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WARM SPOT IR SIGNATURES OF SEVERE WEATHER IN EARLY SPRING THUNDERSTORMS

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The enhanced-V severe weather satellite picture signature using the MB curve was described by McCann (1980). The enhanced-V storm by definition has a warm spot or a warm area downstream from the cold top. Much of the kinematics is given by Adler and Mack (1984) and Adler and Mack (1985). Fujita (1978) noted that warming of thunderstorm tops observed in satellite imagery was related to downbursts and occasionally tornadoes, but these warm tops are different from the enhanced-V.

In the early spring, when the tropopause is usually low, the overshooting tops are not as evident or seen very clearly, nor is the cold part of the enhanced-V often seen clearly. Thus, in these early spring situations in which the maximum tops are in the dark gray or black part of the MB curve, the severe weather signature may be a light gray warm spot in the temperature range of -43.2 to -53.2°C. Four cases of light gray warm spots in which severe weather occurred will be presented here.

We believe the same mechanism is occurring in these cases as the one that produced the more familiar enhanced-V as shown in Fig. 1. This storm produced damaging winds and flash flooding in Cherry and Keya Paha counties in north central Nebraska.

Case 1 - April 15, 1982

This afternoon and evening severe weather episode was unique in that the IR satellite images had a persistent small warm top in southeast Nebraska. Severe weather events were often just upstream of this top. Also unique was that this storm produced flash flooding in Cass County, Nebraska in the area of the warm spot. Fig. 2a shows the outflow boundary laid out by nocturnal convection. Fig. 2b shows intense convection beginning to develop in the late afternoon. Other settings for this severe/flash flood event were a moist axis at the surface and 850 mb into southeast Nebraska, and a warm front moving northward with a low level jet into a region of a -8 Showalter Index at OMA by evening. The 500 mb temperature was -17°C.

Fig. 3 shows pictures close to times when severe weather occurred. It is interesting to note that the tornado occurred at Cook, Nebraska, just upstream

of the small warm spot shown on the 01Z satellite picture. This suggests that the appearance of the warm spot, which showed up as early as 0030Z, could be a useful severe weather predictor when used in conjunction with radar. The use of radar is helpful to enable the forecaster to distinguish a warm spot severe weather signature from simply a weakening thunderstorm.

Case 2 - March 30, 1983

In the evening of this day strong thunderstorms developed in north central Texas and moved northeast into Oklahoma. A strong thunderstorm with hail and gust winds was reported at Archer City, Texas. Waurika, Oklahoma received large hail and damaging winds. Note that the warm spot which developed at 0230Z moved northeast to the Red River by 0300Z and appears embedded in a dark gray enhanced-V (see Fig. 4).

Case 3 - April 25, 1984

Considerable severe weather occurred in northeast and part of central Nebraska the evening of April 25, 1984. The first occurrence of severe weather possibly occurred with the collapse of overshooting tops (see Fig. 5) between 0200 and 0230Z. At 0219Z an F3 tornado touched down at St. Paul, Nebraska. If a forecaster were looking at satellite pictures only there would be a tendency to discount any severe weather threat from the imagery. The warm, tame-looking tops occur often in the early spring. We have also observed by radar microbursts and even tornadoes with thunderstorm tops around 20,000 ft in the early spring. The warm top "signature" did not appear until later in the life of the thunderstorm complex. But as in Case 1, the warm tops were persistent as was the occurrence of severe weather (see Fig. 6).

This severe weather outbreak was associated with a strong surface low that moved into the northeast part of Nebraska by 12Z the next morning. The 500 mb temperature at 12Z April 26 at OMA was -19°C. If the pictures in Figs. 5 and 6 were of July convection one would guess that a few light showers might be occurring, but note the difference that the time of the year and the low tropopause make.

Case 4 - May 12, 1986

A cold front moved into eastern Nebraska/western Iowa this evening producing several reports of large hail, some wind damage and some reports of funnel clouds. The lifted index at OMA that evening was -6. The 500 mb temperature was -15°C, with some cold advection. Note that the warm spot in Fig. 7 (in this case the warm spot is downstream from an overshooting top) showed up 15 minutes prior to the severe weather occurrence.

Conclusions

In the early spring the classical enhanced-V signature is not as readily detectable in satellite imagery as in the late spring and summer because of low tropopause heights and the characteristics of the MB curve.

Infrared satellite imagery must be used carefully in conjunction with radar in predicting severe weather in the early spring. When viewing a warm spot (usually light gray embedded in dark gray of area of a thunderstorm complex) there could be severe weather near or just upstream of the warm top, if there is supporting evidence from radar.

Care must be taken to distinguish the warm spot associated with severe weather from warm spots due to thunderstorm dissipation.

