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A FLASH FLOOD PRODUCING MESOSCALE CONVECTIVE COMPLEX

Myron I. Berger
National Weather Service Forecast Office
Omaha, Nebraska

In the early morning on August 3, 1985, locally heavy rainfall of up to six inches fell in a six to nine hour period over parts of the Little Blue River Basin in south central Nebraska. Fig. 1 shows the surface/sea level pressure map for 03Z on August 3rd at about the time convection developed in south central Nebraska. Since sea level pressure isobars are not to be trusted over the mountains and High Plains (see accompanying TA), surface geostrophic wind [9A(M,V)] charts for 21Z of the previous afternoon and 03Z are also shown as Figs. 2 and 3. Note the strong (40 knots and up) geostrophic winds in western Kansas and southwest Nebraska at 21Z. By 03Z these had subsided to 25 to 30 knots. The strong south geostrophic winds at 21Z represent a horizontal pressure force directed from the east. The resulting imbalance would accelerate the low level air parcels upslope, aiding in cloud and thunderstorm formation. A weak stationary front extended across the Kansas-Nebraska line. First period (Tonight) MOS PoP's were around 30 percent in the rain area.

Fig. 4 shows the precipitation amounts for 24 hours ending at 12Z. The rain occurred mainly between 06Z and 12Z. Also shown in Fig. 4 are the antecedent precipitable water values and stability indices (Lifted Indices and Total Totals) for 00Z. Warm, moist, unstable air to the south was being advected northwest to the frontal area. This pattern resembles the "frontal" flash flood type event as described by Maddox (1978a and b), which is usually nocturnal.

Figs. 5 through 7 show the 00Z August 3 upper air analyses for the 850 mb, 700 mb, and 500 mb levels, respectively. The 850 mb chart showed strong warm advection over the frontal area with high dew points. Thunderstorms began developing just north of the surface front and near the axis of strongest 850 mb winds. At 700 mb there was lesser warm advection over the frontal area. The moisture depths and the precipitable water values were not exceptionally great. The latter were near the climatological normals for mid-summer on the Plains. The low level advection of warm, moist, unstable air over the front was a very respectable trigger of thunderstorm development, despite the warm 700 mb temperatures above 10°C in southern Nebraska, which could act as a "capping" mechanism. Computations made by Sangster (personal communication) show warm air advection values of 8.3°C/12 hours in the lowest

90 mb between Salina and Goodland, KS at 00Z, and lesser values at lower pressures.

In addition, the 500 mb chart showed a weak mesoscale trough moving through the long wave ridge. Such short waves are usually associated with frontal flash flood events (around 85 percent of the time are according to Maddox, 1979a and b). Wind speeds over the area increased little with height, although significant veering occurred. This veering favored movement of the storms parallel to the front (see Fig. 4), and as described by Maddox, inflow of moist, unstable air continued unimpeded on their right flank.

Fig. 8 shows that heavy rainfall paralleled the Little Blue River Basin as the thunderstorms moved in the downstream direction of river flow. Flash flooding occurred on the upper reaches on the mainstem Little Blue and some tributaries. General flooding continued downstream of Deweese for two to three days because the rainfall occurred all along this lengthy basin.

The mainstem Little Blue came 4 to 6 feet out of banks in the upper parts and 3 to 5 feet over flood stage in the lower reaches. Thousands of acres of agricultural lowland were flooded. Several bridges and approaches suffered damage and many miles of roads were inundated. Urban flooding hit several small towns along the mainstem including Deweese, Hebron, and Fairbury (see Fig. 8). This was the worst flooding in this area since the late 1960's. A contributing factor to this extensive flooding was one to two inch rains a few days earlier in the same area, which made the soils very moist. Fortunately no lives were lost.

Figs. 9a-f are satellite pictures (IR, MB curve) showing the development of the mesoscale convective complex on the cool side of the surface position of the front.

In summary, this was a nocturnal frontal flash flood event with low level advection of warm and moist unstable air over a weak stationary front and a 500 mb short wave trough moving through. The diurnally varying surface geostrophic wind probably also was a factor, but it is difficult to get a handle on exactly how this effect works. These factors triggered the mesoscale convective complex just north of the front even though warm 700 mb temperatures tended to cap convection and the moist layer was not that deep. The storms moved parallel to the front.

