DRAFT CRUISE INSTRUCTIONS

NOAA Ship RONALD H. BROWN

March, 2006

Cruise Number:	RB-06-04
Project:	African Monsoon Multidisciplinary Analysis/PIRATA
Cruise dates:	23 May to 16 July 2006
Chief Scientists:	Rick Lumpkin Leg 1; Claudia Schmid Leg 2 NOAA/AOML
Working Area:	Tropical Eastern Atlantic Ocean
Itinerary:	From Charleston, South Carolina to Recife, Brazil 27 days
	From Recife, Brazil to Charleston, South Carolina 25 days

Endorsements:

Dr. Robert Molinari	Dr. Robert Atlas	CAPT John Rix
Project Lead	Director, AOML	Commanding Officer, MOA
NOAA/AOML	Miami, FL 33149	Norfolk, VA 23510

CRUISE OVERVIEW

A. Summary

The African Monsoon Multidisciplinary Analysis (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. Recognizing the needs of society, AMMA also will seek to provide the observations and underpinning science needed to relate variability of the WAM to issues of health, food security and water resources.

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 multidecadal 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.

We are currently hindered in providing skilful predictions of WAM variability. This is 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 "seedings" 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.

AMMA has four broad internationally agreed objectives:

(i) Scientific knowledge

The major objective 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.
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> **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.
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> **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.

(ii) Socioeconomic implications

A related objective of AMMA is to provide the data and underpinning science needed to characterise the impact of West African climate variability on water resources, food security, health, and to explore the feedback of human activities on climate variability.

(iii) Monitoring strategies

To achieve the above scientific and societal objectives, AMMA will recommend, and implement the multi-scale and integrated monitoring network needed to support research and prediction of WAM variability and its impacts. It is envisioned that satellites will play a strong role in this and so their potential needs to be evaluated fully.

(iv) Building capacity in partnership with African Institutions

AMMA will seek to develop blended training and education activities for African research and technical institutions as an integral part of its field operations. AMMA also intends to forge links with several education and outreach programs in the U.S. (e.g. GLOBE) and to involve these programs in the field phase in West Africa.

International discussions have led to the establishment of three interrelated observing periods during the AMMA program to meet the objectives of the program. The three planned observing periods are:

The Long Term Observing Period (LOP) is concerned with multi-year observations of the coupled atmosphere-ocean-land system. Two types of observations are envisioned: (i) historical observations not yet archived, requiring data archaeology, to study interannual-to-decadal variability of the WAM and (ii) additional long-term observations (2001-2010) to document and analyze the interannual variability of the WAM and support research into its impact on health, food security, and water resources.

The Enhanced Observing Period (EOP) is designed to serve as a link between the LOP and the SOP (below). Its main objective is to strengthen observations along a climate transect in order to capture the annual cycle of the surface and atmospheric conditions and atmosphere and to study the surface memory effects at the seasonal scale. A major focus will be on improving the radio-sounding network spanning the extreme climate gradient between the Gulf of Guinea and the Sahara Desert. The EOP will cover the period 2005-2007.

The Special Observing Period (SOP) will provide a multi-scale analysis of one monsoon season. As well as continuous monitoring of the WAM through the season, there will be more intensive observations of shorter duration that are concerned with key processes important for weather and climate. Focused process studies will take place during three key stages of the rainy season of 2006:

(i) **SOP-1** (May 15 – June 30): Atmosphere-ocean-land interactions during the onset of the West-African monsoon, including a focus on Gulf of Guinea Ocean processes and SSTs.

(ii) **SOP-2** (July 1 –August 14): Mesoscale and synoptic scale weather systems over West Africa; water cycle in the atmosphere and at the land surface; continental ITCZ migration

(iii) **SOP-3** (August 15 – September 15: Fate of mesoscale and synoptic scale weather systems downstream over the tropical Atlantic including their association with tropical cyclogenesis; nature of the oceanic ITCZ; role of Aerosol and the Saharan Air Layer

Specific objectives of the *RONALD H. BROWN CRUISE*

The objectives of the RHB cruise include those related to the AMMA program and those related to NOAA's Climate Goal. Although the RHB cruise will be conducted during SOP-1 and 2, long-term observations are planned to include data collection during the EOP and LOP and to address seasonal-to-interannual climate signals. 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 the RHB 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. Two ATLAS moorings will be deployed to provide time series of the upper ocean temperature, salinity and current structure. Two additional moorings will be deployed in FY2007. Shipboard observations will include upper ocean and surface heat flux data along a section at 23°W. 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 are to be collected over at least 5-years providing a picture of seasonal-to-interannual variability. The evolution of the SST filed will also be compared to the evolution of the West African Monsoon to study the effects of the ocean on this atmospheric phenomenon, an AMMA objective.