References

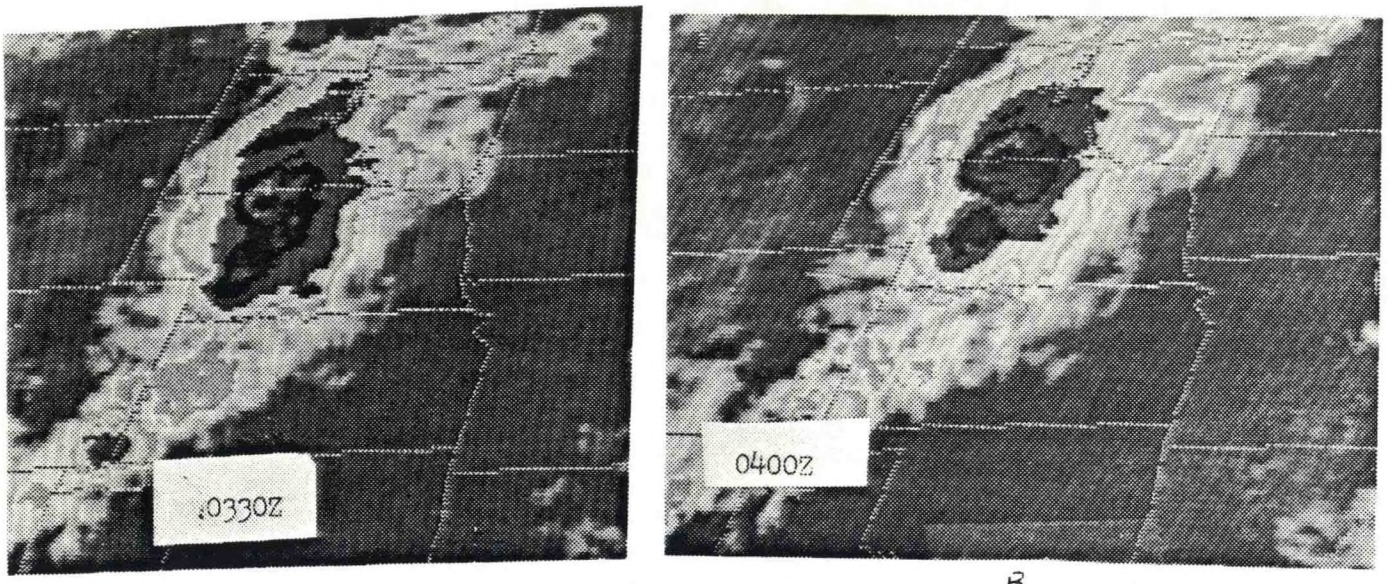
Adler, R.F., and Mack, R.A., 1984: Thunderstorm cloud top dynamics as inferred from satellite observations and models. Preprints, Conf. Satellite/Remote Sensing and Applications, Clearwater Beach, FL, Amer. Meteor. Soc., 115-120.

_____, 1985: A cloud top parcel model for thunderstorms - Comparisons with satellite observations. Preprints, 14th Conf. on Severe Local Storms, Indianapolis, IN, Amer. Meteor. Soc., 155-158.

McCann, D.W., 1980: The Enhanced-V, A Signature of Some Severe Thunderstorms on Satellite Pictures. Technical Attachment 80-6, National Weather Service Central Region, Kansas City, MO.

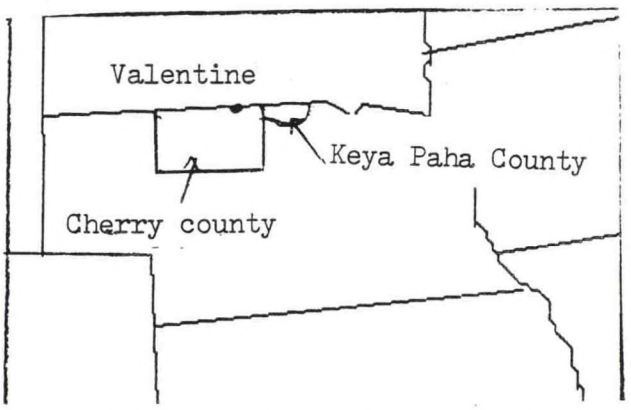
Fujita, T.T., 1978: Manual of Downburst Identification for Project NIMROD, SMRC Research Paper 156, University of Chicago, 104 pp.

