NWS-CR-TA-88-43

CRH SSD
DECEMBER 1988

CENTRAL REGION TECHNICAL ATTACHMENT 88-43

UTILIZATION OF THE GRAPHIC OMAHO AND MESOSCALE ANALYSIS IN THUNDERSTORM PREDICTION

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1. Introduction

Forecasters continue to see an increase in the number of application programs and graphic products useful in determining the occurrence and location of severe convective weather. However, time is often not available to look at every analysis or guidance product. Frequently forecasters have to focus on the basics in order to use available time efficiently.

Bullock (1986) suggested that the synthesis of meteorological information should progress from the large scale to the small scale. In this light, the forecaster should begin the shift by becoming familiar with the big picture. A basic part of this process involves checking the upper air charts, noting moisture and temperature advection for the forecast area as well as identifying the location of closed lows and/or short waves. Moisture and thermodynamic properties of the upper atmosphere are derived from the soundings. This can be accomplished by running the RAOB program for the soundings in the area of interest, and then running CONVECT (Stone, 1986) for the individual stations. The AFOS command at the ADM is RUN:CONVECTA CCC/s which produces the CCCHO graphic.

If the RAOB and CONVECT program indicate adequate moisture, instability, favorable shear, and positive energy, the forecaster should consider the effects of differential advection. Then a mesoscale surface analysis, combined with SWIS loops, will enable the identification of boundaries or convergence zones where the forcing and focusing of convection is expected. In this paper, three cases utilizing the OMAHO graphic and mesoscale analysis are shown in which intense convection occurred.

2. Case Studies

A. Case One - June 12, 1987

The forecaster coming on duty at 8:00 a.m. on June 12th checked the upper air charts and noted that warm advection was occurring at 850 mb and that at 500 mb, weak cold advection was occurring with west to northwest flow. A 14Z surface analysis revealed a very weak surface pattern (see Fig. 1). However, there was a weak mesoscale low from OMA to OLU to ONL. There had been some nocturnal thunderstorms in northeast Nebraska. Also, there was a surface trough approaching from the west and a good moisture axis into southeast Nebraska.

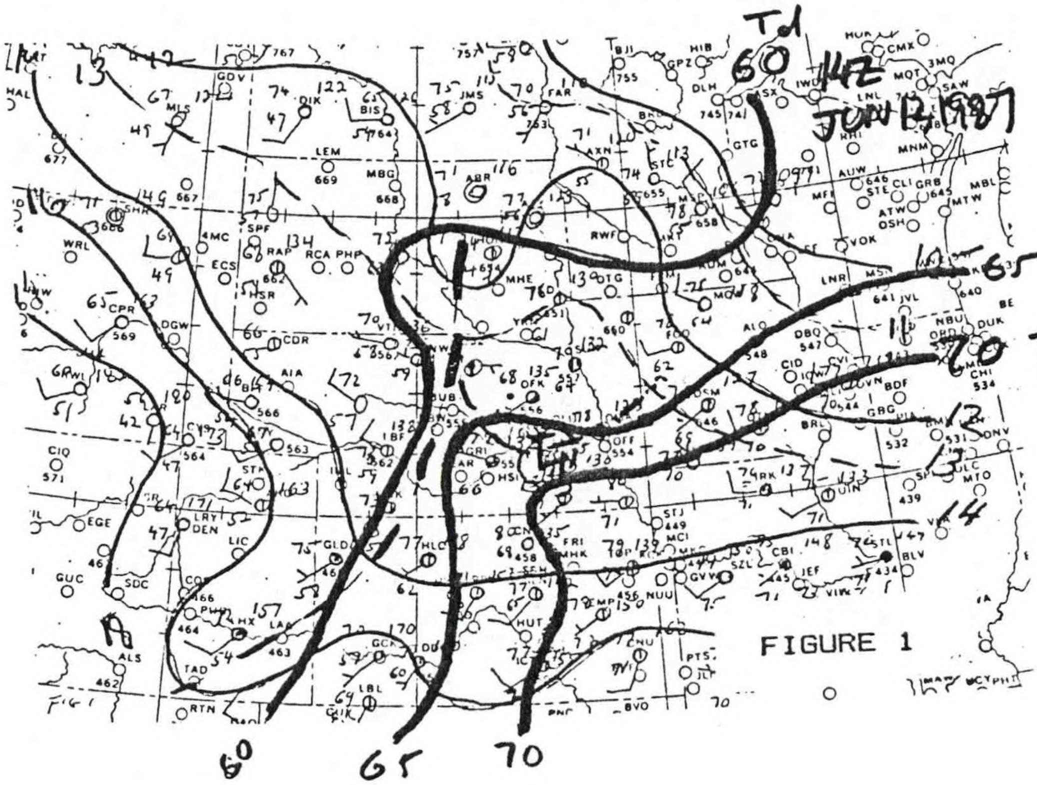


FIGURE 1

Fig. 1 Surface analysis for 14Z, June 12, 1987. Solid bold line is dew point (°F). Solid thin line is surface pressure (mb).

The forecaster was able to make another quick surface analysis (Fig. 2) at 1500Z before finalizing the forecast. The 1500Z analysis revealed that the east/west boundary was stalling across east central Nebraska. The CONVECTA program was then run (see OMAHO, Fig. 3).

