

R/V Seward Johnson Operations during RICO



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Background

Researchers from the Univ. of Miami (UM), the Univ. of Colorado (CU) and the Environmental Technology Laboratory (ETL) collaborated to address several questions on trade-wind cumuli and PBL studies for RICO.

In the first year, this work involved equipment preparation on the cloud radars (UMDCR and NOAA-K), the installation of these radar systems along with the flux/PBL system, the ETL lidar, and the microwave radiometer system, on the R/V *Seward Johnson* (SJ), and deployment of the ship to the RICO field program near Barbuda Island.

The *SJ* was positioned in areas scanned by the island-based S-POL radar and provided detailed observations of trade-wind cumuli with evolving high reflectivity cores. We were able to sample 'pure' clouds over undisturbed marine conditions away from island topography.



Scientific Objectives

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?

What microphysical / dynamical factors and time scales are involved in the production of **large-drop concentrations** in fair-weather cumulus clouds?

How do the raindrop size distributions evolve from the **initial to mature precipitating** stages of shallow cumuli?

How is the **marine boundary layer altered by precipitation** from trade-wind cumuli?

What are the statistical properties of precipitating trade-wind cumuli from the cloud to **mesoscale scale**?

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

Instrumentation

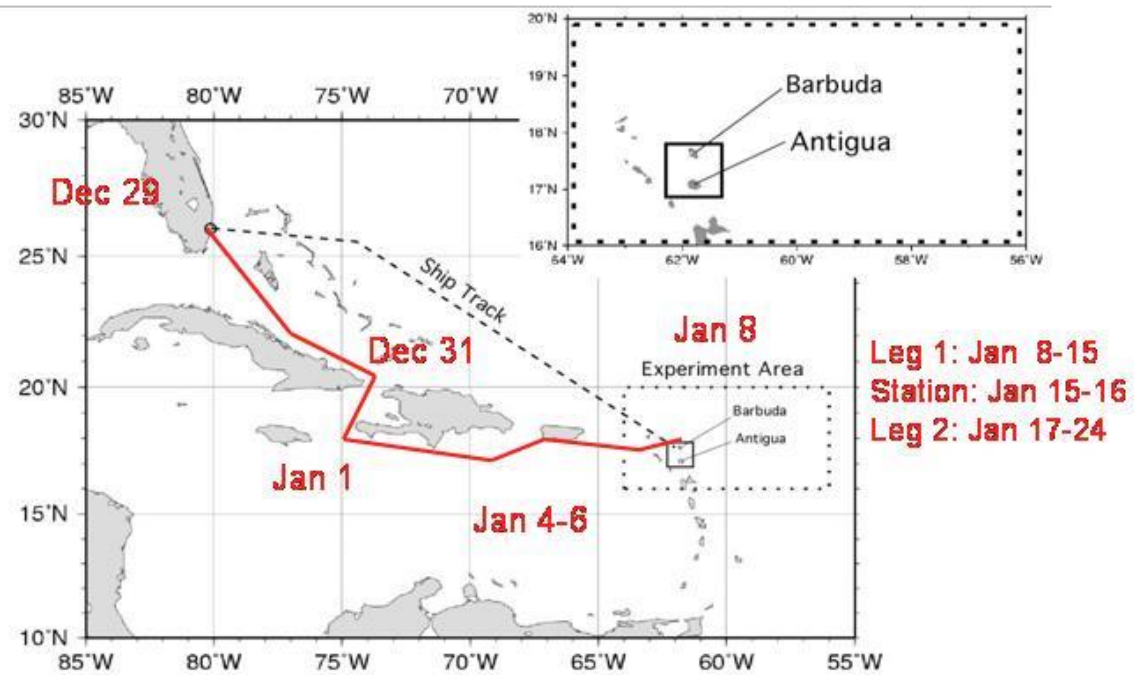
Table 1. Instruments and measurements for the ship-based cloud microphysics and PBL properties in precipitating trade cumulus clouds during the RICO study.

