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CLEVELAND'S FIRST EXPERIENCE WITH BOTHWELL SURFACE ANALYSIS PROGRAMS DURING SEVERE WEATHER

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Editors Note: This is a good opportunity to review the uses of mesoscale fields. A brief discussion of these fields is included as an appendix to this technical attachment.

The afternoon of March 10, 1986 gave WSFO Cleveland our first opportunity to run the new surface mesoscale analysis programs developed by Phil Bothwell during a potential severe weather episode (NOAA Technical Memorandum NWS SR-114.)

Although no dramatic discoveries were made, we thought it worth while to share our results with other Eastern Region offices. On the surface, these programs offer exciting potential for improving our understanding of weather and applying this new knowledge to short range forecasts and decisions. We look forward to compare what we learn with what other Eastern Region offices learn using these new programs.

For those not familiar with the Bothwell programs, here is a brief description. These programs "have been designed to maximize the information available from conventional surface and upper-air data" (from NTM NWS SR-114). Using hourly surface observations and the latest upper air data, the programs calculate and contour the following fields:

Hourly stability index with reference to the latest 500mb temperatures.
Hourly stability index with reference to the latest temperature at 400, 300, 250, or 200 mb (operator selectable).
Surface wet-bulb potential temperature
Potential Temperature
Surface Moisture Convergence
Surface Wind Convergence
Surface Relative Vorticity
Advection of temperature on a constant pressure surface
Surface Mixing Ratio

In addition to the above fields, the programs will also analyze changes in these fields:
Altimeter
Moisture Convergence
Relative Vorticity

A surface plot and weather depiction chart are also a products of these routines.

This particular episode caused numerous tornadoes and straight line winds in excess of 60 knots across the southern two-thirds of Indiana, northern Kentucky, western and north-central Ohio. Figure 1 shows the location of the severe weather reports for the period from 17Z-23Z obtained from the Daily Tornado Statistics issued by Kansas City using the Severe Weather Report Plotter (SWX.SV and SWY.SV - ERCP No. 23 by Hugh Stone).

Figure 3 shows the location of surface synoptic features at 17Z on March 10th. Figure 4 is the radar summary chart from 1735Z radar observations. Outlined on this figure is Severe Thunderstorm Watch Number 16 valid until 7pm EST.

We were able to run the Bothwell mesoscale routines at 17Z, 19Z, 21Z, and 02Z. It takes about 15 minutes to get a full complement of charts from a set of surface observations.

These four runs produced 53 different charts, far too many to reproduce here. But the most interesting field during this episode was the change in moisture convergence series (Figure 2). The central Indiana storms were preceded by significant rises in moisture convergence. The storms that moved along the Ohio River seemed to move along with moisture convergence rises. The +10 to +15 area in Figure 2b, if moved along the path established by comparing the max areas in 2a with 2b, moves toward where severe weather was about to occur in the following two hours from 21Z to 23Z (figure 1c).

The reader should be careful when examining figure 2c. This chart shows moisture convergence change from 23Z to 02Z, a period of five hours. Figures 2a and 2b show only 2 hour changes. By 02z, the severe weather was well east of the moisture convergence change maximum shown in north central Ohio at this time. This chart does not depict the net change ahead of the severe weather, it probably best describes the net change in moisture convergence from two hours before the severe weather occurred in north-central Ohio to two hours after the severe weather occurred.

Numerous articles have been written on the use of moisture convergence. A good place to start is Doswell's description of moisture convergence starting on page IV-2 of NOAA Technical Memorandum NWS NSSFC-5, "THE OPERATIONAL METEOROLOGY OF CONVECTIVE WEATHER -- VOLUME I: OPERATIONAL MESOANALYSIS. At this time we are re-reading these articles in the hopes of trying to better use the new tools Bothwell has provided.

