THE SEPTEMBER 24, 1987, YUMA PROVING GROUND TORNADO

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ABSTRACT

Numerous reports of a tornado on the Yuma Proving Grounds (YPG), Arizona were recorded on September 24, 1987. These reports were contested because of several large dust devils observed in the area during the afternoon. An investigation of photographic evidence and eyewitness accounts affirmed the tornado occurrence.

1. INTRODUCTION

Numerous reports of a tornado on the Yuma Proving Ground (YPG), Arizona (Fig. 1), were recorded at approximately 1600 MST (2300 GMT) on Thursday, September 24, 1987. These reports have been contested because several large dust devils were also observed in the area that afternoon. But, after further investigation of the photographic evidence and eyewitness accounts, the storm in question (Figs. 2A–D) has been determined to have indeed been a tornado.

The eyewitness accounts include an Arizona Department of Transportation engineer who stated that the storm in question started as a funnel cloud that dropped down to the surface. This was confirmed by a YPG photographer who also sighted the funnel cloud. The most conclusive eyewitness account, though, came from a YPG security guard who was approximately 200 yards from the storm during passage and visually observed cloud rotation (the mesocyclone) where the funnel joined the cumulonimbus cloud. Surface damage caused by the tornado was negligible as it was of short duration and passed over open range.

2. ANALYSIS

Leading up to the 24th, the "Arizona Monsoon" was definitely active; a moist south to southeast low-level (surface–10,000 ft) wind flow, originating from the Gulf of California, had caused average daily dew points on the 21st through the 23rd to rise to the upper 50's and low 60's°F. On the 22nd and 23rd this low level moisture combined with daytime heating and the dynamics from a 500-mb cold core cut-off low-pressure center, which was stationary off the northern Baja California coast (Fig. 3), to cause isolated thundershowers on and in the vicinity of YPG.

On the morning of the 24th, the 1200 GMT YPG sounding (Fig. 4) indicated a K-Index of 33, Lifted Index of −3, moist east to south low-level (surface–10,000 ft) wind flow, and a surface dew point of 58°F. The convective temperature was 91°F and the high temperature for the day was expected to be in the middle 90's (actual maximum was 95°F).

Scattered early morning altocumulus gave way to clear skies by late morning. But, by 1200 MST (1900 GMT), as the convective temperature was met, scattered cumulus began to develop to the east along with a few towering cumulus. By 1400 MST (2100 GMT), numerous cumulonimbus began to develop over the eastern portion of YPG's Kofa Firing Range, and by 1430 MST (2130 GMT) thundershowers developed.

At 1600 MST (2300 GMT), a YPG sounding (Fig. 5) was taken at approximately the time the tornado occurred. The K-Index was 32, Lifted Index was zero, the low-level (surface–10,000 ft) winds were shifting toward the northwest, and the surface dew point was 52°F (which had fallen from 60°F at 1500 MST (2200 GMT) due to a thundershower gust front).

Though conditions leading up to the tornado were indeed moist and unstable, they were not extreme enough that a forecaster would think "tornado." In fact, much more moist and unstable conditions than those of the 24th have been previously recorded at YPG and have resulted in only weak, isolated thundershower activity. Let's put things in perspective and review the conditions leading up to the tornado and then draw conclusions:

1. Sufficient, but not extreme, low-level moisture was present (dew points during the day ranged from 56–60°F, which are common for September rainfall events).
2. The convective temperature was exceeded.
3. Sufficient, but not severe, instability was present (K-Indexes of 33 (1200 GMT) and 32 (2300 GMT), Lifted Indexes of −3 (1200 GMT) and zero (2300 GMT)).
4. Low-level convergence was present, as the 850-mb and 700-mb troughs passed between 1400 MST (2100 GMT) and 1600 MST (2300 GMT). The 2300 GMT YPG sounding indicated that the 500-mb center/trough was also beginning to pass.
5. The nearness of the 500-mb Low center's passage (Fig. 6) provided maximum dynamics. These dynamics were in the form of cold upper tropospheric temperatures and maxima of both positive vorticity advection and positive vertical velocity.
6. Throughout the 24th, sharp drying occurred above approximately 550 mb.

