KWAJEX Cruise Instructions

(Final Draft 13 July 1999)

Cruise RB-99-05

25 July 1999 – 13 September 1999

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Endorsements:

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1.0 OVERVIEW

1.0.a
The Kwajalein Experiment (KWAJEX) will be conducted between 25 June and 13 September 1999. The primary purpose for NOAA ship RONALD H. BROWN is to support C-band radar data collection, including dual Doppler radar scanning in conjunction with the Kwajalein S-band radar, and to launch upper air soundings. Other experiments that will be conducted on-board include: sea surface scattering, surface flux, radiation budget, vertical profiling of precipitation, cloud-base height, water vapor isotope, and microwave emission measurements. Basic meteorological and upper ocean measurements will also be collected as part of the campaign. Data will be collected 24 hours a day, 7 days a week.

1.0.b
For the KWAJEX campaign, the ship will be based out of Kwajalein Island. Forty-eight days at sea are allocated to KWAJEX starting 25 July and ending 13 September. The days at sea will be split into two roughly equal time periods (IOPs) with a 4 day in-port at Kwajalein Island toward the middle of the experiment (currently scheduled for 20-24 August – see Appendix A). Changes to this port-call schedule can only be made in exceptional circumstances due to the necessity to accommodate the inflexible schedules of the few, fully booked flights, the shortage of lodging on Kwajalein and other logistical concerns.

1.1 Administrative

1.1.1 Area of Operation:

Marshall Islands, Central Equatorial Pacific Ocean

1.1.2 Participating Institutions:

NASA Goddard Space Flight Center
NOAA Aeronomy Laboratory
NOAA Environmental Technology Laboratory
Texas A & M University
Texas Tech University
University of Houston
University of Iowa
University of Washington

1.1.2.a
NOAA provides support for ship operations on RONALD H. BROWN during KWAJEX. The NASA TRMM program provides scientific support for KWAJEX.

1.1.2.b
The Chief Scientist is Dr. Robert Cifelli (JCET/NASA TRMM Office) for the first IOP (25 July-20 August) and Dr. Colleen Leary (Texas Tech University) for the second IOP (24 August-13 September).

1.1.2.c
Foreign Clearances Required: Republic of Marshall Islands.

1.1.2.d
Scientists and engineers who are scheduled to participate in either IOP 1 or IOP 2 on-board RONALD H. BROWN follow the standard protocol with regard to accommodations: accommodations will be granted starting the last day in port and ending the first day of port arrival.

1.2 Loading and Setup

1.2.a
Loading and setup of scientific equipment for the KWAJEX campaign will take place while RONALD H. BROWN is in-port at Kwajalein Island (19 July-24 July). This period will also provide time for technicians and scientists to "check-out" their instruments and perform calibration tests. It is likely that the ship technician (Jonathan Shannahoff) will provide training to the science crew in the launching and tracking of upper air soundings. Thus, several sondes will be launched and monitored during this period. Also, it will be necessary for members of the scientific crew to operate the C-band radar. Radar operation is necessary, not only for calibration purposes, but also to test scanning strategies to be performed during KWAJEX and to train personnel on the SIGMET IRIS system. Permission to operate RONALD H. BROWN's radar while the ship is in port will be obtained from Mr. Tony Correa (USAKA Safety Division) and Mr. Mike Wyatt (Kwajalein Missile Range (KMR) Frequency Control and Analysis).

1.2.b
In addition to equipment loaded in Kwajalein, several other instruments and/or containers from previous 1999 missions will remain on-board, either to participate in KWAJEX or subsequent missions or to be transported back to the U.S. Copies of equipment lists, including serial numbers and country of origin, must be supplied to the Executive Officer (XO) and Chief Scientist prior to departure from Kwajalein. It is the responsibility of each group of investigators to arrange for shipping its equipment to and from RONALD H. BROWN, including all customs requirements, documentation, and transfers between the receiving dock and the ship. Any modification to the ship's equipment or special requirements for the cruise should be brought to the attention of the ship's Field Operations Offices (FOO) and the Chief Scientist as soon as possible.

1.2.c
Scientists and other KWAJEX participants should check with the Atlantic Marine Center (AMC) in Norfolk, (http://www.pmc.noaa.gov/amc.htm) Tel. 757-441-6208) or the ship's homepage (http://www.pmc.noaa.gov/rb/index.htm) for updates on planned arrival and departure time of RONALD H. BROWN at Kwajalein Island. Travelers should allow for possible flight delays due to weather, holidays, and other considerations.

2.0 CRUISE PLAN

2.0.a
The NOAA ship RONALD H. BROWN will not be following a track during KWAJEX but rather will operate within a region defined by a 52-km radius circle centered on Kwajalein Island shown in Figure 1. The ship operations region encloses the location of the two NOAA TAO buoys (east buoy and west buoy in Figure 1). Most of the time during the campaign, the ship will operate within 2 km of the following positions 8.36° N, 167.73° E (IOP 1: 25 July-20 August) and 8.46° N, 167.98° E (IOP2: 24 August – 13 September).

These positions are indicated by the "RHB" symbol in Fig. 2. The dual Doppler lobes in Figure 2 show the region over which three-dimensional wind data can be obtained by combining data from the C-band radar on the ship and the S-band radar on Kwajalein Island.

3.0 LOGISTICS:

3.1 Contact Information

3.1.1 Ship Operations:

AMC Operations

CDR Jon E. Rix
439 W. York St.
Norfolk, VA 23510-1114
757-441-6844 (V)
757-441-6495 (fax)
jon.e.rix@noaa.gov
http://www.pmc.noaa.gov/amc.htm

RONALD H. BROWN

At Norfolk, VA: 757-441-6206 (AMC Operations Office)
Cellular: 757-439-0530 (or –1231)

CO: CAPT Roger Parsons
FOO (Field Operations Officer): LT Alan Hilton
XO: LCDR Fred Rossmann
Senior Survey Tech: Jonathan Shannahoff
Navigation: LT Mark Boland
Medical/Environmental Compliance Officer, LCDR Dan Aronson, USPHS

3.1.2 Agents:

In U.S.

Quincy Allison
NASA Ames Research Center
Moffett Field, CA 94035
650-604-3493 (V)
650-604-3625 (F)
qallison@mail.arc.nasa.gov (Email)

At Kwajalein Island

Military Sealift Command
Denise Roberts
805-355-3798 (or –2182) (V)
805-355-1814 (F)
droberts@kls.usaka.smdc.army.mil

Shipping details should be cc'd to the ship's CO and FOO at RL_Parsons%Brown@ccmail.rdc.noaa.gov and Alan_Hilton%Brown@ccmail.rdc.noaa.gov, respectively.