Item	System	Measurement
1	Motion/navigation package	Motion correction for turbulence
2	Sonic anemometer/thermometer	Direct covariance turbulent fluxes
3	IR fast H ₂ O/CO ₂ sensor	Direct covariance moisture/CO ₂ fluxes
4	Mean SST, air temperature/RH	Bulk turbulent fluxes
5	Pyranometer/Pyrgeometer	Downward solar and IR radiative flux
6	Ceilometer	Cloud-base height
7	Lasair-II	Aerosol size spectrum
8	Vaisala rawinsonde system	Profiles wind, temperature, and humidity
9	915-MHz wind profiler	PBL 3-D winds, inversion height, clouds
10	94-GHz Doppler radar (UMDCR)	High resolution Doppler spectra, cloud and precipitation microphysics and dynamics
11	9.4 GHz (X-Band) Doppler Radar (UM)	Cloud dynamics and precipitation physics
12	23 and 31 GHz microwave radiometer	Integrated cloud liquid water Integrated total water vapor
13	35 GHz Doppler cloud radar (NOAA/K)	Cloud microphysical properties
14	Doppler lidar (NOAA ETL)	High resolution Doppler spectra around and below clouds

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Cruise Track



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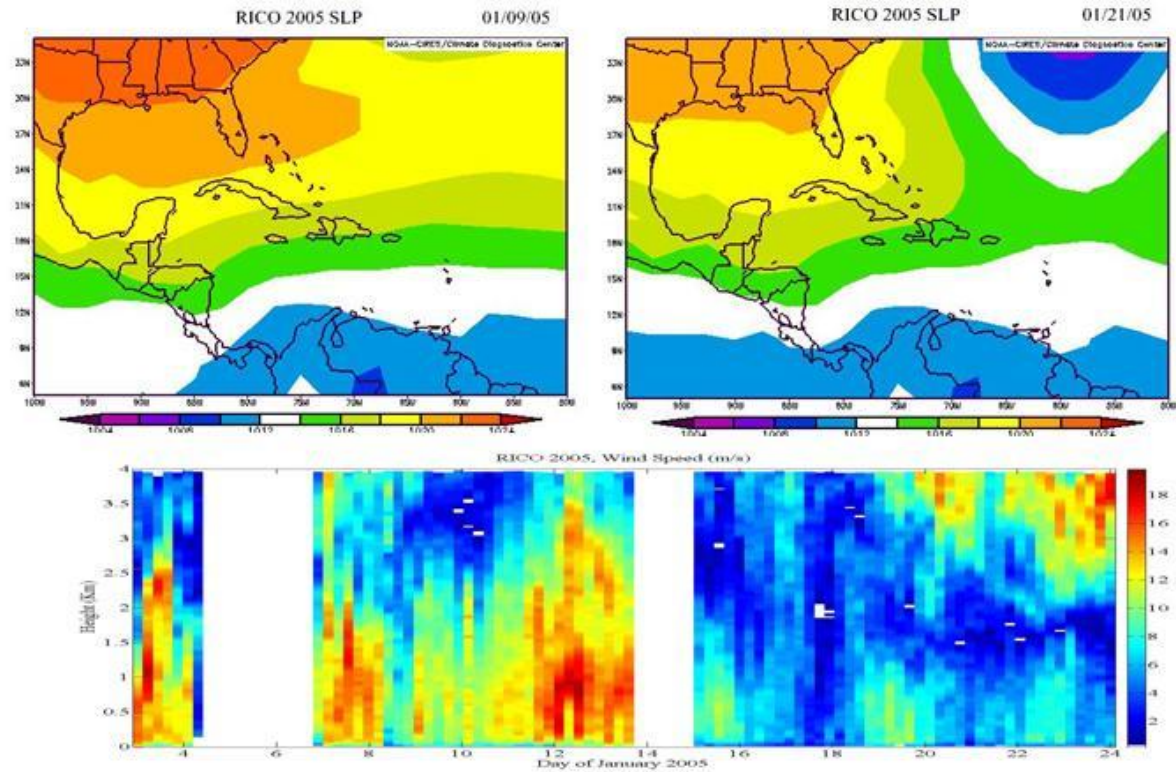
Leg I: Sea state



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Wind Speed and Direction During RICO



