2B.2 THE EFFECTS OF BUOYANCY, SHEAR AND HUMIDITY ON CONVECTION IN THE EASTERN TROPICAL PACIFIC

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1. INTRODUCTION

The tropical regions of the atmosphere are characterized by the presence of cumulus convection, particularly within the Inter-Tropical Convergence Zone (ITCZ). This convection can have a “patchy” appearance in space and may include both deep and shallow cumulus clouds. The thermodynamic structure of the tropical atmosphere exhibits a fairly small variability in terms for example of the convective available potential energy (CAPE). Meso- and large scales influence the development and evolution of tropical disturbances but it is not clear what their role is on the convective activity observed.

The development of deep convection in the tropical Eastern Pacific is one of the research topics to be addressed with the observations obtained from the field campaign EPIC2001 (East Pacific Investigation of Climate). In the 6 week period from 1 September to 15 October, two aircraft (NCAR-C130 and NOAA WP-3D) and two ships (NOAA R. Brown and NSF New Horizon) participated in the project. Two main fight patterns were flown by the C130 to study: a) the characteristics of convection in the ITCZ region determined by 8-12 ^{0}N and 93-97 ^{0}W; and b) the boundary layer structure along the 95 ^{0}W meridien from 12 ^{0}N to the Equator.

In particular, in the present study we investigate some of the potential factors that may govern the development of deep convection in the ITCZ region defined above. We utilize data from dropsondes released from the C130 during all research flights.

2. ANALYSIS METHODOLOGY

Figure 1 presents the data obtained from the average of dropsondes released by the C130 on 7 September 2001 (RF03) during a 95W flight. The data are shown in terms of the moist specific entropy (s) and the saturated entropy (s_{sat}) as a function of pressure. The vertical line corresponds to the entropy of a saturated parcel rising adiabatically from cloud base (estimated as the average entropy between 1000 and 970 hPa).

In order to characterize the soundings, we have defined 3 layers that will aid in classifying them:

a) the layer below cloudbase (between 1000 and 970 hPa, denoted by the subscript “b”);
b) the lower cloud region (between 925 and 875 hPa, denoted by the subscript "l"); and
c) the mid-cloud region (between 800 and 600 hPa, denoted by the subscript “m”).

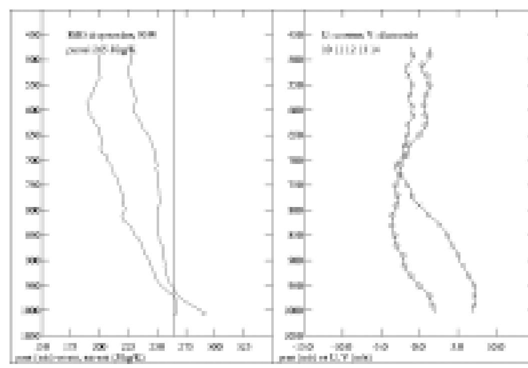

Figure 1. Average vertical sounding from dropsondes on RF03. The left panel shows the entropy and saturated entropy and the right panel the horizontal wind components.

We have calculated certain variables as indicators of atmospheric thermodynamic structure derived from the dropsonde data:

- Pseudo-CAPE (pCAPE), as the difference between s_b and s_{sat-m}, an indicator of atmospheric thermal instability
- Saturation deficit (SD), as the difference between s_{sat-m} and s_m, an indicator of humidity at mid-cloud levels, and
- Convective inhibition (CIN), as the difference between s_{sat-l} and s_b, an indicator of the potential for free convection.

The motivation for the analysis is an attempt to identify a relationship between these indicators and the presence and strength of convection.

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3. RESULTS AND DISCUSSION

Figure 2 presents the CIN as a function of the pCAPE, for all research flights. While in theory these two variables should be negatively correlated, there is a significant scatter present in the dataset. A majority of soundings show positive pCAPE and both positive and negative CIN, which suggests that CAPE may not be an adequate indicator for convection. Soundings with positive CIN correspond mainly to those released south of 8^0N, where cooler surface temperatures result in more stable atmospheric conditions.

