

DISASTROUS MISSISSIPPI ICE STORM OF 1994

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Abstract

A damaging ice storm with freezing rain accumulations of 50 to 120 mm (3 to 6 inches) occurred across north Mississippi, southeast Arkansas, west Tennessee, northwest Alabama, north Louisiana, and extreme northeast Texas during the period, 9–11 February 1994. In Mississippi, the ice storm was the worst since 1951 with total damage estimates exceeding 300 million dollars and a federal disaster declaration for 26 counties. An analysis of the synoptic and mesoscale meteorological features of this ice storm is made. Data from newly available technology including WSR-88D products from Jackson, Mississippi, and Little Rock, Arkansas, and gridded data files from the National Weather Service's National Meteorological Center are examined. It is determined that an unusually effective combination of synoptic and mesoscale features worked in tandem to produce the thick glaze of ice and subsequent damage.

1. Introduction

"I haven't seen damage this widespread since Hurricane Camille!"

Miss. Power & Light spokesperson
E. Jussely quoted in the Jackson
Clarion-Ledger

The above quote concisely sums up the terrible ice storm of 9–11 February 1994 that plagued 26 counties in northern Mississippi. The storm damage resulted in a federal disaster declaration from President Clinton for 26 counties and total damage estimates exceeding three hundred million dollars. For Mississippians, the ice accumulation was the heaviest since the "Great Southern Glaze Storm" in January 1951 (Harlin 1952).

According to Mississippi Power and Light (M. P. & L.) estimates, 500,000 persons in roughly 200,000 homes had no electricity at the height of the storm and 175,000 homes had no water. Consequently, in a state with about 2.5 million residents, 20 percent of Mississippians lost power for at least a day. M.P. & L. estimates that even on Monday, 14 February, three days after the storm, 151,000 homes were still without power. In areas serviced by smaller power companies, electricity was out for three weeks or more due to the ice. People had to resort to fireplaces for heat, and candles and flashlights for light. Food that was refrigerated had to be eaten quickly or thrown out, and travel was almost impossible. Water systems were also severely affected for a week or more with over 300,000 customers of about 300 water systems advised to boil the water before use.

Agriculture, Mississippi's livelihood for most of its history, took a severe blow. Five percent of the state's pecan trees were reported destroyed and 6,000 acres severely damaged as most of the state's commercial pecan orchards were located in the hard hit counties of Coahoma, Bolivar, and Tallahatchie (Delta counties located between the Mississippi River and Interstate

55 in northwest Mississippi). It will be at least 3 and more likely 5 years before pecan production can recover. Huge losses to commercial tree crops were front page news across the State the week following the storm. The state's education system, from grammar schools to large state universities, sustained severe damage, with schools in the disaster area forced to cancel classes for up to two weeks after the storm.

Ice storms are very difficult to forecast anywhere, and especially so in the deep south. Forecasters at the National Weather Service Forecast Office (NWSFO) in Jackson, Mississippi did an outstanding job of providing early warning of this event. Early notice of a potential ice problem was provided for the fourth period (Thursday) forecast at 1620 LST Tuesday, 8 February. The mention of freezing rain was carried through the 2120 LST Tuesday and 0420 LST Wednesday, 9 February packages. Forecasters at Jackson were also concerned with the potential for heavy rain (a Flash Flood Watch was issued for the northwest third of Mississippi early Tuesday) and very dense sea fog that moved north from the Gulf of Mexico across the three Mississippi coastal counties. The sea fog contributed to a 17 car accident on the Pascagoula River bridge in Jackson County (a Dense Fog Advisory was in effect).

With temperatures falling and persistent reports of icing from Arkansas and the Memphis area, a Freezing Rain Advisory was issued in the 1020 LST Wednesday, 9 February, forecast package. Map discussion, held routinely at NWSFO Jackson, was an open exchange with the possibility of a major ice storm for the northern counties the main topic. It was a group decision led by the Forecaster-In-Charge to issue an Ice Storm Warning for 39 counties north of a Hollandale-Kosciusko-Macon line and a Freezing Rain Advisory for central Mississippi north of a Port Gibson-Magee-Quitman line (Fig. 1). Specific cities were mentioned in the text and people warned of significant ice accumulations. Advice was offered concerning preparations for downed power lines. State utility companies and the highway patrol were notified individually.

As the event continued, forecasters tailored the warning area to those counties along and northwest of a Greenville to Tupelo line and extended the time period through Friday morning. The 1020 LST zone forecast product Thursday, 10 February, trumpeted damaging ice accumulations of 3 to 6 inches and reiterated that this was a dangerous situation. As power was lost to NOAA Weather Radio sites, utility companies made numerous calls to the Jackson NWSFO for updated weather information. To make the situation even more difficult, a Tornado Watch was issued for southeast Mississippi that afternoon in advance of the developing wave in the northern Gulf of Mexico.

The counties which suffered the worst damage were under a Freezing Rain Advisory from 1020 LST to 1620 LST Wednesday, 9 February, and an Ice Storm Warning from 1620 LST Wednesday through 1020 LST Friday, 11 February, a total of 48 hours. In spite of the severity and broad scale in both time and space (icing occurred in northeast Texas, north Louisiana,

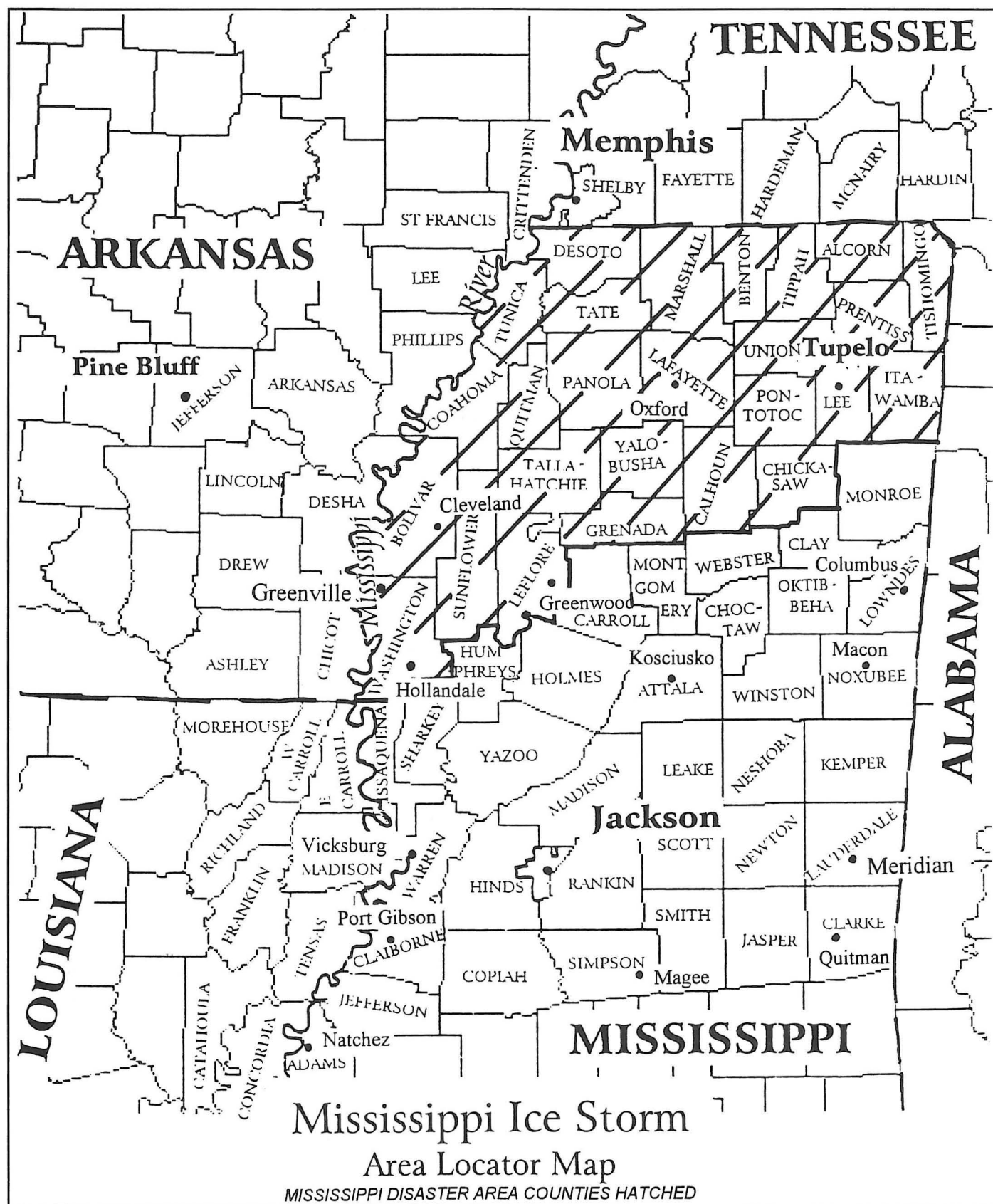


Fig. 1. Mississippi ice storm area locator map.

north Mississippi, southeast Arkansas, west Tennessee [including the Memphis metro area], and northwest Alabama) there was a curious lack of attention from the national media concerning this event. In fact, most Americans outside the affected area knew little about the storm and its effect on area residents. This lack of attention was detrimental to recovery efforts by utility companies and emergency management offices.

