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CENTRAL REGION TECHNICAL ATTACHMENT 87-8

MIXING RATIO...A CLUE TO SHORT TERM DEVELOPMENT

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Introduction

It's a summer day at 4:00 pm. Zones are due and a front is over the northwest part of your state. Upper dynamics are very weak. Although clouds are associated with the front, surface, radar, or satellite data does not indicate formation of convective rainfall. Morning RAOBs were stable, even with some lift caused by the front. You decide to leave thunderstorms out of the forecast. However, the zones have to be updated one hour later as the convective rainfall develops along the front.

Sound familiar? By using the meso-analysis programs, especially the "SMR" (Surface Mixing Ratio) chart combined with the instability chart and surface convergence one can often not only determine where (from moisture convergence) but in the short range (one to four hours) when (from the surface mixing ratio chart combined with surface heating) showers will occur.

Case Study

On Saturday, August 23, 1986 at 00Z scattered showers and thunderstorms developed along a cool front over Iowa and northern Kansas (Figs. 1 and 2).

However, a look at the 12Z August 22 Omaha sounding (Fig. 3) indicated a cap near 700 mb and a fairly stable atmosphere, even with lifting due to an approaching front convection would be unlikely.

Even though a weak 500 mb trough was moving east over the Northern Plains, the 500 mb height and temperature at Omaha had not changed from 12Z August 22nd to 00Z August 23rd (Figs. 6a and 6b).

From 12Z on August 22 to 00Z August 23, surface dew points over western Iowa increased from the lower 60's to the lower 70's (Figs. 3 and 5).

At 00Z, as the front was approaching Omaha, an analysis of the sounding indicated that the average low level mixing ratio had increased from 11.1 G/KG at 12Z to 16.8 G/KG at 00Z (Fig. 6). This increase in the low level moisture coupled with surface heating had created enough instability so that the stable layer near 700 mb no longer acted as a cap for convection.

Conclusions

1. The moisture increase at low levels, indicated by increasing surface mixing ratios, allowed the lifting ahead of the front to trigger convection.

2. A forecast of afternoon surface temperature could be used with a morning sounding to indicate a "critical" surface mixing ratio for convection. To find this critical mixing ratio value:

A. Run the "ANALYZ" application program for the appropriate sounding (in this case Omaha).

B. Hit the "DRY" and create the adiabatic line 2 to 3 degrees below the expected high for the afternoon.

C. Hit the "WET" box and move to the right of the old mixing ratio along the dry adiabat until an LFC is found.

D. At this point hit "VALUE" and compute the pressure and temperature value at the LFC.

E. Go to a Skew T or pseudo-adiabatic chart to determine the appropriate mixing ratio value (Fig. 7).

3. By running the applications program NMCGPHSMR watch for values close to the critical values that are derived from the morning sounding. When these values have been reached, convection can be expected in the favored spot along the front where instability and moisture convergence are highest (Figs. 9, 10 and 11).

5. If a front is moving through the state and convection has not occurred by 4:00 pm the forecaster can have reasonable confidence of convection occurring within the next several hours if:

