

Ship-Based Measurements of Cloud Microphysics and PBL Properties in Precipitating Trade Cumuli During RICO

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Ship-Based Radars

- 915-MHz wind profiler--PBL 3-D winds, inversion height, cloud and precipitation structure
- 9.4 GHz Doppler Radar (upward pointing)—Reference reflectivity; Doppler spectra ; Cloud dynamics and precipitation physics
- 35 GHz Scanning Doppler cloud radar—Reflectivity and Doppler moments; Cloud mapping and microphysical properties; precipitation mapping
- 94-GHz Doppler radar (stabilized/scanning)--High resolution Doppler spectra; cloud and precipitation microphysics

Scanning Doppler Lidar (NOAA ETL)

Range resolved radial wind speed and intensity measurement once a second

Resolution/Range: $\sim 20 \text{ cm s}^{-1}$; 5 km

Scanning: Motion compensated hemispheric scanner

Measurements: Aerosol distributions and wind motions around and below clouds

Ship-Board Instrumentation

System	Measurement
Motion/navigation package	Motion correction for turbulence
Sonic anemometer/thermometer	Direct covariance turbulent fluxes
IR fast H ₂ O/CO ₂ sensor	Direct covariance moisture/CO ₂ fluxes
Mean SST, air temperature/RH	Bulk turbulent fluxes
Pyranometer/Pyrgeometer	Downward solar and IR radiative flux
Ceilometer	Cloud-base height
23 and 31 GHz microwave radiometer ARM type (Mailbox)	Integrated cloud liquid water Integrated total water vapor
Riegl Laser wave sensor	Ocean surface wave height/period
Precipitation spectrometer	Drizzle droplet size spectra
BNL rotating shadowband radiometer	Direct/diffuse solar
Rawindsondes	T, RH, Wind Profiles

