CRH SSD
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CENTRAL REGION TECHNICAL ATTACHMENT 89-39

A CASE OF STRONG CONVECTIVE GRADIENT WINDS

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1. INTRODUCTION

At 1:00 a.m. CDT Tuesday morning (June 20, 1989), the National Weather Service at Sioux Falls received a bit of a surprise. Radio station KWYR in Winner called to report that 50 to 70 mph winds at both Winner and Colome had knocked down some trees and power lines. In fact, KWYR was without power when they called and a little nervous about what was going on. Both Alliance and Huron radars were showing scattered thunderstorms over north central and south central South Dakota. Maximum tops of 40,000 feet barely reached the tropopause, but no storm intensity greater than DVIP 2 was in this area, or had been for more than one hour prior. Several meteorological parameters suggested this was a strong convectively-enhanced gradient wind case, rather than typical severe thunderstorm gusts. Consequently, a high wind warning was issued for zones 15, 16 and 19 in south central South Dakota (see South Dakota zone map, Fig. 1).

Shortly after 2:00 a.m., a report was received of 50 mph winds south of Murdo. A telephone call to Pierre indicated that winds had suddenly picked up there as well, and had just gusted to about 40 mph. Also, since wind gusts to 45 mph had been reported at Valentine about 30 minutes before the Winner and Colome reports, it was obvious that the strong winds were translating northward. As a result, the high wind warning was extended to include zone 10.

Later reports from the Winner area indicated that strong winds gusting to around 60 mph continued until about 3:00 a.m. CDT, or for two hours. Strong winds at Pierre, frequently gusting to 40 to 60 mph, lasted for slightly more than two hours, from 2:00 a.m. until around 4:15 a.m.

2. DISCUSSION

Figures 2 and 3 show 00Z soundings for North Platte, Nebraska and Huron, South Dakota. The North Platte sounding, which was most representative of the air in the thunderstorm area, was a classic example of a sounding likely to produce dry microbursts. Table 1 is a completed copy of a checklist for forecasting dry microbursts (Caracena et al., 1989) which clearly shows all indicators necessary for dry microbursts. Although the Huron RAOB was not a typical dry microburst sounding, it did satisfy all of the criteria of the intermediate microburst sounding as has been discussed by Caracena et al.,

