ABSTRACT

Shipboard monitoring of stratocumulus cloud properties in the PACS region

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In this project we implemented a modest ship-based cloud and flux measurement program to obtain statistics on key surface, MBL, and low-cloud macrophysical, microphysical, and radiative properties. The measurements were made as part of the PACS/EPIC monitoring program for the 95 W and 110 W TAO buoy lines in the tropical eastern Pacific (Cronin et al., 2002). Our goal was to acquire a good sample of most of the relevant bulk variables that are commonly used in GCM parameterizations of these processes. These data are being compared to known relationships in other well-studied regimes. While not comprehensive, these data are useful for MBL/cloud modelers (both statistically and for specific simulations) and to improve satellite retrieval methods for deducing MBL and cloud properties on larger spatial and temporal scales.

The primary objectives are to

*Obtain new measurements of near-surface, cloud, and MBL statistics for comparison to existing data on northern hemisphere stratocumulus systems.

*Obtain quantitative information on cloud droplet and drizzle properties and probability of occurrence of drizzle and possible links to deviations from adiabatic values for integrated cloud liquid water content..

*Examine applicability of existing bulk parameterizations of stratocumulus radiative properties for the Peruvian/Equatorial regime.

*Characterize surface cloud forcing and possible ocean-atmosphere coupling through stratocumulus-SST interactions.

*Provide periodic high quality near-surface data for intercomparison with ship-based IMET and buoy-based meteorological measurements.

*Provide high quality measurements of basic surface, MBL and cloud parameters for ‘calibration’ of satellite retrieval techniques.

ETL/PMEL PACS PROGRAM
Enhancements for the Spring and Fall TAO Maintenance Cruises

A modest ship-based cloud measurement program to obtain statistics on key surface, MBL, and low-cloud macrophysical, microphysical, and radiative properties as part of the PACS/EPIC monitoring program for the 95 W TAO buoy line in the tropical eastern Pacific

Goal: to acquire a good sample of most of the relevant bulk variables that are commonly used in GCM parameterizations and to improve satellite retrieval methods for deducing MBL and cloud properties on larger spatial and temporal scales.

Completed: Seven cruises since 1999 (plus the EPIC2001 cruise)

Cronin, M. F., N. Bond, C. W. Fairall, J. E. Hare, M. J. McPhaden, and R. A. Weller, 2002: Enhanced oceanic and atmospheric monitoring for the Eastern Pacific Investigation of Climate Processes (EPIC) experiment. *EOS, Transactions of AGU*, **83**, 205-211.

*Buoys are REFERENCE sites. *High-resolution data*:
  More accurate, more detailed, more fundamental
  Shows **why** buoys get the fluxes they get.

Example: Buoy data show NCEP suppose overestimates downward solar flux by 100 W/m^2 in spring but not in fall. Ship data gives us cloud fraction, cloud optical depth, clear sky solar flux, aerosol optical depth, PBL height

