5B.2 CONVECTIVE VARIABILITY ACROSS THE EAST PACIFIC: A COMPARISON OF PRECIPITATION STRUCTURE IN THE TEPPS AND EPIC DOMAINS

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1. INTRODUCTION

A number of studies have examined differences in the structure of convection and associated precipitation characteristics between the tropical east and west Pacific (e.g., Berg et al. 2002). However, few studies have attempted to quantify possible differences within the east Pacific domain itself. Satellite data indicates large differences in the spatial distribution and magnitude of seasonal rainfall across the eastern Pacific depending on the algorithm utilized and satellite sensors available, suggesting important differences in precipitation vertical structure across the region.

Previous ship-based radar studies (Yuter and Houze. 2000; Serra and Houze 2002; Petersen et al. 2003) have shown that convective activity is strongly modulated by the passage of Easterly waves in both the Pan American Climate Studies Tropical Eastern Pacific Process Study (TEPPS) and the East Pacific Investigation of Climate Processes in the Coupled Ocean-Atmosphere System (EPIC) domains. TEPPS (EPIC) was conducted at 7.8º N, 125º W (10º N, 95º W) in August (September) 1997 (2001). Broadly speaking, the EPIC and TEPPS regions are both located within the east Pacific ITCZ; however, the EPIC region is located only ~ 400 km from the Americas while the TEPPS domain is more representative of an open ocean location.

2. METHODOLOGY

In this study, radar reflectivity and upper air sounding thermodynamic data are used to compare precipitation structure and environmental characteristics between the TEPPS and EPIC regions. The data sets collected during the two field programs are similar: both experiments were focused in their respective ITCZ locations for approximately three weeks; radar data was collected continuously throughout each campaign using the 5-cm scanning radar on board the NOAA research vessel Ronald H. Brown; and upper air soundings were launched at a frequency of six times/ day (from the Ronald H. Brown).

The radar data were Quality Controlled (QC'd) using an algorithm from the NASA Tropical Rainfall Measuring Mission (TRMM) Office to remove spurious echos (e.g., sea clutter). The data were interpolated to a cartesian grid extending 120 km from a fixed point (7.8º N, 125º W for TEPPS and 10º N, 95º W for EPIC) in the horizontal direction at 1 km resolution and 18 km in the vertical at 0.5 km resolution. The sounding data were QC'd by the UCAR Joint Office for Scientific Support (JOSS) following the methodology of Loehrer et al. (1996). Convective Available Potential Energy (CAPE) was calculated assuming a 50 mb mixed layer and pseudo adiabatic ascent with no contribution from ice processes.

3. RESULTS

Scatter plots of CAPE vs. equilibrium level for all available soundings launched from the Ronald H. Brown during EPIC and TEPPS are shown in Fig. 1. The relative differences in the environments of the two regions are dramatic: the CAPE sampled during EPIC was substantially larger, on average, compared to TEPPS (mean values are 1674 vs. 669 J kg^{-1}, respectively), with a much narrower equilibrium level distribution in the EPIC soundings. CAPE values never exceeded about 1900 J kg^{-1} in the TEPPS soundings, whereas a number of EPIC soundings had CAPES well in excess of 2000 J kg^{-1}. These results suggest that the EPIC environment was more conducive to deep and intense convection compared to TEPPS, despite the fact that the sea surface temperatures (SST's) were similar during the field campaigns (~29° C - not shown).

Figure 2 shows cumulative frequency distributions (CFD) of radar reflectivity for EPIC and TEPPS. The mode of the EPIC CFD is shifted several dB higher relative to TEPPS at all levels. The differences in radar reflectivity distributions becomes especially pronounced above the melting level (~ 5 km). For example, the height of the 99.0% occurrence of 30 dBZ is about 8 (5.5) km in EPIC (TEPPS). These results are consistent with lightning flash rate climatologies from the TRMM Lightning Imaging Sensor (LIS – not shown) and suggest more vigorous updrafts and resulting mixed phase processes in EPIC convection compared to the TEPPS region.

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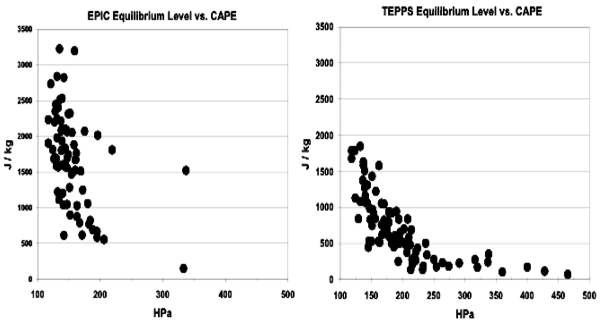


Figure 1. Scatter plot of equilibrium level (mb) vs. CAPE (j kg^{-1}) for (left) EPIC and (right) TEPPS.

