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CENTRAL REGION TECHNICAL ATTACHMENT 89-37

WET BULB ZERO HEIGHTS AS AN INDICATOR OF SURFACE HAIL SIZE FOR THE APRIL 3, 1989 SEVERE WEATHER EPISODE

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1. Introduction

Numerous incidents of large hail were reported across southern Missouri, southern Illinois, and southern Indiana, northeast Texas, Arkansas and Kentucky on the afternoon and evening of April 3, 1989. Altogether there were 112 reports of 3/4 inch or larger hail with 64 (57 percent) of these over primarily southern Missouri and Arkansas (see Fig. 1). Hail sizes in the one to two inch range accounted for a rather large 79 (71 percent) of these reports. The largest hail was concentrated across southern Missouri, southern Illinois and far southern Indiana with each state having two reports of baseball size (2 and 3/4 inch) hail. Along with the large hail, there were 23 tornado reports (two in Tennessee) and 15 reports of wind damage or winds in excess of 50 knots.

Synoptically, at 12Z on the 3rd (Fig. 2) a cold front extended south from a low pressure area over western Minnesota through Iowa and into northwest Missouri before curving west through the Texas Panhandle. By 00Z the cold front had occluded over Wisconsin, then extended southwest as a cold front through east-central Missouri, northwest Arkansas, and northeast Texas before curving northwest. A sharpening 500 mb trough extended from the upper Mississippi River Valley southwest through the Central Plains. Very unstable air was in place ahead of the cold front. An 850 mb low level jet (LLJ) of 45 knots was observed at Little Rock, Paducah, and Nashville at 00Z on the 4th with 850 mb temperatures around 15°C and 850 mb dew point depressions of only a couple degrees. This very warm moist air in the lower levels was occurring with 500 mb temperatures around -15°C.

At 00Z on the 4th, 500 mb lifted indices were -6 at Paducah and Little Rock with Total Totals of 56 at both Paducah and Little Rock. The most impressive index however, was the SWEAT index, which was greatly enhanced by good veering and strengthening winds with increasing height. SWEAT indices at 00Z on the 4th included an unusually high 518 at Paducah, 471 at Little Rock, and 347 at Nashville. With this much instability, energy, and an approaching cold front, there was little doubt that severe thunderstorms would develop. This was well depicted by SELS Day 1 severe weather outlook which included a moderate risk from southern Illinois and southern Indiana southwest into most of Arkansas.

