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SUBTROPICAL JET DISTURBANCES AS INITIATORS OF CONVECTION DURING BAMEX

by

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1. INTRODUCTION:

The Bow Echo and Mesoscale Convective Vortex Experiment (BAMEX) was conducted from 18 May to 7 July 2003. Information on the BAMEX scientific objectives can be found at: (http://www.mmm.ucar.edu/bamex/science.html). The experiment was conducted out of the Mid America Airport located approximately 40 km east of St. Louis, Missouri. The period 5-14 June 2003 was noteworthy because an unusually strong subtropical jet (STJ) was situated from the east-central Pacific eastward to the lower Mississippi Valley. The purpose of this paper is to present the results of a preliminary analysis of the impact of this strong STJ on the evolution of convective systems within the BAMEX domain.

The first comprehensive documentation of the STJ was presented by Krishnamurti (1961). Recent work (e.g., Iskenderian 1995) has documented that long mid- and upper-level cloud plumes emanating from the tropics are signatures of the STJ over eastern ocean basins and the adjacent continents. Another important attribute of the STJ is that it can serve as a baroclinic waveguide (e.g., Hoskins and Ambrizzi 1993; Hoskins and Hodges 2002) and as a source of Rossby wave breaking in jet-exit regions (e.g., Thorncroft et al. 1993; Black and Dole 2000; Shapiro et al. 2001).

2. DATA SOURCES:

Data was obtained from the BAMEX Web site (http://www.joss.ucar.edu/cgi-bin/catalog/bamex/ops/index) and archives at the University at Albany. Global 1.0° x 1.0° GFS grids, available four-times daily, were used for all diagnostic calculations.

3. RESULTS:

The composite time-mean and anomalous 200 hPa height and wind fields for 5-14 June 2003 established that this period was characterized by an anomalously strong STJ that extended from the eastern Pacific Ocean eastward to Texas and then northeastward to New England and Atlantic Canada. Eastward-moving transient disturbances embedded in the STJ over the eastern Pacific acted to trigger mesoscale convective systems (MCSs) and mesoscale convective vortices (MCVs) east of the Rockies after they moved inland over the southwestern US. These transient disturbances are readily seen by superimposing the 300 hPa absolute vorticity over the 500-200 hPa thickness.

As an example, Fig. 1 shows that at 1200 UTC 9 June 2003, four distinct and regularly spaced 300 hPa vorticity maxima are strung out along the STJ from east-northeast of Hawaii to southwestern Arizona. Comparison of Fig. 1 with the infrared satellite imagery for 1800 UTC 9 June 2003, shown in Fig. 2, reveals that there is little in the way of significant deep cloudiness associated with the aforementioned vorticity maxima. Ascent associated with cyclonic vorticity advection at 300 hPa by the 500-200 hPa thermal wind ahead of each disturbance was insufficient to produce deep clouds and precipitation while these disturbances were over the Pacific Ocean and the southwestern US (not shown).

The quasi-regular spacing of the four disturbances shown in Fig. 1, and the fact they formed along a shear line on the cyclonic shear side of the STJ (not shown), suggests that barotropic instability may have played a role in their formation. To test this hypothesis we computed the time-mean 300 hPa heights and zonal wind component from the GFS grids for 1200 UTC 8 June through 0000 UTC 11 June 2003. We used the time-mean zonal wind field to compute the meridional gradient of absolute vorticity. The meridional gradient of absolute vorticity is shown superimposed on the time-mean 300 hPa height field in Fig. 3. Note that the meridional gradient of absolute vorticity is negative, a necessary condition for barotropic instability, in the region where the four individual 300 hPa vorticity centers embedded in the STJ appear in Fig. 1.

The disturbances embedded in the STJ shown in Fig. 1 helped to trigger MCSs and MCVs once they crossed the southern Rockies and encountered warm, moist unstable air. The tracks of 19 MCSs, MCVs, squall lines and bow echoes that formed in the BAMEX region during the 5-14 June 2003 period are shown in Fig. 4. Track number 12 is a long-lived MCV that originated over northeastern Texas and southeastern Oklahoma near 0600 11 June 2003 in response to the arrival of the leading STJ disturbance shown in Fig. 1. This MCV moved northeastward while maintaining its identity, reaching northeastern Lake Erie near 0000 UTC 13 June 2003. The evolution and structure of the convection and surface

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mesolow associated with this long-lived MCV will be featured as a case study (not shown) in our poster presentation.

4. CONCLUSIONS:

During the period 5-14 June 2003, an unusually strong STJ was situated from the east-central Pacific eastward to the lower Mississippi Valley. Transient disturbances, embedded in the STJ, originated over the eastern Pacific in an environment where the necessary condition for barotropic instability was satisfied. Once these STJ disturbances crossed the Rockies they penetrated to the surface, helping to trigger convection in a warm, moist and unstable airmass. A particularly long-lived MCV formed over Oklahoma near 0600 UTC 11 June at the northern end of a squall line that was triggered by the aforementioned leading transient disturbance. This MCV could be tracked northeastward to Ohio and was noteworthy for: 1) upshear tilt, 2) growing upscale, and 3) strengthening as it attached itself to a surface baroclinic zone.