The CONVECTA results indicated that the lifted index (LI) was negative, the maximum vertical velocity (WMAX) of 48 m/sec was strong (Weisman and Klemp, 1984), and the available buoyant energy (B+) was moderately strong, 1252 (m/sec)**2 (Weisman and Klemp, 1982). The convective temperature was computed as 92 degrees. From these data it was determined that thunderstorms, some severe, would develop in east central Nebraska. Rapid development of convective activity was expected around the time that the convective temperature would occur, and that the convection would be focused along the east/west boundary.

Post analysis revealed that the convective temperature was reached around 1830Z, and thunderstorms developed shortly thereafter (see satellite pictures in Figs. 4a, b, and c). Figure 5 shows the 1930Z radar observation from OVN. Finally, Figure 6 shows the location of severe weather events that occurred with this as the thunderstorms moved southeast.

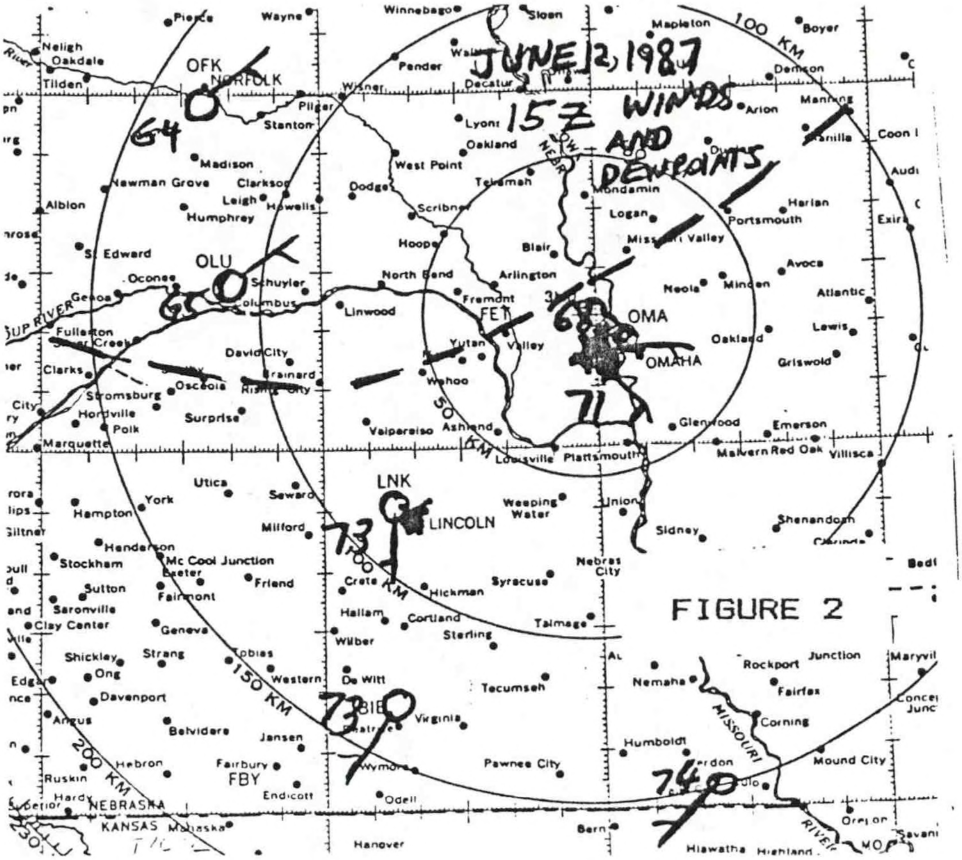
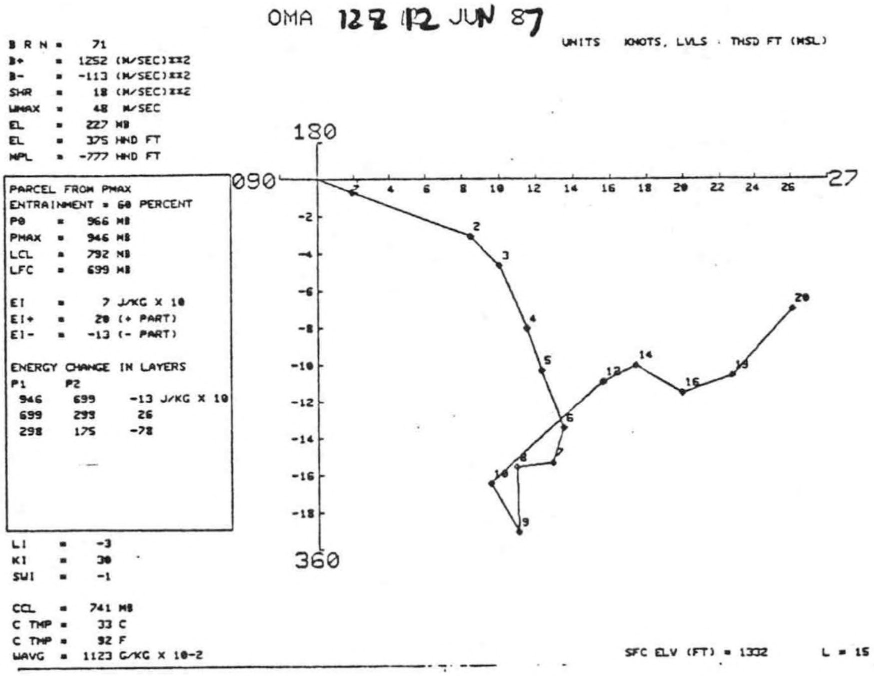


Fig. 2 Plotted surface winds and dew point temperatures for 15Z, June 12, 1987.