Marine Meteorology: Atmospheric data will be collected to characterize the vertical structure of the Saharan air layer (SAAL), including mineral dust aerosol over the Atlantic Ocean. The cruise track will allow for an unprecedented transverse analysis of the SAL during the peak dust month. The atmospheric data will also be used to investigate the effect of the SAL on the marine boundary layer, clouds, precipitation, and tropical cyclogenesis.

Atmospheric Chemistry: Atmospheric data will be collected to investigate the linkages between the vertical distribution of tropospheric ozone with Saharan dust outbreaks. Historical data show a seasonal variation in tropospheric ozone that peaks during June-August. The sources of this peak remains uncertain and may be due to anthropogenic sources (e.g., biomass burning in the Congo Basin) or natural sources (e.g., lightning over west Africa). In addition, a suite of trace gas and aerosol ambient measurements, ozonesondes and aerosol sampling will be taken to quantify the microphysical and chemical evolution of the Saharan dust, to analyze the biological and chemical content of size –fractionated aerosol samples and to characterize the density and mass concentrations of aerosols within the SAL.

Satellite validation: Visible, microwave, infrared (hyperspectral and broad-band flux) and in situ measurements will be collected to support the validation and improvement of advanced satellite retrievals and data products including the Aqua Atmospheric Infrared Sounder (AIRS) and Moderate Resolution Imaging Spectroradiometer (MODIS).

B. Operating Area

The operating area is the eastern tropical Atlantic primarily along 23°W. The cruise will be split into two legs as shown on the attached chart. A port stop will be made in Recife, Brazil.

C. Participating Institutions

United States Department of Commerce
National Oceanic and Atmospheric Administration

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c) Earth System Research Laboratory (NOAA/ESRL)
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Howard University
Program in Atmospheric Sciences (HUPAS)
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University of Miami
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D. Personnel

Name	Sex	Nationality	Affiliation
Leg 1			
Claude (Rick) Lumpkin	M	USA	NOAA/AOML
Christopher Meinen	M	USA	NOAA/AOML
Derrick Snowden	M	USA	NOAA/AOML
Pedro Pena	M	USA	NOAA/AOML
Nick Nalli	M	USA	NOAA/HUPAS
Everette Joseph or Vernon Morris	M	USA	HUPAS
Tamara Battle	F	USA	HUPAS
Torreon Creekmore	M	USA	HUPAS
Michelle Hawkins	F	USA	HUPAS
TBD graduate student			HUPAS
TBD graduate student			HUPAS
TBD graduate student			HUPAS
Steve Kunze	M	USA	NOAA/PMEL
Soyna Noor	F	USA	NOAA/PMEL
TBD			NOAA/ETL
TBD			NOAA/ETL
Malgorzata Szczdorak	M	Canada	RSMAS/UM
Miguel Izaguirre	M	USA	RSMAS/UM
Ludovic Bariteau			RSMAS/UM
Ieng Jo			RSMAS/UM
Leg 2			
Claudia Schmid	F	USA	NOAA/AOML
Gustavo Goni	M	USA	NOAA/AOML
Derrick Snowden	M	USA	NOAA/AOML
Pedro Pena	M	USA	NOAA/AOML
Gregory S. Jenkins	M	USA	HUPAS
Everette Joseph or Vernon Morris	M	USA	HUPAS
Tamara Battle	F	USA	HUPAS
Michelle Hawkins	F	USA	HUPAS
TBD graduate student			HUPAS

TBD graduate student			HUPAS
TBD graduate student			HUPAS
TBD graduate student			HUPAS
TBD			NOAA/ETL
TBD			NOAA/ETL
Malgorzata Szczdrak	M	Canada	RSMAS/UM
Miguel Izaguirre	M	USA	RSMAS/UM
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E. Administrative

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OPERATIONS

A. Data to be collected and operations

1. Deployment of 2 ATLAS moorings along 23°W at 4°N and 11.5°N
2. Servicing of ATLAS mooring at 0°, 23°W
3. CTD profiles to 1500m depth along 23°W. Station positions given below.
4. Salinity of the water samples collected with the bottles on the CTD rosette.
5. Dissolved oxygen concentration in the water samples collected with the bottles.
6. Continuous recording of ship mounted ADCP data.
7. Heading data from both the MAHRS gyro system and the Seapath GPS system for comparison of heading quality for the MAHRS.
8. Continuous recording of Thermosalinograph (TSG).
9. Continuous recording of Seabeam bathymetry requested (with help from ship science technician)
10. Lidar wind observations
11. Sun photometers
12. Wind profiles from launching of 86 radiosondes
13. Ozone profiles from launching of 20-30 ozonesondes
14. Laser particle counters
15. Launching of 100 XBTs
16. Microwave radiometer to measure SST
17. Broadband pyronometer to measure solar radiation
18. Trace gas measurements

B. Staging Plan

Staging for the cruise will be conducted in Charleston, South Carolina and San Juan, Puerto Rico. Equipment characteristics are given in the Appendix. Some equipment (CTD frame, sample bottles, etc.) will be left onboard the ship in a 10-ft container at the end of RB-06-02.
Charleston staging:
Monday, 3 April
ETL/RSMAS large rented crane to load van and MAERI and other RSMAS gear on the O-2 deck FWD
HUPAS van loaded with ship's crane if it is less than 14,000 lb; use rented crane if more on port side O1 deck, outboard slot
Tuesday, 4 April
3 Atlas moorings, reels, anchors, etc.

