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TORNADIC THUNDERSTORM DEVELOPMENT IN WEST TEXAS 27 MAY 1978

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ABSTRACT

The evolution of a thunderstorm complex on the South Plains of Texas on 27 May 1978 is followed through the development of funnels and a tornado. Upper air and surface data revealed very unstable conditions with strong triggering in advance of a jet maximum. At the surface, a mesoridge across the Texas Panhandle promoted strong advection of gulf moisture into the South Plains. A thunderstorm doublet northwest of Lubbock was evident in both visible and infrared satellite imagery. Radar portrayed the strong convection and associated hook echoes. Information on the tornado scale was provided by eyewitness photographs of the largest funnel. The production of intense convection followed by vigorous outflows appears to have been the primary factor leading to the tornadic features of a thunderstorm complex.

1. INTRODUCTION

During 1978, severe weather across the Southern High plains was especially strong in the last week of May. Hail to 11 cm diameter fell near Spearman TX; a disastrous flood struck the Palo Duro region; and numerous funnels and tornadoes were reported across the Panhandle and South Plains of Texas.

This paper explores several aspects of tornadic activity on 27 May 1978, including (a) the synoptic setting, (b) the mesoscale triggering and (c) the appearance of the largest tornado. Conventional surface and upper-air data, as well as radar observations, satellite imagery and eyewitness photographs are incorporated into the analysis.

The record leads to the conclusion that a persistent thunderstorm complex became tornadic when overtaken by the outflow from a smaller thunderstorm group 50km away.

2. SYNOPTIC SETTING

At 1200 GMT on the 27th, an upper-level trough was oriented north-northwest to south-southeast from Idaho to New Mexico. At 300mb (Fig. 1), a jet maximum pivoting around the trough was situated over northern Mexico. Winds within the diffluent exit zone over northwestern Texas were at least 65kt, with strong cyclonic shear to the left and notable cross-current flow to the right of the jet axis. Positive vorticity advection was apparent at 500mb (Fig. 2); the thermal pattern (not shown) revealed the cool air associated with the disturbance.

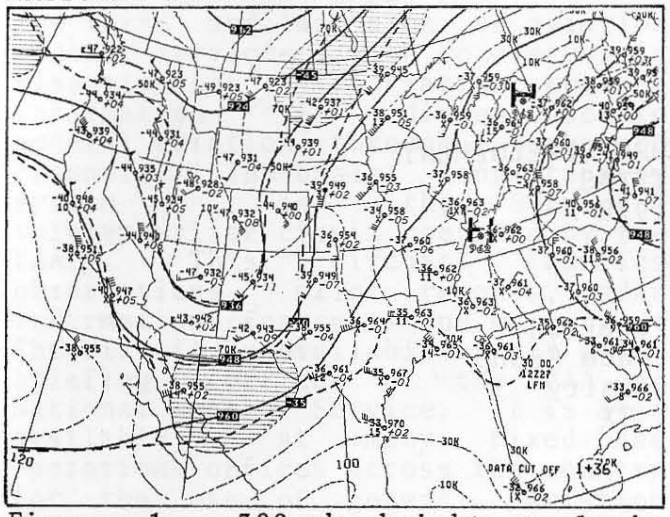

Figure 1. 300-mb height analysis (dam), 1200 GMT 27 May 1978 with temperature and isotach analyses (NMC).

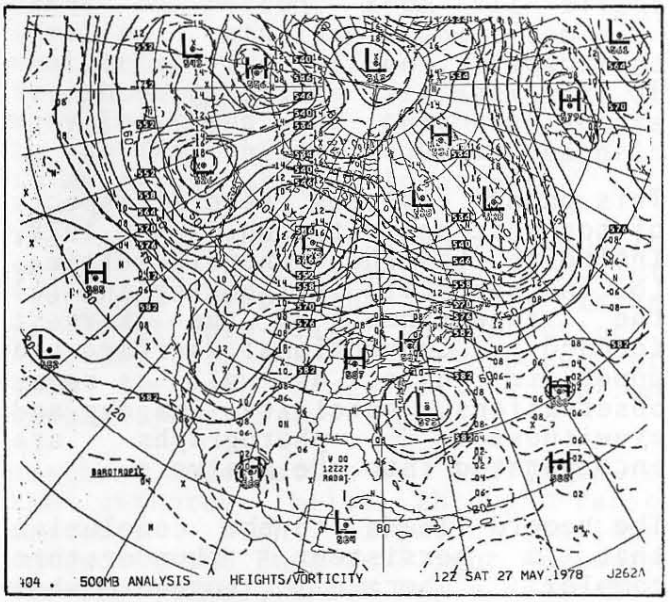

Figure 2. 500-mb height (dam) and vorticity (10 to -5 per sec) analyses, 1200 GMT 27 May 1978 (NMC).