A. Lifted indices are less than zero,

B. moisture is increasing, or

C. mixing ratios are reaching critical values.

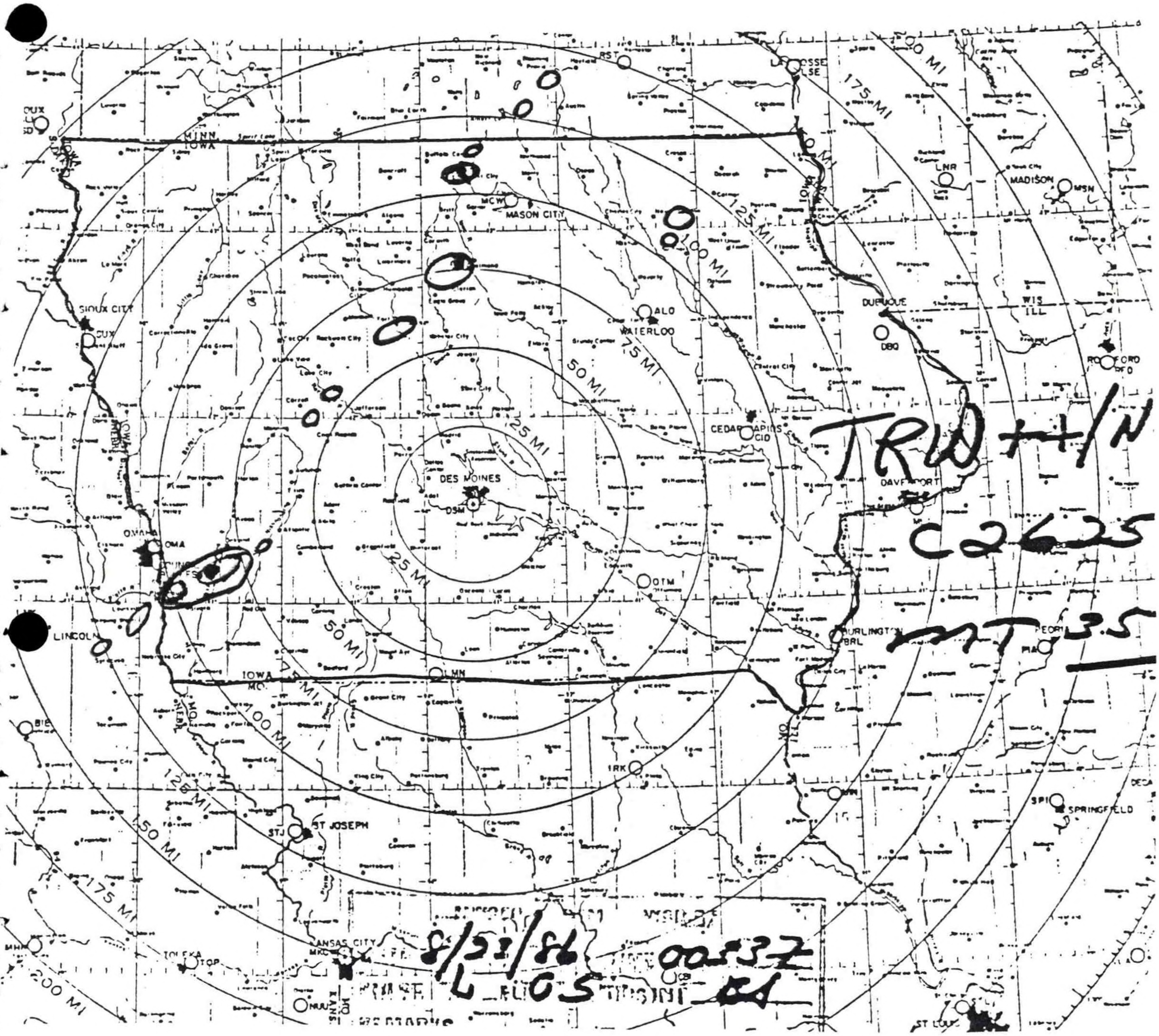

Fig. 1. Radar overlay from Des Moines for 0033Z August 23, 1986.

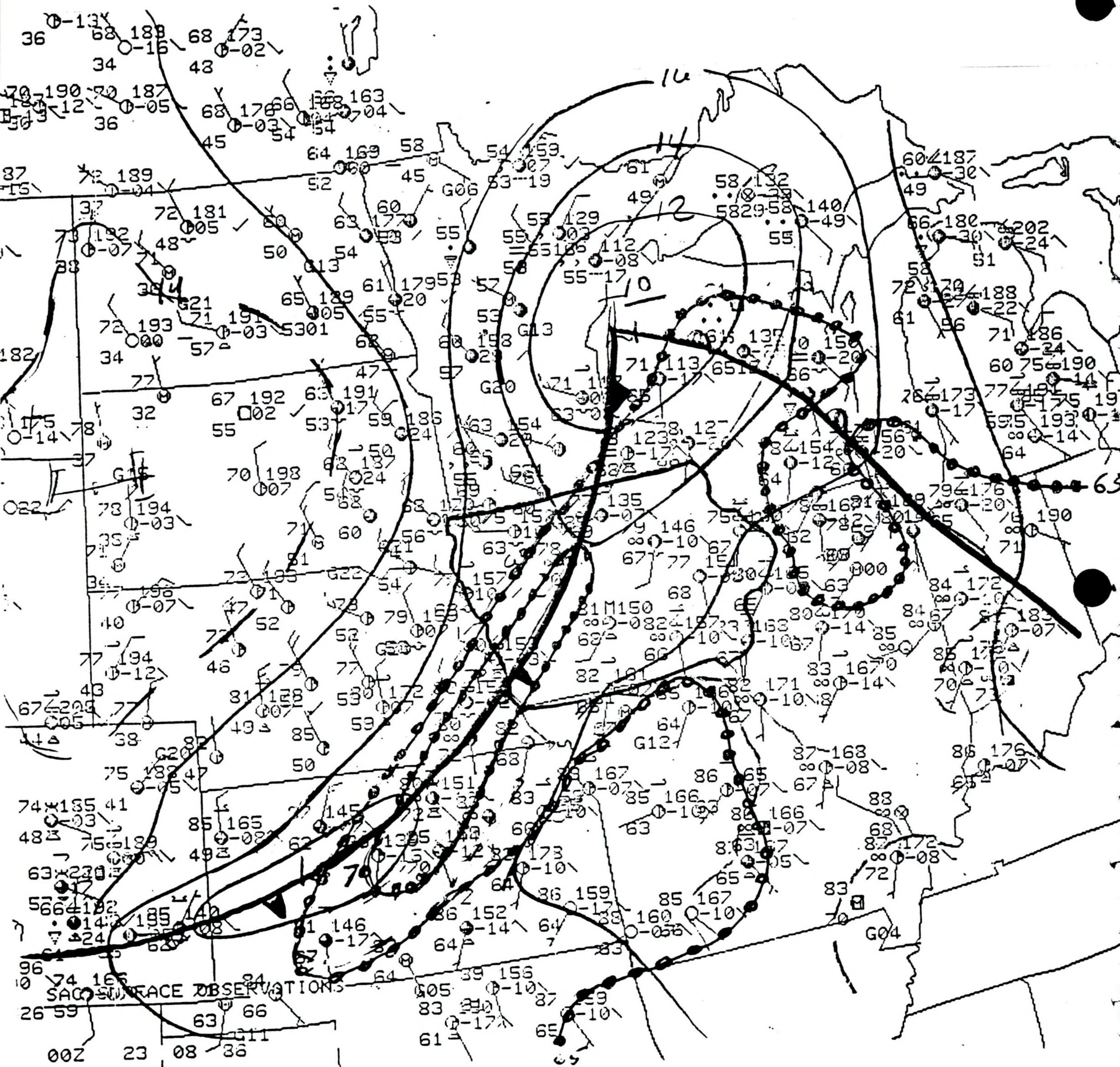

Fig. 2. Surface chart for 00Z August 23, 1986. The 65°F and 70°F dew point contours are dotted.