Therefore, evaporative cooling maintained cold upper tropospheric temperatures and sustained atmospheric instability.

3. CONCLUSION

The above conditions were indeed favorable for thunderstorm development, but were they severe enough for tornadic activity? Obviously they were, but a forecaster during the morning of the 24th would likely think not. For example, during the November 1986 tornado outbreak near Phoenix, Arizona, dew points were in the low 60's°F (record levels) with Lifted Indexes near −6. No such anomalously moist or unstable conditions were present at YPG. Therefore, most likely, no one condition was responsible for the tornado, but it was a combination of the above conditions and the nearly direct overhead passage of the 500-mb low-pressure center that provided excellent dynamics. So, when moist and moderately unstable conditions, which would normally support only isolated air-mass thunderstorm formation, are enhanced by strong dynamics (e.g., from a vigorous 500-mb cold core cut-off low-pressure center) the forecaster must be aware of

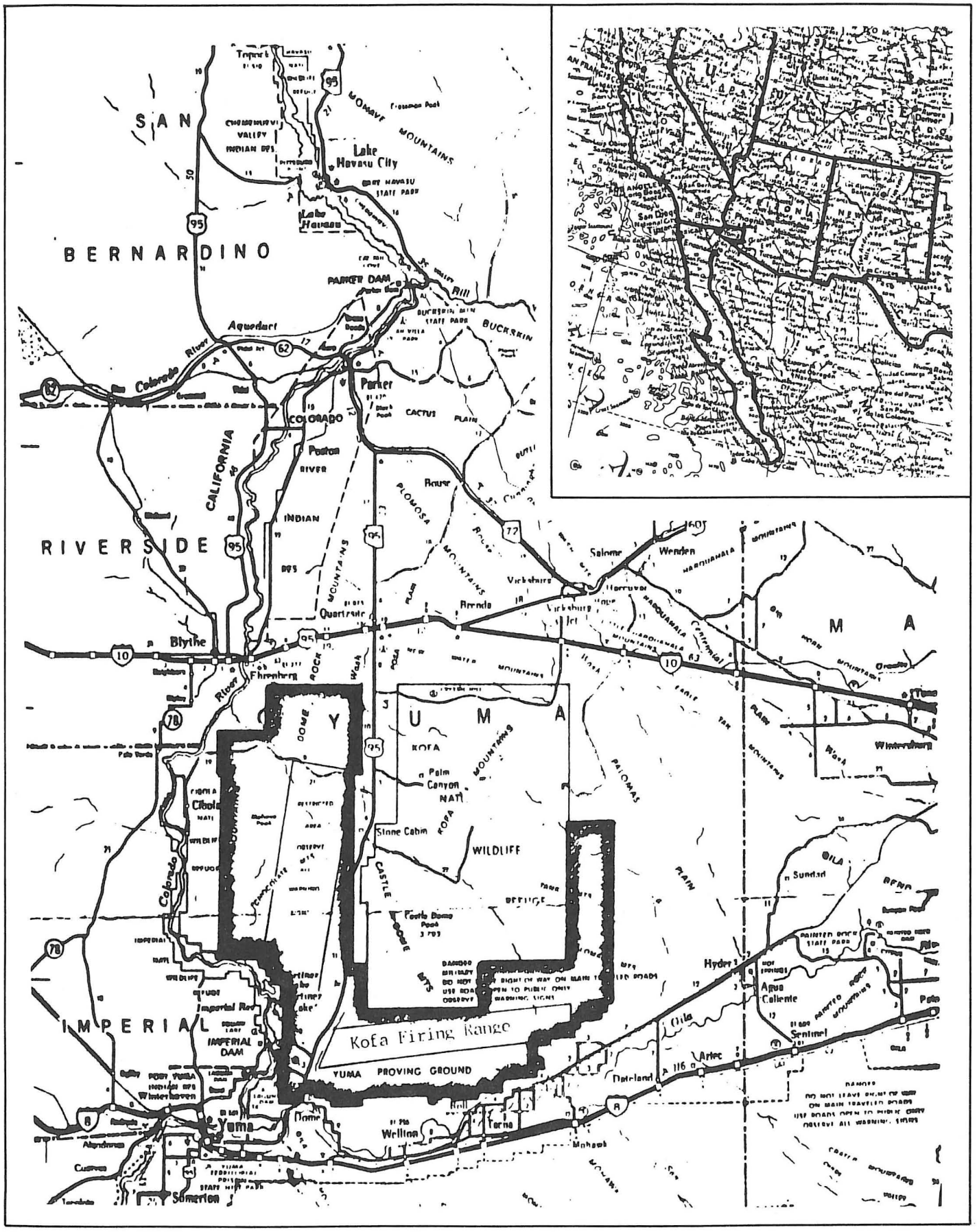

Fig. 1. Map of southwest United States and Yuma Proving Ground

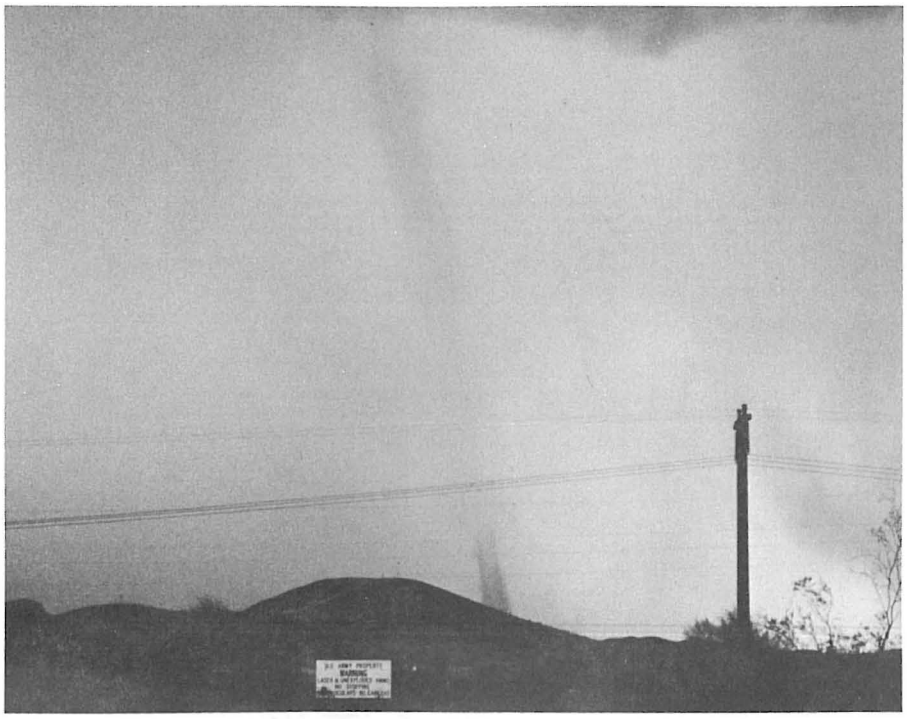

Fig. 2A. Initial Stage

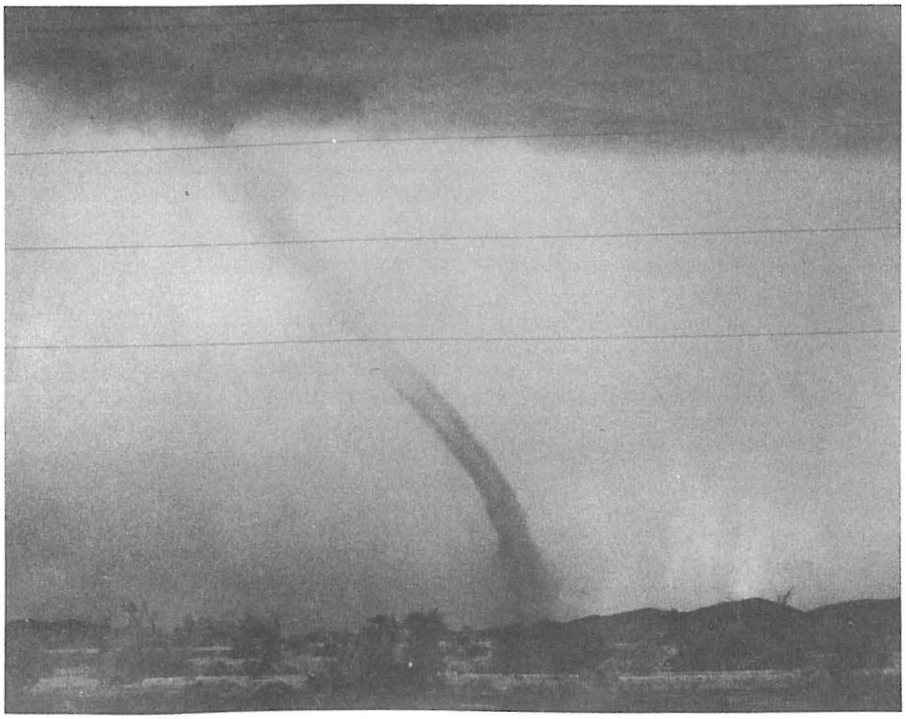

Fig. 2B. Mature Stage

Fig. 2C. Mature Stage (close-up)

