13A.1 LARGE SCALE FLOW PATTERNS AND THE RAPID INTENSIFICATION OF WESTERN NORTH PACIFIC TROPICAL CYCLONES

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1. INTRODUCTION

Recent modeling studies have proposed that variations in simple zonal flows (Peng et al. 1999) can influence the final intensity and intensification rates of tropical cyclones by producing certain asymmetries in core convection and rainfall rates. Western Pacific tropical cyclones develop in a limited set of lower level large scale flow patterns, as were described by Ritchie and Holland (1998). These patterns are characterized by meridional cyclonic shear of the zonal wind and/or confluence of monsoon westerlies and trade easterlies. The focus question of this study is, "Can variations of horizontal wind patterns influence the early intensification rates of western north Pacific tropical storms?" Our approach is to look at the most rapid early intensification cases associated lower level and upper level large scale flow patterns (NCEP/NCAR reanalysis data) and compare for differences with more slowly developing cases. A second purpose of the study is to examine the characteristics of upper level trough-tropical storm interaction prior to rapid intensification and compare with earlier Atlantic results.

2. DATA AND METHODOLOGY

JTWC best track data (1975-2001) is used to identify 35kt intensity tropical storms that intensify by 30kts or more in a 24hr period (definition of rapid intensification), and represents the top 12% of intensification rates from 35kts intensity and has 88 cases. NCEP/NCAR reanalysis u and v component wind data is used to retrieve storm centered fields around future rapid intensifiers at 850mb and 200mb. Storm centered fields are suitable for storm composites. Scalar EOF analysis of the storm centered zonal wind component is performed as a method of defining distinct, repeating circulation patterns around the cases. The same procedure is performed for a set of storms that intensify by only 10kts/24hrs for comparison. Secondly cases in which upper level potential vorticity (PV) maxima approach within 500km prior to the onset of rapid intensification are composited in a storm centered sense.

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3. RESULTS

Figure 1 shows 4 composite circulation patterns, defined using the EOF method, 6hrs prior to the onset of rapid intensification. EOF1 defines a classic strong monsoon shear line, EOF2 a system embedded in easterlies and EOF3 and EOF4 are variations of the monsoon confluence region. Interestingly 14/18 cases that intensify very rapidly (>40kts/24hrs) correspond strongly to EOF3 or EOF4 in terms of large principle components. This implies that the most rapid intensifying cases are dominantly associated with confluence patterns as opposed to the more common shear line and easterly pattern. Applying the same technique to 10kt/24hr intensifiers results in only the 4th EOF appearing as a clear confluence pattern, further suggesting that confluence patterns in the lower levels are most favorable for early rapid intensification. The results are presently being used to design model experiments, in which the influence of differing shear line and confluence patterns on the intensification rate will be studied.

Fifteen cases within the rapid intensifier set mutually approached upper level PV maxima, just prior to the onset of intensification. Figure 2. shows the composite PV at 350K for the 15 cases -24hrs,-12hrs before and 0hrs and +12hrs after the onset of intensification. Similar to Hanley et al. (2001), such near superposition cases were approached within 500km of the PV maximum. A lobe of high PV approaches the tropical storm (-24hrs to 0hrs) at the center of the grid, and then clearly erodes as intensification begins between 0hrs and +12hrs. Note, the upper PV maximum never quite crosses the lower level tropical storm center. The character of events looks very similar to the positive superposition composite presented by Hanley (2001) for Atlantic cases. This gives more confidence that this sequence of events prior to intensification is not just a facet of Atlantic ECMWF data, and may occur in every tropical cyclone basin.