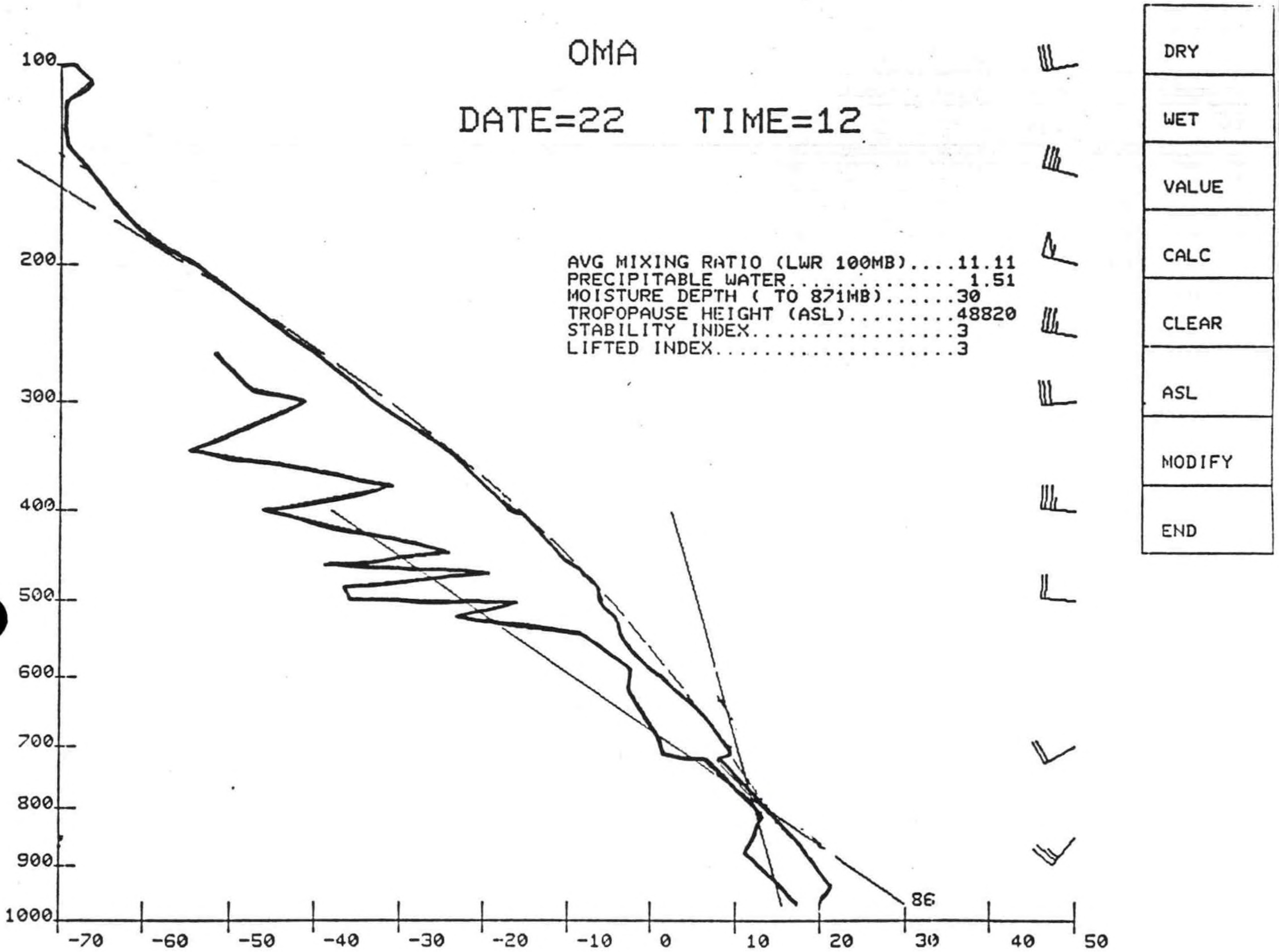

Fig. 3. Omaha sounding from 12Z August 22, 1986.