2. Synoptic Scale Overview

The synoptic-scale meteorological situation at 0000 UTC 9 February 1994, showed a split flow in the middle and upper troposphere over the contiguous United States (Figs. 2 and 3). The northern branch showed a strong northwest to southeast flow down the lee side of the Canadian Rockies and a southwest to east-northeast flow through the Great Lakes region; the mean trough extended into the Dakotas from central Canada. The southern branch was generally oriented southwest to northeast over the extreme southwest and southeast quadrants of the United States; a relatively strong storm system was beginning to move ashore over southern California. At the surface, a shallow (generally less than 1 km) but very cold Arctic air mass had moved southward across the high plains from central Canada behind a strong surface cold front (Fig. 4). A 7.5°C per 100 km temperature gradient existed across the front and surface winds behind the front were generally 8 m s^{-1} from the north; ahead of the front winds were generally 6 m s^{-1} from the south.

The frontogenesis function as defined by Bluestein (1992) states that the geostrophic total derivative of the gradient of temperature on a constant pressure surface is equal to the geostrophic frontogenesis. Near the surface (1000 mb), a more meaningful result is obtained by using the total wind to obtain a measurement of the actual frontogenesis. Using PCGRIDDS (Personal Computer GRIdded Data Display System—which in NWS field offices is a program widely used to display and analyze model gridded output—Petersen 1991; Meier 1993) to calculate this function at 1000 mb yields maximum frontogenesis of about $1^{\circ}\text{C (100 km)}^{-1}\text{ h}^{-1}$ across southern Arkansas, northeast Texas and northwest Mississippi at 1200 UTC 9 February (not shown), increasing to $2^{\circ}\text{C (100 km)}^{-1}\text{ h}^{-1}$ near the Mississippi Gulf coast at 1200 UTC 10 February (not shown). The frontogenesis function thus shows a horizontal deformation field tending strongly toward strengthening the front.

The cold front entered extreme northwest Mississippi around 0800 UTC 9 February and moved steadily through the north and central counties, only to stall across south Mississippi as a wave began to develop in the Gulf of Mexico. Temperatures in northern Mississippi dropped steadily behind the front and became subfreezing in the northwest corner of the state by mid morning, 9 February. Cold air advection (approaching 2°C h^{-1}) existed behind the surface cold front across southeast Arkansas while warm air advection (0 to $0.5^{\circ}\text{C h}^{-1}$ at the 850-mb level) existed ahead of the surface front.

Moisture flux convergence was strong at the 850-mb level across the ice storm area (not shown). A strong 500-mb vorticity center (valued at $28 \times 10^{-5}\text{ s}^{-1}$ [Fig. 5]) moved east across Texas and then northeast through the Lower Mississippi Valley; at the same time weaker vorticity lobes passed across the ice storm area ahead of this vorticity center. These weak short waves provided additional dynamic lift to complement the mechanical lift of the very cold air moving under the warm, moist air already in place, and consequently light rain began

to fall across the extreme northwest Mississippi counties, Wednesday morning.

As the strong California system began to move across the southern Rockies and into Texas, a wave developed along the front in the northern Gulf of Mexico, off the Louisiana coast. Ahead of this developing low pressure system, very warm, moist air from the Gulf increased temperatures to the 20 – 25°C range across the southeast and coastal counties of Mississippi, and enhanced the overrunning of the cold surface air in the North. From the Little Rock, Arkansas, rawinsonde sounding, the cold air in north Mississippi was only 300 to 1,200 meters thick at most, with a pronounced “nose” of very warm, moist air at 850 to 800 mb. This “nose” is classically associated with freezing rain (Harlin 1952; Williams 1960). Comparison of Little Rock rawinsonde soundings at 0000 UTC on 10 and 11 February (Figs. 6 and 7) show increases in temperature and dew point in the 850–800 mb layer, presumably due to advection.

Heavy rains fell over all but extreme southeast Mississippi, and, where icing did not occur, some minor flooding was reported. With northwest Mississippi well below freezing, damaging ice accumulations of 50 to 120 mm (2 to 5 in.) were common. The freezing rain reached its peak intensity Wednesday night and Thursday, 9–10 February, with rainfall totals in the 26 county disaster area ranging from 63 to over 127 mm (2.5 to 5 in.) (Fig. 8). The rainfall finally ended early in the morning on Friday, 11 February.

3. National Meteorological Center (NMC) Model Forecasts and Interpretation

Overall, NMC's three operational models, the 80 km Eta, the Nested Grid (NGM), and the Aviation (AVN), did well in providing advance notice of the impending ice storm for north Mississippi. The overall split flow pattern and the subsequent forecasts of the California system were consistent and reasonable, and Jackson NWSFO forecasters were able to use the models to correctly forecast heavy rain. Temperature forecasts were very difficult, because the Model Output Statistics (MOS) had trouble with the very shallow, cold air mass at the surface; thus, MOS forecasts were too warm. Even so, forecasters at the Jackson NWSFO were able to key in on the PCGRIDDS data for the Eta, NGM and AVN models and use the 1000-mb forecast temperatures and winds to successfully position advisories and warnings.

Of the three gridded data models, the 80 km resolution Eta model provided the best and most consistent forecast of the freezing and subfreezing temperatures for northwest Mississippi. As early as the 1200 UTC run on Tuesday, 8 February, the models showed possibly heavy rain with temperatures below freezing over the northern half of the State. The problem was how much of the State would have temperatures below freezing and how long such conditions would last. The early Eta model initially was too fast and too far south with the freezing temperatures, as was the NGM's 1000-mb temperature forecast. By 0000 UTC on 9 February, about 12 hours before the beginning of the ice storm, the Eta and NGM still placed the freezing temperatures too far south, and the NGM showed a dramatic warm-up at 48 hours that neither of the other models showed. The Ice Storm Warning was issued with the benefit of the 1200 UTC 9 February model runs, with all models reasonably consistent and correctly targeting the Delta and northern counties for the main ice accumulations. The NGM, however, still showed a dramatic warm-up in the 36- and 48-hour period forecasts that did not show up in the other two model runs.

