8B.7 DECADAL TRENDS IN TROPICAL CAPE

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1. INTRODUCTION

Recent observational studies have focused on trends in tropical temperature and relative humidity at the surface and aloft. Gutzler (1996) has noted increases in surface humidity and tropospheric warming in the past three decades in the western Pacific while Gaffen et al (2000) reported increases in tropical surface temperature and humidity. Ross and Elliott (2001) observed increases of temperature and humidity throughout the depth of the western Pacific troposphere.

These findings would suggest increases in tropical Convective Available Potential Energy (CAPE) and, possibly, tropical convective activity may also have occurred. To investigate the first of these possibilities, we construct DJF and JJA seasonal mean CAPE composites at 00Z and 12Z for 34 tropical sounding locations. In addition to CAPE, we also examine trends in convective inhibition (CIN), level of free convection (LFC) and level of neutral buoyancy (LNB) for lifted parcels.

2. DATA AND ANALYSIS METHODS

Soundings used in this study are taken from the National Climatic Data Center (NCDC) Global Upper Air Network (GUAN) data set, a subset of the NCDC Comprehensive Aerological Reference Data Sets (CARDS) selected based on length and quality of temporal record and geographic location. All soundings in this dataset have been subjected to the Complex Quality Control procedures described by Eskridge et al. (1995). From this dataset, individual soundings located within +/- 25^{o} of the equator were selected for consideration and were tested on a sounding-by-sounding basis for inclusion or elimination from the sample. Once a time series of useable soundings was constructed, details of the time series (based on the number of soundings available per month, consistency of station location and sonde type) for each sounding station were determined. Soundings were vetically interpolated to 10 mb resolution. CAPE, CIN, LFC, and LNB were all determined using the method of Emanuel et al (1994?) using parcels that were lifted from the level nearest to 15 mb above the surface.

3. RESULTS

Results of the CAPE analysis are presented in Fig. 1 for each season (DJF or JJA) and hour (00Z or 12Z). Although the sign of the trend changes for different seasons or hours at a handful of stations, the results are geographically similar for all four season-hour subsets. Positive decadal increases in CAPE are apparent throughout the western and central Pacific basin, as well as in the Carribbean and over the Arabian peninsula. Clusters of negative decadal trend are seen over the maritime continent and, to a lesser degree, over southern South America.

These results are in good agreement with similar analysis done by Gettleman et al (2002), which provides an extra measure of confidence for both studies. The main potential difference between their results and those presented here is the spatial separation of positive and negative CAPE trends seen in Fig. 1, but not in the Gettleman et al (2000) results. However, this apparent difference simply arises from the smaller number of stations analyzed by Gettleman et al (2000)

4. DISCUSSION AND FUTURE WORK

The pattern of CAPE trend increases and decreases yield little insight into why these changes may be taking place. The significance of the results at numerous stations (indicated by filled triangles), however, suggest that these results are real and related to the previously reported increases in surface temperature and moisture. Causes for regional negative CAPE trends will require further investigation to determine if near-surface temperature and humidity trends are influencing CAPE trends, or if other factors have any influence.

Current efforts are focused on 1) examining the trends in CAPE in relation to the North Atlantic Oscillation (NAO) and ENSO, 2) determining if increases in CAPE correspond to increases in precipitation, and 3) examining CAPE trends on other time scales, such as that of ENSO and the Madden-Julian oscillation.

5. REFERENCES

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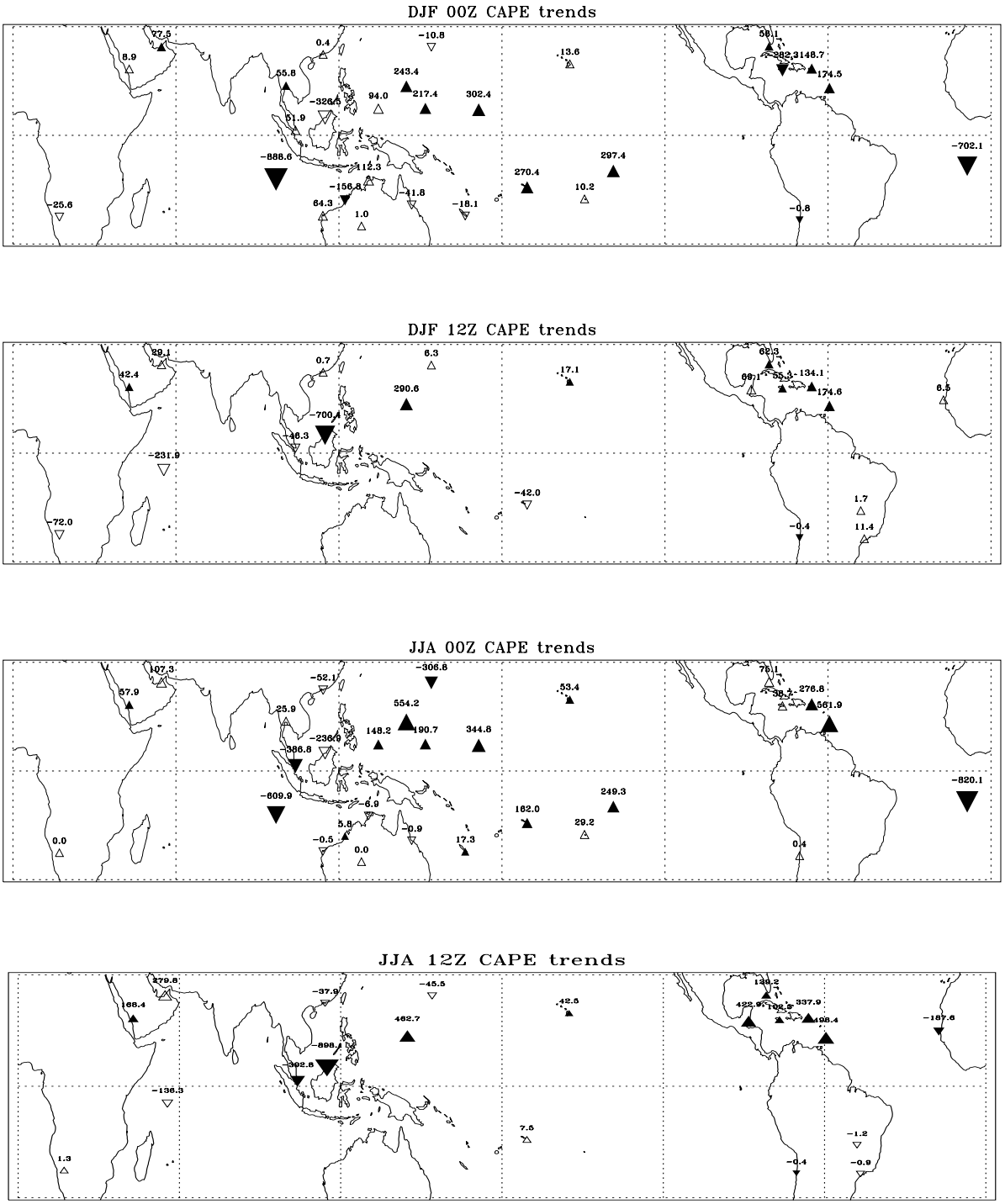

Fig. 1. Trends in CAPE at several tropical locations. Unit are J/kg decade^{-1}. Filled (open) triangles indicate stations where the regression coefficient is (is not) significant at the 95% confidence interval. Triangle sizes are scaled according to the magnitude of the trend.