Cruise Instructions

Date Submitted: 10 August 2012
Platform: NOAA Ship *Ronald H. Brown*
Cruise Number: RB-12-05

Project Title: PIRATA Northeast Extension / AEROSE

Cruise dates: 31 August — 1 October 2012

Prepared by: ________________________Dated: __________________
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Approved by: ________________________Dated: __________________
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Approved by: ________________________Dated: ____________________
Captain Anita L. Lopez, NOAA
Commanding Officer
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I. **Overview**

A. Cruise Period

31 August — 1 October 2012

B. Service Level Agreements

Of the _32_ DAS scheduled for this project, _32_ DAS are funded by the program. This project is estimated to exhibit a Medium Operational Tempo.

C. Operating Area

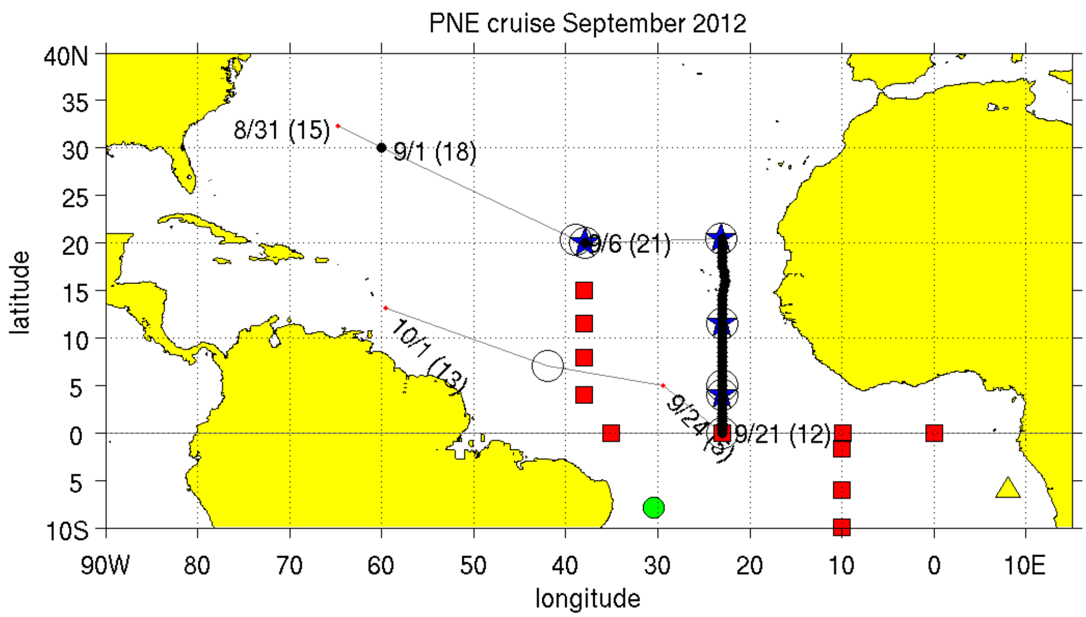


Fig. 1: cruise track of RB-12-05 (black line) and locations of Tropical Atlantic data buoy moorings. Symbols indicate the PIRATA backbone (red squares), the PIRATA SW extension (green dot), the PIRATA SE extension (yellow triangle). Blue stars indicate the PIRATA Northeast Extension. Open circles without stars indicate the locations of three hydrophone moorings to be serviced. Black dots show CTD stations (test site and 23 W section). Not shown is the location of the drifting NTAS mooring (it is somewhere northeast of Barbados and could be close enough to the cruise track to be picked up if time allows).

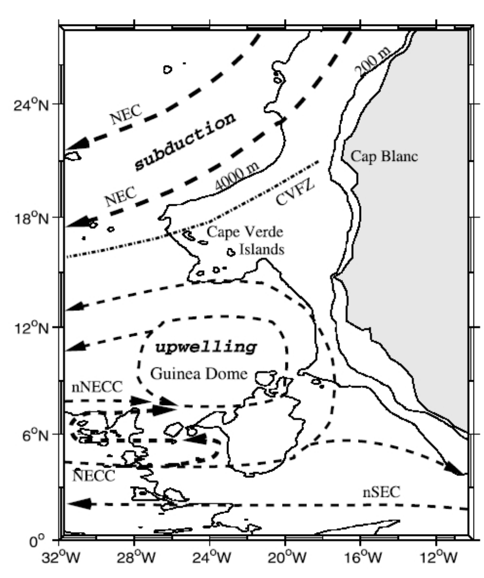
The operating area is the eastern tropical Atlantic primarily along 23°W. The ship will depart from St Georges, Bermuda and proceed to the first hydrophone mooring at 20ºN, 39°W. The hydrophone mooring site is called EA-1, it will be a recovery of the mooring and redeployment with a new hydrophone. A hydrographic test cast will be performed along the way (at about 30ºN, 60ºW). The ship will then continue to the first PNE mooring station at 20ºN, 38°W to recover and deploy the ATLAS buoy and the Tropical Flex (TFlex) mooring that are located approximately 5nm apart. A hydrographic line will be conducted up 23°W, from 20.5°N the equator, detouring slightly eastward around the Cape Verde plateau. Along this line, ATLAS moorings will be serviced at 20.5ºN, 11.5ºN and 4ºN (recovery/redeployment for these three). In addition, the second hydrophone mooring will be serviced at 5ºN, 23W. This hydrophone mooring is called EA-2, and will be recovered and redeployed with a new hydrophone. The equatorial Atlas mooring is working well at this time but could need repairs if any instruments fail prior to this cruise . The ship will proceed to the third and final hydrophone site at 7ºN, 42ºW (4665 m deep). Called EA-6, this mooring site is a new deployment of a hydrophone mooring and no recovery is required. It is important to avoid the Brazilian EEZ during the deployment. If time allows, then an attempt will be made to recover the drifting NTAS mooring (i.e. if the mooring is close enough to the ship track). Then the ship will proceed to Bridgetown, Barbados. Atmospheric measurements, sonde launches and tests of an underway CTD will be performed throughout the cruise. XBT casts and float as well as drifter deployments are also planned.

D. Summary of Objectives

The PIRATA Northeast Extension

The Pilot Research Moored Array in the Tropical Atlantic (PIRATA) is a three-party project between Brazil, France and the United States that seeks to monitor the upper ocean and near surface atmosphere of the Tropical Atlantic via the deployment and maintenance of an array of moored buoys and automatic meteorological stations. This array is the Atlantic's analogue of the Pacific Ocean's TAO array. The PIRATA array consists of a backbone of ten moorings that run along the equator and extends southward along 10ºW to 10ºS, and northward along 38ºW to 15ºN (Fig. 1).

The northeastern and north central Tropical Atlantic is a region of strong climate variations from intraseasonal to decadal scales, with impacts upon rainfall rates and storm strikes for the surrounding regions of Africa and the Americas. The northeastern Tropical Atlantic includes the southern edge of the North Atlantic subtropical gyre, defined by the westward North Equatorial Current (NEC), and the northern edge of the clockwise tropical/equatorial gyre defined by the North Equatorial Countercurrent (NECC) (Fig. 2). This area is the location of the North Atlantic's oxygen minimum zone at a depth of 400—600m. The size and intensity of this zone is a potential integrator of long-term North Atlantic circulation changes (Zheng et al., 2000), and the extremely low oxygen values have significant impacts on the biota of the region (Childress and Seibel, 1998). The cyclonic Guinea Dome (c.f., Siedler et al., 1992) is centered near 10ºN, 24ºW (Stramma et al., 2005), between the NECC and NEC in the eastern TA. It is driven by trade wind-driven upwelling, and may play an active role in modulating air-sea fluxes in this region (Yamagata and Iizuka, 1995).



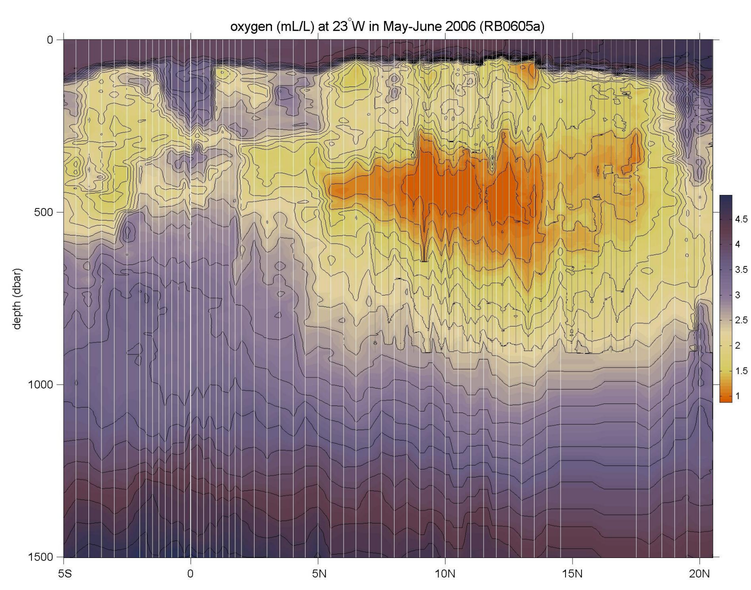


Fig. 2: *Left*: schematic of surface currents and features in the northeastern TA, from Stramma *et al.* (2005). *Right*: oxygen (mL/L) measured during the 2006 PNE cruise aboard Ronald H. Brown, showing the pronounced oxygen minimum.

The Tropical North Atlantic is the Main Development Region (MDR) of tropical cyclones. Many major hurricanes that ultimately threaten the eastern United States begin as atmospheric easterly waves that propagate off the African continent. Once over the MDR in the band 10-20ºN, these waves are exposed to convective instability driven by the upper ocean's heat content. The resulting infusion of energy can result in closed cyclonic circulation and development from tropical depression to tropical storm and hurricane. These hurricanes are known as Cape Verde-type hurricanes, to distinguish them from storms forming further west, and they are often the most powerful storms to strike the US east coast. Prominent examples include Andrew (1992), Floyd (1999) and Ivan (2004). An average season has two Cape Verde hurricanes, but some years have up to five while others have none. There is profound uncertainty regarding the specific atmospheric/oceanic conditions that determine which of the atmospheric waves will develop into tropical cyclones and then hurricanes (on average, one of ten; J. Dunion, personal communication). Specifically, the quantitative effects of the Saharan Aerosol Layer (SAL), anomalous sea surface temperatures (SST), upper layer oceanic heat content and atmospheric wind shear on the formation of tropical cyclones are poorly known.

Seasonal tropical storm and hurricane forecasts are generated annually and based primarily on statistical analyses of historical data and the formulation of empirical predictors (e.g., ENSO index, Atlantic SST, Sahel rainfall, etc.). Recent empirical studies have demonstrated that tropical storm and hurricane activity in the Atlantic Ocean varies on decadal and multi-decadal time-scales and that this variability is correlated with sea-surface temperature anomalies in the MDR (e.g., Shapiro and Goldenberg, 1998). The SST signal in the MDR has been correlated with the North Atlantic Oscillation (NAO) on decadal time-scales. The multi-decadal signal indicates that an extended period of increased hurricane activity is to be expected. Other historical studies have also demonstrated spatial variability in storm formation areas and landfall locations on longer timescales.

Despite the climate and weather significance of the Tropical North Atlantic region, it was not sampled by the PIRATA backbone array apart from the 38°W line of moorings extending north to 15°N (Fig. 1). In 2005, a formal Northeast Extension of PIRATA was proposed as a joint project between NOAA/AOML and PMEL (Rick Lumpkin, Mike McPhaden and Bob Molinari, co-principal investigators). This PIRATA Northeast Extension (PNE) was proposed to consist of four moorings, three creating a northward arm up 23°W (building upon the equatorial backbone mooring there), and a fourth extending the 38°W arm to 20°N.