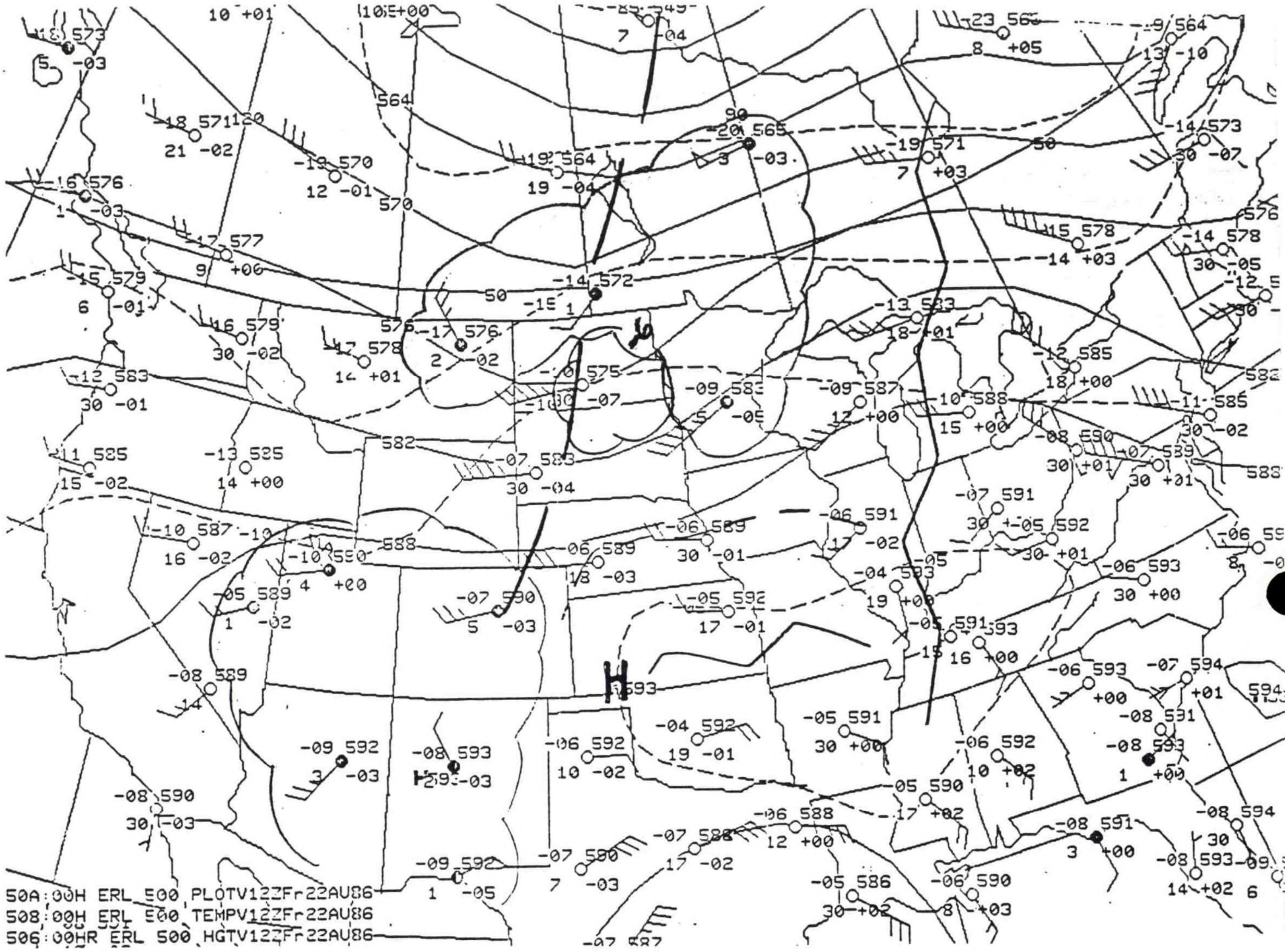

Fig. 4a. 500 mb chart at 12Z August 22, 1986.

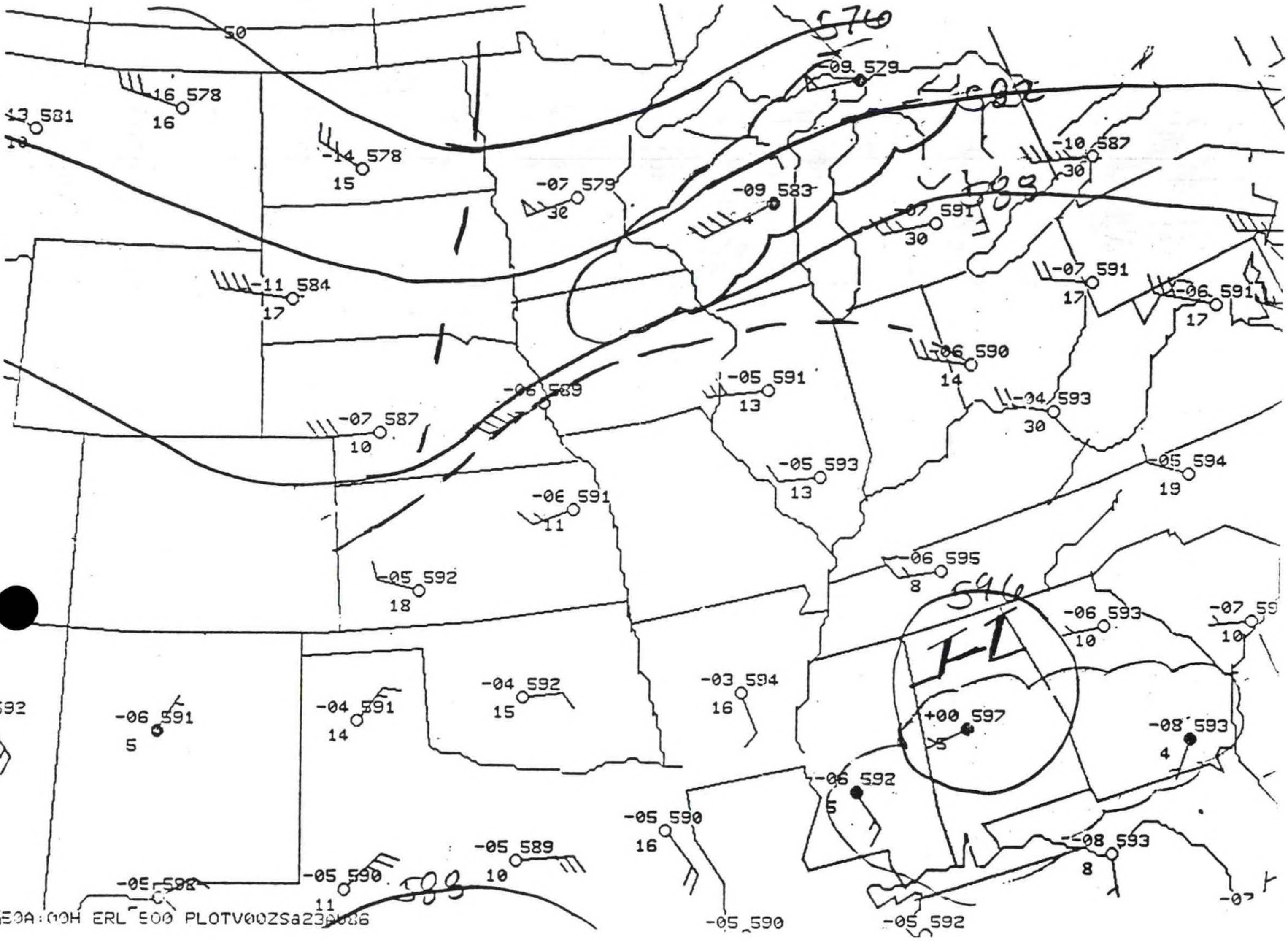

Fig. 4b. 500 mb chart at 00Z August 23, 1986.