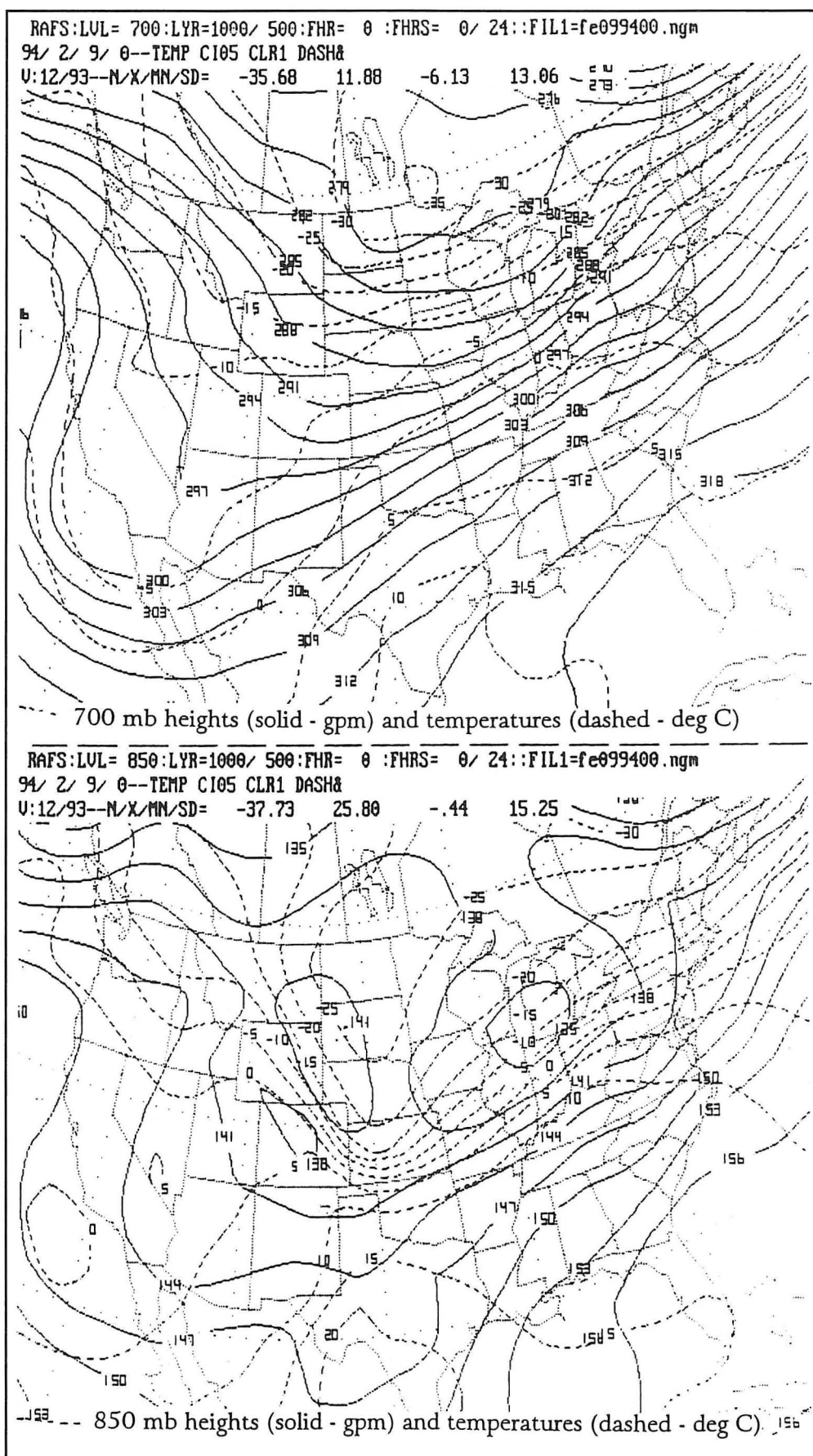


Fig. 2. Height and temperature analyses at 850 and 700-mb levels, 0000 UTC 9 February 1994.

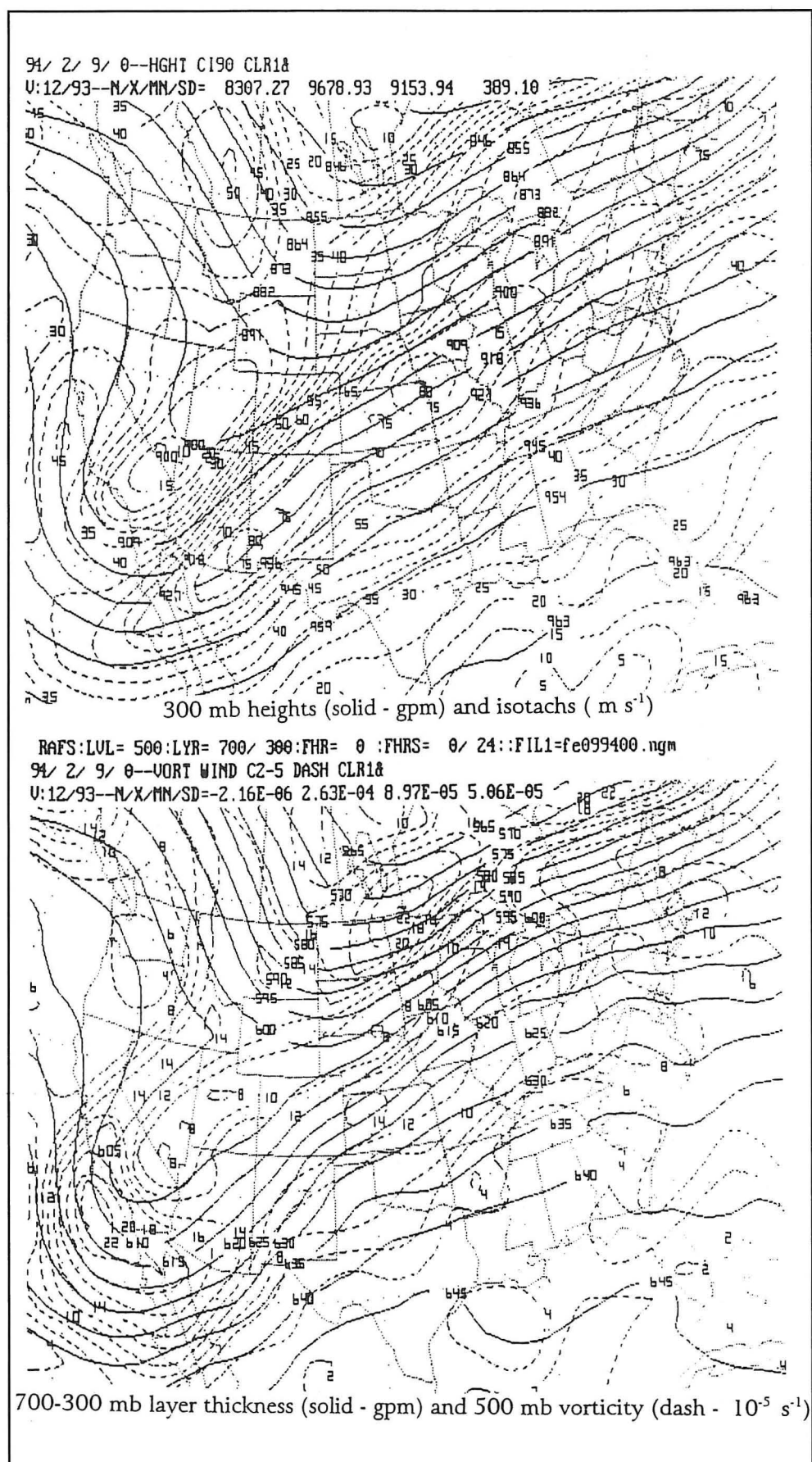


Fig. 3. Upper-air analyses for 0000 UTC 9 February 1994.

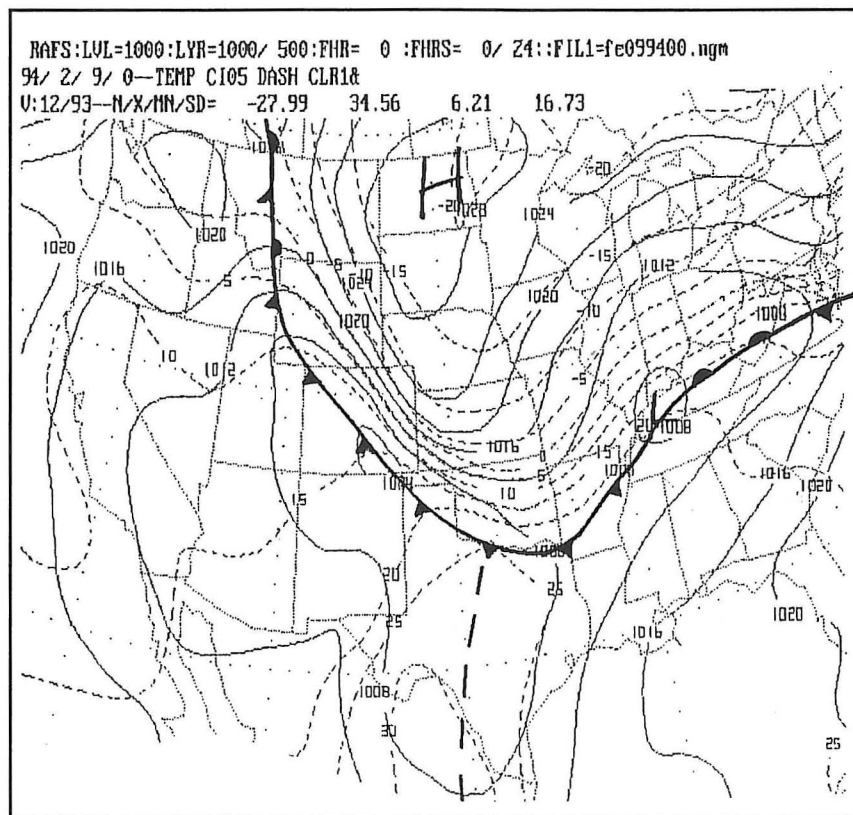


Fig. 4. Surface analysis for 0000 UTC 9 February 1994. Isobars (solid) are in mb and isotherms (dashed) are in deg C.

