Western Region Technical Attachment
91-30
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USING THE 700-500 MB LAPSE RATE TO FORECAST INTENSE CONVECTION

[Editor's Note: This Technical Attachment is a summary of an article written by Charles Doswell, Fernando Caracena, and Mark Magnano which appeared in the Preprint Volume of the 14th Conference on Severe Local Storms, Indianapolis, 1985.]

This study focuses on the interaction between regions of high lapse rates in the mid troposphere (usually initiated over higher terrain) and regions of low-level moisture in triggering intense convection. The goal is to understand the processes by which the environment becomes ripe for intense convection and how this potential is maintained. Although the authors' conclusions are based on a case study in the Southern Plains where low-level moisture is often abundant, some of the general ideas have relevance in the Western Region, especially in Arizona and eastern Montana.

The Analysis and Event

Figure 1 shows that initially at 00Z on May 19, 1982, the region of high lapse rates was over the high terrain of Colorado, New Mexico, and Texas (dark solid lines), while the highest 850 mb dew points were well east of the high lapse rate region (light solid lines). Convection developed in between the two regions and moved into the more stable air. This nocturnal convection produced little in the way of severe weather.

By the next morning, the high lapse rate region had moved much closer to the low-level moisture (Fig. 2). The eastward progression of the high lapse rate region coincided with the progression of a 500 mb short-wave trough and associated jet streak. As the day progressed, the region of highest lapse rates began to overlap the highest 850 mb dew points more and more. It was right where these regions

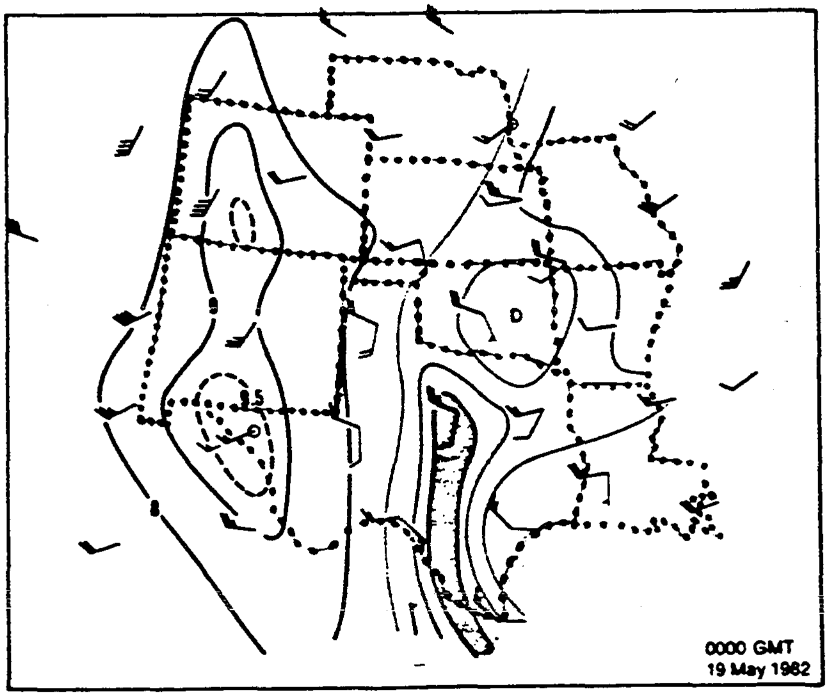

Fig. 1

overlapped, the eastern edge of the high lapse rate region and the western edge of the high 850 mb dew points, where a tornadic supercell developed along with several other intense storms.

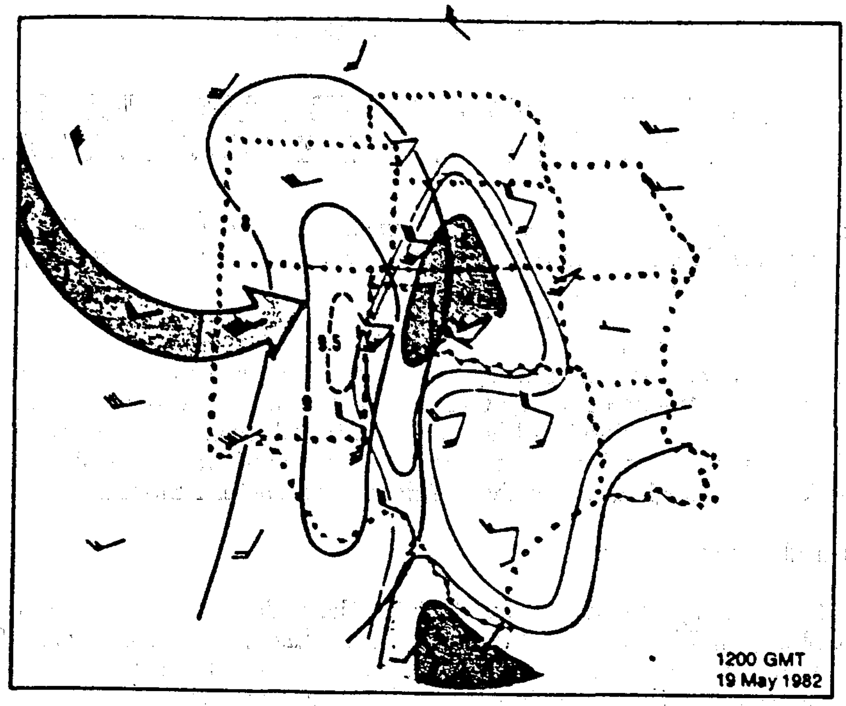

Fig. 2

Implications

Doswell, et al, suggest that the conceptual model of an air mass awaiting the triggering mechanism of a short-wave trough needs to be adjusted somewhat based on their study. Rather, the dynamics associated with the short-wave trough either act to create a region of mid-tropospheric unstable lapse rates or act to maintain or enhance a pre-existing region of unstable lapse rates produced by diabatic processes (in this case heating of elevated terrain). The short-wave then brings into superposition the unstable lapse rate region with the low-level moisture region.

The idea of a trigger moving into a homogeneous air mass is therefore somewhat misleading. The superposition of the unstable lapse rates over the low-level moisture is a **dynamic** process. In fact, the most unstable lapse rates in this case were probably not by coincidence in the same location as the left exit region of the jet streak, a favored location for decreasing stability (Hovanec and Horn, 1975). In other words, the authors' general conclusion is that the primary role of large-scale circulations in the initiation of intense convection is to prepare the environment through lapse rate changes (and also vertical wind shear). The large-scale vertical motions by themselves cannot be the "trigger" for convection. This is a concept that others have since echoed.

Doswell, et al, offer one final thought in regard to forecasting implications. Convective forecasting tends to focus on the use of a single "index" which describes the convective instability of the air mass (combination of moisture and lapse rates). While rules-of-thumb such as convective indices are often quite useful, one is assuming the concept of a pre-existing air mass waiting for a "trigger". If one were to diagnose moisture and lapse rate **independently**, the creation of convective instability could be **anticipated.** Furthermore, the idea that the creation of convective instability is a **dynamic** process (the superposition of the mid-tropospheric lapse rates and low-level moisture as well as the maintenance of the lapse rates are influenced by large-scale circulations) is important to think about.

Reference

Doswell, C.A. III, F. Caracena, M. Magnano, 1985: Temporal Evolution of 700-500 mb Lapse Rate as a Forecasting Tool - A Case Study. *Preprints, 14th Conf. Severe Local Storms* (Indianapolis), Amer. Meteor. Soc., 398-401.