In June 2006, the first two moorings of this extension were deployed during RB-06-05a. The mooring at 11.5°N, 23°W was deployed on June 7, and the mooring at 4°N, 23°W was deployed on June 11. Both moorings were replaced in May 2007, during RB-07-03, and two more moorings were added at 20.5°N, 23°W and 20°N, 38°W. The four buoys were planned for servicing in the April 2008 cruise RB-08-03. Due to the cancellation of this cruise, the buoys failed and a data gap was introduced in mid to late 2008. All four sites were subsequently serviced in November 2008 by NOAA charter of the French R/V Antea. In 2009, the four moorings were serviced during RB-09-04. The four buoys, which are serviced annually, are currently successfully reporting meteorological and oceanographic data onto the Global Telecommunications System for weather and climate forecasting. In the Memorandum of Understanding from the PIRATA-12 meeting (November 2006), the United States agreed that

> [I]t is recognized that the Parties are dependent upon year-to-year funding allocations from their governments, and thus commitments for future funding and logistical support cannot be guaranteed. Given this proviso, the Parties affirm that PIRATA is a high priority for Brazil, France, and the United States, and that the institutions are making plans for continued support … NOAA will provide ship time for maintenance of four moorings in the North East Extension.

Ronald H. Brown's cruise RB-12-05 serves to honor this commitment for the year 2012.

Aerosols and Ocean Science Expeditions (AEROSE)

Large uncertainties remain in our understanding of the impact of mineral dust and biomass burning aerosols on the weather and climate of the tropical Atlantic. In order to advance knowledge and improve predictive models, it is important that we address gaps in our understanding of regional and trans-boundary aerosol issues. The African continent is one of the world's major source regions of mineral dust and biomass burning aerosols. This makes the need for understanding the mobilization, transport, and impacts of aerosols originating from natural and anthropogenic processes in Africa a high priority. Saharan dust storms are estimated to inject over three billion metric tons of mineral aerosols into the troposphere annually, with large quantities of these advecting out over the tropical North Atlantic within tropical easterly winds and waves. These aerosols impact phenomena ranging from cloud-seeding and precipitation, to ocean fertilization, and to downstream air quality and ecosystem impacts in the Caribbean and U.S. eastern seaboard. Red tides, increasing rates of asthma, and precipitation variability in the eastern Atlantic and Caribbean have been linked to increases in the quantities of Saharan dust transported across the Atlantic. The contribution of the Saharan air layer (SAL) to the development of the West African Monsoon (WAM) and its role in tropical cyclogenesis are just beginning to be understood. The interplay between thermodynamics, microphysics, and aerosol chemistry are currently unknown and these field measurements represent a unique data set for unraveling these complex interactions.

The Aerosols and Ocean Science Expeditions (AEROSE) constitute a comprehensive measurement-based approach for gaining understanding of the impacts of long-range transport of mineral dust and smoke aerosols over the tropical Atlantic (Morris et al., 2006; Nalli et al., 2011). The project, involving international coordination of monitoring in Puerto Rico, Mali, the Canary Islands, and Senegal, hinges on multi-year, trans-Atlantic field campaigns conducted in collaboration with PNE project over the tropical Atlantic. AEROSE is supported through collaborative efforts with NOAA's National Environmental Satellite Data and Information Service, Center for Satellite Applications and Research (NESDIS/STAR) and the National Weather Service (NWS), as well as NASA and several academic institutions linked through the NOAA Center for Atmospheric Sciences at Howard University.

The AEROSE campaigns (to date, comprised of eight separate trans-Atlantic Project legs) have thus provided a set of *in situ* measurements to characterize the impacts and microphysical evolution of continental African aerosol outflows (including both Saharan dust and sub-Saharan and biomass burning) across the Atlantic Ocean (Nalli et al., 2011). AEROSE has sought to address three central scientific questions (Morris et al., 2006):

1) How do Saharan dust, biomass burning aerosol, and/or the SAL affect atmospheric and oceanographic parameters during trans-Atlantic transport?
2) How do the Saharan dust aerosol distributions evolve physically and chemically during transport?
3) What is the capability of satellite remote sensing and numerical models for resolving and studying the above processes?

Specific objectives of RB-12-05

The objectives of this *Ronald H. Brown* project address NOAA's Climate Goal and Weather and Water Goal, and are an explicit NOAA contribution to the PIRATA and AEROSE programs. Specific goals are in the areas of oceanography, marine meteorology, atmospheric chemistry and satellite validation.

Oceanography: Numerical models that are used to simulate the coupled air-sea system and to forecast atmospheric climate are notoriously inaccurate in the eastern tropical Atlantic. For example, the majority of the models cannot simulate the sign of the equatorial sea surface temperature (SST) gradient. They show cold water in the west and warm water in the east, exactly out of phase with observed conditions. The main objective of the oceanographic component of *RB-12-05* is to collect the data needed to evaluate the terms in the heat budget of the upper ocean and to compare the observed results with model results. The comparison should identify areas/processes of model deficiencies. Four ATLAS moorings and one TFlex mooring will be recovered and redeployed. The purpose of these moorings is to provide time series of the upper ocean temperature, salinity, current structure and heat fluxes between the ocean and atmosphere. Shipboard observations will include upper ocean and surface heat flux data along 23°W, from 5°S to 20.5°N. These observations will be supplemented by data from surface drifters and profiling floats to be deployed during this and other cruises to the area. Combining the various data will allow estimation of the terms in the heat budget. Data to be collected provide an improved picture of seasonal-to-interannual variability. The hydrophone mooring data will be used assess the anthropogenic and natural sound levels in the equatorial Atlantic as well as the distribution large baleen whale populations in the region. The coasts of eastern South America and West Africa are area of focused oil exploration and we expect high levels of noise introduced by seismic airguns. The equatorial mid-Atlantic is also the site of one of the ocean's largest transform faults and we plan to record earthquake from this fault to test earthquake prediction (retrospective) methods.

Marine Meteorology: Atmospheric data will be collected to characterize the vertical structure of the Saharan air layer (SAL) (e.g., Nalli et al., 2005; 2011), including mineral dust aerosol over the Atlantic Ocean. The atmospheric data will also be used to investigate the effect of the SAL on the marine boundary layer, clouds, precipitation, and tropical cyclogenesis, with September being the peak month for Atlantic hurricane season.

Recent publications by Min et al 2009 indicate that ice particles are abundant in the dusty sectors of deep tropical convective systems that have entrained Saharan mineral dust. This is particularly evident at altitudes at which heterogeneous ice nucleation is a dominant process. Other studies suggest that mineral dust may be of critical importance in precipitation processes but studies are inconclusive regarding whether it suppresses or enhances rainfall in tropical systems. The AEROSE team will take advantage of opportunistic events where dust storms are ingested into deep convective systems via soundings, ship-based lidar, optical and chemical determination of the dust load composition, A-train and/or other relevant satellite observational overpasses.

Atmospheric Chemistry: Profile measurements of the atmosphere will be conducted to investigate the linkages between the vertical distributions of tropospheric ozone with dust and smoke outflows (e.g., Nalli et al., 2011). Historical data show a seasonal variation in tropospheric ozone that peaks during June-August. The origins of this peak remain uncertain and may be due to anthropogenic sources (e.g., transport from biomass burning in the Congo Basin) or natural sources (e.g., lightning over West Africa, stratospheric injections).

Current atmospheric chemistry models are challenged by the need to account for a variety of processes in dense aerosol outflows. Very few in-situ measurements have been reported for tropical air masses that are rich in mineral dust aerosols, biomass burning aerosols, West African megacity aerosols, and/or mixtures of these aerosol types that characterize the trade wind and SAL outflow regimes. AEROSE will extend its record of key measurements of trace gases that will allow for better constraints on the chemistry within these outflows. The measurements include ozone, carbon monoxide, sulfur dioxide, NOx (nitric oxide and nitrogen dioxide), methane, and aggregate non-methane volatile organic carbon species (VOC).

A comprehensive suite of aerosol measurements and in situ sampling will also be performed in order to quantify the microphysical and chemical evolution of the Saharan dust during trans-Atlantic transport, to characterize aerosol mixing, to identify microbial distributions and microbial load on the aerosols, to determine evidence for heterogeneous chemistry within dusty air mass outflows. Offline microbiological and chemical composition as a function of size and source region will be performed so sample collection and processing will be conducted prior to freezing filter samples collected during the cruise. Number distributions will be measured continuously for Aitken, accumulation mode, and fine aerosols using mobility analyzers and optical particle counters. Mass density and gravimetric aerosol analysis will be performed using a suite of tandem quartz crystal cascade impactors, cyclone impactors, a high volume gravimetric sequential sampler.

Satellite validation: Visible, microwave, infrared and *in situ* measurements will be collected to support the calibration/validation and improvement of advanced satellite retrievals and data products (Nalli et al., 2011) including the NOAA R-Series Geostationary Operational Environmental Satellite (GOES-R) , and especially the recently launched Suomi National Polar-orbiting Partnership (NPP) Cross-track Infrared Microwave Sounding Suite (CrIMSS) (Nalli et al., 2012). .

E. Participating Institutions

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3.	Grant Rawson	M	USA	CIMAS/UM	Y
4.	Verena Hormann	F	Germany	CIMAS/UM	Y
5.	Marlos Goes	M	Brazil	CIMAS/UM	Y
6.	Michael Strick	M	USA	NOAA/PMEL	y
7.	Linda Stratton	F	USA	NOAA/PMEL	Y
8.	Malgorzata Szczodrak	F	Canada	RSMAS/UM	?
9.	Vernon Morris	M	USA	NCAS	y
10.	Everette Joseph	M	USA	NCAS	
11.	Nicholas Nalli	M	USA	NOAA/NESDIS	y
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13.	Mayra Oyola	F	USA	NCAS	y

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15. Christopher Spells	M	USA	NCAS	y
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22. TBD			observer	
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Agent in Bermuda: None
Agent in Barbados: None

2. Diplomatic Clearances

Research clearance has been requested for Bermuda (UK), Cape Verde and Barbados. The requests are submitted to the State Department by Wendy Bradfield-Smith <Wendy.Bradfield-Smith@noaa.gov> As of Aug 10, 2012, no clearance was received.

3. Licenses and Permits

not applicable

II. Operations

A. Cruise Plan/Itinerary

The primary goal of the cruise is to recover and redeploy the Atlas moorings of the PIRATA Northeast extension and to continuously sample oceanic and atmospheric variables along the cruise track. An underway CTD will be tested throughout the cruise. A CTD section will be taken along 23°W from 20.5°N to the equator. CTD station locations are given in Appendix H. The actual hydrographic stations sampling plan may deviate from this proposed plan in both number of stations and their locations. Some CTD station locations are in Cape Verde's EEZ. Clearances for Cape Verde, Bermuda and Barbados are pending.

ATLAS moorings will be recovered and new ones deployed at 20°N, 38°W, as well as at 20.5°N, 11.5°N, and 4°N along 23°W. In addition, a TFlex mooring will be recovered and a new one deployed at 20°N, 38°W. For the mooring at the equator, 23°W a visit is planned as all instruments are working at this time. An instrument repair could become necessary and will be done if the time allows. This year, three hydrophone moorings will be recovered and redeployed (the Atlas mooring team will be in charge). They are located at 20ºN, 39°W; 5ºN, 23°W and 7ºN, 42ºW.

Atmospheric data will be collected throughout the cruise; such data are not subject to restrictions in foreign EEZs. Changes in speed may be required for radiosonde launches which will be done at positions determined by the atmospheric scientists and based on satellite overpass predictions determined on the ship while underway (i.e., pre-cruise positions cannot be provided). Small changes in heading may also be required for large-balloon ozonesonde launches, depending on wind conditions. Satellite tracked surface drifters and Argo floats will be deployed along the trackline at locations determined by the Chief Scientist. Pre-cruise deployment locations cannot be provided as final deployment sites will be determined by the locations of floats and drifters previously deployed.