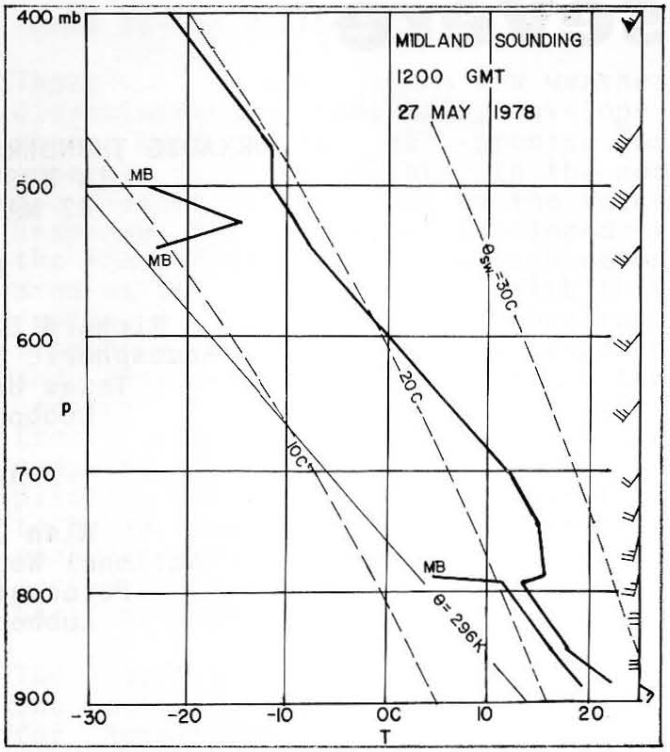

Figure 3. Midland TX sounding, 1200 GMT 27 May 1978.

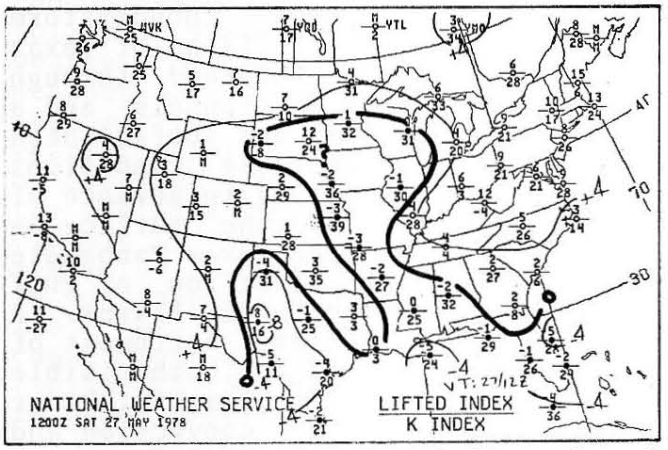

Figure 4. Lifted and K indices based on 1200 GMT 27 May 1978 soundings (NMC).

The air moving across the Texas South Plains was typified by the 1200 GMT Midland sounding (Fig. 3). The lowest 100 mb were almost saturated; cooler and very dry air lay above a slight inversion. The sounding revealed that the atmosphere was conditionally and convectively unstable; latent instability existed in the layer below 790mb. The tongue of unstable air across the region was evident in the distribution of the lifted index (Fig. 4), with -8 at Midland; the very dry air at 700mb (Fig. 5) led to the low K-indices.