3.1.2.a
Note: Contractual arrangements exist between the port agents and the CO for services provided to NOAA ship RONALD H. BROWN. The costs of any services arranged through the ship's agent by the scientific program which are considered to be outside the scope of the agent/ship support will be the responsibility of that program. Reimbursement for all such services will be the responsibility of the program.

4.0 SCIENTIFIC OBJECTIVES

4.0.a
The specific goals of the KWAJEX campaign as they pertain to RONALD H. BROWN are listed below.

- The primary objective during KWAJEX will be high resolution radar measurements. Coordinated radar scanning between the Kwajalein S-band and RONALD H. BROWN C-band Doppler radars will be performed in order to assess the kinematics, microphysics, and precipitation structure of precipitating systems in the vicinity of Kwajalein Island. The radar scanning will also be tailored to sample precipitation in conjunction with insitu aircraft penetrations of precipitation. An additional objective is to provide an extended area of rain mapping around Kwajalein and to provide cross validation for similar measurements from the TRMM satellite and ground instrumentation on Kwajalein atoll (rain gauges, disdrometers, and vertical precipitation profilers).

- Upper air sounding launches using the ship Vaisala system. The soundings will be launched 8 times/day during the entire KWAJEX cruise and will be part of a sounding network deployed around Kwajalein Island. The information will be used to construct heat and moisture budgets in the Kwajalein region to compare with similar estimates from the radar data and will provide initialization/validation of thermodynamic and kinematic data for numerical models.

- High resolution measurements of hydrometeors in the vertical using an S-band precipitation profiler. This data will be used to examine the vertical structure of precipitation over the ship and compare with estimates from the Kwajalein S-band radar.

- Examination of the sea surface scattering properties both during precipitating periods and under clear sky conditions using a Ku-band microwave scatterometer. The data will be used to compare with the TRMM satellite precipitation radar algorithm to measure ocean surface scattering effects at various angles.

1. Measurement of the polarized emission from rain and the ocean surface using a combination of polarimeteric radiometers.

- Examination of oxygen and hydrogen isotope ratios of precipitation and water vapor. The goal is to distinguish water vapor originating from rain evaporation and water vapor originating from seawater. The information should provide a measure of validation for numerical models attempting to model rain evaporation in precipitating systems.

- Measurement of the drop size distribution of rainfall to compare with similar estimates from rain gauges.

- Estimates of cloud-radiative interactions including surface fluxes of heat, moisture, and momentum using a combination of radiometers, ceilometer, and wind profiler.

- Evaluation of the marine boundary layer height and its diurnal variability.

4.1 Scientific Instruments

Instrument	Comments	Mentor (Organization)
C-band Doppler radar	3D structure of precipitation	Cifelli (NASA) & Leary (TTECH)
Vaisala GPS upper air soundings	Tropospheric wind and thermodynamics: 8/day	Cifelli (NASA) & Leary (TTECH)
IMET	Surface Meteorology (wind, T, RH, pressure, SW flux)	ShipTech (NOAA RHB)
Thermosalinograph	Near surface temp and salinity	ShipTech (NOAA RHB)
CTD Profiles	Profile of ocean temperature and salinity	ShipTech (NOAA RHB)
Ku-band Microwave	Ocean surface scattering	Contrereas (UW-APL) & Nystuen (UW-APL)
Water vapor H and O isotopes	Ratio of evaporation (rain vs. seawater)	ShipTech (NOAA RHB)
Scanning microwave polarimeters (8 mm and 2 cm)	Polarized emission from rain and ocean surface	Otten (NOAA ETL)
Air-sea flux system	Turbulent fluxes – heat, moisture, and momentum	Otten (NOAA ETL)
Ceilometer	Cloud-base height, not stabilized, 7.6 km max altitude, vertical only	Otten (NOAA ETL)
UHF wind profiler	Lower tropospheric winds, stabilized, 0-3, 0-16 km modes	Otten (NOAA ETL)
5mm scanning radiometer	SST, air-sea temp difference, temp profile in MBL	Otten (NOAA ETL)
Water vapor/liquid microwave radiometers – 2 channel	Column water vapor and liquid water, not stabilized, vertical-only	Otten (NOAA ETL)
Disdrometers	Drop size distribution	Kucera (UI) & Wolff (NASA)
S-band profiler	Precipitation vertical structure, vertical only, not stabilized	Otten (NOAA ETL)

Navigation, Ocean Sensors	Ship's Instrument, SCS	ShipTech (NOAA RHB)
Rain gauges	Ship's instruments, optical and gravity	ShipTech (NOAA RHB)
Sea surface Temperature	5m depth	ShipTech (NOAA RHB)
Terascan Satellite Receiver	GMS, GOES, AVHRR, and SeaWIFS satellite data	ShipTech (NOAA RHB), Cifelli (NASA) & Leary (TTECH)

4.1.a
Most instruments are designed to take data unattended and continuously. The only instrument being brought on-board by KWAJEX investigators that requires an operator role for ship's personnel is the water vapor hydrogen and oxygen isotope experiment. As discussed below in Sec. 5.6, operation of the isotope experiment involves collecting samples (expected to take less than 30 minutes) every 8 hours (perhaps more frequently for selected events). The PI for the water vapor hydrogen and oxygen isotope experiment (Jim Lawrence) will be in Kwajalein prior to the start of the first IOP in order to setup equipment and provide sample collection training. Ship personnel will provide training and oversight of sounding launches on an as-needed basis during KWAJEX. Ship's personnel are listed above only in reference to those ship instruments that are particularly important to the success of KWAJEX.

4.1.b
Ship personnel will not be requested to support the mission in any way other than those duties already undertaken to mentor the indicated ship's instrumentation. However, the science party may want to consult with the ship's personnel to better understand data management of the ship-collected data and calibration of the ship's sensors.

4.1.c
Ship personnel will not be asked to operate or monitor the C-band radar but may need to help in initial training, trouble shooting, repairs, and data management.

4.1.d
For more information, see Appendix: B for physical descriptions and power requirements of the scientific instruments and Appendix C for a listing of the science party.

5.0 OPERATIONS SUMMARY

5.1 Background

Instruments deployed in the KWAJEX campaign will typically be acquiring data continuously while the ship is on-station. Figure 2 shows the proposed on-station locations for RONALD H. BROWN for the first IOP (Fig. 2a) and second IOP of KWAJEX (Fig. 2b).