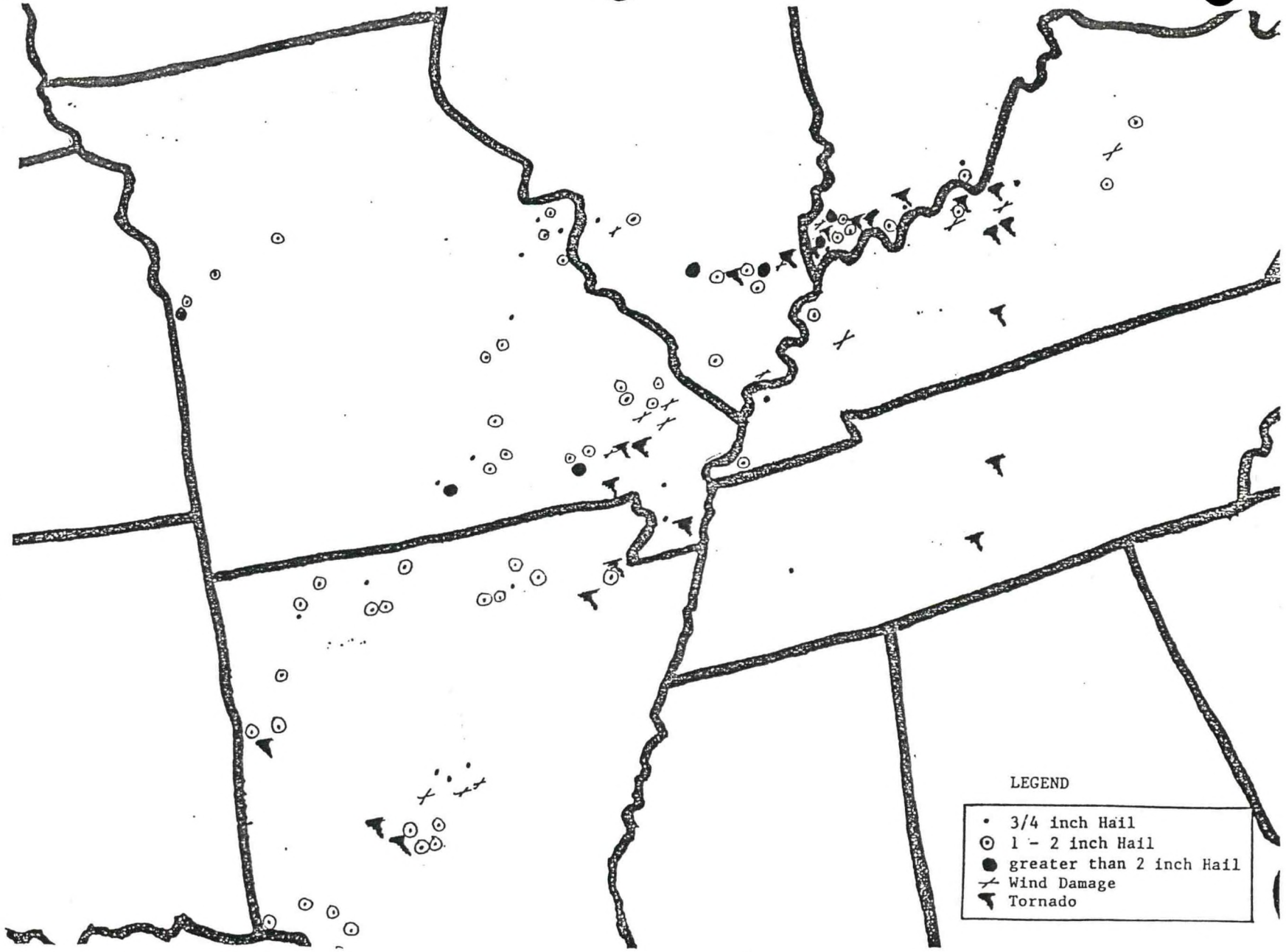

Figure 1 Surface synoptic conditions for 12Z, April 3, 1989.

