AMMA 2006/ PIRATA Northeast Extension / Sahara Dust Cruise Report
NOAA Ship *Ronald H. Brown*
RB-06-05

Leg 1: May 27—June 18, 2006
San Juan, Puerto Rico to Recife, Brazil
Chief scientist: Rick Lumpkin, NOAA/AOML

Leg 2: June 22—July 16, 2006
Recife, Brazil to Charleston, USA
Chief scientists: Claudia Schmid, NOAA/AOML (June 22—July 4) and Vernon Morris, HUPAS (July 4—16)

Overview

The 2006 AMMA/PIRATA Northeast Extension Cruise RB0605 was designed to collect a suite of oceanographic and meteorological observations in the northeast Tropical Atlantic, to deploy two new moorings as a northeast extension of the PIRATA array, and to service a PIRATA backbone mooring at 0º, 23ºW. The cruise track and northeast extension were planned along 23ºW, a longitude cutting through the climatologically significant TNA (Tropical North Atlantic) region, including the southeast corner of the subtropical North Atlantic (a region of subduction for the subtropical cell circulation); the Guinea Dome and oxygen minimum shadow zone where the subtropical and tropical gyres meet, and the Tropical Atlantic current system and equatorial waveguide. All scientific goals of RB0605 were achieved.

We thank the officers of the Ronald H. Brown for their tireless work and input before and during this cruise. Despite a delayed departure due to circumstances beyond their control, the officers enabled us to accomplish all planned scientific goals of this cruise. The CO, the XO, and the FOO relayed information continuously and clearly to the scientific party. We never felt “in the dark”; we understood all decisions being made, and appreciate the great efforts made towards maximizing the scientific accomplishments of the cruise.

We would like to single out the engineers for our deep gratitude; they worked intensely around the clock in San Juan in order to enable departure as rapidly as possible.
Our very sincere thanks go to the deck crew who deployed two ATLAS moorings through two nighttimes, and spent an entire day on the equator recovering one ATLAS mooring and deploying a second one. Their efficiency and familiarity with these operations was evident and impressive to all of us. We thank the Chief Survey Technician for his continuous assistance and advice in CTD operations, Seabeam surveys, XBT launches, shipboard ADCP operation, and drifter and float deployments. We also thank all the crew who kept ship operations running smoothly, including the winch operators, Electronic Technician, galley crew, and all the other crewmen and women of the Brown.

Introduction

1. African Monsoon Multidisciplinary Analysis (AMMA)

AMMA is a coordinated international project to improve our knowledge and understanding of the West African Monsoon (WAM), its variability and impacts. AMMA will carry out the research needed to improve our ability to monitor and predict the weather and climate of West Africa and downstream tropical Atlantic. AMMA will facilitate the multidisciplinary research required to provide improved predictions of the WAM and its impacts on daily-to-interannual timescales. This will be achieved through international coordination of ongoing activities, promoting necessary basic research, and a multi-year field campaign over West Africa and the tropical Atlantic. During 2003, AMMA received endorsement from the international CLIVAR and GEWEX projects within the WCRP and also has strong linkages with IGBP.

There are multiple scientific and societal reasons why AMMA is needed at this time. West Africa is a region that experiences marked variability in rainfall. The dramatic change from wet conditions in the 1950s especially and 1960s to much drier conditions in the 1970s, 1980s and 1990s in this region represents one of the strongest climate signals on the planet during the last century. Superimposed on this multi-decadal trend, marked interannual variations have resulted in extremely dry years with devastating environmental and socioeconomic impacts. Vulnerability of West African societies to climate variability is likely to increase in the next several decades, as demands on resources increase in association with one of the World's most rapidly growing populations. The situation also may be exacerbated by regional climate change. There is a strong societal need to develop strategies that reduce the socioeconomic impacts of WAM variability that will benefit from useful predictions of WAM variability and its impacts.

The scientific community is currently hindered in providing skilful predictions of WAM variability, due to a combination of factors. In addition to the large systematic errors exhibited by dynamical models used for weather and climate prediction and the sparse West African observing network, there are fundamental gaps in our knowledge of the coupled atmosphere-ocean-land system at least partly arising from lack of appropriate observational datasets but also because of the complex scale interactions between the atmosphere, biosphere and hydrosphere that ultimately determine the nature of the WAM.

Variability in West African weather and climate also impacts the rest of the world. Latent heat release in deep cumulonimbus clouds in the ITCZ over tropical Africa represents one of the major heat sources on the planet. Its annual migration and associated regional circulations impact other tropical regions, as exemplified by the known positive correlation between the interannual variability of West African rainfall and Atlantic hurricane frequency. While we know that a majority of tropical cyclones that form in the Atlantic originate from weather systems over West Africa, much less is known about the processes that account for this association and why only a small fraction of these “seeds” actually become tropical cyclones.

West Africa also is part of the world’s major source region of mineral dust aerosol. Given the great uncertainties regarding the impact of dust on weather and climate, there is an important opportunity to address aerosol issues within the AMMA project. Mobilization, transport, and impacts of aerosol on weather and climate in West African and Atlantic regions need to be investigated.

The major scientific objective of the AMMA project is to investigate the coupled atmosphere-ocean-land system processes that characterize the WAM with the aim of improving weather and climate prediction capabilities, and improving our confidence in climate change scenarios. The US will make a major contribution to this research, which will be undertaken in the following key interacting science areas:

> *A: Weather Systems and Processes:* AMMA will strive to provide an improved understanding of the nature and variability of individual weather systems that comprise the WAM, focusing on mesoscale convective systems and African easterly waves over the continent and their fate and association with tropical cyclones downstream in the Atlantic.
>
> *B: Climate System and Processes:* AMMA will investigate the key processes that influence variability and predictability of the West African monsoon on seasonal-to-interannual timescales. Along with a consideration of key global teleconnections (e.g. those associated with ENSO), special emphasis will be given to improving our understanding of the roles played by West African land surface conditions and the tropical Atlantic Ocean.
>
> *C: Aerosols:* AMMA will investigate the chemical, physical, and radiative properties of aerosols, including their impact on West African regional weather and climate

including the downstream tropical Atlantic. AMMA also will consider the aerosol sources and source processes.

2. *PIRATA Northeast Extension (PNE)*

The Pilot Research Moored Array in the Tropical Atlantic (PIRATA) is a three-party project involving 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. The array consists of a backbone of ten moorings that run along the equator and extend southward along 10ºW to 10ºS, and northward along 38ºW to 15ºN. Given the widely varying dynamics of various sub-regions of the Tropical Atlantic, future extensions of the array had been anticipated by the PIRATA Science Steering Group to further the scientific scope of the observing system and improve weather and climate forecasts. In August 2005 a Southwest Extension of three moorings was added off the coast of Brazil (PIs: P. Nobre, E. Campos, P. Polito, O. Sato and J. Lorenzzetti). A new Southeast Extension (PI: M. Rouault) is being deployed near 6ºS, 8ºE during the EGEE3-PIRATA FR15 cruise in June 2006 (concurrent with RB0605).

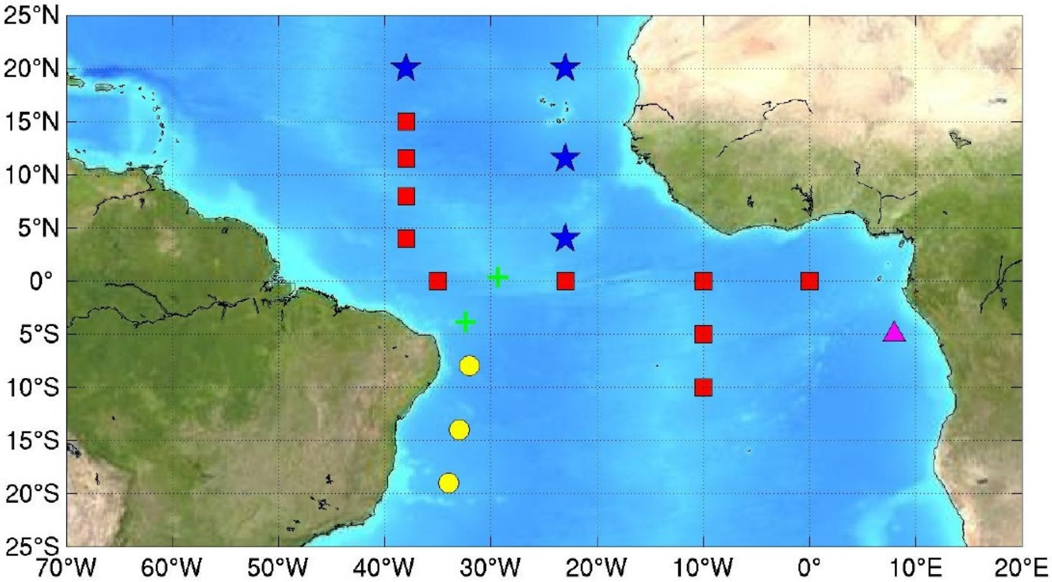

Fig. 1: The Tropical Atlantic, showing the PIRATA backbone (red squares), automatic meteorological stations (green +), southwest extension (yellow circles), southeast extension pilot site (magenta triangle), and the Northeast Extension (blue stars).

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 storms for the surrounding regions of Africa and the Americas. PIs R.Lumpkin, B.

Molinari and M. McPhaden proposed a NOAA-funded Northeast Extension of the PIRATA array at the 2005 PIRATA meeting in Toulouse, France. This extension will consist of four moorings (Fig. 1), the first two deployed during this cruise. Moored observations in these regions will improve our knowledge of atmosphere-ocean heat exchanges and dynamics impacting the WAM, marine Intertropical Convergence Zone, upper ocean dynamics affecting heat content and SST variability in the Tropical North Atlantic hotspot, possible connections between SST patterns and North Atlantic climate regimes of variability, and the development of atmospheric easterly waves into tropical cyclones. A better understanding of the processes driving SST anomalies in the TNA region will lead to better predictions of rainfall and other climate signals across a broad geographical domain at timescales from seasonal to decadal.

Due to commitments elsewhere, including in the Gulf of Guinea for EGEE3, the French were unable to service the backbone PIRATA mooring at 0º, 23ºW in the summer of 2006. Because the NOAA vessel Ronald H. Brown was scheduled to occupy the RB0605 hydrographic section down 23ºW, the US representatives of the PIRATA Science Steering Committee offered to take this opportunity to service the mooring during RB0605a.

Leg 1

Hydrography:

CTD console, salinity sampling and LADCP operation:
Rick Lumpkin, Christopher Meinen (NOAA/AOML)
Oxygen sampling and titration, LADCP operation and deployment/recovery:
Pedro Pena (NOAA/AOML)
Oxygen sampling, CTD processing, LADCP operation and depl./recov.:
Derrick Snowden (NOAA/AOML)
Salt sampling, processing and depl./recov.:
Kyle Howell (Florida Institute of Technology)
Salt processing:
Seydi Ababacar Ndiaye (Cheikh Anta Diop University)

Moorings:

Steve Kunze and Sonya Noor (NOAA/PMEL)

Note: All figures and results reported here are subject to major revision after quality control and final calibration.

Order of operations:

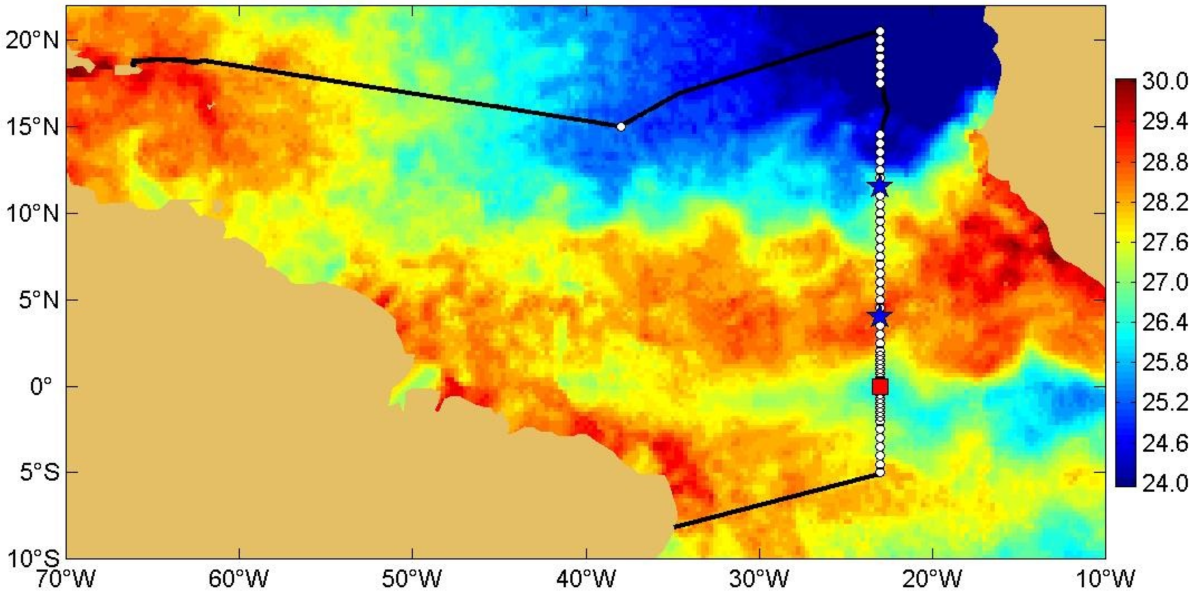

Fig. 2: cruise track of the R/V Ronald H. Brown during RB0605a (black), with CTD stations (white bullets), PNE deployment sites (blue stars), and the PIRATA backbone servicing site (red square) superimposed. Background shading is SST (ºC) on 13 June 2006, from merged TMI/AMSRE microwave satellite observations (Remote Sensing Systems).

Leg one of the 2006 AMMA/PNE cruise RB0605 was initially scheduled to depart San Juan, Puerto Rico on 23 May and arrive in Recife on 18 June. Due to repairs needed for two of the ship's generators, a brief delay was anticipated and communicated to the scientific party several days before the planned departure. This delay was exacerbated by poor service and communications from the shipping company tasked to deliver the required parts to the ship in San Juan, PR.

The Ronald H. Brown (RHB) left dock for RB0605 on 27 May at approximately 0900 local, and finished sea trials by 1800. We then conducted a Seabeam survey along the northern coast of Puerto Rico while beginning our steam to the planned test CTD site and potential mooring repair at 15ºN, 38ºW. This Seabeam survey had been planned as part of RB0604, but was curtailed when the ship developed generator problems; it was completed during RB0605a without impacting the cruise negatively.

With all three main generators working, the RHB was able to regain a considerable amount of time with a swift transit across the tropical Atlantic. While steaming to our test cast site (15ºN, 38ºW) we began deployments of Argo floats and XBTs. We arrived at 15ºN, 38ºW late in the evening of June 2. There we performed a Seabeam survey, a fly-by of the Brazilian-maintained PIRATA buoy (see Fig. 1) and a test CTD cast (cast #0).

After completing the test cast, we proceeded towards the Cape Verde islands while awaiting word of our clearance status. We received confirmation on 2 June that we had clearance to collect oceanographic measurements in Cape Verde waters, and continued on to the planned site of a 2007 PNE mooring at 20º30'N, 23ºW (immediately north of Cape Verde EEZ). We arrived at 20º30'N, 23ºW on the morning of 5 June, conducted a Seabeam survey and identified a tentative deployment location. We then conducted CTD cast #1. From there we steamed south, running down 23ºW and conducting CTD casts every half-degree of latitude. On 6 June at 0825 UTC we completed cast #7 at 17º30'N. Between 17ºN and 15ºN, 1500dbar casts are not possible along 23ºW due to the presence of the Cape Verde Plateau. The RHB passed east around the Cape Verde islands during the 6th of June, with dense XBT drops to measure the thermal structure. The 23ºW hydrographic section was continued with CTD #8 at 14º30'N, initiated at 0035 UTC on 7 June.

The RHB continued south along 23ºW, occupying CTD stations every half-degree, and reached the first PNE mooring deployment site at 11º30'N on the evening of June 7. The Seabeam survey initially showed us passing over a seamount cresting 400m above the abyssal plain; immediately south of 11º30'N, the sea floor became flat and ideal for deployment, and a drop point was identified a few miles to the south. Mooring deployment was conducted through the night. After the anchor was released, and while the mooring was settling, CTD#14 was conducted. A final fly by revealed that one sensor on the mooring – the temperature/conductivity sensor at 40m depth—was not transmitting data, but otherwise everything on the mooring and buoy were operating properly. PMEL standard operating procedures for ATLAS deployments call for recovery and redeployment if three or more sensors are not functional. Following these procedures, and noting the potential need for the backup anchor and the ship days if more significant problems were experienced in later deployments, we decided to proceed southward.

CTD casts 15—28 were successfully conducted from 11ºN to 4º30'N on June 8–11. We arrived at the second PNE site, 4ºN, 23ºW, on the evening of 10 June. Once we identified an optimal anchor release site with a Seabeam survey, we began the deployment operation. The deployment was conducted through the night, with the anchor released early on June 11. CTD#29 was occupied while the mooring settled; this time, all sensors were reporting during the fly by.

CTD casts 30—32 were conducted from 3º30'N to 2ºN, concluding at 2317 UTC on 11 June. We then began quarter-degree spaced CTD to achieve higher resolution of the equatorial waveguide from 2ºN to 2ºS.

The RHB reached the equator in the early hours of June 13. We conducted a Seabeam survey, did CTD#41, and attempted to establish communications with the PIRATA backbone mooring's acoustic release while night gave way to dawn, then daylight. We then confirmed release, recovered the buoy with the rigid inflatable boat and Brown acting in concert with a stern-first recovery. The mooring itself had been damaged, perhaps by traumatic impact from a vessel, with the anemometer missing, the antenna housing damaged, radiometer plate bent, and the temperature-conductivity sensor closest to the surface was missing. Starting at 1600 UTC, the RHB deployed the replacement 0º, 23ºW PIRATA backbone mooring that now included a longwave sensor and a barometer to further enhance the value of this critical platform. After the anchor was dropped and the mooring settled, CTD#42 was conducted and a cluster of four drifters was deployed. A fly by of the mooring allowed us to verify that all sensors were functioning well.