There is a possibility for a synergistic NASA Global Hawk UAS overflight of the ship location during a window-of-opportunity occurring during the first outbound transit leg from Bermuda to the first buoy waypoint at (20°N, 38°W), 1- 6 September, in collaboration with the 2012 NASA Hurricane and Severe Storm Sentinel (HS3) campaign. Another lesser window-of-opportunity for an overflight would be on the return transit leg to Barbados within the region of (10-20 N, 40-60 W), 24-30 September. The NASA Global Hawks are high-altitude scientific research aircrafts capable of flight altitudes greater than 55,000 ft and flight durations of up to 30 h. The HS3Global Hawk during PNE/AEROSE will be flying out of Wallops Island, Virginia. The over-flight possibility is contingent upon the hurricane activity during the two windows of opportunity indicated. If there is little to no hurricane activity, then it is more likely that the overflight of the ship will be sought out. Assuming this to be the case for the either window periods, the overflights will be coordinated via email to coincide as best as possible with a Suomi NPP overpass (usually within an hour or two of 01:30 or 13:30 LST) for calibration/validation of the new CrIMSS sensors onboard. The instrumentation on the Global Hawk include a Scanning High-resolution Interferometer Sounder (S-HIS) and dropsondes. The S-HIS is a passive infrared spectrometer that can obtain measurements throughout the overflights, whereas dropsondes would cease within the vicinity of the ship's location. Ship operations, including cruise heading/speed and scientific data collection, both AEROSE and PNE, would continue as normal. AEROSE radiosondes will be launched ~0.5 hr prior to the NPP overpass, which will place the balloon in the lower troposphere at the time of the aircraft overflight.

NOAA Ship *Ronald H. Brown* (RHB) will depart St Georges, Bermuda on 31 August and transit to the test cast site (at about 30°N, 60°W). RHB will then proceed to the site of the first hydrophone mooring (20ºN, 39°W). RHB will complete mooring deployment and steam to the 20°N, 38°W, where a CTD cast will be conducted and an ATLAS and TFlex mooring will be recovered and redeployed. The RHB will continue to 20.5°N, 23°W for the next CTD cast and Atlas mooring recovery and deployment. The RHB will continue southward nominally along 23°W (staying east of the Cape Verde Islands) to the 11.5°N mooring and take CTD stations along the way. There, the next Atlas mooring will be recovered and redeployed and the RHB will continue the CTD section while heading southward along 23°W to the hydrophone mooring at 5°N for another recovery and deployment. The next Atlas mooring recovery and deployment follows at 4°N, 23°W. From there the RHB will continue to the last Atlas mooring site for a visit (or repair if necessary and the available time allows). Then the RHB will continue to the last hydrophone site at 7ºN, 42ºW, while staying north of the Brazilian EEZ, for another mooring recovery and redeployment. Then the RHB will head for Barbados to arrive on October 1, but the RHB may try to capture the drifting NTAS mooring if there is enough time to do that.

B. Staging and Destaging

Staging for the cruise will be conducted in Miami, FL and Boston, MA. Equipment characteristics are given in Appendix B.

AOML Equipment for the collection of hydrographic data will be loaded in Miami (for GOMECC and PNE).

Drifters for PNE: loading in Miami and Boston.

Equipment for recovery/deployment of four ATLAS moorings, one Tflex mooring and three hydrophone moorings will be loaded in Boston. A large part of this equipment needs to be stored near the fantail (typically on the port side).

RSMAS M-AERI: installation on the forward 02 Level in Miami, as on the previous PNE/AEROSE cruises (2004, 2006–2011). This requires a crane lift.

NCAS van: 20 ft van with standard fitting. The plan is to load the van with a rented crane, since it is too heavy (expected more than 15,000 lb). During WACS the van will be on the main deck. During and after PNE will be on the forward 02 Level. Crane usage in Boston and Bermuda will be coordinated with WACS.

NCAS requires engineering help on connecting van to ship's power supply before departure from Bermuda. A NCAS team will work on sensor deployment during the port of call in Bermuda.

NCAS requires help unloading and securing gas cylinders (30 about 4.5 ft tall), secured on O1 deck aft of the winch house. The loading will be coordinated with WACS.

Small items loading needs to be coordinated with the OPS if not included in the NCAS van. NCAS will take care of them.

AOML will require the assistance of the shipboard ET to help install computer systems. The science party will stay onboard the ship night of August 30 to allow for maximum time for setup of the scientific gear prior to sailing. We understand that the galley may not be available for meals on August 30. Request that Scientists will be allowed to stay onboard RHB the night of arrival in Barbados.

De-staging will occur at Charleston, SC.

Charleston de-staging
AOML: all
NCAS: all

PMEL: all
RSMAS: all
NESDIS: all
NMFS: all

C. Operations to be Conducted

RHB will steam from Bermuda to the test cast near 30ºN, 60ºW. RHB will proceed to the hydrophone mooring at 20ºN, 39°W and then to the Atlas and TFlex moorings near 20°N, 38°W (all three moorings will be recovered and redeployed). RHB will continue to the Atlas mooring at 20.5ºN, 23°W for another recovery/deployment, and begin CTD stations to the equator, 23°W. Along the way the Atlas moorings at 11.5ºN , 23°Wand 4ºN, 23°W and a hydrophone mooring at 5ºN , 23°W will be recovered and redeployed. After a fly-by at equatorial Atlas mooring at 23°W RHB will then head west for the last hydrophone mooring deployment at 7ºN, 42ºW and then to Barbados (on this transect a detour around the EEZ of Brazil is necessary). XBT drops, tests of an underway CTD, drifter deployments and Argo float deployments will be performed along the cruise track.

Approximate Station Locations are listed in Appendix H. These are subject to small changes.

The ship shall continuously collect ADCP, meteorological, thermosalinograph (TSG), and bathymetric (SeaBeam) data while underway. The ship shall also collect heading information from both the gyro compass and GPS system for comparison and testing.

Small boat operations will be required during the servicing of the ATLAS moorings at 4°N, 23°W; 11.5°N, 23°W; 20.5°N, 23°W and 20°N, 38°W and the hydrophone moorings at 20ºN, 39°W, 5ºN , 23°W, 7ºN, 42ºW If the Atlas mooring at the equator, 23W requires repairs and the time to do them is available, then small boat operations will be required at that location. Small boat operations will be conducted at the discretion of the Commanding Officer.

SeaBeam EM122 monitoring at the recovery/redeployment sites is requested for the Atlas, hydrophone and TFlex mooring sites. The Chief Scientist will provide areas and coverage parameters for the surveys relative to time available as the cruise progresses. The Chief Survey Technician will generate contoured plots of the mooring site survey. No systematic survey (typical full surveys cover 5 nm x 5 nm around the sites) is necessary since previous year's surveys should be sufficient for mooring ops for most mooring sites. Therefore we just need to record SeaBeam EM122 while operating in the area of these moorings. The only exception could be the hydrophone mooring at 7ºN, 42ºW.

Data to be collected and operations

1. Recovery and redeployment of ATLAS moorings along 23°W at 4°N, 11.5°N and 20.5°N, 23°W and 20°N, 38°W. Recovery and redeployment of one TFlex mooring at 20°N 38°W.
2. Repair Atlas mooring at equator, 23W if necessary and time allows.
3. Hydrophone recovery and redeployment at 20°N 39°W, 5°N 23°W. Hydrophone deployment at 7°N 42°W.
4. CTD profiles along 23°W and at the Atlas mooring locations. CTD casts will include the CTD unit and a Rosette sampler with 12 bottles. The 48 station locations to 1500 m. The cast rate is about 60m/min, or shallower in the vicinity of Cape Verde are listed in Appendix H. We will require a package tracking system and display for the CTD operations (Knudsen/Bathy2000).
5. Salinity of the water samples collected with the bottles on the CTD rosette.
6. Underway CTD will be tested throughout the cruise. No adjustment of the cruising speed is required.

7. Dissolved oxygen concentration in the water samples collected with the bottles.
8. Continuous recording of ship mounted ADCP data.
9. Heading data from both the gyro compass system and the GPS system for comparison of heading quality for the gyro compass system.
10. Continuous recording of Thermosalinograph (TSG).
11. Continuous recording of SeaBeam EM122 bathymetry requested (with help from ship science technician)
12. Lidar wind observations (UM)
13. Lidar aerosol and wind observations (NCAS)
14. Sun photometers
15. Tropospheric profiles of pressure, temperature, humidity and wind from launching of 126Vaisala RS92 radiosondes during Suomi NPP CrIMSS, MetOp IASI and Aqua AIRS overpasses. They will be launched with small (200 g) balloons at locations along the trackline specified by the Chief Scientist.
16. Ozone profiles from launching of 20 ozonesondes during MetOp and Aqua overpasses. Theywill be launched with large (1200 g) balloons at locations along the trackline specified by the Chief Scientist.
17. Laser particle counters
18. Ceilometer (ESRL)
19. Launching of up to 200 XBTs
20. Deployment of 8 Argo floats along the trackline specified by the Chief Scientist. No slow-down or stop is required.
21. Deployment of 15 surface driftersalong the trackline specified by the Chief Scientist. No slow-down or stop is required.
22. Marine Atmospheric Emitted Radiance Interferometer (M-AERI) (an infrared Fourier transform spectrometer (FTS)) to measure uplooking and downlooking spectral radiances, marine boundary layer profiles of temperature and water vapor, and skin SST (UM)
23. Broadband pyranometers and pyrgeometers to measure downwelling solar (visible) and terrestrial (infrared) radiation
24. Trace gas measurements
25. Aerobiological sampling
26. Sequential high-volume aerosol sampler (Partisol)
27. Low-volume bulk sampler (for fungi and chemical analysis)

D. Dive Plan

N/A

E. Applicable Restrictions

Conditions which preclude normal operations: (list restrictions such as poor weather conditions, equipment failure, safety concerns, unforeseen circumstances, as well as mitigation strategies that might be used).

III. Equipment

A. Equipment and Capabilities Provided by the Ship

The following communications devices are currently on board *Ronald H. Brown*.

1. Hull-mounted transducer for release deckset use

2. A VSAT for 24/7 Internet capabilities. There will no longer be a charge for e-mail. All scientists will be provided an email address from the ship, but will not have to pay for large messages, etc. A usage policy is being crafted by the ship and will be posted on the RHB web site once complete.

Scientific Equipment requested from the Ship

1. Echo Sounder (Ocean Data Equipment Corporation (ODEC) Bathy 2000 or the Knudsen system) used in 12 kHz mode (to track CTD package to within 10 meters of the bottom) to be used while on CTD station.
2. Continuous SeaBeam EM12 (12 kHz) swath bathymetric sonar system sampling while underway between stations.
3. Barometer
4. WOCE IMET sensors
5. Hydrographic Winch system and readouts (using 322 conducting cable for CTD operations).
6. Hull mounted acoustic Doppler current profiler (RD Instruments (RDI), 75 kHz Ocean Surveyor acoustic Doppler current profiler) with gyro compass input.
7. gyro compass system for acquisition of heading data used by acoustic Doppler current profiler.
8. GPS system for acquisition of heading data.
9. Winch and A-frame for ATLAS deployment and recovery.
10. Two Guildline 8400B Autosals for processing salinity bottle samples. Also need a temperature controlled room stable to within one degree C.
11. CTD package as backup for the package provided by the science party

The above listed scientific equipment provided by the ship is all critical for meeting the objectives of this cruise. However, the hull-mounted transducer, SeaBeam, IMET, sADCP and TSG are particularly important for satisfying the objectives of this cruise.