SCIENTIFIC SERVICES DIVISION, ERH
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Attachments
 Figures 1 through 4
 Appendix

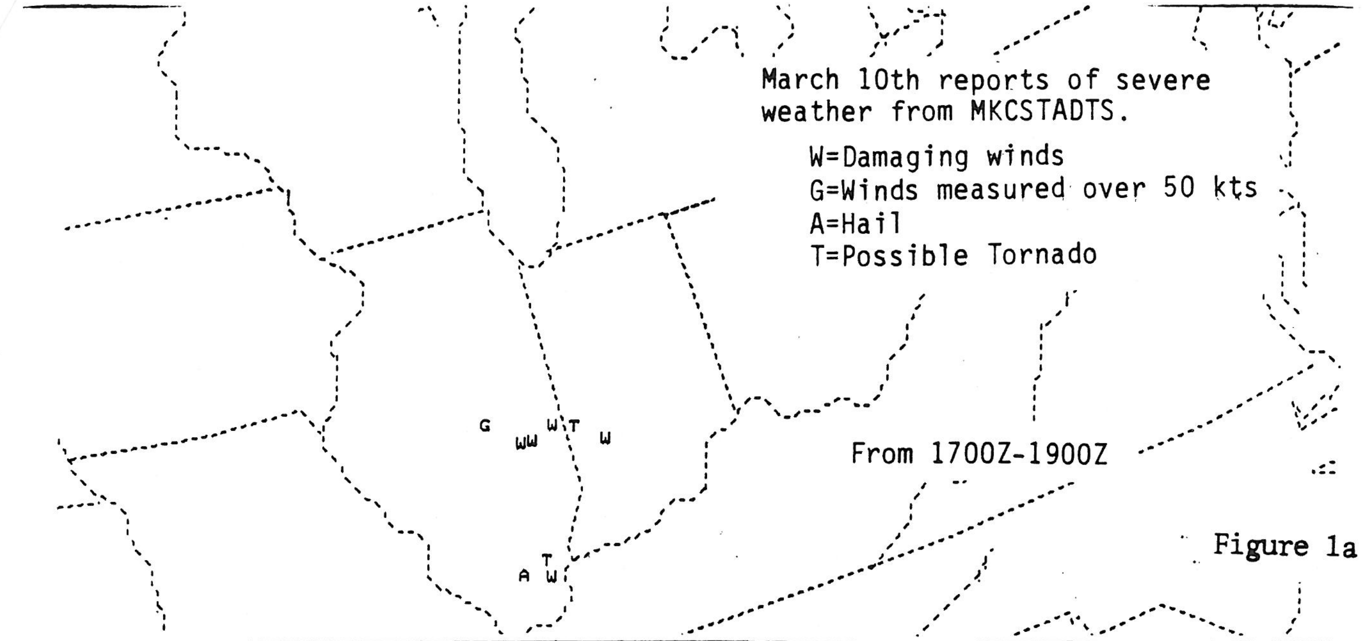

Figure 1a

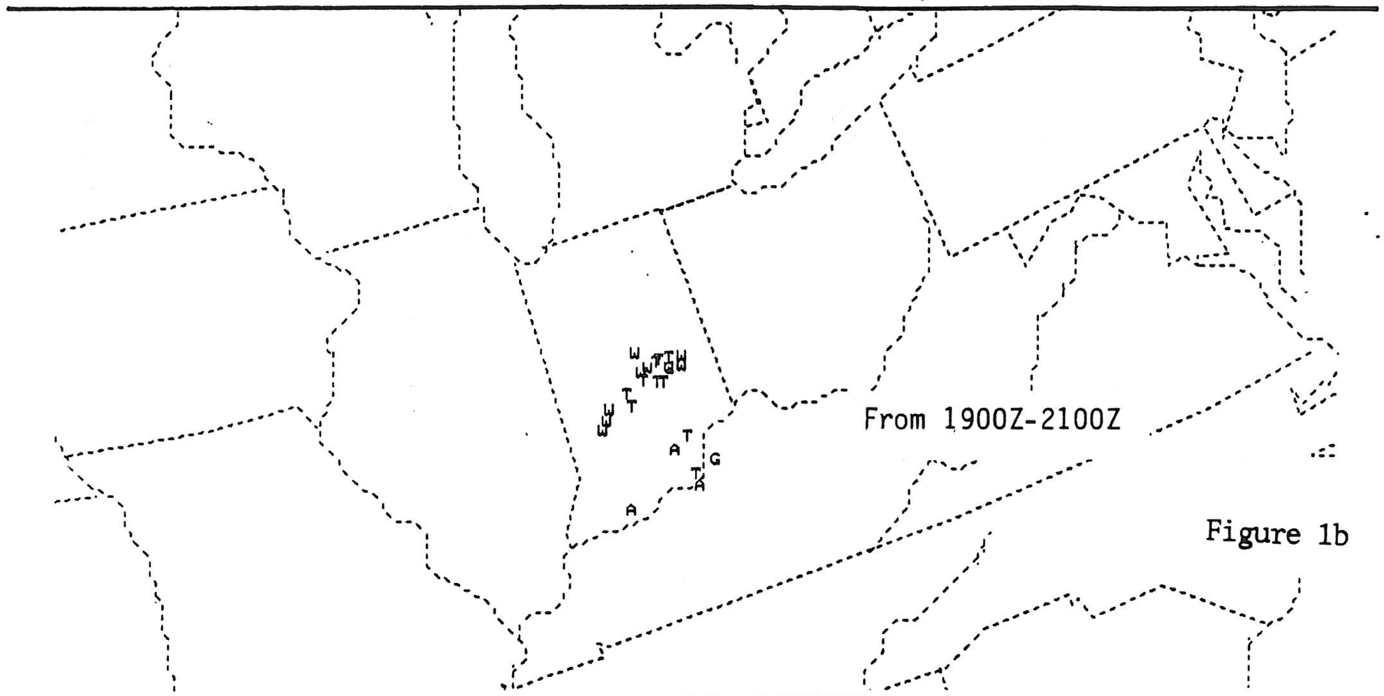

Figure 1b

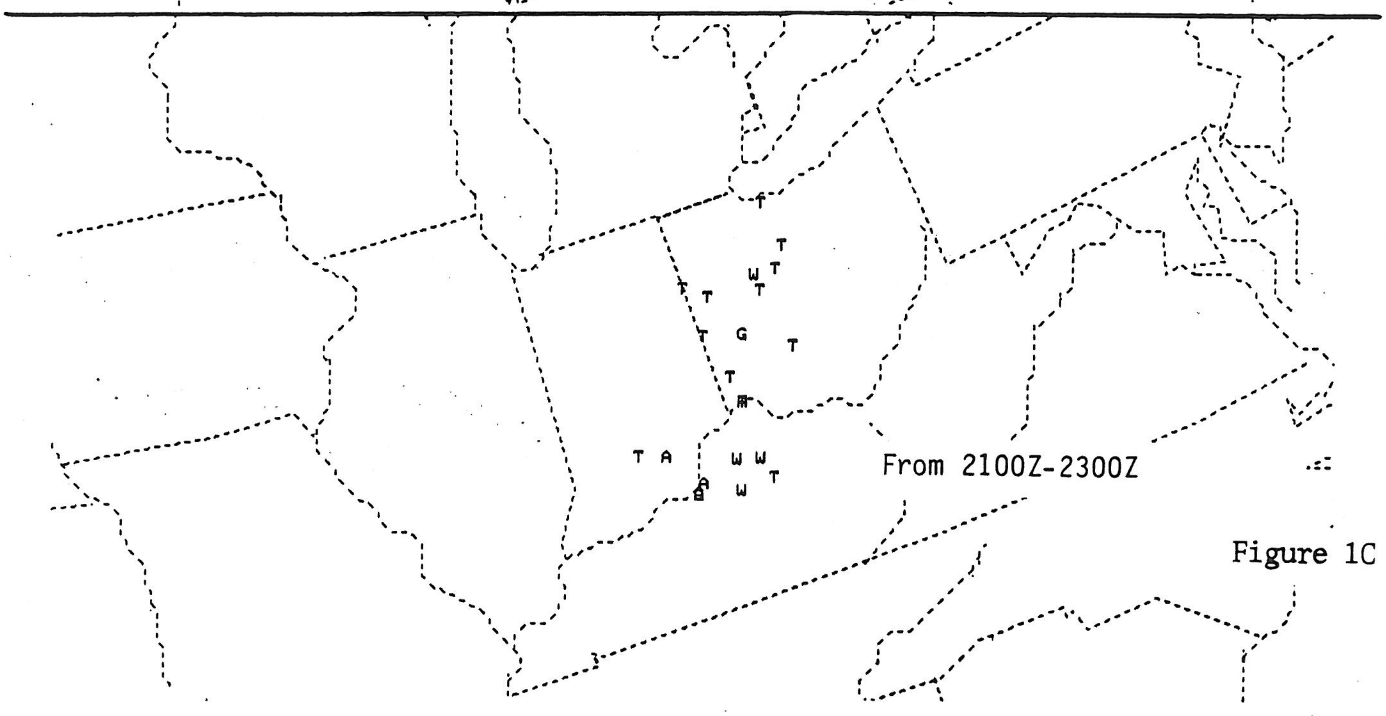

Figure 1C

Figure 2a

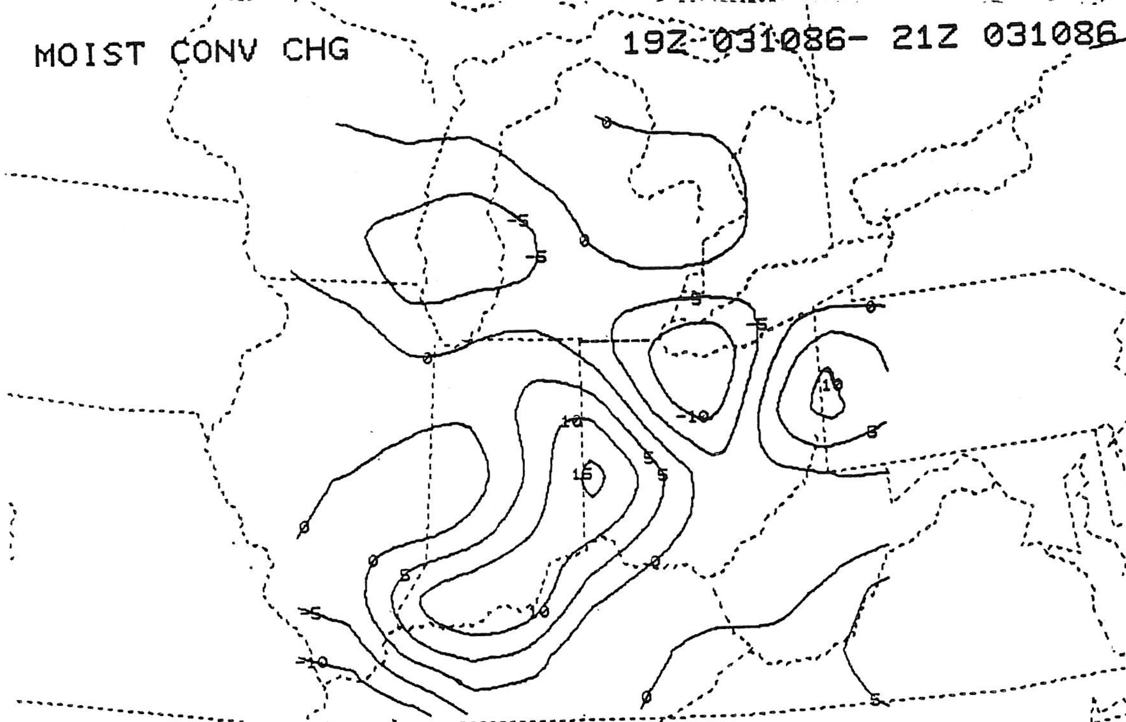

Figure 2b

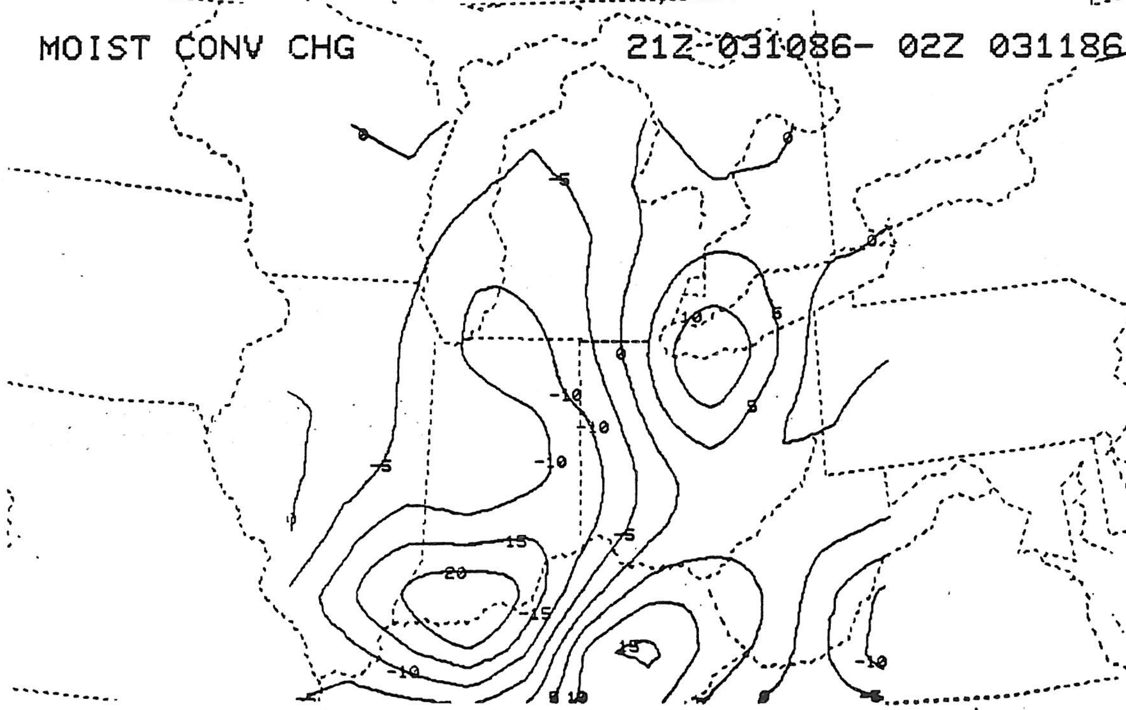

Figure 2c

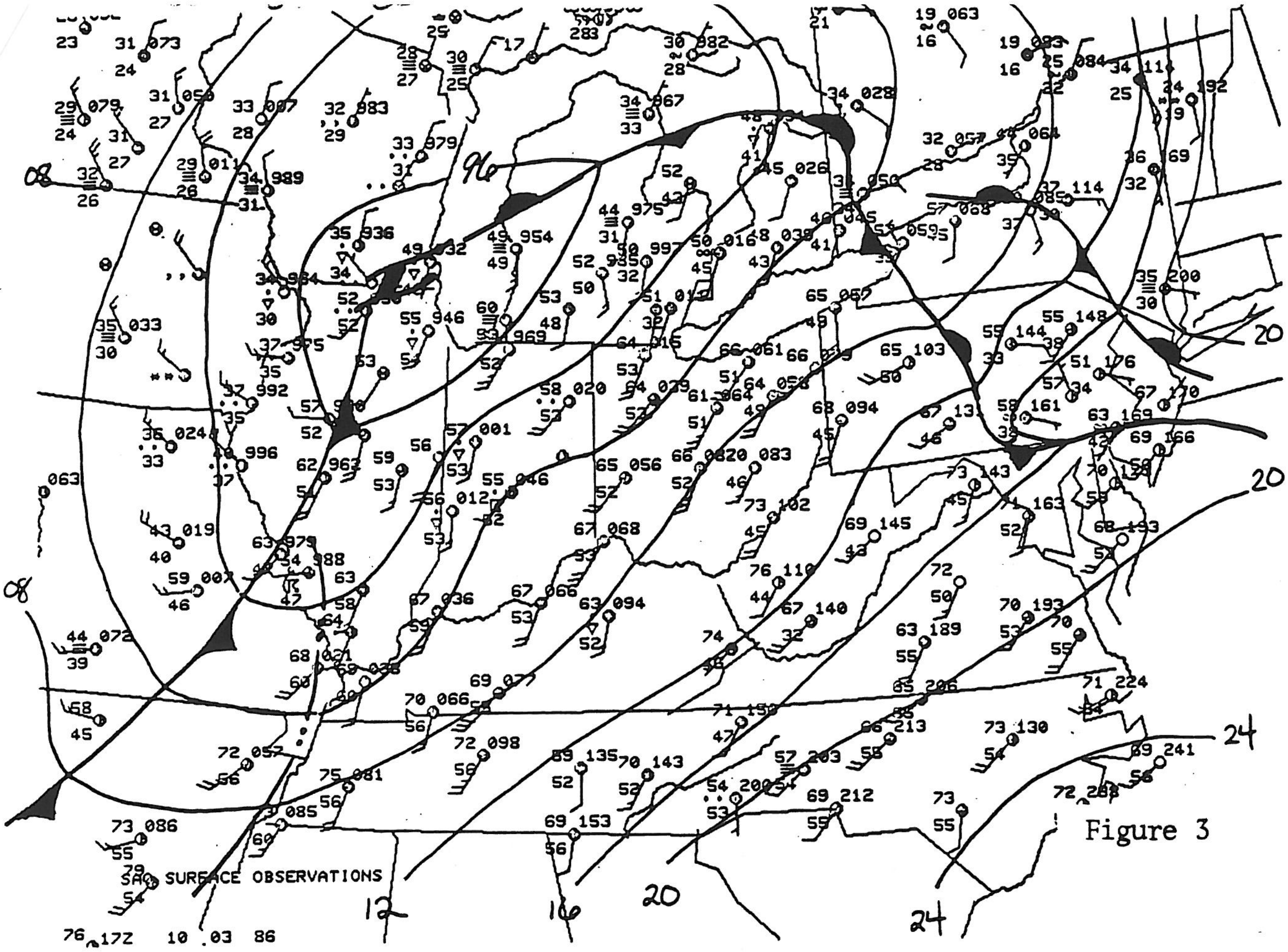

Figure 3

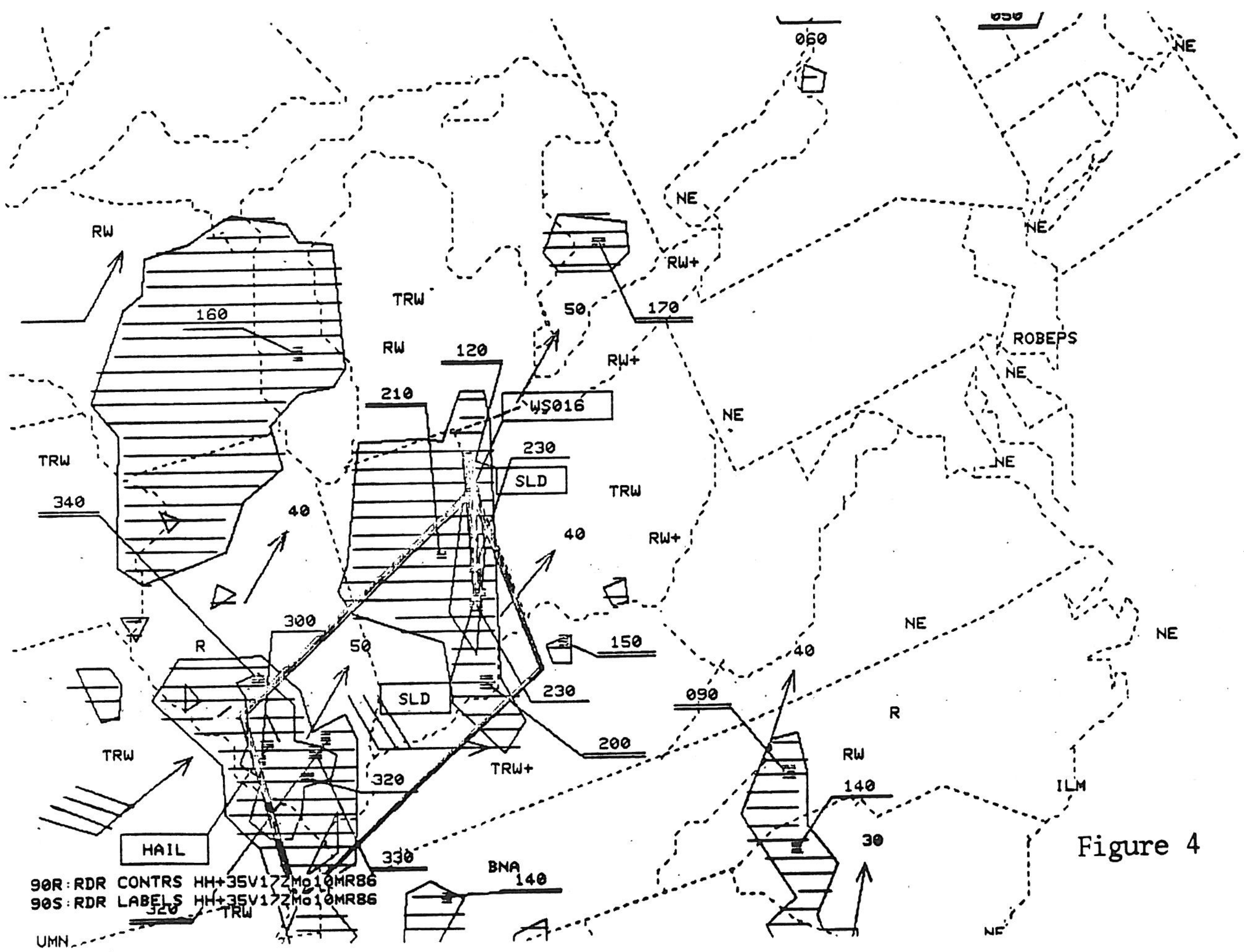