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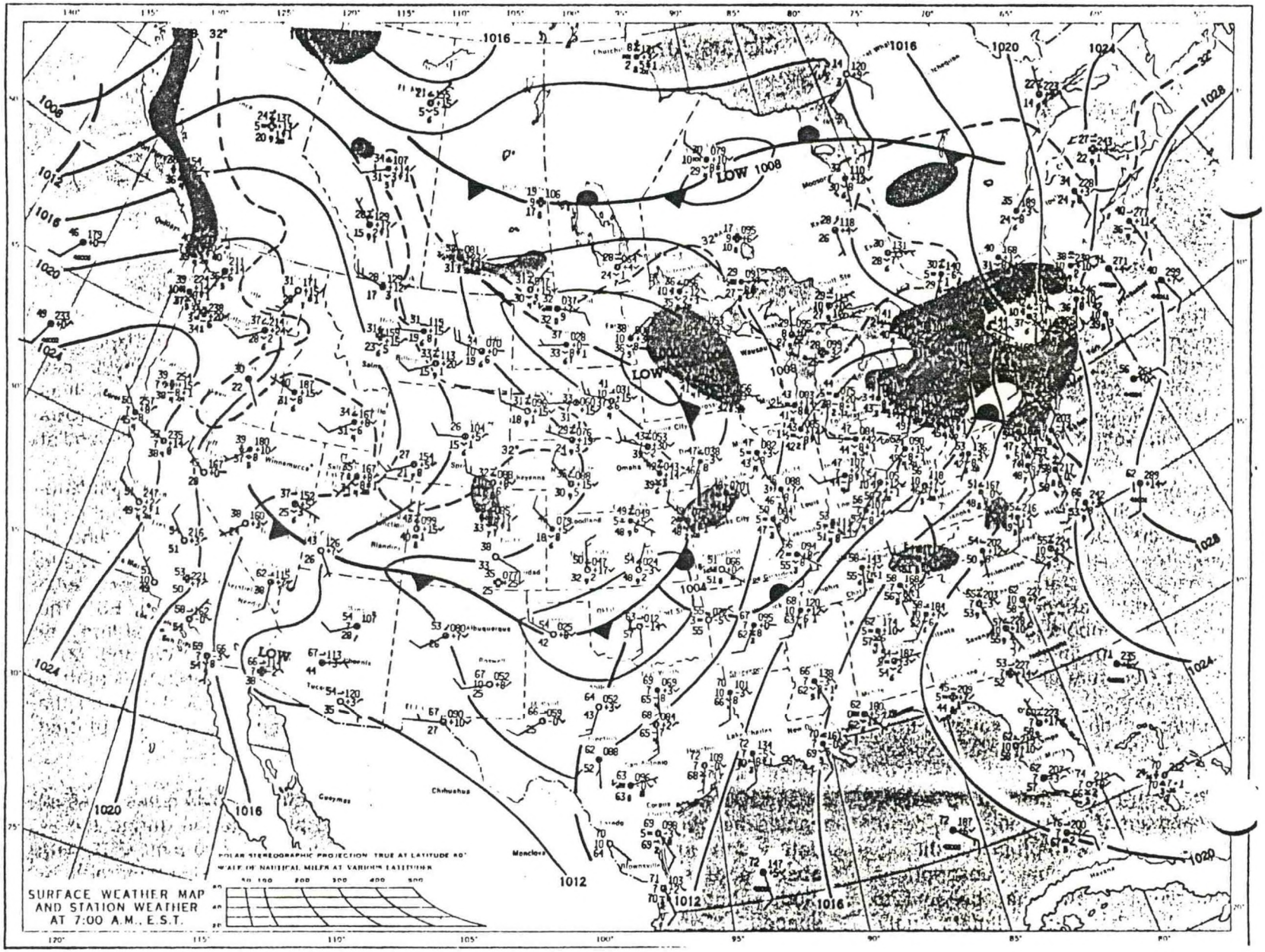

Figure 2 A severe weather report for 12Z April 3 to 12Z April 4, 1989.

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Severe thunderstorms sometime occur without the observance of hail at the surface. The main purpose of this paper is to show the relationship between the wet bulb zero (WBZ) height and surface hail size using the severe weather episode of April 3, 1989 as an example.

2. Wet Bulb Zero Heights

The WBZ height is derived from the upper air analysis on a SKEW-T. It is the height of the 0°C environmental wet bulb temperature (see Fig. 3). The WBZ height above the surface may be the best single index for determining if severe weather phenomenon will reach the ground. More specifically, in studies of hail storms it has been found that over 90 percent of reported surface hail occurred with a WBZ height between 5,000 and 12,000 feet above the terrain. The largest hail sizes have been reported in instances of WBZ heights around 9,000 feet above the terrain. Similar WBZ heights have been noted for thunderstorm wind gusts of 50 knots or greater and tornadoes (except for tornadoes in a Gulf Coast environment where higher WBZ heights have been noted) (Miller, 1975).

3. Wet Bulb Zero Heights on April 3, 1989

The upper air analysis from 00Z on the 4th indicated WBZ heights of 8,800 feet at Little Rock, 9,900 feet at Paducah, and 7,400 feet at Nashville (see Figs. 3, 4, and 5). Notice how the drier air in the mid-levels at Little Rock and Nashville helped produce lower WBZ heights. This exemplifies an inaccuracy involved with simply using the freezing levels for forecasting surface hail size. Severe thunderstorms were beginning to move into the Paducah area around the 23Z rawinsonde release time. This likely caused some moisture entrainment at Paducah giving a WBZ height slightly higher than those that actually existed a short time earlier. Similar WBZ heights were noted 12 hours earlier with 7,500 to 8,500 foot readings at Monett, Little Rock, Paducah, and Nashville. Overall, WBZ heights likely averaged in the 8,000 to 9,000 foot range (prime for large surface hail) in the environment that yielded the 112 reports of large surface hail and other severe weather phenomenon.

