EASTERN REGION TECHNICAL ATTACHMENT
No. 89-11
October 17, 1989

SEVERE WEATHER OUTBREAK IN THE NORTHWEST PIEDMONT OF NORTH CAROLINA ON MAY 5, 1989

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INTRODUCTION

A fast moving meso-low[1] that formed from an old Gulf Coast States Mesoscale Convective Complex (MCC) 12 to 24 hours earlier moved northeast through western South Carolina and the western sections of North Carolina. It produced extensive wind damage and several tornadoes on the evening of May 5, 1989. Forsyth county, especially the city of Winston Salem, received the worst damage in the Northwest Piedmont but fortunately no lives were lost. Figure 1 shows approximate positions of the line of severe thunderstorms from 05/2315 UTC to 06/0130 UTC.

METEOROLOGICAL CONDITIONS

On the morning of May 5th, a meso-low was developing and moving through the Gulf Coast States. At 05/0900 UTC (Figure 2), the meso-low was positioned in northern Louisiana. Shortly before noon, it had moved to near Birmingham, Alabama and had started to gain forward speed. By 05/2100 UTC the meso-low was starting to enter extreme western South Carolina and the swath of severe weather had started. By 06/0000 UTC, it's position was just north of Charlotte, North Carolina. By 06/0300 UTC, the meso-low had exited North Carolina northeast of Raleigh. The average speed of movement was nearly 50 mph from west of Birmingham, Alabama to Virginia.

At 850 mb (Figure 3a), the meso-low (05/1200 UTC) was in the southeast corner of Arkansas with a 40 knot jet to the south over southeast Texas and southern Louisiana. Ahead of the jet was a small area of dew point depressions less than 5 degrees in central Mississippi and Alabama. A thermal ridge was already in place from southern Louisiana through northern Georgia to western North Carolina. At 06/0000 UTC (Fig. 3b), a strong trough at 850 mb extended from extreme western North Carolina to central Georgia and off the Gulf Coast at the Florida peninsula. A 40 to

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[1] A meso-low is a subsynoptic weather disturbance with an overall dimension of 10-100 km. The meso-low in this case study is on the upper end of this dimension scale.

50 knot jet extended from central Georgia northeast through Greensboro, North Carolina. A strong thermal ridge was in place from southern South Carolina to central and western North Carolina. Dew point depressions of less than 5 degrees covered a large area coinciding with the 40 knot plus jet. Realizing this chart is an after the fact product, it shows the fast development and setup of the severe weather ingredients in just 12 hours.

At 300 mb. (05/1200 UTC) (Figure 4a) a jet maximum was to the northwest near Huntington, W.V. moving northeast. At 06/0000 UTC (Figure 4b) the jet maximum was over southern Ontario indicating western North Carolina was in the right rear quadrant of the jet. The windspeed at 300 mb. at Greensboro increased from 60 knots at 051200 UTC to 75 knots at 06/0000 UTC.

At 05/2200 UTC the ADAP surface parcel Lifted Index (LI) chart (Figure 5) showed values of -5 to -6 over western North Carolina. At the same time the ADAP surface moisture flux convergence chart showed high convergence values with a tight gradient in the western sections of South and North Carolina with the axis orientated southwest/northeast (Figure 6). Two hours earlier, the large center over western South Carolina was located about 80 miles west which indicated the tight gradient was progressing toward the threat area. Figure 7 from ADAP shows an axis of relatively high average theta (Potential Temperature) advection values extending from about 50 miles southeast of Greer S.C. through the Charlotte N.C. area to the Virginia border northeast of Greensboro, N.C. from 05/2000 UTC to 05/2200 UTC.

The most significant part of the ADAP run was the total pressure change chart for 05/2000 UTC to 05/2200 UTC. (Figure 8) A -11 (hundredths inch) fall center was just to the north of Charlotte N.C. and a +8 (hundredths inch) rise center was just to the west of Atlanta Ga. The line drawn on the chart indicates the axis of the fall/rise couplet.

DISCUSSION

The 05/2200 UTC ADAP run showed a significant fall/rise couplet whose axis closely defined the projected path of the tornadic producing meso-low and the locus of anticipated severe storms. The axis of warm advection in the theta (potential temperature) field nearly coincided with the fall/rise couplet giving more confidence to the projected path of the meso-low...while defining the eastern boundary of the area of highest concern. The moisture convergence axis defined the western boundary of the area of possible severe weather. The threat area was located on the moist side of that axis. (See bottom of Figure 9.)

Around 05/2300 UTC the line of thunderstorms entered North Carolina in the counties west of Charlotte, N.C. Wind damage and tornadoes were being reported along it's path through western South Carolina. When the thunderstorms entered Lincoln county, a tornado touched down shortly before 05/2330 UTC. At 06/0005 UTC

the staff at WSO Greensboro issued the first Tornado Warning for the southwestern counties of the Northwest Piedmont. Shortly after 06/0030 UTC and just before the line entered Forsyth county the line started to bow. Note that the Kavouras picture from the Charlotte WSO radar indicated only small cores of VIP 4 level reflectivity. Also, some precipitation attenuation might have occurred. The mid-section of the bow echo passed through Forsyth county between 06/0035 UTC and 06/0105 UTC. The top of Figure 9 is a recap of the actual Storm Data Report for Forsyth County.

That evening a total of 5 tornado warnings and 1 severe thunderstorm warning were issued by WSO Greensboro and most were for multiple counties.

CONCLUSION

The severe event of May 5, 1989 was the result of 1) a rapidly moving and strong meso-low producing a bow echo (defined very well by a strong pressure fall/rise couplet), 2) strong warm air advection in the lower levels, 3) low lifted index levels, 4) a tight moisture flux convergence gradient and 4) divergence aloft from the right entrance region of the 300 mb. jet. In this event, ADAP provided considerable help in defining the area of heightened concern for damaging winds and tornadoes.

ACKNOWLEDGEMENTS

I would like to thank the meteorologists and especially Jan Price at the WSFO at Raleigh for supplying much of the data and advice for this paper.