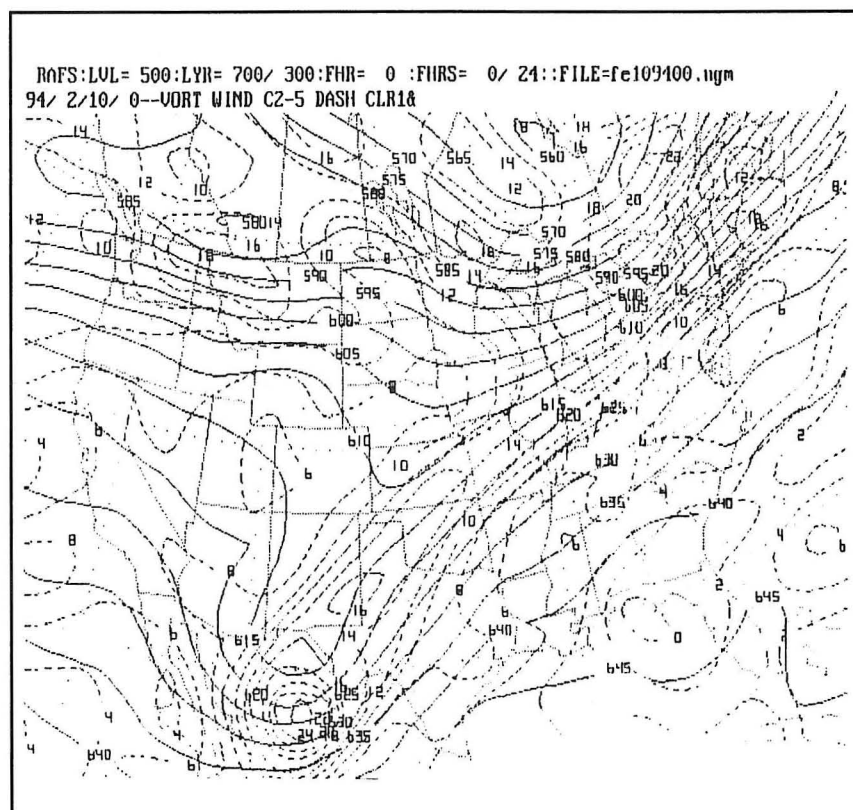


Fig. 5. Analyses of 700-300 mb layer thickness (solid—gpm) and 500-mb vorticity (dashed— 10^{-5} s^{-1}) for 0000 UTC 10 February 1994.

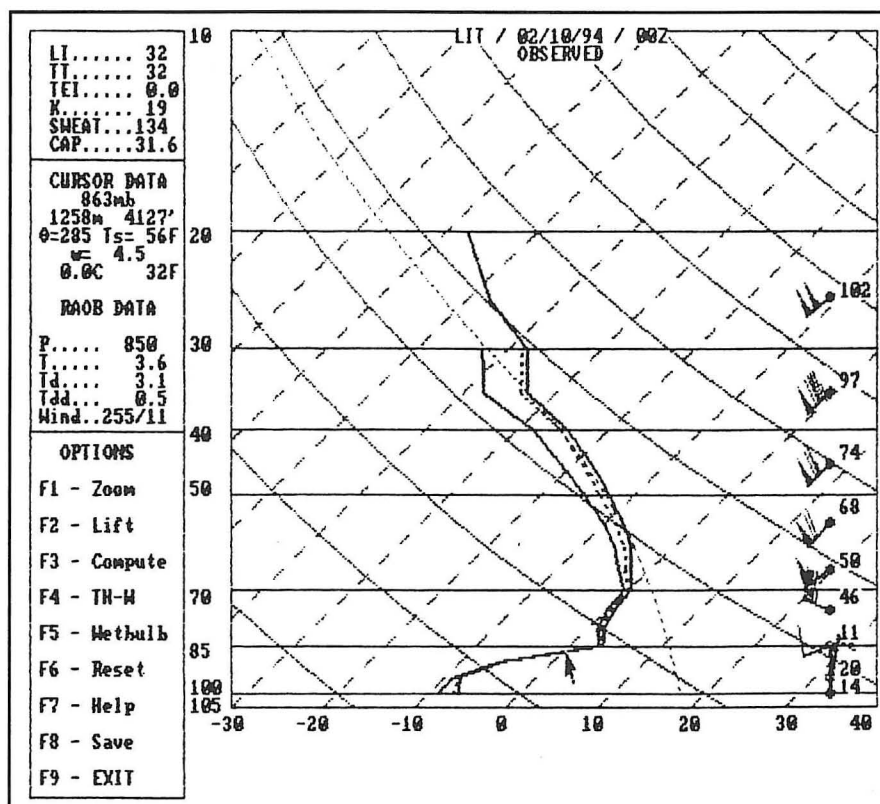


Fig. 6. Little Rock (LIT) sounding for 0000 UTC 10 February 1994.

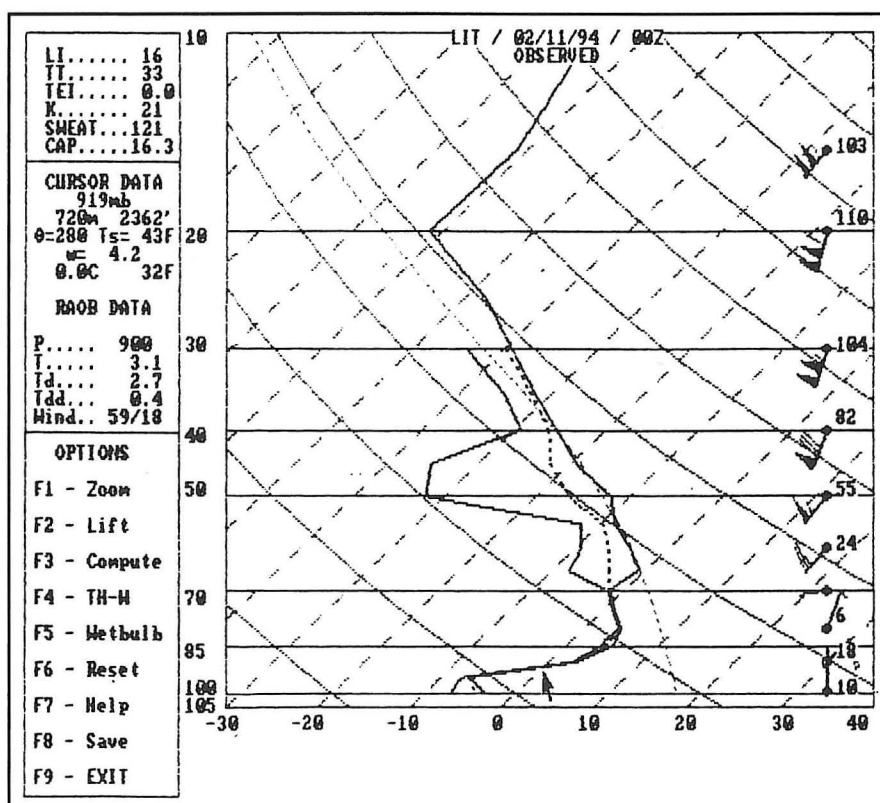


Fig. 7. Little Rock (LIT) sounding for 0000 UTC 11 February 1994.