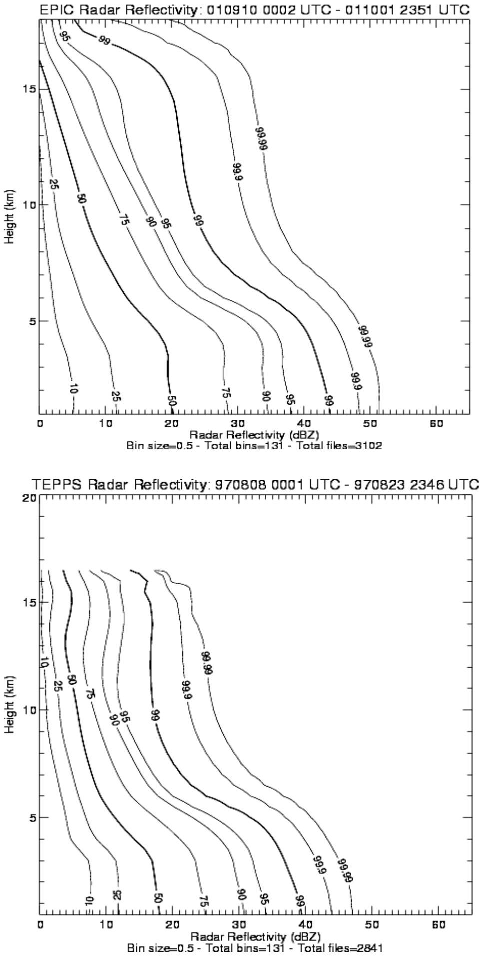
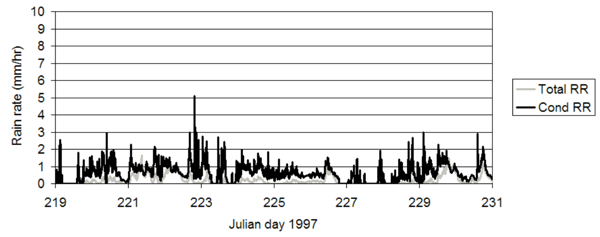


Figure 2. Cumulative frequency distributions of radar reflectivity (dBZ) for (a) EPIC and (b) TEPPS. The 50% and 99% contours are highlighted.

Time series of total and conditional rain rate for each campaign are shown in Fig. 3. Consistent with the larger buoyancy and more developed vertical structure, the EPIC time series shows higher rain rates. Conditional rain rates are especially higher, which is consistent with the higher convective rain fraction observed in the EPIC domain (not shown).

(a) TEPPS



(b) EPIC

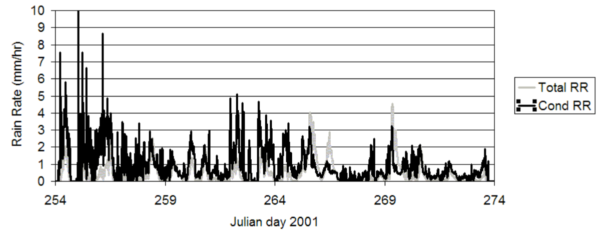


Figure 3. Rain rate time series for (a) TEPPS and (b) EPIC based on radar data within 48 km of the Ronald H. Brown.

4. CONCLUSIONS

Results indicate that the EPIC and TEPPS domains display large differences in environmental properties and precipitation feature characteristics, despite the fact that both field campaigns were conducted during periods of similar SST's. Previous studies have shown that convective activity in both EPIC and TEPPS was heavily modulated by the passage of Easterly Waves. However, the radar and upper air sounding data indicate that the environment was more conducive to intense, deep convection and that this deep convection occurred much more frequently in EPIC compared to TEPPS. The proximity of the EPIC domain to land and the location of TEPPS relative to the descending branch of the Walker circulation are likely causes for the observed differences.

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5. REFERENCES

Berg, W., C. Kummerow, and C.A. Morales, 2002: Differences between east and west Pacific rainfall systems. *J. Climate*, **15**, 3659-3672.

Loehrer, S. M., T. A. Edmands and J. A. Moore, 1996: TOGA COARE upper-air sounding data archive: development and quality control procedures. *Bull. Amer. Meteor. Soc.*, **77**, 2651-2671.

Petersen, W.A., R. Cifelli, D.J. Boccippio, S.A. Rutledge, and C. Fairall,2003: Convection and easterly wave structure in the eastern Pacific warm pool during EPIC-2001. *J. Atmos. Sci.*, **60**, 1754-1773.

Serra, Y.L., and R.A. Houze Jr., 2002: Observations of variability on synoptic timescales in the east Pacific ITCZ. *J. Atmos. Sci.*, **59**, 1723-1743.

Yuter, S.E., and R.A. Houze Jr., 1997: The 1997 Pan American Climate Studies Tropical Eastern Pacific Process Study. Part I: ITCZ region. *Bull. Amer. Meteor. Soc.*, **81**, 451-481.