Small items (e.g., 35 He cylinders with racks, sondes, drifters, floats, etc.) loading needs to be coordinated with the FOO if not included in the above vans. The objective, load all gear before the OE group arrives for loading on 6 April.

Any items sent to San Juan must be reported to the FOO with number of boxes, tracking numbers, expected date of arrival and other pertinent information.

Other AOML equipment such as the CTD, sensors, etc. can be hand carried aboard. The surface drifters, Argo floats and XBTs require a crane. Scientists will arrive on Monday, 22 May to complete loading and set up of the CTD package. Scientists arriving earlier will have to make lodging arrangements ashore. AOML will require the assistance of the shipboard ET and Survey Technician for 4 hours Monday and 8 hours Tuesday to help install computer systems, complete terminations for the CTD and position other scientific equipment. The science party will stay onboard the ship Monday night 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 Monday. Chief Scientists for the two legs will make the berthing arrangements for scientists arriving and departing the ship in Recife. Scientists will be allowed to stay onboard the RHB the night of arrival in Charleston.

C. Cruise Plan

The NOAA Ship *Ronald H. Brown* (RHB) will depart San Juan, Puerto Rico 23 May and steam to 20°N and 23°W passing the two way points given above. Atmospheric observations will be taken along this trackline. Changes in speed may be required for sonde launches. The primary goal of the cruise is to deploy two ATLAS moorings along 23°W and to continuously sample oceanic and atmospheric variables along this longitude from 5°S to 20°N. CTD operations will begin at 20°N, 23°W. Preliminary station CTD locations for both legs are given in the following table. The actual hydrographic stations sampling plan may deviate from this proposed plan in both number of stations and their locations. ATLAS moorings will be deployed at 11.5°N and 4°N and a French PIRATA mooring will be serviced on the equator. The RHB will steam to 5°S collecting CTD data and then steam to Recife, Brazil for a port stop beginning on 18 June. The RHB will depart Recife on 22 June and steam to 5°S, 23°W and begin a CTD section, which will end at 20°N, 23°W. Upon completion of the section, the RHB will return to Charleston, South Carolina on 16 July. Atmospheric data will be collected throughout the cruise. The potential for disembarking scientists in Cape Verde prior to the transect to Charleston is being investigated by AOML. The ship will incur no extra costs or workload if this is accomplished nor will the scheduled arrival date in Charleston be delayed.

D. Waypoints

The RHB will steam from Charleston to 15°N, 40°W, then to 15°N, 30°W then to 20°N, 23°W to begin the hydrographic section.
Approximate Station Locations are listed in Table 1. These are subject to change.

Table 1. Station Locations

CTD station	Latitude		Longitude		Notes
1	20	0 N	23	0 W	
2	19	30 N	23	0 W	
3	19	0 N	23	0 W	
4	18	30 N	23	0 W	
5	18	0 N	23	0 W	
6	17	30 N	23	0 W	
7	17	0 N	23	0 W	
8	16	30 N	23	0 W	
9	16	0 N	23	0 W	
10	15	30 N	23	0 W	
11	15	0 N	23	0 W	
12	14	30 N	23	0 W	
13	14	0 N	23	0 W	
14	13	30 N	23	0 W	
15	13	0 N	23	0 W	
16	12	30 N	23	0 W	
17	12	0 N	23	0 W	
18	11	30 N	23	0 W	Deploy ATLAS buoy
19	11	0 N	23	0 W	
20	10	30 N	23	0 W	
21	10	0 N	23	0 W	
22	9	30 N	23	0 W	
23	9	0 N	23	0 W	
24	8	30 N	23	0 W	
25	8	0 N	23	0 W	
26	7	30 N	23	0 W	
27	7	0 N	23	0 W	
28	6	30 N	23	0 W	
29	6	0 N	23	0 W	