5.2 C-Band Radar Operations

5.2.a
The C-band radar on-board RONALD H. BROWN will be operated continuously while the ship is on station. As noted in the Overview section, the C-band radar will be operated in conjunction with the S-band Doppler radar on Kwajalein Island. Research aircraft will also be participating in KWAJEX in order to collect insitu cloud microphysical

measurements. One of the goals of the campaign is to compare the data collected by aircraft with radar data collected by the C and S-band radars. In order to meet this requirement, it will be necessary for the ship to hold it's position within 2 km of the specified coordinates discussed in Sec. 2. This will ensure that the aircraft do not drift out of the radar field of view during intercomparison periods.

5.2.b
The preferred orientation and position of weather systems in the vicinity of Kwajalein during the KWAJEX campaign can not be predicted with any degree of certainty. Therefore, it may be possible that a different on-station location is desired during either of the IOP's. Any decision to change the on-station location will be by mutual agreement of the Operations Center on Kwajalein Island, the Chief Scientist, and the Commanding Officer of RONALD H BROWN (see Sec on General Provisions).

5.2.c
It is expected that the C-band radar will be setup to run a variety of tasks in order to meet the science goals of the experiment. The exact specification of each radar task (range of elevation angles, azimuth range, number of samples, etc) will be determined while the ship is in port during the 19-25 July period. Moreover, all three of the in-port periods (19-25 July, 20-24 August, 13-18 September – see Appendix A) will provide opportunities to perform sphere calibrations of the radar system. A sphere calibration will be performed during each of these in-port periods using a metal sphere target (with known backscatter characteristics) tied to a free-floating upper air sounding balloon. The release location for the balloon and sphere will be at the balloon shelter near the existing KMR weather station (adjacent to the golf course). During the calibration procedure, RONALD H. BROWN's C-band radar will scan over a 20-30 deg azimuth sector centered on the location of the sphere for a limited range of elevation angles. A bridge crew member will assist the science party in the operation of ship survey equipment (aledaide and sextant) to provide azimuth and elevation information of the sphere during the balloon flight. This information will facilitate pointing of the radar antenna in the direction of the metal sphere. It is anticipated that each calibration procedure will take less than an hour to perform. The exact dates and times of the calibration tests will be determined by mutual agreement between the ship crew, KMR, and the Chief Scientist.

5.2.d
Because the stops on the C-band radar antenna limit the antenna from scanning at < 10° below the horizon, it may be necessary for the ship to attempt to minimize the roll and pitch during rough seas by pointing the bow into the direction from which the waves are coming. The Chief Scientist will inform the Commanding Officer if rough seas are having a deleterious effect on the radar data collection. The Commanding Officer will determine what, if any, action can taken to help keep the radar scanning within the tolerances of the radar system.

5.2.e
An additional SIGMET license will be purchased so that both the radar and computer lab HP workstations can display and record the C-band radar data (the configuration will be setup so that only the radar HP can be used to change radar tasks). The science party will install several exabyte tape recorders (either in tandem on the radar HP or one on the radar HP and one on the computer lab HP) in order to archive the radar data. The exabyte tapes will be changed on a daily basis. Several PC's and laptops will be

brought on-board to make an additional copy of the radar data, perform analyses and QC, and keep science logs (see items 10-12 of the equipment list in Appendix B).

5.3 Rawindsonde Operations

5.3.a
While on-station, the science party will launch and monitor 8 Vaisala sondes each day. The launch schedule will be 00, 03, 06, 09, 12, 15, 18, and 21 UTC. As noted above, ship personnel will provide training of the science party prior to beginning of each cruise and will assist in the sonde launches on an as-needed basis. The science party will supply the necessary He and sonde balloons to support the launch schedule during KWAJEX. The ship may be required to point the bow of the ship in the upwind direction in order to facilitate the launch of each balloon. The sounding data (i.e., an ASCII file of pressure, temperature, dewpoint temperature, and wind for each launch) will be transmitted to a computer site on the mainland (to be determined) once per day via ftp and the ship's INMARSAT-M system (see Sec. 10).

5.3.b
During the campaign, a number of sites around Kwajalein Island will be launching sounding periodically each day. The launch frequency of these sondes will be 2-8/day. Because there will be occasions when more than one sonde will be in the air at any given time, the science party on the ship may need to offset the operating frequency (up or down) from the factory set value to prevent interference from other sonde units. The offset value will be determined by mutual agreement of the science party and operations Center on Kwajalein Island.

5.4 Operation of ETL Flux System

The flux system was operated during the NAURU99 campaign and will collect continuous measurements in KWAJEX. The instrument package will be operated in a similar fashion to the NAURU99 cruise. The person responsible for performing calibration checks, archiving data, and QC'ing data will be Jeff Otten of NOAA ETL (both IOPs).

5.5 ETL Remote Sensor Operations

5.5.a
These systems are engineered to operate continuously and unattended except for data storage and media exchanges. With the exception of the scanning polarimetric radiometers, all the ETL remote sensing instruments were operated during NAURU99 and will remain on-board during KWAJEX.

5.5.b
Two scanning polarimetric radiometers will be installed on Kwajalein Island prior to the KWAJEX mission. Similar to the other remote sensing instruments, these radiometers will operate continuously throughout the experiment. The window of each polarimetric radiometer will be periodically cleaned with distilled water and paper towels.

5.5.c
Jeff Otten of NOAA ETL will be responsible for maintaining the operation of all the NOAA ETL remote sensing instruments. The microwave radiometer will be calibrated in cloud-

free conditions by performing “tip curves” where the spinning reflector is tilted to receive radiation from several different zenith angles. The aft deck must be cleared, port and starboard, in the radiometer’s narrow scan plane for this procedure.

5.5.d
The S-band precipitation profiler, UHF wind profiler, and ceilometer will produce screen images of recent measurements.

5.6 Water Vapor Isotope Analysis

Samples of water vapor will be collected in order to analyze the isotopic ratio of hydrogen and oxygen. This information will allow the fraction of water vapor evaporated from rain vs. evaporation from seawater to be determined. The instrument PI, Dr. Jim Lawrence, will install the isotopic analysis equipment in Kwajalein prior to the start of the first IOP and will provide the necessary training for ship personnel to collect samples during the experiment. It is expected that samples will be collected approximately every 8 hours.

5.7 Ku-Band Microwave Operations

The microwave system is designed to operate continuously and unattended except for data storage and media exchanges. Robert Contreras (IOP 1) and Jeff Nystuen (IOP 2) will be responsible for maintaining the operation of the instrument.

6.0 FACILITIES

6.1 Equipment and Services to be Provided by Ship

6.1.1 Communications

AN INMARSAT link for data and written messages, and e-mail with maximum 1-day delay. Ship-to-shore voice communications via HF radio will also be needed. The ship will have a HF set for project use, which can be used from the Computer Lab, After Con, or by extension to the Main Lab or Bio Lab, as well as normal sets on the bridge and the radio room.

