PICTURE OF THE MONTH

Satellite Depiction of the Life Cycle of a Mesoscale Convective Complex

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1. Introduction

During the evening and early nighttime hours of 3 and 4 June 1980 severe thunderstorms struck eastern Nebraska producing hail, high winds, heavy rains, flash flooding and seven tornadoes. Intense tornadoes[1] killed five and injured 200 persons while inflicting substantial property damage.[2] The initial severe thunderstorms grew into a large Mesoscale Convective Complex (MCC) that moved slowly eastward through the night, eventually dissipating over Illinois and Indiana by midmorning on 4 June. The meteorological situation, however, was most interesting because of the seemingly benign large-scale setting within which the severe storms developed. Maddox (1980) has documented the frequent occurrences of similar MCC weather systems over the central United States and shown that they constitute an important operational forecast problem because of their nocturnal nature and the widespread significant weather they often produce.

2. The Grand Island MCC

The life cycle of the Grand Island MCC is illustrated both in the enhanced infrared (IR) satellite imagery shown in Fig. 1 and by the radar summary charts shown in Fig. 2. The image for 2345 GMT 3 June (Fig. 1a, note that 2345 GMT is 0545 PM CST) shows an isolated thunderstorm development in south-central Nebraska. By 0145 GMT on the 4th (Fig. 1b) the storm had grown rapidly with high, cold cirrus indicated over much of eastern Nebraska [note the distinct V-notch formed by the colder cloud tops at the west end of the system—this characteristic is often associated with severe thunderstorms (e.g., Fujita, 1978; Reynolds, 1980)]. The 0135 GMT radar summary (Fig. 2a) shows intense echoes over south-central Nebraska. The first of the seven tornadoes formed at about 0145 GMT.

Approximately 6 h later (0730 GMT, Fig. 1c) the satellite imagery indicates that the storm complex had grown to cover much of Iowa and eastern Nebraska but that the southern and western edges of the system had moved little (see also the radar depictions in Figs. 2a and 2b). Very heavy rains were now being reported over eastern Nebraska, southwestern Iowa and extreme northwestern Missouri. Rainfall amounts eventually reached 5–7 inches (12.7–17.8 cm) with flash flooding occurring in portions of eastern Nebraska and northwest Missouri. By 1130 GMT the cold cloud shield had grown considerably larger than the state of Iowa (see Figs. 1d and 2c) and the entire system was moving southeastward into Illinois. By 1500 GMT (Fig. 1e) cloud top temperatures were warmer and during the next two hours the storm complex rapidly dissipated. Note that a completely separate area of intense thunderstorms persisted through the night over the Dakotas and Minnesota (see again Figs. 1 and 2).

3. Meterological setting

A surface analysis for 0000 GMT 4 June is illustrated in Fig. 3. The severe thunderstorms and the Grand Island MCC developed just to the north of an east–west frontal boundary that stretched from Nebraska to the Ohio Valley. Surface dew points were very high (≥70°F) both north and south of the frontal zone over Kansas and south-central Nebraska. A low-pressure center was located to the northwest of Nebraska over the western Dakotas while a second low and a quasi-stationary dryline were positioned over Colorado, western Nebraska and western Kansas. The surface pattern was quite similar to that shown by Maddox *et al.* (1980) to be often associated with "mini-outbreaks" of tornadic storms.

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[1] T. T. Fujita, R. M. Wakimoto, R. F. Abbey, Jr. and J. R. McDonald: SMRP Color Map 801, September 23, 1980, "Grand Island, Nebraska Tornadoes."

[2] Statistics on these storms were taken from the NOAA, EDIS publication *Storm Data* for June 1980 (Vol. 22, No. 6).