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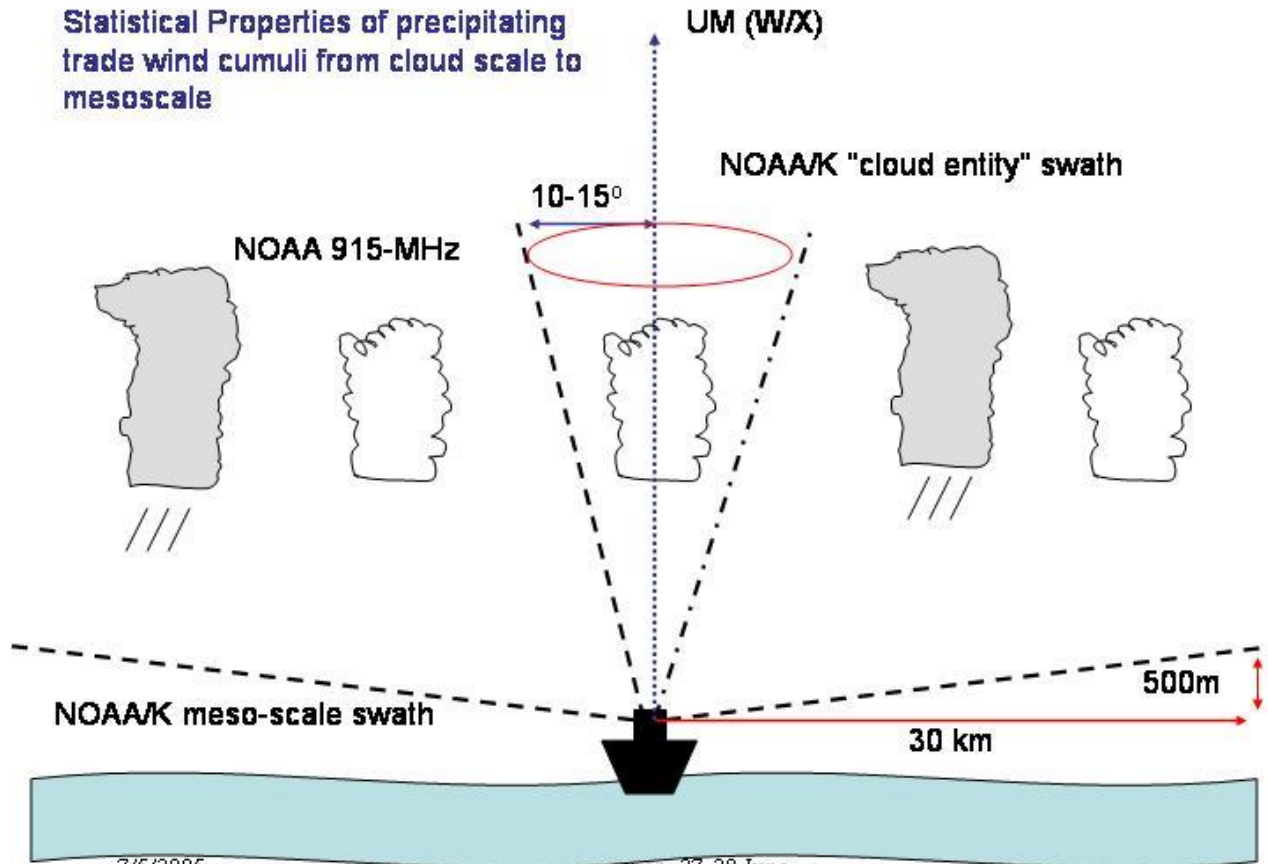
Leg II: Sea state