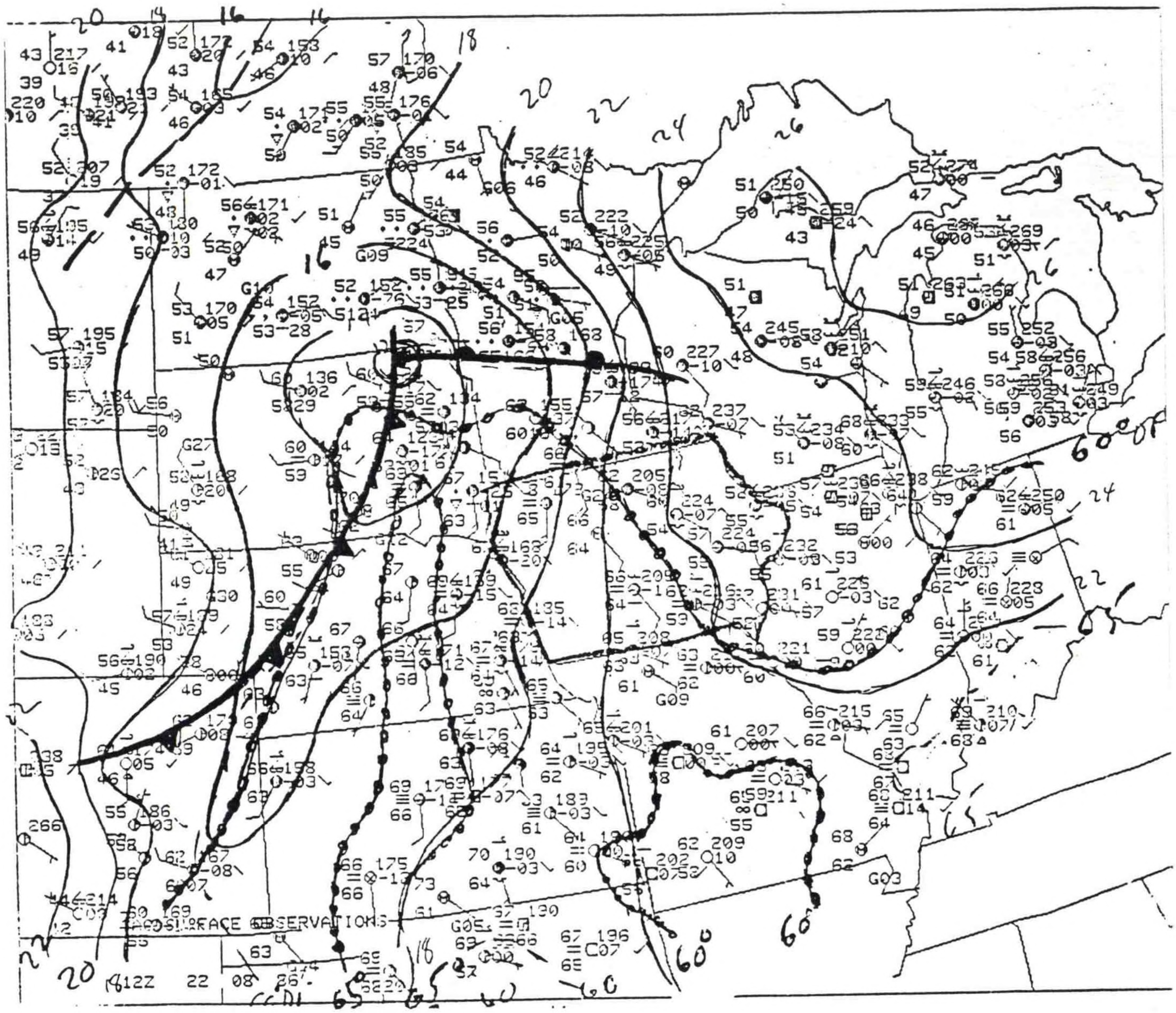

Fig. 5. Surface chart for 12Z August 22, 1986. The 60°F and 65°F isodrosotherms are dotted.