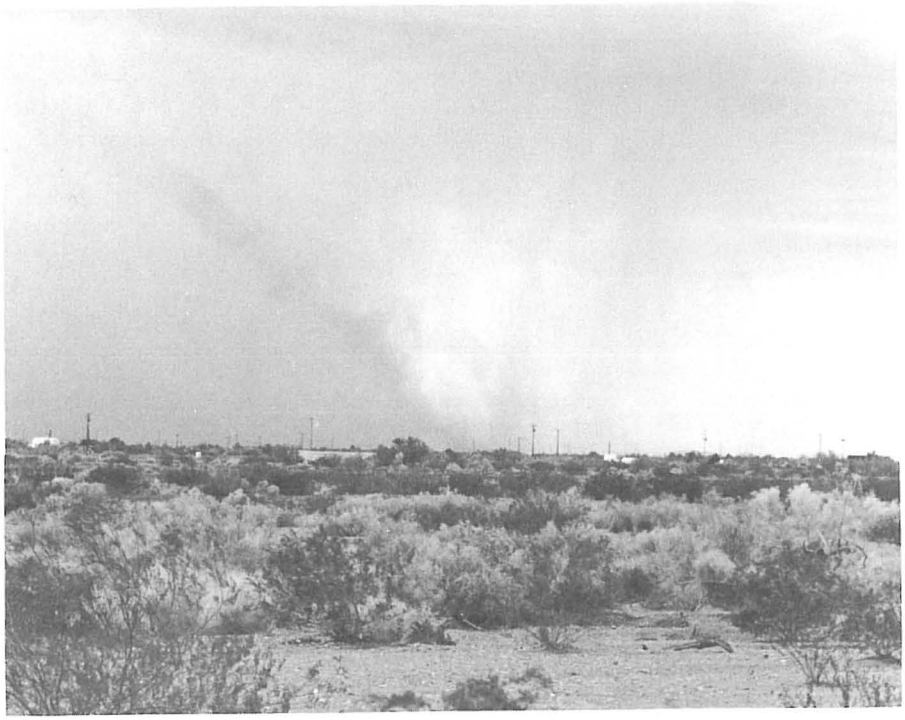

Fig. 2D. Dissipating Stage

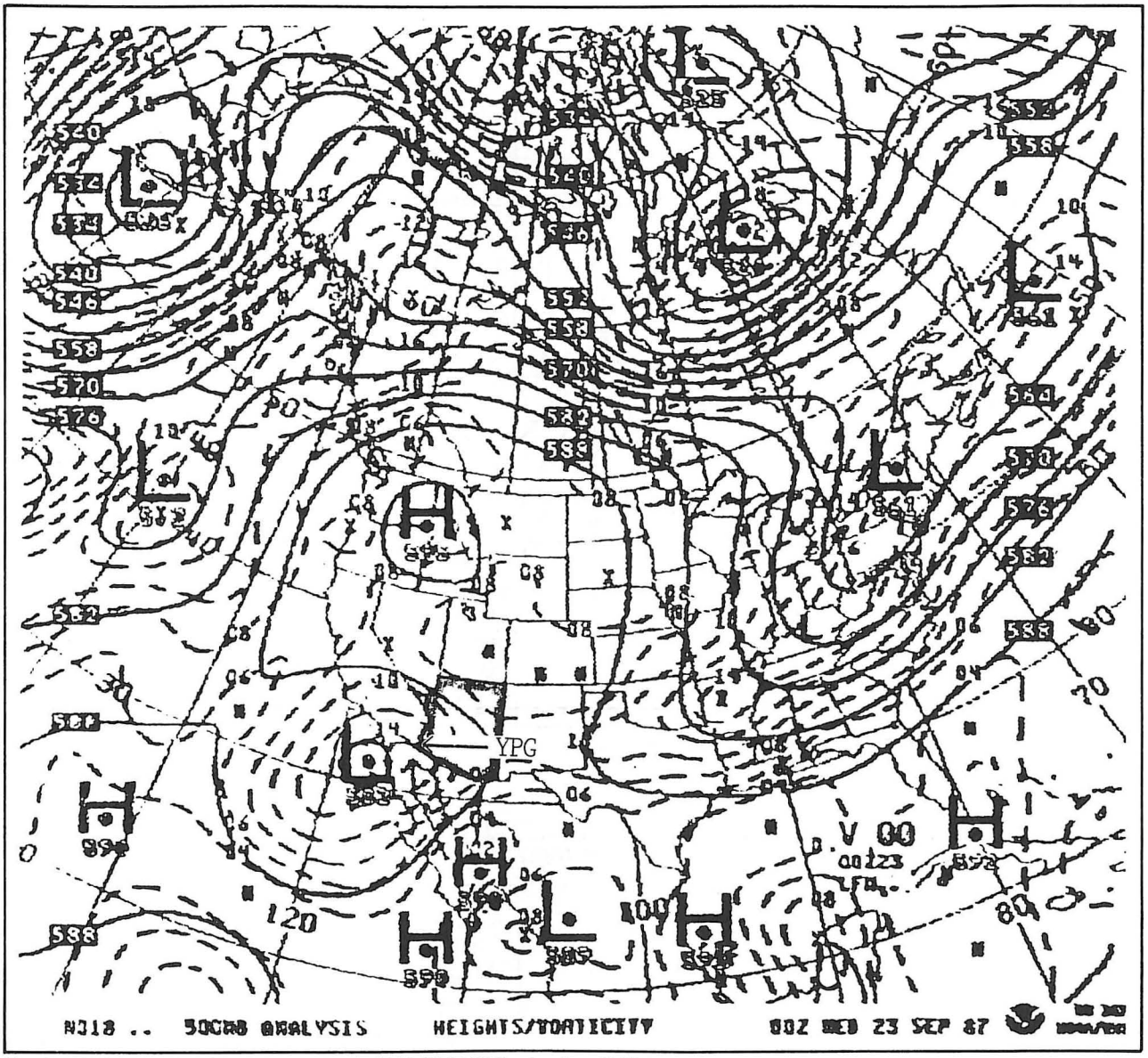

Fig. 3. 500 MB Heights/Vorticity Analysis 0000 GMT 23 September 1987.

severe thunderstorm formation, which in extremely rare cases may produce tornadic activity.