4. Summary and Conclusions

While the WBZ height alone cannot be used as a unique predictor, it can provide valuable input to forecasting surface hail size and associated severe weather. The WBZ height is readily available from the AFOS SKEW-T application program. The severe weather episode of April 3, 1989 illustrated how a WBZ height analysis can help the forecaster in the delineation of expected hail size.

5. Acknowledgements

A special thanks to Ernest H. Goetsch (Lead Forecaster at WSFO Louisville, Kentucky) for his advice and input.

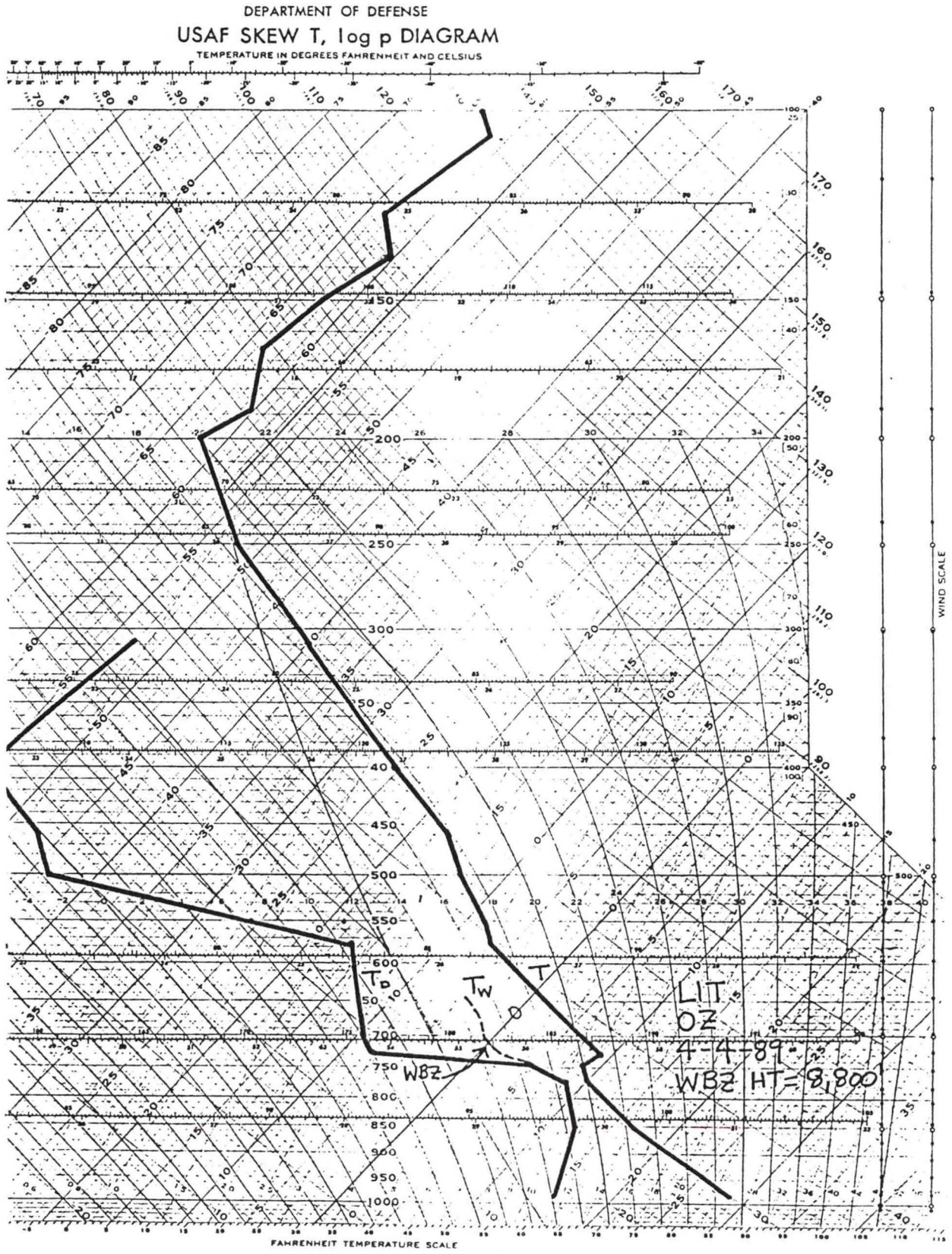

Figure 3 Little Rock, Arkansas sounding analysis for 00Z April 4, 1989.