A stationary front was positioned north- to-south across New Mexico; to the east of the front, strong low-level advection of moist air had yielded low clouds east of a Tucumcari - Midland line at 1200 GMT, with fog in the northern section. A meso-analysis at mid-morning (1400 GMT) revealed a high pressure ridge of cooler, drier air between Lubbock and Amarillo (Fig. 6). The low clouds to the southwest of this mesoridge dissipated during the late morning (1700 GMT) as drier air penetrated from the southwest;

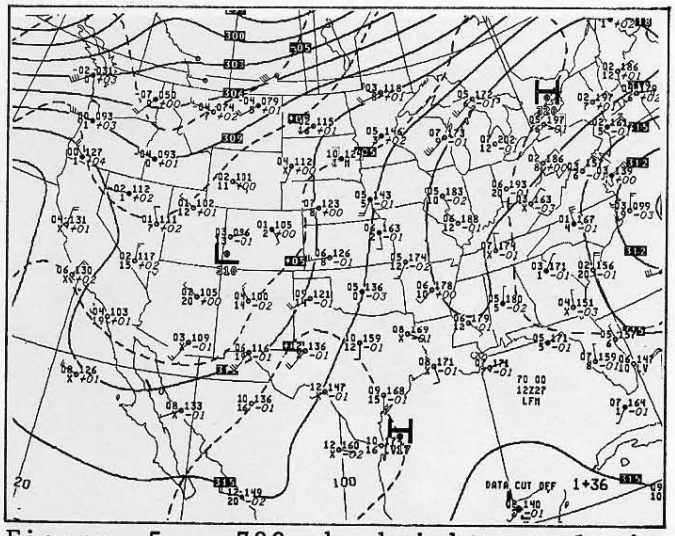

Figure 5. 700-mb height analysis (m), 1200 GMT 27 May 1978 with temperature analysis (NMC).

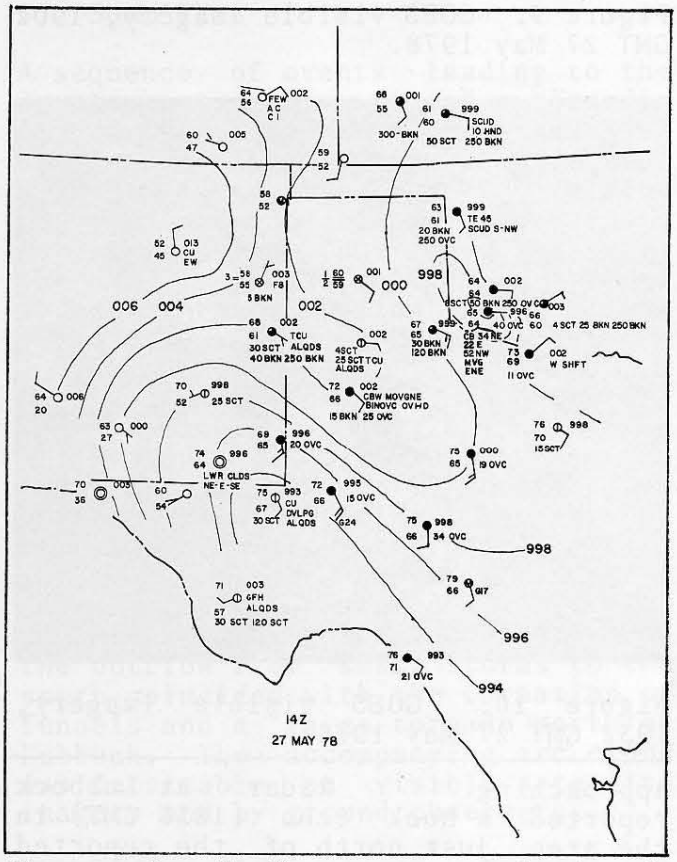

Figure 6. Surface mesoanalysis of altimeter settings (in Hg), 1400 GMT 27 May 1978.

dewpoints northeast of a line from Abilene to Tucumcari continued to rise however.

Subsequently, the approach from the southwest of the dryline stimulated isolated activity southwest of Lubbock; the dewpoints at Lubbock and Reese AFB fell to only 62F and 53F respectively (0000 GMT).

3. MESOSCALE TRIGGERING

By 1400 GMT convective activity had developed to the west of Lubbock along the southwestern flank of the mesoridge. Infrared imagery at 1532 GMT (not shown) revealed two growing cells separated by about 80 km. Lubbock radar at this time indicated a heavy thunderstorm 40km to the west-northwest. Throughout the remainder of the day this doublet persisted and generated adjacent cells while moving to the northeast at 15-20kt.