30	5	30 N	23	0 W	
31	5	0 N	23	0 W	
32	4	30 N	23	0 W	
33	4	0 N	23	0 W	Deploy ATLAS buoy
34	3	30 N	23	0 W	
35	3	0 N	23	0 W	
36	2	30 N	23	0 W	
37	2	0 N	23	0 W	
38	1	45 N	23	0 W	
39	1	30 N	23	0 W	
40	1	15 N	23	0 W	
41	1	0 N	23	0 W	
42	0	45 N	23	0 W	
43	0	30 N	23	0 W	
44	0	15 N	23	0 W	
45	0	0 N	23	0 W	Service PIRATA buoy
46	0	15 S	23	0 W	
47	0	30 S	23	0 W	
48	0	45 S	23	0 W	
49	1	0 S	23	0 W	
50	1	15 S	23	0 W	
51	1	30 S	23	0 W	
52	1	45 S	23	0 W	
53	2	0 S	23	0 W	
54	2	30 S	23	0 W	
55	3	0 S	23	0 W	
56	3	30 S	23	0 W	
57	4	0 S	23	0 W	
58	4	30 S	23	0 W	
59	5	0 S	23	0 W	

E. Station Operations

CTD Operations: CTD casts will include the CTD unit and a Rosette sampler. Approximately 60 casts will be conducted to 1500m depth on both legs. We will require a package tracking system and display for the CTD operations (Knudsen/Bathy2000).

ATLAS Mooring Deployments at 4°N and 11.5°N, 23.5°W and service an equatorial mooring.

Deploy surface drifters: 19 surface drifters will be deployed at locations along the trackline specified by the Chief Scientist.

Deploy Argo profiling floats: 12 profiling floats will be deployed at locations along the trackline specified by the Chief Scientist.

Deploy radiosondes: 86 profiling floats will be deployed at locations along the trackline specified by the Chief Scientist

Ozonesondes: 20-30 profiling floats will be deployed at locations along the trackline specified by the Chief Scientist

F. Underway Operations

The ship shall continuously collect P-code GPS, ADCP, meteorological, thermosalinograph (TSG), and bathymetric (Seabeam) data while underway. The ship shall also collect heading information from both the MAHRS gyro and SEAPATH GPS system for comparison and testing.

G. Small Boat Operations

Small boat operations may be required during the deployment and servicing of the ATLAS moorings. The small boat operations will be conducted at the discretion of the commanding officer.

H. De-staging Plan

De-staging will occur at Charleston, South Carolina on 16 July.

FACILITIES

A. Equipment and Capabilities Provided by the Ship

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

1. High Frequency SSB (SEA 330): SEA Inc. 300-watt high frequency transceiver. The transceiver covers a frequency range from 1.6 to 29.9 MHz
2. Sperry Global Maritime Distress and Safety System (GMDSS)
3. Five fixed VHF radios with eight channels pre programmed with a selection of marine band and NOAA frequencies.
4. Cell phones
5. A VSAT for 24/7 Internet capabilities. There will no longer by 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.

The electronic instrumentation used for navigation includes:

6. Magnavox MX-200 GPS
7. Northstar 941x differential GPS
8. Sperry Mark 37 Gyro Compass
9. Sperry Rascar Touch Screen navigational radar. (S-band (10 cm) 30 kW radar and an X-band (3 cm) 25 kW radar)
10. Simrad Robertson Dynamic Positioning System
11. Raytheon model DSN-450 Doppler Speed/distance log
13. NAVTEX receiving and printing the international automated medium frequency (518 KHz) weather warnings
14. Weather maps: Medium frequency/high frequency

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 2112 (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 input.
7. MAHRS gyro system for acquisition of heading data used by acoustic Doppler current profiler.
8. Seapath GPS system for acquisition of heading data for testing the new MAHRS system.
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.

B. Equipment and Capabilities Provided by the Scientists
In addition to the suite of oceanographic and meteorological instruments on board the Ronald H. Brown, the science party will bring the following instruments and materials on board (see appendix for full specifications):

AOML equipment

1. Seabird 911+ CTD to collect profiles of depth. An altimeter will be installed, but it is considered a backup to the shipboard 12kHz tracking of the CTD package.
2. General Oceanics 24 bottle rosette wheel to collect water samples for comparison with the CTD profiles.
3. Salinity sample bottles and standard seawater.
4. One automated oxygen titration system to measure the dissolved oxygen concentration in the water samples.
5. Several computers for data acquisition and initial processing.
6. Equipment to support two ATLAS mooring deployments and one mooring servicing.
7. One PC/Laptop running Windows NT or 2000 for SCS feed into wet lab.
8. Nineteen satellite tracked drifting buoys
9. Nine Argo profiling floats

HUPAS equipment

1. Micropulse lidar
2. Microtops sun photometers
3. Vaisala RS92 radiosondes
4. Vaisala ozonesondes
5. M-AERI
6. Cascade impactors
7. RAAS high volume sampler
8. Laser particle counter
9. MFRSR
10. Microwave radiometer
11. Broadband pyronometer
12. Trace gas instruments O3, CO, SO2
13. CCN counter

RSMAS/UM equipment: included in appendix 2
NOAA/ETL: included in appendix 2

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:

- PCODE_TIME (HHMMSS)
- PCODE_LAT (DEGMIN)
- PCODE_LON (DEGMIN)
- PCODE_QUALITY (1=std)
- PCODE_COG (Degrees)
- PCODE_SOG (Knots)
- MK37-Gyro (Degrees)
- PCODE-SOG-msec (M/SEC)
- 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 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 Meetings

A pre-cruise meeting between the Commanding Officer and the Chief Scientist will be conducted either the day before or the day of departure of each of the two legs, 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.