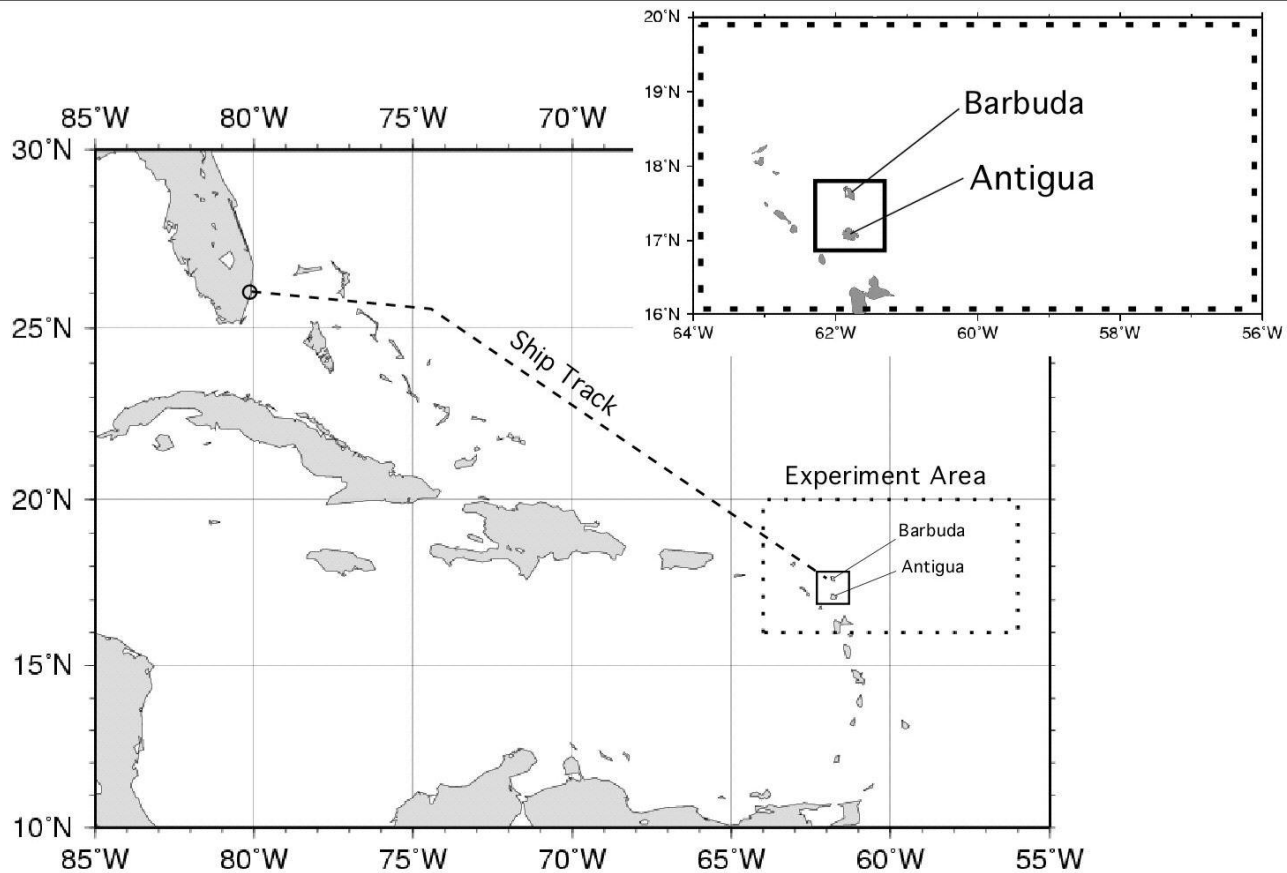
R/V Seward Johnson

General Specifications

- Length Overall - 204 feet.
- Length between Perpendiculars - 183 feet.
- Beam Overall - 36 feet.
- Fuel Capacity - 60,000 Gal.
- Fuel Consumption - 70 gal./hr., normal cruise.
- Potable Water - 15,000 gal. with RO Unit (120 gal. hr.).
- Accommodations - 40 (including crew).
- Speed - 13 knots.
- Year Built/Converted - 1984/1994.