B. Equipment and Capabilities Provided by the Scientists

In addition to the suite of oceanographic and meteorological instruments on board *Ronald H. Brown*, the science party will bring the following instruments and materials on board (see Appendix B for full specifications):

AOML equipment

1. Salinity sample bottles and standard seawater.
2. One automated oxygen titration system to measure the dissolved oxygen concentration in the water samples.
3. Several computers for data acquisition and initial processing.
4. One PC/Laptop running Windows NT or 2000 for SCS feed into wet lab.
5. XBT (9 boxes of 12 deep blue): often stored in the lab forward of the staging bay.
6. CTD/LADCP
7. Most of the above will be in up to 8 D containers, size 48x40x39"
8. up to 15 Satellite tracked drifting buoys: often in forward science storage
9. up to 10 Argo profiling floats: often stacked in main lab or staging bay
10. Underway CTD (about 400 lbs), the estimated weights for the individual boxes are as follows:
    a) UCTD Main Winch: 96 LBS. 32x21x16"
    b) UCTD Rewinder: 39 LBS. 41x17x7"
    c) UCTD Power Supply: 44 LBS. 27x21x11"
    d) UCTD Davit: 50 LBS. 49x17x7"
    e) UCTD Probes (2): 50 LBS. 25x20x12"
    f) UCTD Dummy Probe and Bumper: 40 LBS. 25x20x9

NCAS equipment

1. Microtops sun photometers
2. EN-SCI ECC ozone sondes
3. QCM Cascade Impactors and control units
4. Climet laser particle counter
5. Partisol sequential aerosol sampler
6. Staplex cyclone impactor
7. Respicon 3-stage impactors
8. Single-stage impactors
9. Ceilometer
10. MFRSR
11. Microwave radiometer
12. Broadband pyranometer
13. Pyrgeometer
14. TSI SMPS
15. Thermo Ozone monitor
16. Thermo Carbon Monoxide monitor
17. Thermo Sulfur Dioxide monitor
18. Thermo VOC monitor
19. Thermo NOx monitor
20. Assorted pumps

1. Gas cylinders for balloon launches

NOAA/NESDIS equipment:

1. Vaisala RS92 rawinsondes
2. 200 g balloons

RSMAS/UM equipment:

see Appendix C

NOAA/ESRL equipment:

see Appendix D

PMEL equipment (see Appendix E)

1. three ATLAS buoy/tower/bridle sets (two will be turned around at sea)
2. 4 4480 lb anchors
3. 2 5980 lb anchors
4. 6 spools Nilspin wire
5. 7 tube boxes with meteorological instruments
6. 8 temperature module boxes
7. 2 electronics boxes (laptops, telonics, etc.)
8. 1 hardware box
9. 2 toolboxes
10. 17 spools nylon
11. 3 boxes of current meters
12. 6 boxes of acoustic releases and two deck sets
13. 3 boxes of hydrophones
14. 1 box with acoustic release turnaround kits
15. 3 800 lb anchor
16. 9 empty spools
17. 2 aluminum reel stands
18. 8 hydrophone spools with vectran or yalex

WACS equipment:
see Appendix F
NTAS equipment:
see Appendix G

IV. Hazardous Materials

A. Policy and Compliance

The Chief Scientist is responsible for complying with FEC 07 Hazardous Materials and Hazardous Waste Management Requirements for Visiting Scientific Parties (or the OMAO procedure that supersedes it). By Federal regulations and NOAA Marine and Aviation Operations policy, the ship may not sail without a complete inventory of all hazardous materials by name and the anticipated quantity brought aboard, MSDS and appropriate neutralizing agents, buffers, or absorbents in amounts adequate to address spills of a size equal to the amount of chemical brought aboard, and a chemical hygiene plan. Documentation regarding those requirements will be provided by the Chief of Operations, Marine Operations Center, upon request.

Per FEC 07, the scientific party will include with their project instructions and provide to the CO of the respective ship 60 to 90 days before departure:

- A list of hazardous materials by name and anticipated quantity
- A list of neutralizing agents, buffers, and/or absorbents required for these hazardous materials, if they are spilled
- A chemical hygiene plan.

A chemical hygiene plan is a written document establishing procedures, equipment, personal protective equipment and work practices to protect employees from the health hazards from chemicals used in that particular workplace. This document is usually managed by the laboratory or science center personnel. On most projects, the program doesn't bring the entire hygiene plan, just the relevant portions about PPE; spills, etc for underway operations. For reference: http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=10106

Upon embarkation and prior to loading hazardous materials aboard the vessel, the scientific party will provide to the CO or their designee:

- An inventory list showing actual amount of hazardous material brought aboard
- An MSDS for each material
- Confirmation that neutralizing agents and spill equipment were brought aboard

Upon departure from the ship, scientific parties will provide the CO or their designee an inventory of hazardous material indicating all materials have been used or removed from the vessel. The CO's designee will maintain a log to track scientific party hazardous materials. MSDS will be made available to the ship's complement, in compliance with Hazard Communication Laws.

Scientific parties are expected to manage and respond to spills of scientific hazardous materials. Overboard discharge of scientific chemicals is not permitted during projects aboard NOAA ships.

B. Radioactive Isotopes

N/A.

C. Inventory

see appendix A
The required MSDS for all chemicals loaded before to the start of PNE will be provided by the chief scientists of the prior cruises.
Additional MSDS will be provided by the Chief Scientist of this cruise if necessary.

V. Additional Projects

A. Supplementary ("Piggyback") Projects
B. NOAA Fleet Ancillary Projects

Any additional work will be subordinate to the primary project and will be accomplished only with the concurrence of the Commanding Officer and the Chief Scientist.

The following projects will be conducted by ship's personnel in accordance with the general instructions contained in the MOC Directives, and conducted on a not-to-interfere basis with the primary project:

a. SEAS Data Collection and Transmission
b. Marine Mammal Reporting
c. Bathymetric Trackline
d. Weather Forecast Monitoring
e. Sea Turtle Observations
f. Automated Sounding Aerological Program

The underway sensors on RHB will be used in support of the objectives of the Global Carbon Cycle Research (GCC) to quantify the uptake of carbon by the world's ocean and to understand the bio-geochemical mechanisms responsible for variations of partial pressure of CO_2 in surface water (pCO_2). This work is a collaborative effort between the CO_2 groups at AOML and PMEL.

Principal investigators:

Dr Rik Wanninkhof, AOML 305-361-4379	wanninkhof@aoml.noaa.gov
Dr Richard Feely, PMEL 206-526-6214	feely@pmel.noaa.gov

The semi-automated instruments are installed on a permanent basis in the hydrolab of RHB. All work is performed on a not-to-interfere basis and does not introduce any added ship logistic requirements other than the continuous operation of the bow water pump and thermosalinograph. The chief scientist assumes responsibility of the hazardous materials aboard RHB for this project. A list of the HAZMAT associated with this project is provided in Appendix A.

VI. Disposition of Data and Reports

A. Data Responsibilities

The Chief Scientist will be responsible for the disposition, feedback on data quality, and archiving of data and specimens collected on board the ship for the primary project. As representative of the program manager (Director, AOML), the Chief Scientist will also be responsible for the dissemination of copies of these data to participants in the cruise, to any other requesters, and to NESDIS in accordance with NDM 16-11 (ROSCOP within 3 months of cruise completion). The ship may assist in copying data and reports insofar as facilities allow.

The Chief Scientist will receive all original data gathered by the ship for the primary project, and this data transfer will be documented on NOAA Form 61-29 "Letter Transmitting Data". The Chief Scientist in turn will furnish the ship a complete inventory listing all data gathered by the scientific party detailing types and quantities of data.

Individuals in charge of piggyback projects conducted during the cruise have the same responsibilities for their project's data as the Chief Scientist has for primary project data. All requests for data should be made through the Chief Scientist.

The Commanding Officer is responsible for all data collected for ancillary projects until those data have been transferred to the project's principal investigators or their designees. Data transfers will be documented on NOAA Form 61-29. Copies of ancillary project data will be provided to the Chief Scientist when requested. Reporting and sending copies of ancillary project data to NESDIS (ROSCOP) is the responsibility of the program office sponsoring those projects.

DATA REQUIREMENTS

The ship's SCS system should log the following parameters:

- Gyro compass (Degrees)
- GPS positions from Northstar 941 and Furuno GP-90 systems
- TSG_Unit_Temp (Degrees_C)
- TSG_Conductivity (Mega_Mhos)
- TSG_Salinity (PPT)
- Barometer (MB)
- Precip9-trwlhs (mm/hr)
- Imet-Rain (mm)
- Imet-Rel_Hum (Percent)
- Imet-Temp (Degrees_C)
- Fluoro-Value (PPM)
- Imet-TWind1-Speed-MSEC (M/SEC)
- Imet-Twind1-Dir (Degrees)
- Imet-Rwind2-Spd-Knts (Knots)
- Imet-TWind2-Speed-KNTS (Knots)
- Imet-TWind2-Dir (Degrees)
- Bottom Depth (meters)

The Chief Survey Technician (CST) will provide an event file logging all of the above variables as two-minute averages. The CST will also provide an additional event file with the parameters needed for LADCP and SADCP processing as will be requested at the time of sailing.

The Chief Survey Technician (CST) will translate the data from thermosalinograph to ASCII and plot the data on a daily basis.

The ship shall record ADCP raw data continuously during the cruise.

The following data products will be produced by the ship and, if requested, will be given to the Chief Scientist at the end of each leg:

a. navigational log sheets (MOAs);
b. salinity determinations;
c. calibration data for Autosals;
d. copy of SEAS data diskettes;
e. CDs of Sea Beam EM122 and navigational data, including location and depths of acoustic profile locations;
f. SCS tapes;
g. ADCP raw data on CD
h. CD of two event files: summary data above, and LADCP-SADCP event files

B. Pre and Post Cruise Meeting

A pre-cruise meeting between the Commanding Officer and the Chief Scientist will be conducted either the day before or the day of departure, with the express purpose of identifying day-to-day project requirements, in order to best use shipboard resources and identify overtime needs. A brief post-cruise meeting will be held when convenient.

If need be, upon completion of the cruise, a post-cruise meeting will be held and attended by the ship's officers, the Chief Scientist and members of the scientific party, the Vessel Coordinator and the Port Captain to review the cruise. Concerns regarding safety, efficiency, and suggestions for improvements for future cruises should be discussed. Minutes of the post-cruise meeting will be distributed to all participants with email to the CO.MOC.Atlantic@noaa.gov and ChiefOps.MOA@noaa.gov .

C. Ship Operation Evaluation Report

Within seven days of the completion of the cruise, a Ship Operation Evaluation form is to be completed by the Chief Scientist. The preferred method of transmittal of this form is via email to OMAO.Customer.Satisfation@noaa.gov . If email is not an option, a hard copy may be forwarded to:

Director, NOAA Marine and Aviation Operations
NOAA Office of Marine and Aviation Operations
8403 Colesville Road, Suite 500
Silver Spring, MD 20910

VII. Miscellaneous

A. Meals and Berthing

Meals and berthing are required for up to 26 scientists. Meals will be served 3 times daily beginning one hour before scheduled departure, extending throughout the cruise, and ending two hours after the termination of the cruise. Since the watch schedule is split between day and night, the night watch may often miss daytime meals and will require adequate food and beverages (for example a variety of sandwich items, cheeses, fruit, milk, juices) during what are not typically meal hours. Special dietary requirements for scientific participants will be made available to the ship's command at least seven days prior to the survey (e.g., Chief Scientist is allergic to fin fish).

Berthing requirements, including number and gender of the scientific party, will be provided to the ship by the Chief Scientist. The Chief Scientist and Commanding Officer will work together on a detailed berthing plan to accommodate the gender mix of the scientific party taking into consideration the current make-up of the ship's complement. The Chief Scientist is responsible for ensuring the scientific berthing spaces are left in the condition in which they were received; for stripping bedding and linen return; and for the return of any room keys which were issued. The Chief Scientist is also responsible for the cleanliness of the laboratory spaces and the storage areas utilized by the scientific party, both during the cruise and at its conclusion prior to departing the ship.

All NOAA scientists will have proper travel orders when assigned to any NOAA ship. The Chief Scientist will ensure that all non NOAA or non Federal scientists aboard also have proper orders. It is the responsibility of the Chief Scientist to ensure that the entire scientific party has a mechanism in place to provide lodging and food and to be reimbursed for these costs in the event that the ship becomes uninhabitable and/or the galley is closed during any part of the scheduled project.

All persons boarding NOAA vessels give implied consent to comply with all safety and security policies and regulations which are administered by the Commanding Officer. All spaces and equipment on the vessel are subject to inspection or search at any time. All personnel must comply with OMAO's Drug and Alcohol Policy dated May 7, 1999 which forbids the possession and/or use of illegal drugs and alcohol aboard NOAA Vessels.