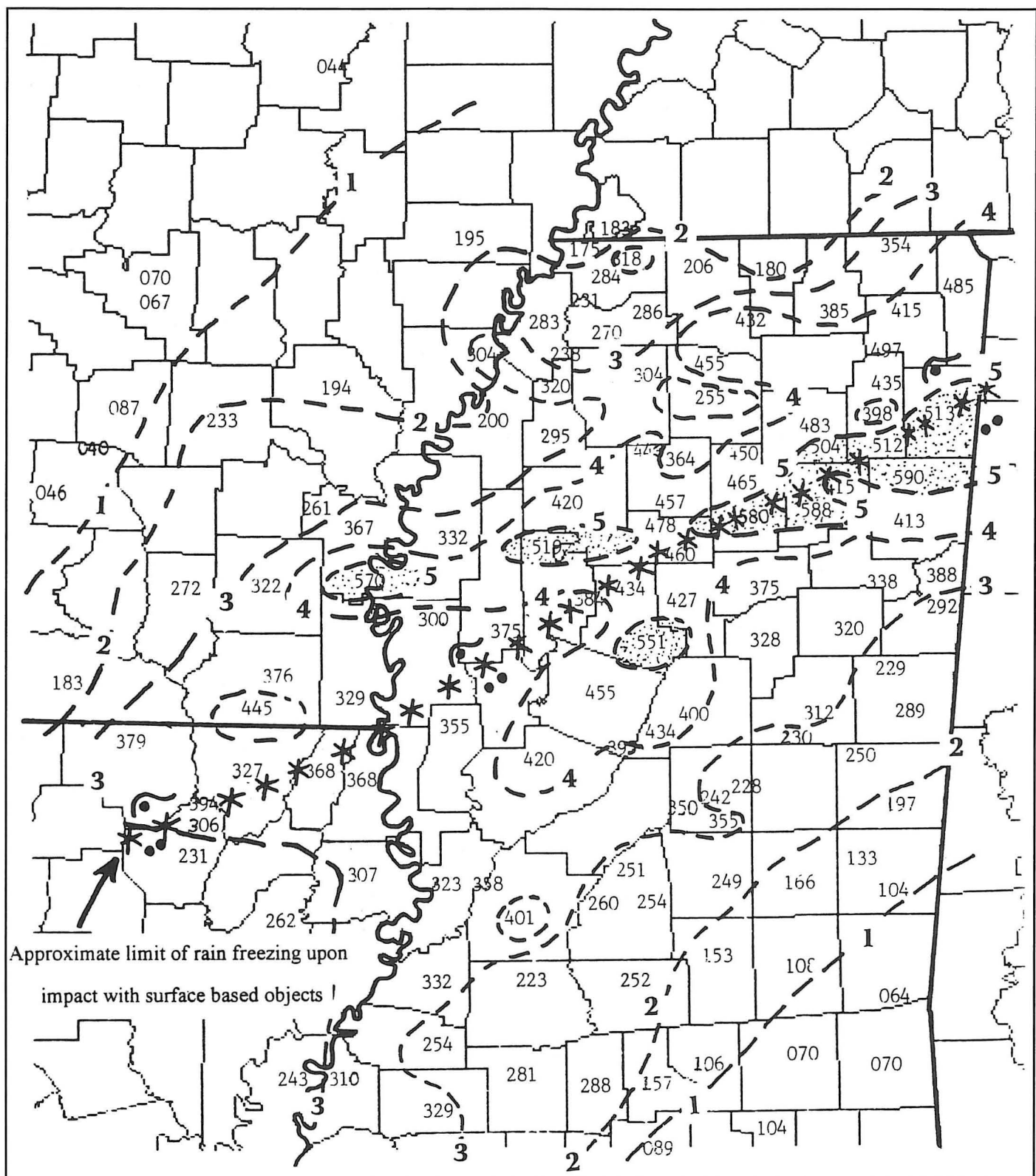


Fig. 8. Storm Total Rainfall from 1200 UTC 9 February to 1200 UTC 11 February 1994. The 48-hour totals are in inches and hundredths (e.g., 395 = 3.95 in.).

NWSFO Jackson forecasters commendably rejected this dramatic warm-up and accepted the Eta and AVN solutions for low-level temperatures. Overall, the Eta model did the best with the low-level, shallow, cold air forecast.

Precipitation amounts were substantially underforecast by all three models, and all three models had precipitation centers too far south. Junker (1990) has shown that the NGM will underforecast precipitation amounts over the southern U.S. in the presence of moderate to strong southerly flow from the Gulf. However, it was surprising that the newer 80 km Eta (Fig. 9), with its better resolution of lower levels and Betts parameterization scheme, also underforecast this event. Comparison of the actual reported 48-hour precipitation totals for the ice storm area with total model precipitation forecasts shows that the models were underpredicting the precipitation by as

much as a factor of 2, consistent with Junker's findings for the NGM (Fig. 10; Aviation model Fig. 11). It must be noted that the model resolution constraints cannot be blamed for the underforecast of the rain amounts since the affected area for this case was large and stretched across several states.

4. Mesoscale Considerations

a. General

Beginning 1200 UTC 9 February, a strong upper-atmospheric jet in excess of 80 m s^{-1} at the 300-mb level over the Midwest (see Fig. 3) moved such that its right rear entrance region was over the ice storm area for much of the event. As explained by Bluestein (1993), vertical motion is enhanced by this jet

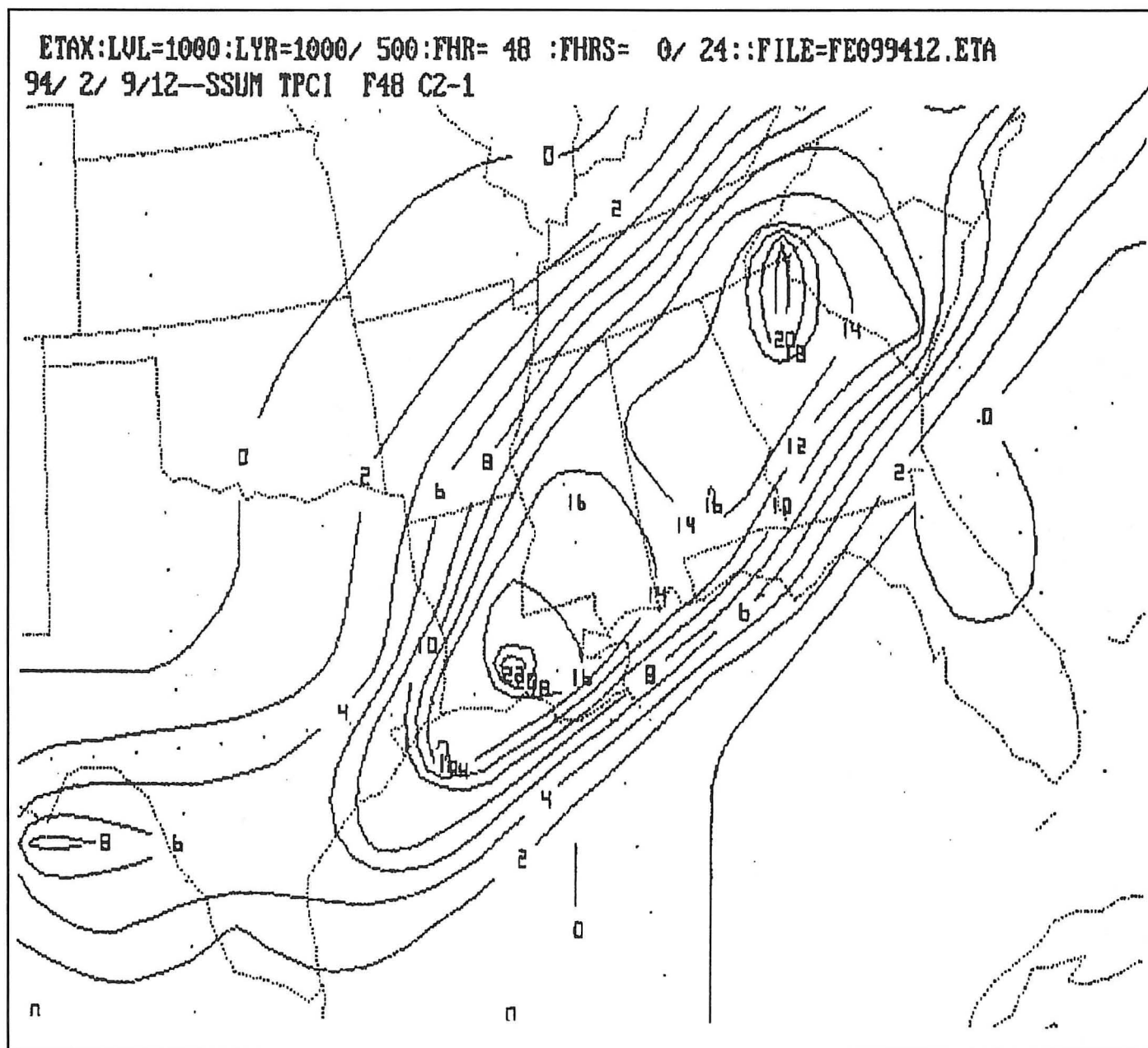


Fig. 9. Forecast of 48-h precipitation (tenths of an inch) from the Eta model run at 1200 UTC 9 February 1994.