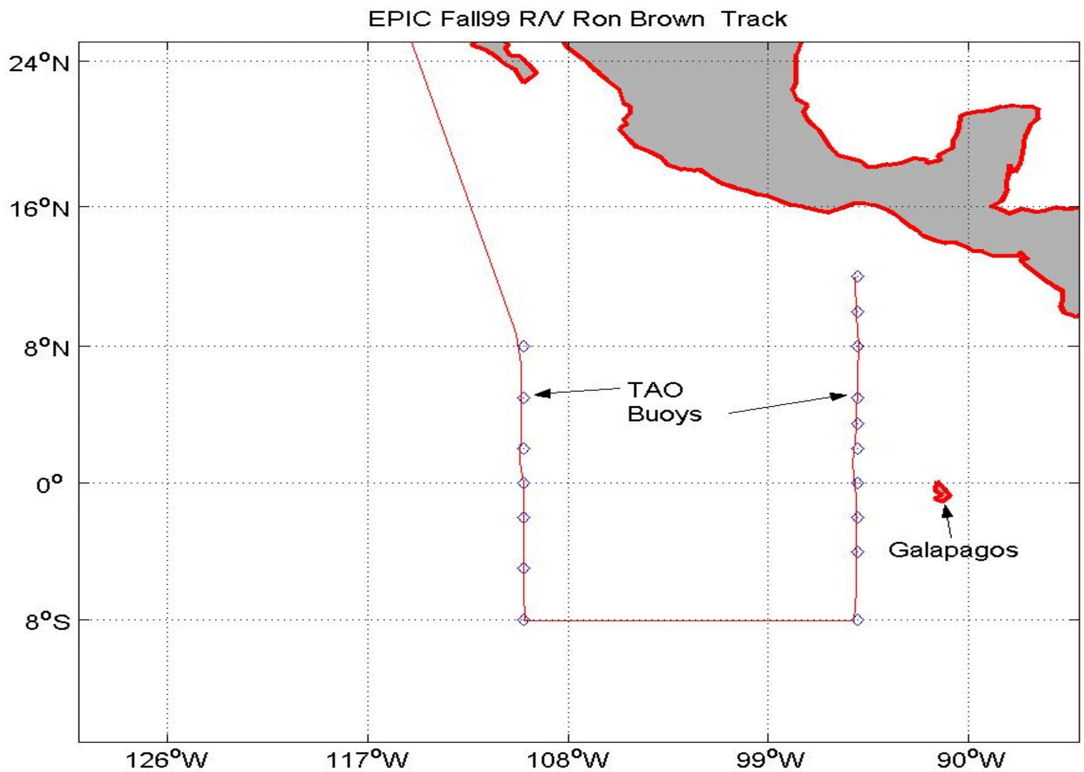

Table 1-1. Present processed data availability at the ETL PACS ftp site: D - data available on this site, I - image files only, X - available but not posted.

Mission	Flux	Radar profiler	Ceilom.	MWR	Sonde	Cloud radar	C-band radar
fall99	D	I	D	D	D	NA	X*
sp00	D	X	D	D	D	NA	NA
fall00	D	X	D	D	D	I*	I*
sp01	D	X	D	D	D	NA	NA
fall01	D	X	D	D	D	X	X
sp02	X	X	X	X	X	NA	NA
fall02	X	X	X	X	X	NA	NA

Table 1. Instruments and measurements for ETL ship-based cloud/MBL monitoring.		
Item	System	Measurement
1	Motion/navigation package	Motion correction for turbulence
2	Sonic anemometer/thermometer	Direct covariance turbulent fluxes
3	Mean SST, air temperature/RH	Bulk turbulent fluxes
4	Pyranometer	Downward solar radiative flux
5	Pyrgeometer	Downward IR radiative flux
6	Ceilometer	Cloud-base height
7	0.92 or 3 GHz Doppler radar profiler	Cloud-top height, MBL microturbulence
8	Rawinsonde	MBL wind, temperature, humidity prof.
9	35 GHz Doppler cloud radar	Cloud microphysical properties
10	20, 31, 90 GHz µwave radiometer	Integrated cloud liquid water
11	Upward pointed IR thermometer	Cloud-base radiative temperature