B. Medical Forms and Emergency Contacts

The NOAA Health Services Questionnaire (NHSQ, Revised: 02 JAN 2012) must be completed in advance by each participating scientist. The NHSQ can be obtained from the Chief Scientist or the NOAA website at http://www.corporateservices.noaa.gov/~noaaforms/eforms/nf57-10-01.pdf. The completed form should be sent to the Regional Director of Health Services at Marine Operations Center . The participant can mail, fax, or scan the form into an email using the contact information below. The NHSQ should reach the Health Services Office no later than 4 weeks prior to the cruise to allow time for the participant to obtain and submit additional information that health services might require before clearance to sail can be granted. Please contact MOC Health Services with any questions regarding eligibility or completion of the NHSQ. Be sure to include proof of tuberculosis (TB) testing, sign and date the form, and indicate the ship or ships the participant will be sailing on. The participant will receive an email notice when medically cleared to sail if a legible email address is provided on the NHSQ.

Contact information:

Regional Director of Health Services
Marine Operations Center – Atlantic
439 W. York Street
Norfolk, VA 23510

Telephone 757.441.6320
Fax 757.441.3760
E-mail MOA.Health.Services@noaa.gov

Prior to departure, the Chief Scientist must provide a listing of emergency contacts to the Executive Officer for all members of the scientific party, with the following information: name, address, relationship to member, and telephone number.

C. Shipboard Safety

Wearing open-toed footwear or shoes that do not completely enclose the foot (such as sandals or clogs) outside of private berthing areas is not permitted. Steel-toed shoes are required to participate in any work dealing with suspended loads, including CTD deployments and recovery. The ship does not provide steel-toed boots. Hard hats are also required when working with suspended loads. Work vests are required when working near open railings and during small boat launch and recovery operations. Hard hats and work vests will be provided by the ship when required.

D. Communications

A progress report on operations prepared by the Chief Scientist may be relayed to the program office. Sometimes it is necessary for the Chief Scientist to communicate with another vessel, aircraft, or shore facility. Through various modes of communication, the ship is able to maintain contact with the Marine Operations Center on an as needed basis. These methods will be made available to the Chief Scientist upon request, in order to conduct official business. The ship's primary means of communication with the Marine Operations Center is via e-mail and the Very Small Aperture Terminal (VSAT) link. Standard VSAT bandwidth at 128kbs is shared by all vessels staff and the science team at no charge. Increased bandwidth in 30 day increments is available on the VSAT systems at increased cost to the scientific party. If increased bandwidth is being considered, program accounting is required it must be arranged at least 30 days in advance.

Program contacts

Claude (Rick) Lumpkin	Rick.Lumpkin@noaa.gov	305-361-4513
Claudia Schmid	Claudia.Schmid@noaa.gov	305-361-4313

E-mail addresses:

MOP radio room:	Radio.Room@noaa.gov
Commanding Officer, RHB	CO.Ronald.Brown@noaa.gov
Executive Officer, RHB	XO.Ronald.Brown@noaa.gov
Field Operations Officer, RHB	OPS.Ronald.Brown@noaa.gov
Medical Officer, RHB	Medical.Ronald.Brown@noaa.gov

E. IT Security

Any computer that will be hooked into the ship's network must comply with the *NMAO Fleet IT Security Policy* prior to establishing a direct connection to the NOAA WAN. Requirements include, but are not limited to:

(1) Installation of the latest virus definition (.DAT) file on all systems and performance of a virus scan on each system.

(2) Installation of the latest critical operating system security patches.
(3) No external public Internet Service Provider (ISP) connections.

Completion of these requirements prior to boarding the ship is required.

Non-NOAA personnel using the ship's computers or connecting their own computers to the ship's network must complete NOAA's IT Security Awareness Course within 3 days of embarking.

F. Foreign National Guests Access to OMAO Facilities and Platforms

All foreign national access to the vessel shall be in accordance with NAO 207-12 and RADM De Bow's March 16, 2006 memo (http://deemedexports.noaa.gov). National Marine Fisheries Service personnel will use the Foreign National Registration System (FRNS) to submit requests for access to NOAA facilities and ships. The Departmental Sponsor/NOAA (DSN) is responsible for obtaining clearances and export licenses and for providing escorts required by the NAO. DSNs should consult with their designated NMFS Deemed Exports point of contact to assist with the process.

The following are basic requirements. Full compliance with NAO 207-12 is required.

Responsibilities of the Chief Scientist:

2. Provide the Commanding Officer with the e-mail generated by the FRNS granting approval for the foreign national guest's visit. This e-mail will identify the guest's DSN and will serve as evidence that the requirements of NAO 207-12 have been complied with.
3. Escorts – The Chief Scientist is responsible to provide escorts to comply with NAO 207-12 Section 5.10, or as required by the vessel's DOC/OSY Regional Security Officer.
4. Ensure all non-foreign national members of the scientific party receive the briefing on Espionage Indicators (NAO 207-12 Appendix A) at least annually or as required by the servicing Regional Security Officer.
5. Export Control - *The NEFSC currently neither possesses nor utilizes technologies that are subject to Export Administration Regulations (EAR).*

The Commanding Officer and the Chief Scientist will work together to implement any access controls necessary to ensure no unlicensed export occurs of any controlled technology onboard regardless of ownership.

Responsibilities of the Commanding Officer:

7. Ensure only those foreign nationals with DOC/OSY clearance are granted access.
8. Deny access to OMAO platforms and facilities by foreign nationals from countries controlled for anti-terrorism (AT) reasons and individuals from Cuba or Iran without written NMAO approval and compliance with export and sanction regulations.
9. Ensure foreign national access is permitted only if unlicensed deemed export is not likely to occur.
10. Ensure receipt from the Chief Scientist or the DSN of the FRNS e-mail granting approval for the foreign national guest's visit.
11. Ensure Foreign Port Officials, e.g., Pilots, immigration officials, receive escorted access in accordance with maritime custom to facilitate the vessel's visit to foreign ports.
12. Export Control - 8 weeks in advance of the cruise, provide the Chief Scientist with a current inventory of OMAO controlled technology onboard the vessel and a copy of the vessel Technology Access Control Plan (TACP). Also notify the Chief Scientist of any OMAO-

sponsored foreign nationals that will be onboard while program equipment is aboard so that the Chief Scientist can take steps to prevent unlicensed export of Program controlled technology. The Commanding Officer and the Chief Scientist will work together to implement any access controls necessary to ensure no unlicensed export occurs of any controlled technology onboard regardless of ownership.

13. Ensure all OMAO personnel onboard receive the briefing on Espionage Indicators (NAO 207-12 Appendix A) at least annually or as required by the servicing Regional Security Officer.

Responsibilities of the Foreign National Sponsor:

A. Export Control - The foreign national's sponsor is responsible for obtaining any required export licenses and complying with any conditions of those licenses prior to the foreign national being provided access to the controlled technology onboard regardless of the technology's ownership.
B. The DSN of the foreign national shall assign an on-board Program individual, who will be responsible for the foreign national while on board. The identified individual must be a U.S. citizen, NOAA (or DOC) employee. According to DOC/OSY, this requirement cannot be altered.
C. Ensure completion and submission of Appendix C (Certification of Conditions and Responsibilities for a Foreign National Guest) as required by NAO 207-12 Section 5.03.h.

APPENDICES

Appendix A. List of Hazardous Materials

RSMAS

Person Responsible	chemical/compressed gas	quantity	unit	neutralizer
Malgorzata Szczodrak	Dilute Nitric Acid (5%)	1	0.5 liter	none
Malgorzata Szczodrak	Ethanol	1	0.5 liter	none
Malgorzata Szczodrak	Acetone	1	0.5 liter	none
Malgorzata Szczodrak	Nitrogen	1	cylinders	none

NCAS

Person Responsible	chemical/compressed gas	quantity	unit	neutralizer
Vernon Morris	Helium	30	cylinders	none
Vernon Morris	UHP Nitrogen	2	cylinders	none
Vernon Morris	Air	3	cylinders	none
Vernon Morris	Hydrogen	1	cylinder	none
Vernon Morris	ethanol	1	1-L	spill kit
Vernon Morris	toluene	1	1-L	spill kit
Vernon Morris	Sodium Phosphate	1	200-g	spill kit
Vernon Morris	Hydrogen peroxide	1	0.5-L	spill kit
Vernon Morris	Drierite	16 (1 case)	0.5-L bottles	spill kit
Vernon Morris	hexane	1	1-L	spill kit

OXYGEN

Person Responsible	chemical/compressed gas	quantity	unit	neutralizer
Grant Rawson	sodium iodide & alkaline Iodide		5 l	spill kit
Grant Rawson	Manganese Chloride		5 l	spill kit
Grant Rawson	Dilute H_2SO_4 (Sulfuric Acid)		5 l	spill kit
Grant Rawson	Sodium Thiosulfate		5 35g	spill kit
Grant Rawson	potassium iodate		5 l	spill kit

From WACS (contact person is Kristen Schulz, NOAA PMEL)

Common Name	Concentration	Amount	Neutralizer	Notes - van
Acetone		4 L	Dry lime, sand, soda ash	Alvan
Acetonitrile		16 L	Dry lime, sand, soda ash	Alvan
Ammonium Nitrate		500 g	Dry lime or soda	AeroChem

			ash	
Ammonium Sulfate		500 g	Sweep up	AeroChem
Ascarite (NaOH)		500 g	Sweep up	Alvan
Breathing air		2 tanks	none	AeroChem
Butanol		20L	Vermiculite or sand	Alvan
Calcium sulfate (drierite)		5 kg	Sweep up	Alvan
CH4	5% balance He	2 tanks	Evacuate	AeroChem
Charcoal		2 kg	Sweep up	Univ. VA
CO2		2 tanks	Evacuate	AeroPhys
Formaldehyde	10%	25 ml	Vermiculite or sand	Guest
Glycerol		500 ml	Vermiculite or sand	Alvan
Hexane		3 L	Vermiculite or sand	Alvan
Hydrochloric acid		1L	Sodium carbonate	Alvan
Hydrogen peroxide	10%	500 ml	Vermiculite or sand	Alvan
Isopropyl alcohol		1L	Vermiculite or sand	Seawater
Liquid N2			Evacuate	O2 deck
Liquinox		250 ml		Univ. VA
Lithium chloride		500 g	Sweep up	Alvan
Lithium fluoride		500 g	Vermiculite or sand	Alvan
Methanol		9L	Dry lime, sand, soda ash	Univ. VA, Alvan
N2		5 tanks	Evacuate	Guest
Nitric acid	2N	2 L	Vermiculite or sand	Alvan
O2	10% balance He	2 tanks	Evacuate	AeroChem
Phosphoric acid	80%	500 ml	Sodium carbonate	Alvan
Phosporus acid		100 g	Sodium carbonate	Alvan
Potassium hydrogen phthalate (KHP)		100 g	Sweep up	Seawater
Potassium nitrate		100 g	Vacuum	Seawater
Silica gel		1 kg	Sweep up	Alvan
Sodium bicarbonate		500 g	Sweep or vacuum	Alvan
Sodium carbonate		500 g	Sweep or vacuum	Alvan
Sodium chloride		500 g	Sweep or vacuum	AeroChem

Sodium hydroxide	20% w/w	250 ml	Acetic, hydrochloric, or sulfuric acids	Seawater
Sucrose		500 g	Sweep up	AeroChem
Sulfuric Acid	18M	2L	Soda ash or lime	Alvan
Trichloroacetic acid		250 ml	Sodium carbonate	Guest
UHP H2		2 tanks	Evacuate	AeroChem
UHP He		2 tanks	Evacuate	AeroChem

Appendix B. Equipment/Van List
1) AOML

in D containers: up to 8, size - 48x40x39"

CTD
CTD sensors
LADCP
altimeter
Oxygen equipment (sample bottles, analysis system, reagents)
Salinity equipment (sample bottles and standard water, autosal interface)

Underway CTD: The system will arrive on a single pallet (48x42x30") at approximately 400LBS.