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B R N =    71
B+     =  1252 (M/SEC)**2
B-     =  -113 (M/SEC)**2
SHR    =    18 (M/SEC)**2
WMAX   =    48  M/SEC
EL     =   227 MB
EL     =   375 HND FT
MPL    =  -777 HND FT

PARCEL FROM PMAX
ENTRAINMENT = 60 PERCENT
P0     =   966 MB
PMAX   =   946 MB
LCL    =   792 MB
LFC    =   699 MB

EI     =     7 J/KG X 10
EI+    =    20 (+ PART)
EI-    =   -13 (- PART)

ENERGY CHANGE IN LAYERS
P1      P2
 946     699      -13 J/KG X 10
 699     299       26
 298     175      -78

LI     =    -3
KI     =    30
SWI    =    -1

CCL    =   741 MB
C THP  =    33 C
C THP  =    92 F
WAVG   =  1123 G/KG X 10-2
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Fig. 3 OMAHO chart for 12Z, June 12, 1987.

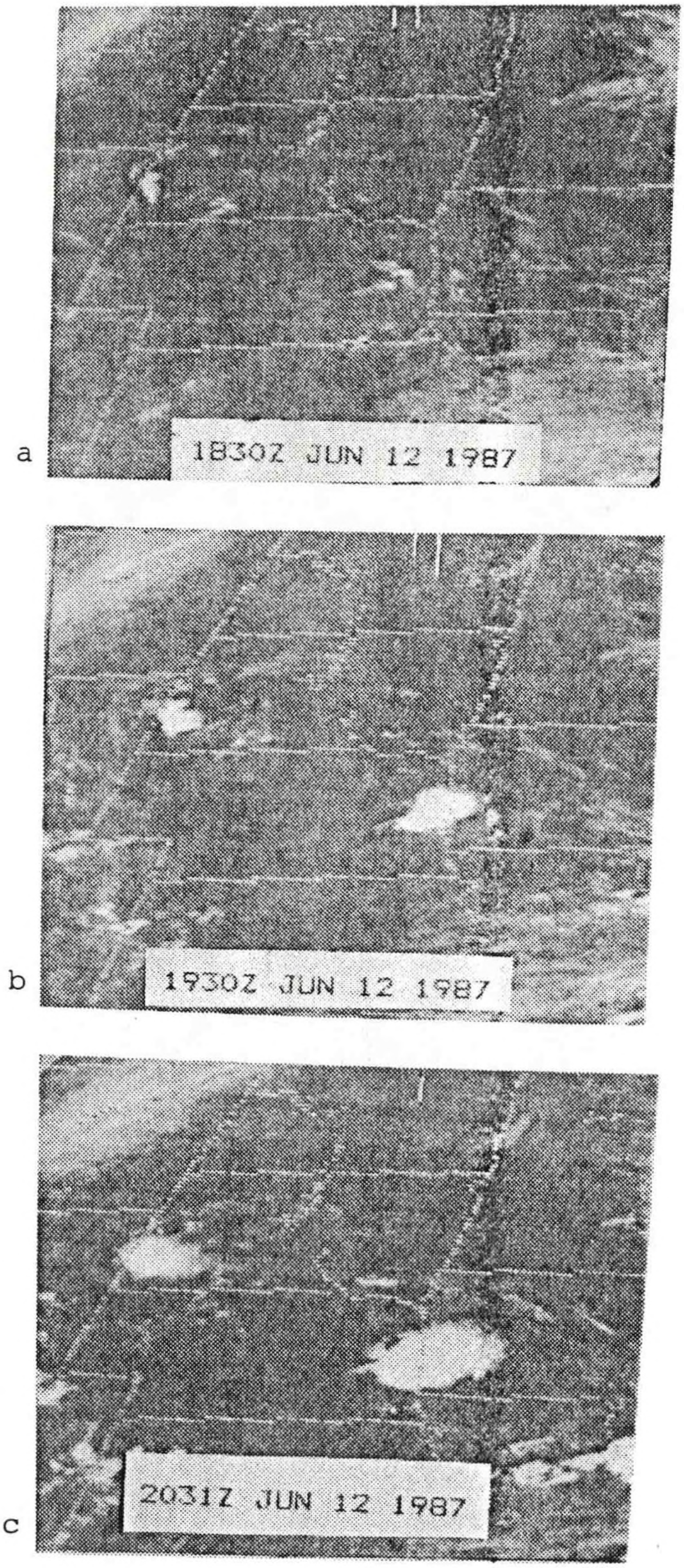


Fig. 4 Visible satellite charts for (a) 1830Z, (b) 1930Z, and (c) 2031Z.