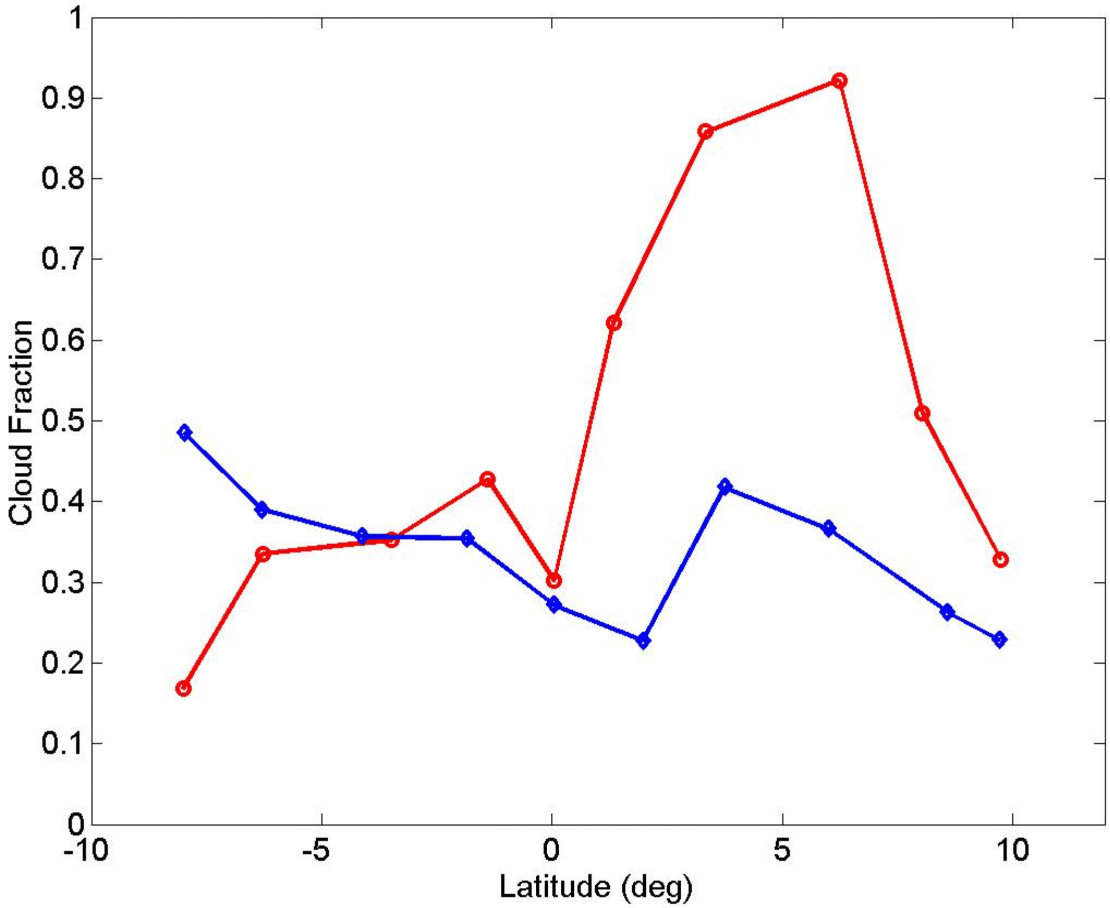

Figure 1. Bin-averaged measurements of low-cloud fraction. Red circles for are fall and blue diamonds are spring.

