Ship-based Cloud and Precipitation Air-Sea Interaction Studies in EPIC2001:

C. Fairall, T. Uttal, J. Intrieri, K. Gage, A. S. Frisch, B. Orr, D. Hazen, G. Feingold
NOAA Environmental Technology Laboratory

GOALS

*ITCZ study: Improve parameterizations of turbulent and radiative fluxes and provide new descriptions of PBL structure in precipitating systems, plus application of multiple remote sensors for better quantitative precipitation estimates of area-average rain rates and evaluation of convective heating profiles.

*ABL/Cold Tongue study: Investigate the role of surface fluxes and clouds in driving diurnal and spatial variability of entire PBL (cloud and sub-cloud layers).

*Stratocumulus study: Improve bulk cloud-radiative parameterizations, expansion of methods for retrieving stratocumulus cloud microphysical properties, and investigation of the relative roles of cloud-top entrainment and drizzle production on the dynamics of stratocumulus.

APPROACH

Operate four sets of systems on the *R/V Ron Brown* (the flux/PBL system, the cloud radar and microwave radiometer system, S-band radar, and the lidar systems) plus a precipitation radar on the *R/V New Horizon* for the field program in the second year, and analysis and modeling in the third year.

*Estimate microphysical properties of the convective outflows (midlevel and cirrus) and relate them to the cloud radiative properties.
*Comprehensive characterization of clouds, surface fluxes, and PBL profiles from the stratocumulus region, into the shallow convection and finally into the ITCZ.
*Examine the relative contributions of turbulent and radiative fluxes to the surface heat budget of the ocean and get high-quality measurements of cloud forcing of surface fluxes in a region that is a problem for coupled ocean-atmospheric models.
*Acquire data on cloud microphysics (integrated liquid water, drop size and number concentration) to evaluate various bulk models of stratocumulus cloud radiative transfer properties.
*Use LES simulations with explicit cloud/aerosol microphysics to examine the coupling of condensation dynamics, microphysics, and precipitation production.

ACCOMPLISHMENTS AND INTERESTING FINDINGS

*All measurement systems operated with near 100% data collection efficiency. Exception was Doppler lidar which lost some time on leg II due to burned mirror.

*The weather was incredibly cooperative. Lots of deep convection in the ITCZ (580 mm of precipitation in 18 days) and 90% overcast conditions in the stratocumulus region.

LEGI

*Complete characterization of ocean surface energy budget and atmospheric boundary layer to match measurements of oceanic mixing (UW/APL) and oceanic radiative properties (UCSB).

*Comprehensive documentation of local cloud and precipitation microphysics (cloud radar, 915 MHz wind profiler, microwave radiometers) to complement spatial convective structure measurements with Doppler C-band radar (CSU).

*Modulation of the surface energy budget by deep convection was larger than observed in the TWP (TOGA COARE) and in the Indian Ocean (JASMINE): from **heating** of 50-100 W/m^2 in suppressed conditions to a **cooling** of 100 to 250 W/m^2 in disturbed conditions.

*Very strong diurnal cycle of deep convection with 80% of the precipitation accumulated from local midnight to noon.

LEGII

*Continuous surface based observations of cloud microphysics, surface fluxes, and boundary layer properties. The most comprehensive ever made from and ship and the first made in the Peruvian stratus belt.

*Observed strong diurnal variations in the cloud thickness and optical properties with frequent occurrences of afternoon clearing.

*Clouds 300-400 m thick at night with LWP on the order of 200 g/m^2.

*Drizzle almost always observed (by the cloud radar) at night and often during the day. Drizzle rarely reached the surface in measurable amounts.