6.1.2 Navigational Systems

Navigation information will be recorded in the format replacing the Marine Operations Abstract (MOA – OSC Worksheet 001). All events, such as when the ship changes course or speed, will be recorded as they occur. In the event of a Ship’s Computer System (SCS) failure, the bridge will record hourly GPS positions. Most of the ship's networked computers (Windows NT workstations) will have the capability to access SCS data in real time as it is acquired and logged and the SCS system will be time synchronized to a time-dedicated GPS receiver, as well as GPS position data. The ship will have the capability to extend time-synchronizing to other Windows NT workstations over the network, if necessary. The system is not designed to synchronize system clocks on other platforms/operating systems. However, serial strings that contain SCS data, including GPS position and time, can be output to asynchronous serial ports on systems so equipped. This would not synchronize system clocks, but would provide time stamps for SCS-acquired data that could be compared to other non-SCS data acquired on the same platform. Some of the ship's "standalone" systems, like the Doppler radar, Vaisala, ADCP, and Terascan will have their own GPS inputs, and time stamps that may vary by a few fractions of a second from that of SCS.

6.1.3 Thermosalinograph Records

Thermosalinograph records for the entire cruise are required. Calibration procedures will be performed similar to previous cruises (i.e., NAURU99).

6.1.4 Science Party Laboratory Work Space Requirements

Work space in the main lab, hydro lab, bio lab, and computer room, primarily for instrument data systems whose sensors are positioned outside, is required. One unit of computer space is defined as counter-top space 2 feet wide, 30 inches deep, and 3 feet high.

Needed are:

Sensor	Sensor Location	Lab	Units Needed
C-band Radar	Above Pilot House	Main	4
Wind Profiler	Main Deck Aft, Port	(As setup during previous missions)	
Ceilometer	Main Deck Aft, Port	(As setup during previous missions)	
Flux System	Jack Mast	(As setup during previous missions)	
ETL Radiometers	Bow Tower	(As setup during previous missions)	
S-Band Radar	03 Forward, Port	(As setup during previous missions)	
WV Isotope	In-lab*	Hydro	2
SPR**.	02, Radiometer Van top, Port		
Ku-Band Microwave	Jack Mast, Radiometer Van	Bio	2
Disdrometers	02, open area near rain gauges	None required	

* Instrument needs access to outside, ambient airflow
** Scanning Polarimetric Radiometers

6.1.5 Power to Vans

Power to all vans is needed, as indicated in Appendix B. Only the following power outputs are available from the ship, all at 60 Hz: 1) 450 VAC, 3 phase, 2) 220 VAC, 1 or 2 phase, and 3) 120 VAC, 1 or 3 phase. Three-phase power is configured as “delta” (no ground), not as “Y” (with central ground). Transformers or motor-generators for other power requirements will not be provided by the ship and must be provided by the participants. Only US standard power plugs and jacks will be provided by the ship.

6.1.6 SCS Data Stream

6.1.6.a
Access to ship’s high speed data (0.5 Hz) is required, including ring gyro, relative wind speed and direction, barometric pressure, air temperature, solar irradiance, salinity, rain rate (both optical gauges), sea water temperature (5 m depth), and GPS Pcode longitude, latitude, ship speed, ground speed, ship direction, ship heading. At regular intervals not to exceed 5 days, ship’s personnel will archive ship’s data to tape (medium

to be determined) for delivery to the Chief Scientist at the end of each IOP. All ship's sensors are to be calibrated routinely and calibration data provided together with sensor data.

6.1.6.b
Network connections are by ethernet 10-base-T. IP addresses will be assigned by the ship's ET.

6.1.c
It is requested that the ship continue to record the same navigation data for wind profiler support as was done for NAURU99. This file contains the date, time, Pcode SOG and COG, Lat., Lon., and laser ring gyro heading at 15s intervals.

6.1.7 C-Band Doppler Radar

The scientific party will have a designated radar engineer/technician for each KWAJEX cruise in order to perform calibrations and maintain the radar system during operation. The scientists responsible for running the 5-cm Doppler radar may need assistance from the ship's personnel early in each of the KWAJEX cruises in order to become familiar with the installation and operation of the radar. In addition to daily internal (and solar) calibrations while the ship is on-station, it is expected that sphere calibrations will be attempted while RONALD H. BROWN is in port at Kwajalein Island. As noted in Sec. 5.2.c, the sphere calibrations will be performed using a metal sphere flown beneath a balloon normally used for radiosonde flights. The balloon-sphere system will be launched from a facility adjacent to the KMR weather station. Ship personnel may be needed to assist scientists in providing azimuth and elevation information during the balloon-sphere flight in order to steer the radar antenna to the appropriate location.

6.1.8 ASAP Van

The ASAP van will be used to track, and possibly to launch, rawidsondes every 3 hours during KWAJEX. Help from the ship's crew will be needed to move helium cylinders to support these operations. Scientists will be responsible for all radiosonde launches and monitoring of sondes not part of the ship's normal operations.

6.1.9 IMET System

The ship's IMET system will be operated and calibrated throughout KWAJEX, and it's data made available to scientists via the SCS network.

6.1.10 CTD Profiles

6.1.10.a
CTD profiles are routinely collected after the deployment of TAO moorings for comparison to the mooring subsurface temperature and conductivity measurements. These comparisons offer good confirmation of the moored data quality at the time of deployment but give no information as to the time history of possible sensor drifts. Daily CTDs collected during this cruise will provide a unique opportunity for mooring/CTD intercomparison.

6.1.10.b

CTD profiles will be collected once a day to a depth of 1000 meters. The scheduled time of each profile will be determined by the Chief Scientist and bridge watch. The package is to be readied and the data acquired by the ship's survey personnel. Two water samples will be collected during each cast, one at 1000 meters and one near the surface in the mixed layer. Salinity analysis will be performed on the water samples every 3-4 days by the ship's survey personnel. The assembly and termination of the CTD underwater package using the ship's equipment and instrumentation will be the responsibility of the ship's ET's and survey personnel prior to the cruise.

6.1.11 Terascan Satellite Receiver

The Terascan system will be utilized to download appropriate GMS/GOES, AVHRR and SeaWIFS imagery throughout KWAJEX. The imagery will be used by the scientific party to help interpret synoptic and mesoscale meteorological conditions and to compare satellite observed cloud features with corresponding upper air sounding and radar measurements. Ship personnel will provide training so that scientists can use the system to generate hard copy plots of satellite imagery.