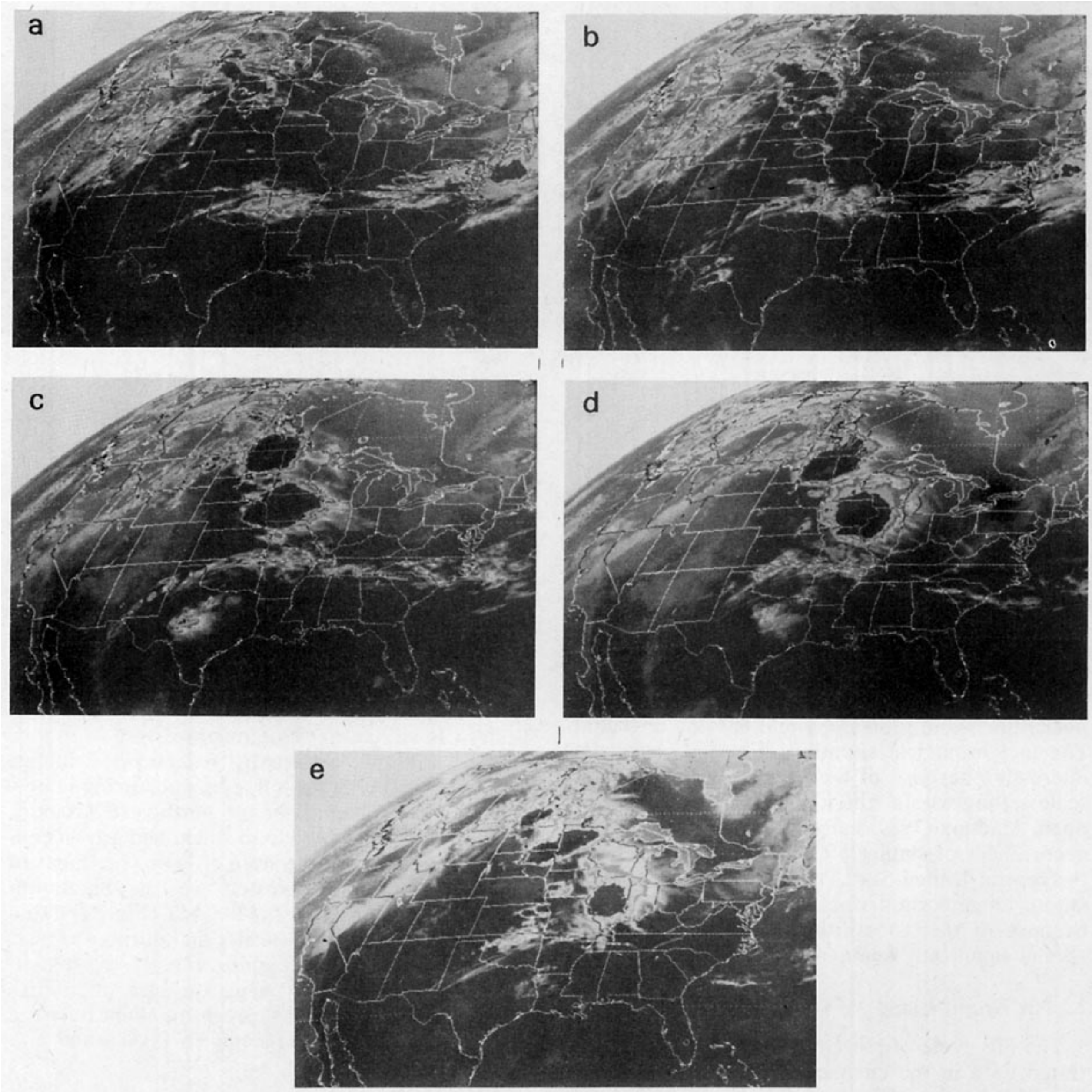

FIG. 1. Enhanced IR satellite images showing the development and evolution of the Grand Island MCC. Image times are (a) 2345, (b) 0145, (c) 0730, (d) 1130, (e) 1500 GMT on the 3rd and 4th of June 1980. All images are from GOES-East and the MB enhancement curve (medium gray −32 to −41°C, light gray −41 to −52°C, dark gray −52 to −58°C, black −58 to −62°C and repeat gray to white shades < −62°C) is used throughout.

The Limited Fine Mesh (LFM) 500 mb height and vorticity analysis for 0000 GMT 4 June is presented in Fig. 4a and the 12 h 500 mb forecast (valid at 1200 GMT on the 4th) is shown in Fig. 4b. The severe storms and intense MCC developed just ahead of a weak, slow moving short-wave trough (note in Fig. 4a the vorticity maximum analyzed just southwest of Nebraska). During the night the storm system moved eastward *through the ridge position* of the nearly stationary (contrast Figs. 4a and 4b) large-scale pattern. Thus the setting was quite unlike that typically associated with tornadic storms [e.g., fast moving, strong mid-level short-wave trough with significant positive vorticity advection (see Miller, 1967)]; however, it was quite similar to patterns that are often associated with heavy rains and flash flooding (see Maddox *et al.*, 1979).

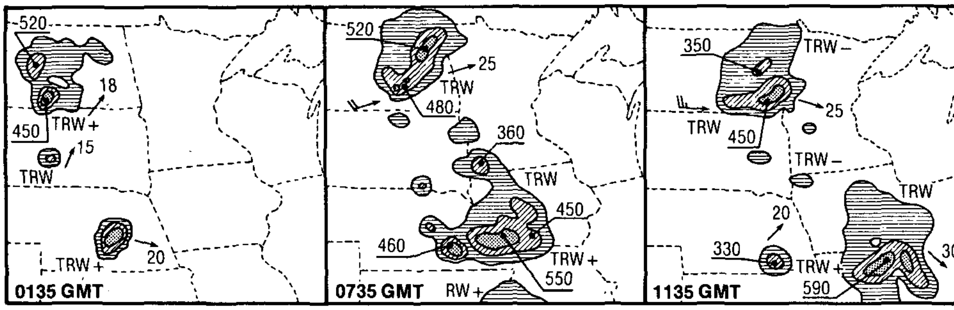

Fig. 2. Radar summary charts for (a) 0135, (b) 0735 and (c) 1135 GMT 4 June 1980.