The RHB proceeded south, conducting CTD casts every quarter-degree to 2ºS (#50, completed 1908 UTC June 14), then every half-degree to 5ºS (#56, completed 2206 UTC June 15). Having completed all planned scientific goals of leg one, the RHB then steamed west to Recife, Brazil for its scheduled 18 June arrival.

Oceanographic data collected on leg one:

1. ATLAS moorings of the Pilot Array in the Tropical Atlantic (PIRATA) were deployed at two new sites. These were the first two moorings of the PIRATA Northeast Extension (PNE), a US contribution to PIRATA. A French PIRATA backbone mooring at 0º, 23ºW was recovered and redeployed. The moorings are relaying real-time data including air temperature, relative humidity, wind speed and direction, rain rate, shortwave and longwave radiation, barometric pressure, sea surface temperature, subsurface currents at ~10m depth, and subsurface temperature and salinity at multiple points through the upper 500m of the water column.

2. Conductivity-Temperature-Depth (CTD) data were collected at 57 casts, including a test cast at 15ºN, 38ºW and 56 casts on a meridional section from 20º30'N, 23ºW to 5ºS, 23ºW. All casts were conducted to a pressure of 1500dbar, or the bottom (if shallower). On all casts water samples were taken at various depths to calibrate salinity and oxygen sensors.
3. Lowered Acoustic Doppler Current Profiler (LADCP) data were collected at all 57 casts. These data were collected using two 300 kHz workhorse LADCPs.

4. 13 ARGO floats were deployed to measure temperature and salinity profiles and currents at 2000m depth, as part of the 3000 float global array.
5. 12 satellite-tracked surface drifters were deployed to measure sea surface temperature and mixed layer currents, as part of the 1250 drifter global array.
6. 69 expendable bathythermographs (XBTs) were launched to measure temperature profiles of the upper ocean.
7. Shipboard data was collected throughout the cruise using a 75 kHz Ocean Surveyor hull-mounted Acoustic Doppler Current Profiler (SADCP). Heading data for the SADCP was provided by the MAHRS system, with data from the ship's gyro for comparison.

On this cruise, XBT temperature profiles and CTD temperature/salinity profiles were transmitted in near-real time via the Global Telecommunication System (GTS) for model calibration and validation. Although XBT data is commonly transmitted on the GTS from Voluntary Observation Ships, this is the first time to our knowledge that CTD data have been transmitted in near-real time for weather and climate prediction.

ATLAS moorings (text by S. Kunze, Table 1)

15ºN38ºW – The swap of a questionable sea surface temperature/conductivity sensor here was a last minute inclusion on the itinerary prior to departure. It was scheduled as a precautionary repair due to a two-day anomalous fluctuation in sea surface conductivity measurements observed earlier in the month. We arrived at the site too early in the evening to warrant an overnight stay for a morning repair. This decision was made easier due to the fact that the sensor had been operating normally since its fluctuations weeks earlier. S. Kunze had doubts that a good quality survey of the area had ever been performed so he requested a Seabeam scan on the approach to the mooring and the survey technician complied. Upon arrival a test CTD cast and a flyby visit of the mooring were conducted. The timing was also coincident with a transmit window and meteorological observations were made.
20.5ºN, 23ºW - The Seabeam survey conducted here was for a new mooring intended for initial site deployment in fiscal year 2007. The original plan was to conduct this at 20ºN but that area is within the Cape Verde Exclusive Economic Zone. The chief scientist contacted PMEL and suggested to move the future planned location one half degree further north to minimize any future logistical issues that could arise and the lab agreed to this. The Seabeam was run on the approach from the west only up until we reached the 23ºW transect. A good location for the future deployment was determined.

11.5ºN23ºW – This site is new as part of the NE extension of the PIRATA array. Operations got underway not long after midnight local. Three other vessels hovered in the area around us during the early part of the deployment but eventually moved on. The only other notable part of the operation was the loss of communications with the 40-meter temperature/conductivity sensor observed on the flyby.

4ºN23ºW – This was the second and only other mooring new to the NE extension on this cruise and was again a late night operation. All instruments were operational upon flyby although word came from PMEL days later that the sea surface conductivity sensor appeared to be malfunctioning. The following cruise for the RHB is taking the ship back through this region so plans began to take shape for a possible sensor replacement. This turned out to be unnecessary as the sensor stabilized to normal output levels shortly thereafter.

0º 23ºW – The existing mooring, PM514A, was discovered to have been vandalized. The wind sensor had been broken off and the mast was flailing loosely by one mounting screw. Remarkably, the inside of the tube tophat was completely dry. The top of the rain sensor was broken off, the radiation mount on the tower was bent apparently from a blow to the radiation mast, and the plate on the sensor was also bent. Longline was found on the subsurface portion down to the current meter at 13 meters. The core of the nilspin was exposed at a cut in this section. The 10 meter TC was missing, the Sontek fin was broken off, and both the 13.3 meter TV and 120 meter TC were out of their mounts and hanging on by the tie wraps. Anti-fouling pucks were missing here and there as well. The release took an unusually long time to fire. Ranging efforts were futile too. The subsequent deployment went without any problems. After all mooring operations were completed PMEL relayed that all three of the new deployments were fully functional with the exception of the 40-meter sensor on the first deployment.

Conductivity-Temperature-Depth (CTD) casts

We conducted 57 CTD casts, including a test cast at 15ºN, 38ºW, to 1500dbar during leg one of the cruise (Fig. 2). One cast, #23 at 6º59.7'N, 22º59.7'W, was conducted above a bathymetric feature associated with the Sierra Leone Rise where the bottom depth was 1485m; this cast was conducted to 1451 dbar, 19m above the bottom according to the altimeter on the CTD package. On each cast, water samples were obtained via 12 Niskin bottles. Oxygen and salinity were sampled for sensor calibration. Oxygen was sampled from all bottles. Salinity was sampled from all bottles on casts #0 (test cast) through #30. At this point, CTD calibration (D. Snowden) suggested that the conductivity sensors were experiencing no significant drift with time or dependence upon pressure, and that fewer samples could be processed to maintain comparable accuracy. Chief scientist R. Lumpkin decided to sample salinity from every other bottle for subsequent casts. By cast #50, it was apparent that the surface bottle (fired with the CTD package sitting immediately beneath the surface) was not useful for oxygen calibration, presumably due to the extreme gradient of oxygen in the upper ocean caused by wave breaking and stern thruster-induced turbulence. For casts 51—56, the "surface" bottle was fired at depths of 15-50m in the mixed layer.

CTD processing was performed using Seabird software and Matlab routines developed by C. Fonseca, who provided several time-intensive training pre-cruise sessions.

No communication problems between the CTD console and the package were experienced during the cruise. We employed a relatively new frame, which may have caused some bottle firing failures due to the carousel pins impacting the frame – particularly the pin for bottle #11, which struck the frame at an oblique angle and may have resulted in slight malformation of the pin's end.

On cast #22 (7º30'N, 23ºW), the package was deployed with the Niskin bottle valves left open. Oxygen samples were not drawn from this cast.

CTD casts are tabulated in Table 2, and preliminary sections are shown at the end of this preliminary cruise report.

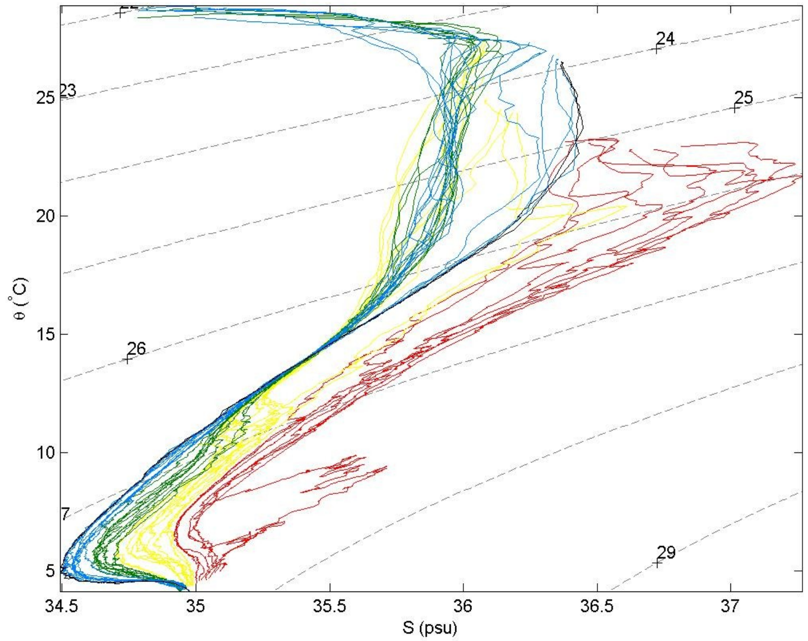

Fig. 3: salinity vs. potential temperature along the 23ºW section. Colors indicate latitude band: 15—20ºN (red), 10—15ºN (yellow), 5—10ºN (green), 0—5ºN (blue) and 5ºS—0 (black). Contours are sigma-theta values of constant potential density.

The Temperature-Salinity structure along 23ºW from the CTD casts is shown in Fig. 3. Strong T-S anomalies at the northern two casts may be associated with an intrusion of high-oxygen Mediterranean Water north of the Cape Verde islands. The nearly linear T-S relationship at intermediate densities is the signature of Central Water.

Lowered Acoustic Doppler Current Profilers (LADCP)

A dual 300 kHz system was deployed in the CTD package at each cast. The LADCP acquisition computer and power supply was set up in the aft wet lab, so that there was a short distance to run the sea cables – one for power, and two for communication with the instruments – to the package. We performed first pass processing incorporating navigation data on the data acquisition PC in the wet lab immediately after each cast, using processing software developed by M. Visbeck, A. Thurnherr, and L. Beal. We used the LADCP-derived depth and the engineering plots and warning messages from this software to assess the quality of the data download before erasing the LADCP recorders.

For all casts, one of the four beams on the downward-looking LADCP experienced dropouts, resulting in a significant fraction of the processed solution being "three beam". In early casts, this fraction was 18%; by the end of leg one, nearly all (~90%) of solutions were three beam solutions. E-mail and voice exchanges with Lisa Beal (RSMAS, Univ. Miami) were invaluable in assessing how this was impacting our results: the solutions were very clean, particularly compared to the 3000—4000m casts common in the Western Boundary Time Series program, and the failure of the fourth beam was expected to primarily impact error estimates (although it also left us with no redundancy, meaning a second beam failure during leg two will drastically impact data quality). Initial troubleshooting focused upon the instrument voltage, which had caused similar beam errors during the 2006 Western Boundary Time Series cruise. However, the voltage on the charged instrument and the battery pack were consistently found to be within the normal range of operation. We rotated the LADCP 90º to see if the beam was somehow being blocked, but this did not change the processed solutions. We hope that the level two processing, which will incorporate SADCP and CTD information, will ameliorate the error estimation problem. In the meantime, we recommend further testing of the instrument when it is returned to AOML, which may determine that servicing at RD Instruments is needed.

In addition, the processing software – graciously provided for us on this cruise along with a training session (L. Beal and R. Smith) – appeared to be extracting navigation information for a time window starting when the LADCPs began pinging (often 10—20 minutes before the cast) and ending when they ceased pinging (a few minutes after the cast). Because the ship's track ran north to south, and we were usually coming on station during the window between pinging initiation and CTD package deployment, a spurious north-to-south offset was introduced to the LADCP solution impacting the meridional speed (and to a much lesser degree, the zonal speed due to slight zonal drift while coming on station). We anticipate that this issue will be resolved in post-processing.

The LADCP system measured the structure of the tropical and subtropical gyre down 23ºW, including an anticyclonic eddy centered at ~13.5ºN (Fig. 4; this feature is also seen in XBT-derived isotherms, Fig. 7). Major tropical currents are robust features in these data; abbreviations in Fig. 7 indicate the central branch of the South Equatorial Current (cSEC), Equatorial Undercurrent (EUC), northern branch of the South Equatorial Current (nSEC), North Equatorial Countercurrent (NECC), South Equatorial Countercurrent (SECC), and the North and South Intermediate Countercurrents (NICC and SICC). The strongest current encountered during the cruise was the EUC, peaking at over 77 cm/s, which invariably caused large wire angles as the CTD package passed through 50—150m in the band 2ºS—2ºN.

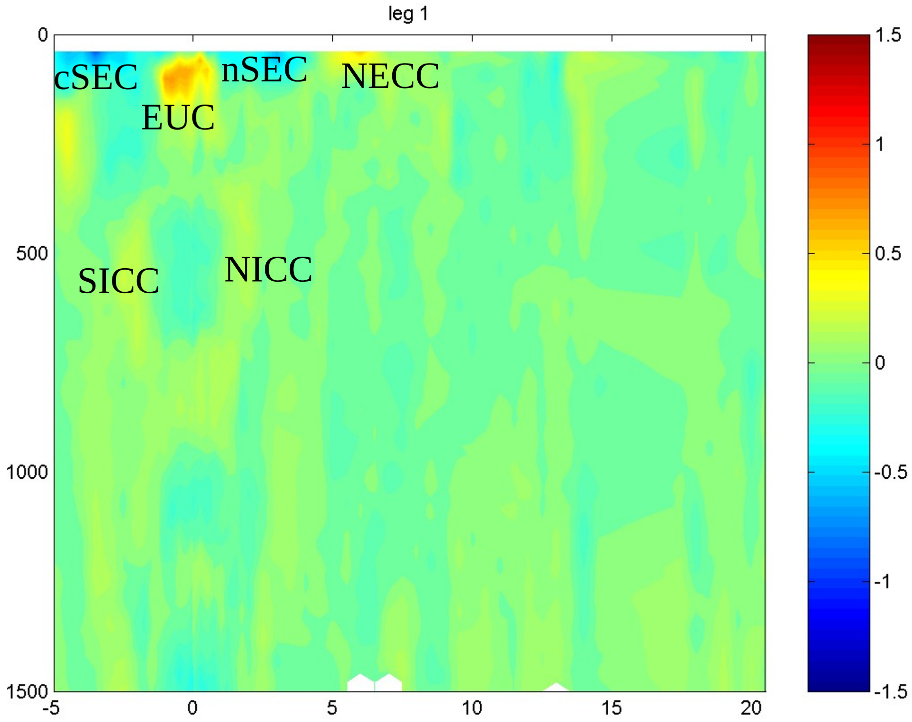

Fig. 4: zonal currents (m/s; red=eastward, blue=westward) measured by the LADCP system down 23ºW. Major currents are labeled.

Floats and Drifters

Thirteen floats and twelve drifters were deployed during leg one of the cruise, as shown in Fig. 5a and compiled in Table 3. The floats were Argo WHOI-SOLO, designed to sink to a parking depth of 2000m, stay there for 10 days following currents at that depth, then rise to the surface while profiling temperature and conductivity for transmission to Argos satellites.

The drifters were mini-Surface Velocity Program satellite-tracked drifting buoys, drogued at 15m to follow mixed layer currents. All included a thermistor on the surface buoy for SST. Their data are transmitted in real time via the Argos system. During this cruise, a cluster of four drifters was deployed on the equator as part of the Atlantic Data Buoy (ADB) study. The goal of ADB is to compare the performance and lifetime of drifters from each of the four manufacturers (Clearwater, Metocean, Pacific Gyre and Technocean) tapped by NOAA’s Global Drifter Program.

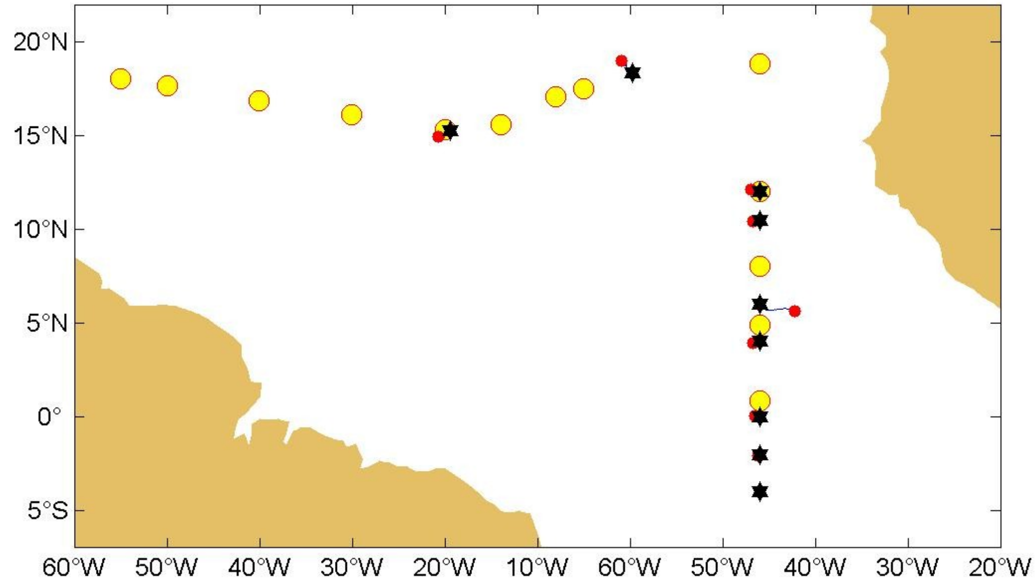

Fig. 5a: location of Argo float (yellow bullets) and surface drifter (black star) deployments (see Table 3). The subsequent trajectories of the drifters (blue lines) and positions as of 16 June 2006 (red bullets) are also shown.

The drifters deployed at several locations have already displayed inertial looping trajectories characteristic of abrupt changes in a wind field over the mixed layer. Two examples are shown in Fig. 5b. Drifter 62315 is looping with a period of ~2.3 days; the local inertial period at 12ºN is 2.40 days. Drifter 62320 has completed two loops of period ~2.8 days; the inertial period at 10.4ºN is 2.76 days. The ADB drifters are propagating west northwestward as a cluster, with – so far – minimal dispersion.