NOTE

1. Mr. Paul R. Vukits is a supervisory meteorologist with the U.S. Army Atmospheric Sciences Laboratory (ASL). He is station Chief of the ASL Meteorological Team at the Yuma Proving Ground, Arizona. He graduated with a B.S. degree in meteorology from The University of Michigan in 1980. He began work with ASL in 1985.

FOLKLORE

"ENGLAND'S FEBRUARY SPRING ISN'T WORTH A PIN"

Sue Mroz

No one in England or America should trust springlike weather conditions during the month of February. A sudden warm-up is pleasant, but it can cause premature development of crops and fruit trees that may be harmed by the return of colder weather.

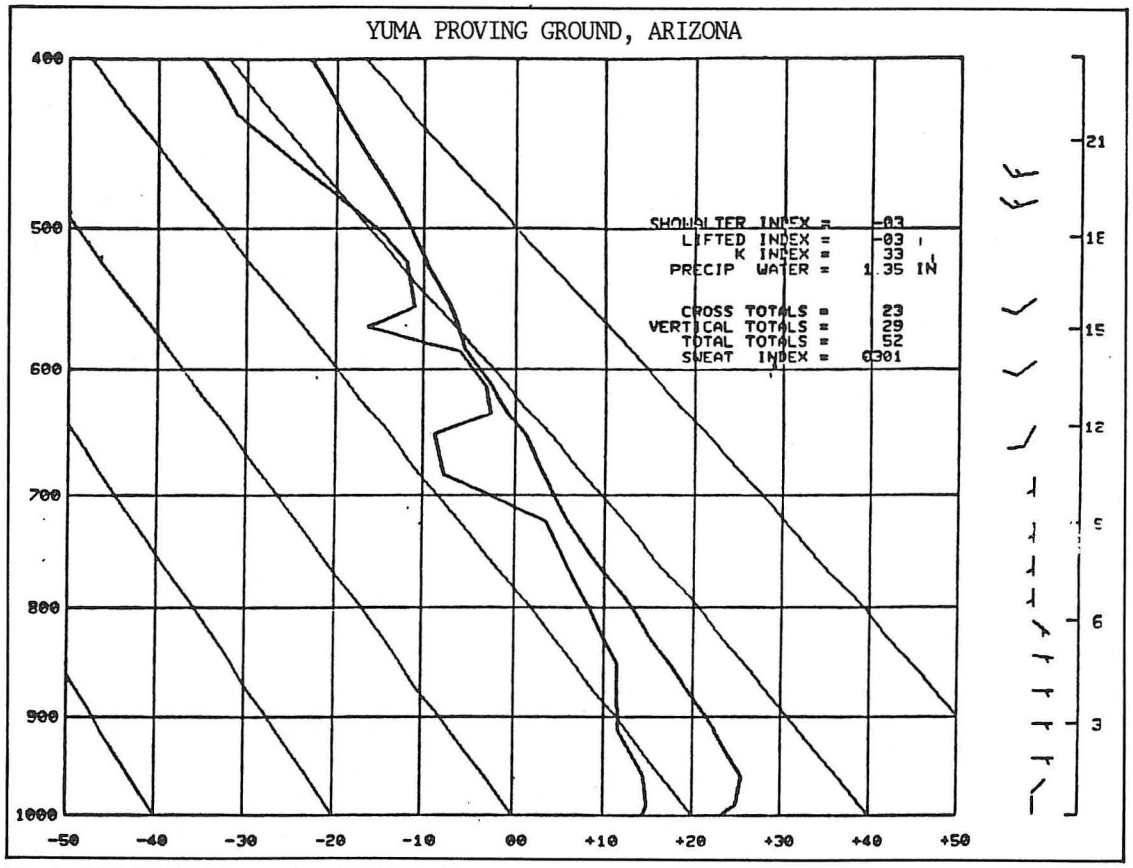

Fig. 4. 1200 GMT 24 September 1987 Sounding.