6.1.12 Miscellaneous

The science party may ask the ship to temporarily store several wooden crates, perhaps broken down, in which equipment arrives. These same crates will be used to ship gear home from Kwajalein Island. An estimate of the number of crates to be stored and the total storage volume will be provided to the ship by the Chief Scientist at least 2 weeks prior to the beginning of the mission.

6.2 Equipment and Services to be Provided by the Scientific Party

Science party responsibilities can be divided into the following groups:

6.2.1 ETL Systems

6.2.1.a
These instruments include the flux system (radiation and bulk meteorology), S-band precipitation profiler (precipitation profiles), UHF wind profiler (wind profiles), ceilometer (cloud base), 2-channel microwave radiometer (column liquid and water vapor), scanning polarimetric radiometers (polarized emission from rain and the ocean surface), and 5-mm scanning radiometer (SST, temperature profiles).

6.2.1.b
The flux system, precipitation profiler, wind profiler, ceilometer, 2-channel radiometer, and 5-mm scanning radiometer will be on-board prior to KWAJEX, having been deployed in NAURU99.

6.2.1.c
The scanning microwave polarimeters will be installed at Kwajalein Island prior to the start of the first IOP.

6.2.1.d
As often as possible when skies are clear, tip calibrations will be performed on the 2-channel microwave radiometer system. Also, the scanning polarimetric radiometers will

be periodically cleaned. Any activity on top of vans (i.e., the radiometer van) will be coordinated with the bridge, and will require the use of a safety harness, tethers, and jacklines.

6.2.1.e
Jeff Otten of NOAA ETL will be responsible for mentoring all of the ETL instruments during KWAJEX. Note that the radiometer van will not have the boom extended as was done in NAURU99.

6.2.2 Ku-Band Microwave Scatterometer

6.2.2.a
This instrument will be used to determine the effect of rainfall on backscatter from the ocean surface at the frequency of the TRMM satellite. The system will be brought on-board at Kwajalein Island prior to the beginning of KWAJEX.

6.2.2.b
An RF module will be mounted on a platform on the Jack mast with an actuator that will allow the incidence angle of the instrument to be varied. An IF module with power supplies and a data acquisition system will be mounted either in the Radiometer Van or in the lab (Bio?). The Jack mast may have to be climbed once per week to clean the actuator. Any activity on the mast will be coordinated with the bridge and will require the use of a safety harness.

6.2.2.c
Several small boxes containing spare parts will be brought on-board (2'X2'X3') and stored in the lab space allocated to the instrument (see Sec. 6.1.4).

6.2.3 Water Vapor Isotope System

This instrument will be installed on Kwajalein Island prior to the beginning of KWAJEX. The instrument setup will be performed by Dr. Jim Lawrence of the University of Houston. Dr. Lawrence will also be responsible for training ship personnel in mentoring the instrument during the experiment.

6.2.4 Disdrometers

Two impact-type disdrometers (APL) will be installed at Kwajalein Island before the ship departs for the first IOP. The disdrometer instruments are self contained units with their own power source, designed to operate unattended for extended periods. No oversight of these units is anticipated during the experiment. Dr. Ali Tokay (NASA GSFC) or Mr. Paul Kucera (U Iowa) will be responsible for setting up the instruments. The proposed location of each unit is undetermined; however, it should be in an open area with a minimum of vibrational interference. Because of the potential for flooding on the exterior decks during heavy rain, the disdrometer scientists will mount each disdrometer unit on a small platform (provided by the scientific party) above the deck surface. The scientists responsible for the setup of the disdrometer units will work with ship personnel to determine appropriate locations for each instrument.

6.2.5 Miscellaneous

The KWAJEX science party is responsible for supplying all meteorological balloons, sondes, and helium for the balloons (including those used to launch radar calibration spheres). It is anticipated that a total of 58-76 He cylinders will be brought aboard the ship in Kwajalein prior to KWAJEX. The exact number depends on the relative quantity of 219 vs. 291 ft^3 cylinders that will be sent to Kwajalein. The science party will also supply all archive media to collect C-band radar data (exabyte tapes) and sounding data (zip disks) as well as exabyte tape drives on the HP computers to collect the raw C-band radar data. Printer paper, toner cartridges, and ink jet cartridges will also be supplied. The science party will install a temporary license to run the SIGMET IRIS system of the computer lab HP during KWAJEX. The science party will also install an INMARSAT-M satellite phone adjacent to the radar system to be used as an emergency link to radar engineers on the mainland (see Sec. 10.c and Appendix B).

7.0 DISPOSITION OF DATA AND REPORTS

7.1 Data Responsibilities

7.1.a
The Chief Scientist, working with the Commanding Officer of RONALD H. BROWN, is responsible for providing adequate opportunity for participants to acquire relevant data sets with their instruments. However, each instrument PI (or their designated representative) is responsible for quality control, archiving, and data accessibility to other participants. The Chief Scientist will request the following ship's data to be provided in support of the KWAJEX campaign:

- Calibration information for ship's instruments;
- Marine Operations Abstract (MOA);
- Deck log / weather observation sheets;
- Sea surface temperature and salinity logs;
- Thermosalinograph data;
- Sonde data;
- IMET data;
- Rain gauge data; and
- Ship meteorological sensor data

7.1.b
The Chief Scientist is responsible for dissemination of data to nations in whose EEZ data are acquired and requested. The Chief Scientist will furnish the ship a complete listing of all data gathered by the primary scientific party, detailing types and quantities of data. The Chief Scientist will receive all original data gathered by the ship for the primary mission, and this data transfer will be documented on NOAA form 61-29. The Chief Scientist will be responsible for managing all requests from interested parties for ship data following the completion of the KWAJEX campaign and will attempt to facilitate data exchanges among the science party participants.

7.2 Ancillary Projects

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, Letter Transmitting Data. Copies of ancillary project data will be provided to the Chief Scientist on request.

The following ancillary projects will be carried out by ship's personnel in accordance with general instructions contained in PMC OPORDERs: a) SEAS Data Collections and Transmission (PMC OPORDER 1.2.1); b) Marine Mammal Reporting (PMC OPORDER 1.2.2); c) Sea Turtle Observations (SP-PMC-2-89); d) others to be specified, with concurrence of the Chief Scientist and Commanding Officer, on a not-to-interfere basis.

7.3 Ship Operation Evaluation Report

The Chief Scientist will complete the Ship Operations Evaluation Form and forward it to Director, Office of NOAA Corps Operations within 20 days of the completion of the cruise.

7.4 Foreign Research Clearance Reports

Request for research clearance in Foreign waters (Republic of Marshall Islands) have been submitted by NOAA Corps to the U.S. Department of State on behalf of the Chief Scientists for the KWAJEX mission. Copies of the clearances received will be provided to the Field Operations Officer before departure. The Chief Scientists are responsible for satisfying the post-cruise obligations associated with diplomatic clearances to conduct research operations in foreign waters. These obligations consist of (1) submitting a "Preliminary Cruise Report" immediately following the completion of the cruise involving research in foreign waters, due at ONCO within 30 days, and (2) ultimately meeting the commitments to submit data copies of the primary project to host foreign countries.

