --- Time of First Ping (yr/mon/day,hour:min:sec)
TP = 00:01.00 ------------ Time per Ping (min:sec.sec/100)
TS = 14/10/30,21:01:19 --- 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)
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)
```

STARMONs:

STARMON MINI CONFIGURATION: NTAS-14

NOTE: Must set PC clock to UTC prior to sequence start, since PC
time is automatically retrieved and downloaded to instrument

Files to keep from setup:

    *.RDT   new measurement sequence information
            (includes recorder information in .RIT file)

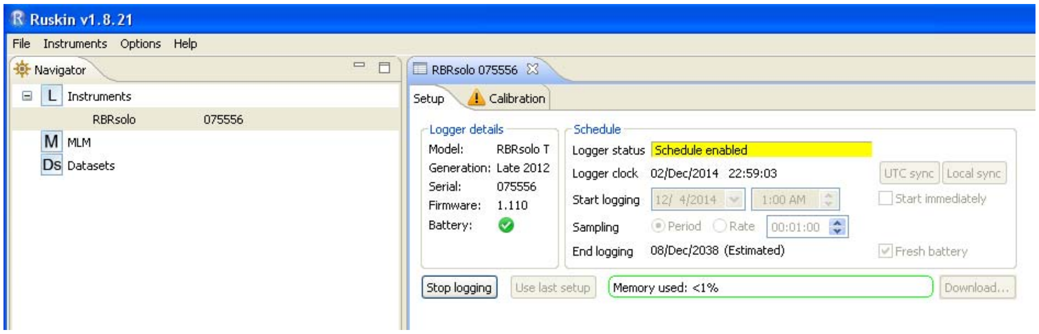
Files to keep from data offload:

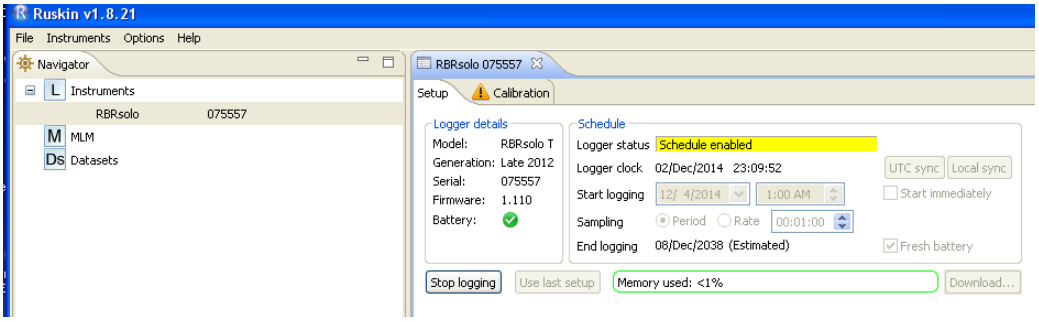
    *.CCT   clock drift: PC connect time vs. internal clock
    *.DAT   data file (ascii)
    *.MIT   setup and and data retrieval information
    *.RCI   calibration information
    *.RIT   recorder information

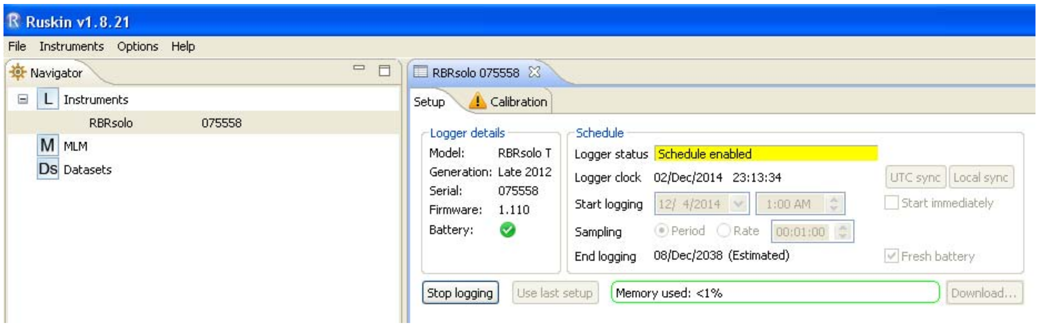
Using SN 3167 as example, assume others will have similar battery capacity since all were new or refurbished in 2009.