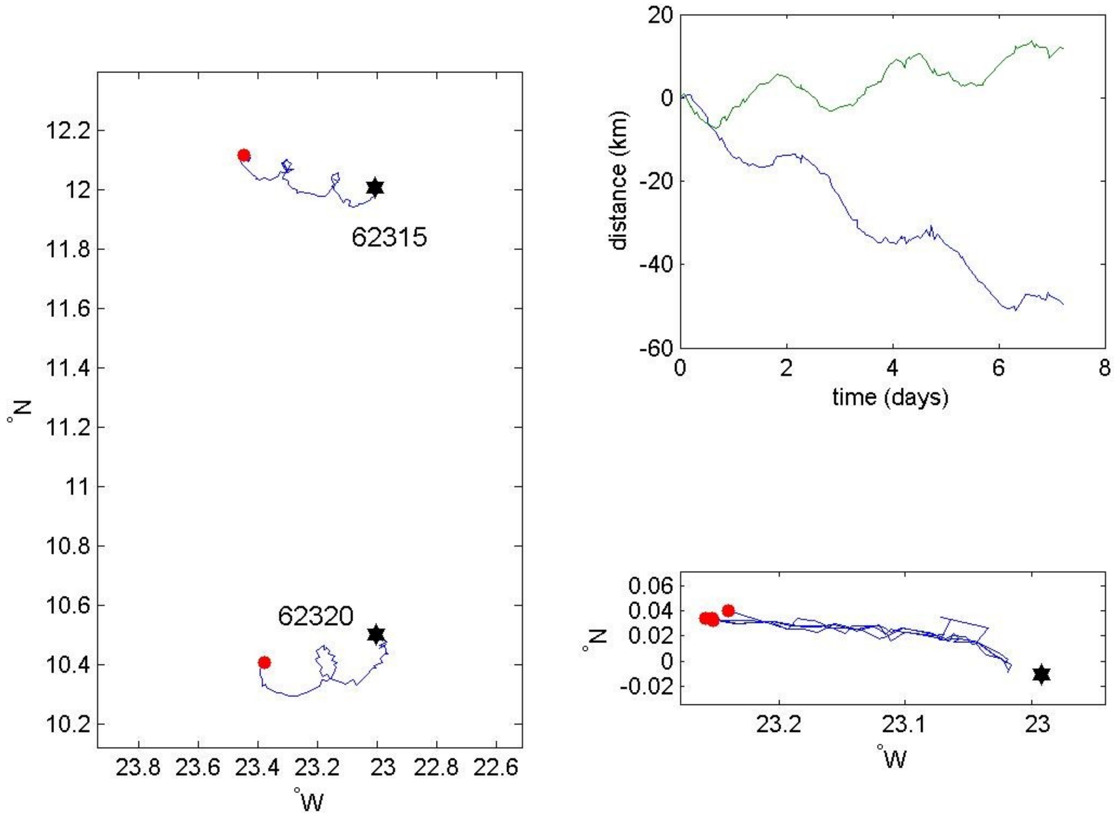

Fig. 5b: Left: close-up of Fig. 5a for drifters deployed at 10.5ºN and at 12ºN, showing inertial loops. Top right: time series of displacement for drifter 62315. Bottom right: trajectories of ADB drifters as of 16 June 2006.

Expendable Bathythermograph (XBT) casts

A total of 69 XBTs were dropped during leg one of the cruise (Fig. 6 and Table 4). These measured temperature to depths of 900m. On this cruise, a computer was donated to the RHB dedicated to Seas2k collection and transmission of the XBT data. This system was initially tested using a hand launcher brought from AOML, but test data (collected with an XBT in a bucket of sea water) appeared extremely noisy. Switching to one of the ship’s hand launchers solved the problem, and subsequent data were excellent with few exceptions. Six of the profiles (X060604N06, X060604N09, X060605N03, X060606N09, X060609N03, X060609N01) were identified as “bad” due to an unrealistic thermal structure, and are not included in subsequent figures.

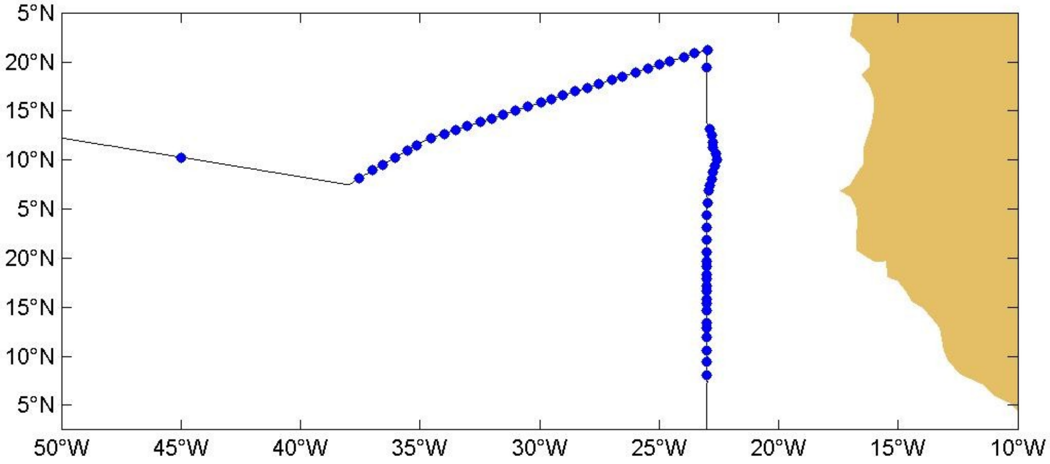

Fig. 6: location of XBT deployments (blue bullets).

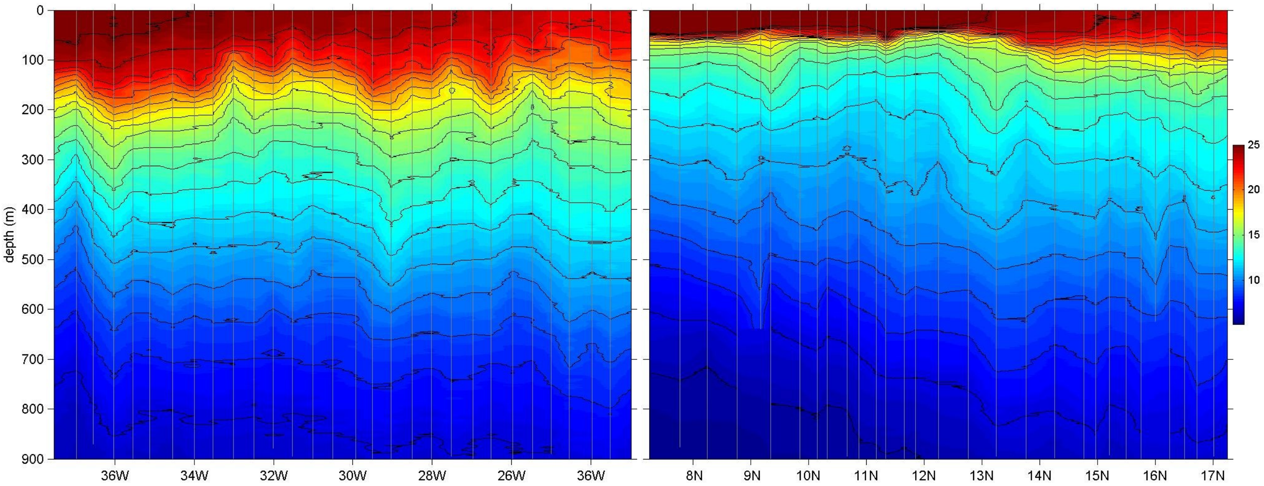

Fig. 7: temperature sections (ºC) from XBT deployments. Left: approximately zonal section from 37º32’W to 22º59’W, 10—20ºN. Right: meridional section from 17º15’N to 7º15’N, ~23ºW.

Preliminary property sections

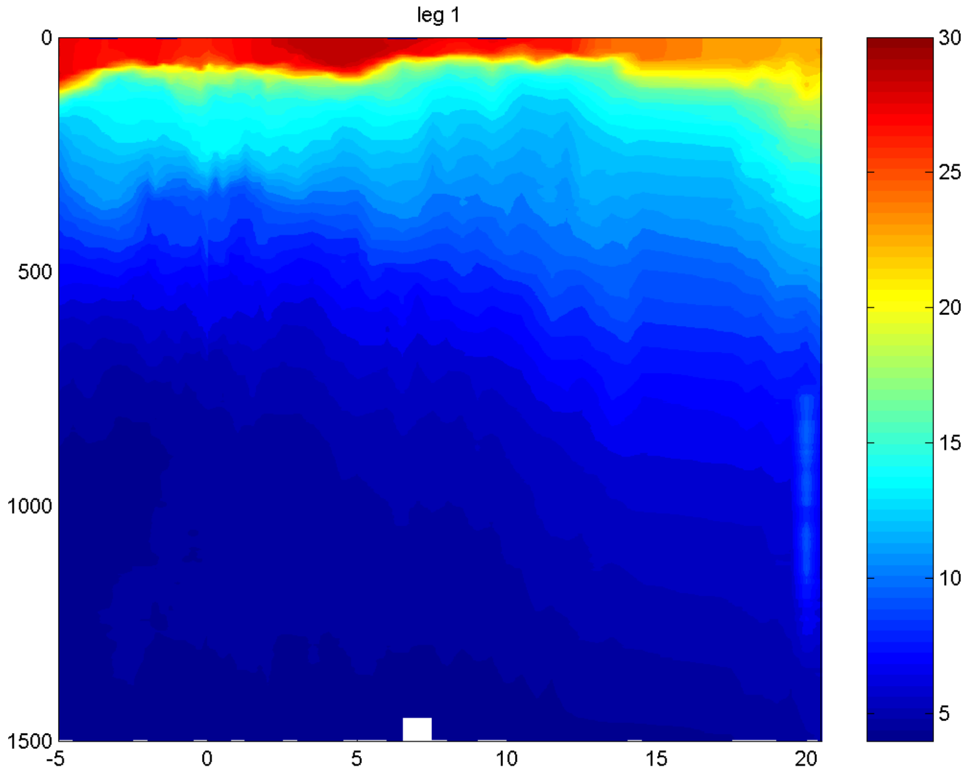

Fig. 8: temperature (ºC) vs. pressure from CTD at 23ºW.

Temperature vs. depth along the 23ºW section is shown in Fig. 8. Surface features include the warm, thick subtropical gyre and hot, shallow tropical surface water layer. Subsurface isotherms reveal the equatorial shoaling. Dramatic deep anomalies at 20ºN were seen in both downcast and up-cast, and were accompanied by salinity and oxygen anomalies – at this stage in the analysis of these data, we believe this to be a genuine feature. At depths of 100—400 dbar, rapidly shoaling isotherms from 14ºN to 12ºN may be associated with the cyclonic Guinea Dome (Siedler *et al.*, 1992), although the presence of an anticyclonic eddy, noted earlier, confuses the thermal structure. More careful analysis of the SADCP and LADCP velocities and the density structure will be necessary for clear identification.

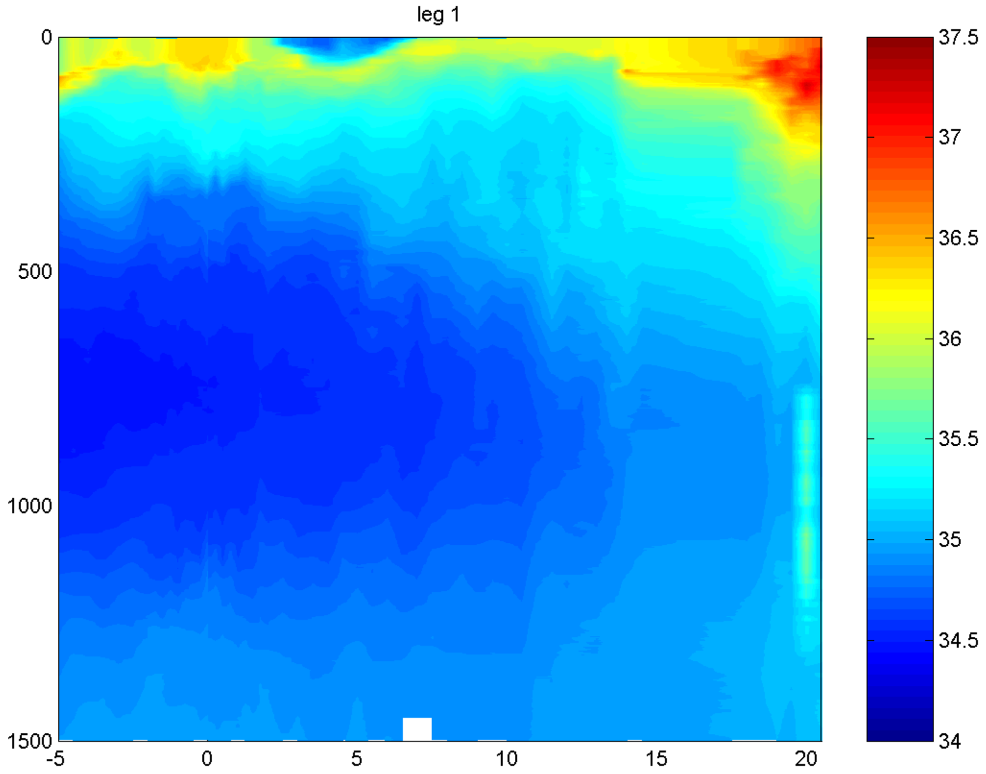

Fig. 9: salinity (psu) vs. pressure at 23ºW.

Salinity vs. depth (Fig. 9) shows the increased salinity of the subtropical waters to the north, in the region where increased evaporation-minus-precipitation drives subduction and the production of Salinity Maximum Water (SMW). Tropical SMW is seen beneath the surface, where low salinity is caused by the precipitation associated with the Intertropical convergence zone. At 500—1000 dbar, the signature of northward-flowing fresh Antarctic Intermediate Water dominates the section.

Oxygen vs. depth along 23ºW is shown in Fig. 10. The oxygen minimum water at 400—500 dbar dominates the section. This water is in the stagnant shadow zone of the North Atlantic, not participating in the ventilated thermocline circulation of the subtropical gyre (e.g., Luyten and Stommel, 1986). The abrupt increase in oxygen values north of 14ºN marks the Cape Verde Frontal Zone, which also marks the boundary between North Atlantic and South Atlantic Central Water (Stramma *et al.*, 2005). High oxygen values are also found at depths of 100—250m, straddling the equator from 1ºS to 1ºN. The position of this anomaly corresponds to that of the EUC, suggesting that higher oxygen water has been advected from the west.

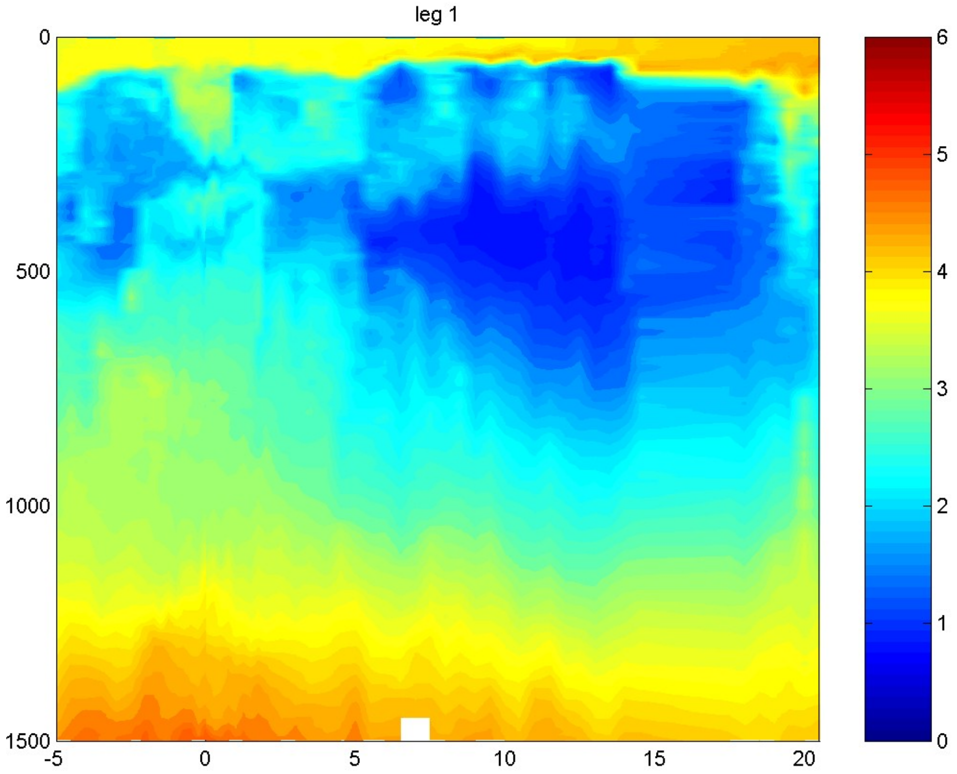

Fig. 10: oxygen (ml/l) vs. pressure at 23ºW.