Acknowledgements:

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References:

Maddox, R.A., 1979a: A methodology for forecasting heavy convective precipitation and flash flooding. Nat. Wea. Dig., 4, 30-42.

___________, 1979b: Synoptic and meso- scale aspects of flash flood events. Bull. Amer. Meteor. Soc., 60, 115-123.

National Weather Service, 1985: Monthly report of river and flooding conditions for Nebraska, August 1985. Forms E-3 and E-5, National Service Forecast Office, Omaha, Nebraska.

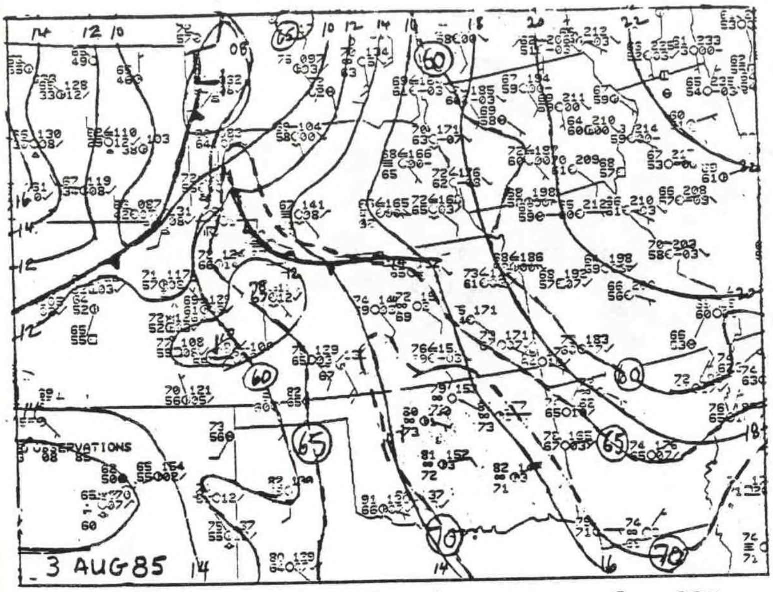

Fig. 1. Surface/sea level pressure for 03Z, August 3, 1985. Included are isodrosotherms for 60°F, 65°F and 70°F in dashed lines.

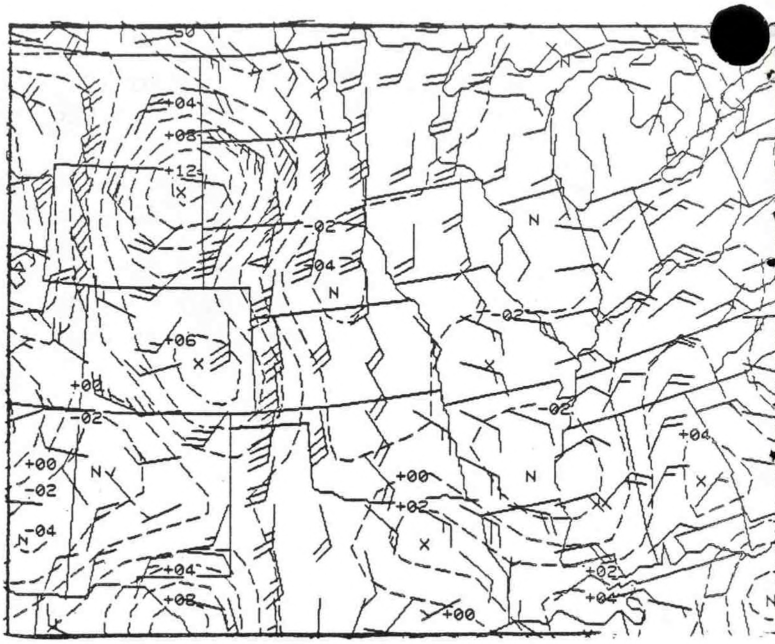

Fig. 2. Surface geostrophic wind and vorticity chart for 21Z August 2, 1985.