R/V Seward Johnson



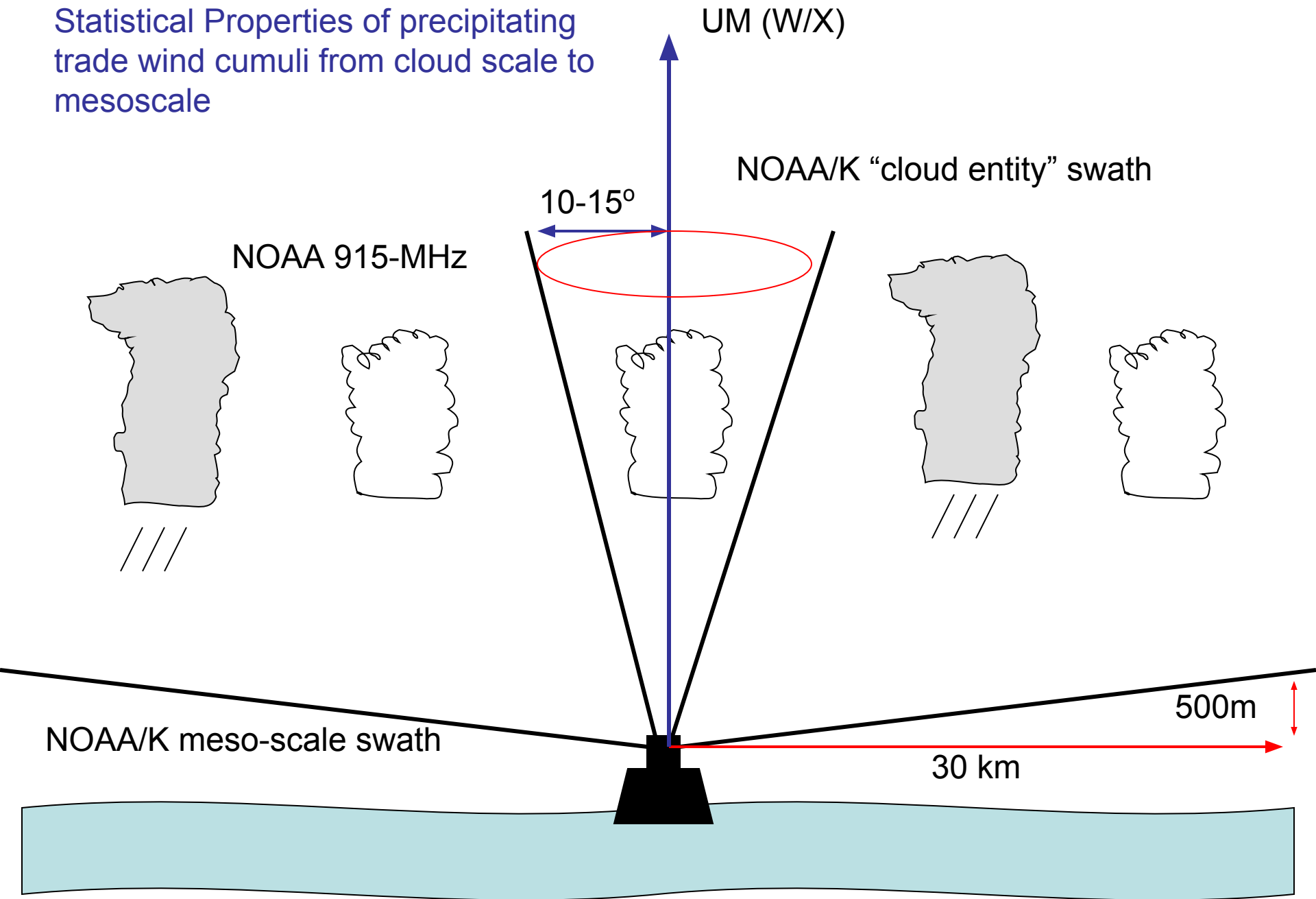


Activity	Location	Dates
Staging	Ft. Pierce, FL	Dec. 13-21
Transit	Atlantic/Caribbean	Dec. 29-Jan. 3
On Station (Leg 1)	Upwind of Barbuda—20-100 km	Jan. 4-14
Port Call	Antigua	Jan. 15
On Station (Leg 2)	Upwind of Barbuda	Jan. 16-26
Transit	Atlantic/Caribbean	Jan. 27-Feb 2

Ship Operations

- Remote Sensing and In Situ -- Continuous
- Rawinsondes – 6/day
- Coordination with Island-based Radars—
Approx 20 km off shore (daily (?)
repositioning)
- Scanning for K_a -Band Radar and Doppler
Lidar

Statistical Properties of precipitating trade wind cumuli from cloud scale to mesoscale



Coordination with Other RICO Operations

- Operations Center
 - Needs: Ship info for mission planning; Ship positioning and operations
 - Mode: Internet; Telephone; Radio (?)
 - Schedule: Before and after planning meetings; regular 6 per day soundings; on-demand
- Surface-Based Radars
 - Needs: Positioning of ship; Ship operations; Met Input for island-based radar operations
 - Mode: Radio, Internet, Telephone
 - Schedule: On demand; scheduled times)
- Aircraft
 - Needs: Ship operations and positioning; Observational input for in-flight operations
 - Mode: Radio
 - Schedule: On demand

Scientific Questions to be Addressed

5. *Can we find evidence for cloud processing of aerosol in the aerosol size distributions?*
6. *Can we detect changes in cloud microphysics under different aerosol loadings?*

UM Cloud and Precipitation Mobile Observatory

UM W-band Doppler radar

Frequency: 94.2 GHz (wavelength = 3.19 mm)
Antenna: 0.91 m, Cassengrain
0.24° beamwidth (8-10 m at 1 km range)
Vertical resolution: 30 m, **Temporal Resolution:** 0.5 -1 sec
PRF: 5-10 kHz (4-8 ms⁻¹) Nyquist
Doppler spectra, raw I/Q
Sensitivity: -52 dBZ @ 1 km

UM X-band Doppler radar

Frequency: 9.4 GHz (wavelength = 3.2 cm)
Antenna: 2 m, Cassengrain
Vertical resolution: 60 m, **Temporal Resolution:** 0.5 -1
sec
PRF: 1-2.5 kHz (8-20 ms⁻¹) Nyquist
Doppler spectra, raw I/Q
Sensitivity: -25 dBZ @ 10 km

Ceilometer

Broadband radiometers

IRT

Surface Met.

Rain gauge

** NOAA/ETL 2 channel Microwave Radiometer

Scientific Questions to Be Addressed

1. *What is the range of the dynamical and microphysical structures in trade-wind cumuli, and how do these structures affect the lifecycle of clouds under varying wind shear, stability, and aerosol conditions?*
2. *What microphysical / dynamical factors and time scales are involved in the production of large-drop concentrations in fair-weather cumulus clouds?*
3. *How do the raindrop size distributions evolve from the initial to mature precipitating stages of shallow cumuli?*

Scientific Questions to be Addressed

4. *How is the marine boundary layer altered by precipitation from trade-wind cumuli?*
5. *What are the statistical properties of precipitating trade-wind cumuli from the cloud to mesoscale scale?*

Approaches

- Coordination with Surface-Based Radars and Aircraft and Integration of Observations
- Continuous Monitoring for Cloud Statistics