Table 1: Summary of Mooring Operations

Site	Mooring ID #	Operation
15ºN 38ºW	PM531A	Seabeam survey/Visit
20.5ºN 23ºW		Seabeam survey of future site
11.5ºN 23ºW	PM595A	Seabeam survey/Deployment
4ºN 23ºW	PM598A	Seabeam survey/Deployment
0º 23ºW	PM599A	Seabeam survey/Recovery/Deployment

Table 2: location and time of CTD casts

CTD cast #	*Date*	*Time (UTC)*	*Lat*	*Lon*
test (0)	2-Jun-06	0:03:15	14.9862	-37.963
1	5-Jun-06	3:57:56	20.5033	-22.9885
2	5-Jun-06	8:30:21	19.9992	-22.9999
3	5-Jun-06	12:56:43	19.4979	-23.0011
4	5-Jun-06	17:11:26	19.015	-23
5	5-Jun-06	21:46:17	18.5	-23
6	6-Jun-06	2:32:20	18.005	-23
7	6-Jun-06	7:18:03	17.4969	-23.0013
8	7-Jun-06	0:25:27	14.52	-22.9945

9	7-Jun-06	4:31:45	13.9985	-22.9959
10	7-Jun-06	8:17:36	13.4984	-22.9997
11	7-Jun-06	11:56:31	12.9988	-23.0018
12	7-Jun-06	16:03:25	12.5027	-23.0008
13	7-Jun-06	20:26:45	12.0017	-23
14	8-Jun-06	7:30:14	11.4986	-23.0005
15	8-Jun-06	12:11:04	10.9999	-23.001
16	8-Jun-06	16:41:03	10.5	-23
17	8-Jun-06	21:19:48	10.0017	-23
18	9-Jun-06	2:04:27	9.5083	-22.9997
19	9-Jun-06	6:42:08	9.0007	-22.9996
20	9-Jun-06	11:21:10	8.5	-22.9987
21	9-Jun-06	15:49:22	8.0017	-22.9967
22	9-Jun-06	20:19:58	7.5003	-22.9983
23	10-Jun-06	0:33:53	7.0033	-23
24	10-Jun-06	4:57:04	6.4984	-22.9987
25	10-Jun-06	9:07:03	5.9999	-22.999
26	10-Jun-06	13:20:18	5.4987	-22.9999
27	10-Jun-06	17:23:22	5.0017	-23
28	10-Jun-06	21:36:40	4.5017	-23
29	11-Jun-06	8:18:29	4.0375	-22.987
30	11-Jun-06	13:19:08	3.4999	-23.0013
31	11-Jun-06	17:38:32	3.0017	-23
32	11-Jun-06	22:11:09	2.5017	-23
33	12-Jun-06	3:07:44	2.0015	-23.0007
34	12-Jun-06	6:13:48	1.7513	-23.0008
35	12-Jun-06	9:15:24	1.5015	-23.0008
36	12-Jun-06	12:27:12	1.2519	-23.003
37	12-Jun-06	15:26:10	1	-23
38	12-Jun-06	18:32:46	0.75	-23
39	12-Jun-06	21:37:14	0.5	-23
40	13-Jun-06	0:36:33	0.2583	-23
41	13-Jun-06	4:47:17	0.0049	-23.0126
42	13-Jun-06	17:30:41	-0.0067	-22.9967
43	13-Jun-06	20:44:40	-0.2483	-23
44	13-Jun-06	23:39:16	-0.5	-23
45	14-Jun-06	3:20:43	-0.7499	-22.9996
46	14-Jun-06	6:21:15	-1.0001	-22.9993
47	14-Jun-06	9:13:30	-1.2495	-23.0008
48	14-Jun-06	12:19:36	-1.4993	-23.0006
49	14-Jun-06	15:10:27	-1.75	-23
50	14-Jun-06	18:03:59	-2	-23
51	14-Jun-06	22:31:55	-2.5017	-23.0033
52	15-Jun-06	3:02:07	-3	-23
53	15-Jun-06	7:28:59	-3.4994	-23.0012
54	15-Jun-06	11:54:52	-4.0002	-23.0007
55	15-Jun-06	16:28:25	-4.5	-23
56	15-Jun-06	21:00:30	-5	-23

From float status table on AOML's Argo operations web page

```
AOML    WMO    TRANS profiles       period                QC % failed
 ID     ID      ID                                        Tp   Tm   Sp   Sm
1873 4900754 64080 23 ( 31) 29.05.2006 - 25.03.2007  0%   0% 22%  3%
1874 4900755 64081 31 ( 31) 29.05.2006 - 26.03.2007 10%   1% 26%  3%
1871 4900756 64077 30 ( 31) 30.05.2006 - 27.03.2007 80% 39% 97% 97%
1862 4900757 57486 25 ( 25) 31.05.2006 - 26.01.2007 32% 24% 76% 24%
1869 4900758 64074 31 ( 31) 01.06.2006 - 28.03.2007  0%   0%  6%  0%
1864 4900759 64061 31 ( 31) 02.06.2006 - 29.03.2007  0%   0%  6%  1%
1863 1900707 57489 31 ( 31) 02.06.2006 - 30.03.2007  0%   0% 10%  4%
1875 1900708 64076 31 ( 31) 03.06.2006 - 30.03.2007  0%   0%  3%  0%
1870 1900709 64075  0 (  0) 05.06.2006                   no profiles
1868 1900710 64073 30 ( 30) 07.06.2006 - 25.03.2007  0%   0% 10%  1%
1860 1900711 57464 30 ( 30) 09.06.2006 - 26.03.2007  0%   0% 23%  3%
1867 3900577 64072 15 ( 15) 10.06.2006 - 29.10.2006 60% 21% 93% 21%
1866 3900579 64070 30 ( 30) 12.06.2006 - 30.03.2007  0%   0% 10%  4%

Most floats (8) perform well (small percentages indicate good profiles)
and are still active.
```

Table 3: deployment log for floats (top) and drifters (bottom). "ADB" refers to the Atlantic Data Buoy comparison study.

ID number	Year	Month	Day	Hour (GMT)	Minute	Lat. deg.	Lat. min.		Lon. deg.	Lon. min.	
ARGO floats											
590/64080	2006	5	29	11	39	18	4.617	N	57	29.795	W
591/64081	2006	5	29	22	21	17	41.065	N	54	59.851	W
587/64077	2006	5	30	19	28	16	53.924	N	50	0.003	W
558/57486	2006	5	31	16	38	16	6.719	N	45	0.001	W
584/64074	2006	6	1	14	1	15	19.066	N	39	59.946	W
571/64061	2006	6	2	7	0	15	35.041	N	36	57.808	W
561/57489	2006	6	2	22	19	17	4.43	N	33	59.32	W
586/64076	2006	6	3	5	28	17	32.48	N	32	30.1	W
585/64075	2006	6	5	19	41	18	50.161	N	23	0.04	W
583/64073	2006	6	7	21	43	12	0.43	N	23	0.26	W
536/57464	2006	6	9	15	45	8	0.67	N	22	59.85	W
572/64072	2006	6	10	19	11	4	54.54	N	23	0	W
580/64070	2006	6	12	17	45	0	51.717	N	22	59.979	W
Drifters											
62322	2006	6	1	15	8	15	16.505	N	39	43.751	W
62316	2006	6	3	18	8	18	21.74	N	29	52.66	W
62315	2006	6	7	21	44	12	0.43	N	23	0.27	W
62320	2006	6	8	18	0	10	30	N	23	0.1	W
62321	2006	6	10	10	18	5	59.148	N	22	59.959	W
62324	2006	6	11	9	36	4	2.651	N	22	59.232	W
ADB 63950	2006	6	13	19	0	0	0.66	S	22	59.515	W
ADB 62243	2006	6	13	19	0	0	0.66	S	22	59.515	W
ADB 60356	2006	6	13	19	0	0	0.66	S	22	59.515	W
ADB 62896	2006	6	13	19	0	0	0.66	S	22	59.515	W

62323	2006	6	14	19	30	2	2.518	S	22	59.287	W
62317	2006	6	15	13	4	4	0.151	S	23	0.08	W

Table 4: deployment log for XBTs.

XBT file ID	***Date***	***Time (UTC)***	***Lat***	***Lon***
X060531N03	5/31/2006	16:50	16.108	-44.976
X060602N01	6/2/2006	03:48	15.258	-37.544
X060602N02	6/2/2006	07:03	15.577	-36.976
X060602N03	6/2/2006	09:23	15.82	-36.543
X060602N04	6/2/2006	11:58	16.103	-36.036
X060602N05	6/2/2006	14:32	16.379	-35.545
X060602N06	6/2/2006	16:46	16.61	-35.133
X060602N07	6/2/2006	19:49	16.898	-34.541
X060602N08	6/2/2006	22:24	17.072	-33.994
X060603N01	6/3/2006	00:40	17.219	-33.525
X060603N02	6/3/2006	03:04	17.379	-33.016
X060603N03	6/3/2006	05:38	17.543	-32.494
X060603N04	6/3/2006	07:57	17.695	-32.011
X060603N05	6/3/2006	10:19	17.848	-31.525
X060603N06	6/3/2006	12:48	18.009	-31.01
X060603N07	6/3/2006	15:16	18.166	-30.511
X060603N08	6/3/2006	18:00	18.345	-29.933
X060603N09	6/3/2006	19:59	18.48	-34.507
X060603N10	6/3/2006	22:11	18.625	-29.039
X060604N01	6/4/2006	00:42	18.792	-28.506
X060604N02	6/4/2006	03:05	18.945	-28.013
X060604N03	6/4/2006	05:24	19.098	-27.518
X060604N04	6/4/2006	08:01	19.27	-26.972
X060604N05	6/4/2006	10:16	19.41	-26.519
X060604N06	6/4/2006	12:51	19.575	-25.989
X060604N07	6/4/2006	12:56	19.582	-25.966
X060604N08	6/4/2006	15:32	19.747	-25.475
X060604N09	6/4/2006	17:43	19.873	-25.026
X060604N10	6/4/2006	17:50	19.881	-24.998
X060604N11	6/4/2006	20:02	20.023	-24.543
X060604N12	6/4/2006	22:49	20.204	-23.959
X060605N01	6/5/2006	00:53	20.344	-23.508
X060605N02	6/5/2006	04:18	20.503	-22.988
X060605N03	6/5/2006	06:55	20.262	-23
X060605N04	6/5/2006	11:13	19.777	-23
X060606N01	6/6/2006	10:38	17.247	-22.87
X060606N02	6/6/2006	11:55	17.012	-22.816
X060606N03	6/6/2006	13:19	16.727	-22.772
X060606N04	6/6/2006	14:47	16.514	-22.737
X060606N05	6/6/2006	16:07	16.253	-22.621
X060606N06	6/6/2006	17:20	16.008	-22.59
X060606N07	6/6/2006	18:35	15.759	-22.67

X060606N08	6/6/2006	19:49	15.498	-22.738
X060606N09	6/6/2006	21:02	15.24	-22.806
X060606N10	6/6/2006	21:11	15.204	-22.815
X060606N11	6/6/2006	22:18	14.971	-22.878
X060606N12	6/6/2006	23:16	14.767	-22.93
X060607N01	6/7/2006	03:15	14.26	-22.988
X060607N02	6/7/2006	06:56	13.771	-22.999
X060607N03	6/7/2006	10:43	13.253	-23
X060607N04	6/7/2006	14:29	12.768	-23.009
X060607N05	6/7/2006	18:59	12.248	-23
X060607N06	6/7/2006	22:45	11.85	-23
X060607N07	6/7/2006	23:52	11.663	-23
X060608N01	6/8/2006	10:02	11.341	-23
X060608N02	6/8/2006	11:01	11.175	-23
X060608N03	6/8/2006	14:14	10.873	-23.016
X060608N04	6/8/2006	15:36	10.67	-23.032
X060608N05	6/8/2006	19:13	10.325	-23
X060608N06	6/8/2006	20:24	10.15	-23
X060608N07	6/8/2006	23:51	9.848	-23
X060609N01	6/9/2006	01:06	9.664	-23
X060609N02	6/9/2006	04:23	9.346	-23.002
X060609N03	6/9/2006	05:30	9.182	-23
X060609N04	6/9/2006	05:33	9.17	-23.001
X060609N05	6/9/2006	09:31	8.762	-23
X060609N06	6/9/2006	14:14	8.249	-22.993
X060609N07	6/9/2006	18:41	7.773	-22.997
X060609N08	6/9/2006	23:12	7.244	-22.999

Leg 2

Hydrography:

CTD console, LADCP operation and recovery:
Claudia Schmid, Gustavo Goni (NOAA/AOML)
Oxygen sampling and titration, LADCP operation and deployment:
Pedro Pena (NOAA/AOML)
Oxygen sampling, CTD processing, LADCP operation and deployment:
Derrick Snowden (NOAA/AOML)
Salt sampling, processing and deployment, XBT deployment:
Kyle Howell (Florida Institute of Technology)
CTD console, Salt sampling, XBT deployment:
Chris Jeffery (NOC Southampton)
Salt processing:
Seydi Ababacar Ndiaye (Cheikh Anta Diop University)

Order of operations:

Leg two of the 2006 AMMA/PNE cruise RB0605 was scheduled to depart Recife, Brazil on 22 June and arrive in Charleston on 16 July at 13:00. Because of expected deliveries of spare parts and mail the departure on 22 June was delayed to 19:30.

The RHB headed east to 5ºS, 23ºW and started the CTD section towards the north on June 25. The stations were occupied every half-degree, except between 2ºS and 2ºN, where the stations spacing was a quarter degree (Figure 11). The section ended at 14.5ºN. Upon departure from the Cape Verde Islands an XBT section was done between 24ºW and 60.5ºW.

A fly by of the mooring at 4ºN, 23ºW was done.

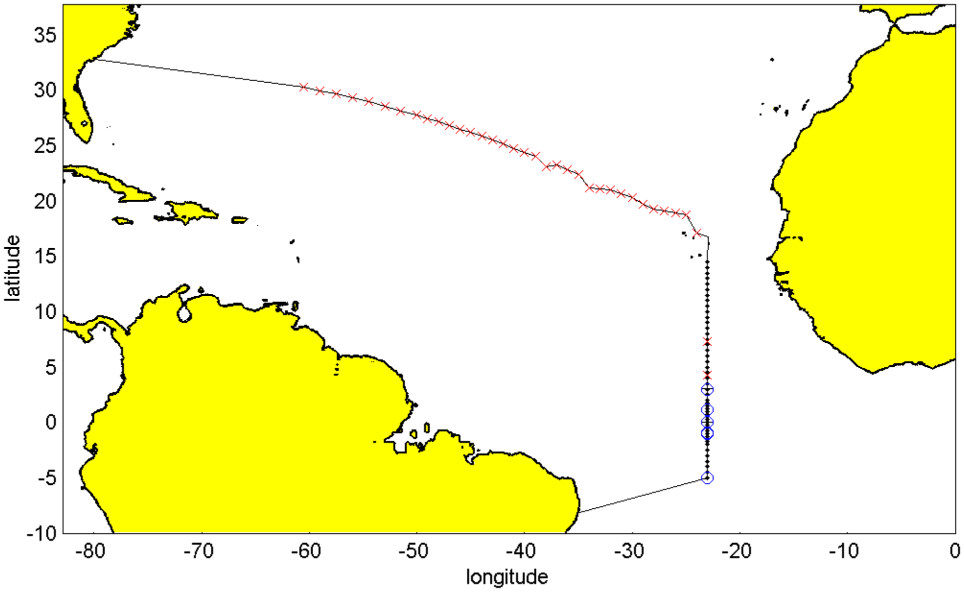

Fig. 11: cruise track of the R/V Ronald H. Brown during RB0605b (black), with CTD stations (black bullets), drifter deployments (blue circles), float deployments (black plusses) and XBT profiles (red crosses).

Oceanographic data collected on this leg:

1. Conductivity-Temperature-Depth (CTD) data were collected at 48 casts (Table 5). All casts were conducted to a pressure of 1500dbar, or the bottom (if shallower). On all casts water samples were taken at various depths to calibrate salinity and oxygen sensors.
2. Lowered Acoustic Doppler Current Profiler (LADCP) data were collected at all casts. These data were collected using two 300 kHz workhorse LADCPs.
3. 36 expendable bathythermographs (XBTs) were launched to measure temperature profiles of the upper ocean (Table 6).
4. 2 ARGO floats were deployed to measure temperature and salinity profiles and currents at 2000m depth, as part of the 3000 float global array (Table 7).
5. 9 satellite-tracked surface drifters were deployed to measure sea surface temperature and mixed layer currents, as part of the 1250 drifter global array (Table 7).
6. Shipboard data was collected throughout the cruise using a 75 kHz Ocean Surveyor hull-mounted Acoustic Doppler Current Profiler (SADCP). Heading

data for the SADCP was provided by the MAHRS system, with data from the ship's gyro for comparison.

On this cruise, XBT temperature profiles and CTD temperature/salinity profiles were transmitted in near-real time via the Global Telecommunication System (GTS) for model calibration and validation. Although XBT data is commonly transmitted on the GTS from Voluntary Observation Ships, this is the first time to our knowledge that CTD data have been transmitted in near-real time for weather and climate prediction.

Conductivity-Temperature-Depth (CTD) casts

We conducted 48 CTD casts (Table 5). One cast, #89 at 6º59.9'N, 23º0.0'W, was conducted above a bathymetric feature associated with the Sierra Leone Rise where the bottom depth was 1492m; this cast was conducted to 1401 dbar, since the height above the bottom could not be measured (altimeter on the CTD package kept reporting ~510m). On each cast, water samples were obtained via 12 Niskin bottles. Oxygen and salinity were sampled for sensor calibration. Oxygen was sampled from all bottles. Salinity was sampled from every second bottle since, CTD calibration (D. Snowden) during leg 1 suggested that the conductivity sensors were experiencing no significant drift with time or dependence upon pressure, and that fewer samples could be processed to maintain comparable accuracy. To learn more about the large oxygen differences at 15 m another bottle was closed at 40m (in the mixed layer) starting with cast 64 (before only two casts a day had several mixed layer bottles to help the chlorophyll A project). CTD processing was performed using Seabird software and Matlab routines developed by C. Fonseca, who provided several time-intensive training pre-cruise sessions.

CTD casts are tabulated in Table 5, and preliminary sections are shown below.

The Temperature-Salinity structure along 23ºW from the CTD casts is shown in Fig. 12. The nearly linear T-S relationship at intermediate densities is the signature of Central Water. A few casts have problems with salinity spikes. These will be removed in the final data processing.

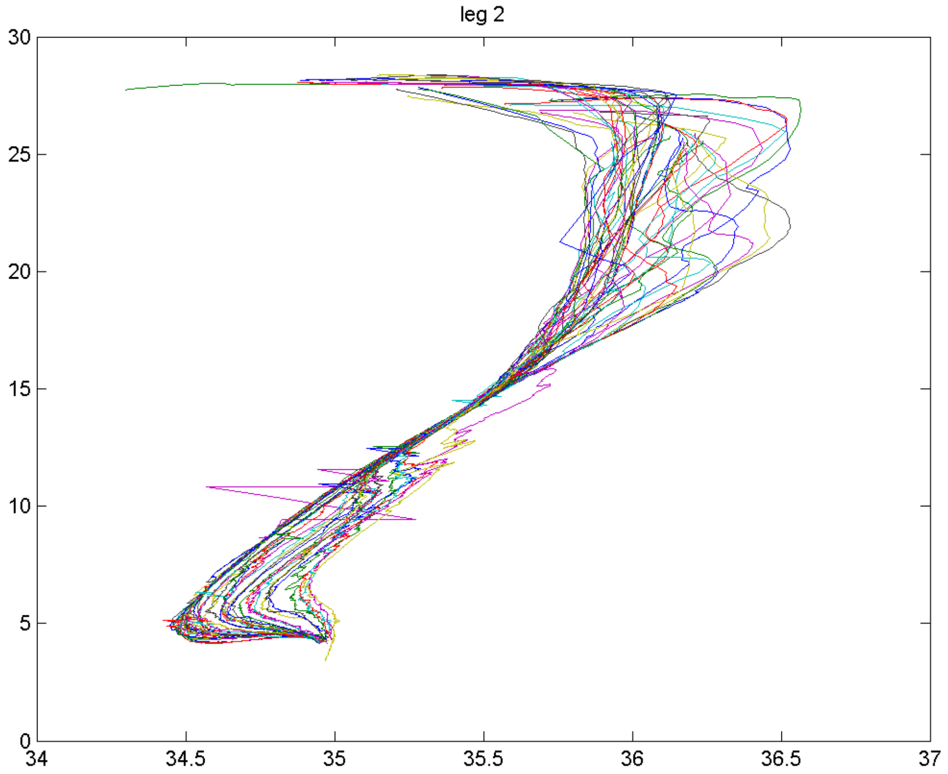

Fig. 12: temperature (ºC) vs. salinity (psu) at 23ºW.