The estimated weights for the individual boxes are as follows:

UCTD Main Winch: 96 LBS. 32x21x16"

UCTD Rewinder: 39 LBS. 41x17x7"

UCTD Power Supply: 44 LBS. 27x21x11"

UCTD Davit: 50 LBS. 49x17x7"

UCTD Probes (2): 50 LBS. 25x20x12"

UCTD Dummy Probe and Bumper: 40 LBS. 25x20x9

Argo floats (up to 10): often stacked in main lab or staging bay

Total weight: 90 lbs each = 540 lbs total
Size: each box (one float) 18”*18”*96”

surface drifters (up to 15): often in forward science storage

Total weight: about 560 lbs
Size: 1 pallet 48” by 40” by 90”
Note: drifters can be removed from boxes for individual storage

XBT (9 boxes of 12 deep blue): often stored in the lab forward of the staging bay.

2) ATLAS MOORINGS (NOAA/PMEL)
WT: approx 22 tons

see Appendix E for details

3) HYDROPHONE MOORINGS (NOAA/PMEL)

Total weight approx 2.5 tons
3 hydrophones 72” x 16” x 15” – 525 lbs
1 box with acoustic release kits 24”x20”x30” – 110 lbs
3 – 800lb anchors – 2400 lbs
8- spools of yalex or vectran to make 2 hydrophone moorings – 2000 lbs

4) NCAS He cylinders: racks for 30 cylinders

NCAS Van 01 deck
NCAS radiometers – mounted atop NCAS van
NCAS Partisol sequential sampler – 02 deck railing
NCAS bio-samplers 02 deck railing
NCAS Helium gas cylinders behind winch 02 deck
NCAS Microwave radiometer 01 starboard railing

5) NESDIS/NCAS sonde launches

sonde launches from fantail and hangar

6) NCAS general laboratory requirements -

Site: Main Laboratory: 24-30 feet of contiguous lab space (tables), storage cabinets, and benchtop – roughly 5-6 tables and seating for 9-10 persons
Bio-Lab: 6-ft of benchtop space and storage
Hazmat locker: Modest chemical stores

7) UM/RSMAS equipment

The RSMAS equipment is described in detail in Appendix C

8) WACS equipment:

see Appendix F

9) NTAS equipment:

see Appendix G

Appendix C: UM/RSMAS Sea-going Equipment (PNE 2012)

Point of Contact:

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As in previous PNE cruises, the equipment to be installed by RSMAS will operate in a continuous mode without interfering with other activities on the ship, No station-time is required, and no modifications to the cruise track or station plan are required.

The equipment is listed in Table 1 and suggested installation in Table 2. The locations are a compromise between the measurements being made with a minimum of influence from the ship, cable lengths, and access for maintenance. The M-AERI cable length is such that the external unit can be mounted to give a clear view of the sea ahead of the bow-wave, and have the electronic rack in the Main Lab. The rack has to be close (within 10ft) of the main aft doors of the Lab. Other computers, electronics components and printer require about 12 linear feet of bench space and it would be more convenient for this bench space to be allocated close to the M-AERI electronics rack. Other than the M-AERI and hard hat float, the instruments can be mounted on railings on the O2 or O3 deck, a choice that will be made dependent on the layout of other senor sans vans, with the objective of obtaining as clear a view of the sky as possible while still permitting access during the cruise.

Access to the instruments is required for:

14. M-AERI: covering the instrument for heavy rain of sea-spray
15. All-sky camera: cleaning the mirror and lens
16. Weather station: cleaning radiometer domes
17. Hard-hat float: deployment and recovery

Table 1. Measured and derived variables and sensors.

Variable	Ship-based Sensor
Skin sea-surface temperature	M-AERI
Bulk sea-surface temperature	Surface-following float
Infrared spectra of surface emitted radiation	M-AERI
Infrared spectra of atmosphere emitted radiation	M-AERI
Cloud type and cover	All-sky camera
Insolation (SW↓)	Gimbaled Eppley pyrometer
Incident thermal radiation (LW↓)	Gimbaled Eppley pyrgeometer
Columnar water vapor	Microwave radiometer
Air Temperature	Thermistor*
Relative humidity*	Vaisala “Humicap” *
Wind speed*	R. M. Young anemometer*
Wind direction*	R. M. Young anemometer*
Barometric pressure*	Digital barometer*
**Part of Coastal Environmental System’s “Weatherpak”*	

Table 2 Summary of instruments, preferred location and power requirements.

Instrument	*Preferred Location*	*Power*
Marine-Atmospheric Emitted Radiance Interferometer	Starboard side railing. Deck O2 ahead of the Bridge	120 V A/C, 2 kW maximum, 800W normal.
Weather station	Forward railing above Deck O2 or O3	120 V A/C, 1 W
Surface temperature float	Deployed by hand from the foredeck, computer in Main Lab	120 V A/C, 20 W
All-sky camera	Starboard side railing. Deck O2 ahead of the Bridge	120 V A/C, 15 W
Microwave radiometer	Starboard side railing. Deck O2 ahead of the Bridge	120 V A/C, 1 kW max

A – The M-AERI

Our main piece of equipment is the M-AERI, which sits on a table that mounts on the railing where it can view the surface of the sea ahead of the bow wave, at an angle of about 55º to the vertical. On the Ronald H Brown, this is on the O2 deck (Figure 1a). The M-AERI electronics rack is usually installed in the Main Lab. The cable connecting the M-AERI to the electronics rack is a thick 'umbilical' bundle (about 5 cm diameter). We provide all of the mounting structure for the MAERI, so there are no special requirements from the ship for this, only that the area where we install it be available. In order to get the MAERI components to the appropriate deck we require a crane – the weight is 280kg. Power for the M-AERI is provided via cables to the interior lab. We provide an isolation transformer as well as a UPS unit. Power requirements are maximum ~2 KW.

Figure 1a. M-AERI mounted on starboard side railing on the O2 deck of the *Ronald H Brown*. The instrument is covered by a tarpaulin, which is the case when there is heavy rain or sea-spray. Measurements are not taken while covered.

Figure 1b shows the interior equipment in the Met Lab on the USCGC *Polar Star* (keyboard, flat-panel display, laptop computers and video monitors) on the far bench in the lab. (A printer was mounted on another shelf off the photograph.)

B- Meteorology and incident radiation

We set up a Met package on the forward railing of the O2 deck or above the bridge. Parameters measured are wind speed and direction, air temperature and humidity, surface air pressure and incident long and short wave radiation (Eppley radiometers mounted on gimbals with pendulums (Figure 2). Power is provided via cables to the Lab. Power requirements are 120 V A/C, 0.2 amps.

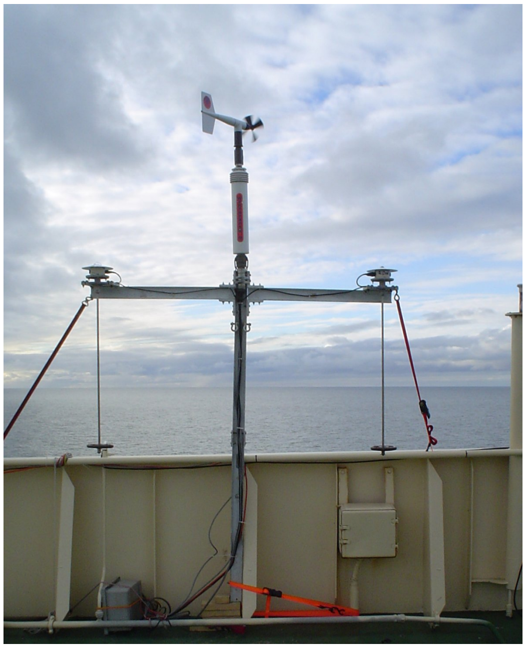


Figure 2. Weather station mounted above the bridge of the I/B *Kapitan Dranitsyn.*

C - All-sky camera

We mount a sky camera system where as unobstructed as possible view of the dome of the sky is available such as on the bridge top (Figure 3). All of the mounting structure is provided by us, there are no additional requirements from the ship. Power is supplied from to the Lab where the images are acquired by a laptop computer 120 V A/C, 50 watts.

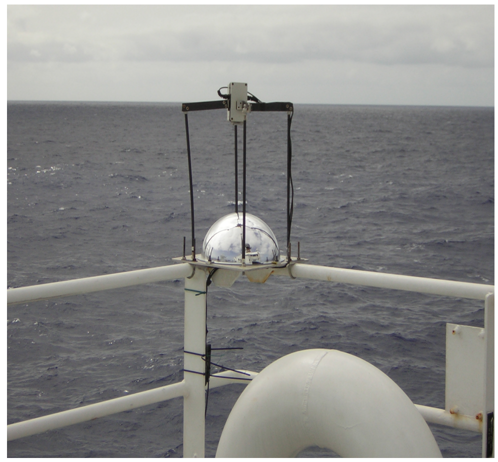


Figure 3. Sky camera setup on the bridge top of the RHB during the AMMA 2006 cruise.

D - Microwave radiometer

We set up a Microwave Radiometer where it has a clear view from zenith to the horizon. It measures atmospheric precipitable water, and cloud liquid water content, (Figure 4). The instrument mounts conveniently on the stand shown in the photo, but can be adapted to mount without the stand if there is a more suitable location. Power for this instrument is provided via cables into the Lab. Power requirements for the radiometer are 120 V A/C, 1 amp. The instrument also has an air blower fan which requires 120 V A/C, 1000 watts, 4 amps. B- Meteorology and incident radiation

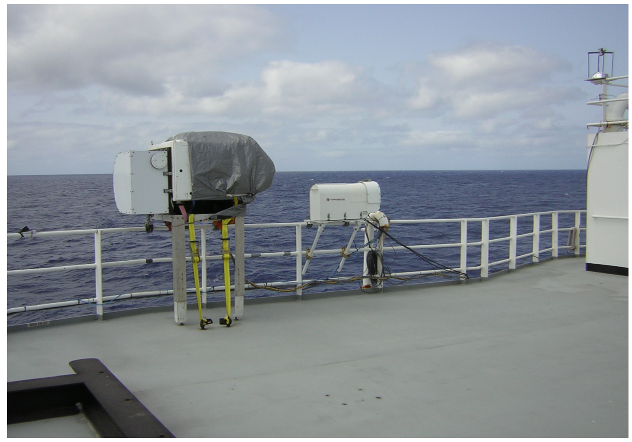
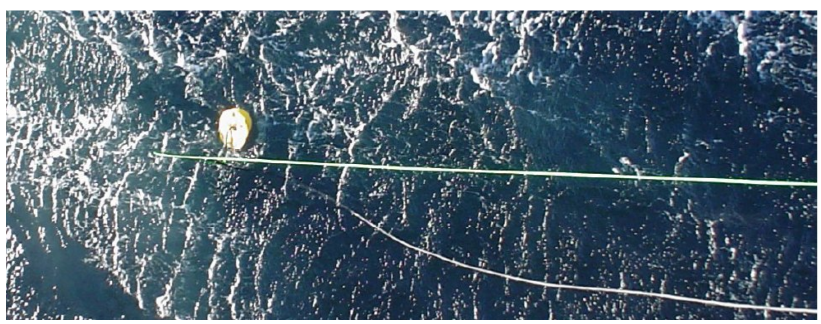


Figure 4. Microwave radiometer next to the M-AERI on the RHB during the AMMA 2006 cruise

E – Near surface bulk temperature.

The near surface bulk sea temperature is measured by a precision thermistor mounted in a small surface-following float constructed from a "hard hat" (Figure 5). This is deployed by hand when the ship is on station, drifting or making way at less than a few knots (dependent on sea state). The thermometer is at a nominal depth of 5cm and is sampled every second, and 20-s averages are logged by a laptop computer.

Figure 5. The Hard–Hat float of the port bow of the R/V *Tangaroa*, when seen from above.