8.0 HAZARDOUS MATERIALS

8.0.a
RONALD H. BROWN will operate in full compliance with all environmental compliance requirements imposed by NOAA. All hazardous materials/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. RONALD H. BROWN Environmental Compliance Officer will work with the Chief Scientist to ensure that this management policy is properly executed, and that any problems are brought to the attention of the Commanding Officer.

8.0.b
All hazardous materials require a Material Safety Data Sheet (MSDS). Copies of all MSDSs shall be forwarded 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.

8.0.c
The Chief Scientist will complete a local inventory form, provided by the Commanding Officer, indicating the amount of each material brought onboard, and for which the Chief Scientist is responsible. This inventory shall be updated at departure, 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.

8.0.d
The ship's dedicated HAZMAT Locker contains two 45-gallon capacity flam cabinets and one 22-gallon capacity flam cabinet, plus some available storage on the deck. Unless there are some 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.

8.0.e
The scientific party, under the 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.

8.0.f
The Chief Scientist is directly responsible for the proper 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.

9.0 MISCELLANEOUS

9.0.a
Small boat operations are weather dependent and at the Command's discretion.

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

9.0.c
The Chief Scientist is responsible for assigning berthing for the scientific party within the spaces approved as dedicated scientific berthing. The ship will send stateroom diagrams to the Chief Scientist showing authorized berthing spaces. The Chief Scientist is responsible for returning the scientific berthing spaces back over to the ship in the condition in which they were received; for stripping bedding and for linen return; and for the return of any room keys, which were issued.

9.0.d
The Chief Scientist is also responsible for the cleanliness of the laboratory spaces and storage areas used by the science party, both during the cruise and at its conclusion prior to departing the ship.

9.0.e
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. These can be combined with the NOAA Health Services Questionnaire on the forms provided.

9.0.f

Wearing open-toed footwear (such as sandals) outside of berthing areas is unsafe and is not permitted. This shipboard safety regulation is included in the Commanding Officer's Standing Orders, and will be enforced. All members of the scientific party are expected to be aware of this regulation and to comply with it.

9.0.g
Chief Scientists shall be cognizant of the reduced capability of RONALD H BROWN's operating crew to support 24-hour mission activities with a high tempo of deck operations at all hours. Wage marine employees are subject to negotiated work rules contained in the applicable collective bargaining agreement. Day workers' hours of duty are a continuous eight-hour period, 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. Day workers 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 no day workers being available to support science operations until the rest period has been observed. All wage marine employees are supervised and assigned work only by the Commanding Officer or designee. The Chief Scientist and the Commanding Officer shall consult regularly to ensure that the shipboard resources available to support the embarked mission are utilized safely, efficiently, and with due economy.

10.0 COMMUNICATIONS

10.0.a
RONALD H BROWN during the KWAJEX campaign will supply a HF radio set. This radio will be used as the primary means to communicate between the ship and the KWAJEX Operations Center on Kwajalein Island. The HF radio can be accessed from the Computer Lab, After Con (e.g., both radar workstation locations), or by extension to the Main Lab or Bio Lab, as well as the normal sets on the Bridge and the Radio Room. The HF radio will be available 24 hours per day during KWAJEX for communications between the Operations Center and the science crew on-board RONALD H BROWN. Specific frequencies for the operation of the HF need to be agreed upon by the ship crew and KMR and have not been set yet. The HF communication system will be tested and frequencies assigned while the ship is in-port during the 19-25 July period. The science party may attempt to take advantage of the ship's HF ARQ Telex (teletype) communications in order to facilitate the transmission of radiosonde data to the Operations Center.

10.0.b
The Chief Scientist or designated representative will have access to both INMARSAT-A (for high speed data transmission and high quality telephone communications - $7-$15/minute) and INMARSAT–M (for moderate quality voice telephone communications and 2400 baud data transfer - ~$3/minute) satellite communications. The latter system will be used preferentially for Fax, electronic mail, and other ship-to-shore and ship-to-ship communication. This system will also be used to transmit radiosonde data (one ASCII file for each launch) to a computer site on the mainland via ftp. To use INMARSAT for fax or voice communications, participants must bring a valid credit card. The number of INMARSAT-A is 011-872-154-2643 and the number of INMARSAT-M is 011-872-761-266-581. E-mail charges for all personnel will be borne by the ship, provided size and quantity restrictions are not exceeded. Unless otherwise arranged, e-mail exchanges via INMARSAT will take place only once per day. Embarking scientists

will be issued an account on Lotus cc:Mail by the shipboard electronics staff. The general form is:

Firstname_Lastname%Brown@ccmail.rdc.noaa.gov.

Due to the escalating volume of e-mail and its associated transmission costs, each member of the ship's complement, crew and scientist, will be authorized to send/receive up to 15 KB of data per day ($1.50/day or $45/month) at no cost. E-mail costs accrued in excess of this amount must be reimbursed by the individual. At or near the end of each leg, the Commanding Officer will provide the Chief Scientist with a detailed billing statement for all personnel in his party. Prior to their departure, the chief scientist will be responsible for obtaining reimbursement from any member of his party whose e-mail costs have exceeded the complimentary entitlement.

10.0.c
An INMARSAT-M satellite phone system (provided by NASA) will be installed by the science party in a location adjacent to one of the radar HP workstations for use by the radar and sounding operation's crew. The primary use of this communication system will be as an emergency link to radar engineers on the mainland in order to help troubleshoot problems with the radar system. Previous experience has shown that having long distance voice communications co-located with the radar system can greatly facilitate fixing problems when they occur. The phone will also serve as a backup for voice, fax, and e-mail purposes when the ship's INMARSAT-M system is busy. A steerable antenna will be mounted on the ship (location to be determined) in order to keep the phone signal locked onto the satellite. A cable that connects the antenna to the handset will be provided by the science party.

11.0 GENERAL PROVISIONS

11.1 Radio Frequency Interference

Radio transmission can interfere with several of the continuous data streams as well as with salinity and nutrient instrumentation. If there is radio interference, the Commanding Officer and Chief Scientist will work out a transmission schedule to minimize the deleterious effects of transmissions.

11.2 Deviations from the Cruise Plan

The Chief Scientist is authorized to alter the scientific portion of this cruise plan with the concurrence of the Commanding Officer, provided that the proposed changes do not:

- jeopardize the safety of personnel or ship;
- exceed the allotted time for the cruise;
- result in undue additional expense; or
- change the general intent of the cruise.