Lowered Acoustic Doppler Current Profilers (LADCP)

A dual 300 kHz ADCP system was deployed in the CTD package at each cast. The LADCP acquisition computer and power supply was set up in the aft wet lab, so that there was a short distance to run the sea cables – one for power, and two for communication with the instruments – to the package. We performed first pass processing incorporating navigation data on the data acquisition PC in the wet lab immediately after each cast, using processing software developed by M. Visbeck, A. Thurnherr, and L. Beal. We used the LADCP-derived depth and the engineering plots and warning messages from this software to assess the quality of the data download before erasing the LADCP recorders.

For all casts, one of the four beams on the downward-looking ADCP experienced dropouts, resulting in a significant fraction of the processed solution being “three beam”. In the velocity sections below the shear solution velocities are shown, since the problem with the navigation data (see leg 1) could not be solved on board. We anticipate that this issue will be resolved in post-processing.

Expendable Bathythermograph (XBT) casts

A total of 36 XBTs were dropped during leg two of the cruise (Table 6). These measured temperature to depths of 900m. The data were collected with the system using a hand launcher provided by the ship.

Floats and Drifters

Two floats and nine drifters were deployed during leg two of the cruise, as shown in Fig. 11 and compiled in Table 7. The floats were Argo WHOI-SOLO, designed to sink to a parking depth of 1000m, stay there for 10 days following currents at that depth, then sink to 2000m before rising to the surface while profiling temperature and conductivity for transmission to Argos satellites.

The drifters were mini-Surface Velocity Program satellite-tracked drifting buoys, drogued at 15m to follow mixed layer currents. All included a thermistor on the surface buoy for SST. Their data are transmitted in real time via the Argos system. During this cruise, a cluster of four drifters was deployed on the equator as part of the Atlantic Data Buoy (ADB) study. The goal of ADB is to compare the performance and lifetime of drifters from each of the four manufacturers (Clearwater, Metocean, Pacific Gyre and Technocean) tapped by NOAA’s Global Drifter Program.

Preliminary property sections

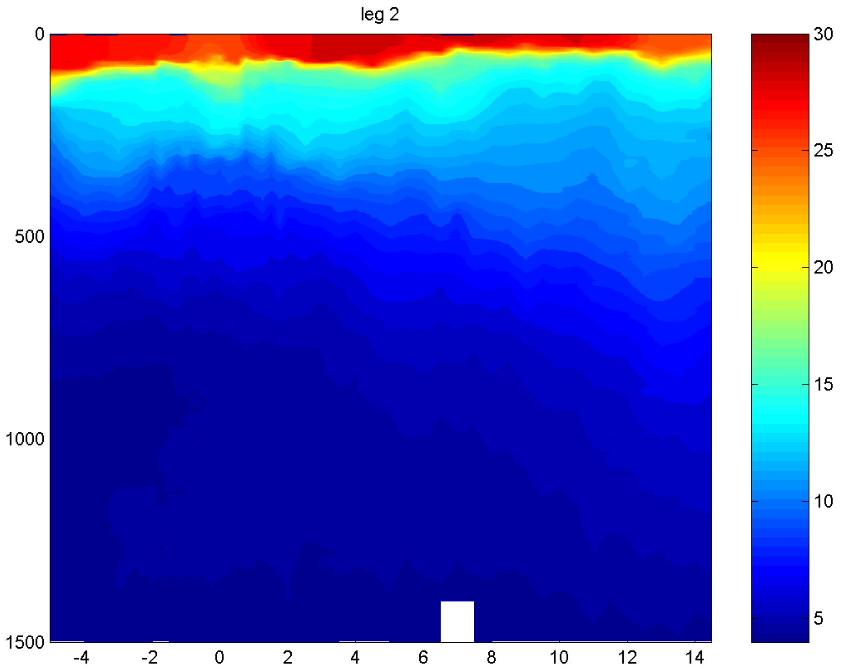

Fig. 13: temperature (ºC) section at 23ºW.

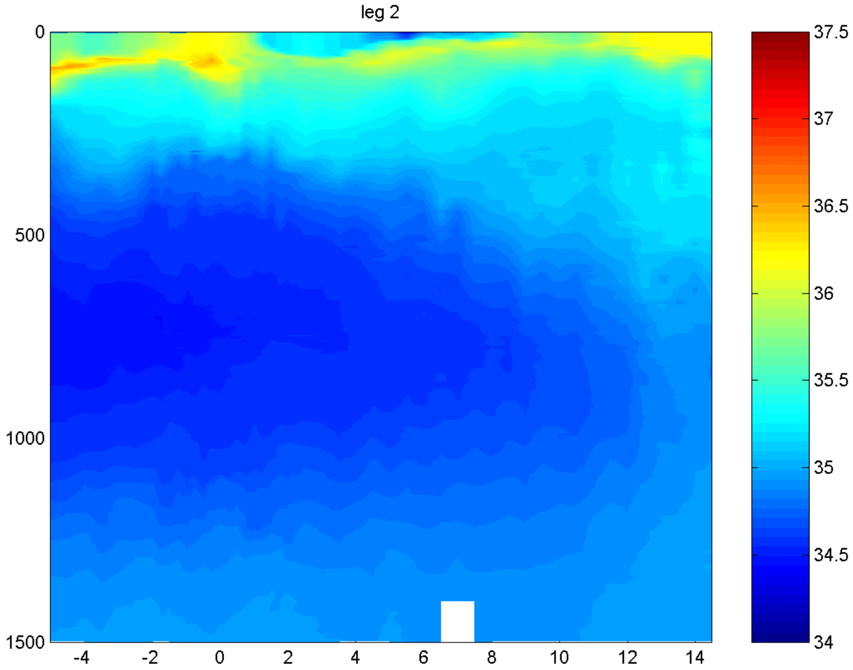

Fig. 14: salinity (psu) section at 23ºW.

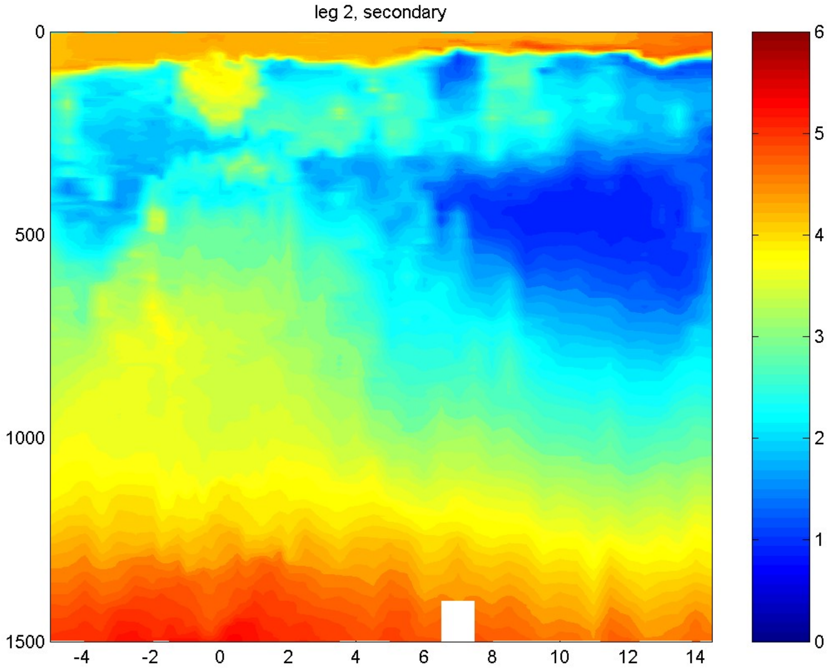

Fig. 15: oxygen (ml/l) section at 23ºW.

The temperature salinity and oxygen sections from legs 1 and 2 look quite similar at first glance. The sections of the differences (Fig. 16 and 17) of these properties reveal some interesting changes over time (final calibration is needed to analyze them). For example, the temperature at about 100 dbar increased by about 6ºC south of 1ºN and near 12ºN. This indicates that the thickness of the mixed layer may have increased. The salinity difference also reveals some interesting features. As for the temperature the differences at about 100 dbar may be linked to a deepening of the mixed layer. In addition there are signs of freshening by 0.8 psu in the mixed layer at various latitudes, and at the about 100 dbar at the northern end of the section (coinciding with cooling), which may be due to a shoaling of the mixed layer.

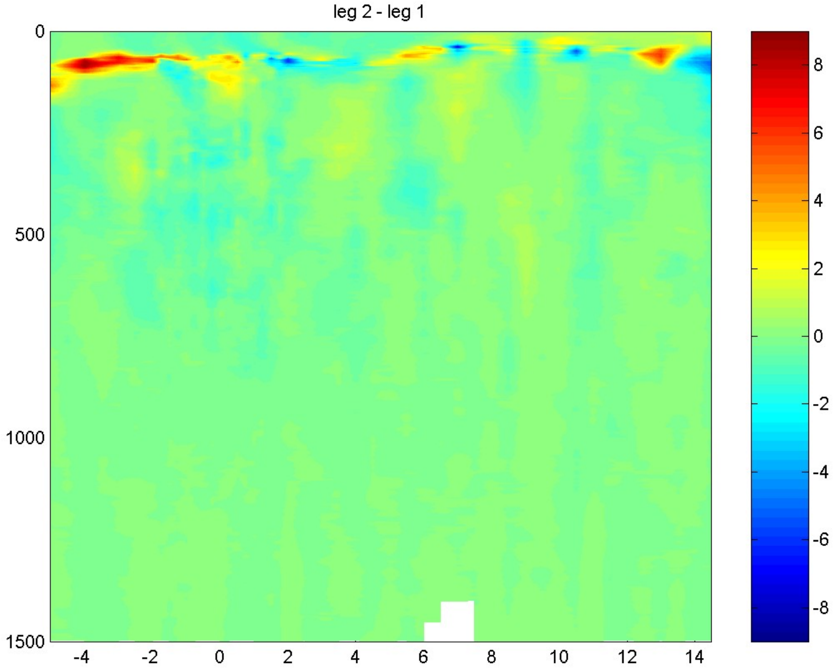

Fig. 16: temperature difference (ºC) section at 23ºW.

The section of the zonal velocity (Fig. 18) shows the same features as the one obtained during leg 1, but there are some differences. The Equatorial Undercurrent (EUC) has lost some of the near-surface signature it had during leg 1 and the northern South Equatorial current (nSEC) has strengthened. As for the hydrographic data, a post-cruise calibration of the velocity has to be done before an analysis of these differences can be done.

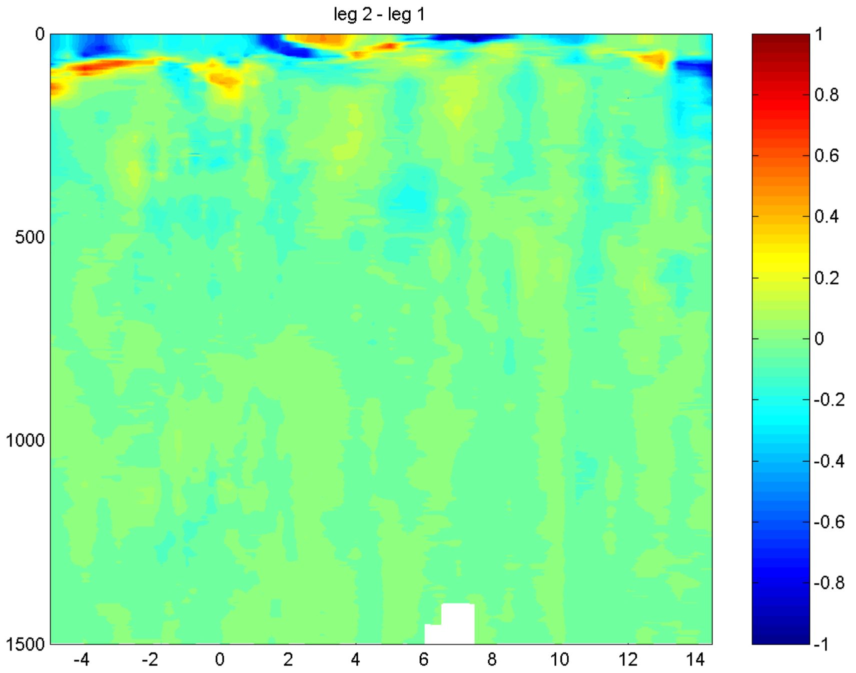

Fig. 17: salinity difference (psu) section at 23ºW.

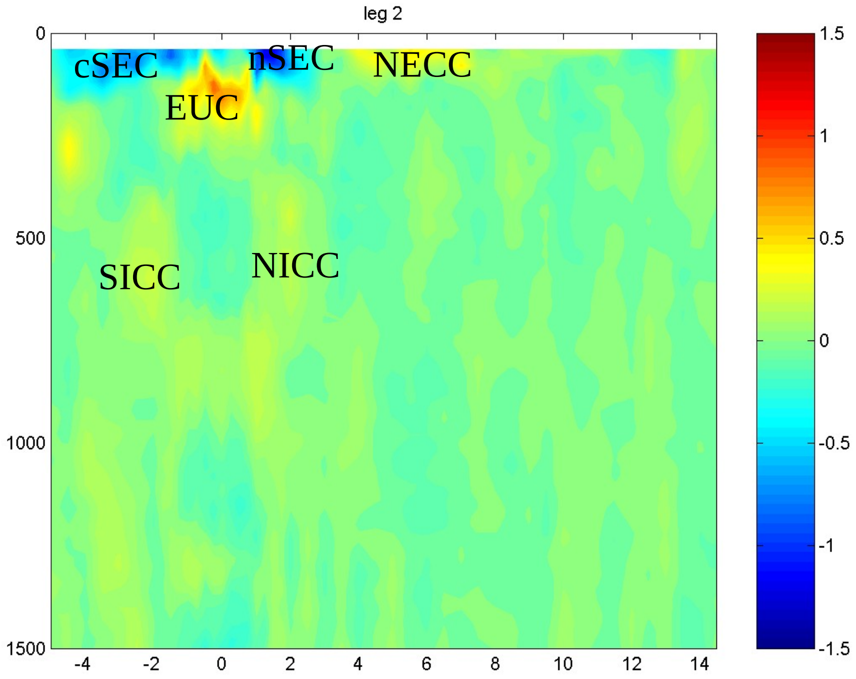

Fig. 18: zonal velocity (m/s; red=eastward, blue=westward) measured by the LADCP system along 23ºW.

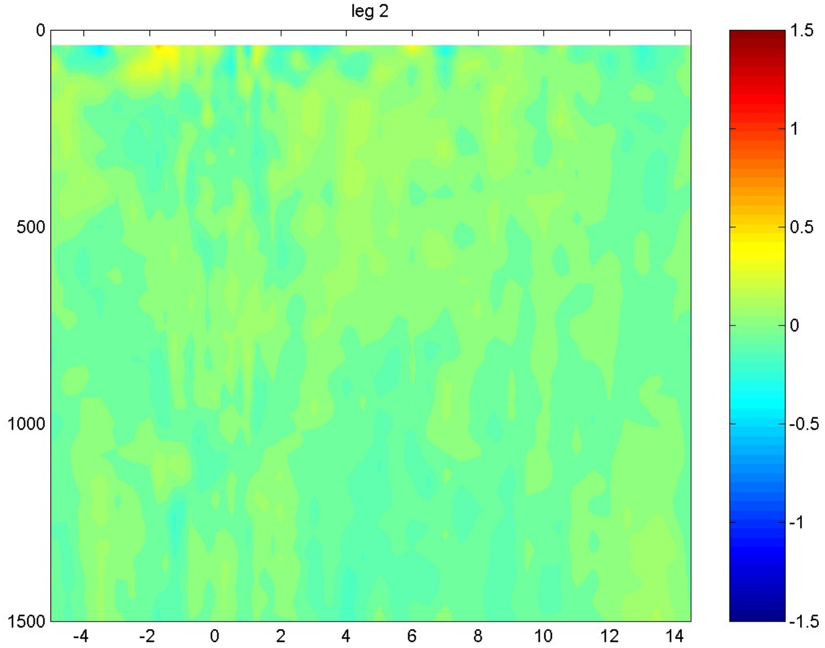

Fig. 19: meridional velocity (m/s; red=eastward, blue=westward) measured by the LADCP along 23ºW.

Problems:

- A small engine problem (contaminated fuel – changing of filters) had to be fixed. The problem caused no significant delay.
- Multiple nylon lines in bottles broke. The flying spring can cause injuries. Suggestion: replace the nylon lines on a regular basis.
- Communications with Master LADCP failed (between casts 80 and 81). Troubleshooting indicates that the data cable was the cause; a temporary fix of the cable was done.
- CTD data acquisition stopped during cast 82 -> have files pne06082* and pne06082up*. The same thing happened during cast 95 -> have files pne06095* and pne06095up*. No other communication problems between the CTD console and the package were experienced during the cruise.
- We employed a relatively new frame, which may have caused some bottle firing failures due to the carousel pins impacting the frame – particularly the pin for bottle #11, which struck the frame at an oblique angle and may have resulted in slight malformation of the pin’s end. Filed the deformations off to reduce friction and put foam pad on the frame to avoid additional deformation. These pads could not withstand the high pressure during the casts, so they gradually lost their effectiveness.