Laboratory Requirements:

Site: Main laboratory; 6-foot contiguous bench space, storage space, 1 seat

Pressurized gas

One cylinder of compressed nitrogen to be properly secured to the railing close to the M-AERI (see Figure 1a).

Appendix D: NOAA/ESRL Equipment (PNE/AEROSE 2010)

Earth Systems Research Laboratory

Physical Science Division

Weather and Climate Physics Branch

Daniel E. Wolfe, Chris Fairall, Sergio Pezoa, and Ludovic Bariteau

NOAA Earth System Research Laboratory

Boulder, CO USA

Background on Measurement Systems

The Physical Science Division (PSD) air-sea flux and cloud group conducts measurements of fluxes and near-surface bulk meteorology during field programs on *Ronald H. Brown* (RHB) .

The air-sea flux system consists of six components:

(1) A fast turbulence system with ship motion corrections mounted on the jackstaff. The jackstaff sensors are: GILL Sonic anemometer, Fast Ozone Sensor's inlet, LiCor LI-7500 fast CO_2/hygrometer, and a Systron-Donner motion-pak.

(2) A mean T/RH sensor in an aspirator on the jackstaff.

(3) Solar and IR radiometers (Eppley pyranometers and pyrgeometers) mounted on the railing on the 03 deck starboard side.

(4) A near surface sea surface temperature sensor consisting of a floating thermistor deployed off port side with outrigger (Sea Snake).

(5) A Riegl laser rangefinder wave gauge mounted on the jackstaff.

(6) An optical rain gauge mounted on the jackstaff. Slow mean data (T/RH, PIR/PSP, etc) are digitized on a Campbell 23x datalogger and transmitted via a combination of RS-232 and wireless as 1-minute averages. A central data acquisition computer logs all sources of data via RS-232 digital transmission:

PSD/Flux also operates two remote systems:

1. Vaisala CL31 cloud base ceilometer
2. Tera Scan Satellite receiver (Sea Space)

The ceilometer is a vertically pointing lidar that determines the height of cloud bottoms from time-of-flight of the backscatter return from the cloud. The time resolution is 30 seconds and the vertical resolution is 15 m.

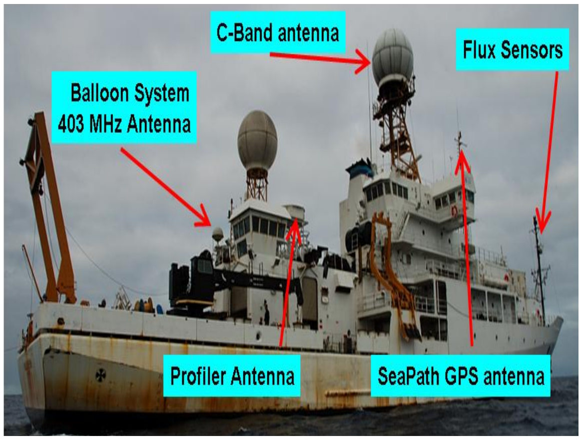
A Tera Scan (SeaSpace) satellite receiver collects High Resolution Picture Transmission (HRPT) data from NOAA's polar orbiting satellites (12, 14, 15, 17, 18). This system is permanently mounted on the RHB and is available on all cruises to visiting scientists or for ship operations.

PSD is also the mentor for the weather balloon operations on board RHB. A Vaisala MW31 system is maintained by PSD and available to visiting scientists upon request. Expendables (balloons, radiosondes, helium, etc) are the responsibility of the person(s) requesting use of this system. This system can handle RS92 digital GPS radiosondes and ozondesondes.

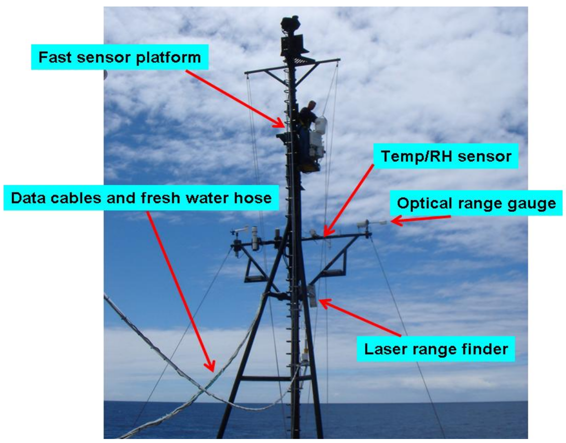
Instrumentation Set-up

The primary flux sensors are already mounted on the forward jackstaff. Data cables run from the mast into the main lab. Three data loggers are mounted on the forward starboard side of the main lab. From these data-loggers cables are run into the Science Office forward of the main computer room. Two computers are setup in this lab and connected to the ship's internet. Power to the instruments is supplied by the AC connections at the bottom of the jackstaff. A water hose is run from the O2 deck fresh water connection to the top of the jackstaff for rinsing the LiCor sensor window. The sea surface temperature sensor (sea snake) is attached to a mounting arm located port-side O1 Deck.

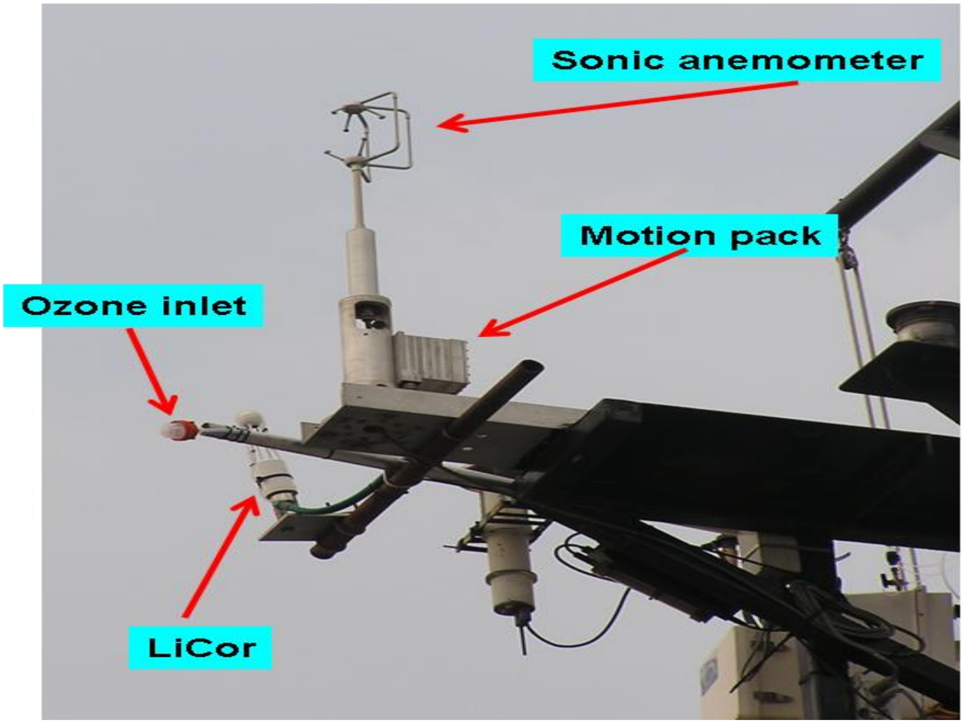
The balloon sounding system stored in Boulder is already deployed on the ship and has been tested.



Stratus 2006



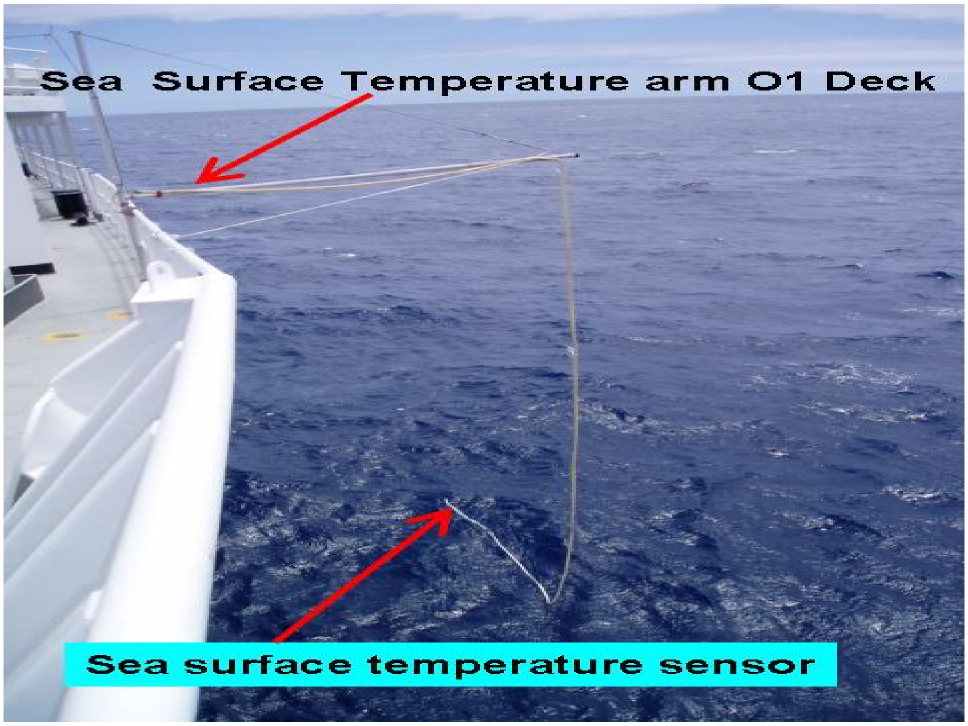
Forward Jack staff with PSD Flux sensors