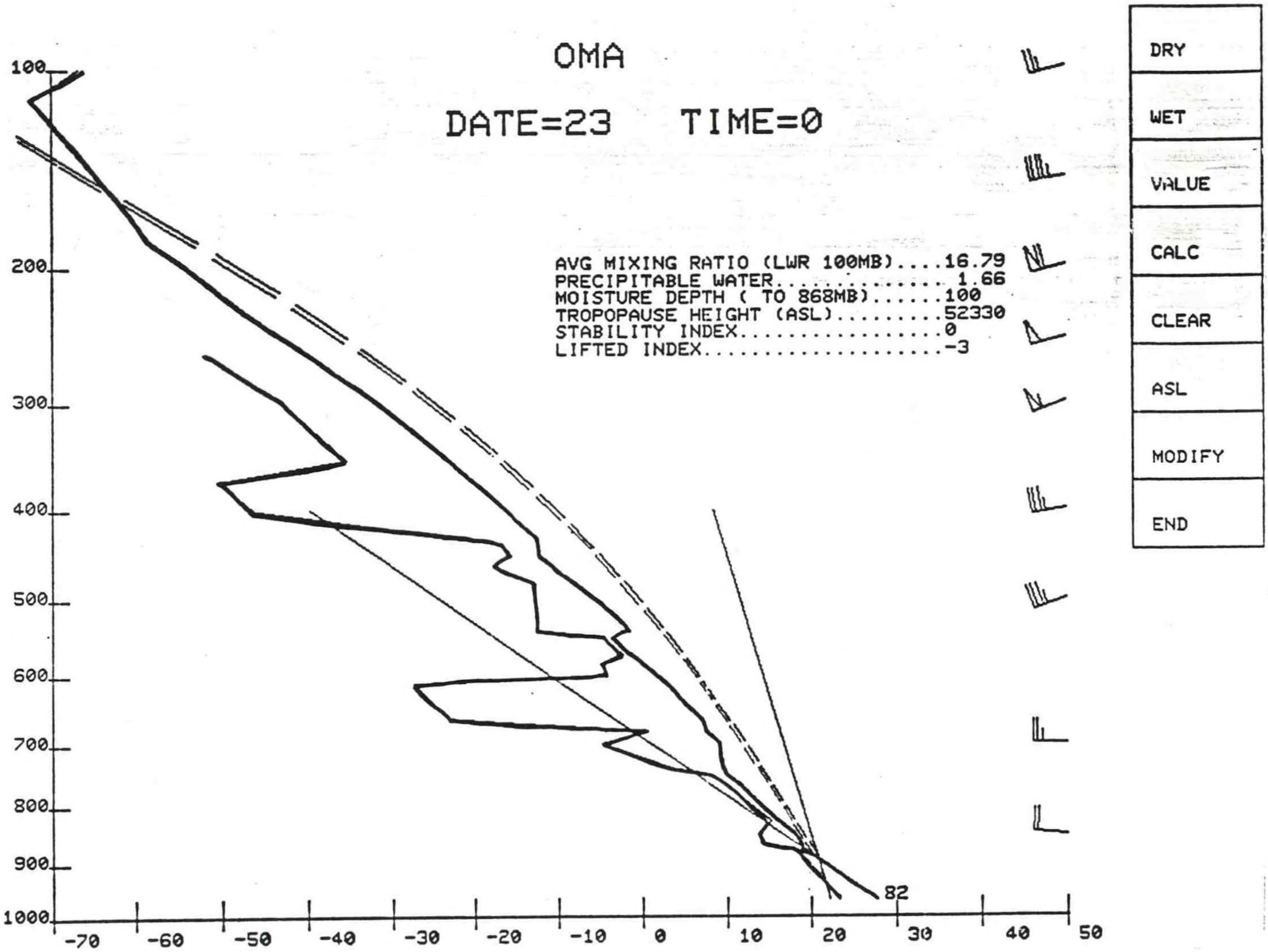

Fig. 6. Omaha sounding from 00Z August 23, 1986.

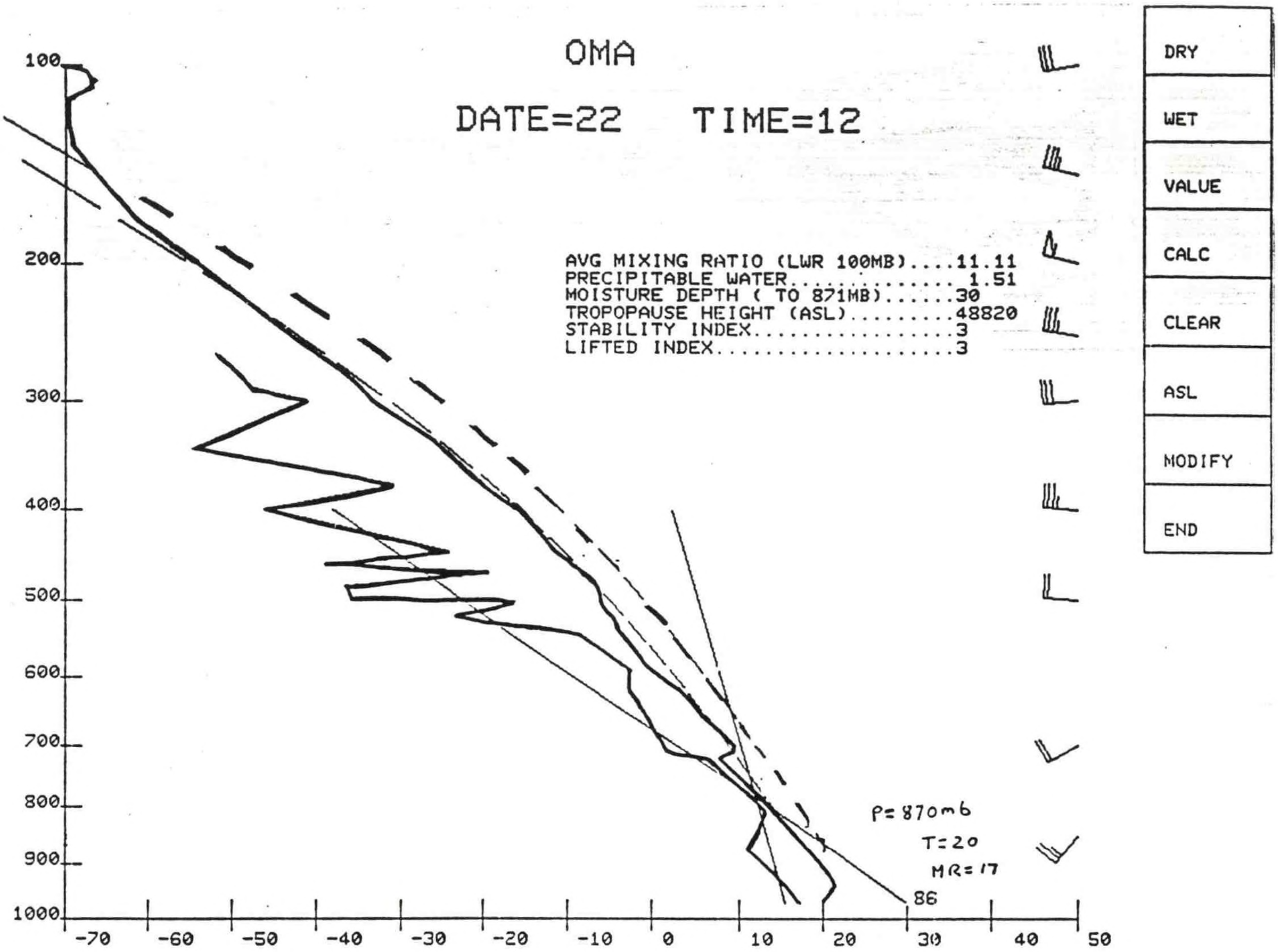

Fig. 7. Determination of "critical" mixing ratio.