ZONE AND LOCAL FORECASTS (C-11) APPENDIX A

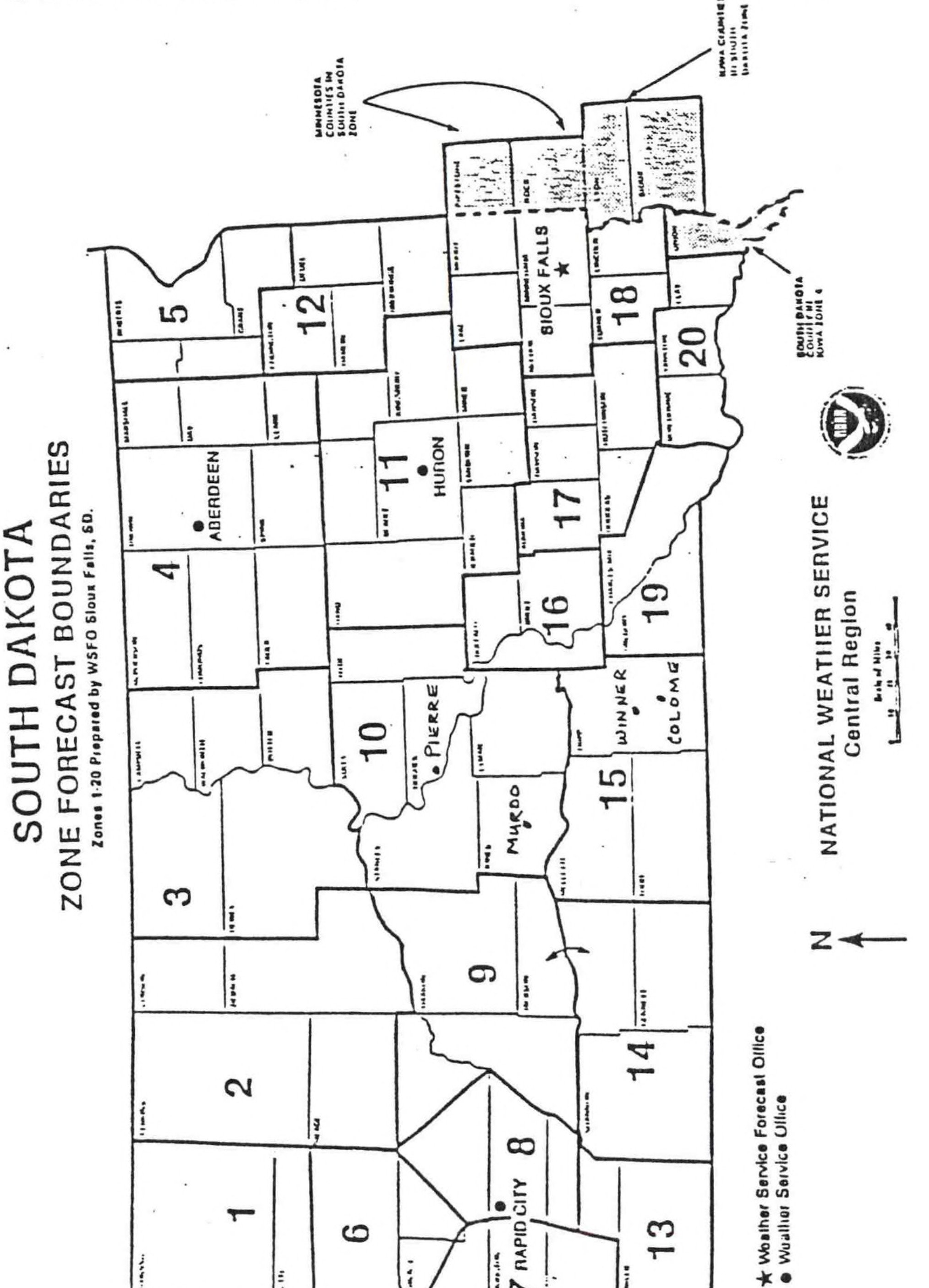

Figure 1

A-50

WSOM Issuance
87-5 8-4-87

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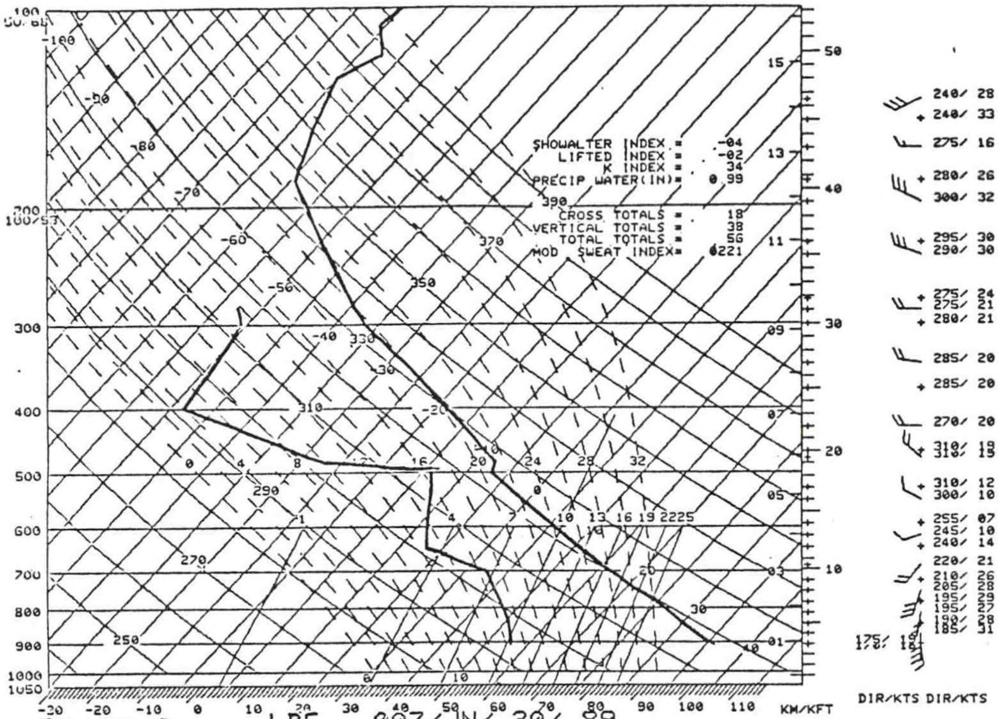