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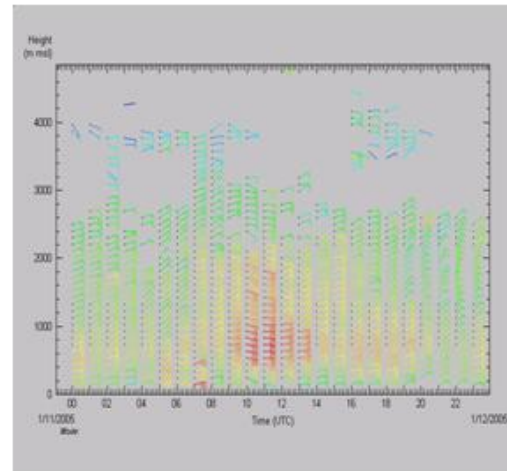
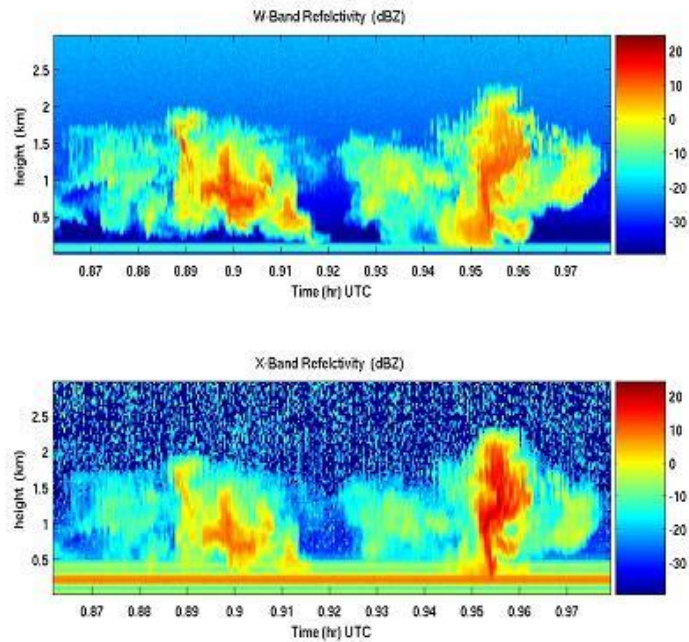
Statistical Properties of precipitating trade wind cumuli from cloud scale to mesoscale



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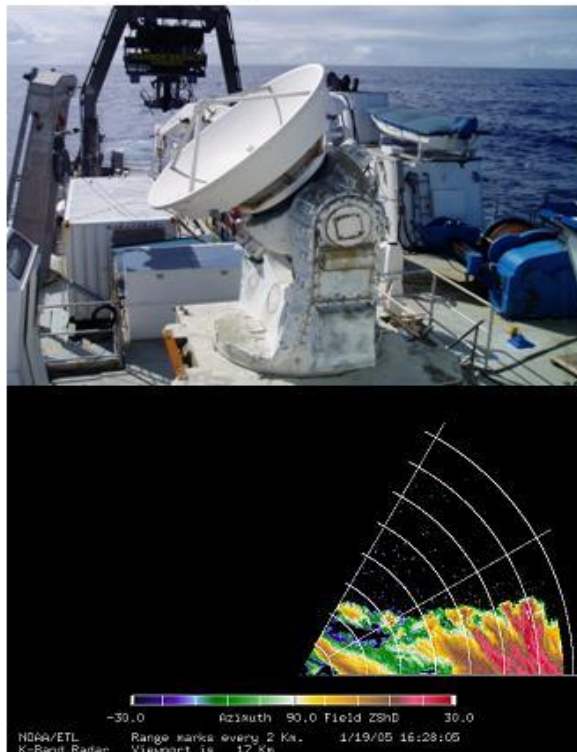
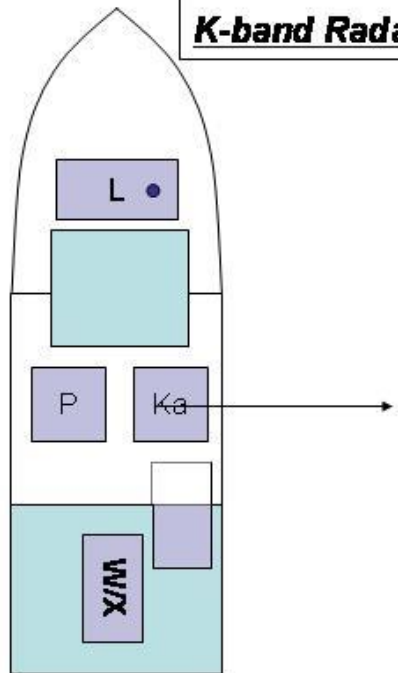
Profiling Radars