Results suggest that battery usage (4%) and memory usage (18%) are small for ~1 year deployment at 10 min interval.
Configuration for C:\AJP\PROJ\NTAS\NTAS14\rawdata\starmon\T3167.RDT

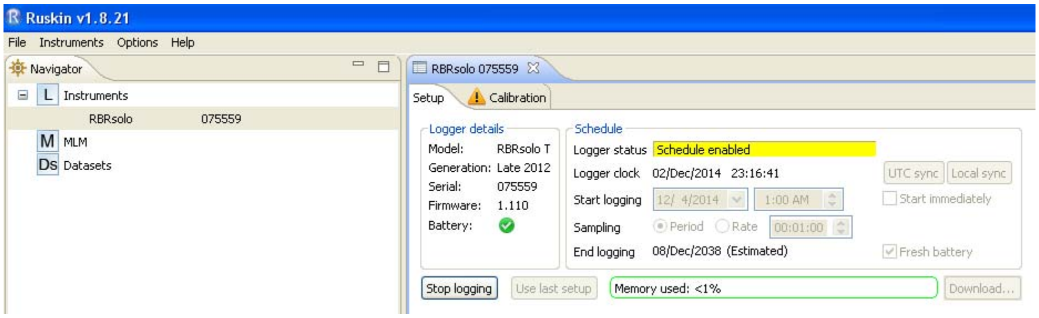
```
----------------------------------------------
Recorder type              : Starmon mini
Recorder number            : T3167
Recorder version           : 17  CRC8/19200
Recorder measures          : Temperature
Recorder memory(byte/meas.) : 524063 / 349375
Measurement sequence number : 8
Recorder started from PC    : 11/25/2014 11:45:34 PM
----------------------------------------------
Measurement start time      : 12/5/2014 1:00:00 AM
Measurement interval def.   : Single interval = 00:10:00
----------------------------------------------
Estimated time duration and battery usage for NMS
Battery energy at start (%):  96.9
-----------------------------------------------------
Cycle 1
Seq/Inr      Date&Time      Batt.used(%)  Mem.used(%)
 1/1   3/4/2016 3:40:00 AM       4          18
 2/2   6/2/2017 6:20:00 AM       9          37
Memory full               : 7/27/2021 6:20:00 AM
   After (days:hours)     : 2426:5
   In Cycle               : 3
   In sequence            : 2
   In Interval            : 1
   In measurement         : 21696
   Total meas. taken      : 349376
   Battery used (%)       :  25.2
   Battery left (%)       :  71.7
```

RBR Solos:

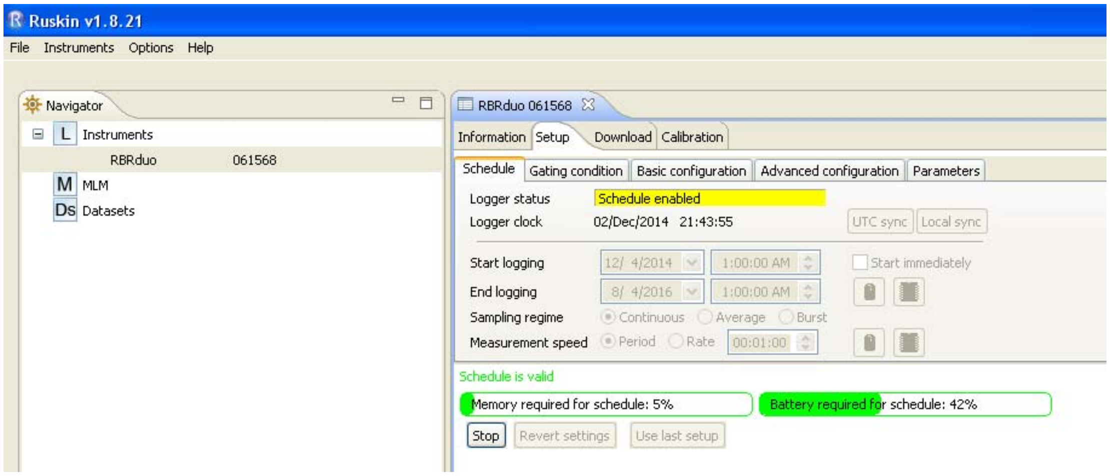

Ruskin v1.8.21
File Instruments Options Help
Navigator
Instruments
RBRsolo 075556
MLM
Datasets
RBRsolo 075556
Setup
Calibration
Logger details
Model: RBRsolo T
Generation: Late 2012
Serial: 075556
Firmware: 1.110
Battery:
Schedule
Logger status Schedule enabled
Logger clock 02/Dec/2014 22:59:03