- Altimeter did not work about 100 m above bottom during the only cast with bottom approach on leg 2.
- Communication with LADCP problematic after cast 98. Break could be sent to both, but then BBTALK only worked for either the downward or the upward-looker. Maybe there is a problem with the star cable, or it happened because break was sent to upward-looker before downward-looker.

Station Tables:

Table 5: location and time of CTD casts

CTD cast #	Date	Time (UTC)	Lat	Lon
57	25-06-2006	16:51	-5 -00.053	-23 -0.093
58	25-06-2006	21:35	-4 -30.002	-23 -0.070
59	26-06-2006	01:14	-3 -59.950	-23 -0.150
60	26-06-2006	06:60	-3 -30.039	-23 -0.045
61	26-06-2006	11:48	-2 -59.987	-23 -0.174
62	26-06-2006	16:46	-2 -30.040	-23 -0.160
63	26-06-2006	20:16	-1 -59.940	-23 -0.030
64	26-06-2006	23:09	-1 -44.887	-23 -0.142
65	27-06-2006	02:07	-1 -29.917	-23 -0.109
66	27-06-2006	05:04	-1 -14.990	-23 -0.039
67	27-06-2006	10:48	0 -59.918	-23 -0.330
68	27-06-2006	13:49	0 -44.900	-23 -0.158
69	27-06-2006	17:35	0 -29.998	-23 -0.045
70	27-06-2006	20:33	0 -14.867	-22 -59.944
71	27-06-2006	22:20	0 00.033	-22 -59.984
72	28-06-2006	01:19	0 14.990	-23 -0.065
73	28-06-2006	04:21	0 29.943	-23 -0.007
74	28-06-2006	07:17	0 45.022	-23 -0.296
75	28-06-2006	10:10	0 59.988	-23 -0.218
76	28-06-2006	13:07	1 14.870	-23 -0.048
77	28-06-2006	17:35	1 30.179	-23 -0.297
78	28-06-2006	20:33	1 44.945	-23 -0.071
79	28-06-2006	22:30	1 59.989	-23 -0.063
80	29-06-2006	03:07	2 29.990	-23 -0.034
81	29-06-2006	08:42	2 59.948	-22 -59.999
82	29-06-2006	12:15	3 29.985	-23 -0.028
83	29-06-2006	17:24	4 00.019	-22 -59.961
84	29-06-2006	23:25	4 30.024	-22 -59.952
85	30-06-2006	04:50	4 59.989	-22 -59.906
86	30-06-2006	08:17	5 29.992	-22 -59.997
87	30-06-2006	13:41	5 59.879	-22 -59.914
88	30-06-2006	18:59	6 29.803	-22 -59.803
89	30-06-2006	23:42	6 59.944	-22 -59.968
90	01-07-2006	03:29	7 29.146	-22 -59.847

91	01-07-2006	08:16	8 00.053	-23 -0.050
92	01-07-2006	13:50	8 29.954	-22 -59.987
93	01-07-2006	18:01	8 59.987	-23 00.000
94	01-07-2006	22:27	9 30.031	-22 -59.960
95	02-07-2006	03:51	9 59.955	-22 -59.990
96	02-07-2006	08:33	10 30.095	-23 -0.003
97	02-07-2006	12:07	10 59.990	-23 -0.004
98	02-07-2006	17:21	11 29.386	-22 -59.721
99	02-07-2006	22:19	11 59.970	-23 -0.019
100	03-07-2006	04:31	12 29.931	-23 -0.075
101	03-07-2006	08:16	13 00.036	-22 -59.990
102	03-07-2006	13:29	13 29.901	-22 -59.826
103	03-07-2006	18:33	14 00.034	-22 -59.960
104	03-07-2006	21:28	14 29.966	-22 -59.989

Table 6: deployment log for XBTs.

XBT file ID	Date	Time (UTC)	Latitude	Longitude
X060629N01	29-06-2006	19:00	4.250	-23.000
X060701N01	01-07-2006	02:26	7.320	-23.000
X060705N01	05-07-2006	12:33	7.106	-24.000
X060705N02	05-07-2006	16:54	18.786	-24.991
X060705N03	05-07-2006	21:15	18.939	-26.000
X060706N01	06-07-2006	01:33	19.092	-27.007
X060706N02	06-07-2006	05:39	19.233	-28.000
X060706N03	06-07-2006	10:45	19.722	-29.002
X060706N04	06-07-2006	15:33	20.293	-30.000
X060706N05	06-07-2006	20:27	20.647	-31.010
X060707N01	07-07-2006	01:07	21.016	-32.000
X060707N02	07-07-2006	06:05	21.058	-33.000
X060707N03	07-07-2006	10:32	21.163	-34.000
X060707N04	07-07-2006	15:13	22.398	-35.000
X060707N05	07-07-2006	20:03	22.814	-36.000
X060708N01	08-07-2006	00:40	23.228	-37.000
X060708N02	08-07-2006	05:11	23.105	-38.000
X060708N03	08-07-2006	09:57	24.025	-39.000
X060708N04	08-07-2006	14:18	24.393	-40.000
X060708N05	08-07-2006	18:50	24.758	-40.983
X060708N06	08-07-2006	23:22	25.130	-42.000
X060709N01	09-07-2006	03:47	25.499	-43.000
X060709N02	09-07-2006	08:16	25.858	-44.000
X060709N03	09-07-2006	12:41	26.176	-45.000

X060709N04	09-07-2006	16:57	26.494	-46.000
X060709N05	09-07-2006	21:22	26.817	-47.000
X060610N01	10-07-2006	01:36	27.132	-48.000
X060610N02	10-07-2006	05:58	27.455	-49.010
X060610N03	10-07-2006	10:13	27.738	-50.000
X060610N04	10-07-2006	16:43	28.150	-51.504
X060610N05	10-07-2006	23:04	28.549	-53.000
X060711N01	11-07-2006	05:38	28.955	-54.500
X060711N02	11-07-2006	11:45	29.315	-56.000
X060711N03	11-07-2006	17:59	29.648	-57.488
X060712N01	12-07-2006	00:41	29.977	-59.000
X060712N02	12-07-2006	07:15	30.311	-60.500

Table 7: deployment log for floats (top) and drifters (bottom). "ADB" refers to the Atlantic Data Buoy comparison study.

ID number	Date	Time (UTC)	Latitude	Longitude
ARGO floats				
589/64079	27/6/2006	23:38	0° 0.333 N	22° 59.990 W
588/64078	29/6/2006	9:03	3° 1.517 N	22° 59.982 W
Drifters				
62319	25/6/2006	17:10	5° 0.0 S	23° 0.11 W
62318	26/6/2006	12:30	2° 59.464 S	23° 0.286 W
62314	27/6/2006	11:15:00	0° 58.39 S	23° 0.370 W
63949 ADB	27/6/2006	23:38	0° 0.294 N	22° 59.982 W
60359 ADB	27/6/2006	23:38	0° 0.294 N	22° 59.982 W
62241 ADB	27/6/2006	23:38	0° 0.294 N	22° 59.982 W
62902 ADB	27/6/2006	23:38	0° 0.294 N	22° 59.982 W
62313	28/6/2006	12:25:56	1° 9.41 N	23° 0.313 W
62312	29/6/2006	8:59:14	2° 59.99 N	22° 59.979 W

From float status table on AOML's Argo operations web page

```
AOML   WMO    TRANS profiles       period               QC % failed
 ID     ID     ID                                       Tp  Tm  Sp  Sm
1872 1900713 64078 28 ( 28) 29.06.2006 - 26.03.2007  0%  0%  4%  0%
2160 1900712 64079 24 ( 24) 27.06.2006 - 13.02.2007  0%  0%  4%  0%
```

`Both floats perform well (small percentages indicate good profiles) and are still active.`

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Luyten, J. R. and H. Stommel, 1986: Gyres driven by combined wind and buoyancy flux. *J. Phys. Oceanogr.*, **16**, 1551-1560.

Sielder, G., N. Zangenberg, R. Onken and A. Morliere, 1992: Seasonal changes in the tropical Atlantic Ocean: observations and simulations of the Guinea Dome. *J. Geophys. Res.*, **97**, 703-715.

Stramma, L., S. Huttl and J. Schafstall, 2005: Water masses and currents in the upper tropical northeast Atlantic off northwest Africa. *J. Geophys. Res*., **110**, C12006, doi:10.1029/2005JC002939.

Appendix A

University of Miami
Rosenstiel School of Marine and Atmospheric Science

Cruise Report

AMMA / AEROSE II

NOAA Ship Ronald H. Brown
24 May to 15 July, 2006
by Peter Minett & Malgorzata Szczodrak

Personnel:

Leg 1: 24 May to 18 June, 2006: San Juan, Puerto Rico – Recife, Brazil
Dr. Malgorzata Szczodrak
Mr. Miguel Izaguirre
Leg 2: 22 June to 15 July, 2006: Recife, Brazil – Charleston, SC
Dr. Malgorzata Szczodrak
Mr. Gustavo Carvalho

Scientific goals:

The goals of the University of Miami (UM) RSMAS group were:
a) to measure the skin sea surface temperature in the tropical Atlantic for validation of SST retrievals from radiometers on NASA satellites.
b) to characterize the vertical structure of the Saharan air layer (SAL) over the Atlantic Ocean, downstream of the source region over the African continent, to support future study of the influence of extreme atmospheric states on the accuracy of measurements of SST from satellites
c) to study the impact of SAL and the dust aerosol on the radiative budget in the marine atmosphere, marine boundary layer, clouds and precipitation.

To facilitate these goals the following instrumentation was installed and operated by the UM group on the Ronald H. Brown during the AMMA/AEROSE II cruise:

1) Marine Atmospheric Emitted Radiance Interferometer (M-AERI):
- infrared spectra of atmospheric emitted radiation
- infrared spectra of sea surface emitted radiation
- skin sea surface temperature
- near surface air temperature
- profiles of temperature and humidity in the boundary layer

2) Coastal Environmental System’s “Weatherpak”
- air temperature
- air relative humidity
- barometric pressure

- wind speed
- wind direction

3) gimbaled Eppley pyrometer and pyrgeometer
  - short wave insolation (SW↓)
  - incident long wave radiation (LW↓)

4) Portable Radiation Package (PRP) including Multi Frequency Rotating Shadow-Band Radiometer (MFRSR), Eppley pyrometer, and Eppley pyrgeometer
  - direct/diffuse short wave radiation (SW↓)
  - aerosol optical thickness
  - short wave insolation (SW↓)
  - incident long wave radiation (LW↓)

5) All sky camera
  - cloud cover and cloud type

6) Surface float
  - bulk sea surface temperature

7) Micropulse LIDAR
  - aerosol and cloud layers

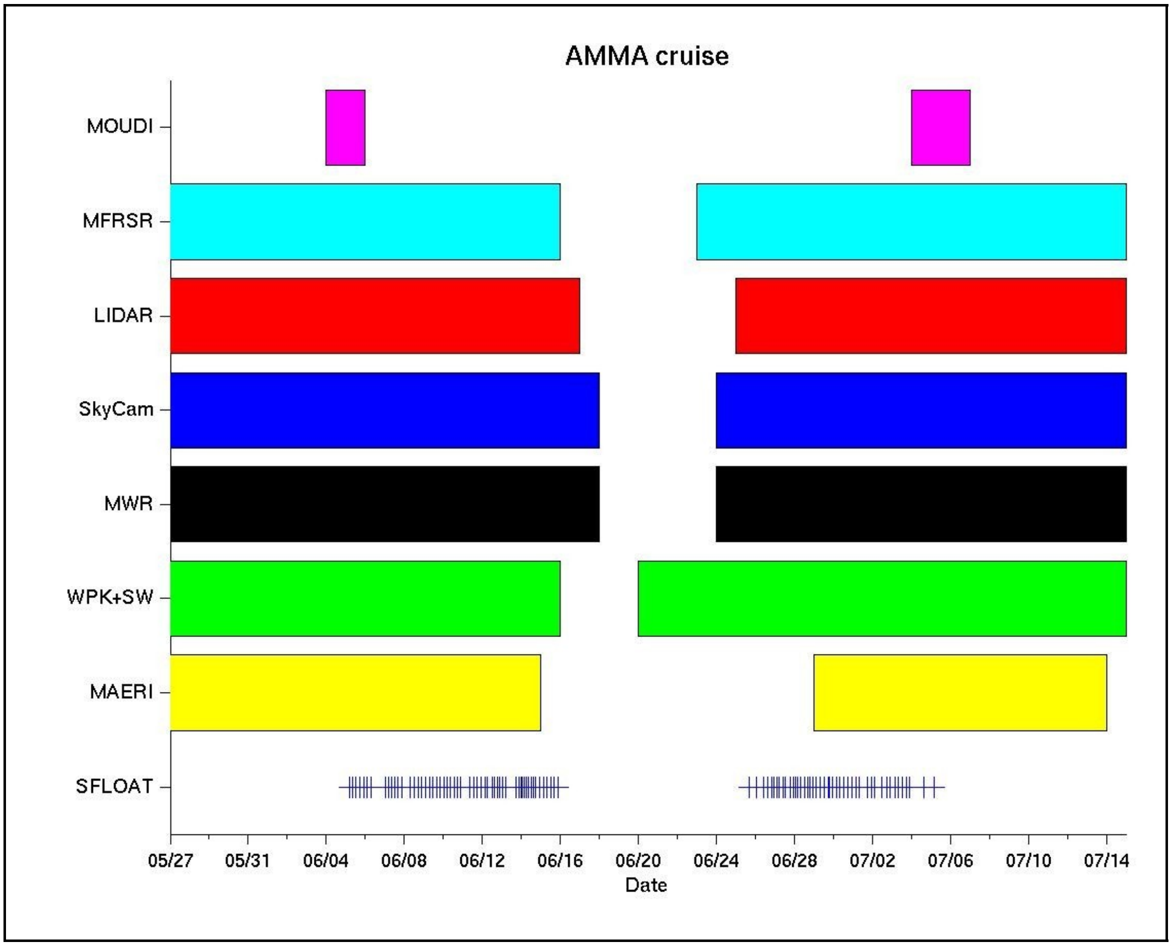
8) Microwave Radiometer (MWR)
  - precipitable water vapor (PWV)
  - cloud liquid water (CLW)

9) Micro-Orifice Uniform Deposit Impactor (MOUDI)
  - surface layer aerosol size distribution

A subset of these instruments (items 1 to 6) were installed on the French research vessel L'Atalante operating in the Gulf of Guinea and eastern Tropical Atlantic with the same objectives.

Summary of data collected:

Most of the instruments were operated continuously throughout the cruise. The surface float was deployed only when the ship was on station. Figure 1 shows the periods of operation of each of the instruments during the AMMA cruise. The gap between June 17 and 22 corresponds to the port call in Recife, Brazil. The larger gap in MAERI data is due to instrument failure. The instrument was repaired and data collection restarted on July 29. The MOUDI samples were collected only when there was indication of dust aerosol presence in the air.



From 14 to 15 July the MAERI was operating in different mode taking measurements of radiation emitted by the ocean skin surface at a range of angels to facilitate the sea surface emissivity modeling efforts.

Preliminary results:

A number of atmospheric and oceanic variables were obtained in real time: M-AERI SST and air temperature, bulk water temperature from the surface float, air temperature and humidity and barometric pressure from the Weatherpak suite, downwelling short and long wave radiation from the Eppley radiometers, and the PWV and CLW from the microwave radiometer. Figures 2a and 2b show the SST measured by M-AERI along the *Ronald H. Brown* cruise track for leg 1 and 2 respectively.

The total moisture content of the atmosphere encountered by the *Ronald H. Brown* was measured in real time by the microwave radiometer. Figures 3a and 3b show the precipitable water vapor along the ship's track on legs 1 and 2 respectively.

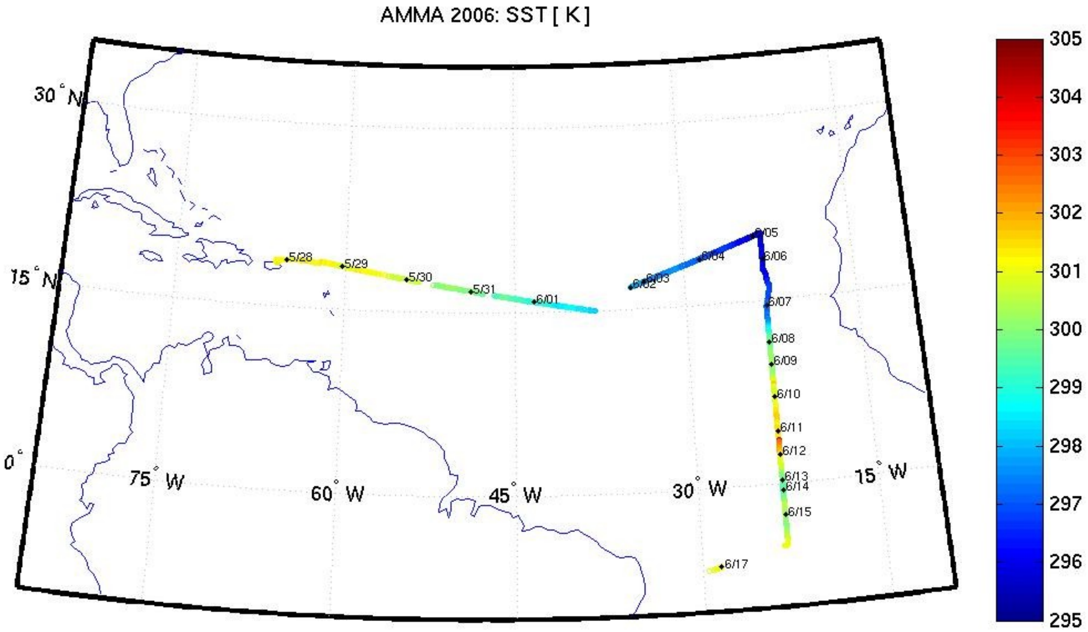


Figure 2a. SST on Leg 1.