FIGURE 2 LBF 00Z/JN/20/89

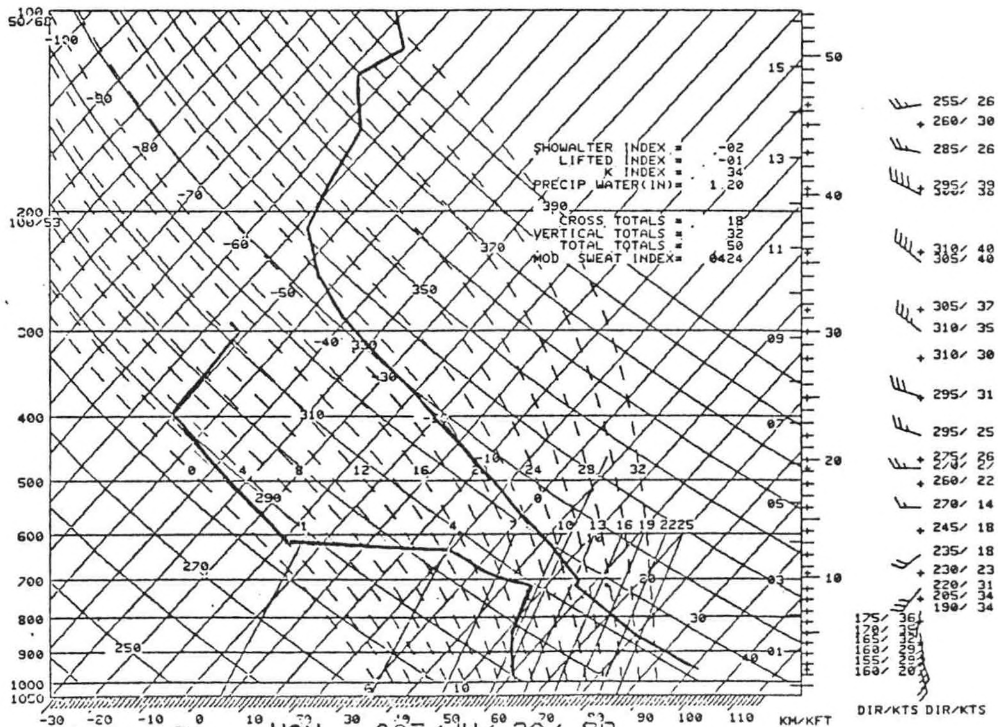

FIGURE 3 HON 00Z/JN/20/89

TABLE 1

Checklist for Forecasting Dry Microbursts

1.	Surface Dew Point Depression Approaching 30 degrees C.	≈ 25 °C => YES
2.	Dry Adiabatic Mixed Layer with top near 500 mb.	YES
3.	Above Dry Adiabatic Layer, Lapse rate is slightly less than moist adiabatic up to trop.	YES
4.	Weak or No PVA	WK PVA => YES
5.	Upper Level Wind Speed Less than 50 Kts	YES
6.	Shallow Inversion from Surface of 40 to 50 mb in depth	YES (BY 06Z VTN, PIR, SF. TMP)
7.	Mixing Ratio decreases with height but approaches saturation at the mid levels	YES
8.	500 mb Temperature between -6 and -12 degrees Celsius	-7° => YES
9.	Dew point depression at 700 mb greater than or equal to 8 degrees C.	13 °C => YES
10.	Dew point depression at 500 mb less than 8 degrees C.	7 °C => YES

