Variability of Heavy Precipitation by Long-Lived Mesoscale Convective Vortices Found in the Southern Plains

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Introduction

A Mesoscale Convective Vortex (MCV) is a low pressure center found within a Mesoscale Convective System (MCS). The structure of an MCV is comparable to that of a Tropical Cyclone as they favor weak to moderate vertical shear and are denoted by their cyclonic flow. Many times after the antecedent MCS dissipates, the MCV can assume its own identity and become the source for convection initiation the following day. When environmental conditions are favorable, an MCV can persist several days through multiple MCS cycles. Such a case is known as an MCV event.

Case Studies

Heavy Precipitation Cases:

Fig. 1: (a) Relative Vorticity at the 500-mb level as a function of longitude and time. (b) 3-hour Total Precipitation at the surface as a function of longitude and time.

Dry Cases:

Fig. 2: (a),(b),(c) Relative Vorticity at the 500-mb level as a function of longitude and time. (d),(e),(f) 3-hour Total Precipitation at the surface as a function of longitude and time.

Data

- Observational Datasets for years 1979-2011 were collected from the NCEP North American Regional Reanalysis
- Grid Analysis Display System (GrADS) plotted Hovmoller analysis of relative vorticity and surface precipitation. (Fig. 1)
- Interactive Data Language (IDL) analyzed images from GrADS and created areas associated with long-lived cyclonic vorticity.

Methods

- Six cases were selected by their discernable quasi-stationary relative vorticity signatures lasting longer than four days.
- Precipitation correlation for each of the six relative vorticity signatures was also applied.
- Composite analysis of heavy precipitation cases and dry cases for multiple variables of the atmosphere.

Results

Heavy Precipitation Cases

Fig. 4: 500-mb Geopotential Height Composite Anomaly (a) 27 June 2007, 7 June 2004, 2 July 2002 (b) 7 July 2005, 7 July 2003, 8 July 1981

Fig. 5: 500-mb Absolute Vorticity, heights, winds (a) 2100 UTC 02 July 2002 (b) 0600 UTC 08 July 2005

Fig. 6: 925-mb Meridional Wind Composite Anomaly (a) 27 June 2007, 7 June 2004, 2 July 2002 (b) 7 July 2005, 7 July 2003, 8 July 1981

Fig. 7: Columnar Precipitable Water Composite Anomaly (a) 27 June 2007, 7 June 2004, 2 July 2002 (b) 7 July 2005, 7 July 2003, 8 July 1981

Fig. 8: Integrated Vapor Flux Composite Mean (a) 27 June 2007, 7 June 2004, 2 July 2002 (b) 7 July 2005, 7 July 2003, 8 July 1981

Conclusion

- 500-mb Geopotential Height Composite Anomalies (Fig. 4) show a ridge displaced further south for heavy precipitation cases and uniform distribution of higher heights over the United States. Dry cases displayed a tighter ridge further north and larger gradients between lower and higher heights.
- Strong southerly flow is evident in the 925 mb Meridional Wind Composite Anomalies for cases with heavy precipitation. (Fig. 6a) This flow helped to loft moisture into the region from the Gulf of Mexico. (Fig. 7a)
- Strong southerly flow and moist atmosphere for heavy rain events.

Future Work

- Look at additional cases to get a better in depth analysis
- Analyze different locations across the US.
- Investigate MCV structure to determine if warm or cold core lows may affect precipitation.

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