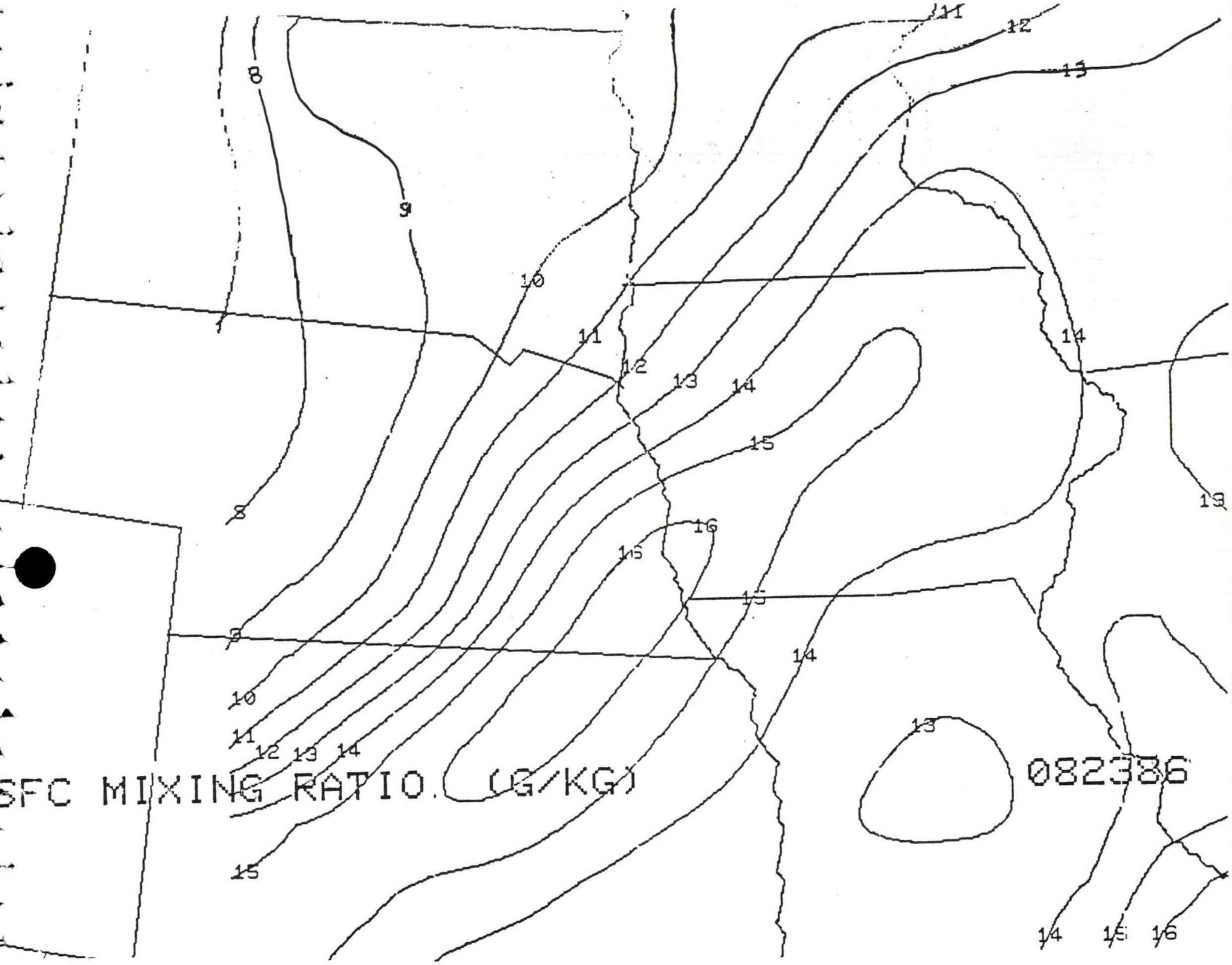

Fig. 8. Surface mixing ratio field at 00Z August 23, 1986.