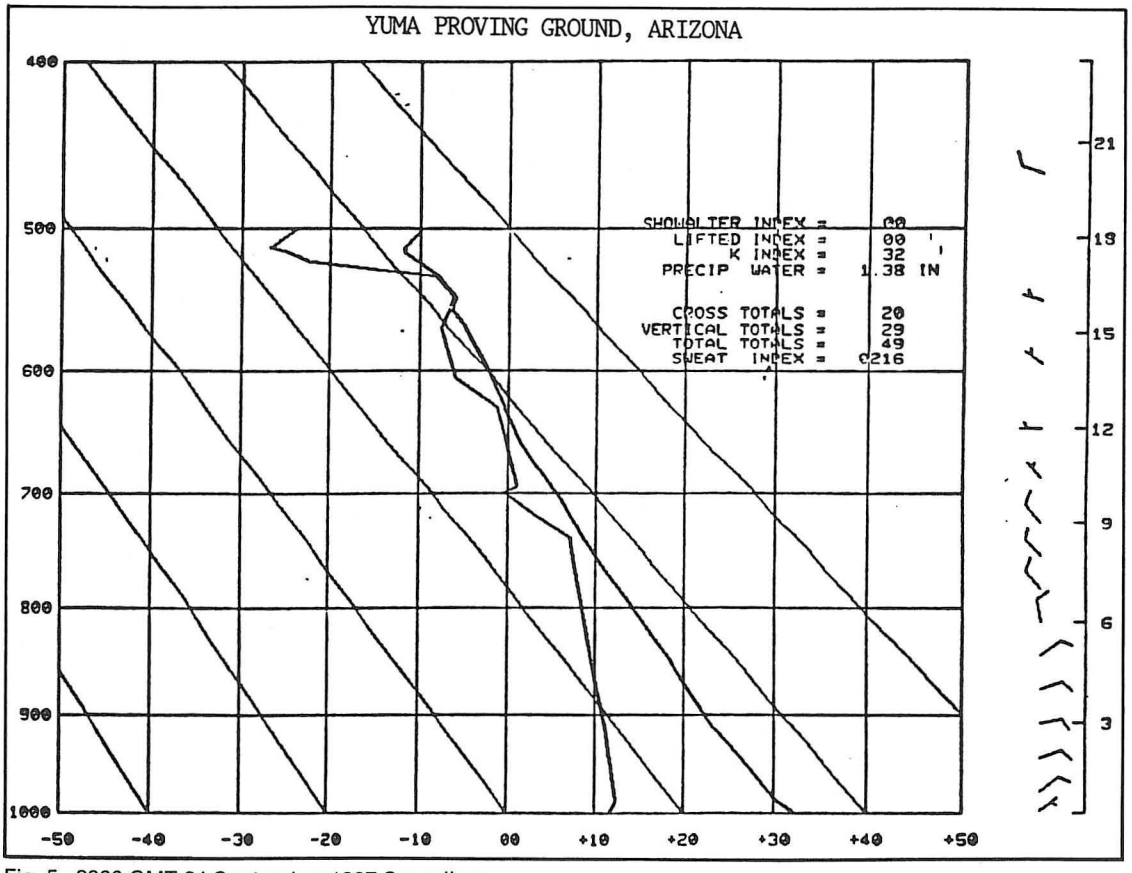

Fig. 5. 2300 GMT 24 September 1987 Sounding.