Fig. 1



A B

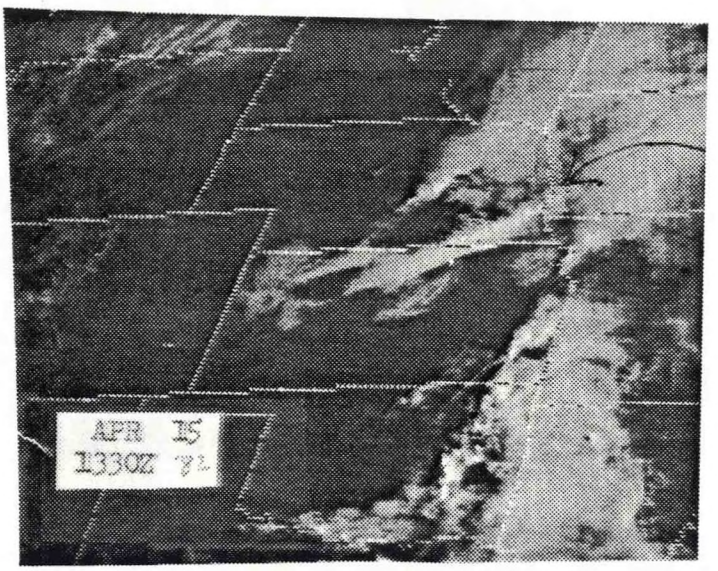
July, 18,1983



This storm with an enhanced-V or better called an enhanced -U in this case produced winds of 70mph at Valentine Nebraska around 0330Z and excessive rain and flash flooding in Cherry and Keya Paha counties of Nebraska.