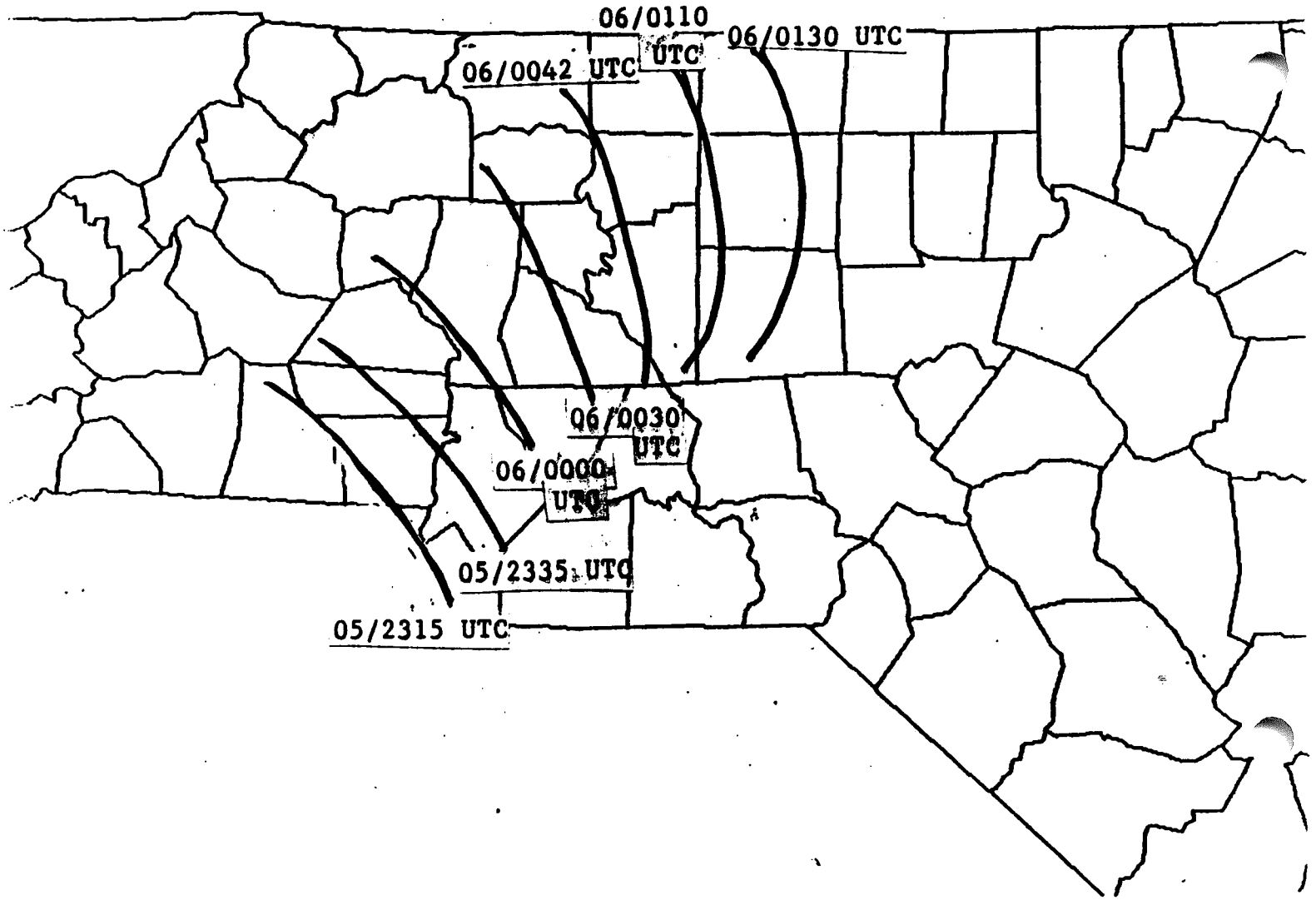

Figure 1. Approximate Thunderstorm Line Positions from 052315 UTC to 060130 UTC

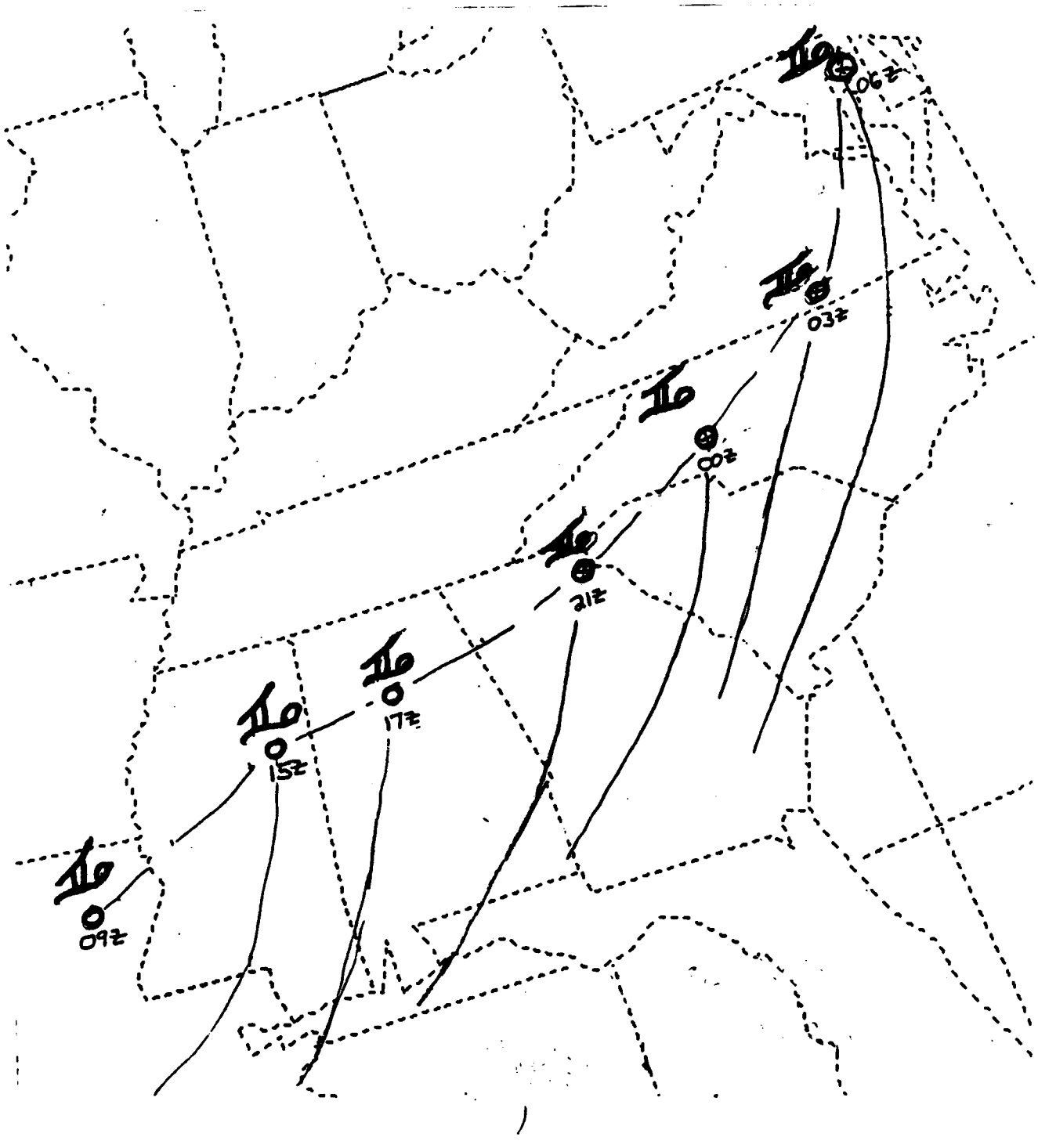