Cirrus shields (to the right of A) are shown (Fig.7) in the 1632 GMT satellite imagery; both had reached severe intensity as a top of 15850m was reported 32km northwest of Lubbock. By 1702 GMT, the imagery shows three apparently small cells 15-25km south southeast of Lubbock. With an abundant supply of low-level moisture, these cells had reached very heavy intensity.

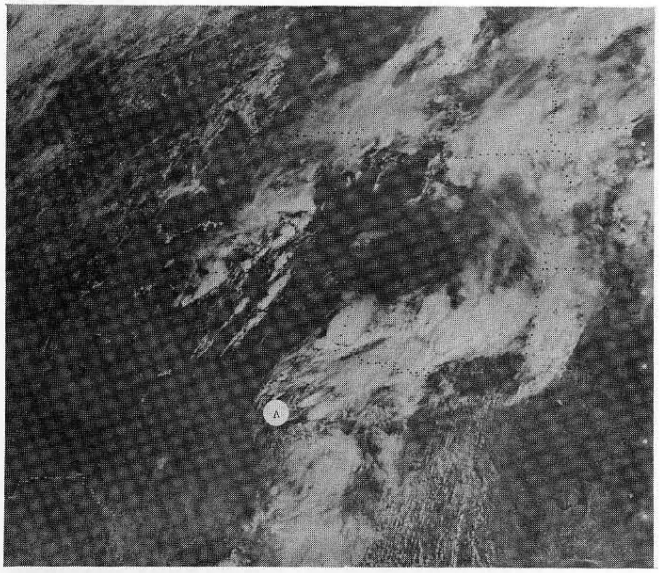

Figure 7. GOES visible imagery, 1632 GMT 27 May 1978. Note that the superimposed grid should be shifted southeastward.

By 1731 GMT (Fig. 8) a large new cell (B) had developed on the southern flank of the complex north of Lubbock, while the cells to the south (above C) had produced narrow-plumed anvils. Pronounced shearing to the northeast and evaporation of the rain into the dry air at mid-levels were confirmed by visual observations of the cells to the south. The resulting strong outflow was made

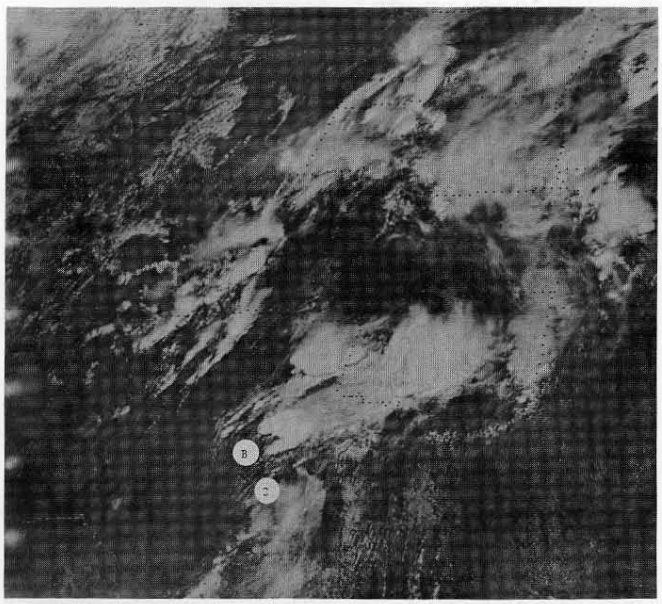

Figure 8. GOES visible imagery, 1732 GMT 27 May 1978.

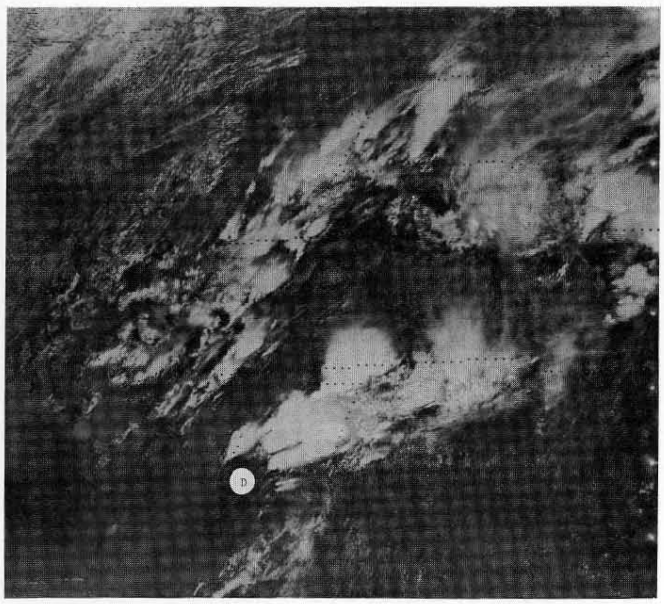

Figure 9. GOES visible imagery, 1902 GMT 27 May 1978.