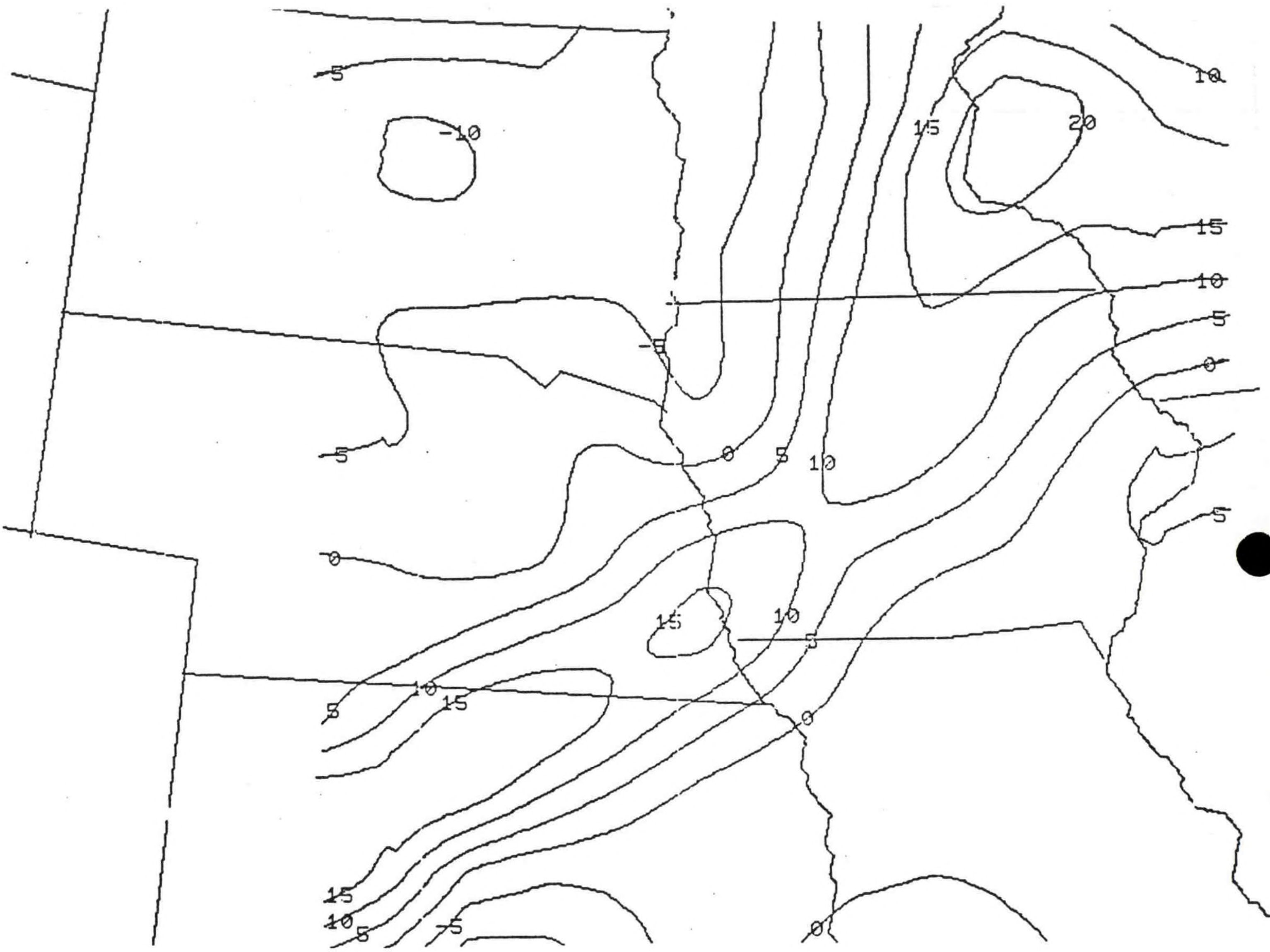

Fig. 9. Surface moisture convergence field at 00Z August 23, 1986.

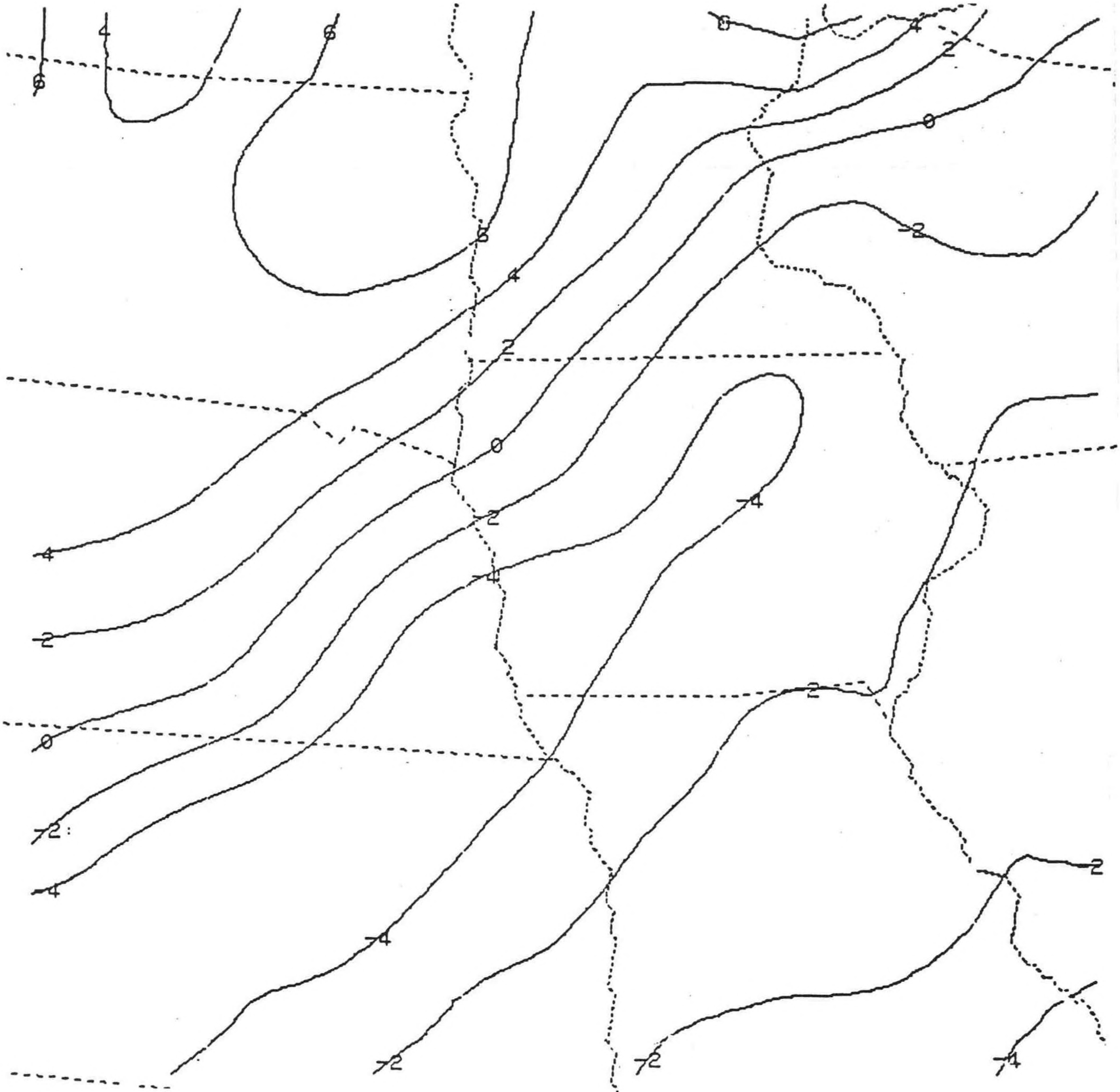

Fig. 10. Surface lifted index at 00Z August 23, 1986.