Figure 2. Positions of Surface Mesolow 05/0900 UTC- 06/0600 UTC

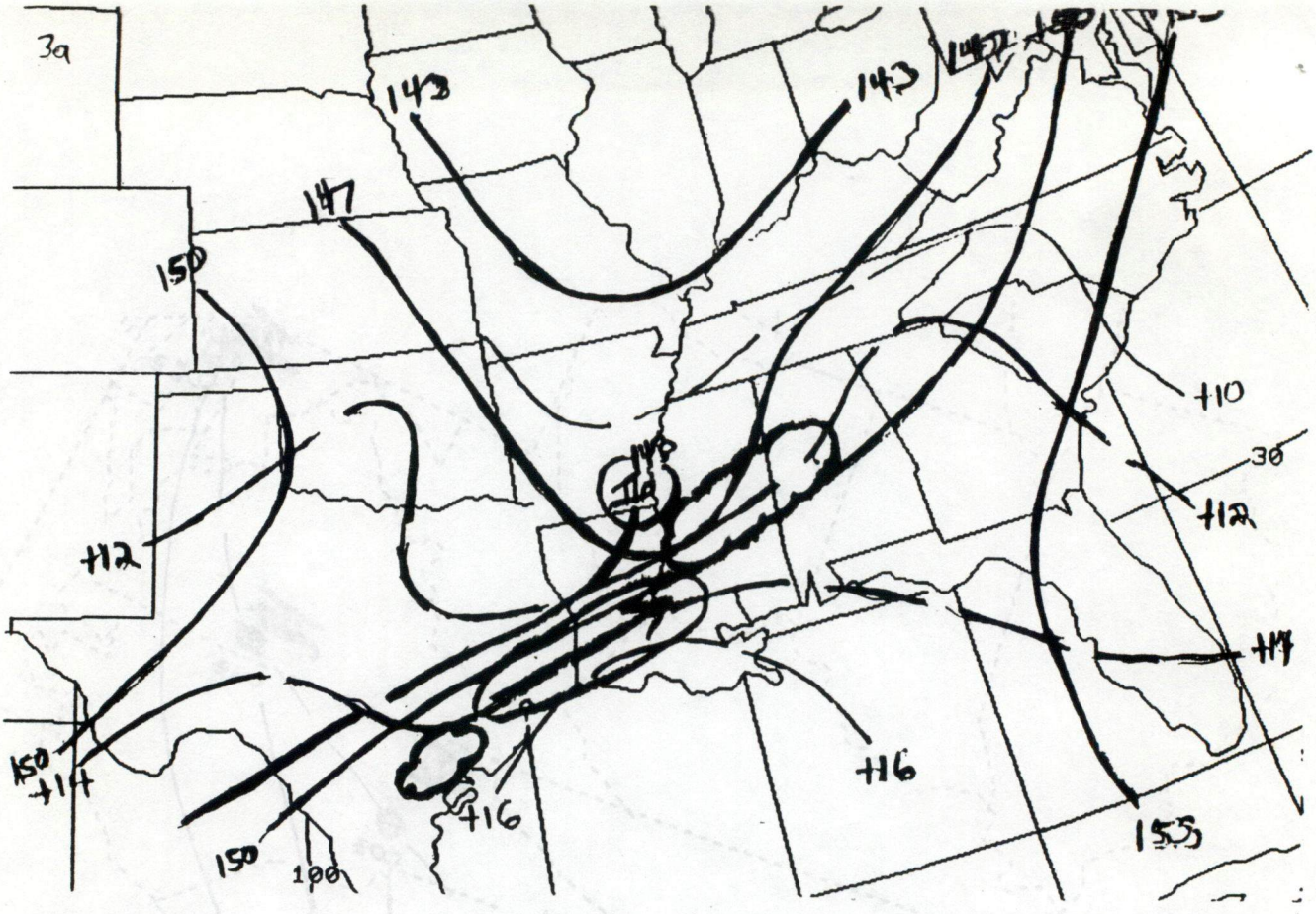

Figure 3a. 850 mb. level- 051200 UTC (with Hts., isotherms, jet in solid line, DP depressions in scallops<5°)