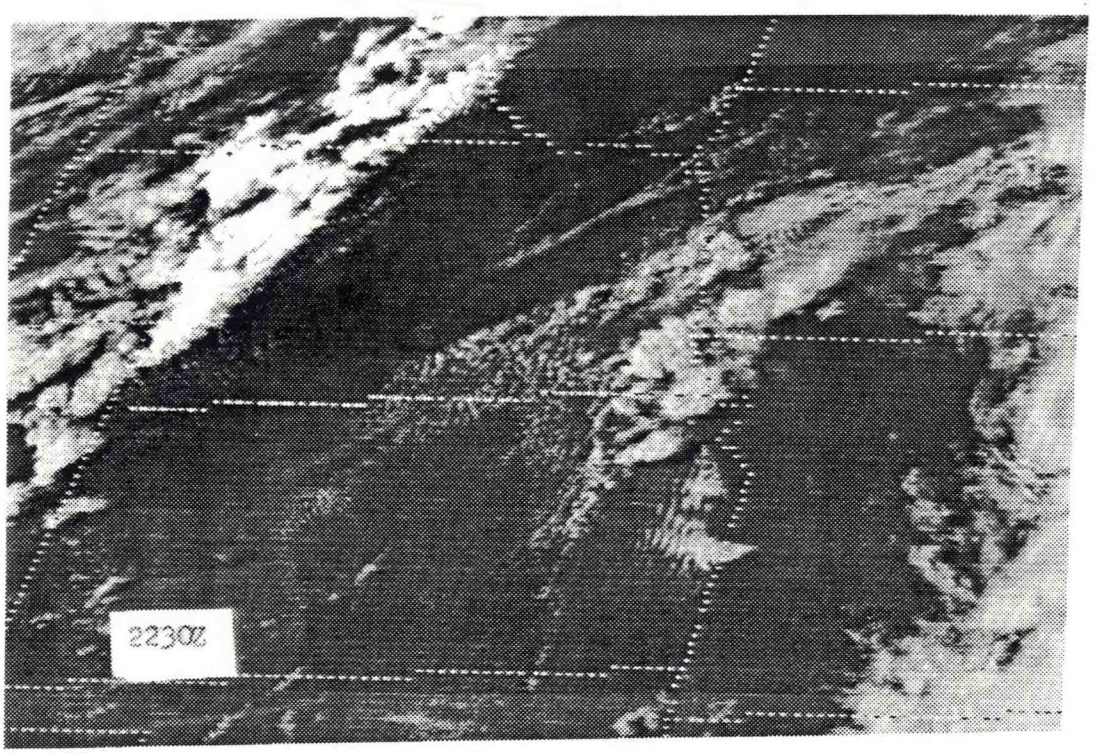
C

Fig. 2



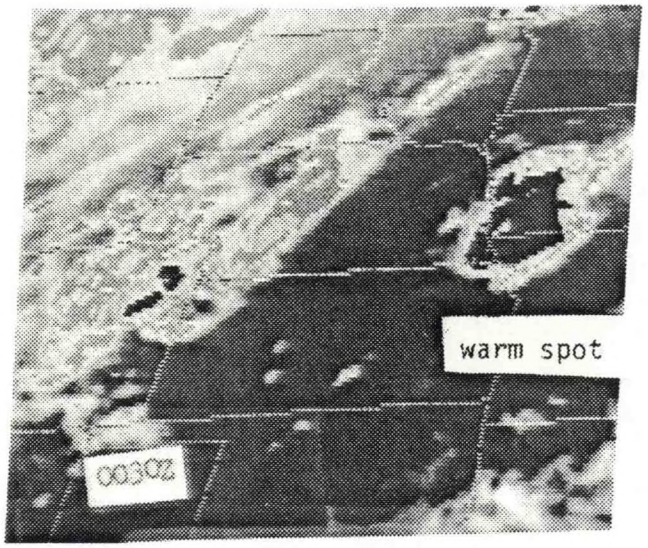
Outflow boundary

A

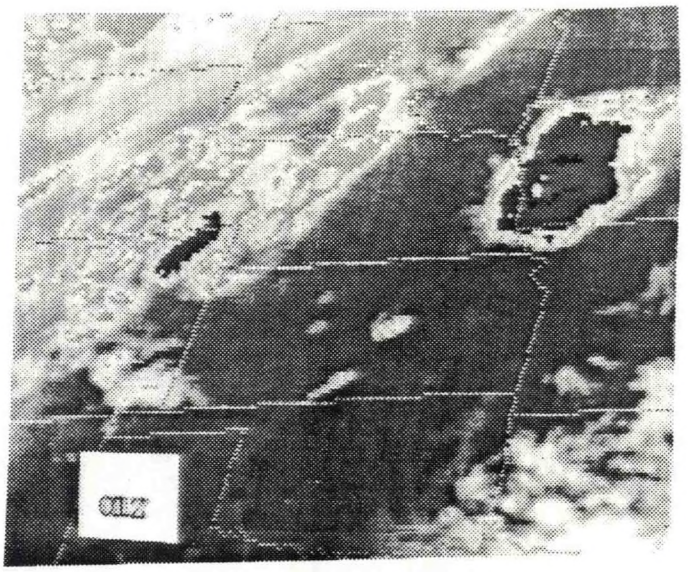


B

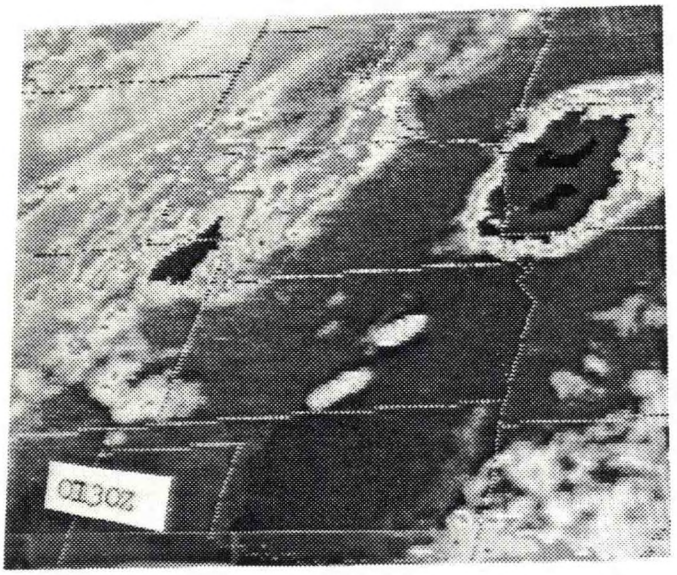
Fig. 3



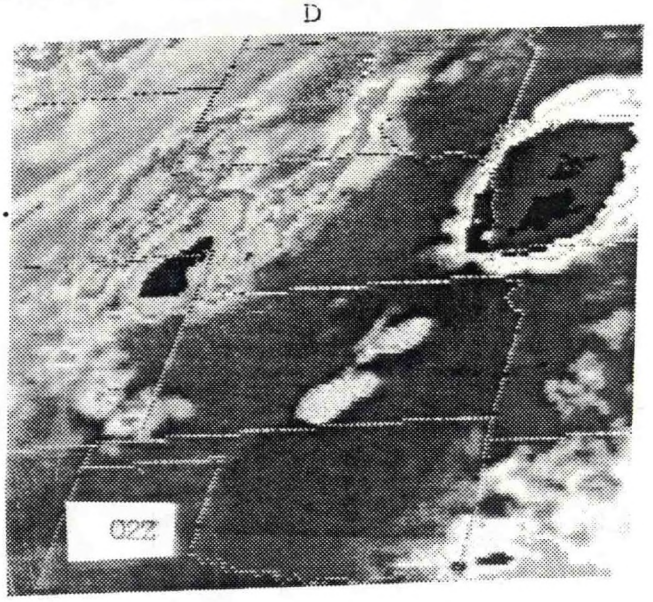
C