Figure 4

Appendix

Some uses of analyses produced by the "MESOS" program:

1. Lifted index at 500mb

This computation uses a surface parcel to lift to the 500mb level, so new stabilities may be computed hourly, if desired, from surface gridpoints, which have closer spacing than the spacing of the radiosonde network. Therefore, pockets of instability between radiosonde stations may be detected, which would otherwise not be noticed.

2. Lifted index at 400, 300, 250, or 200mb

Although use of the 500mb level is traditional for the lifted index computation, use of another level may detect instability (positive energy area) that is not evident at 500mbs.

3. Surface wet bulb potential temperature

This is another measure of stability, since these temperatures correspond to moist adiabats on a thermodynamic diagram and the higher the value, the greater the positive energy area an ascending parcel will have. Thunderstorms tend to develop along the warm edge of the temperature gradient in the presence of surface wind/moisture convergence.

4. Potential temperature (reduced to 1000mb or user specified level)

Over an area of varying terrain, temperature boundaries are sometimes difficult to detect because of the differing station elevations. Reducing temperatures to a specified pressure level helps overcome this difficulty.

5. Surface moisture convergence

It is well known that moisture convergence increases an hour or two prior to the development of convection. One or two hour tendency fields help to locate the current most active areas. After a few hours of existence, divergence will develop beneath a cluster of slowly moving thunderstorms and new convergence will likely develop along the cold air outflow boundary.

6. Surface wind convergence

If moisture observations are not available in a particular area, wind convergence may be used in place of moisture convergence. Usually the fields are quite similar, with wind convergence having the same relationship to convection as moisture convergence.

7. Surface relative vorticity

May be used to detect the development of meso-cyclones prior to the pressure falls. All observing stations report winds, but not all report pressures.

8. Advection of temperature on a constant pressure surface

Useful in estimating the movement of temperature boundaries, where convection is likely to begin.

9. Surface mixing ratio

Convection requires a low level source of moisture, which is easily identified by use of this field.