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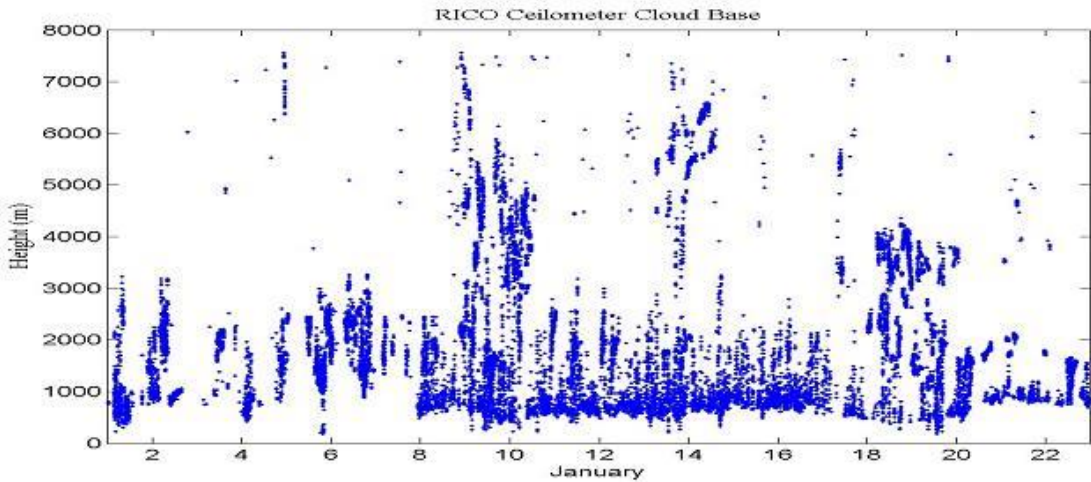
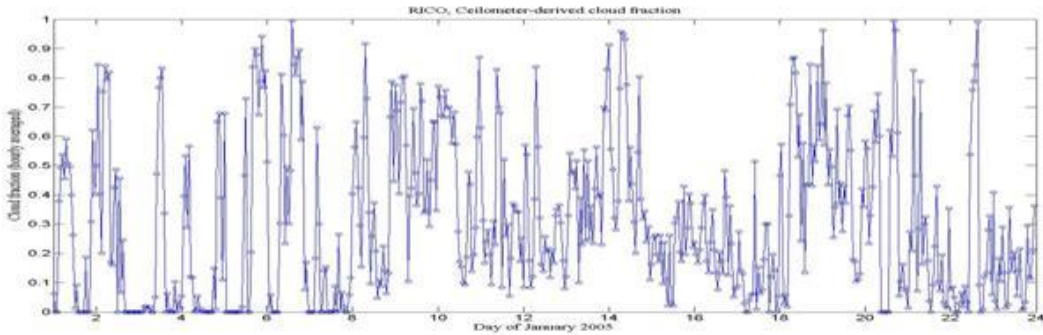
K-band Radar RHI scans



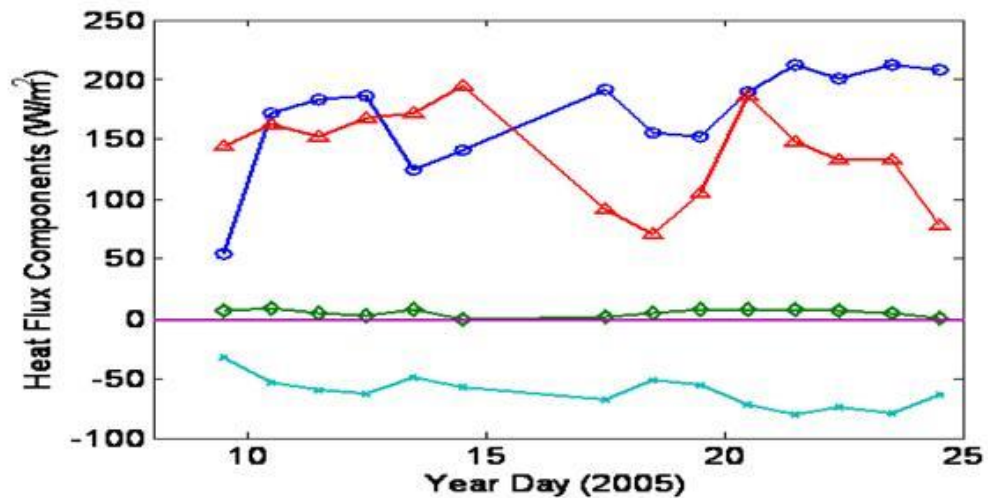
**NOAA K-band Radar
scanning strategies
RICO-January 2005**
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Cloud Fraction