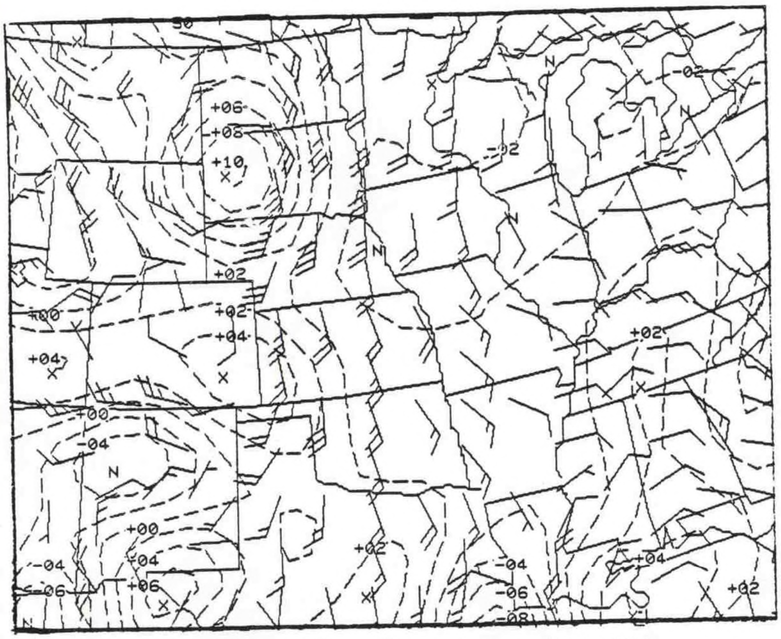

Fig. 3. Same as Fig. 2, except for 03Z August 3, 1985.

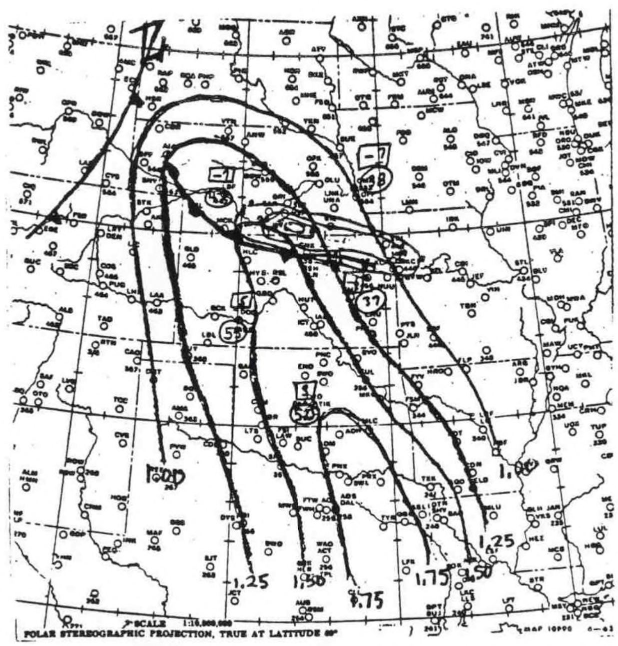

Fig. 4. Precipitation amounts are for the 24 hours ending at 12Z, August 3, 1985. Also shown are the frontal positions for 03Z, August 3, 1985. The precipitable water field, total totals (circled), and Lifted Index (boxed) values are for 00Z.