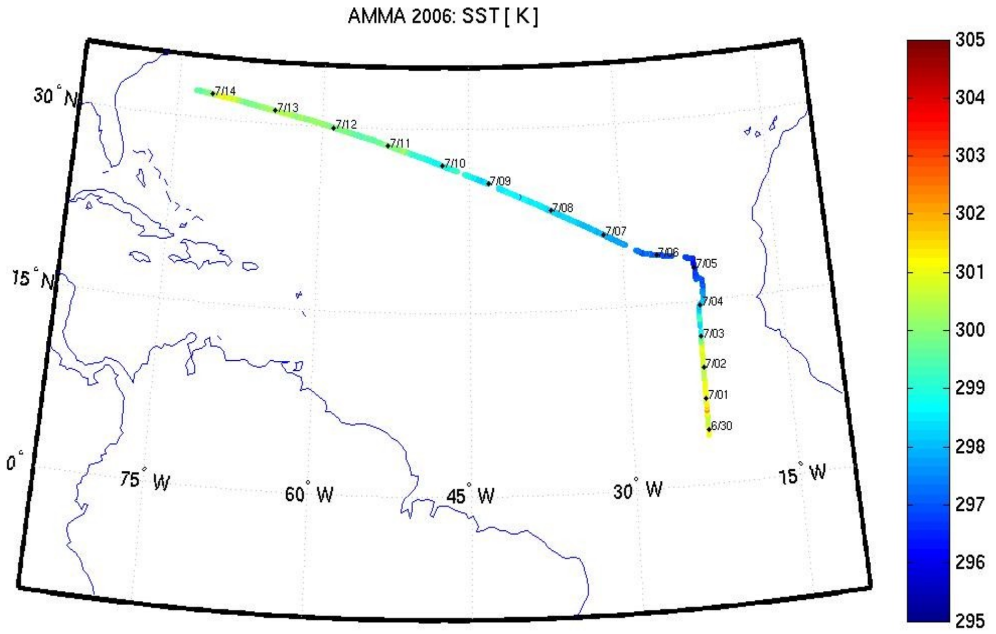


Figure 2b. SST on Leg 2.

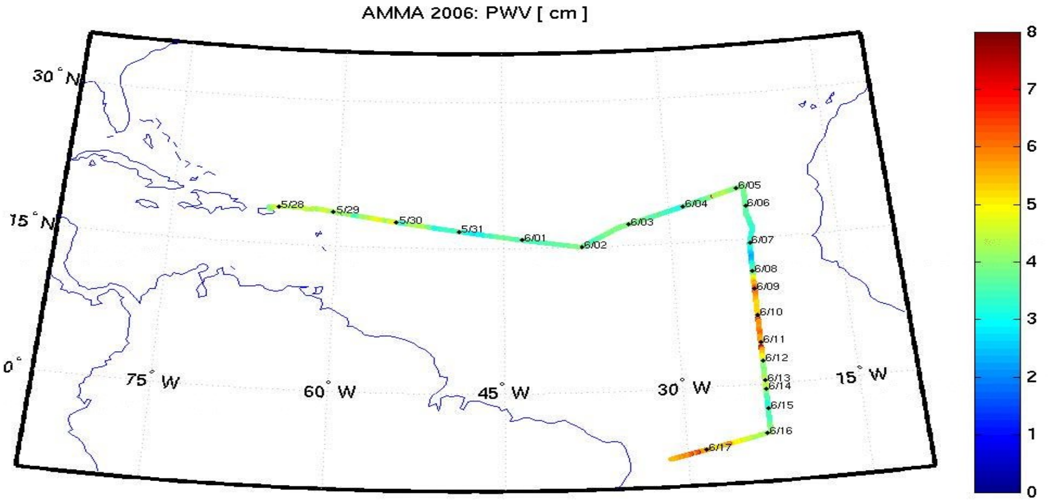


Figure 3a. Precipitable Water Vapor on Leg 1.

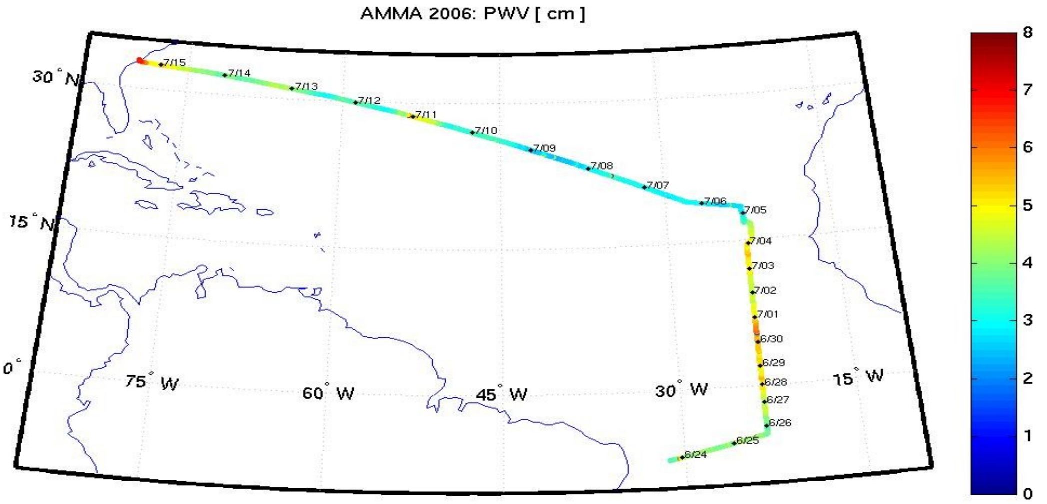


Figure 3b. Precipitable Water Vapor on Leg 2.

The retrievals of the temperature and humidity profiles in the marine boundary layer from M-AERI spectra measurements were done on ship daily. An example of the retrieved boundary layer structure is shown in Figure 4 for July 8. The red vertical lines indicate the times of radiosonde launches form the ship. The radiosonde data was used to initialize the iterative retrieval process. On July 8 *Ronald H. Brown* was in the air affected by the outflow from Africa. An elevated dry air layer (SAL) is present above the ship.

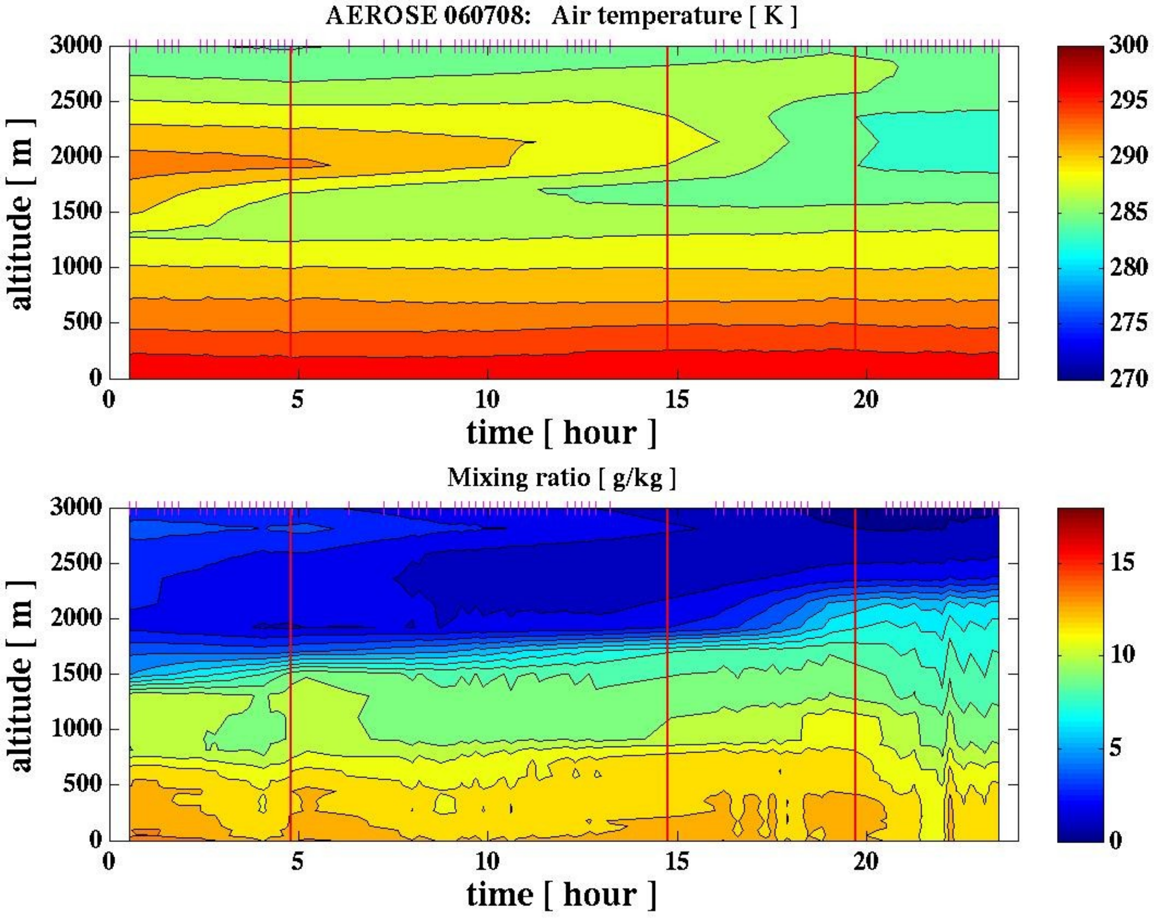


Figure 4. Temperature and mixing ratio structure in the boundary layer on 08 July 2006.

For comparison, Figure 5 shows the boundary layer structure on June 30, few days before *Ronald H. Brown* entered the area affected by SAL. No sharp gradients in the moisture field are observed on June 30.

The comparisons between the M-AERI SSTs from the *Ronald H Brown* and the *L'Atalante* and those derived from the Advanced Microwave Scanning Radiometer for the Earth Observing System (AMSR-E) on the NASA *Aqua* satellite have been completed and the results are shown in Table 1. The validation of the SSTs derived from MODIS (MODerate Resolution Imaging Spectroradiometer) on *Terra* and *Aqua* and AIRS (Atmospheric InfraRed Sounder) on *Aqua* will be done soon.

The LIDAR, PRP, All-sky Camera, and MOUDI data will be processed post cruise.

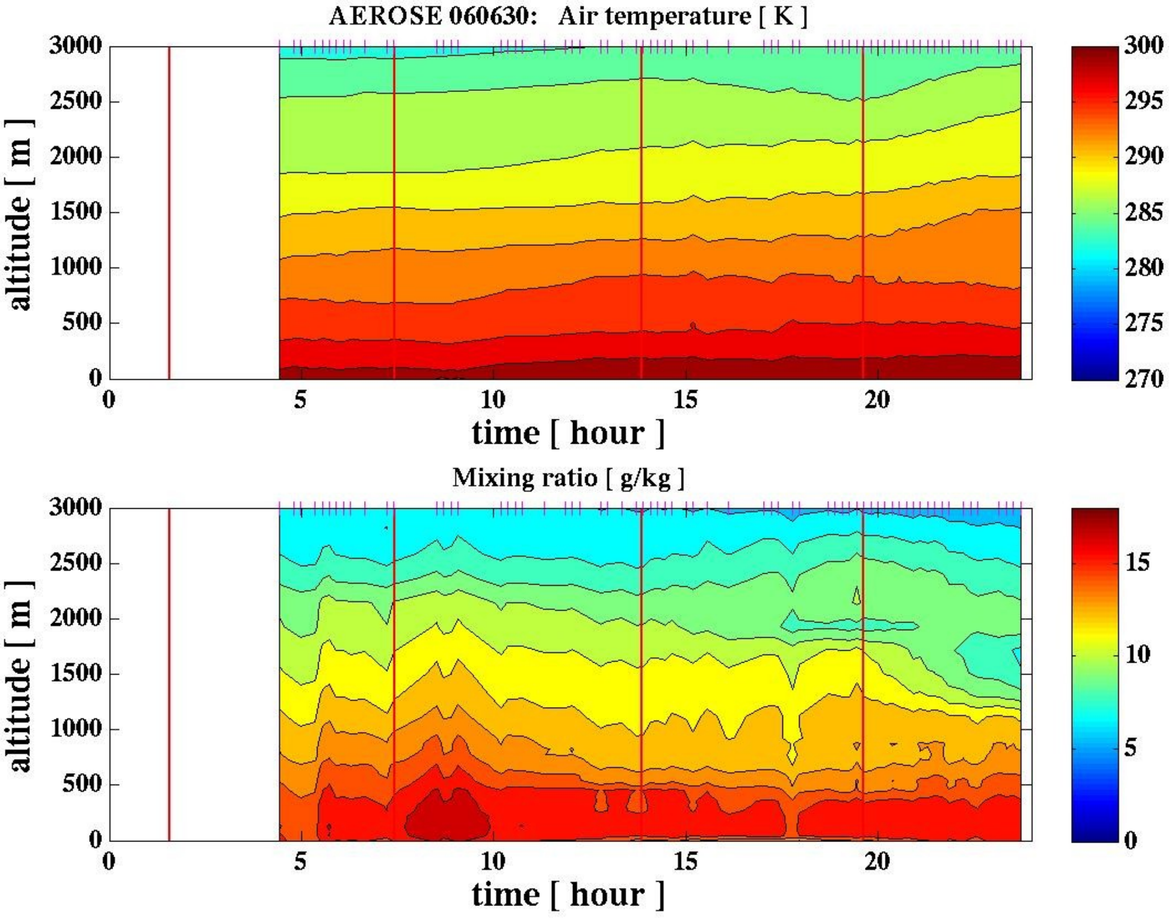


Figure 5. Temperature and mixing ratio structure in the boundary layer on 30 June 2006.

Table 1 validation statistics of AMSR-E SSTs in comparison with M-AERI measurements

	Mean	Standard deviation	N
L'Atalante	K	K	
Ascending arc (daytime)	0.033	0.478	18
Descending arc (night)	0.143	0.350	18

Both	0.088	0.421	36
Ronald H Brown			
Ascending arc (daytime)	0.105	0.439	15
Descending arc (night)	0.081	0.281	17
Both	0.092	0.358	32
Ascending (both ships)	0.065	0.455	33
Descending (both ships)	0.113	0.321	35
All	0.090	0.390	68

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Appendix B

Summary of Atmospheric Measurements for 2006 AMMA/AEROSE-II Cruise

(RB-06-05)

Vernon Morris, Howard University

1. Overview

This report documents atmospheric instrumentation that was deployed for characterization of the Saharan air layer (SAL), ambient and impacted air quality, aerosols, atmospheric profiling and environmental satellite validation. A brief description of the operations and preliminary results are also provided. Although there were several synergistic shipboard measurements acquired from collaborating institutions (e.g, M-AERI from RSMAS/University of Miami), this report summarizes only the NCAS/Howard University instrumentation and measurements.

2. Shipboard Surface Observations

A general listing of the instruments in operation taking atmospheric measurements during the cruise is given in the table below.

Instrument (Institutional Responsibility)	Deployment	Data Set
1. Five-band Sun photometer (HU)	Every 30-minutes during sunlight	Aerosol Optical Thickness
2. Micropulse Lidar (RSMAS)	Continuous	Aerosol vertical distribution
3. Wind profiler (ETL)	Continuous	Vertical distribution of wind directions
4. Laser particle counters (HU, ETL)	Continuous	Size-resolved number concentration for 0.1 – 25 microns
5. Microwave radiometer (RSMAS, ETL)	Continuous	Column water vapor
6. Broadband pyranometer (HU)	Continuous	Downwelling IR
7. Condensation nuclei counter (HU)	Daily during Leg 1	Number densities for 10 to 300 nm
8. Trace Gas Analyzers (HU)	Continuous	O_3, CO, NO_x, SO_2
9. Quartz Crystal Microbalance Cascade Impactor (HU)	Continuous	Size-resolved mass concentration for 0.15 to 10 microns
10. Partisol PM_{10} High Volume Sampler (HU)	Variable sampling throughout Leg 2	Glass fiber filters
11. Cyclone Impactor (HU)	Daily Sampling ~12Z	Biological and

		Mycological filters
12. Moudi Impactor (RSMAS)	Daily sampling Leg 2	Glass fiber filters
13. Multi-frequency Radiometer (HU, RSMAS)	Continuous	Spectral

3. Ozonesondes / Rawinsondes

A total of twenty (20) ozonesondes were launched as part of the AEROSE-II component of the cruise. Six (6) ozonesondes were launched during the southward transit of Leg 1 along 23°W. An additional fourteen (14) ozonesondes were launched during Leg 2 between 6°S and 21°N along 23°W. The table below provides the detailed information regarding the ozonesonde launches.

The schedule allowed for adequate profiling of column ozone through the smoke-impacted, dust-impacted regimes, and mixed regimes. We were successfully able to capture and contrast the O_3-dust vertical profiles for daytime and nighttime in a variety of these meteorological regimes. The schedule was designed to ensure match-ups with EOS-AQUA overpasses for all ozonesonde launches and mapping of the ozone distribution throughout the dust-impacted region surrounding Cape Verde.

The ozonesondes complemented the eighty-six (86) rawinsonde launches executed during the cruise. The AEROSE team attempted to provide match-ups with each EOS-AQUA overpass each day of the cruise.

Date	Approx Latitude at UTC Launch Time	Regime	# Sondes	Comments
6/06	16.7°N – 1301	Dust background	1	800-g
6/08	11°N – 1351	Dust background	1	1200-g
6/10	9°N – 0120	Undetermined	1	1200-g
6/11	7°N – 1303	Marine background	1	1200-g
6/14	3.9°N – 0055	Marine background	1	1200-g
6/15	0.5°S – 1356	Marine background	1	1200-g
6/26	2.5°S – 1333	Smoke	1	1200-g
6/29	1.5°N – 0156	Smoke	1	1200-g
6/29	4°N – 1420	Smoke	1	1200-g
6/30	6.5°N – 1915	Light Smoke	1	1200-g
7/1	9°N – 1406	ITCZ – transitional regime	1	1200-g (800)
7/02	11.5°N – 1315	Dust	1	800-g
7/03	14°N – 0139	Dust	2	800-g

	– 1406			
7/4	16.72ºN, 22.95ºW – 0236 – 1422	Dust-urban plume	1	800 -g
7/5	Regional – 0136 – 1354	Dust - urban plume	2	800-g
7/7	1350	Dust	1	800-g
7/8		Transitional regime	1	800-g
7/9	Subtropical	Dust	1	800-g

Shaded boxes represent areas in which major events occurred.

Figure 1 below depicts a series of raw ozonesonde plots obtained during the cruise. Ozone is given in units of partial pressure (as measured by the sonde) and plotted against altitude through July 4, 2006. The plots indicate a clearly identifiable SAL (marked by significant drying of the lower troposphere) as well as a low-lying jet that has strong influences on tropospheric ozone.