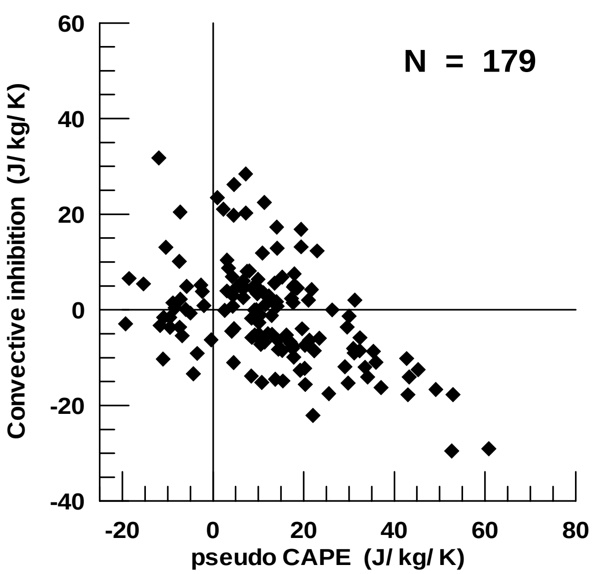

Figure 2. Convective inhibition as a function of pseudo-CAPE for all dropsondes released by the C130 during the project.

In order to concentrate on the cases where convection was most favored, we restrict the subsequent analysis to soundings with pCAPE ≥ 0 and CIN ≤ 0. We have also utilized the GOES 8 satellite infrared images in the ICTZ region of interest to qualitatively identify areas of weak (W), moderate (M) and strong (S) convective activity in an area of 1x1 deg centered on the location of the dropsonde. This stratification of the data is presented in Figure 3, indicating that the humidity at mid-levels does not seem to determine the presence of deep convection.

It is clear that the data presented here do not provide us with insight into the factors that control the strength of tropical convection. *So why is this the case, given that available potential energy and humidity in the environment seem like obvious indicators of convection?* It may be an issue of the spatial and time scales. At the large scale and on average, tropical convection must be governed by atmospheric thermodynamic conditions. But at the individual convective cell scale, it may be the local variability (for example, in surface fluxes or mechanical forcing from precipitation outflows) that is responsible for the convection. Dropsondes were released about 100 km apart on the 95W flights (corresponding to about 15 min), while both space and time separation on the ITCZ flights were variable, ranging from about 20-40km while studying one convective area to more to more than 100km while switching to another convective area.

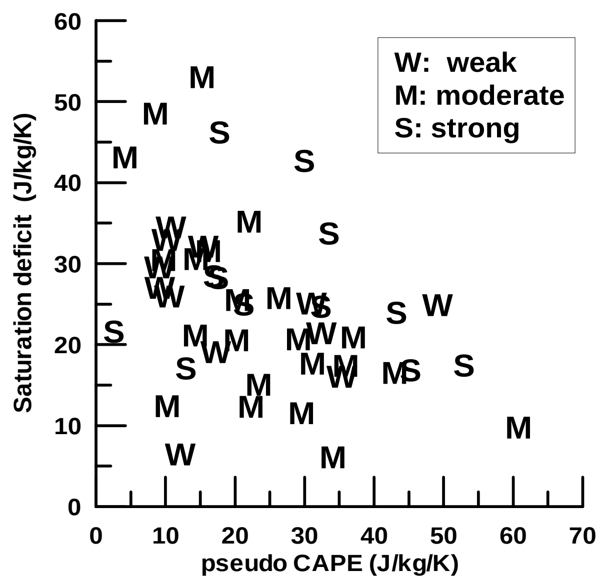

Figure 3. Saturation deficit as a function of pseudo-CAPE for dropsondes released in the ITCZ region defined above.

We conclude that the methodology used in this study failed to provide a definite indicator for the strength of the convection. An approach that will be explored next is to "zoom in" on individual convective cells using *in situ* aircraft data as they relate to the thermodynamic conditions in their near environment. On a case by case study, small scale variability in the soundings (such as dry layers) can be linked directly to the strength of the convection.

4. ACKNOWLEDGEMENTS

The authors acknowledge the efforts of the large number of people that made possible the project from NSF, NCAR and NOAA. Support for this study was provided by grants from NSF ATM-0082612 and 33319 from Conacyt .