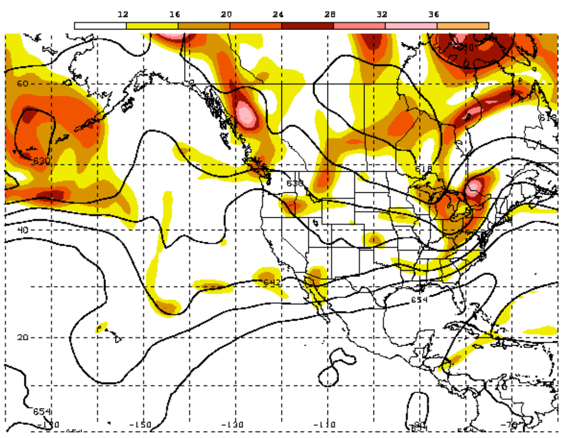

Fig. 1: 500-200 hPa thickness (solid, every 6 dam) and 300 hPa absolute vorticity (shaded according to the color bar for values of 12 x 10^{-5} s^{-1} and greater) for 1200 UTC 9 June 2003.

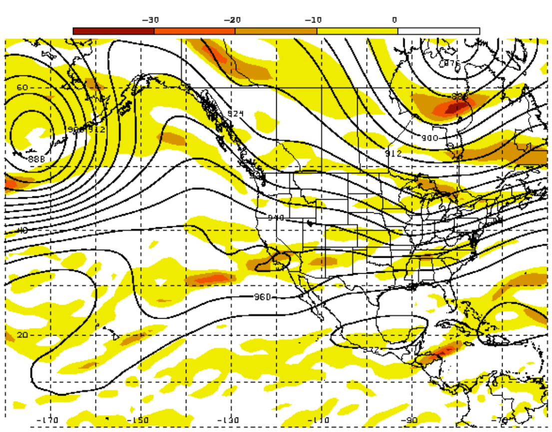

Fig. 3: 300 hPa time-mean heights (solid, dam) for 1200 UTC 8 June through 0000 UTC 11 June 2003. Regions where d[-(du/dy)+f)]/dy are < 0 (in units of 10-11 m^{-1} s^{-1}) are shaded.

5. ACKNOWLEDGEMENT:

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6. REFERENCES:

Black, R. X., and R. M. Dole, 2000: Storm tracks and barotropic deformation in climate models. *J. of Climate*, **13**, 2712–2728.

Hoskins, B. J., and T. Ambrizzi, 1993: Rossby wave propagation on a realistic longitudinally varying flow. *J. Atmos. Sci.*, **50**, 1661–1671.

Hoskins, B. J., and K. I. Hodges, 2002: New perspectives on the Northern Hemisphere winter storm tracks. *J. Atmos. Sci*, **59**, 1041–1061.

Iskenderian, H., 1995: A 10-year Climatology of Northern Hemispheric tropical cloud plumes and their composite flow patterns. *J. Climate*, **8**, 1630–1637.

Krishnamurti, T. N., 1961: On the role of the subtropical jet stream of winter in the atmospheric general circulation. *J. Meteor.,* **18,** 657–670.

Shapiro, M. A., H. Wernli, N. A. Bond, and R., Langland, 2001: The influence of the 1997-99 El Niño Southern Oscillation on extratropical baroclinic life cycles over the eastern North Pacific. *Quart. J. Roy. Meteor. Soc.,* **127**, 331–342.

Thorncroft, C. D., B. J. Hoskins, and M. E. McIntyre, 1993: Two paradigms of baroclinic-wave life-cycle behavior. *Quart. J. Roy. Meteor. Soc.*, **119**, 17–56.

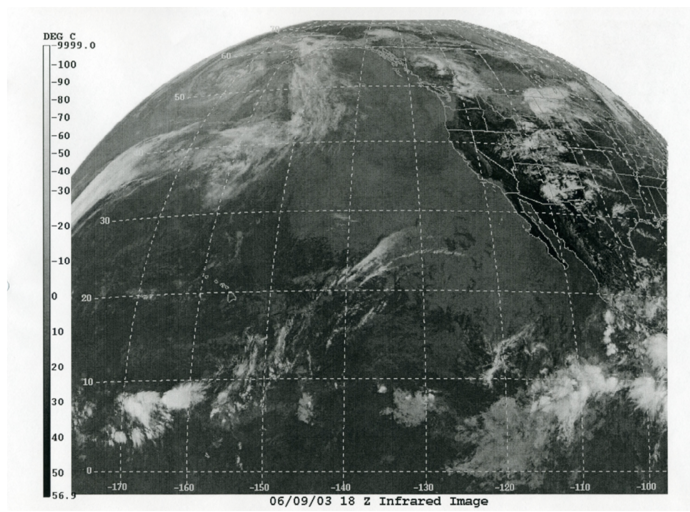

Fig. 2: GOES-West infrared satellite image for 1800 UTC 9 June 2003.

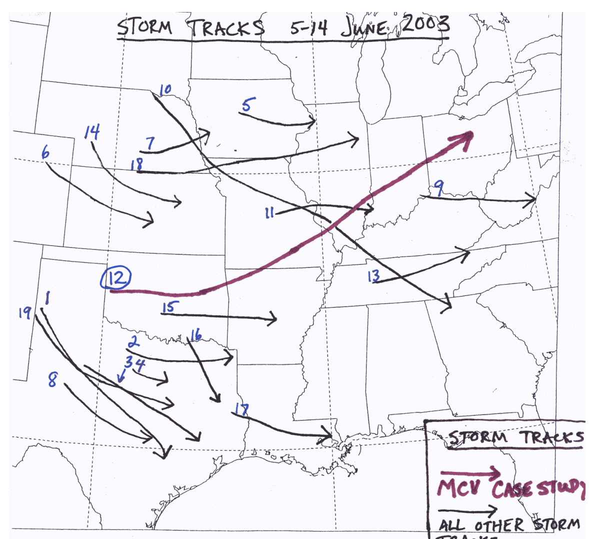

Fig. 4: Tracks of the 19 convective disturbances in the BAMEX domain during the period 5-14 June 2003. Track 12 marks the long-lived MCV of 11-13 June 2003.