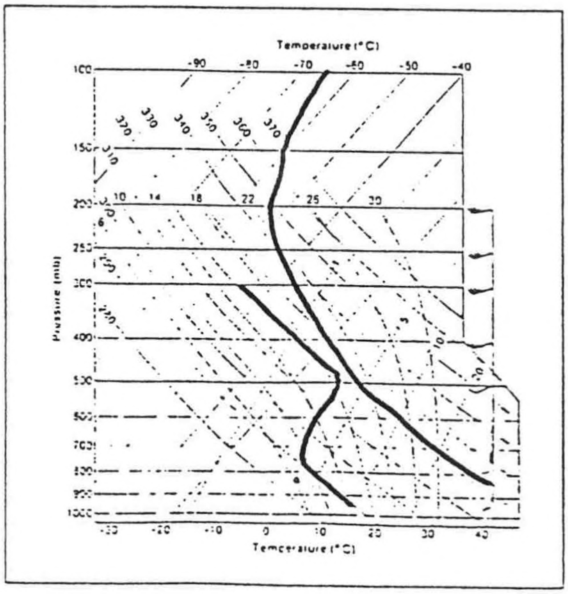

Figure 9a. A composite of five afternoon (0000 UTC) soundings by Brown et al. (1982) for convective events that produced damaging surface winds associated with high-based cumulonimbi in the Front Range area of Colorado. The temperature is represented by the curve on the right, and the dew point temperature by the curve on the left. The sounding is also typical of the type of environment found during

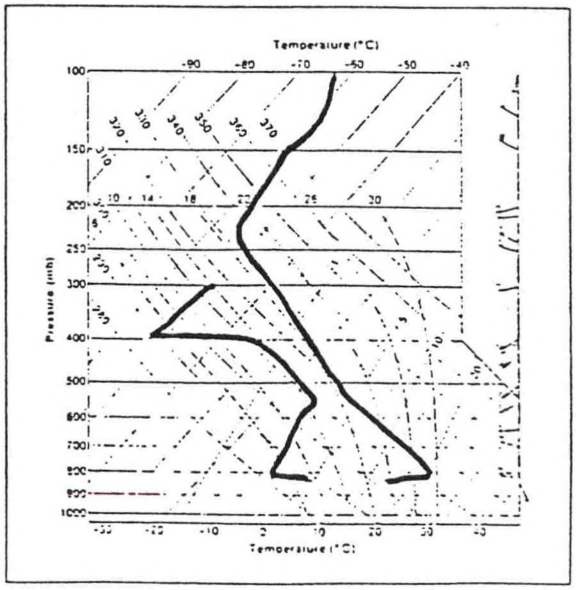

Figure 9b. A dry microburst sounding, as in Fig. 9a, but taken in the morning (1200 UTC) of 31 May 1984, showing the kind of shallow inversion near the surface that usually disappears later in the day to produce a sounding like Fig. 9a, thereby implying a high potential for dry microbursts later in the day. This sounding was taken about 7 hours before a microburst-related near-accident at Stapleton Inter-

(1989). Lifted and Showalter indices on the 00Z soundings ranged from -1 to -4 and by 1:00 a.m. AFOS generated MESOS products indicated a 500 mb lifted index of +1 with a 300 mb lifted index of -1. Other evidence that dry microbursts had occurred was an 18 degree temperature rise at Pierre over two hours, to an extreme 104°F at 4:00 a.m. This extreme temperature is an example of a "hot flash" or "heat burst," as referred to by Schaefer (1987). In these cases, dry warm mid-tropospheric air mixes with the microburst rain-cooled air and is heated adiabatically to the surface resulting in strong gusty winds.

Figure 4, 5, and 6 are surface maps centered around the time of the event. The developing pressure rises behind the cold front, largely a result of decaying thunderstorm activity, caused a rapid eastward movement of the cold front. A warm front and dry line were also noted very close to where the thunderstorms developed.

Figures 7 and 8 show a geostrophic low level jet of 60 knots just east of the area. Figure 9 shows a warm air advection maximum slightly to the southwest. Figure 10 shows fairly good low level convergence in the area. Bases of the thunderstorms were around 10,000 feet or slightly higher.