apparent at 1902 GMT (Fig. 9) by an arc cloud (to the right of D); in the Lubbock vicinity this line was seen to be composed of narrow towering-cumulus elements. With its passage at Reese AFB and Lubbock, the wind backed by 30 degrees accompanied by slightly lower dewpoints.

Strong outflow accompanied the cells to the north as well; however, the vigorous outflow southward confronted by the synoptic-scale moist inflow gave rise to large new cells immediately to the south of the parent complex.

Within the next half-hour (Fig. 10) the outflow from the small cell group had triggered a new cell further to the south (E) and had encroached on the southern flank of the older thunderstorm complex to the north (B). Throughout the remainder of the afternoon, the intensity of the old complex persisted as it moved northeastward; however new cell development to the south was inhibited, apparently due to the stable outflow air.

4 TORNADO DEVELOPMENT

At 1730 GMT, hail to 1.25cm diameter was observed within the storm 30km north- northeast of Lubbock. Funnel cloud activity was first reported at 1813 GMT from the same area as the outflow from the south was

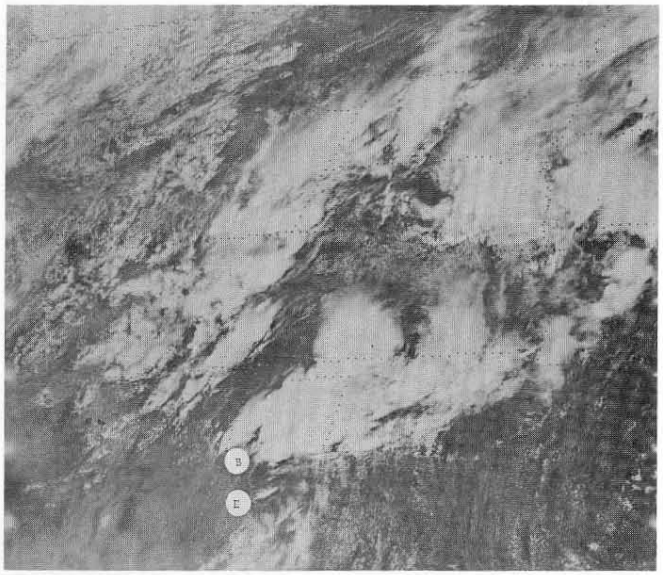

Figure 10. GOES visible imagery, 1932 GMT 27 May 1978.

approaching. Radar at Lubbock reported a hook echo (1835 GMT) in the area just north of the reported funnels. As the outflow continued to press northward, more funnels and eventually a large tornado (1925 GMT) were spawned along the southern flank of the large storm complex.

The tornado shown in Figs. 11a-c was observed for about four minutes as it moved east- northeast at 25kt, from a position just south of Edmonson (55km north-northwest of Lubbock). From a low, ragged base with possible small funnels, a well-organized vortex

evolved, with a smooth condensation funnel that soon reached ground. The funnel grew broader, but just as suddenly began to vanish from below. Moments after Fig. 11c, the funnel had merged with the cloud base. Nevertheless, a debris vortex was still present; and a hook echo was noted on radar (1948 GMT). Perhaps the ultimate effect of the somewhat cooler and drier outflow undercutting the tornado circulation from the south was deleterious, leading to a premature demise of the vortex.

Hook echoes were noted during the next hour as the storm moved northeastward; however, the only visual sighting was a funnel cloud near Tulia (90km north of Lubbock).

5. SUMMARY

A sequence of events leading to the development of a tornadic thunderstorm in west Texas has been outlined. The dryline (a frequent element in severe-storm initiation) was present and advancing; but it did not play an important role. Instead, the formation of vigorous thunderstorm outflow was the key factor.