D

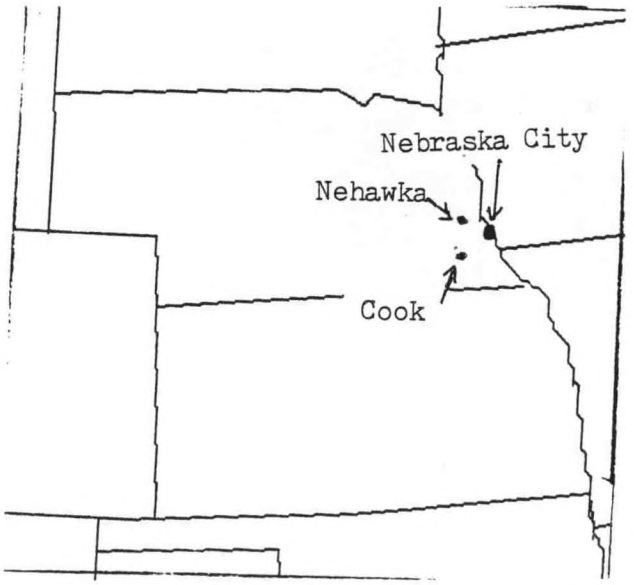


E



F

April 15, 1982



G

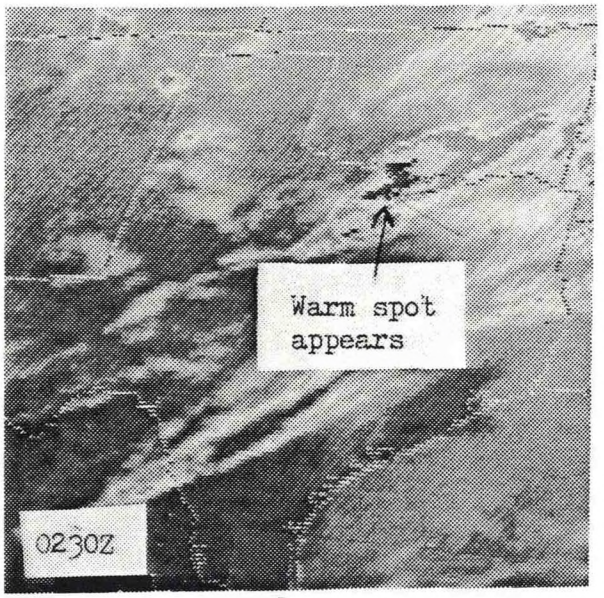
0040Z Tornado 2 SW of Cook NE

Flash flooding Otoe/Cass Counties
NE 0100Z - 0430Z

0110Z Tornado 4N Cook NE and
large hail at Nebraska City.