Surface Flux Data

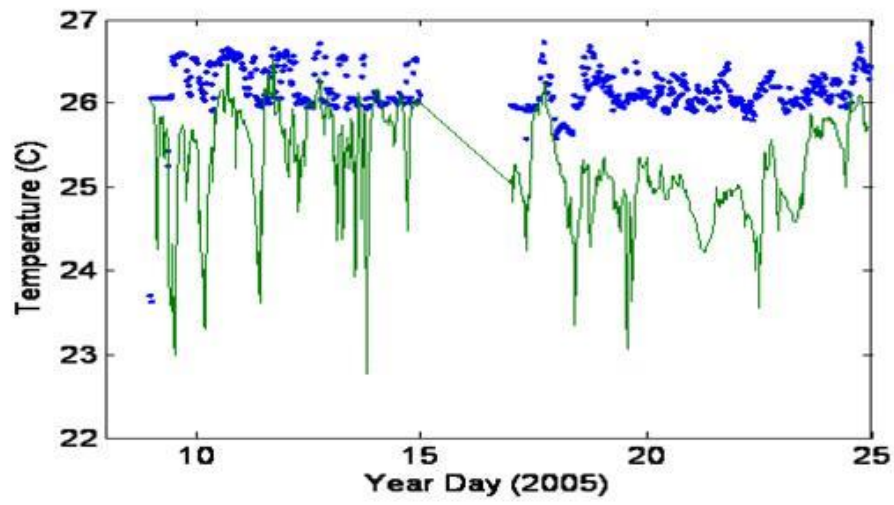


Time series of daily-averaged surface fluxes from the RICO field program: sensible heat flux (green diamonds); latent heat flux (red triangles); net solar flux (blue circles); and net IR flux (light blue x's).

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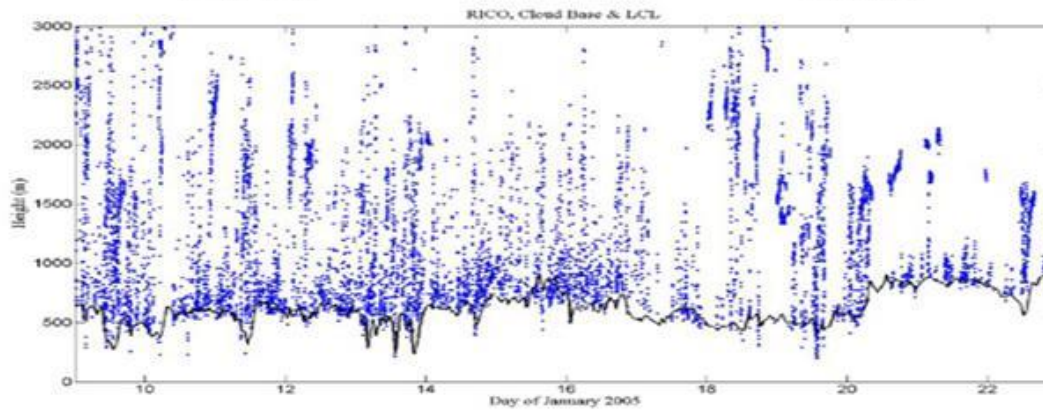
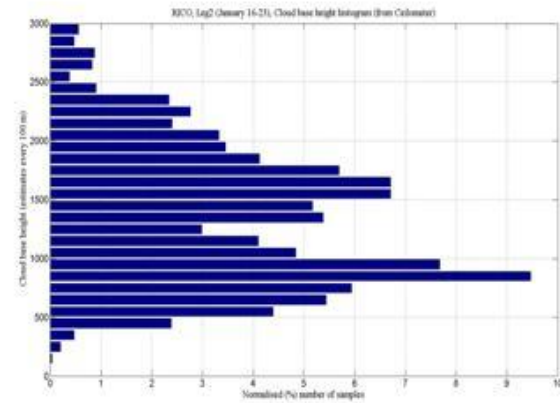
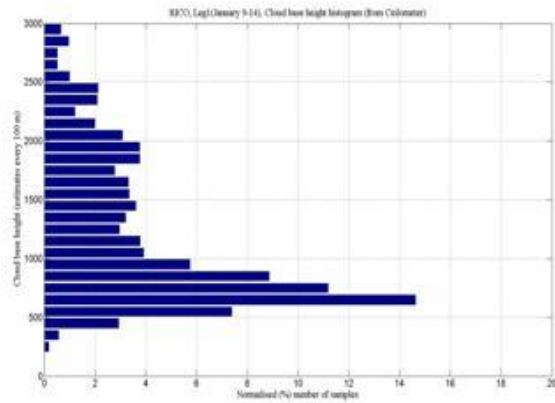
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Air-Sea Temperature