With abundant low-level moisture and very unstable conditions, intense convection developed. In the extremely dry air aloft, shearing led to substantial additional convection. Large storms generated nearby cells, while smaller storms triggered activity at a greater distance. The advance northward beyond Lubbock of the outflow from small storms to the south coincided with the formation of funnels and a large tornado north of Lubbock. The accompanying arc cloud was detectable on visible satellite imagery and by ground observers.

The sudden disappearance of the large tornado was perhaps also due to the undercutting outflow air. In spite of continued radar hook activity, the tornado funnel did not persist; nor did it go through a dissipating rope stage. Instead, it appeared to be desiccated from below.

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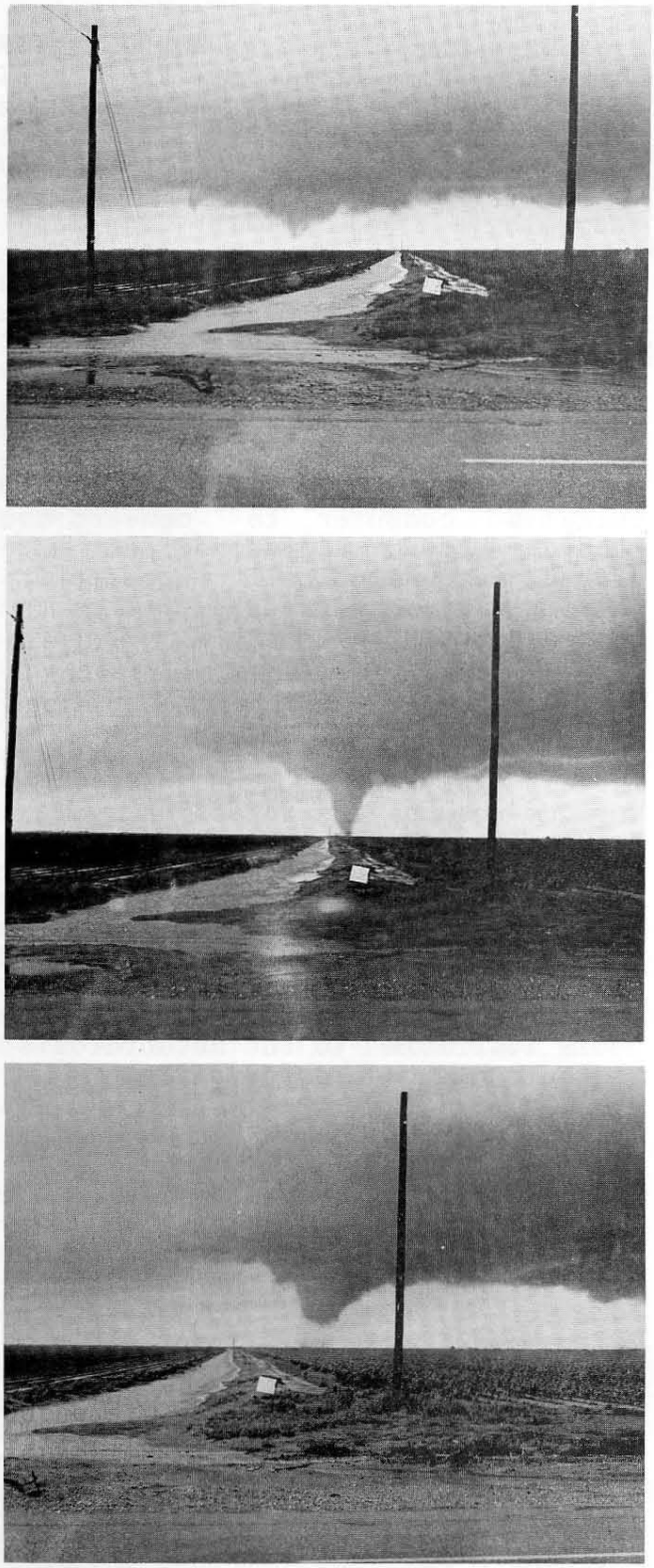

Figure 11. Edmonson tornado at 1925 GMT at approximately one-minute intervals, portraying (a) organization, (b) mature, and (c) dissipating stages. Photos courtesy of Carl Holland.