0210Z large hail at Nehawka
in Cass County NE

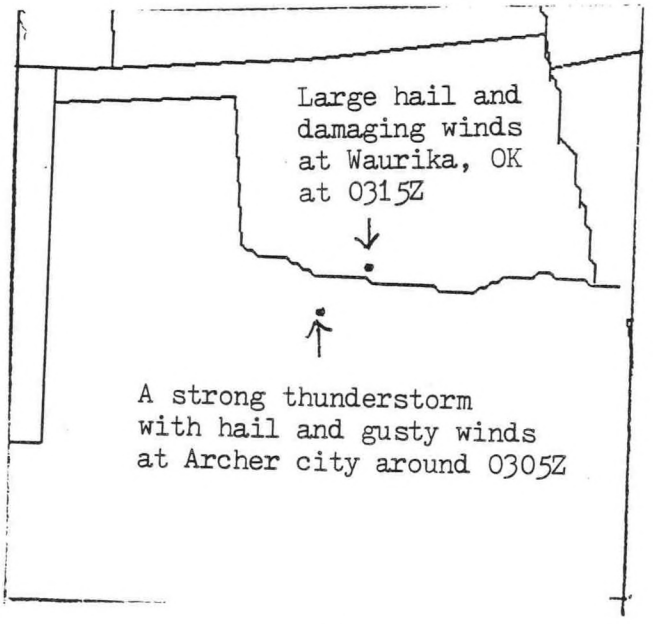
Fig. 4



A

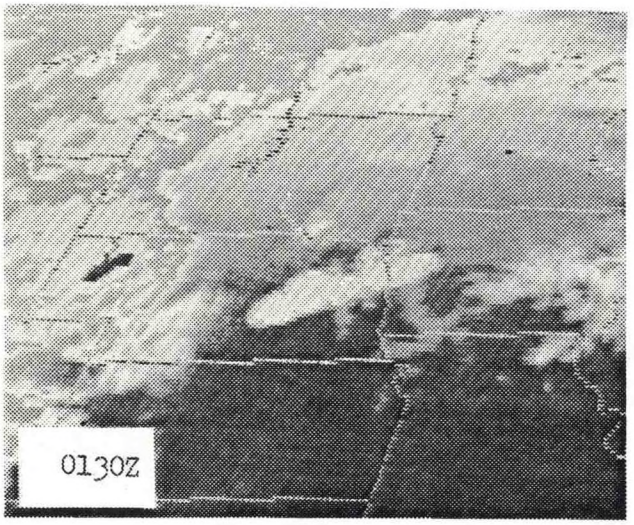
B

March 30, 1983

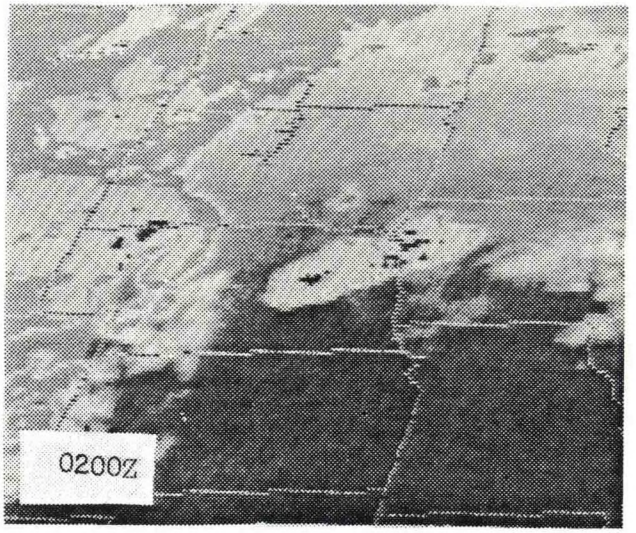


C

Fig. 5



A



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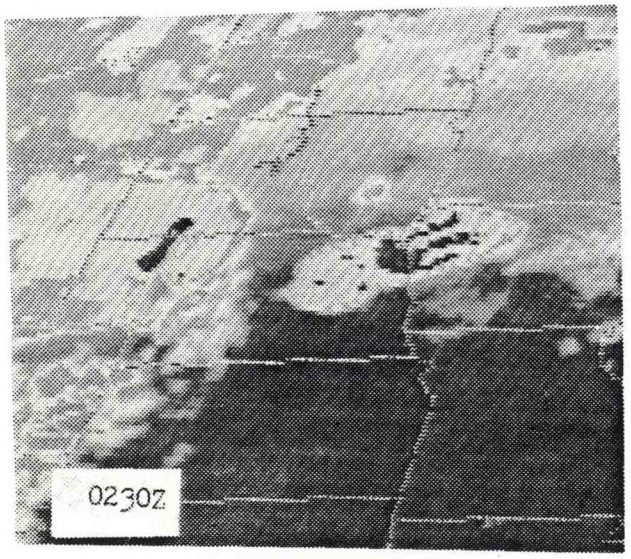
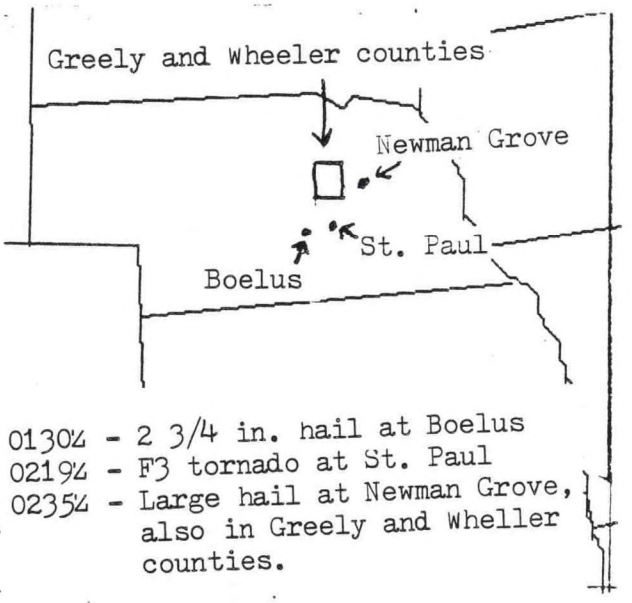
April 26, 1984