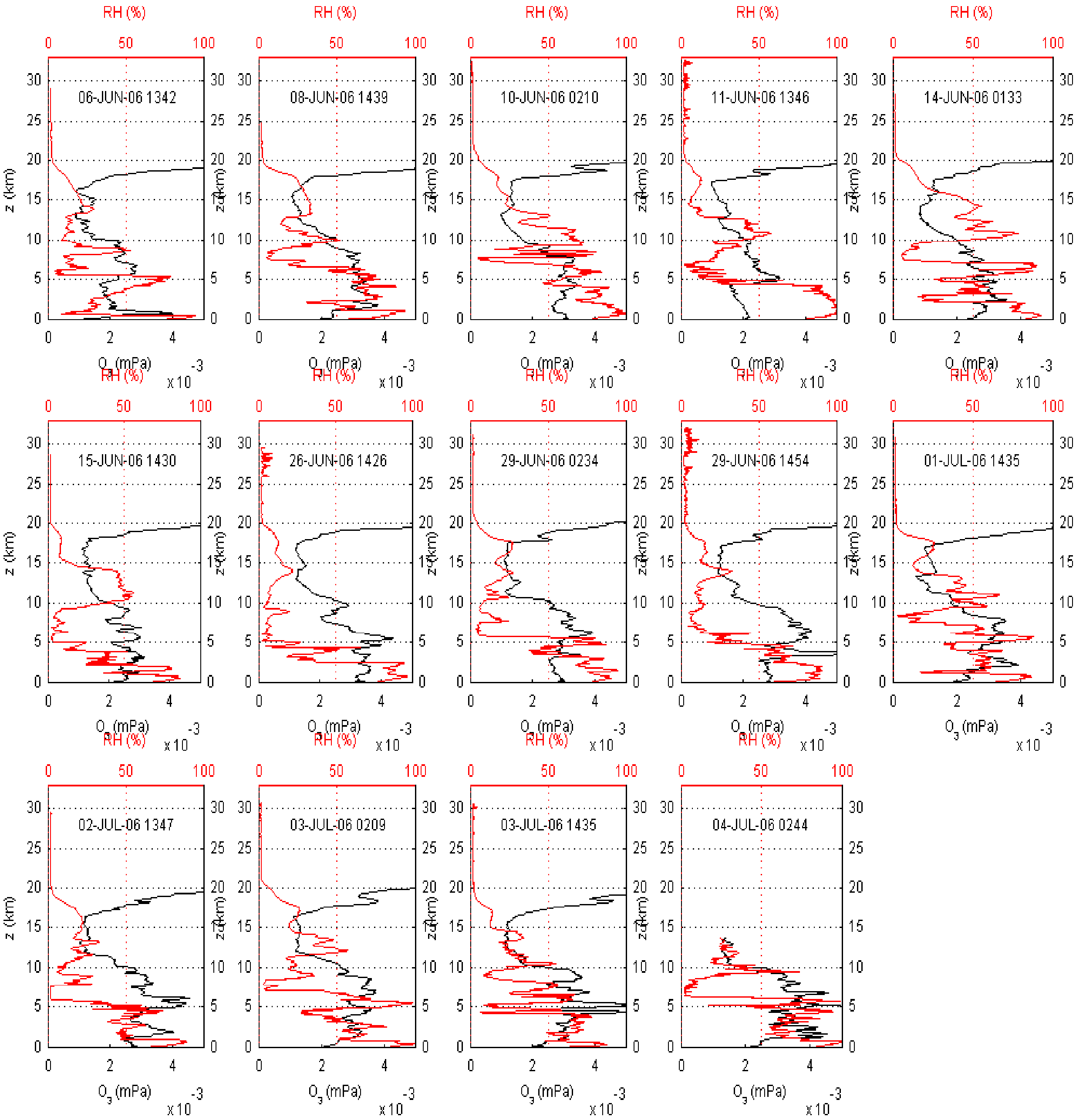

Figure 1: ***Profile measurements of ozone in partial pressure (black line and axis) and relative humidity (red line and axis) during AMMA Cruise Legs 1 and 2***

4. Trace Gases

The AEROSE Team also obtained continuous trace gas measurements (O_3, NO_x, SO_2, CO), during the dust, smoke, and dust-smoke mixture regimes. No trace gas measurements were allowed in EEZ waters other than Cape Verde.

The CO and O_3 time series during the Leg 2 return during June 26-30 are shown in Figure 2 below. These dates correspond to latitudes between 6ºS and 6.5ºN along 23ºW. The fall-off in concentration coincides with ship motion away from the streamline flow from the source region in Central Africa. Mean value of [O_3] during this portion of the transit was ~125 ppb, significantly larger than the typical values that have been observed in this region previously in AEROSE-I and by other investigators. The [O_3] levels return to ambient levels during the 29th and stabilize after that during passage through the ITCZ.

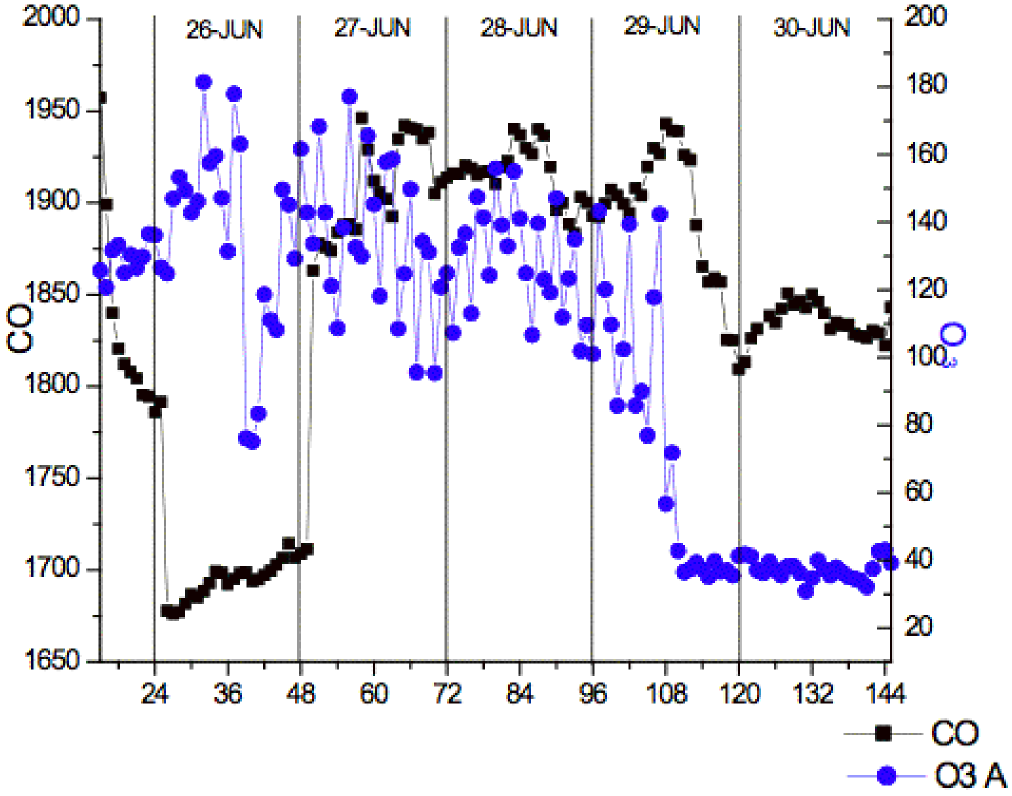

Figure 2: ***Time series of surface CO and O_3 during the AMMA Cruise Leg 2.***

The images in Figure 3 below show the fire counts and locations as determined by the FLAMBE retrieval algorithm for MODIS. The star in each image depicts the approximate position of the *Ronald H. Brown* on June 9 (left image) and June 26 (right image). In both cases the streamline flow both aloft (850 mb) and at the surface were from fire source regions. On both June 9 and June 26 the ship was located south of the ITCZ and the dominant flow patterns were easterly. However, by July 6, 2006 the ship was well north of the ITCZ and the dominant flow was a confluence of easterly and northeasterly as described before.

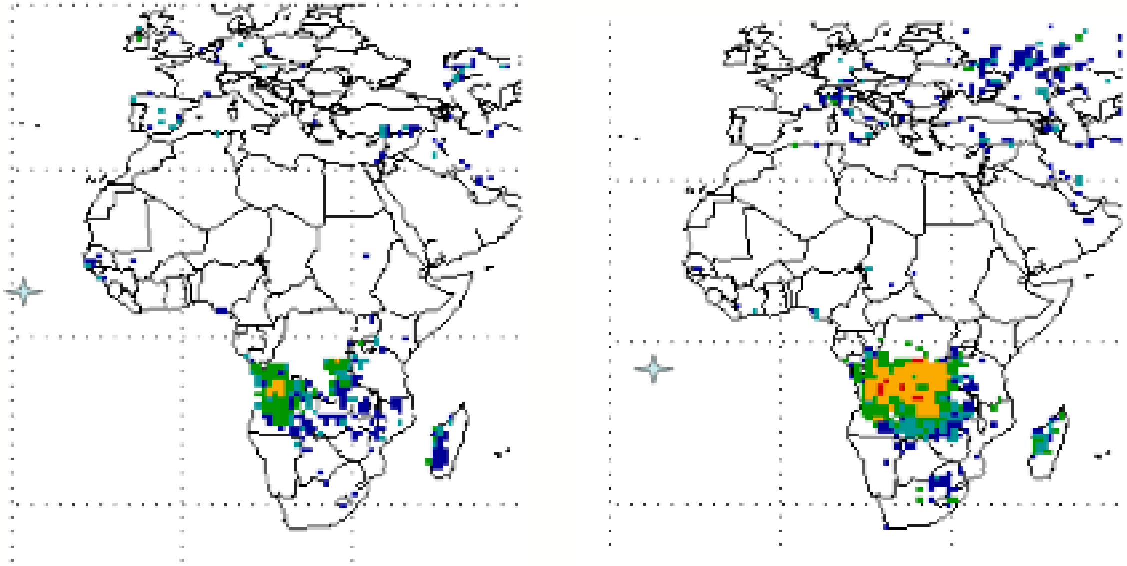

Figure 3: ***Fire counts derived from MODIS on 9 June (left) and 26 June (right).***

5. Aerosols

Aerosol measurements consisted of time-resolved mass and number concentration (LPC and QCM) and integrated mass concentration (Partisol) as well as filter samples during the dust, smoke, and dust-smoke mixture regimes. A CN counter was deployed during Leg 1 to complement the aerosol mass and number concentration measurements, and which subsequently acquired a unique biological sampling cross section between 20ºN and 6ºS along the 23ºW transit. In addition to the measurements aboard the *Ronald H. Brown*, we are conducting complementary downstream measurements with the same instrument suite in southwestern Puerto Rico. These measurements include size-resolved surface aerosol number concentrations and aerosol optical depths.

The focus of the aerosol measurements was to characterize both microphysical and chemical evolution of SAL aerosols and to make critical measurements at the interfaces between continental air masses (Saharan dust, biomass smoke, urban plumes) and marine air masses. Knowledge of how the optical and radiative properties of the aerosols change, especially in mixed environments, can be critical in improving our understanding of the climate impacts of aerosols, satellite retrieval algorithms, and radiative parameterizations. We have identified at least three separate chemical/meteorological regimes during this time period, which covered the southward transect along 23ºW.

The following figure shows two weeks of aerosol number concentration data obtained during Leg 1 of the cruise and illustrates the distinctive characteristics of dust-impacted versus smoke-impacted air masses. Chemical analyses of the samples obtained during this period are underway.

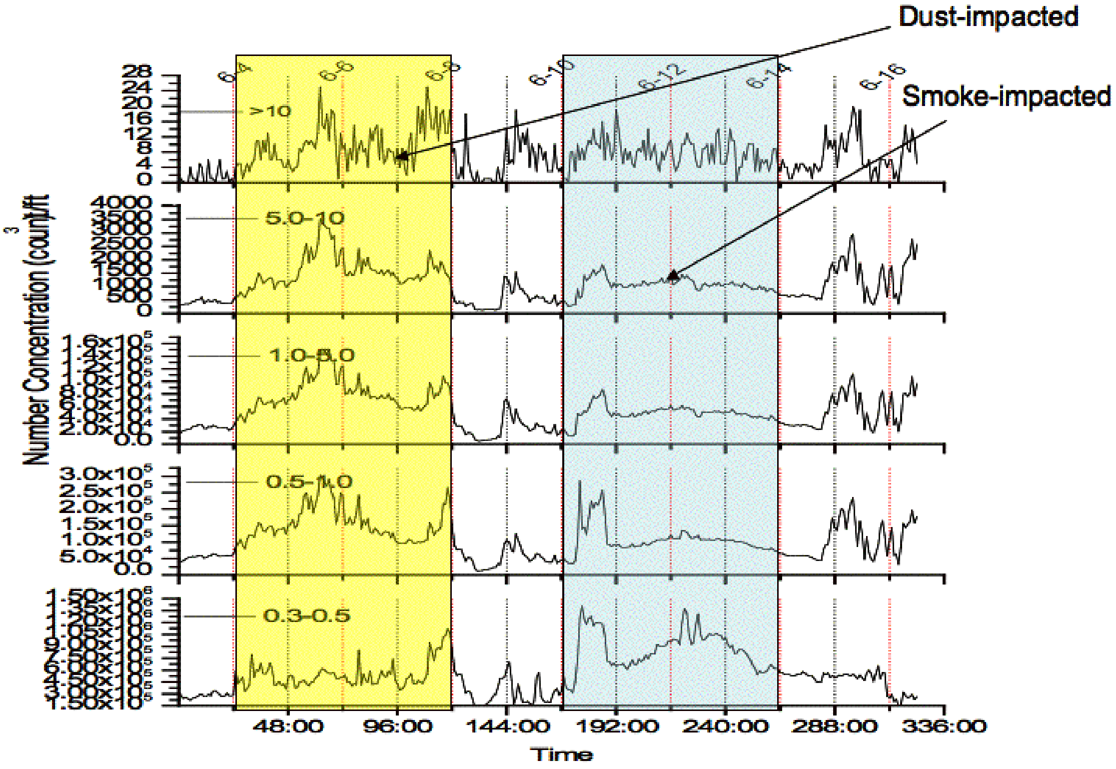

Figure 4: ***Surface aerosol number concentrations obtained during AMMA Cruise Leg 1.***

Aerosol sampling was performed using a PM10 high volume sampler during Leg 2. Approximately twelve (12) filter samples were collected for off-line chemical analysis. In addition, bulk filter samples were collected using a cyclone impactor for off-line biological analysis. These samples were collected daily from May 29 through July 4.

No aerosol measurements or sampling were allowed in the EEZ waters of Brazil.

6. Radiation

The radiation measurement suite largely duplicated instruments deployed by both RSMAS and ETL except for the Microtops sunphotometer. These measurements operated continuously (again, with the exception of the EEZ waters of Brazil).

7. Data Availability

Raw data from the cruise is available upon request from the primary custodian of the data set.

Data set	Primary Custodian	Affiliation	Media/
Trace Gases and Aerosols	Vernon Morris vmorris@howard.edu	Howard University	CD

Radiation/Ozonesondes	Everette Joseph ejoseph@howard.edu	Howard University	CD
Rawinsondes	Nick Nalli Nick.nalli@noaa.gov	NOAA/NESDIS	Anonymous FTP

Summary of Selected Ozonesonde Cases (June 6 – July 4) and Comparison to Surface Measurements

By Vernon Morris

The cases described below illustrate the different regimes that were sampled as well as the different times of day. They do not represent the entirety of the data set. The ozonesonde data listed for this "quick-look" report are limited to the lowest three (3) kilometers of the atmosphere. It is important to note that for this raw data, the surface [O_3] values calculated for the ozonesondes are consistently much lower than those measured by the TECO ozone photometers. This is presumably due to a lack of initialization with the instruments. The qualitative agreement with the surface values is good.

Date / Location	Vertical [O_3]	Surface [O_3]	Surface Aerosol Density (PM5)	Mean AOT	Regime
6/6	Layer peaking near ~800 m	33ppb	8.3e5	1.8	Dust aloft, near Cape Verde
6/8	Double layer structure peaking at 1.8 and 2.8 km	34ppb	8.6e5	1	Light dust aloft
6/10	[O_3] decreasing gradually aloft, no well-defined peaks	No data	4.1e5	None	Light dust aloft, smoke low
6/11	Nearly constant through 3 km	No data	1.0e6	None	Dust aloft, smoke low
6/15	Layer at 1.3 km	45ppb	6.4e5	0.4	Smoke
6/26	Gradual increase from surface to 3 km	137ppb	1.8e6	0.4	Smoke
6/28	Constant throughout 3 km	129ppb	1.0e6	None	Smoke
7/01	Layer with peak at 2.25 km	42ppb	5.9e5	1	Dust

7/03	Gradual increase through 3 km	40ppb	8.6e5	None	Dust
7/04	Layer between 1 and 2.5 km	79ppb	4.5e5	None	Light dust, AH outflow

Summary of Sampling Schedule (29 June – 6 July)

Date / Location	Biological Sampling	PM10 Sample	QCM Sample	General Conditions (see above)
29-June 3.8°N, 23°W	Bio/Myco	094616 / 24-hr	5.0-0.15 µm	
30-June 6.4°N, 23°W	Bio/Myco	094615 / 24-hr	None	
1-July 8.8°N, 23°W	Bio/Myco	094614 / 24-hr	None	
2-July 11°N, 23°W	Bio/Myco	094613 / 20-hr	2.5-0.15 µm	
3-July 13.3°N, 23°W	Bio/Myco	094612 / 12 hr	None	
4-July	-----	094624 / 12-hr	2.5-0.15 µm	
4-July 16.6°N, 23°W	Bio/Myco	094626 / 6-hr	5.0-0.15 µm	
5-July 17°N, 23°W	Bio/Myco	097038 / 6-hr	5.0-0.15 µm	
5-July 18°N, 23.1°W	Bio/Myco	096993 / 6-hr		
5-July	----	097019 / 6-hr		
5-July	----	097023 / 6-hr		
6-July 20.1°N, 29°W	Brush samples	097026 / 12-hr	5.0-0.15 µm	