C. Ship Operations Evaluation Report

A Ship Operations Evaluation Report will be completed by the Chief Scientist of each leg and given to the Director, AOML, for review and then forwarded to OMAO.

ADDITIONAL PROJECTS

A. MOC Directives

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(s).

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

B. Underway Measurements in support of Global Carbon Cycle Research

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 CO2 in surface water (pCO2). This work is a collaborative effort between the CO2 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.

HAZARDOUS MATERIALS

A. Policy Compliance

RONALD H. BROWN will operate in full compliance with all environmental compliance requirements imposed by NOAA. All hazardous materials and substances needed to carry out the objectives of the embarked science mission, including ancillary tasks, are the direct responsibility of the embarked designated Chief Scientist, whether or not that Chief Scientist is using them directly. The ship's Environmental Compliance Officer (ECO) will work with the Chief Scientist to ensure that this management policy is properly executed, and that any problems are brought promptly to the attention of the Commanding Officer. Scientific HAZMATS will not be left aboard without a trained spill responder from the science party remaining aboard with them.

The scientific party, under supervision of the Chief Scientist, shall be prepared to respond fully to emergencies involving spills of any mission HAZMAT. This includes providing properly trained personnel for response, as well as the necessary neutralizing chemicals and clean-up materials. Ship's personnel are not first responders and will act in a support role only in the event of a spill.

The Chief Scientist is directly responsible for the handling, both administrative and physical, of all scientific party hazardous wastes. No liquid wastes shall be introduced into the ship's drainage system. No solid waste material shall be placed in the ship's garbage.

B. Inventory

The Chief Scientist will provide the Commanding Officer with an inventory indicating the amount, concentrations, and intended storage area of each hazardous material brought onboard, and for which the Chief Scientist is responsible (see Appendix A). This inventory shall be updated at time of offload, accounting for the amount of material being removed, as well as the amount consumed in science operations and the amount being removed in the form of waste.

The ship's dedicated HAZMAT Locker contains two 45-gallon capacity flammable storage cabinets and one 22-gallon capacity flammable storage cabinet. Unless there are dedicated storage lockers (meeting OSHA/NFPA standards) in each van, all HAZMAT, except small amounts for ready use, must be stored in the HAZMAT Locker.

C. MSDS

All hazardous materials require a Material Safety Data Sheet (MSDS). Copies of all MSDSs shall be delivered to the ship at least two weeks prior to sailing. The Chief Scientist shall have copies of each MSDS available when the hazardous materials are loaded aboard. Hazardous material for which the MSDS is not provided will not be loaded aboard.

RADIOACTIVE ISOTOPES

No radioactive isotopes will be used on this cruise.

MISCELLANEOUS

A. Scientific Berthing

The Chief Scientist is responsible for assigning berthing for scientific party within the spaces designated as scientific berthing. The ship will send current stateroom diagrams to the Chief Scientist showing authorized berthing spaces. 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 its conclusion prior to departing the ship.

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 Chief Scientist will provide medical forms for all cruise participants as soon as practicable and no less than four weeks prior to departure. Forms must be provided to the ship's medical officer.

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. The ship when required will provide hard hats and work vests.

D. Communications

The Chief Scientist or designated representative will have access to ship's telecommunications systems on a cost-reimbursable basis. Where possible, it is requested that direct payment (e.g. by credit card) be used as opposed to after-the-fact reimbursement. Ship's systems include:

1. INMARSAT-B

INMARSAT-B provides high quality voice and fax communications (9600 baud) and high-speed data transmission, including FTP; it is the primary means of transferring email. Cost is $2.60/min for voice and fax; $7.25/min for high speed. INMARSAT-B calls may be made collect or charged to credit card; cost is approximately $2.60/min **.

2. INMARSAT-M

INMARSAT-M (or Mini-M) provides medium quality voice communications. Cost is $2.15/min. INMARSAT-M may be charged to credit card or collect.

**Note: All rates listed are based on direct-dialed business calls to the US. Collect, or calls charged to credit calls are charged higher rates, subject to additional fees, and may have minimum charges.

5. Contacts

Important phone numbers, fax numbers and e-mail addresses: (Up-to-date phone numbers can be found on the MOC web site at www.moc.noaa.gov/phone.htm#RB)

RONALD H. BROWN (to call from US)

- INMARSAT-B VOICE:	011-OAC-336-899-620 (approx $2.60/min)
- INMARSAT-B FAX:	011-OAC-336-899-621
- INMARSAT "M" VOICE:	011-OAC-761-831-360 (approx $2.99/min)
- CELLULAR:	843-693-2082
- OOD CELLULAR:	843-297-1835

Note: Both the Cellular and OOD phones will work in San Juan.