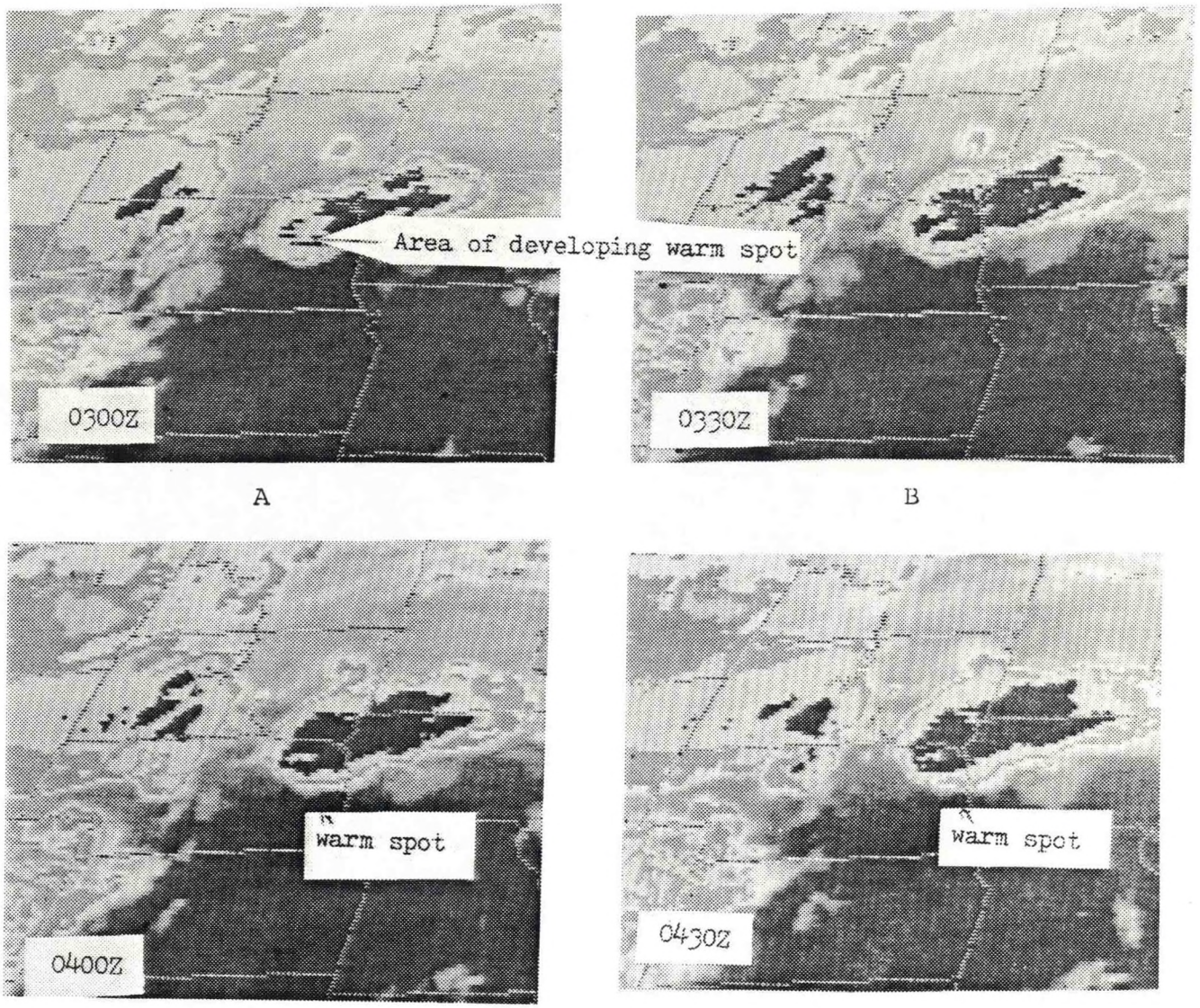


C



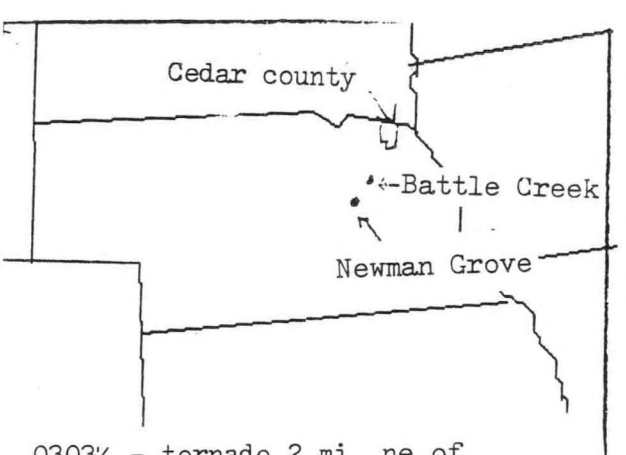
D

Fig. 6



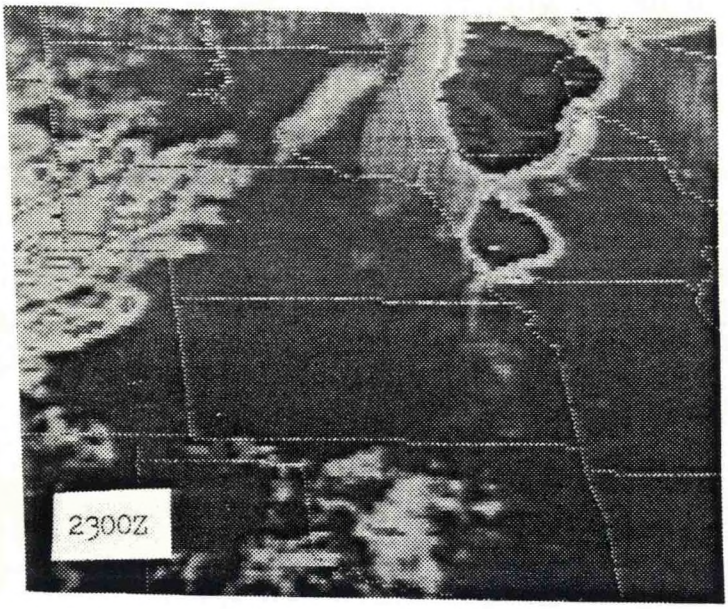
A B C D

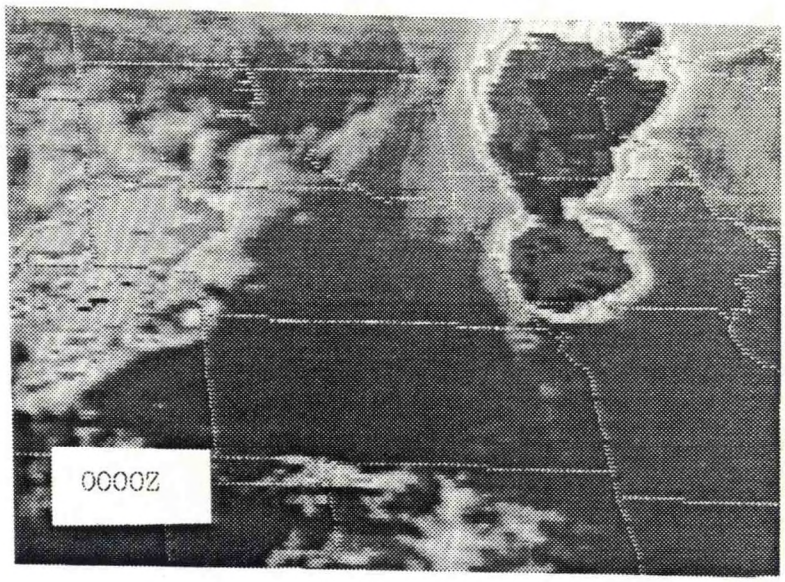
April 26, 1984



0303Z - tornado 2 mi. ne of Newman Grove
0320Z - 2 3/4 in. hail at Battle Creek
0420Z - Large hail in cedar county.