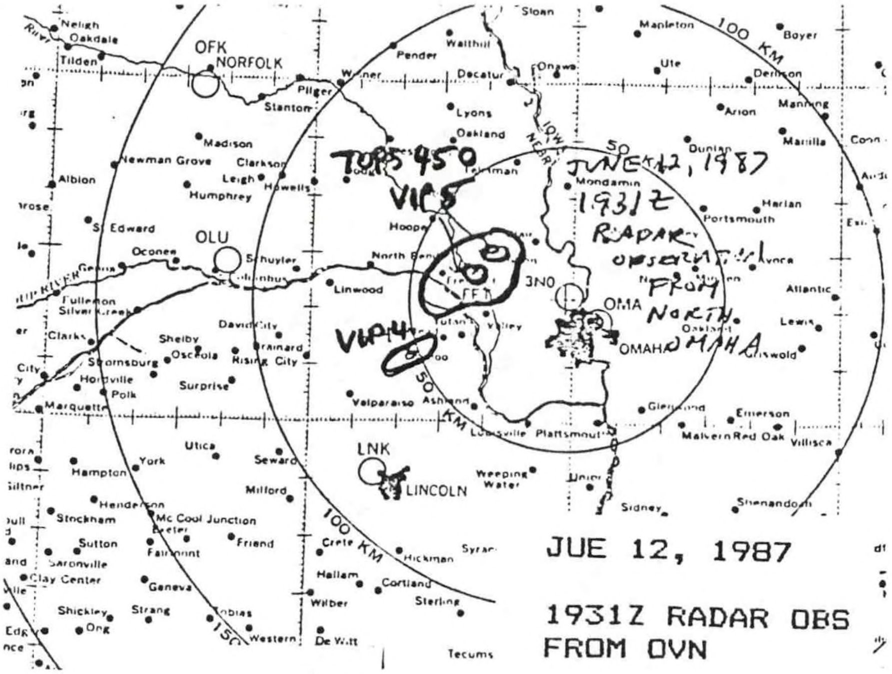


Fig. 5 Radar chart for 1931Z, June 12, 1987 from OVN.

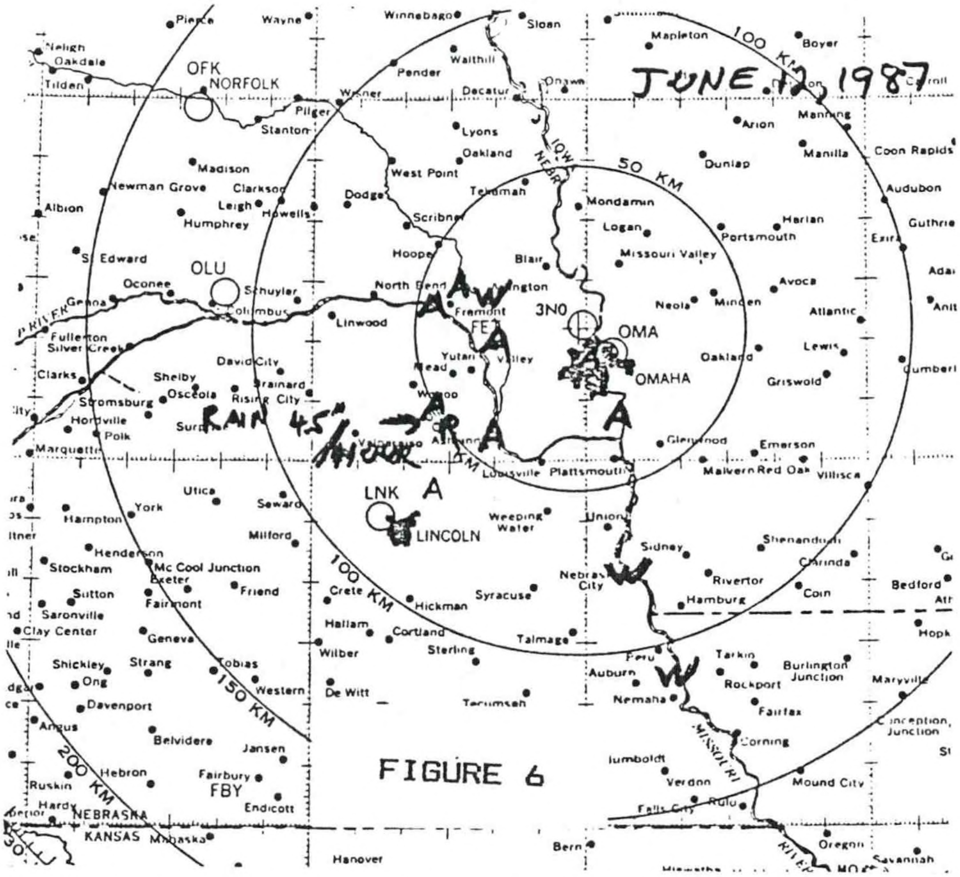


Fig. 6 Reported weather events; (A) hail, (W) wind damage.

B. Case Two - May 7, 1988

During the afternoon of May 7, a strong dry line was pushing slowly east across eastern Nebraska (see Fig. 7). However, by late afternoon the dry line was beginning to shift back to the west in Kansas in response to an approaching short wave wrapping around a closed upper low over western South Dakota (Fig. 8). It has been pointed out by Rhea (1966) that 71 percent of active dry lines are associated with features at 500 mb such as a short wave, 100 to 300 miles upstream. In addition, after sundown there was the usual additional slow down and retreat of the dry line (Schaefer, 1974) (see Fig. 9).

The graphic OMAHO (Fig. 10) for 00Z showed some interesting parameters with the positive buoyant energy (B+) 1339 (m/sec)**2, an LI of -4, no negative energy, and a Bulk Richardson Number (BRN) of 24. The BRN of 24 implied that there was even some supercell potential (Weisman and Klemp, 1984). Thus, in this case, a very active dry line was expected into the evening.