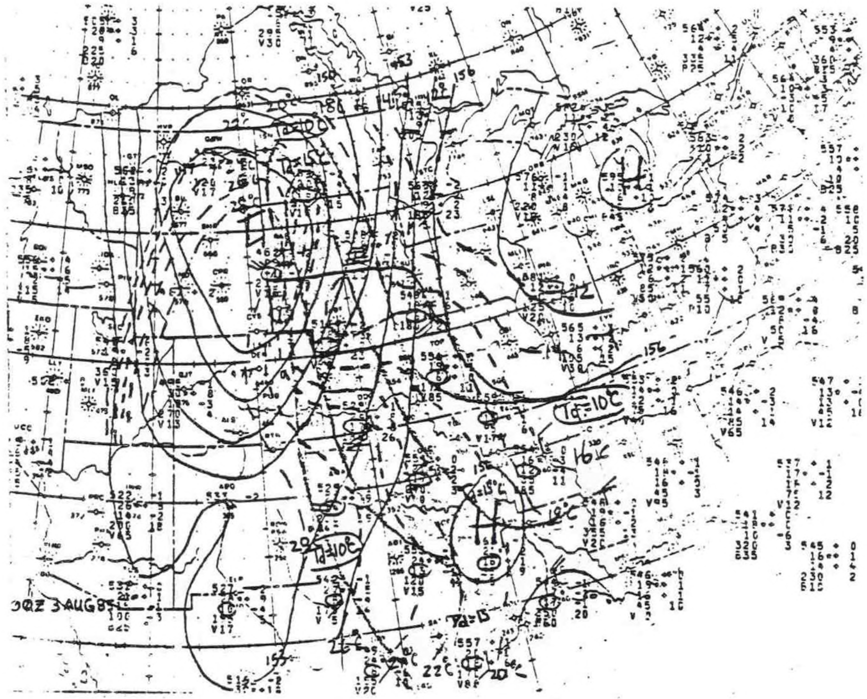

Fig. 5. 850 MB analysis for 00Z, August 3, 1985. Height contours are at 15 meter intervals and isotherms are at 2°C intervals. Included are isodrosotherms for 10°C and 15°C. Dew point values for the stations are circled.

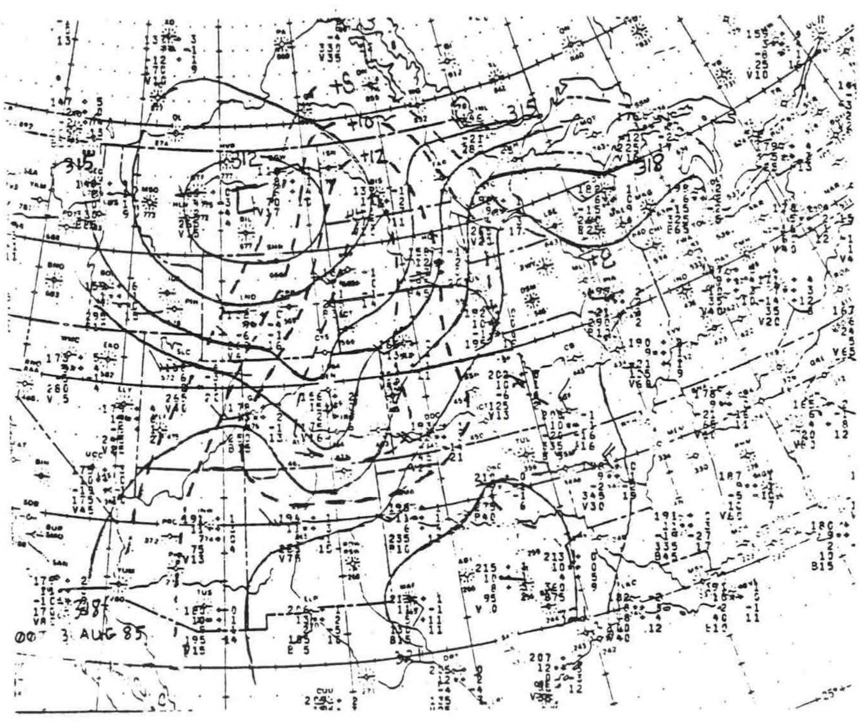

Fig. 6. 700 MB analysis for 00Z, August 3, 1985. Height contours are at 15 meter intervals and isotherms are at 2°C intervals.