Start logging 12/ 4/2014 1:00 AM
Sampling Period Rate 00:01:00
End logging 08/Dec/2038 (Estimated)
UTC sync Local sync
Start immediately
Fresh battery
Stop logging
Use last setup
Memory used: <1%
Download...


Ruskin v1.8.21
File Instruments Options Help
Navigator
Instruments
RBRsolo 075557
MLM
Datasets
RBRsolo 075557
Setup
Calibration
Logger details
Model: RBRsolo T
Generation: Late 2012
Serial: 075557
Firmware: 1.110
Battery:
Schedule
Logger status Schedule enabled
Logger clock 02/Dec/2014 23:09:52
Start logging 12/ 4/2014 1:00 AM
Sampling Period Rate 00:01:00
End logging 08/Dec/2038 (Estimated)
UTC sync Local sync
Start immediately
Fresh battery
Stop logging
Use last setup
Memory used: <1%
Download...


Ruskin v1.8.21
File Instruments Options Help
Navigator
Instruments
RBRsolo 075558
MLM
Datasets
RBRsolo 075558
Setup
Calibration
Logger details
Model: RBRsolo T
Generation: Late 2012
Serial: 075558
Firmware: 1.110
Battery:
Schedule
Logger status Schedule enabled
Logger clock 02/Dec/2014 23:13:34
Start logging 12/ 4/2014 1:00 AM
Sampling Period Rate 00:01:00
End logging 08/Dec/2038 (Estimated)
UTC sync Local sync
Start immediately
Fresh battery
Stop logging
Use last setup
Memory used: <1%
Download...


Ruskin v1.8.21
File Instruments Options Help
Navigator
Instruments
RBRsolo 075559
MLM
Datasets
RBRsolo 075559
Setup
Calibration
Logger details
Model: RBRsolo T
Generation: Late 2012
Serial: 075559
Firmware: 1.110
Battery:
Schedule
Logger status Schedule enabled
Logger clock 02/Dec/2014 23:16:41
Start logging 12/ 4/2014 1:00 AM
Sampling Period Rate 00:01:00
End logging 08/Dec/2038 (Estimated)
UTC sync Local sync
Start immediately
Fresh battery
Stop logging
Use last setup
Memory used: <1%
Download...