Looking at what happened (Fig. 11), there was considerable severe weather through the late afternoon and evening with two tornadoes as late as 0335Z. A tornado touched down in Sarpy County, Nebraska killing two people. Large hail and downbursts hit the Omaha area, then another brief tornado touchdown was reported at 0410Z north of Council Bluffs, Iowa near the town of Crescent.

Another interesting thing about the tornado-producing thunderstorm was that the cell, according to GRI radar, had a maximum top of 450 at 0330Z and 440 at 0430Z. Note that the maximum parcel level (MPL) from the 00Z OMAHO was 438. This is an area that would be interesting for future studies in determining the relationship between the MPL and the occurrence of severe weather.

C. Case Three - September 2, 1988

In this case, the morning OMAHO was not very impressive. However, a strong short wave, with an associated cold front was pushing south into northeast Nebraska at the maximum heating time of the day. The 12Z OMAHO (Fig. 12) indicated a convective temperature of 87 degrees and by 21Z temperatures in eastern Nebraska were at or above this convective temperature. The pseudoadiabatic diagram (Fig. 13) showed that there was deep moisture, and upper air charts showed that by advection further destabilization could be expected during the afternoon.

Convection developed at the time of maximum heating and focused along the cold front. After looking at these data, one would probably conclude, especially from the OMAHO, that no widespread severe weather outbreak was expected. And, as it turned out, the severe weather was minimal and isolated. From Blair, Nebraska south through the Omaha and Council Bluffs area, localized thunderstorm winds of 55 to 65 mph occurred from 00Z of September 3 to 0040Z.

In a post analysis of this event, it was noted that a VIP 3 thunderstorm developed out ahead of the squall line along the frontal boundary (see Fig. 14, and note the storm northeast of OMA at 2220Z). The thunderstorms along the front intensified as they intersected the old outflow boundary left by the

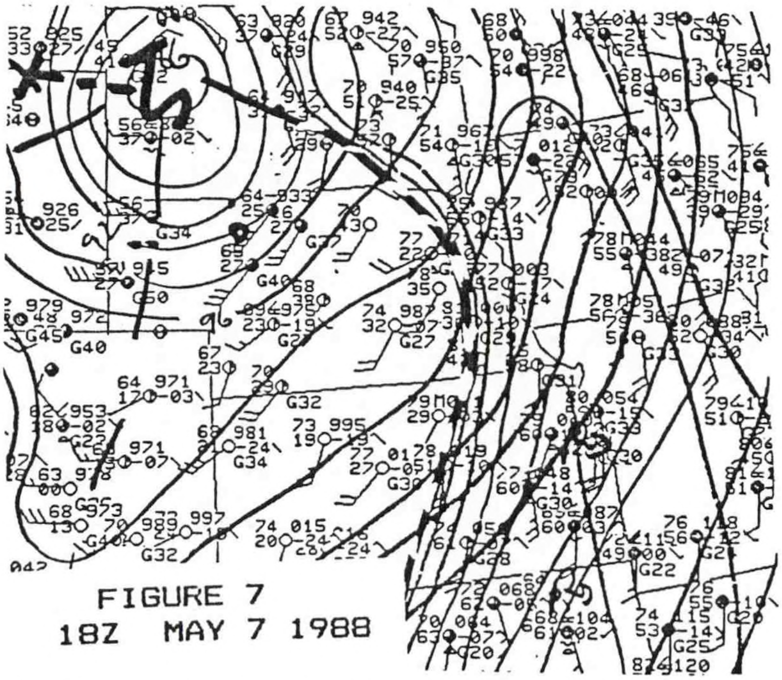


Fig. 7 Surface analysis for 18Z, May 7, 1988.

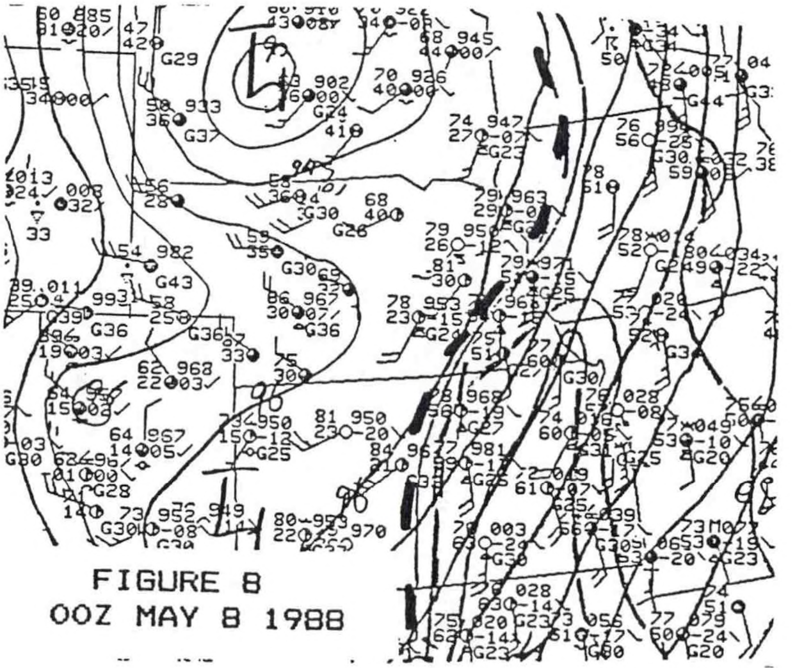


Fig. 8 Same as Fig. 7, only for 00Z, May 8, 1988.