The Satellite Weather Information System (SWIS) showed thunderstorms developing over northwest Nebraska at 7:00 p.m. CDT moving eastward, with a Mesoscale Convective Complex (MCC) clearly formed by 10:00 p.m. This MCC went on to mature at midnight and from midnight until 1:30 a.m. showed characteristic signatures associated with severe weather as noted by the National Severe Storms Forecast Center (NSSFC) in their mesoscale discussion.

3. CONCLUSION

The question is, of course, how can DVIP level 2 thunderstorms cause winds to increase from around 10 mph up to 40 to 70 mph? NSSFC forecaster William Hirt probably hit the nail on the head when he stated in his mesoscale discussion that microbursts had forced the low level jet down to the surface causing the phenomena. Notably, Lead Forecaster Steve Byrd (of WSFO Omaha, Nebraska) had mentioned this theory a little earlier in a telephone conversation. Steve speculated that "dry adiabatic warming and perturbation effects from the microburst, apparently had caused an uneven downward transfer of momentum." Steve also shared his experience that very warm based thunderstorms often do produce microbursts at DVIP levels 3 or 4. In this case DVIP levels were never greater than 2, but one must keep in mind that the Valentine area is about 130 miles from the Alliance radar and around 150 miles from the Huron radar. Beyond a 125 mile range or so, radar usually underestimates storm intensity. Attenuation may also have been a factor, especially for the Alliance radar.

4. References

Caracena, F., R. L. Holle, and C. A. Doswell III, 1989: Microbursts, A Handbook for Visual Identification. NOAA/ERL/NSSL Mesoscale Research Division Publication, available from National Severe Storms Laboratory, Norman, OK, 35 pp.