RBR Duo:



Ruskin v1.8.21
File Instruments Options Help
Navigator
Instruments
RBRduo 061568
MLM
Datasets
RBRduo 061568
Information Setup Download Calibration
Schedule Gating condition Basic configuration Advanced configuration Parameters
Logger status Schedule enabled
Logger clock 02/Dec/2014 21:43:55
UTC sync Local sync
Start logging 12/ 4/2014 1:00:00 AM
Start immediately
End logging 8/ 4/2016 1:00:00 AM
Sampling regime Continuous Average Burst
Measurement speed Period Rate 00:01:00
Schedule is valid
Memory required for schedule: 5%
Battery required for schedule: 42%
Stop Revert settings Use last setup

Subsurface setup:

Instrument	Serial	Depth Meters	Sample Rate	Start Date	Start Time	Date Spike Start	Time Spike Start	Date Spike Stop	Time Spike Stop
SBE37 SST Logger 16	3605	1.5	5 min	12/11/14	21:35:00	12/12/14	12:21:50	12/12/14	unknown
SBE37 SST Logger 12	1836	1.5	5 min	12/4/14	1:00:00	12/7/14	14:25:55	12/7/14	14:55:30
Nortek 2mhz	432	18	20 min	12/4/14	1:00:00	12/8/14	19:55:05	12/8/14	23:08:00
Nortek	9467	5.7	20 min	12/4/14	1:00:00	12/8/14	19:55:05	12/8/14	23:08:00
Nortek-IM	5973	13	20 min	12/4/14	1:00:00	12/8/14	14:39:45	12/8/14	22:56:00
RDI ADCP 300khz	2125	85	1hr	12/4/14	1:00:00	12/10/14	13:05:05	12/10/14	18:08:00
SBE-39	539	5	5 min	12/4/14	1:00:00	12/7/14	16:40:00	12/7/14	17:20:00
SBE-39	545	15	5 min	12/4/14	1:00:00	12/7/14	16:26:30	12/7/14	17:20:00
SBE-39	546	20	5 min	12/4/14	1:00:00	12/7/14	16:40:00	12/7/14	17:20:00
SBE-39	631	30	5 min	12/4/14	1:00:00	12/7/14	16:40:00	12/7/14	17:20:00
SBE-39	677	40	5 min	12/4/14	1:00:00	12/7/14	16:40:00	12/7/14	17:20:00
SBE-39	678	50	5 min	12/4/14	1:00:00	12/7/14	16:26:30	12/7/14	17:20:00
SBE-39	680	60	5 min	12/4/14	1:00:00	12/7/14	16:40:00	12/7/14	17:20:00
SBE-39	681	70	5 min	12/4/14	1:00:00	12/7/14	16:40:00	12/7/14	17:20:00
SBE-39	684	90	5 min	12/4/14	1:00:00	12/7/14	16:40:00	12/7/14	17:20:00
SBE-39	750	100	5 min	12/4/14	1:00:00	12/7/14	16:26:30	12/7/14	17:20:00
SBE-39	3480	110	5 min	12/4/14	1:00:00	12/7/14	16:26:30	12/7/14	17:20:00

SBE37	11392	4996 ***	10 min	12/4/14	1:00:00	12/8/14	19:55:05	12/8/14	23:08:00
SBE37	11393	4996 ***	10 min	12/4/14	1:00:00	12/8/14	19:55:05	12/8/14	23:08:00
SBE37 IM #03 *	669	25m	10 min	12/4/14	1:00:00	12/8/14	14:39:45	12/8/14	22:56:00
SBE37 IM #04 **	684	45m	10 min	12/4/14	1:00:00	12/8/14	14:39:45	12/8/14	22:56:00
SBE37 IM #05 *	686	65m	10 min	12/4/14	1:00:00	12/8/14	14:39:45	12/8/14	22:56:00
SBE39 IM #07	4465	10m	10 min	12/4/14	1:00:00	12/8/14	14:39:45	12/8/14	22:56:00
SBE39 IM #08	4466	80m	10 min	12/4/14	1:00:00	12/8/14	14:39:45	12/8/14	22:56:00
Starmon	3167	110	10 min	12/5/14	1:00:00	12/7/14	16:19:00	12/7/14	17:20:00
Starmon	3168	120	10 Min	12/5/14	1:00:00	12/7/14	16:19:00	12/7/14	17:20:00
Starmon	3169	130	10 min	12/5/14	1:00:00	12/7/14	16:19:00	12/7/14	17:20:00
Starmon	3170	140	10 min	12/5/14	1:00:00	12/7/14	16:19:00	12/7/14	17:20:00
Starmon	3171	150	10 min	12/5/14	1:00:00	12/7/14	16:19:00	12/7/14	17:20:00