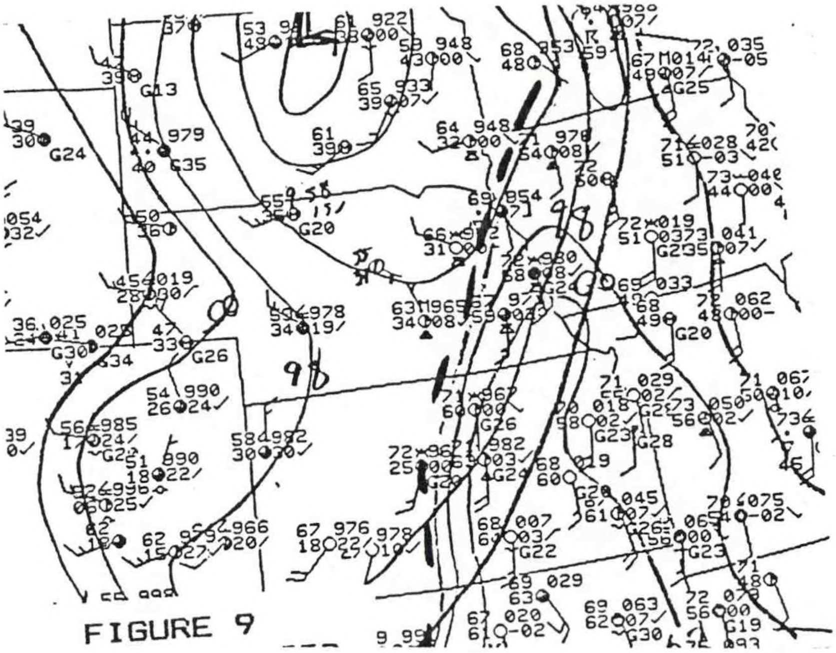
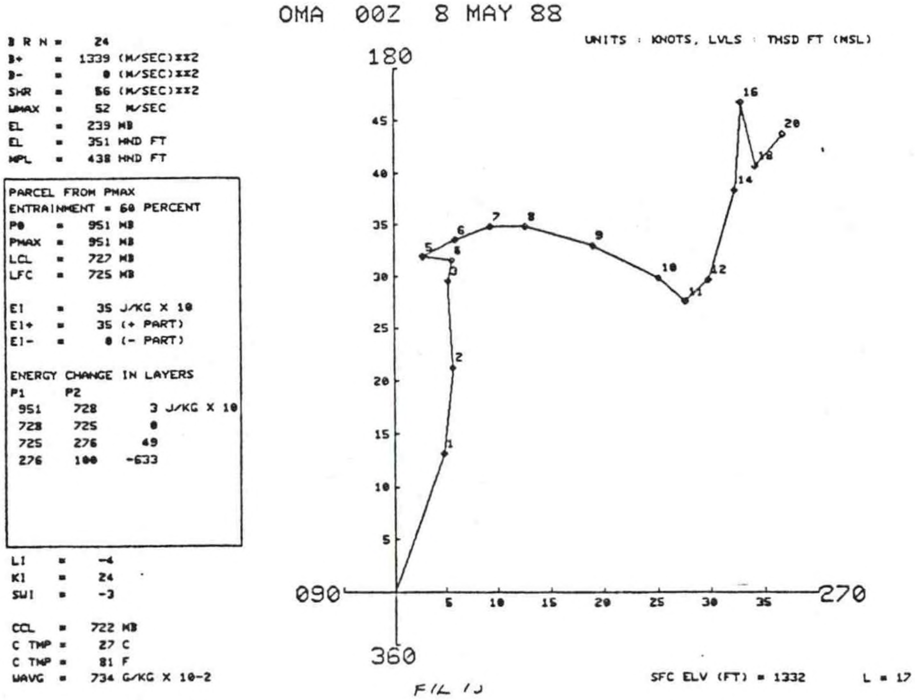


Fig. 9   Same as Fig. 7, only for 3Z, May 8, 1988.



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B R N =     24
B+     =  1339 (M/SEC)**2
B-     =     0 (M/SEC)**2
SHR    =    56 (M/SEC)**2
WMAX   =    52  M/SEC
EL     =   239 MB
EL     =   351 HND FT
MPL    =   438 HND FT

PARCEL FROM PMAX
ENTRAINMENT = 60 PERCENT
P0     =   951 MB
PMAX   =   951 MB
LCL    =   727 MB
LFC    =   725 MB

EI     =    35 J/KG X 10
EI+    =    35 (+ PART)
EI-    =     0 (- PART)

ENERGY CHANGE IN LAYERS
P1      P2
 951     728        3 J/KG X 10
 728     725        0
 725     276       49
 276     100     -633

LI     =    -4
KI     =    24
SWI    =    -3

CCL    =   722 MB
C TMP  =    27 C
C TMP  =    81 F
WAVG   =   734 G/KG X 10-2
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Fig. 10   OMAHO chart for 00Z, May 8, 1988.