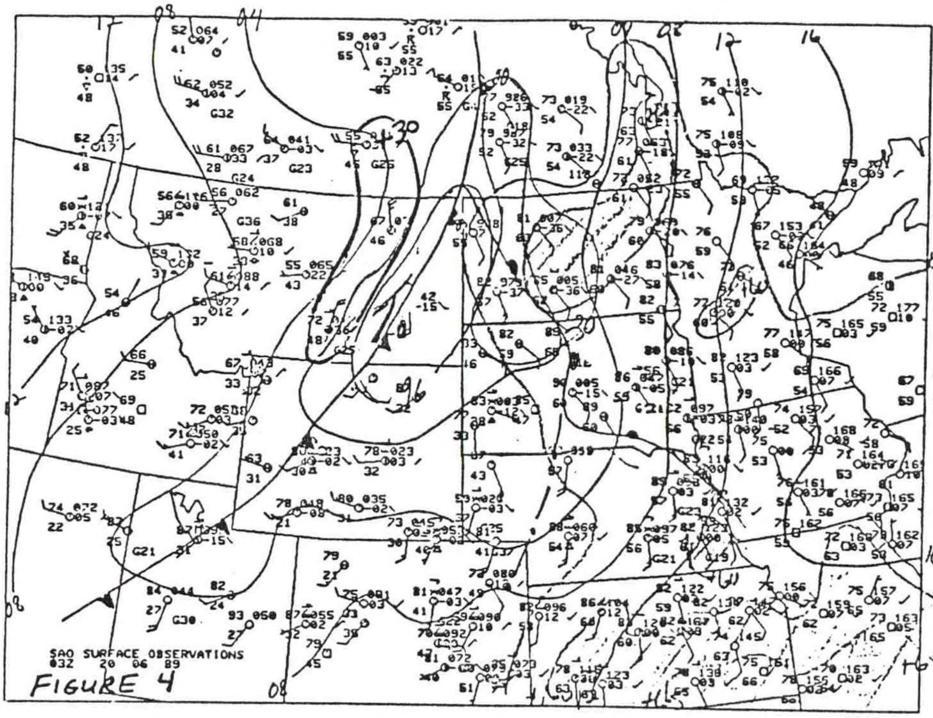

FIGURE 4

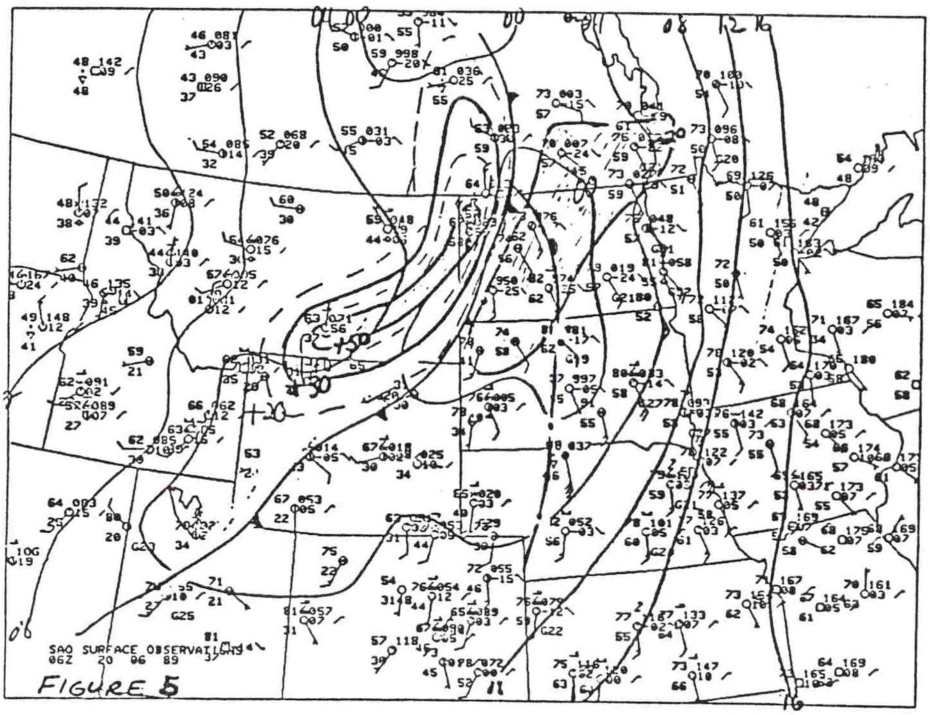

FIGURE 5

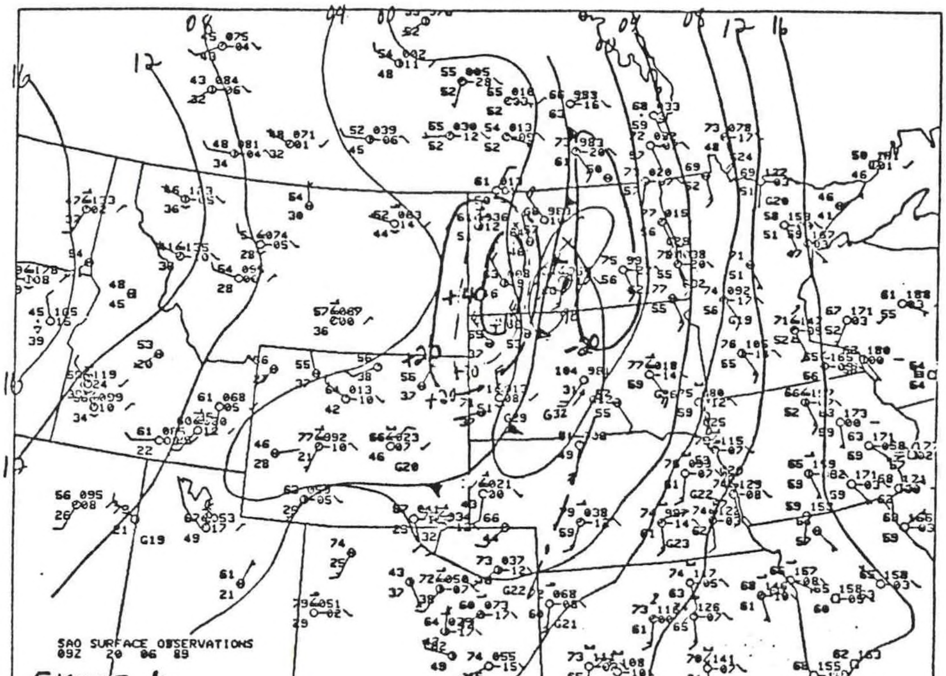

FIGURE 6

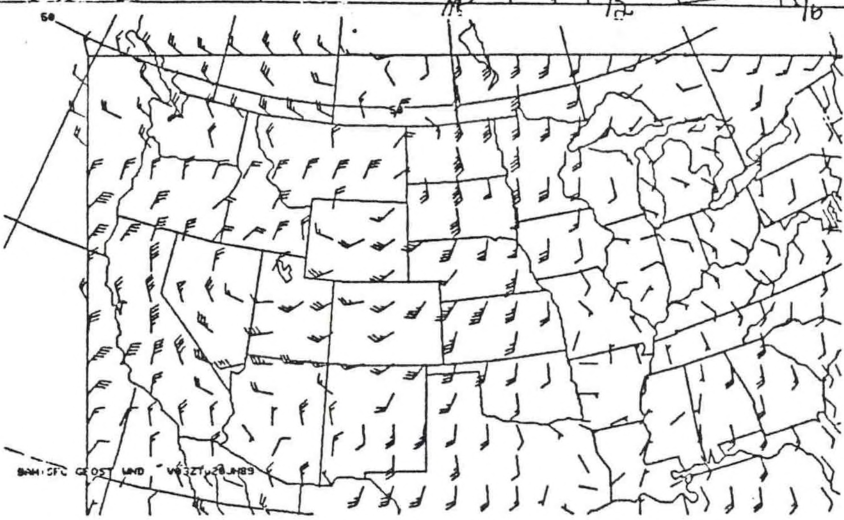