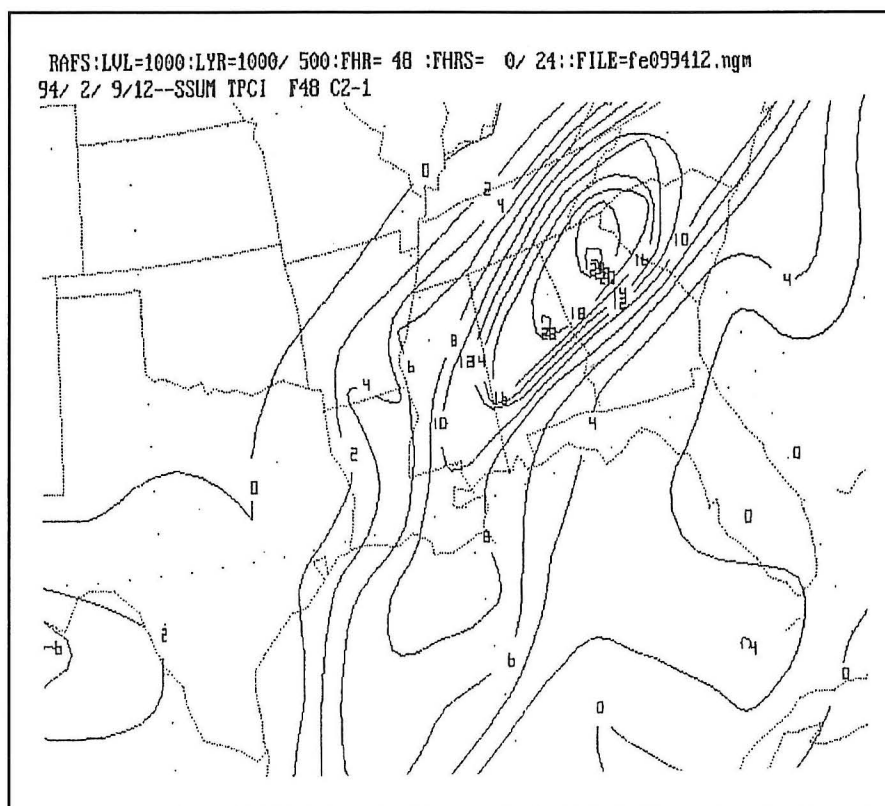


Fig. 10. Forecast of 48-h precipitation (tenths of an inch) from the NGM run at 1200 UTC 9 February 1994.

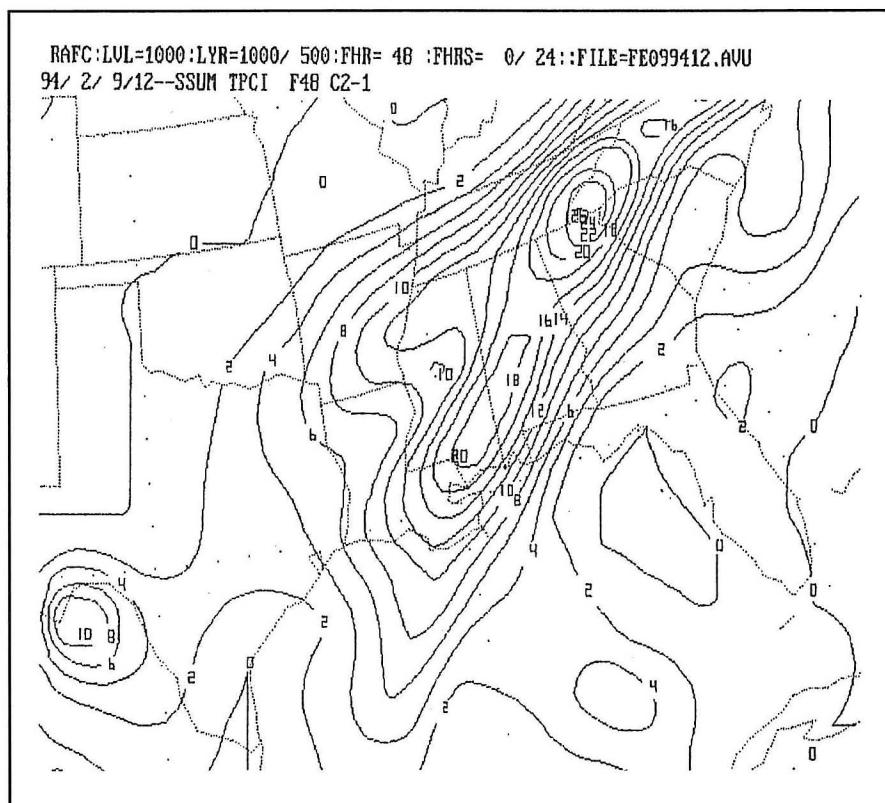


Fig. 11. Forecast of 48-h precipitation (tenths of an inch) from the AVN model run at 1200 UTC 9 February 1994.

streak position, and a direct circulation develops that results in heavier precipitation totals.

b. Model soundings

Model-predicted soundings, which were not available in real time (but were analyzed through the General Meteorological Package (GEMPAK) on workstations at the Cooperative program for Operational Meteorology, Education and Training (COMET) laboratories in Boulder, CO) would have been a huge help to line forecasters during the critical stages of the ice storm. Most interestingly, the model sounding verification for Little Rock, Arkansas, showed wind anomalies at 300 and 250 mb which, when displayed via PCGRIDDS, revealed a weak anticyclonic ageostrophic circulation centered over the Gulf of Mexico with ridging north over East Texas, southwest Arkansas and western Louisiana (Fig. 12). This anticyclonic ageostrophic circulation may be similar to that shown by Maddox (1982) to be associated with Mesoscale Convective Complexes (MCCs). The circulation, in this writer's opinion, is related to vigorous convection that occurred in the warm air south of the front. Lightning data also supports this conclusion.

c. WSR-88D observations

As Memphis (KNQA) WSR-88D data was not available, products from Little Rock (KLZK) and Jackson (KJAN) were analyzed for this storm (see Fig. 13 for relative WSR-88D 230 km ranges). These products accurately depicted the stratiform type precipitation in the ice storm disaster area, and the more convective type precipitation to the south. Echo tops for the stratiform area were generally 6.0 to 7.6 km while in the more convective area echo tops were 9.1 km and higher. Cross sections were taken of the convective cells, but unfortunately none were available for the stratiform area. Higher reflectivities at fairly uniform distances from the Jackson WSR-88D (see Fig. 14 where higher reflectivities are shown from southeast Arkansas into north central Mississippi), lead to the determination of the melting level. As indicated by the bright band, this level is approximately 3,230 m (10,600 ft) agl (using the WSR-88D displayed height above mean sea level and subtracting the radar site elevation). WSR-88D reflectivity data from Little Rock (Fig. 15), confirmed this melting level as well as did the Little Rock soundings.

WSR-88D rainfall products (as generated by the Jackson WSR-88D) substantially underestimated the rainfall in spite of possible contamination by bright banding. However, WSR-88D rainfall products generated by the Little Rock radar grossly overestimated the rainfall. A possible explanation of this dichotomy (compare Figs. 16 and 17) is that the bright band persisted on Little Rock's reflectivity products far longer than on Jackson's, since Little Rock was behind the front in the cold, shallow air mass for the duration of the freezing rain episode. Notice also the double heavy rainfall signatures on the Little Rock Storm Total Precipitation (STP) product for the ice storm period. (The rainfall period for the STP product is from the beginning of the precipitation in northwest Arkansas late on 8 February to the time of the product, 1140 UTC on 11 February.) A maximum of 215.9 mm (8.5 in.) is estimated just south-east of Pine Bluff (PBF), Arkansas, in Jefferson County, but the reported rainfall for Pine Bluff Airport (which is also south-east of the city and very close to the estimated maximum) was only 82.3 mm (3.24 in.), a very large error. A second possible explanation that is just now beginning to be discussed is calibration error between the two WSR-88Ds. A discrepancy of only 2 or 3 dBz between two radars can produce significant differ-

ences in rainfall estimates, as discussed by Ricks, Grischel, and Jones (1995).