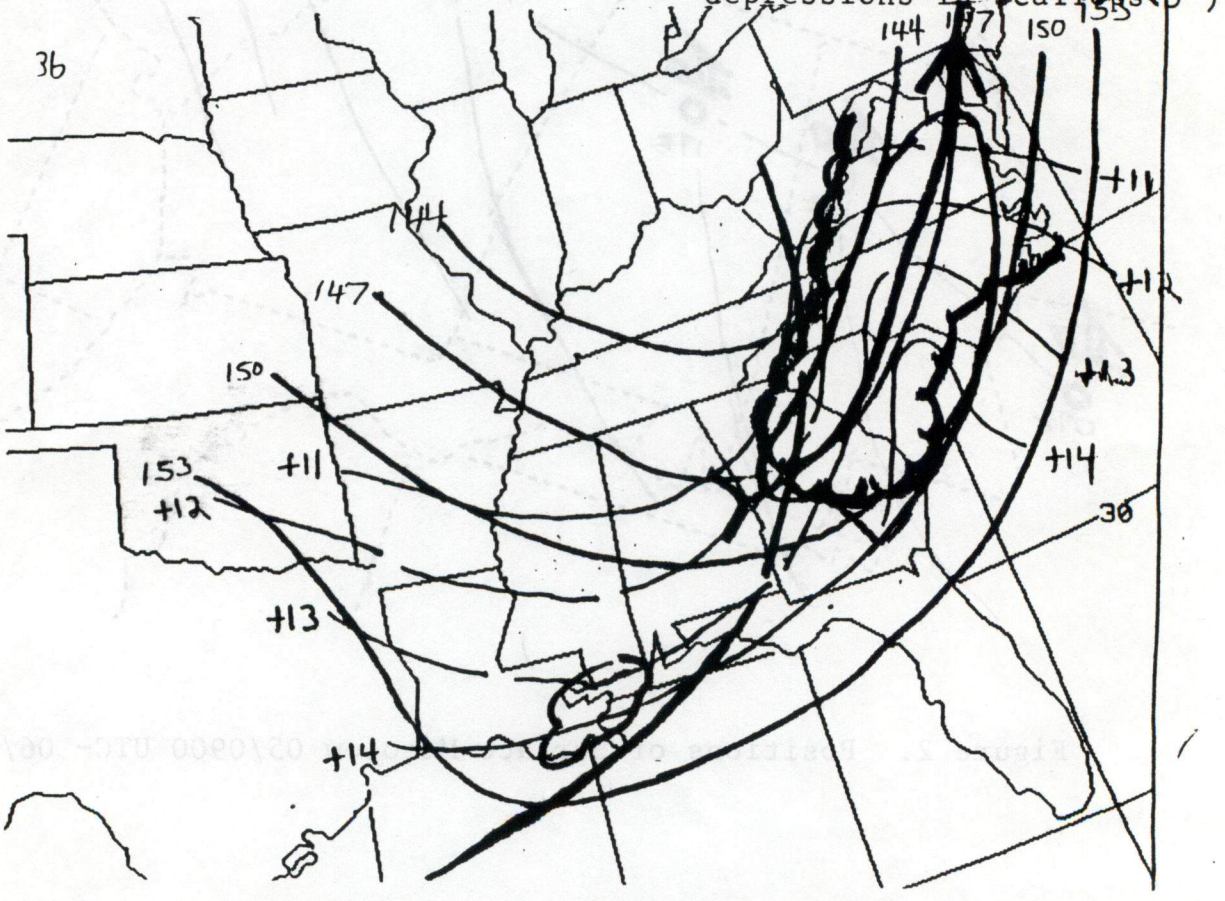

Figure 3b. 850 mb. level- 06/0000 UTC (with Hts., isotherms, jet in solid line, DP depressions in scallop<5°)