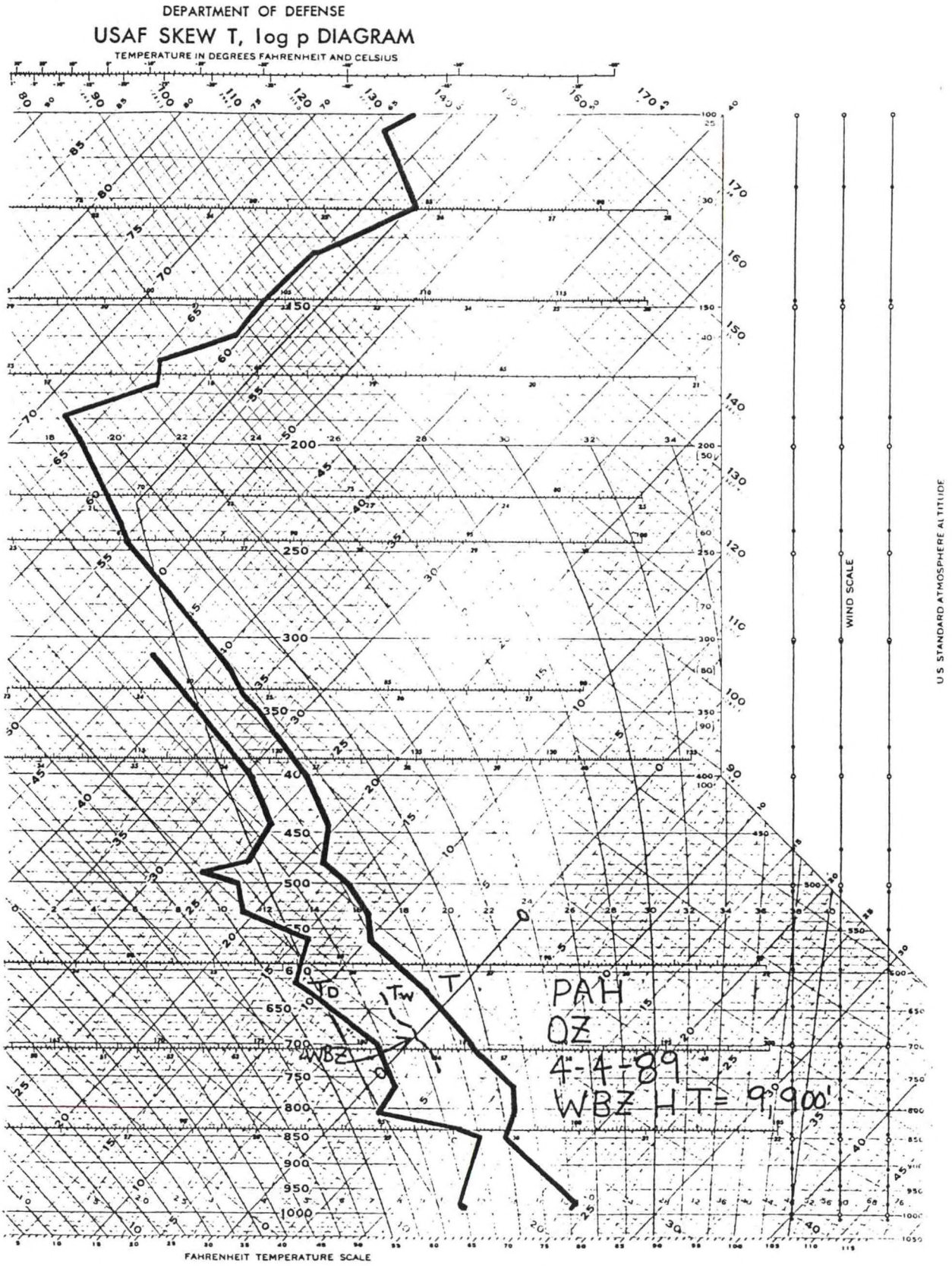

Figure 4 Paducah, Kentucky sounding analysis for 00Z April 4, 1989.