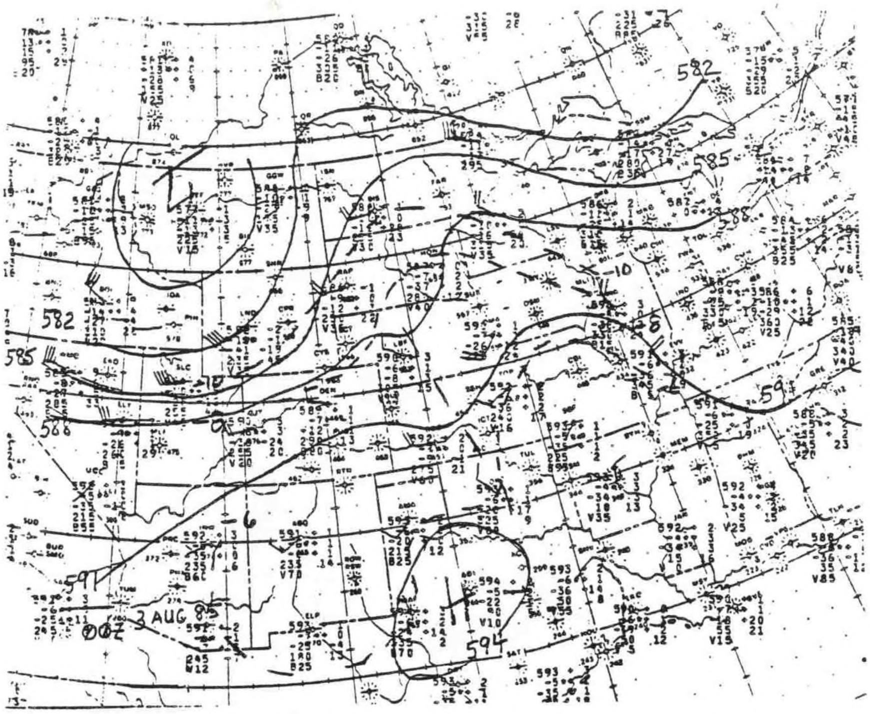

Fig. 7. 500 MB analysis for 00Z, August 3, 1985. Height contours are at 30 meter intervals and isotherms are at 2°C intervals.

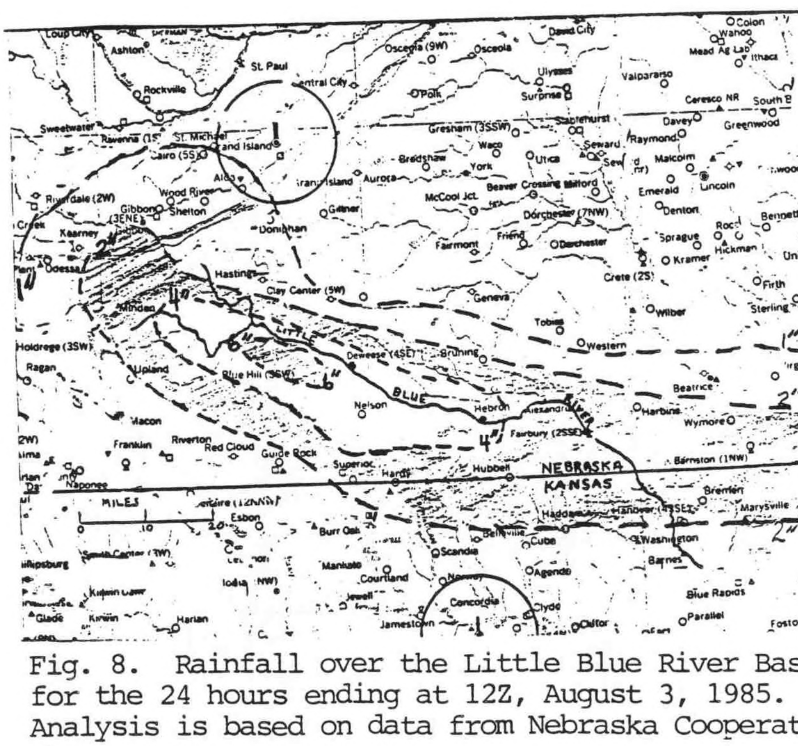

Fig. 8. Rainfall over the Little Blue River Basin for the 24 hours ending at 12Z, August 3, 1985. Analysis is based on data from Nebraska Cooperative Observers.