FIGURE 7

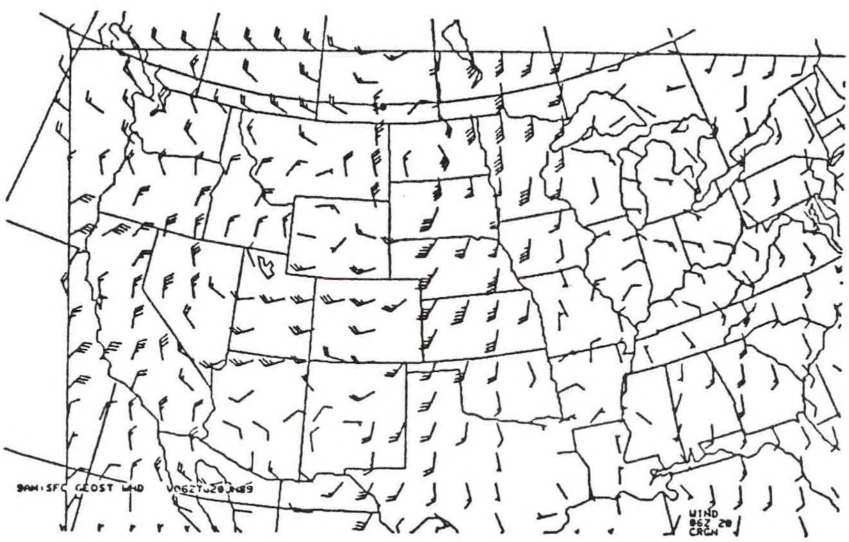

FIGURE 8

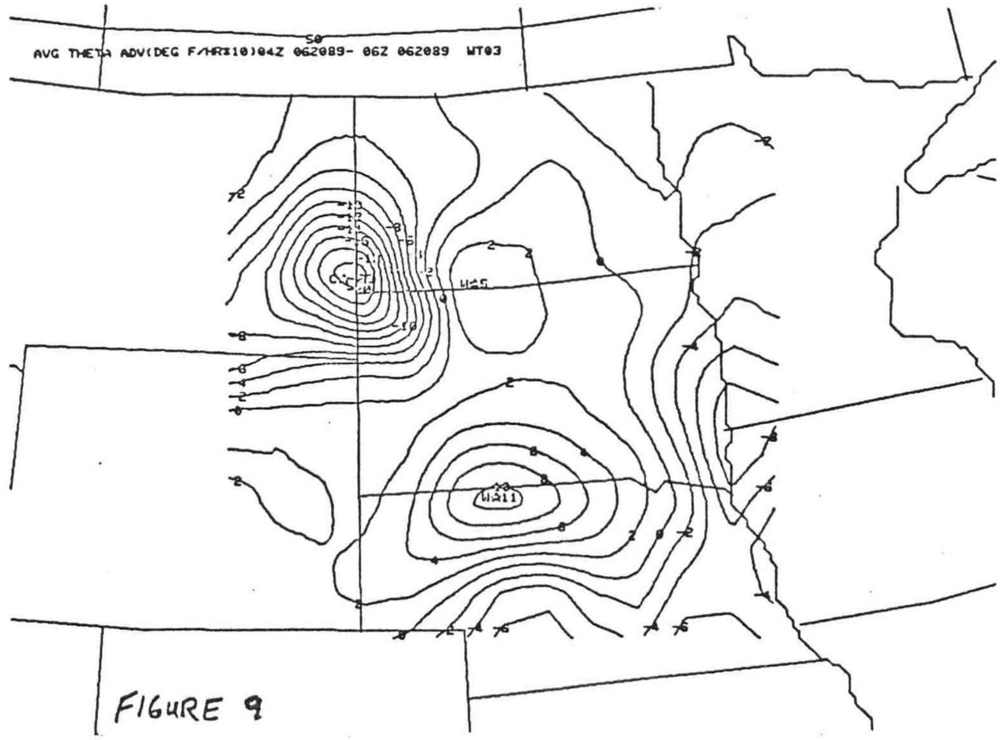

FIGURE 9

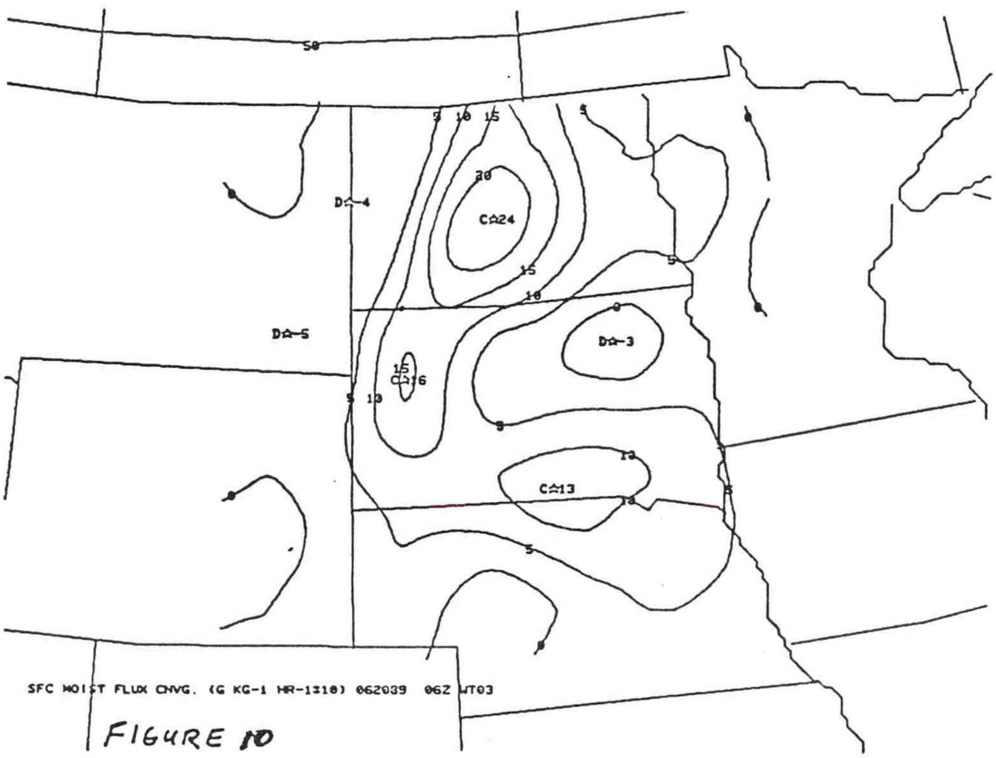

FIGURE 10

Schaefer, J. T., 1987: Thunderstorm "Hot Flashes." Central Region Technical Attachment 87-16, available from National Weather Service Central Region, Scientific Services Division, Kansas City, MO.