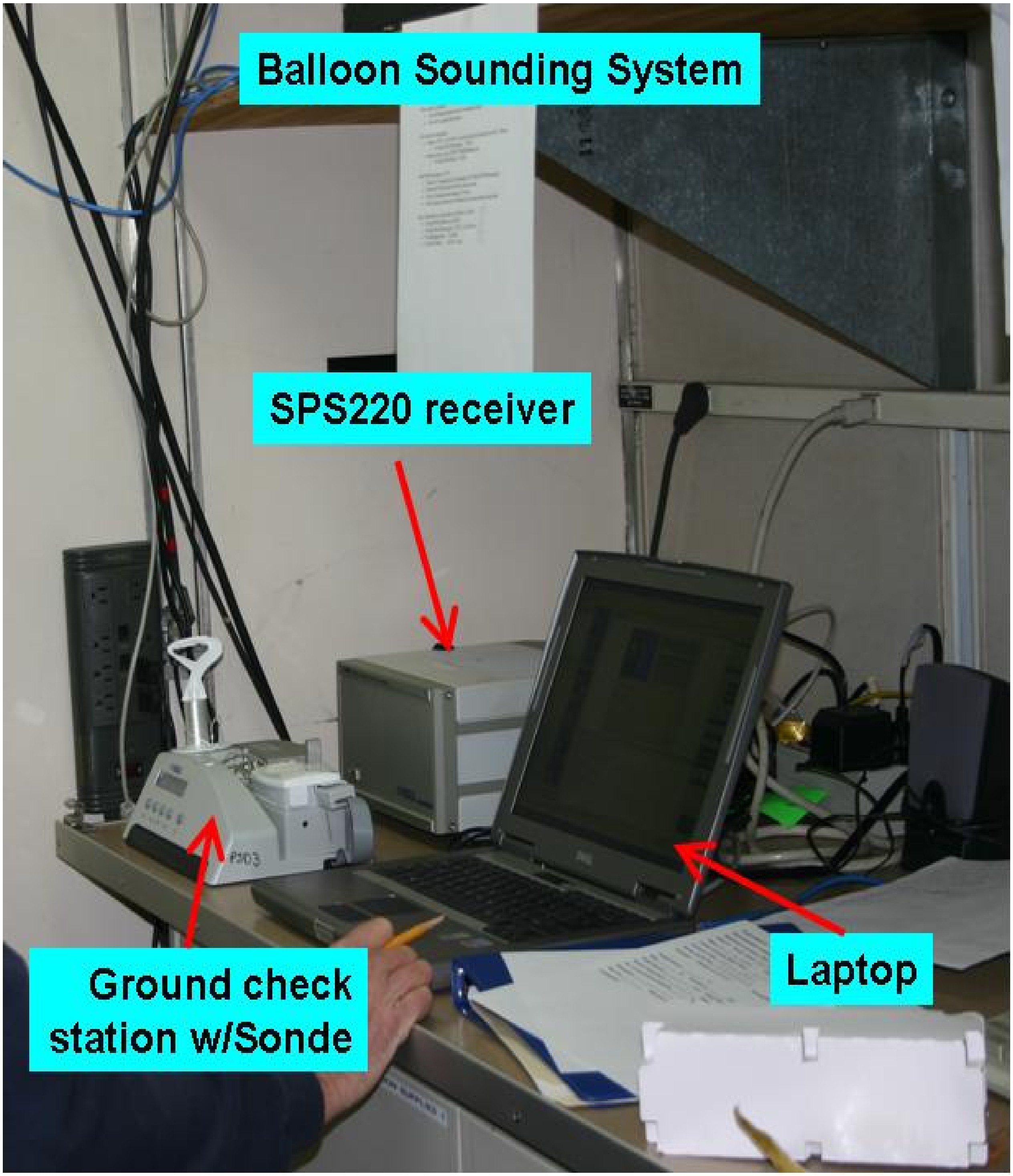
Fast sensor platform configuration

Data loggers in main computer room

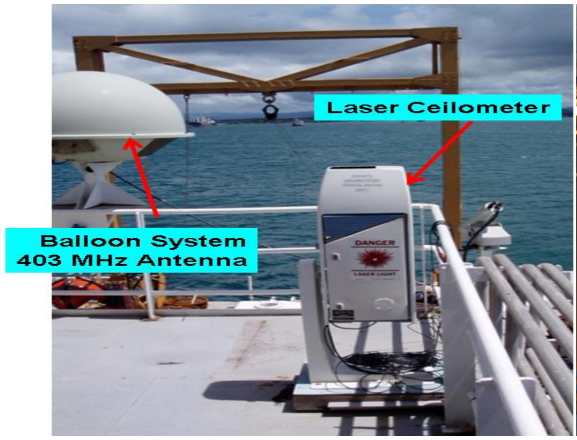
Flux computers in forward science office

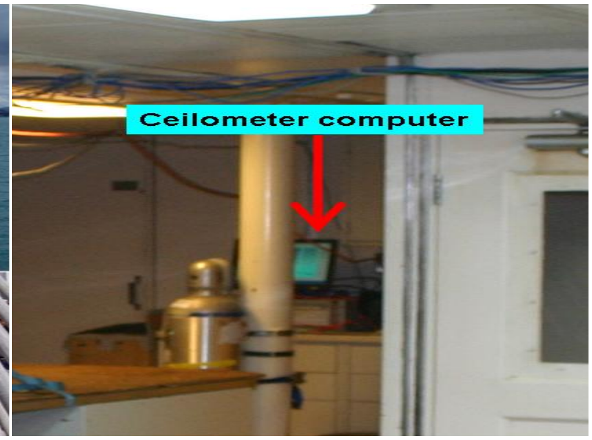


Sea Surface Temperature sensor port-side O1 Deck



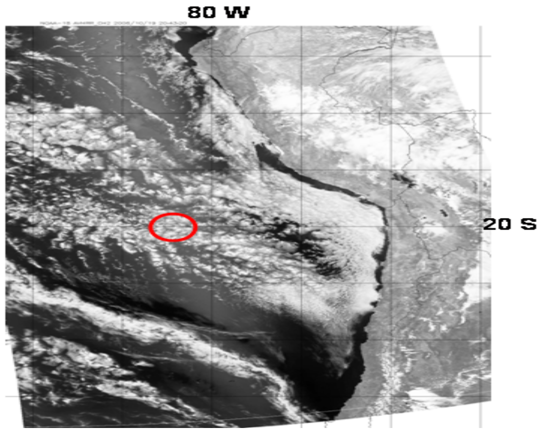
PSD Vaisala sounding system in Hydro-Lab (receiving station)





Ceilometer on O2 Deck

Ceilometer PC in Hydro-Lab



Example of Tera Scan satellite visible image NOAA-18 2043 UTC October 19, 2006. Red circle is the location of the STRATUS buoy (20 S, 85W)

Appendix E: NOAA/PMEL Equipment (PNE 2012)

Total weight approx. 22 tons
3X buoy/tower/bridle sets – 3750 lbs
4X 4480 lb. Anchors – 17,920 lbs
2X 5980 lb Anchors – 11,960
Misc. mooring supplies – 12,000 lbs
- 6 spools Nilspin wire
- 7 tube boxes with meteorological equipment
- 8 temperature module boxes
- 2 electronics boxes (laptops, telonics, etc.)
- 1 hardware box
- 1 toolboxes
- 17 spools nylon
- 2 boxes of current meters
- 6 boxes of acoustic releases; 2 acoustic release deck sets.
- 4 oxygen sensors

	White plastic shipping crate: 35" x 27" x 17"
	4 Sonteks SN:
2	TV cables, spiral wrap
	White plastic shipping crate: 35" x 27" x 17"
1	5 ea. Top-sections
	Action Packer containing
	2 x 1 gal cans paint - Flash point 106F / 41C
	1 x 1 qt can paint - Flash point 106F / 41C
	1 gal can paint - Flash point 79F / 26C
1	** Overpacked used **
6	Acoustic Release Model 8242N:
2	Acoustic Release Deck Set Model 8011M,
	Electronic Tube SN
	Humidity/Temperature Sensors SN
	Wind Sensors SN
	Short Wave Radiation Sensors SN
	Long Wave Radiation Sensors SN
6	Rain Gauges
	Spare Met sensors Barometric Sensors SN
	Wind Sensors SN
	Short Wave Radiation Sensors SN
1	Rain Gauges SN
	11 Temperature Sensors [20N 38W]
1	Sensor SN:

11 Temperature Sensors [20.5N 23W]
1 Sensor SN:

11 Temperature Sensors [11.5N 23W]
1 Sensor SN:

11 Temperature Sensors [4N 23W]
1 Sensor SN:

11 Temperature Sensors [Spare]
1 Sensor SN:

11 Temperature Sensors [Extras]
1 Sensor SN:
2 Current meter stands
1 Rolling Toolcart, tools
1 Pressure Washer
14 600m spool of braided nylon line - unmarked
3 600m spool of braided nylon line - EV 50
1 4 x 50m pieces of nylon on spool
9 empty reels
5 Nilspin wire rope, SN:
1 Nilspin wire rope, 2 x 300 meter lengths
1 Grey Hardware Tote (4'x4'x3') contains chain, hardware, quick release, yale grips, cage?
1 Electronics Toolbox
1 Nylon cutter
1 White plastic box, 24"x16"x13" shipping box - for German O2 loggers, Module mounts, straps
6 Anchors
3 Fiberglass buoy toroid
3 Stainless steel buoy bridle
3 Aluminum buoy tower
6 Buoy leads

1
Panasonic Laptop
Panasonic Laptop
HP Printer Deskjet
Telonics uplink receiver
Fluke Multimeter SN
Fluke Mega-Ohm meter SN
Canon Digital Camera Powershot G3
Cables, comm cables, manuals, office supplies

	White shippping box - 35" x 10" x 17"
1	Dell Inspiron labtop computer
2	Aluminum reel stands
1	Hydraulic spool stand
	hydrophones in boxes 72"x16"x15"
3	
1	Shipping box 24”x20”x30” with turnaround kits for acoustic releases
3	800 lbs anchors
8	Spools vectran or yalex

Appendix F: Equipment from the WACS cruise

On August 28, three of the eight WACS vans will be offloaded in Bermuda with the use of a shore crane. Five WACS vans will remain on the ship. One is a 16' van that will be on the O2 deck forward and four are 20' vans that will be on the O1 deck port side (Two vans will be stacked on top of Alvan and Storage van). Sea Sweep will be deflated and stored in Storage van. Note: blue items stay in board.

	Weight (lbs)	Size (ft)	Power	Other requirements
Main Deck				
PMEL SW van	12,000	8 x 16	480 VAC, 70 A, 3-phase	Phone, Uncontaminated seawater (~5 L/min)
O1 Deck Port Side				
PMEL Storage Van	12,000	8 x 20	110 VAC	
PMEL Alvan	12,000	8 x 20	480 VAC, 30 A, 3-phase	Phone, Fresh water, ethernet connection
Sea Sweep	1,000			goes in storage van
AeroChem	15,000	8 x 20	480 VAC, 70 A, 3-phase	Phone
AeroPhys	17,000	8 x 20	480 VAC, 70 A, 3-phase	Phone, dry compressed air @ 120 psi, 4 CFM
O2 Deck Forward				
GuestVan	15,000	8 x 20	Power from AeroChem van	
Russell Van	15,000	8 x 20	480 VAC, 70 A, 3-phase	Phone, dry compressed air @ 120 psi, 4 CFM, Ethernet connection
Univ VA van	15,000	8 x 20	Power from Russell van	Uncontaminated seawater (~)
Black tubes	1,000			
Frames	9,000			
O3 Deck Forward				
Radon Instrument	250			

Appendix G: Equipment for the NTAS cruise

Two 7000 lb anchors.

Appendix H: Station Locations

CTD station	Latitude			Longitude			Notes
	deg	min		deg	min		
	32	20	N	-64	-45	W	
1	30	0	N	-60	0	W	
	20	20	N	-38	-58	W	hyrdophone recovery/redeployment
	20	1	N	-37	-52	W	ATLAS recovery/redeployment
	20	0	N	38	0	W	Tflex recovery/redeployment
2	20	1	N	-37	-52	W	
3	20	30	N	-23	0	W	
	20	28	N	-23	-4	W	ATLAS recovery/deployment
4	20	0	N	-23	0	W	
5	19	30	N	-23	0	W	
6	19	0	N	-23	0	W	
7	18	30	N	-23	0	W	
8	18	0	N	-23	0	W	
9	17	30	N	-23	0	W	
10	17	0	N	-22	-49	W	
11	16	30	N	-22	-44	W	
12	16	0	N	-22	-36	W	
13	15	30	N	-22	-44	W	
14	15	0	N	-22	-52	W	
15	14	30	N	-23	0	W	
16	14	0	N	-23	0	W	
17	13	30	N	-23	0	W	
18	13	0	N	-23	0	W	
19	12	30	N	-23	0	W	
20	12	0	N	-23	0	W	
21	11	30	N	-23	0	W	
	11	29	N	-22	-59	W	ATLAS recovery/deployment
22	11	0	N	-23	0	W	
23	10	30	N	-23	0	W	
24	10	0	N	-23	0	W	
25	9	30	N	-23	0	W	
26	9	0	N	-23	0	W	
27	8	30	N	-23	0	W	
28	8	0	N	-23	0	W	
29	7	30	N	-23	0	W	

30	7	0	N	-23	0	W	
31	6	30	N	-23	0	W	
32	6	0	N	-23	0	W	
33	5	30	N	-23	0	W	
34	5	0	N	-23	0	W	
	4	59	N	-22	-60	W	hydrophone recovery/deployment
35	4	30	N	-23	0	W	
	4	3	N	-22	-57	W	ATLAS recovery/redeployment
36	4	0	N	-23	0	W	
37	3	30	N	-23	0	W	
38	3	0	N	-23	0	W	
39	2	30	N	-23	0	W	
40	2	0	N	-23	0	W	
41	1	45	N	-23	0	W	
42	1	30	N	-23	0	W	
43	1	15	N	-23	0	W	
44	1	0	N	-23	0	W	
45	0	45	N	-23	0	W	
46	0	30	N	-23	0	W	
47	0	15	N	-23	0	W	
	0	0	N	-23	0	W	ATLAS recovery/redeployment
48	0	0	N	-23	0	W	
	0	-1	S	-23	0	W	ATLAS repair if necessary
	4	55	N	-29	-23	W	
	7	0	N	-42	0	W	hydrophone deployment
	13	10	N	-59	-32	W	Barbados