A CASE STUDY OF ELEVATED CONVECTION IN AN UNSATURATED LARGE-SCALE ENVIRONMENT

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INTRODUCTION

Most severe convective events are associated with convection arising from a convectively unstable boundary layer. This basic association has resulted in a near absence of research done on other types of convection, one such type being elevated convection; which, in a broad sense, will be defined here as convection that occurs above a convectively stable boundary layer. It is important to realize that in this type of convection no inflow air for the storm originates in the boundary layer, but rather has a source of convectively unstable air aloft.

Downdrafts associated with these elevated thunderstorms are frequently warmer than the boundary layer resulting in some interesting interactions. Fujita (1963) mentioned the erosion of cold air from the surface by a downdraft associated with nocturnal convection, resulting in a temperature jump near the ground. The thicker the stable layer, the less likely it is for the downdraft to penetrate to the ground. Goff (1976) reported on a situation in which the downdraft was observed to penetrate approximately 200 m. This would suggest that downdrafts would not penetrate to the ground in the case of elevated convection above a frontal inversion which is 1 or 2 km above ground level. As the downdraft penetrates the inversion and becomes positively buoyant the kinetic energy is transformed into other kinds of energy. One such transformation is into gravity waves, with a strong characteristic of elevated thunderstorms being pressure oscillations associated with these gravity waves.

One possible scenario that may lead to a stratification
conducive to such elevated convection is when the cold air north of a surface front remains relatively shallow and capped by a strong inversion. It is over such a low-level frontal zone that perhaps the most persistent and extensive elevated convection occurs. These storms can be intense, and contribute significantly to precipitation totals. Few however qualify as severe, defined by the U.S. National Weather Service, as, either 1) straight line winds greater than 25 ms\(^{-1}\), 2) hail greater than or equal to 1.9 cm in diameter or 3) tornadic. The case study that will be discussed here is of this frontal type.

OBSERVATIONS

An outbreak of convection occurred over northeast Texas on March 5, 1982 and continued into March 6, 1982. The upper-level flow was dominated by a broad trough centered over the central United States. A surface cyclone had developed on March 3 over extreme western Oklahoma, which tracked east and then northeast to a position over the St. Lawrence River Valley by 12 GMT on March 5. A surface cold front associated with this system moved across Texas on March 4 and stalled over the Gulf of Mexico. Fig. 1 shows the positions of pressure centers and fronts for 12 GMT on March 3, 4 and 5. The passage of the cold front left Texas in a cold north

![Fig. 1. A composite showing the positions of pressure centers and fronts for 12 GMT on March 3, 4 and 5, 1982. Dash-dot and superscript 1 for March 3; dash and superscript 2 for March 4; solid and superscript 3 for March 5. The locations of Longview, Texas, Victoria, Texas and Lake Charles, Louisiana are shown by an *, □ and Δ, respectively.](image-url)