Fig. 7





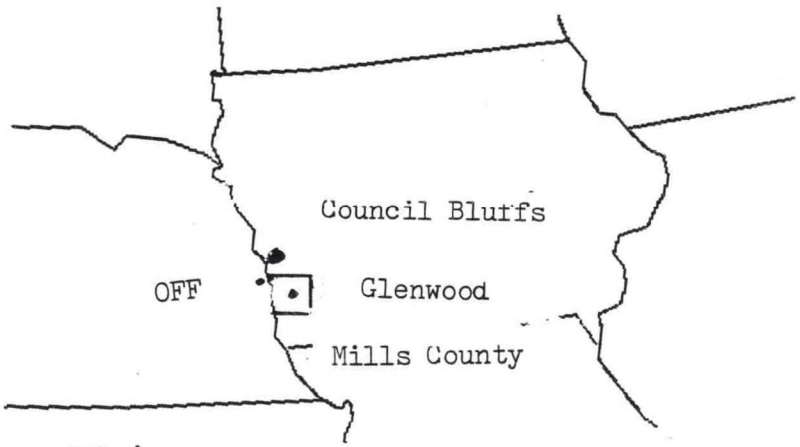
Note warm spot in southwest IA

A

May 12, 1986

B

Warm spot disappears by 00Z. last severe weather at 2358Z with wind damage at Glenwood



2245Z - funnel cloud 8 mi. N of OFF
Large hail at Council Bluffs IA.

2315-2326Z - 2 inch hail in Mills county IA.

C