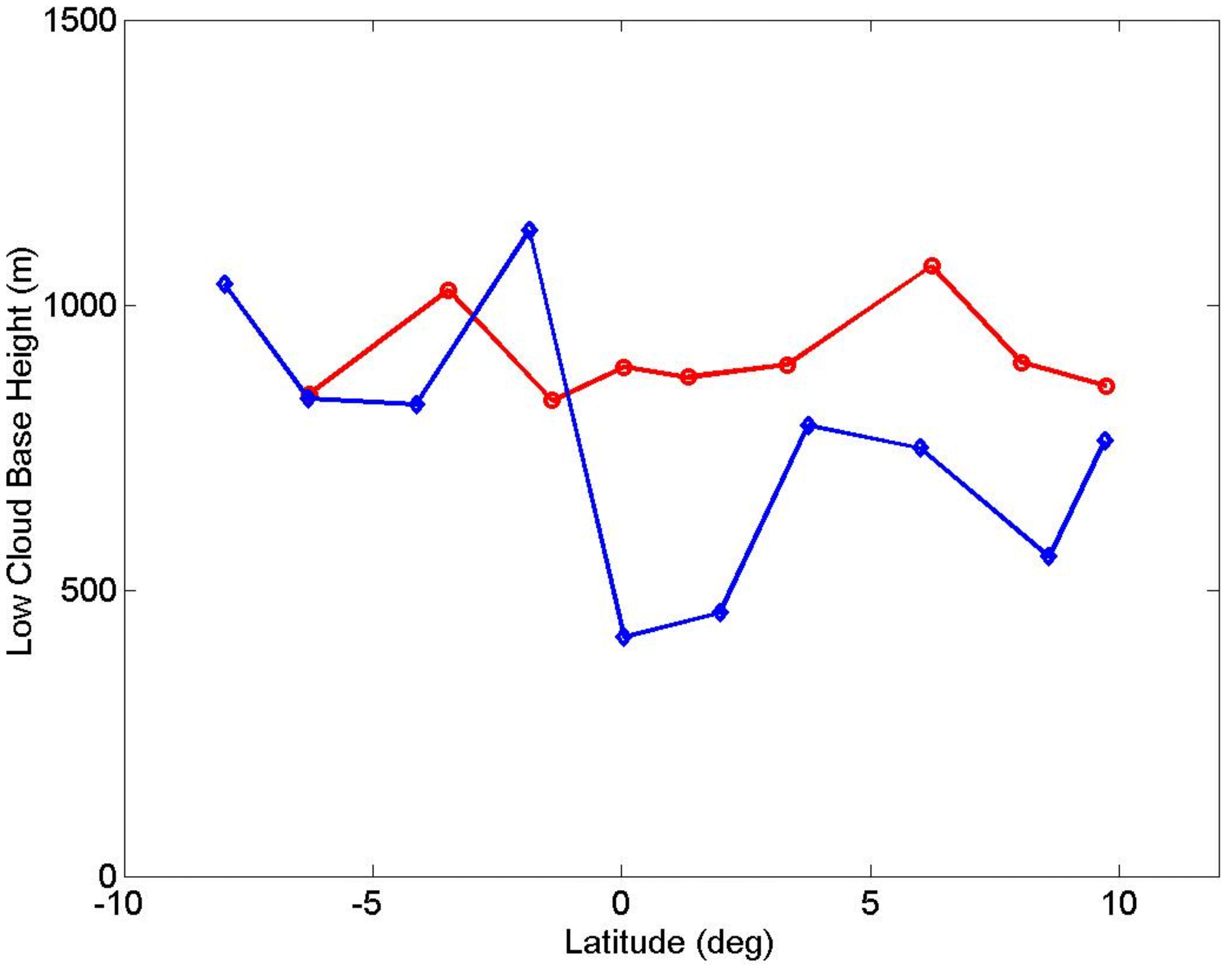

Figure 2. Daily-averaged measurements of low cloud base height. Red circles for are fall and blue diamonds are spring.

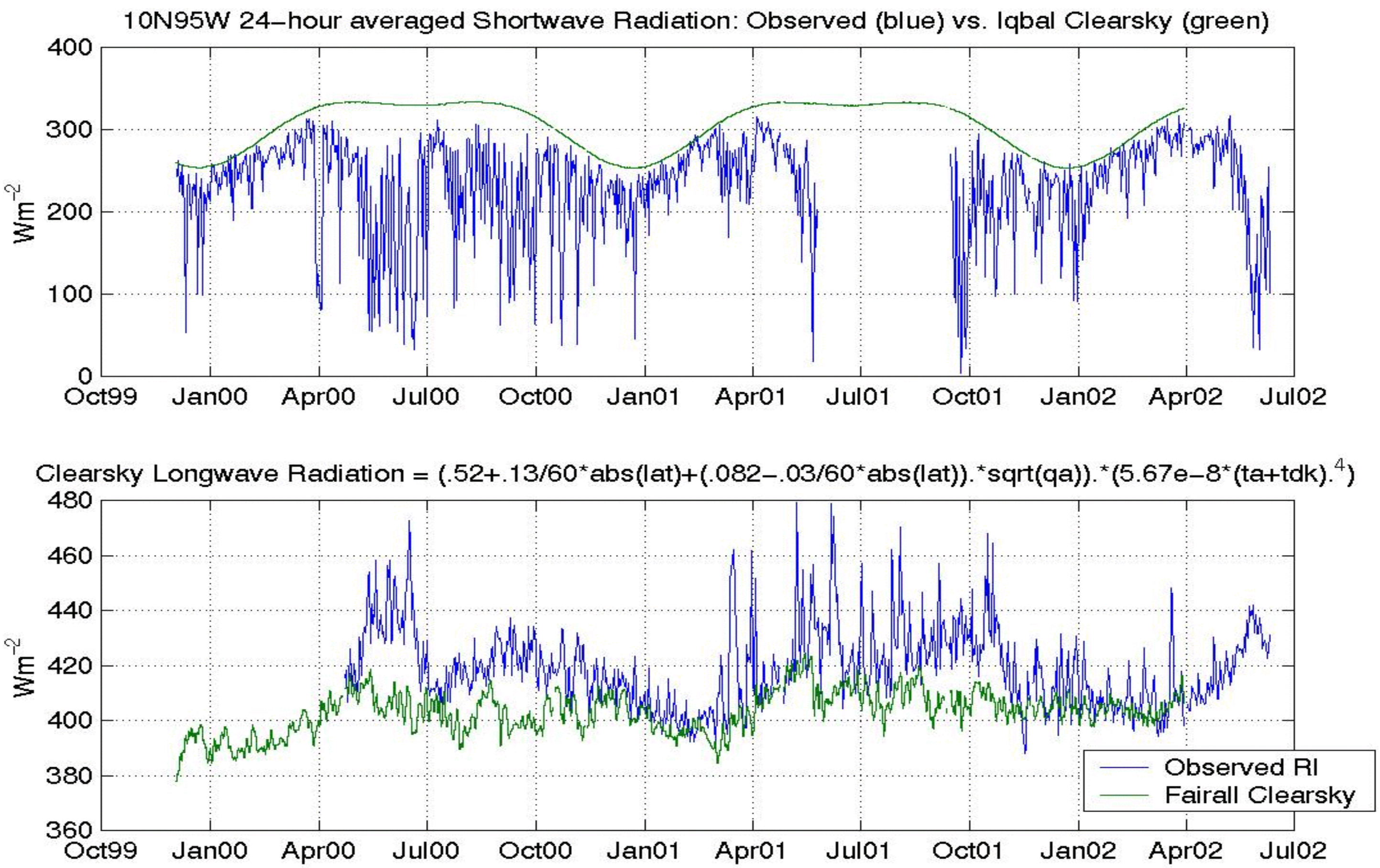

Figure 3. Daily averaged downward solar (upper panel) and IR (lower panel) flux time series for 10 N 95 W. The blue lines are TAO buoy data; the green line clear sky model values based on ETL PACS cruise information. The difference in the two lines is the cloud radiative forcing at the surface. Strong forcing in the May-October period is caused by migration of the ITCZ to 10 N.