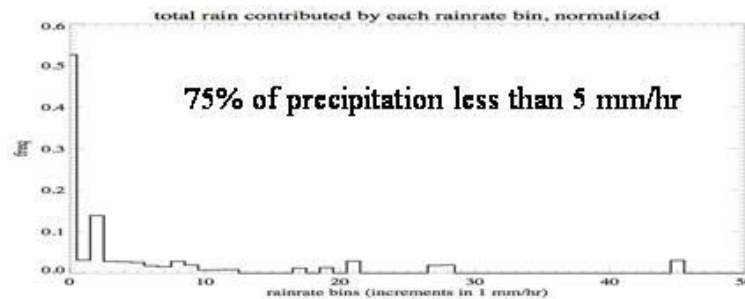
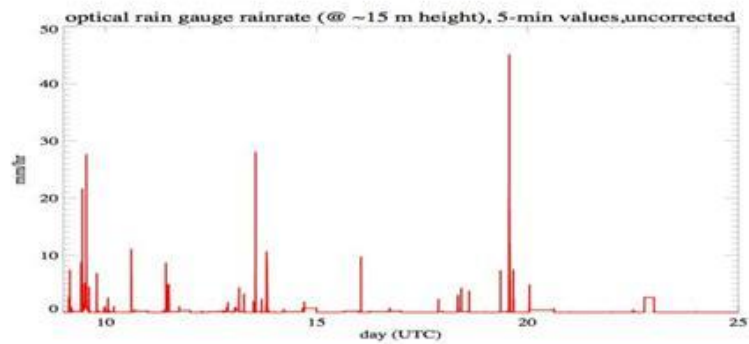


Time series of the near-surface ocean temperature (blue dots) and the 14-m air temperature (green line) from the RICO field program.

Cloud Base Statistics and LCL



Measurable Precipitation



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Data Collection and Post-Processing Report

Table 1. Instruments and measurements for the ship-based cloud microphysics and PBL properties in precipitating trade cumulus clouds during the RICO study.

Item	System	Measurement
1	Motion/navigation package	Data Available
2	Sonic anemometer/thermometer	Data Available
3	IR fast H ₂ O/CO ₂ sensor	Data Available
4	Mean SST, air temperature/RH	Data Available
5	Pyranometer/Pyrgometer	Data Available
6	Ceilometer	Data Available
7	Lasair-II	Only for Leg-II, calibration is needed.
8	Vaisala rawinsonde system	6 sondes per day, data available
9	915-MHz wind profiler	Not processed yet, end of the summer
10	94-GHz Doppler radar (UMDCR)	Data available only for 3 days, need motion correction
11	9.4GHz (X-Band) Doppler Radar (UM)	Data available, need motion correction
12	23 and 31 GHz microwave radiometer	Data available, calibration is an issue, tip cals are available
13	35 GHz Doppler cloud radar (NOAA/K)	Data will be processed by the end of the summer.
14	Doppler lidar (NOAA ETL)	Data Processed/Ship-Motion Correction Applied

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Summary

A wide range of cloud and precipitation conditions were sampled during the cruise and were clearly within the range of conditions expected and needed to accomplish the scientific objectives.

Winds during the cruise were typical of the trades with an average speed of about 8 ms^{-1} from the east-northeast and SSTs of about $26 \text{ }^{\circ}\text{C}$.

Typical trade wind cumuli were observed frequently during cruise with frequent observations of drizzle and precipitation associated with these clouds.

Data Websites - Availability

<http://artemis.rsmas.miami.edu/research/rico/rico05.htm>

<http://www.etl.noaa.gov/programs/2005/rico/>