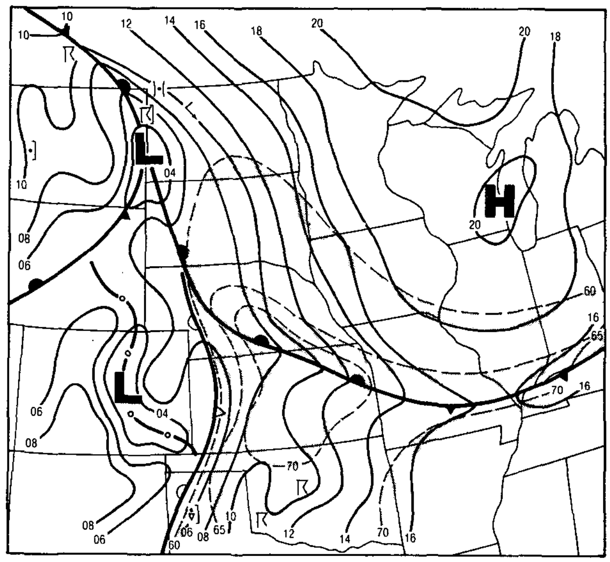

Fig. 3. Surface analysis for 0000 GMT 4 June 1980. Frontal positions, 2 mb isobars (solid) and selected dewpoint isolines (dashed in °F) are shown. Open frontal barbs indicate a dryline.

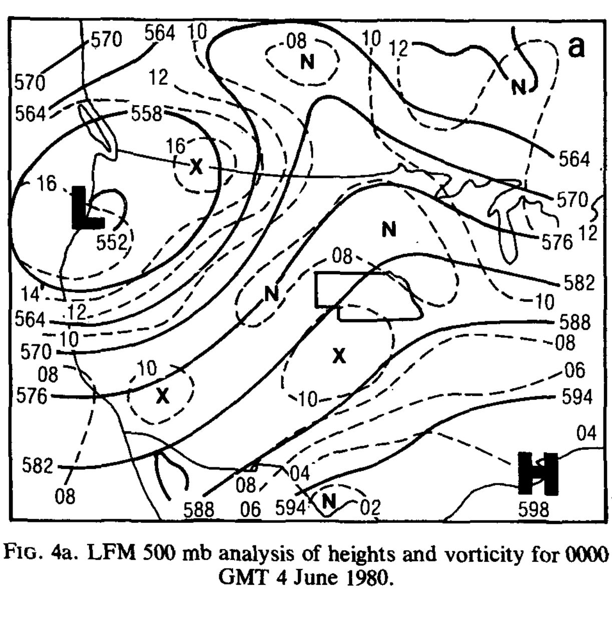

Fig. 4a. LFM 500 mb analysis of heights and vorticity for 0000 GMT 4 June 1980.

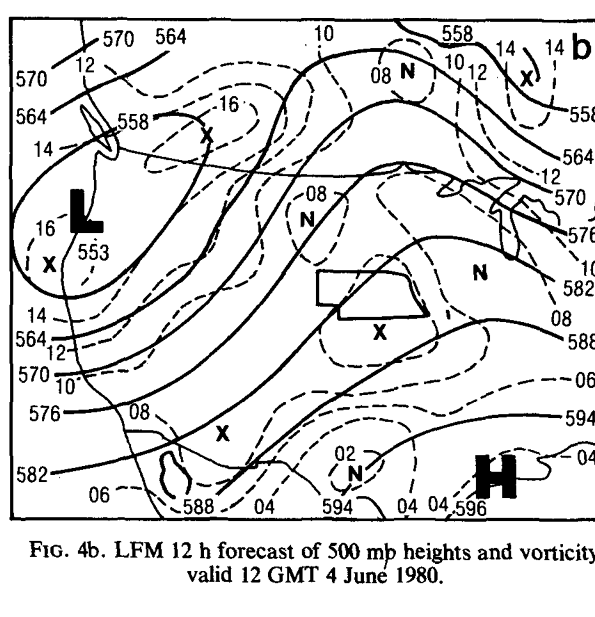

Fig. 4b. LFM 12 h forecast of 500 mb heights and vorticity valid 12 GMT 4 June 1980.

4. Summary

The satellite imagery and radar depiction charts graphically depict the life cycle of the Grand Island mesoscale convective complex during a time period encompassing more than 15 h. The development and evolution of this system was quite typical of the convective complexes that frequently affect the central and northern Plains during the summer. However, this system's slow movement and the apparently benign large-scale setting in which it formed, coupled with the extreme severity of the thunderstorms during its early phases, distinguish it as a particularly noteworthy weather system.

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