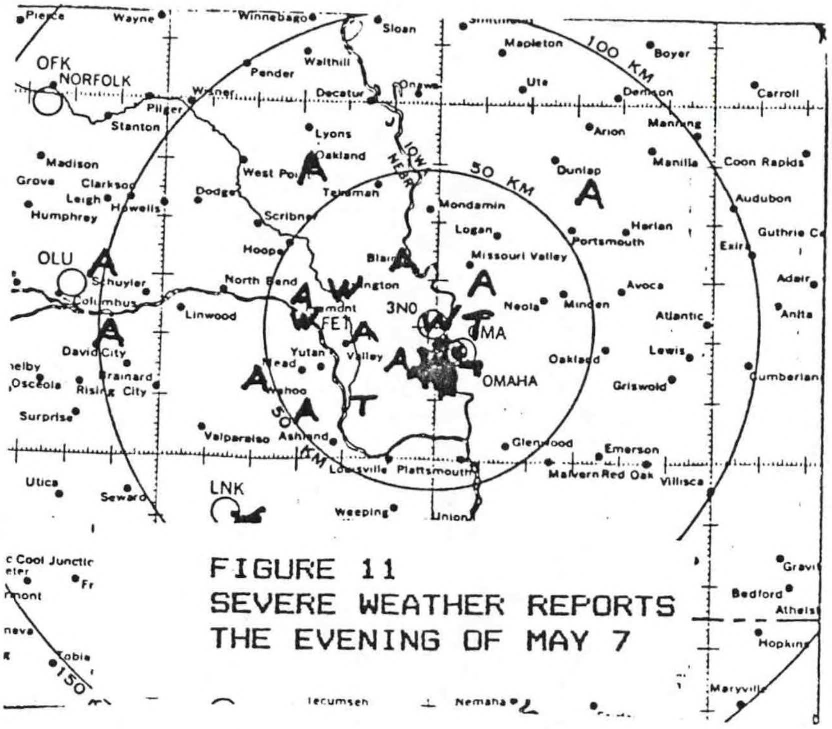
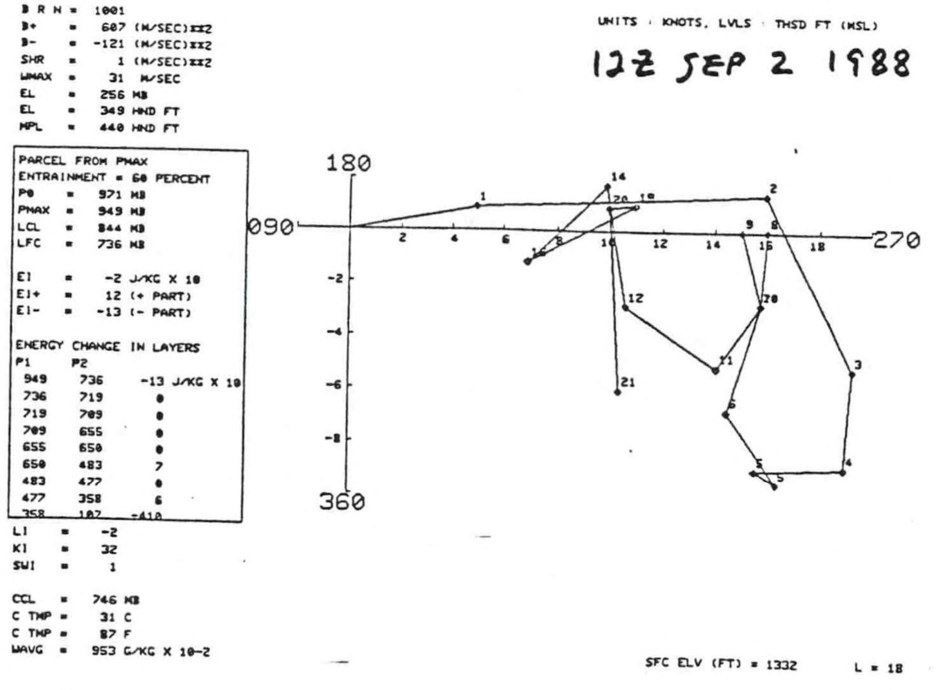


Fig. 11 Weather events for May 7, 1988; (A) hail, (W) wind damage, (T) tornado.



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B R N =  1001
B+    =   607 (M/SEC)**2
B-    =  -121 (M/SEC)**2
SHR   =     1 (M/SEC)**2
WMAX  =    31  M/SEC
EL    =   256 MB
EL    =   349 HND FT
MPL   =   440 HND FT

PARCEL FROM PMAX
ENTRAINMENT = 60 PERCENT
P0     =   971 MB
PMAX   =   949 MB
LCL    =   844 MB
LFC    =   736 MB

EI     =    -2 J/KG X 10
EI+    =    12 (+ PART)
EI-    =   -13 (- PART)

ENERGY CHANGE IN LAYERS
P1       P2
 949      736       -13 J/KG X 10
 736      719         0
 719      709         0
 709      655         0
 655      650         0
 650      483         7
 483      477         0
 477      358         6
 358      107      -410
LI     =    -2
KI     =    32
SWI    =     1

CCL    =   746 MB
C TMP  =    31 C
C TMP  =    87 F
WAVG   =   953 G/KG X 10-2
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Fig. 12 OMAHO chart for 12Z, September 2, 1988.