Starmon	3791	160	10 min	12/5/14	1:00:00	12/7/14	16:19:00	12/7/14	17:20:00
RBR_duo CT	61568	26	1 min	12/4/14	1:00:00	12/7/14	16:22:30	12/7/14	16:32:30
RBR SoloT	75556		1	12/4/14	1:00:00	12/7/14	16:15:00	12/7/14	16:36:30
RBR SoloT	75557		1	12/4/14	1:00:00	12/7/14	16:15:00	12/7/14	16:36:30
RBR SoloT	75558		1	12/4/14	1:00:00	12/7/14	16:15:00	12/7/14	16:36:30
RBR SoloT	75559		1	12/4/14	1:00:00	12/7/14	16:15:00	12/7/14	16:36:30

* SBE37 inductive were reset with correct IDs on 12/11/2014. ** SN684 was stopped and then set to restart on 12/11/2014 1800, but memory was not reset. *** Deep SBE-37s are 31 m above anchor and water depth is 5027 m

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 Mathews 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)	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 14 MOORED STATION NO. 1268

Surface Components

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

Buoy Markings If found adrift contact Woods Hole Oceanogr hic Woods Hole, MA 02543 U 508-5 8-14 1

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

2

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	IMEI: 300124000010620
			SIM: 89881 69312 00205 1328
			NDBC #: 41NTO
SIS/Sable			XEOS IMEI 300034013905090
Iridium(SS)	43720		IMEI 3002 2401 0043 720
↳ L16			
Iridium			
†Depth below buoy deck in centimeters			

3

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		
2	5m	EM chain			12:48		
3		SBE 39	5	539	12:48		
4		Nortek ADCM	5.7	9467	1248		heads up
5		SBE 39	10	4465	1248		IM
6		Nortek ADCM	13	5973	1248		IM heads up
7		SBE 39	15	545	1252		
8		Nortek ADCM	18	432	1252		heads up
9		SBE 39	20	546	1252		
10		SBE 37	25	669	1252		IM
11		RBR Duo CT	26	61568	1252		
12		SBE 39	30	631	1252		
13		SBE 39	40	677	1252		
14		SBE 37	45	684	1252		IM
15		SBE 39	50	678	12:~~50~~ 55		
16		SBE 39	60	680	12:59		
17		SBE 37	65	686	1301		IM
18		SBE 39	70	681	1303		
19		SBE 39	80	4466	1305		IM
20		RDI ADCP	84 85	2125	1312		heads up
21	78	7/16 wire					Note: Depths from the
22	500	3/8 wire					ADCP down are 1m shallower
23		SBE 39	89 90	684	1315		than expected due to shot and
24		SBE 39	99 100	750	1317		chain length
25		SBE 39	109 110	3480	1319		

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	1090	3167	1319		
27		Starmon	1190	3168	1320		
28		Starmon	1290	3169	1326		
29		Starmon	1390	3170	132130		
30		Starmon	1490	3171	132245		
31		Starmon	1590	3791	132310		
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		
37	500	7/8 nylon			1459		
38	2000	3/4 nylon			1515		
39	100	7/8 nylon					
40	1500	1" Colmega			1615		end colmega 16:45
41		glassballs (56)		start end	1741		卌 卌 ||||
42		SBE 37		11392	1750		
43		SBE 37		11393	1750		
44	5	1/2" chain					
45		release		32483	1800		
46		release		33036	1800		
47	5	1/2" chain					
48	20	1" nystron					
49	5	1/2" chain					
50		Anchor			1427 / 1425 / 1827 UTC		14° 44.72 50° 57.6' depth 4992 m (+38)

Appendix 3: NTAS-13 mooring log (page 7 blank).