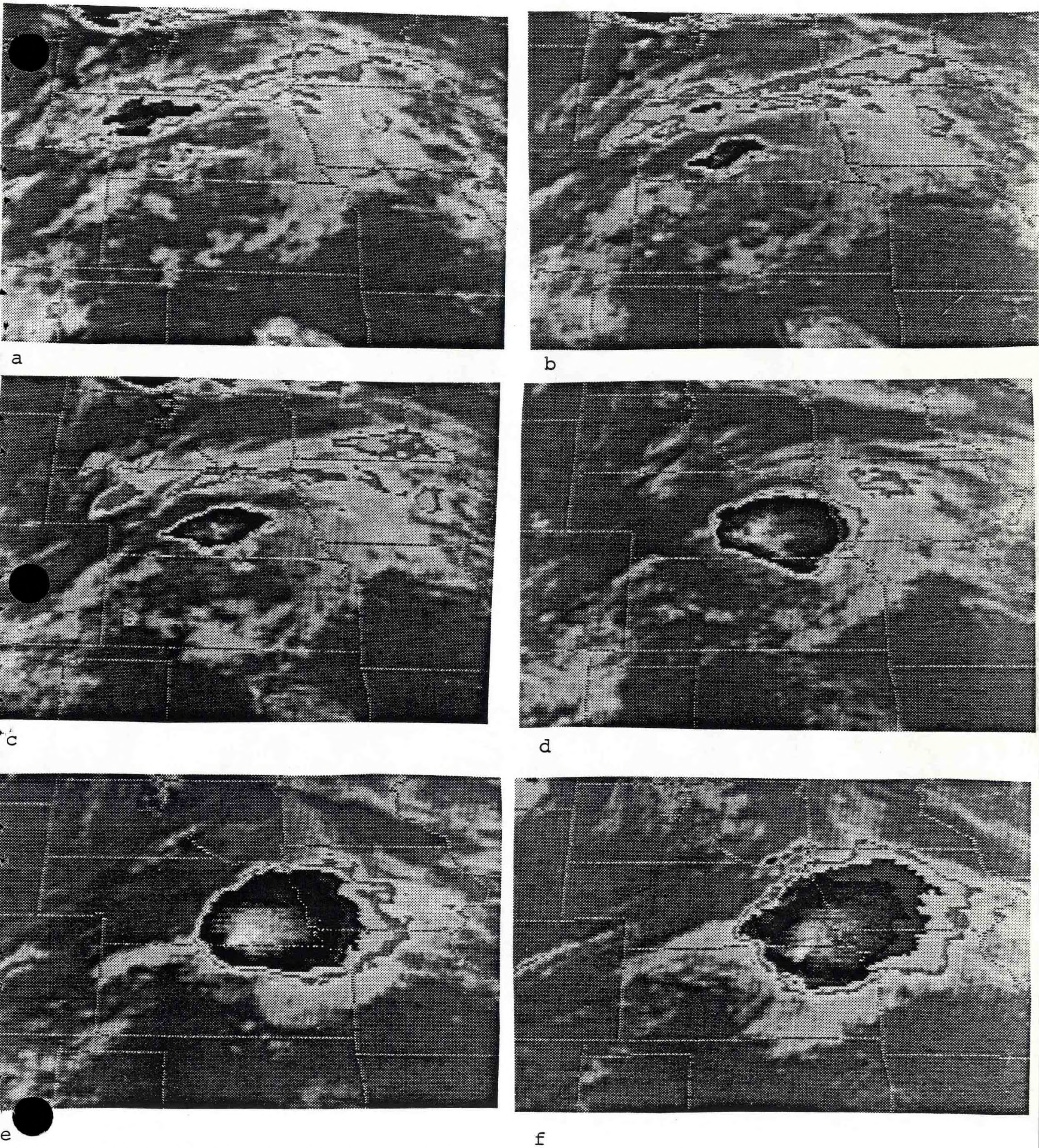

Fig. 9. Enhanced infrared satellite images (MB curve) on August 3, 1985 for (a) 03Z, (b) 04Z, (c) 05Z, (d) 07Z, (e) 09Z, and (f) 11Z.