In spite of the underestimation of the Jackson STP product, the 1108 UTC 11 February Storm Total Precipitation product (the rainfall period for the STP product is from the beginning of the precipitation in southeast Arkansas early on 9 February to the time of the product) did show a relative maximum of precipitation over Holmes and Attala counties but underestimated the amount by 25 to 50 mm (1 to 2 in.) or 20 to 40 percent. The maximum rainfall estimated by the WSR-88D algorithm was 106.7 mm (4.2 in.), but the maximum reported storm total rainfall reported up to that time was 140.0 mm (5.51 in.) at Vaiden. Vaiden is in Carroll County, which is about 30 miles north of the radar indicated maximum.

Meso- γ scale banding was observed on short pulse Doppler velocity products just southeast of Little Rock at 1155 UTC 10 February (Fig. 18) at approximately 300 to 1500 m (1,000 to 5,000 ft) agl oriented somewhat perpendicular to the thermal wind. This banding was occurring below the base of the frontal inversion with directional shear (backing winds) but little speed shear at all, and was probably due to small ripples or gravity waves propagating along the 'roof' of the frontal surface. Other interesting waves were visible on the Velocity Azimuth Display (VAD) wind profile product from Little Rock at 1155 UTC on 10 February (Fig. 19). Beginning at 1132 UTC at 3700 m (12,000 ft) a progressive veering and backing is evident as the cloud base or descending precipitation dropped to 3350 m (11,000 ft). These waves are in a layer that is obviously becoming more moist and has significant speed shear.

d. Conditional Symmetric Instability considerations

Conditional Symmetric Instability (CSI) combines the effects of inertial and gravitational forces and has been observed in association with extratropical fronts (Snook 1992). CSI depends on either or both horizontal and vertical shear in the wind and whether or not the atmosphere is saturated (Bluestein 1993). We use CSI if the atmosphere is symmetrically stable with respect to dry parcels, but symmetrically unstable with respect to saturated parcels. CSI theory has been explained in previous works by Bennetts and Hoskins (1979) and Emanuel (1983a, 1983b). Applying this theory, Emanuel (1985) and Rauber et al. (1994) showed that CSI was a factor in the ice storms they analyzed. Using a method suggested by Snook and diagnosed through PCGRIDDS (Fig. 20), the momentum and theta-e surfaces on a cross section from 38N 95W to 30N 88W (or roughly from southeast Kansas, to the mouth of Mobile Bay) were analyzed. The slope of the momentum surfaces was shallower than the slope of the theta-e surfaces through most of Arkansas and northwest Mississippi as high as 730 mb. This means that parcels moving along the momentum surface would encounter lower theta-e temperatures and be unstable along a slantwise path. The upper-air sounding from Little Rock for the time 1200 UTC on 9 February showed strong vertical wind shear above 700 mb but the sounding was not saturated. At 0000 UTC on 10 February, PCGRIDDS momentum and theta-e surface analyses showed the best potential for CSI somewhat southeast of the Little Rock area. However, at this time the sounding was more favorable for CSI (or had already responded to CSI) with near zero static stability and near saturated conditions in addition to the strong vertical wind shear. The response to CSI by the atmosphere could also be evident here. The atmosphere responds fairly rapidly to CSI conditions and results in a saturated neutral or weakly stable environment. This environment is ripe enough for frontogenetic forcing to produce enhanced vertical circulations necessary for convection (i.e., thunder-

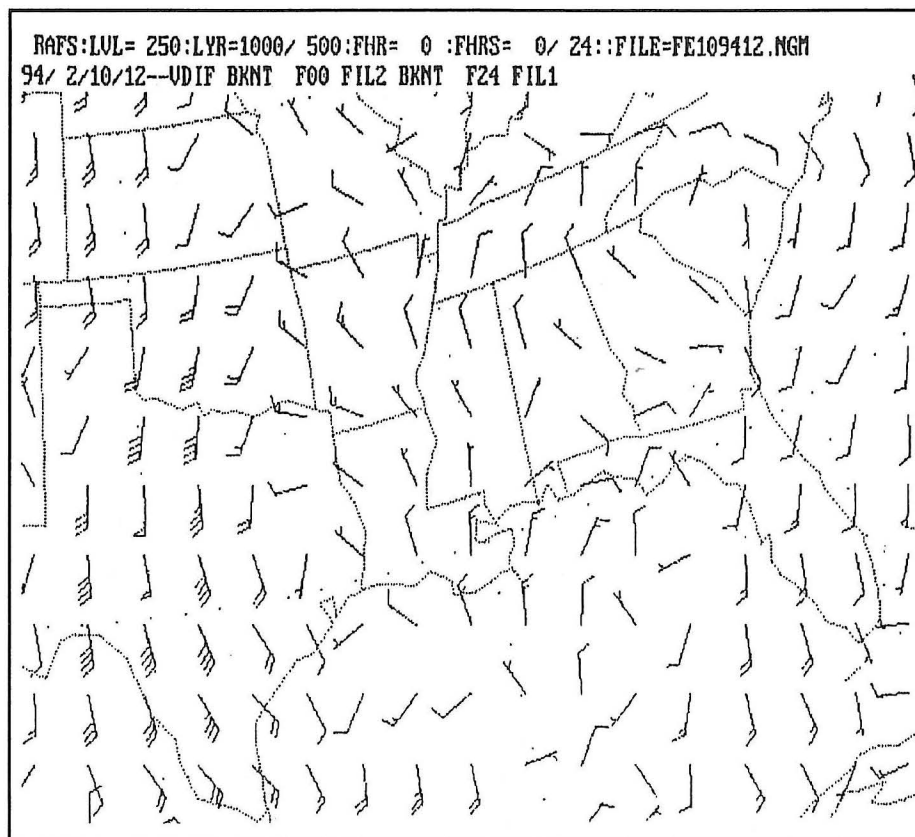


Fig. 12. Vector difference of Total Wind at 250 mb (Total Wind analysis from NGM run at 1200 UTC 10 February 1994 minus 24-h forecast of Total Wind from NGM run 1200 UTC 9 February 1994).

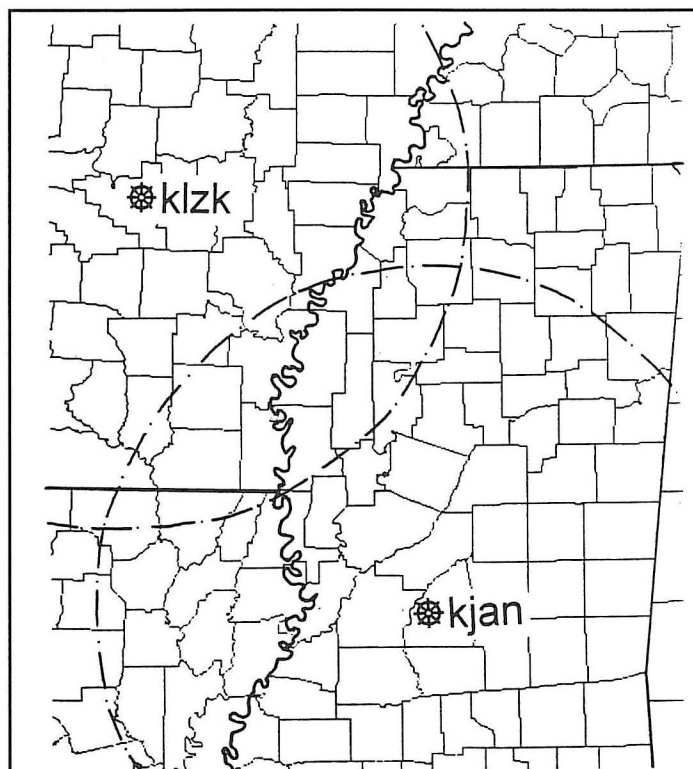


Fig. 13. Relative 230 km ranges from WSR-88D sites at Jackson (KJAN) and Little Rock (KLZK)