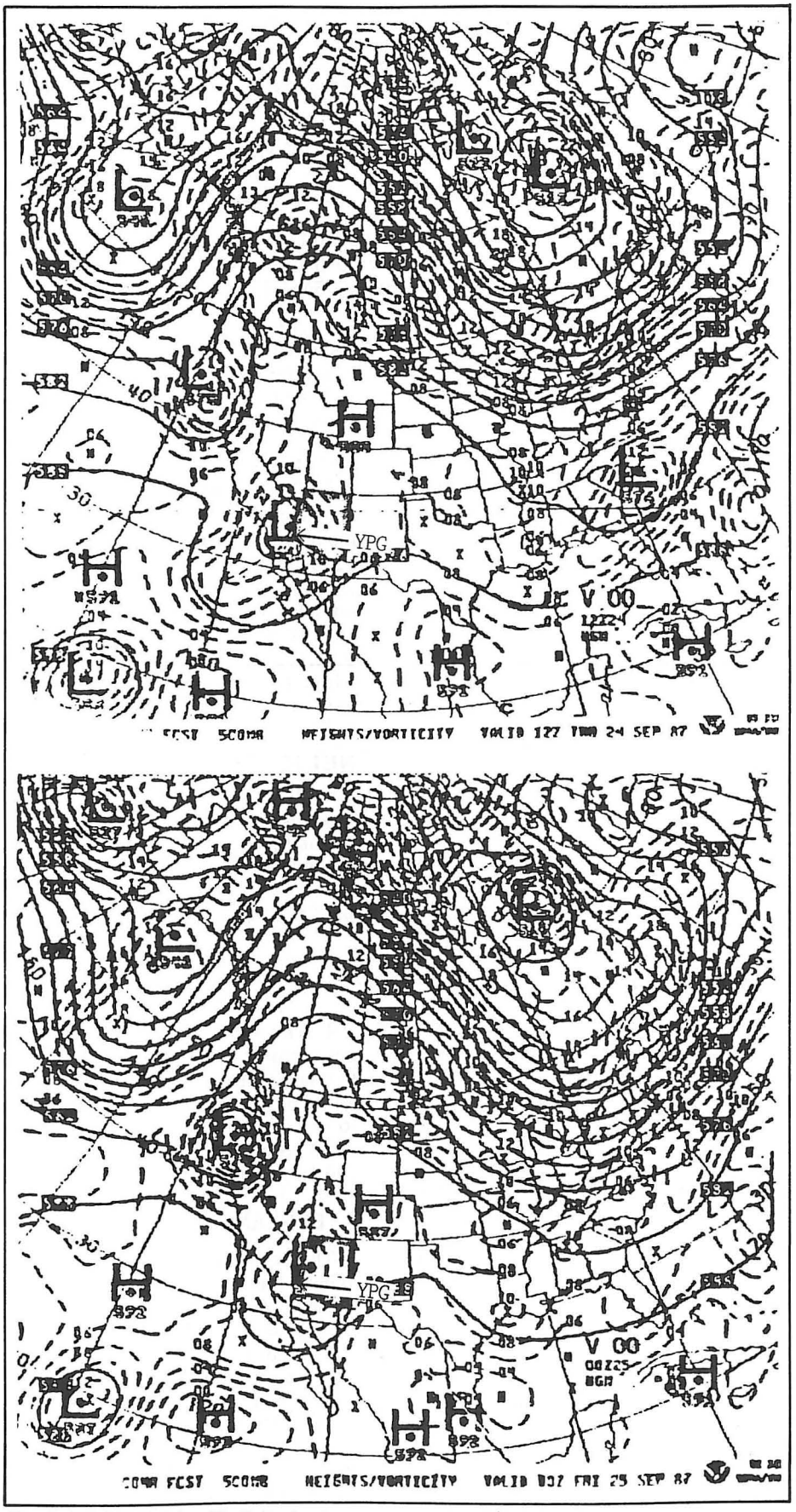

Fig. 6. 500 MB Heights/Vorticity Analyses 1200 GMT 24 September 1987 and 0000 GMT 25 September 1987.