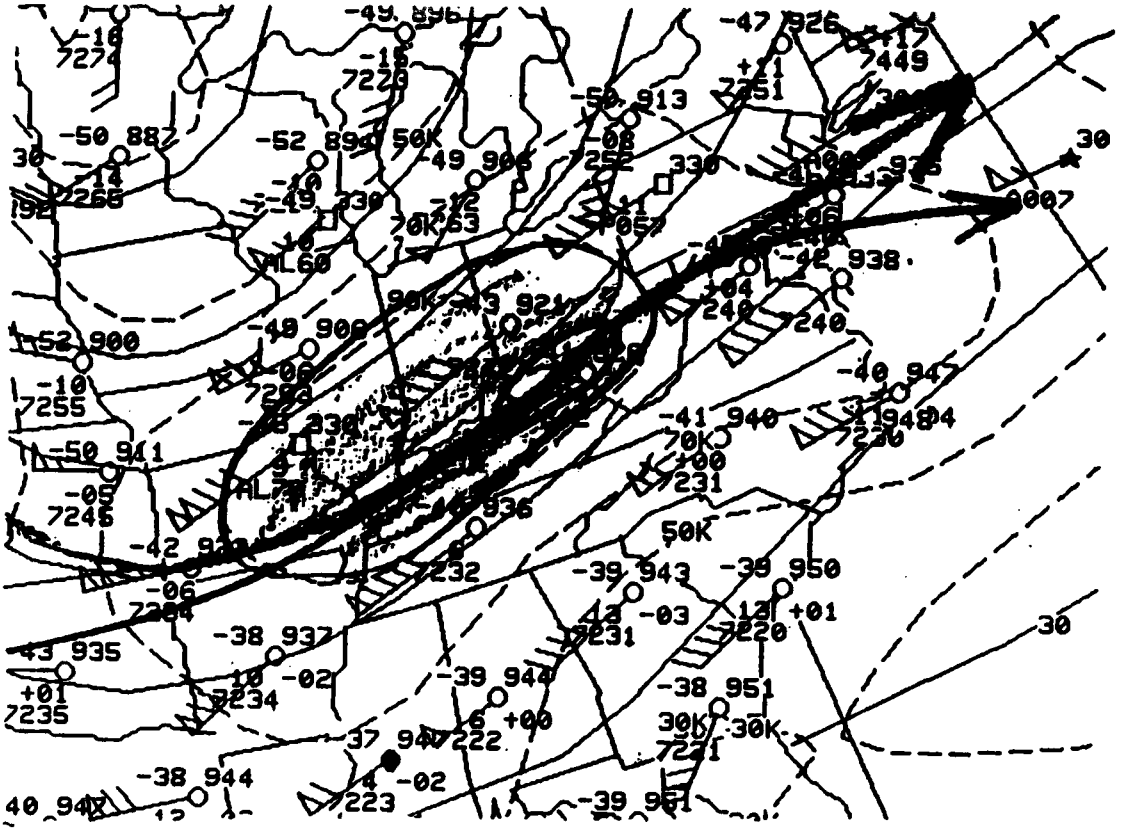

Figure 4a. 300 mb. level 051200 UTC

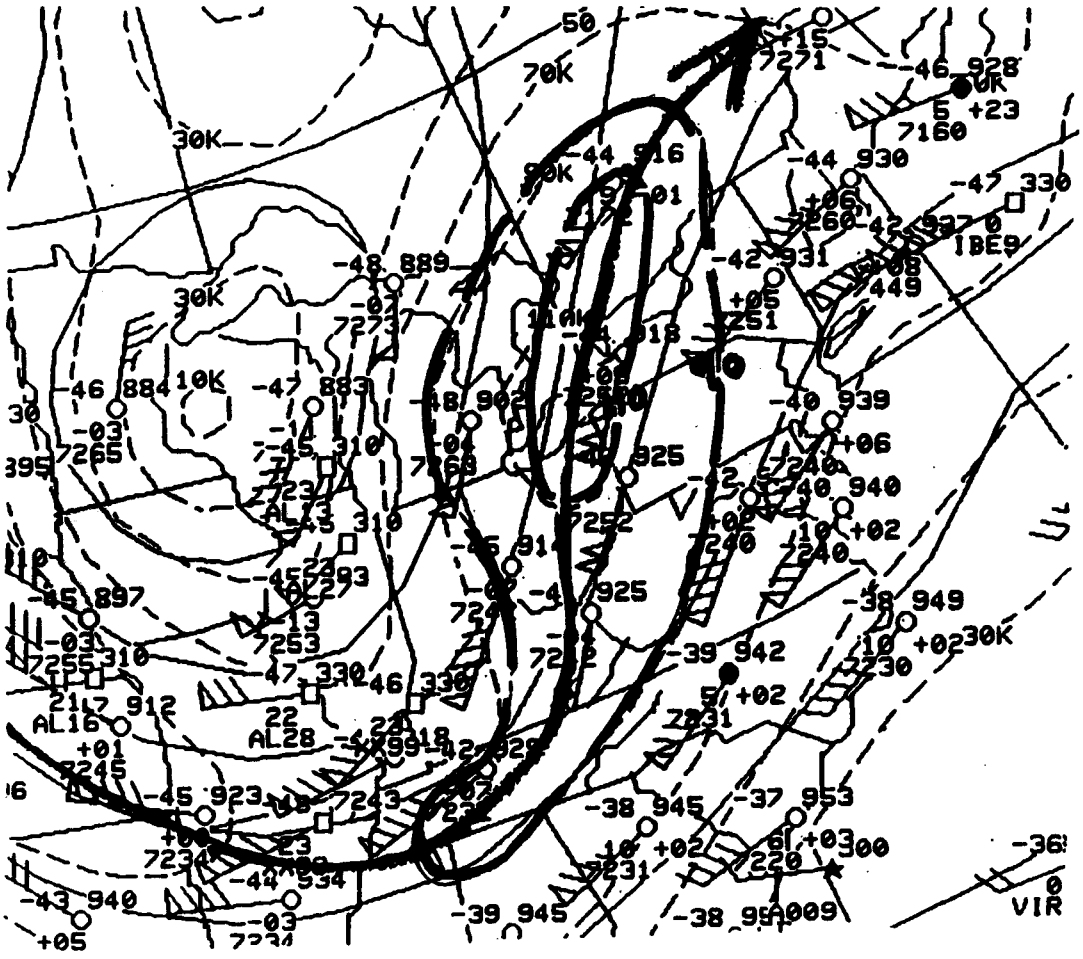

Figure 4b. 300 mb. level 060000 UTC

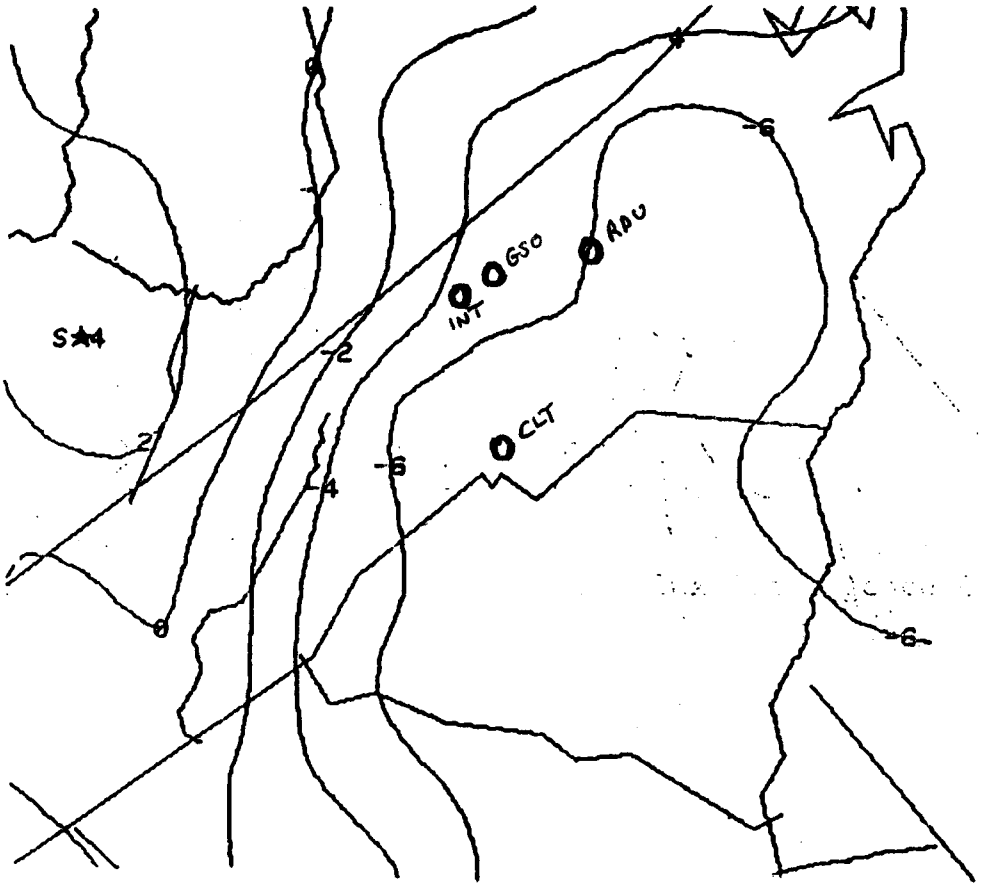

Figure 5. ADAP SFC Parcel LI 052200 UTC

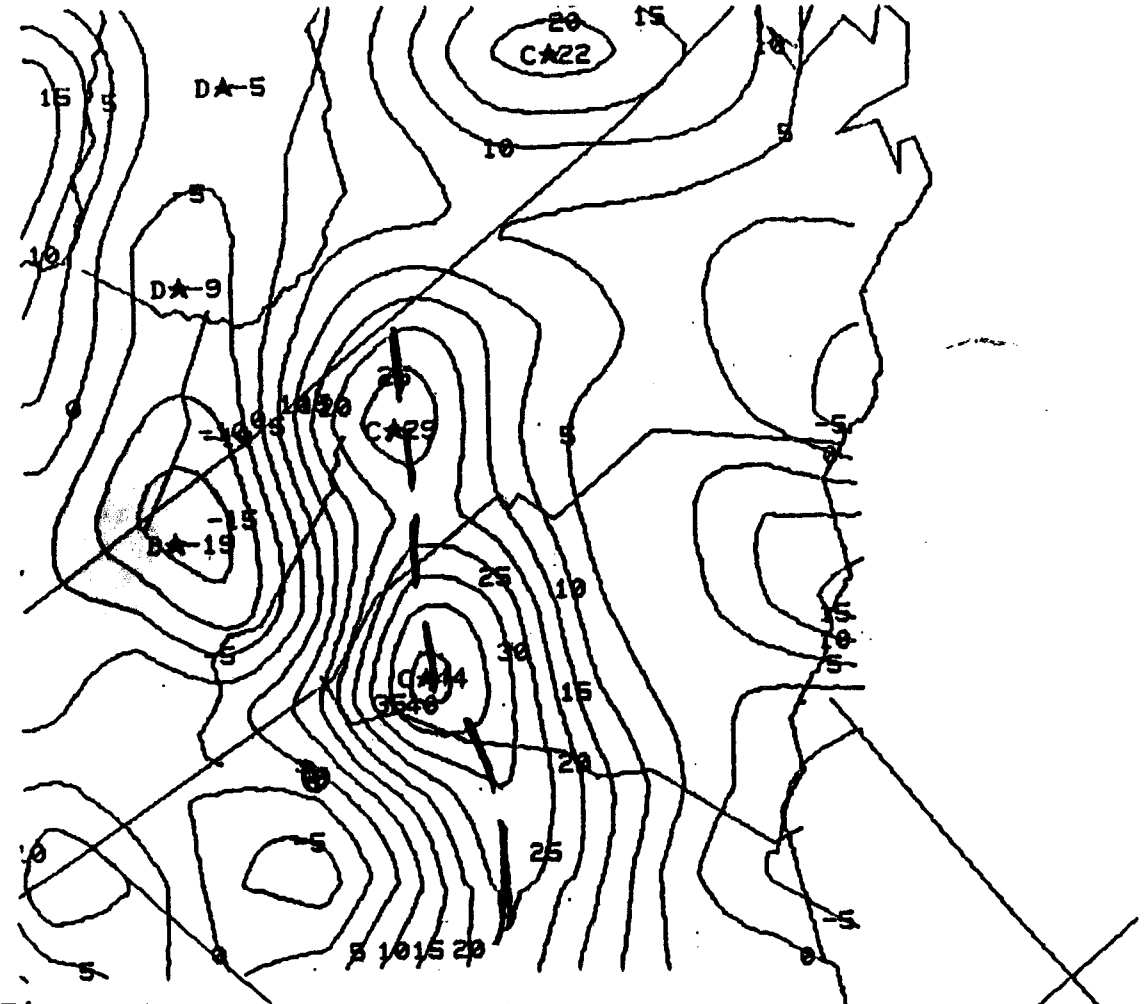

Figure 6. ADAP Surface Moisture Flux Convergence 052200UTC

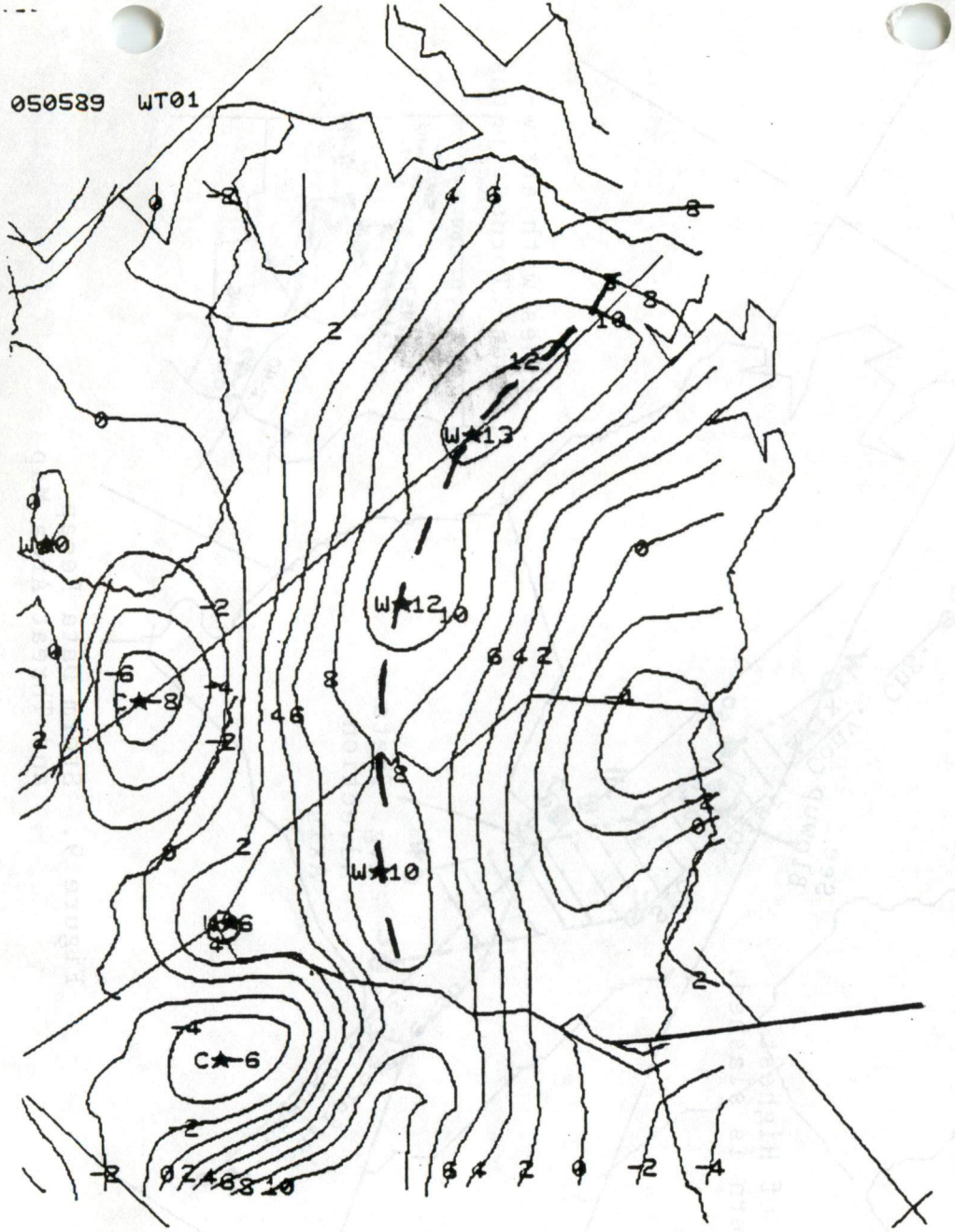

Figure 7. ADAP Avg. Theta Advection
052000 UTC to 052200 UTC