Program contacts

Robert Molinari	bob.molinari@noaa.gov	305-361-4344
Claudia Schmid	Claudia.Schmid@noaa.gov	305-361-4313
Claude (Rick) Lumpkin	rick.lumpkin@noaa.gov	305-361-4513

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	FOO.Ronald.Brown@noaa.gov
Medical Officer, RHB	Medical.Ronald.Brown@noaa.gov

E. Port Agent Services/Billing

Contractual agreements exist between the port agents and the Commanding Officer for services provided to NOAA Ship *RONALD H. BROWN*. The costs for any services arranged through the ship's agents by the scientific program, which are considered to be outside the scope of the agent/ship support agreement, will be the responsibility of that program. Where possible, it is requested that direct payment be arranged between the science party and port agent, as opposed to after-the-fact reimbursement to the ship's accounts.

F. Wage Marine Working Hours and Rest Periods

The Chief Scientist shall be cognizant of the reduced capability of *RONALD H. BROWN's* operating crew to support 24-hour mission activities. Wage marine employees are subject to negotiated work rules contained in the applicable collective bargaining agreement. Dayworkers' hours of duty are a continuous eight-hour day, beginning no earlier than 0600 and ending no later than 1800. It is not permissible to separate such an employee's workday into several short work periods with interspersed non-work periods. Dayworkers called out to work between the hours of 0000 and 0600 are entitled to a rest period of one hour for each such hour worked. Such rest periods begin at 0800 and will result in such a dayworker being unavailable to support science operations until the rest period has ended. All wage marine employees are supervised and assigned work only by the Commanding Officer or his/her designee. The Chief Scientist and the Commanding Officer shall consult regularly to ensure the shipboard resources available to support the science mission are utilized safely, efficiently, and in accordance with the above policies.

APPENDICES

A. List of Hazardous Materials

CHEMICAL REAGENTS USED FOR THE
DETERMINATION OF DISSOLVED OXYGEN IN SEA WATER

NAME OF CHEMICAL	AMOUNT OF CHEMICAL	COMMENTS
Manganese Chloride	2 Liters, (600gr/Liter)	Solution
Alkaline Sodium Iodide	2 Liters, (320gr. Sodium Hydroxide + 600gr. Sodium Iodide, in each liter).	Solution
Sulfuric Acid	2 Liters, 280ml/liter	Dilute Solution
Sodium Thiosulfate	3 Liters, 10gr/Liter 3 vials of 10gr. Thiosulfate	Very Dilute Solution Granular Salt
Potassium Iodate	1 Liter, (0.3567gr/Liter) Std.	Very Dilute Solution Primary Standard
Triton(R) X-100	1 Liter (Polyethylene Glycol Octylphenyl Ether)	Solution

Chemicals used in RSMAS/UM operations

B. Equipment/Van List

1) **AOML General Scientific Equipment**

WT: 0.75 ton
SIZE: Small miscellaneous equipment tools, & laptops
SITE: Oceanographic Lab

Oxygen Equipment:

1. Sample bottles- 10 blue plastic cases, 24 x 16 x 12, 20 lb each.
2. Reagents- 2 blue plastic cases, 24 x 18 x 14, 50 lbs each.
3. Titration Equipment- 1 aluminum box, 24 x 24 x 16, 70 lbs.
4. Misc. supplies- 2 cardboard boxes, 16 x 15 x 14, 30 lbs each.

Misc. Equipment
1. 5 boxes standard water, 6x6x16, 30 lbs total
2. 2 computers, 16x16x10, 20 lbs total
3. 2 laptops, 14x2x9, 10 lbs total
4. 2 LCD monitors, 16x12x2, 4 lbs total

5. 2 tool boxes, 30”x16”x30”, 200 lbs total
6. 2 boxes misc. supplies, 16”x16”x36”, 150 lbs total

2) **AOML CTD Rosette with LADCP (1)**

WT: 1 ton
SIZE: 4'L x 4'W x 6'H
SITE: Standard CTD Location

1. 2- Seabird 9 CTDs, 8”x8”x36”, 60 lbs total
2. 1 – CTD frame, underwater sampling package, 6.5’x48”diameter, 1300 lbs
3. 2 boxes CTD sensors, 16”x18”16, 30 lbs total

3) **ATLAS MOORINGS (2 for Deployment, one for servicing)**

Total weight approx. 15.7 tons
3-buoy/tower/bridle sets – 3750 lbs
4-4480 lb. Anchors, total – 17,920 lbs
Misc. supplies - 9,800 lbs
Size:
SITE:

4) Satellite tracked surface drifters

Total weight: 900 lbs
Size: 3 skids of drift buoys: 2 boxes, 42”*42”*42”, 250 lbs each; 1 box, 42”*42”*60’ weighs 400 lbs
SITE: Available storage space prior to deployment

5) Argo floats

Total weight: 14 boxes, 90 lbs each = 1260 lbs total
Size: each box 18”*18”*96”
SITE: Available storage space prior to deployment

6**) HUPAS van**

WT:
Size: 8 feet by 12 feet by ?
Site: port side O1 deck

7) **HUPAS He cylinders: racks for 35-40 cylinders**

8) HUPAS radiation measurements

Site: radiometers mounted on railing O1 deck

9) HUPAS sonde launches

Site: Hangar and fantail, larger space needed for ozonesondes

10) HUPAS general laboratory requirements

Site: Main laboratory; 12-foot contiguous bench space, storage space,
4 tables, 4 tables, 8 seats
Refrigerator; space for chemical storage
Chemical stores; modest space for chemical storage

11) RSMAS/UM: See other attachment to project instructions

12) NOAA/ESRL/PSD van

Site: Portside location, power required, Ethernet and phone lines requested. Cloud radar from RSMAS/UM will be mounted on the van
Weight: 15,500 lbs

RSMAS Sea-going Equipment (AMMA)

Peter J. Minnett Meteorology and Physical Oceanography Rosenstiel School of Marine and Atmospheric Science University of Miami 4600 Rickenbacker Causeway Miami, FL 33149-1098

Tel: +1 (305) 421-4104 Fax: +1 (305) 421-4622

email: pminnett@rsmas.miami.edu

Table of measured and derived variables and sensors.

Variable	Ship-based Sensor
Skin sea-surface temperature	M-AERI, ISAR
Bulk sea-surface temperature	Surface-following float
Infrared spectra of surface emitted radiation	M-AERI
Infrared spectra of atmosphere emitted radiation	M-AERI
Direct/diffuse SW↓; aerosol optical thickness	MFRSR
Cloud type and cover	All-sky camera
Insolation (SW↓)	Gimbaled Eppley pyrometer
Incident thermal radiation (LW↓)	Gimbaled Eppley pyrgeometer
Atmospheric humidity profiles	Radiosondes
Atmospheric temperature profiles	Radiosondes
Columnar water vapor	Microwave radiometer
Rainfall	Optical rain gauge
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"*	

A – The M-AERI

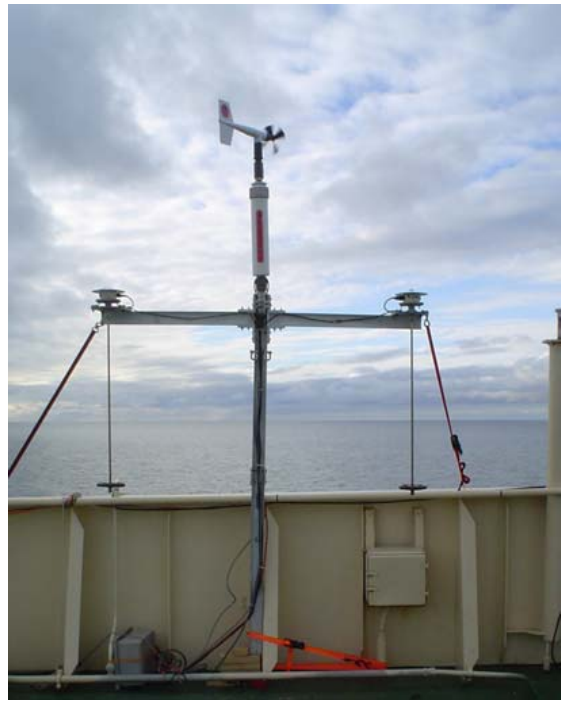
Our main piece of equipment is the M-AERI (Marine-Atmosphere Emitted Radiance Interferometer – see Minnett, P. J., R. O. Knuteson, F. A. Best, B. J. Osborne, J. A. Hanafin, and O. B. Brown (2001), The Marine-Atmospheric Emitted Radiance Interferometer (M-AERI), a high-accuracy, sea-going infrared spectroradiometer, Journal of Atmospheric and Oceanic Technology, 18, 994-1013). It is a bulky piece of equipment 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 55° to the vertical. On the Ronald H Brown, this is on the O2 deck (Figure 1). 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 2 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 3). Power is provided via cables to the Lab. Power requirements are 120 V A/C, 0.2 amps.



We also set up a set of instruments called a PRP (Portable Radiation Package) which measures spectrally resolved incident solar radiation, for the determination of aerosol parameters. This usually is mounted on the flying bridge (Figure 4). Power is supplied via cables to the Lab. We provide a D/C power supply.