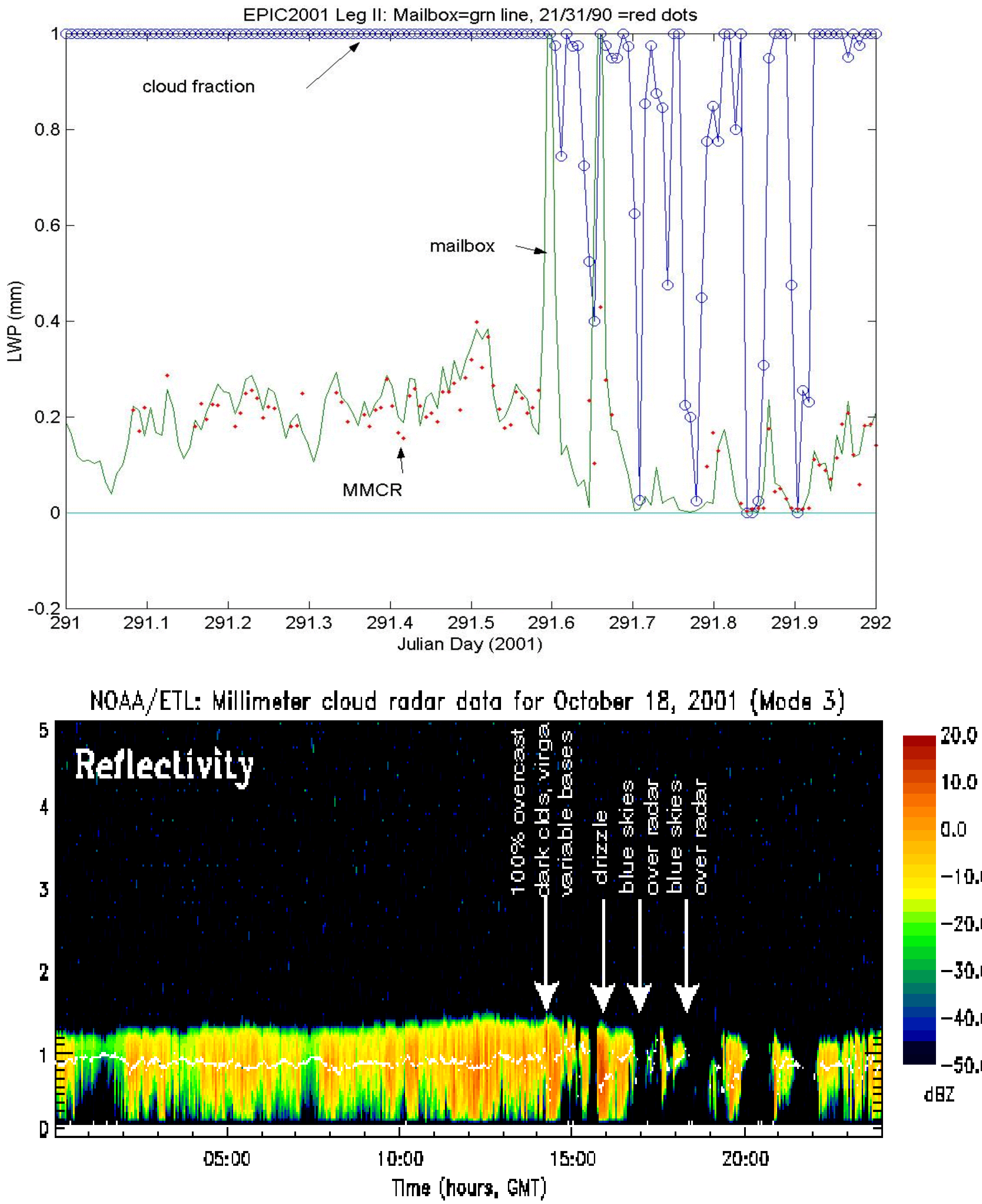

Figure 4. Stratocumulus cloud characteristics on Oct. 18, 2001. Upper panel: total liquid water path (LWP) from two microwave radiometer systems (green line and red dots) and cloud fraction from a ceilometer (blue circles). Lower panel: cloud radar backscatter intensity (color contours) and ceilometer cloud base heights (white dots).