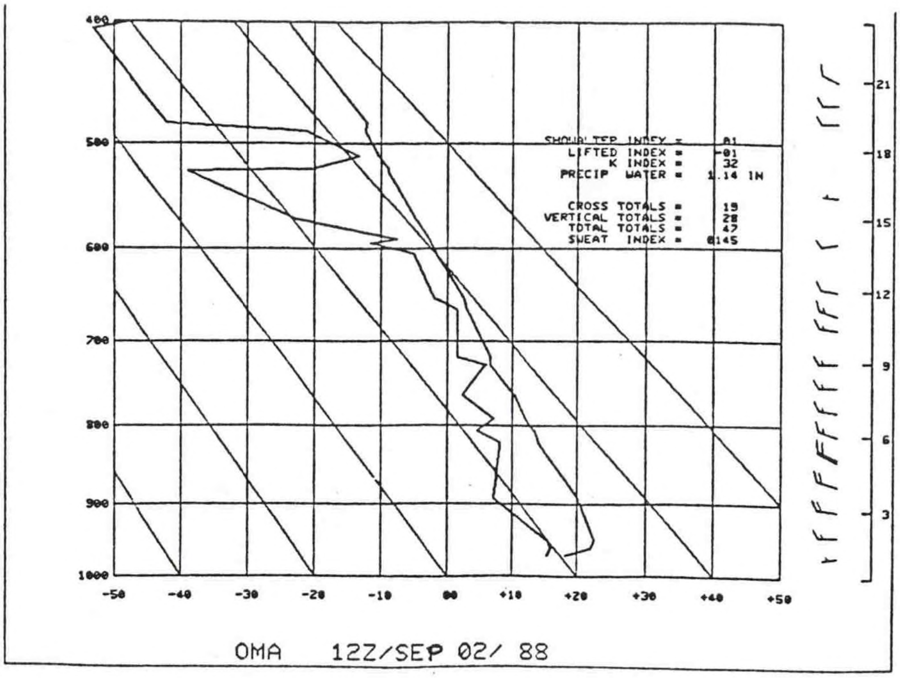

Fig. 13 OMA RAOB analysis for 12Z, September 2, 1988.

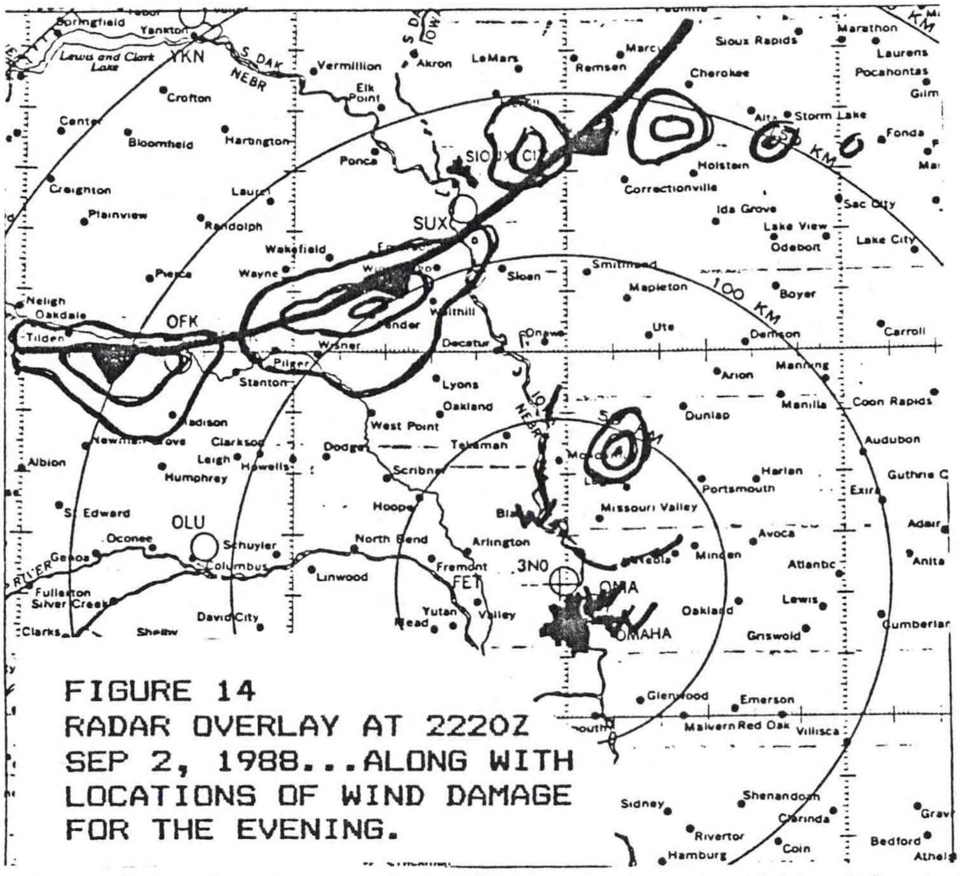

Fig. 14 Radar and weather event chart for September 2, 1988; (W) wind damage.

isolated thunderstorm that had since moved northeast out of Harrison County and dissipated. Wind damage persisted along the Missouri River until the frontal squall line moved well south of the old outflow boundary.

3. Conclusion

One important aspect of the forecast process, focusing on the large scale and then moving to the smaller scale to become familiar with developing or ongoing weather situations, has been demonstrated. It has also been shown, by paying closing attention to the information derived from mesoanalysis, RAOB, and the CONVECTA AFOS programs, that a forecaster can determine a useful and accurate scenario of convective and severe weather events for the day.

4. References

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