Moored Station Log

(fill out log with black ball point pen only)

ARRAY NAME AND NO. NTAS-13 MOORED STATION NO. 1266

Launch (anchor over)

Date (day-mon-yr) 22-Oct-2013 | Time 22:58 UTC

Deployed by Pietro | Recorder/Observer Plueddemann

Ship and Cruise No. RB-13-05 | Intended Duration 12 mo

Depth Recorder Reading 4975 m | Correction Source Kongsberg EM 122 climatology + TSG sensors

Depth Correction N/A m

Corrected Water Depth 4975 m | Magnetic Variation (E/W)

Anchor Drop Lat. (N/S) 14° 49.617' N | Lon. (E/W) 51° 00.838' W

Surveyed Pos. Lat. (N/S) 14° 49.515' N | Lon. (E/W) 51 01.003' W

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

Acoustic Release Model ~~Edgetech~~ ORE 8242 | Tested to 1500 m

Release No. 1 (sn) 31270	Release No. 2 (sn) 31269
Interrogate Freq. 11	Interrogate Freq. 11
Reply Freq. 12	Reply Freq. 12
Enable 460320	Enable 460272
Disable 460345	Disable 460303
Release 444176	Release 444155

Recovery (release fired)

Date (day-mon-yr) 15 Dec 2014 | Time 12:00 UTC

Latitude (N/S) 14° 49.628' | Longitude (E/W) 51° 1.479'

Recovered by Pietro B. / Smith J. | Recorder/Observer Bigorre S.

Ship and Cruise No. Endeavor EN549 | Actual duration 315 (mooring break) 419 (release) days

Distance from waterline to buoy deck 75 cm

1

ARRAY NAME AND NO. NTAS-13   MOORED STATION NO. 1266

Surface Components

Buoy Type MOB 2.7 m foam hull Color(s) Hull Tower blue hull, yellow deck, white tower

Buoy Markings WHOI 508-548-1401 USA

Surface Instrumentation

Item	ID #	Height* cm	Comments
ASIMET Lgr	L03 (Sys1)	buoy well	port side
HRH	226	~~94~~ 238.76	
BPR	207	~~94~~ 238.76	
WND	210	~~105~~ 266.7	
PRC	215	~~100~~ 254	
LWR	207	278.13	
SWR	221	278.13	
SST	3601		
PTT	12785	in-well	ID's 15448, 15449, 15450
ASIMET Lgr	L05 (sys 2)	buoy well	stbd side
HRH	501	238.76	
BPR	505	238.76	
WND	219	266.7	
PRC	~~208~~ 212	259.08	
LWR	208	278.13	
SWR	211	278.13	
SST	2054		
PTT	14623	buoy well	ID's 15441, 15442, 15444
Lascar	307		
SBE-39 AT	5270		
Vaisala WXT	004		
Xeos Melo			IMEI 300034012615100

*Height above buoy deck in centimeters

2

ARRAY NAME AND NO. NTAS-13 MOORED STATION NO. 1266

Subsurface Instrumentation on Buoy and Bridle			
Item	ID #	Depth†	Comments
SST	75764	95 cm	RBR Solo-T, 120°, "port"
SST	75765	85	RBR Solo-T, 180°, fwd
SST	75766	95	RBR Solo-T, 180°, fwd
SST	75767	95	RBR Solo-T, 240°, "stbd"
SIS	267	buoy base	Argos ID 25689
WAMDAS	06017	buoy hull	IMEI: 300224010103770
~~Met Iridium~~	~~325130~~	~~SYS1~~	not deployed
Subsurf Iridium		37100 SYS2	IMEI: 300224010237100

†Depth below buoy deck in centimeters

3

ARRAY NAME AND NO. NTAS-13 MOORED STATION NO. 1266

10/22/13

Item No.	Length (m)	Item	Depth	Inst No.	Time Over	Time Back	Notes * for Recovery, see comments on last page
1		buoy	0	—	1728		
2	5m	EM chain	—	—	1728		
3		SBE-39	5	3479 ~~4462~~	1728		
4		Nortek	5.7	9407	1728		
5		RBR 2050P	6	21589	1725		
6	79	7/16 wire	—	12104-6	1725		BREAK POINT (cable failed near swage)
7		SBE 39	10	4462	1719		IM
8		Nortek	13	6108	1719		IM, vane, heads up
9		SBE 39	15	266	1719		
~~10~~		~~SBE 39~~					
11		RBR 2050P	16	21590	1719		
12		Nortek	18	6855	1719		
13		SBE 39	20	635	1720		
14		SBE 37	25	671	1720		IM
15		RBR 2050P	26	21591	1720	1803	imploded, casing open
16		SBE 39	30	743	1720		