Figure 4 Portable Radiation Package on the I/B *Kapitan Dranitsyn.* above the bridge of the I/B

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 5) 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 5. Sky camera setup on the bridge top of the I/B *Kapitan Dranitsyn*.

D-Microwave radiometer

Kapitan Dranitsyn.

D -Microwave radiometer

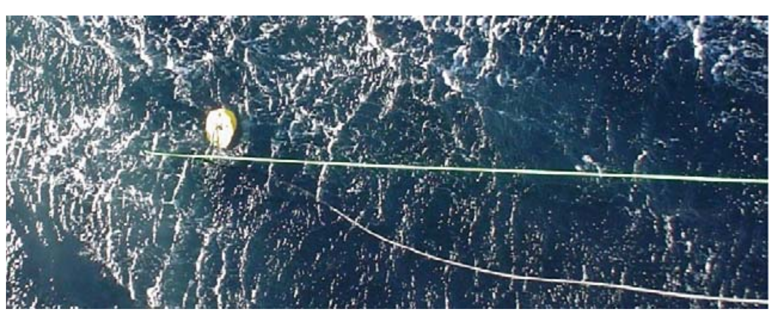
We set up a Microwave Radiometer where ir has a clear view from zenith to the horizon. It measures atmospheric precipitable water, and cloud liquid water content, (Figure 69). The instrument mounts conveniently on the stand shown in the photo, but can be adapted to mount without the stand if there is 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.

Figure 6. Microwave radiometer on flying bridge of the USCGC Polar Sea.

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 7). 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 7. The Hard– Hat float of the port bow of the R/V Tangaroa, when seen from above.



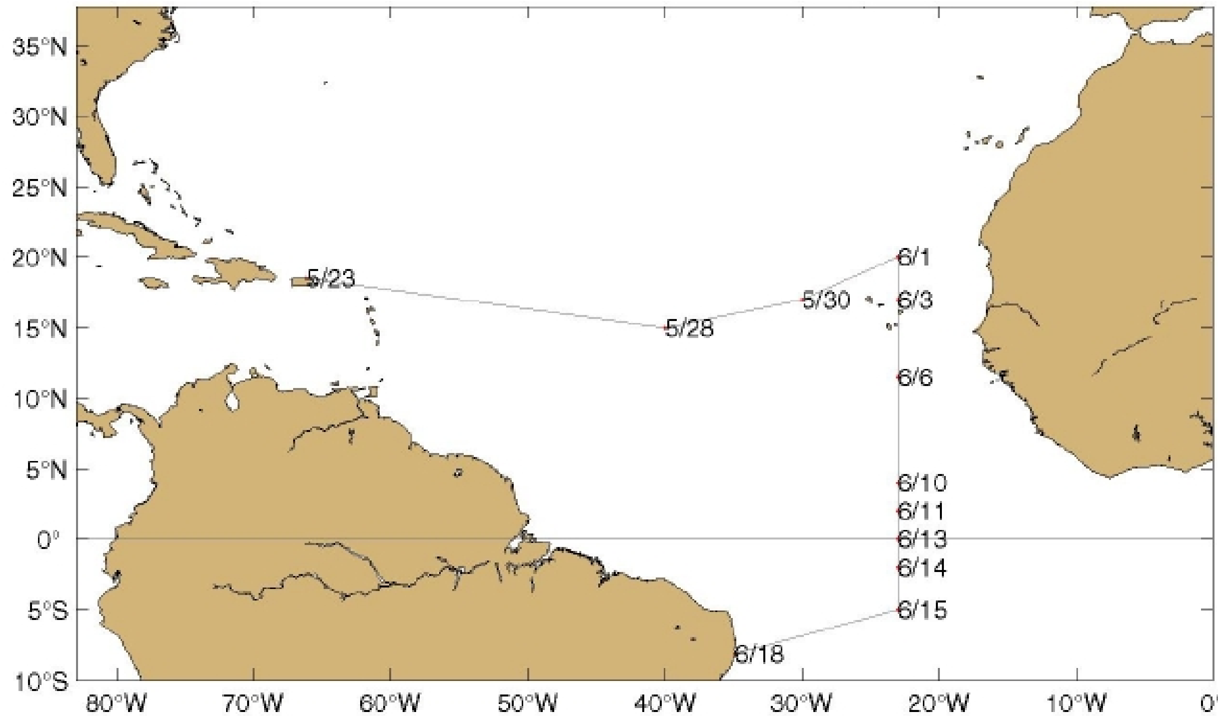
F - Optical rain gauge

Figure 8. The optical rain gauge measures liquid precipitation. The data are logged by a laptop computer in the lab.

Table – 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 bridge	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	Above bridge	120 V A/C, 15 W
Microwave radiometer	Above bridge, or O2 Deck	120 V A/C, 1 kW max
Optical Rain Gauge	Above brodge	120 V A/C, 25 W

2006 AMMA cruise: leg 1



2006 AMMA cruise: leg 2