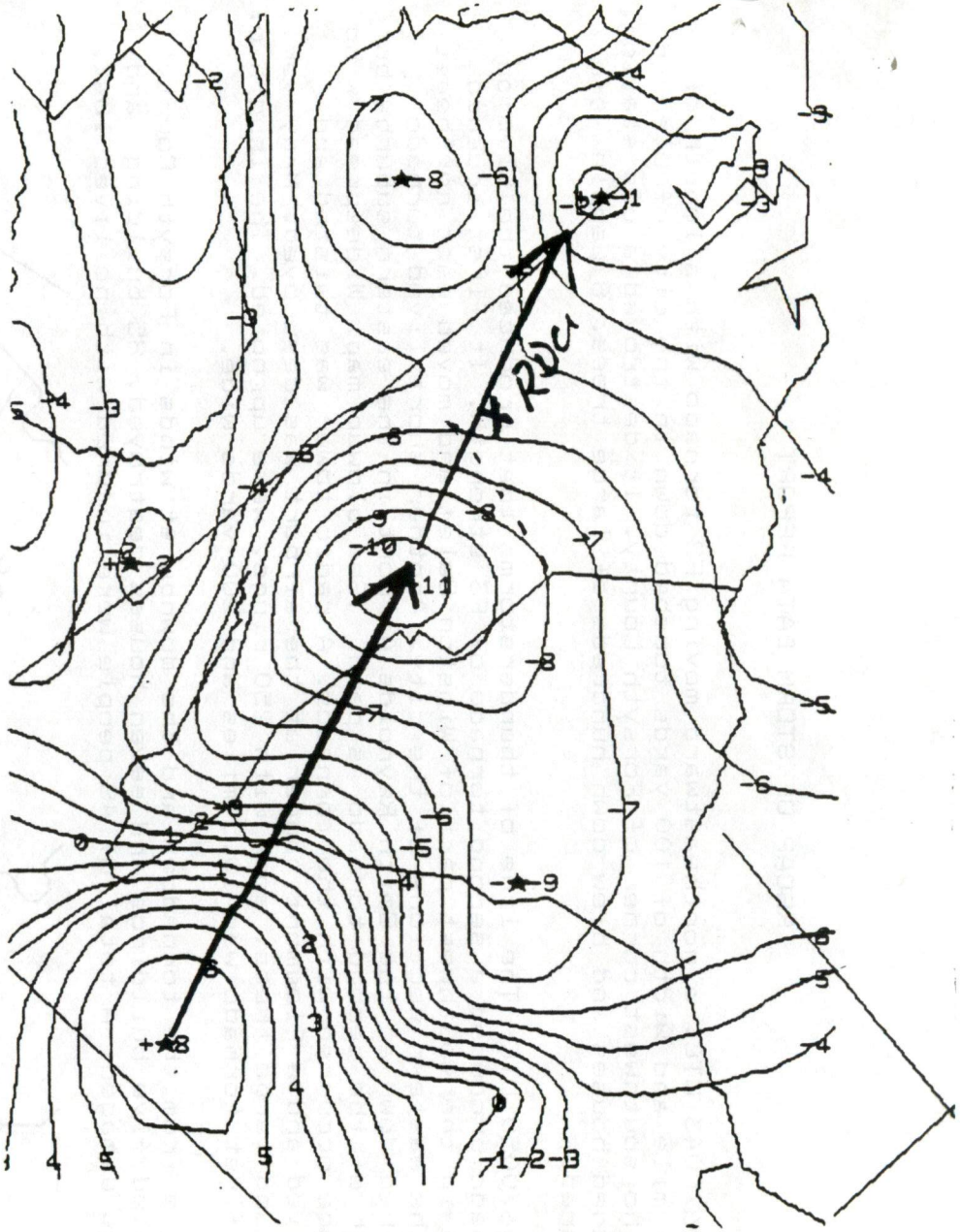

Figure 8. ADAP Total Pressure (Sfc) Change
052000 UTC to 052200 UTC

RECAP OF STORM DATA REPORT

At 06/0043 UTC: a northeastward moving F2 tornado with a length of a half mile and width of 100 yards touched down in the city of Clemmons in the southwest corner of Forsyth County. It destroyed a gas station, damaged houses and blew down hundreds of large trees. 8 people were injured.