Aknowledgements: Support for this work was provided by ONR grant number:N0014-021-0530

4. REFERENCES

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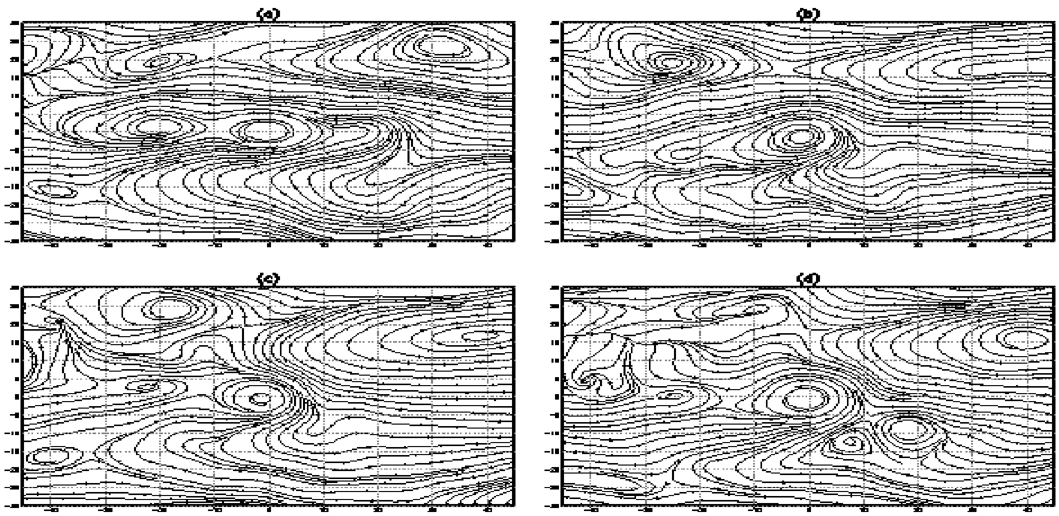

Figure 1. Composite wind fields (850mb) 6hrs prior to rapid intensification for cases where (a) principle component , pc1>1standard deviation above series mean (1sig), (b) pc2>1sig, (c) pc3>1sig, (d) pc4>1sig. All panels in storm relative latitude (-30,30) longitude (-45,45) coordinates.

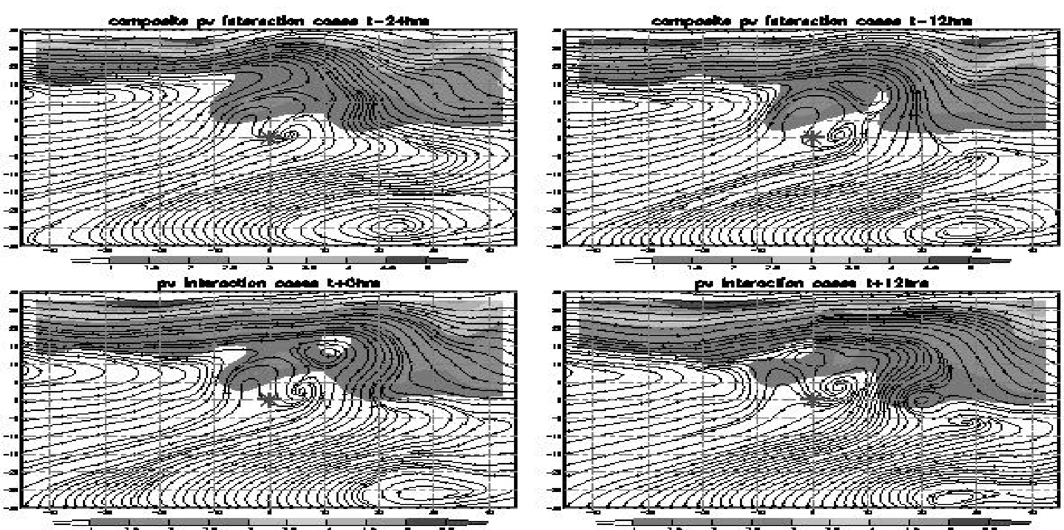

Figure 2. Composite PV (PVU>1 shaded) and streamlines (350K) for 15 near superposition cases-24hrs, -12hrs, 0hrs and +12hrs relative to onset of intensification. All panels in storm relative latitude (-30,30), longitude (-45,45) coordinates .