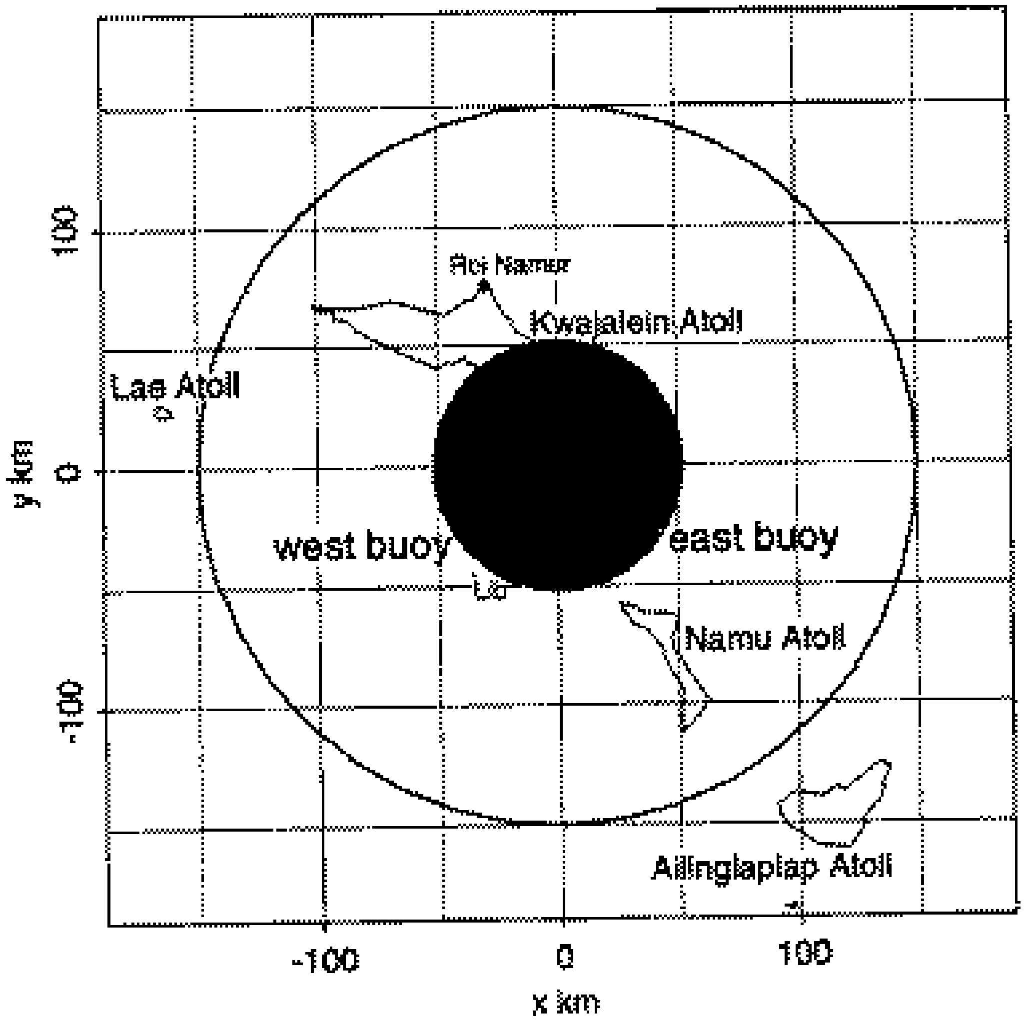

Figure 1. Ship operations area for the *R/V Brown* during KWAJEX is the shaded region within 52 km radius of Kwajalein Island. The operations area encompasses the two TAO buoys (east buoy and west buoy) which may need to be serviced during the project.

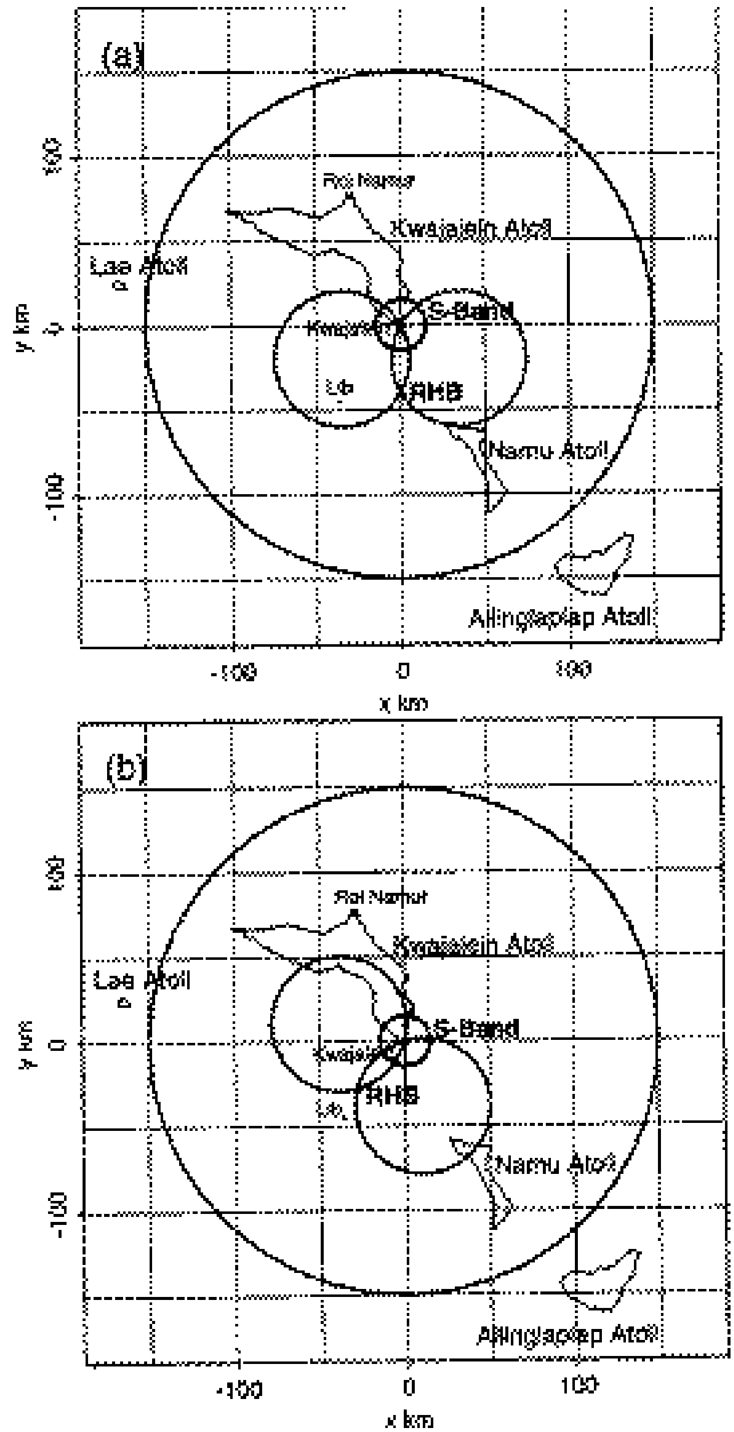

Figure 2. Map showing dual-Doppler lobes when the *R/V Brown* is (a) 40 km south and (b) 40 km southwest of the Kwajalein S-band radar. The outer circle is the 150-km range ring around the Kwajalein radar. Inside the inner 15-km radius circle, data from the Kwajalein S-band radar are *not* useable for research purposes.