17		SBE 39	40	744	1720		
18		SBE 37	45	683	1728		IM
19		RBR 2050P	46	21592	1730		
20		SBE 39	50	745	1730		
21		SBE 39	60	746	1738		
22		SBE 37	65	685	1742		IM, no trawl guard
23		SBE 39	70	747	1745		
24		SBE 39	80	4463	1752		IM
25		ADCP	85	2601	1752	1830	300kHz, heads up imploded

4

ARRAY NAME AND NO. NTAS-13 MOORED STATION NO. 1266

Item No.	Length (m)	Item	Depth	Inst No.	Time Over	Time Back	Notes
26	500	3/8 wire	—	13079-1	1754		
27		SBE 39	90	749	1754		
28		SBE 39	100	751	1756		
29		SBE 39	110	752	1758		
30		Starmon	110	272	1758		
31		Starmon	120	273	1800		
32		Starmon	130	287	1801		
33		Starmon	140	288	1802		
34		Starmon	150	492	1802		
35		Starmon	160	493	1803		
36	500	3/8 wire	—	13079-3	1826		
37	500	3/8 wire	—	12104-2	1845		
38	200	3/8 wire	—	13079-4	1904		
39	100	3/8 wire	—	13147-1	1911		
40	200	7/8 nylon	—	—	1915		
41	500	7/8 nylon	—	—	1932		
42	2000	3/4 nylon	—	—		1601	
43	100	7/8 nylon	—	—	2022		
44	1500	1" colmega	—	—	2024		
45		glass balls		start end	2120 2140	13.38	counted 14 strings of 4 = 56 balls balls come in cluster (RCVRY)
46		SBE 16		2323	2237	1354	38m off bottom no poison plugs
47		SBE 16		2324	2237	1354	
48	5	1/2 chain	—	—	2237		
49		release		31269	2239	1354	
50		release		31270	2239	1354	

ARRAY NAME AND NO. NTAS-13 MOORED STATION NO. 1266

Item No.	Length (m)	Item	Depth	Inst No.	Time Over	Time Back	Notes
51	5	½ chain	—	—	2240		
52	20	1" nystron		—	2240		
53	5	½ chain	—	—	2258		
54		Anchor			2258		
55							
56							
57							
58							
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60							
61							
62							
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71							
72							
73							
74							
75							

6

ARRAY NAME AND NO.________ MOORED STATION NO.________

Date/Time	Comments
RY: 1631 12/15/14	Nylon starts being colored by mud
1338	Glass balls back on deck in clusters
	Only one glass ball imploded

50272-101

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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-13 mooring and deployment of the NTAS-14 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 EN549. The cruise took place between December 5 and 21 December 2014. The NTAS-14 mooring was deployed on December 13, and immediately followed by a 36-hour intercomparison period during which data from the buoy, telemetered through Argos satellite system, and the ship's meteorological and oceanographic data were monitored. The NTAS-13 buoy had parted on September 23 and was recovered on October 28 while drifting freely near Martinique. The rest of the mooring, which had fallen to the seafloor was recovered during EN549, on December 17. 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 EN549 consisted in the recovery and deployment of Pressure Inverted Echo Sounders (PIES) and the acoustic download of data from PIES and subsurface moorings that are part of the Meridional Overturning Variability Experiment (MOVE) array. MOVE is designed to monitor the integrated deep meridional flow in the tropical North Atlantic. Two Argo floats were also deployed during the cruise on behalf of the Argo group at WHOI.

17. Document Analysis a. Descriptors

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Martinique

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