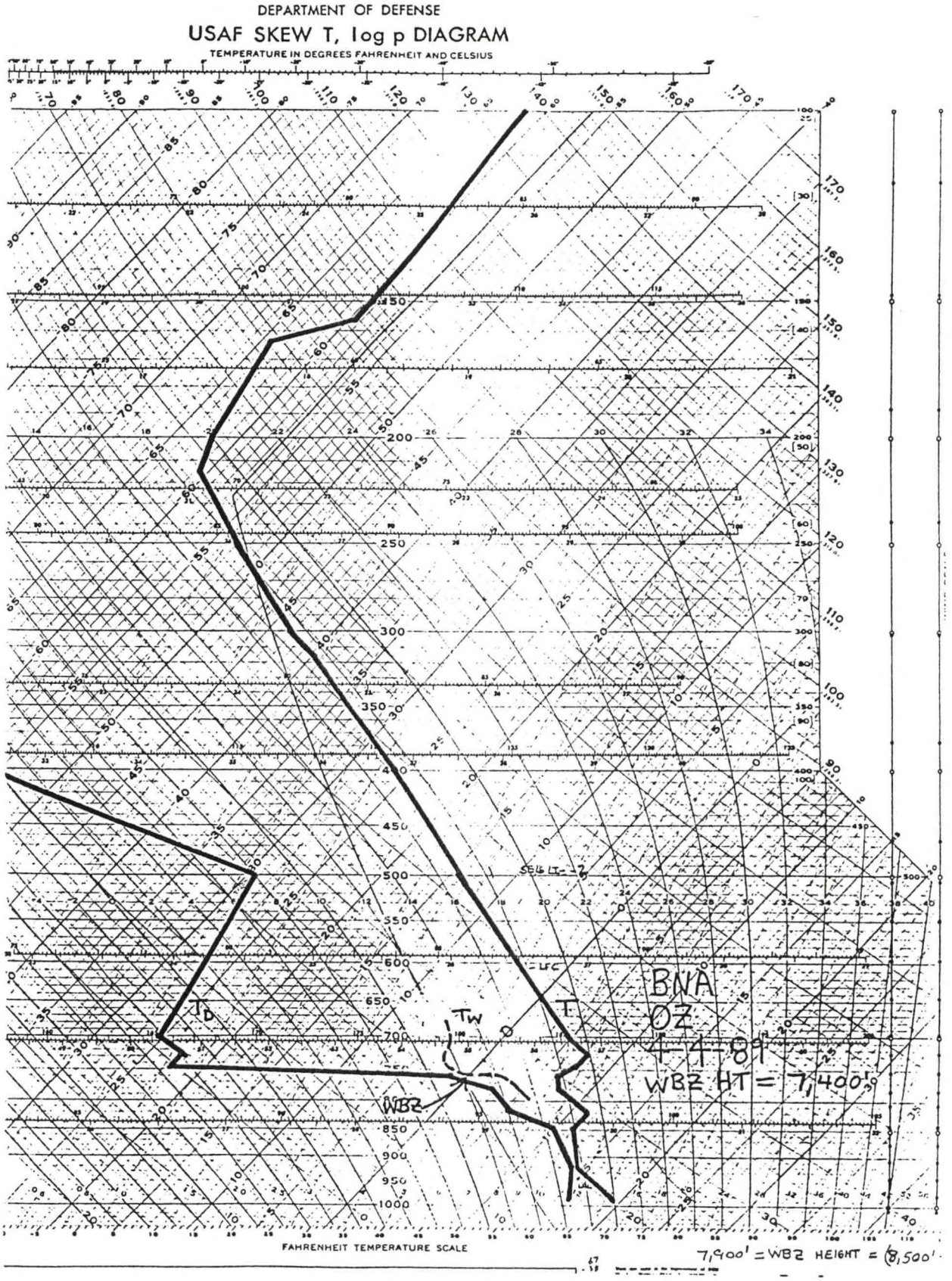

Figure 5 Nashville, Tennessee sounding analysis for 00Z April 4, 1989.

6. Reference

Miller, R. C., 1975: Notes on Analysis and Severe Storm Forecasting Procedures of the Air Force Global Weather Central. Air Weather Service Technical Report 200 (Rev), 1-7.