At 06/0050 UTC: The line of thunderstorms that produced the Clemmons tornado produced a second tornado of F3 strength. It first touched down in the southwest part of Winston Salem and moved east northeast to the eastern sections of the city. Another short lived tornado touched down at the Smith Reynolds Airport in the eastern suburbs but north of the second tornado 's path. (See blowup map) Widespread wind damage occurred with the tornados. A radio tower was twisted and toppled and a Piedmont hanger at the airport was destroyed. Many very old and large trees, some with 250 rings, were uprooted. The length of the first tornado was 10.5 miles and 200 yards wide.

Damage from the tornadoes and the downburst winds in Forsyth County totaled five buildings and seven houses destroyed, 85 buildings and homes damaged. A total of 48 people were injured with no lives lost.

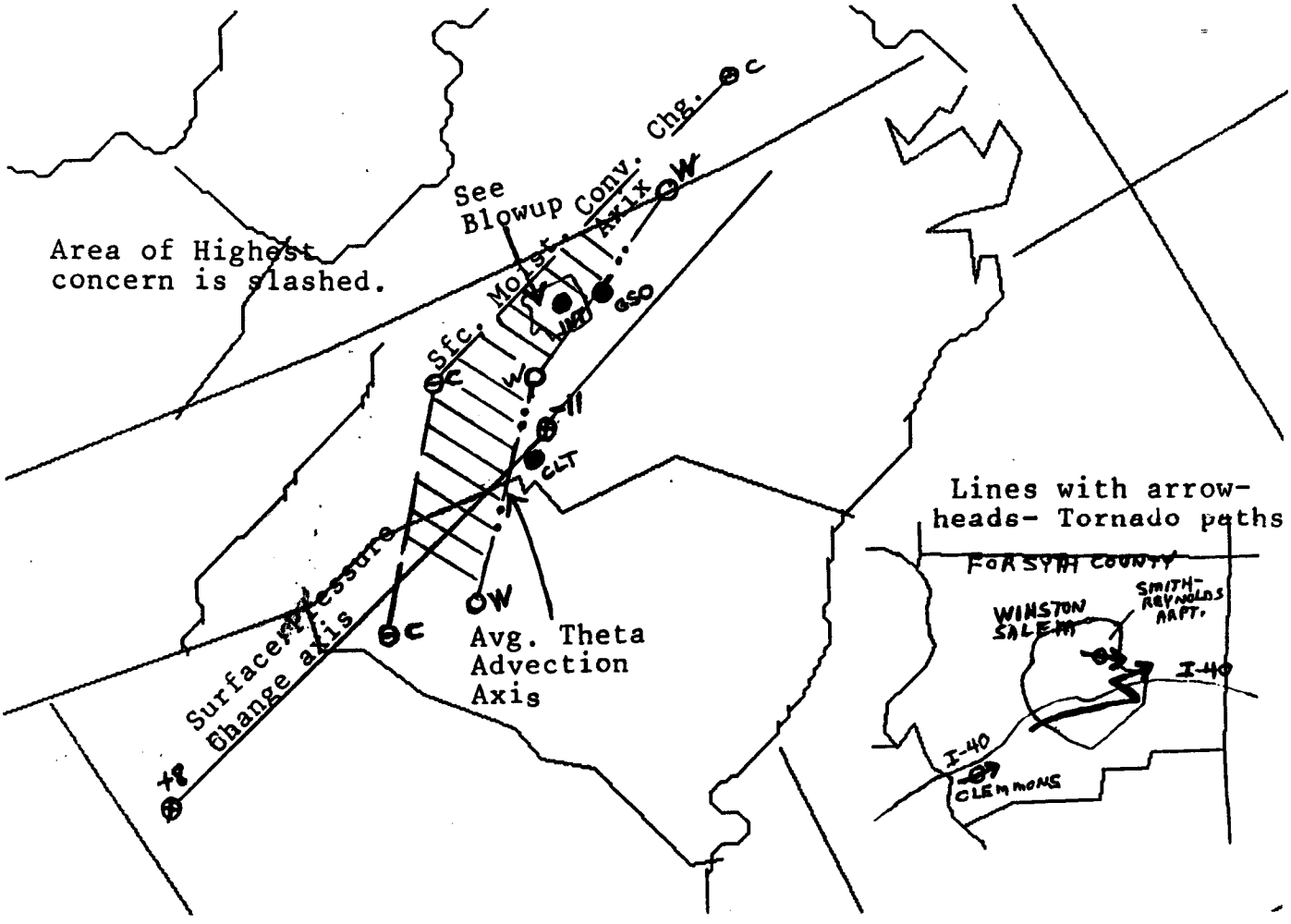

Figure 9. Storm Data Recap and Threat Area Map