Appendix A

Operations Schedule for RONALD H BROWN in KWAJEX

Date	Activity
19-Jul-99	Arrive Kwajalein
25-Jul-99	Leave Kwajalein (start IOP 1)
20-Aug-99	Arrive Kwajalein (end IOP 1)
24-Aug-99	Leave Kwajalein (start IOP 2)
13-Sep-99	Arrive Kwajalein (end IOP 2)
18-Sep-99	Leave Kwajalein (recover moorings)

Appendix B

Equipment List

1. UHF Wind Profiler (NOAA ETL)
   Weight: 600 lbs
   Size: 10'L X 10'W X 7'H
   Power: 120 VAC single phase, 12 amps
   Site: Main deck aft, port

2. S-Band Precipitation Profiler (NOAA AL)
   Weight: 900 lbs
   Size: 7'D X 5'H
   Power: 120 VAC single phase, 12 amps
   Site: 03 forward, port

3. Ceilometer (NOAA ETL)
   Weight: 100 lbs
   Size: 18"L X 18"W X 4'H
   Power: 120 VAC single phase, 6 amps
   Site: Main deck aft, port

4. Flux System (NOAA ETL)
   Weight: 100 lbs
   Size: 2'L X 1'W X 2'H
   Power: 120 VAC single phase, 8 amps
   Site: Various, including jack mast and bow tower

5. Radiometer Van (NOAA ETL)
   Weight: 13,000 lbs
   Size: 20'L X 8'W X 8'H
   Power: 208 VAC 3 phase, 40 amps
   Site: 02 forward, port outboard

6. Scanning Polarimetric Radiometers: 2 units (NOAA ETL)
   Weight: 200 lbs
   Size: 2'W X 5'H cylinders
   Power: 100W
   Site: 02 forward, port outboard – on top of Radiometer Van

7. Water Vapor Isotope System (University of Texas)
   Weight: 70 lbs
   Size: 4'L X 4'W X 2'H
   Power: 110 V, 55 watts (cryocooler); 110 V, 2-3 amps (vacuum pump)
   Site: To be determined (hydrolab)

8. Ku-band radar (UW APL)
   Weight: 30 lbs for RF module
   Size: 1'X1'X2' for RF module
   Power: 120 V, 60 Hz, 4-5 amps

Site: Various – Jack mast (RF module), Radiometer Van / Lab (IF module)

9. Disdrometers (NASA GSFC) – 2 total
   Weight: 20 lbs (each)
   Size: 24”L X 12”W X 12”H
   Power: battery, self contained
   Site: to be determined

10. Gateway P-II 200 MHz and 17” monitor (NASA GSFC)
    Total Weight: 100 lbs.
    Size: Monitor (17”W x 12”H x 18”L), CPU (8”W x 33”H x 30”L)
    Power: AC 110 V
    Site: Main Lab

11. Apple Imac and Zip drive (NASA GSFC)
    Weight: 65 lbs.
    Size: (17”W x 24”L x 18”H)
    Power: AC 110V
    Site: Main Lab

12. Gateway Solo Laptop (NASA GSFC)
    Weight: 10 lbs.
    Size: (2”H x 15”W x 14”L)
    Power: AC 110V or Battery
    Site: Main Lab

13. Epson Color Printer (NASA GSFC) – 2 total
    Weight: 14 lbs.
    Size (20”W x 6”H x 10”L)
    Power: AC 110V
    Site: Main Lab and Computer Lab

14. INMARSAT-M Satellite Phone (NASA GSFC)
    Weight: 20 lbs.
    Size (20”W x 6”H x 24”L) – handset (36”W x 24”H x 36”L) - antenna
    Power: 110VAC
    Site: C-band Radar System

Appendix C

KWAJEX Participants onboard RONALD H. BROWN

RHB Staffing: IOP 1 (25 July-20 August):

Name	Organization	Role	Contact
Anderson	TAMU	radar-sounding	cander@tamu.edu
Cifelli	NASA GSFC	SSC	cifelli@trmm.gsfc.nasa.gov
Contreras	UW APL	Ku-band engineer	robb@apl.washington.edu
Gears	NASA WFF	engineer	lgears@pop500.gsfc.nasa.gov
Kim	UW	radar-sounding	mjkim@atmos.washington.edu
Kucera	UIOWA	radar-sounding	pkucera@iihr.uiowa.edu
Marselek	TTECH	radar-sounding	wadjm@ttacs.ttu.edu
Otten	NOAA ETL	ETL sensors	ottenje@palmer.usap.nsf.gov
Spooner	UW	radar-sounding	cspoon@atmos.washington.edu

RHB Staffing: IOP 2 (24 August-15 September):

Name	Organization	Role	Contact
Carr	UW	radar-sounding	tobias@atmos.washington.edu
Carrie	TAMU	radar-sounding	gordonc@ariel.tamu.edu
Dunnemann	NASA WFF	engineer	neild@ware.internet.net
Gasparini	TAMU	radar-sounding	gasparini@tamu.edu
Leary	TTECH	SSC	x9cal@ttacs.ttu.edu
Marselek	TTECH	radar-sounding	wadjm@ttacs.ttu.edu
Nystuen	UW APL	Ku-band engineer	nystuen@apl.washington.edu
Otten	NOAA ETL	ETL sensors	ottenje@palmer.usap.nsf.gov
Wolff	NASA GSFC	radar-sounding	wolff@trmm.gsfc.nasa.gov

Appendix D

Hazardous Materials List

Isopropyl Alcohol

Quantities and locations of newly arriving hazardous materials will be documented in Kwajalein. The KWAJEX Chief Scientists will work with the departing NAURU99 Chief Scientist and the ship's HazMat Officer to ensure proper tracking of inherited hazardous materials.