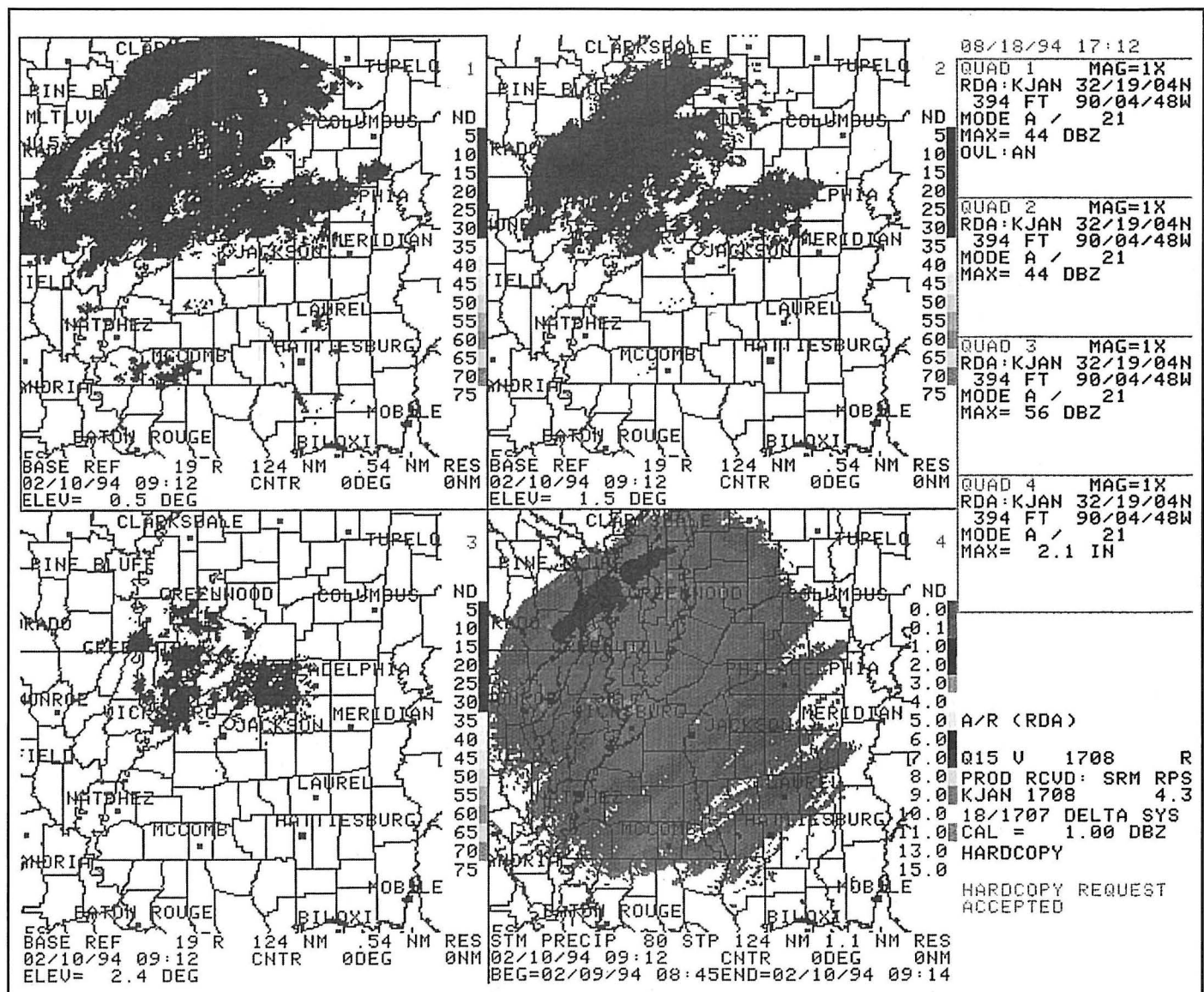


Fig. 14. 4-Panel of reflectivity (0.5, 1.5, 2.4 deg) and STP from Jackson (KJAN) WSR-88D at 0912 UTC 10 February 1994.

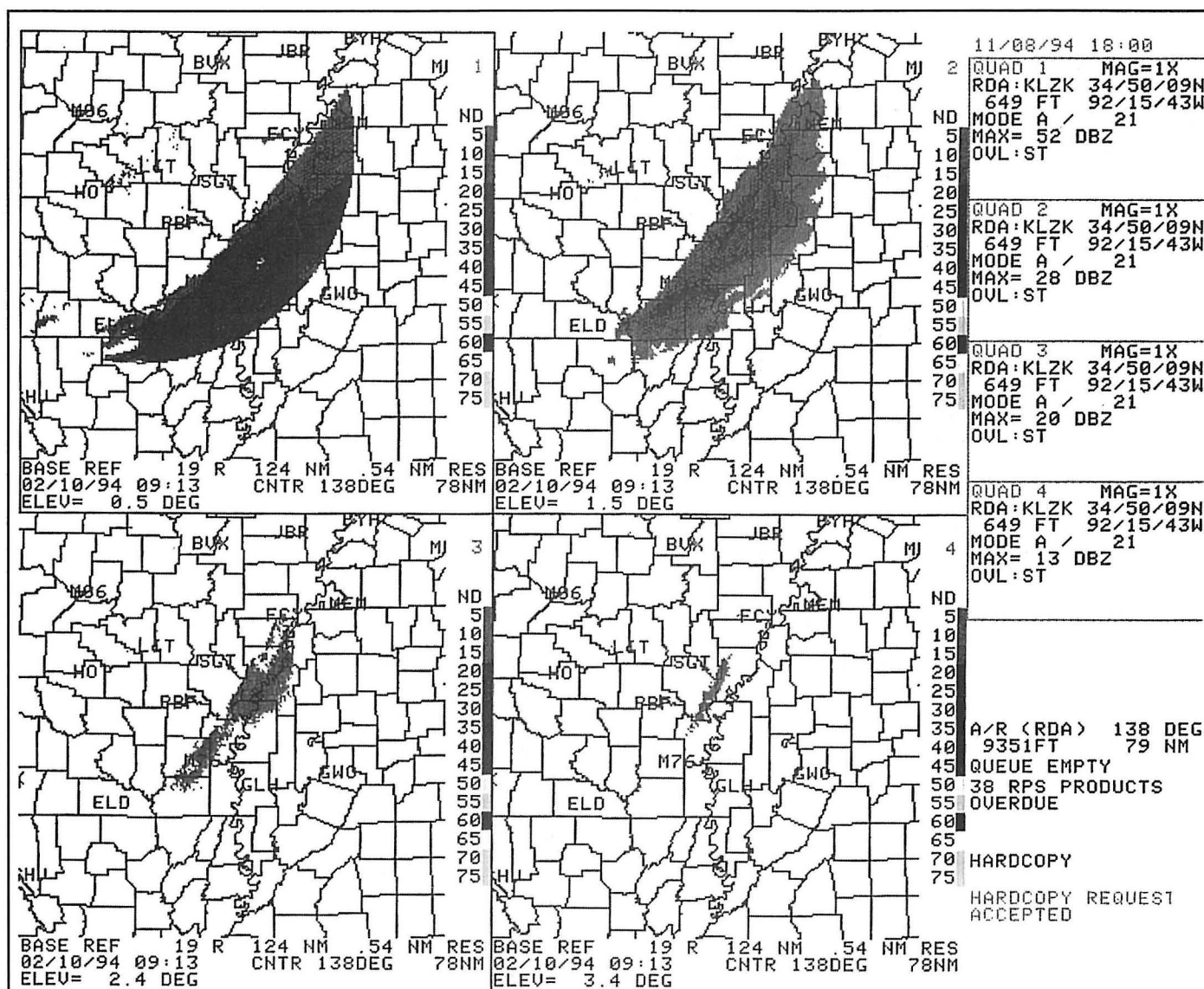


Fig. 15. 4-Panel of reflectivity (0.5, 1.5, 2.4, 3.4 deg) from Little Rock (KLZK) WSR-88D at 0913 UTC 10 February 1994.

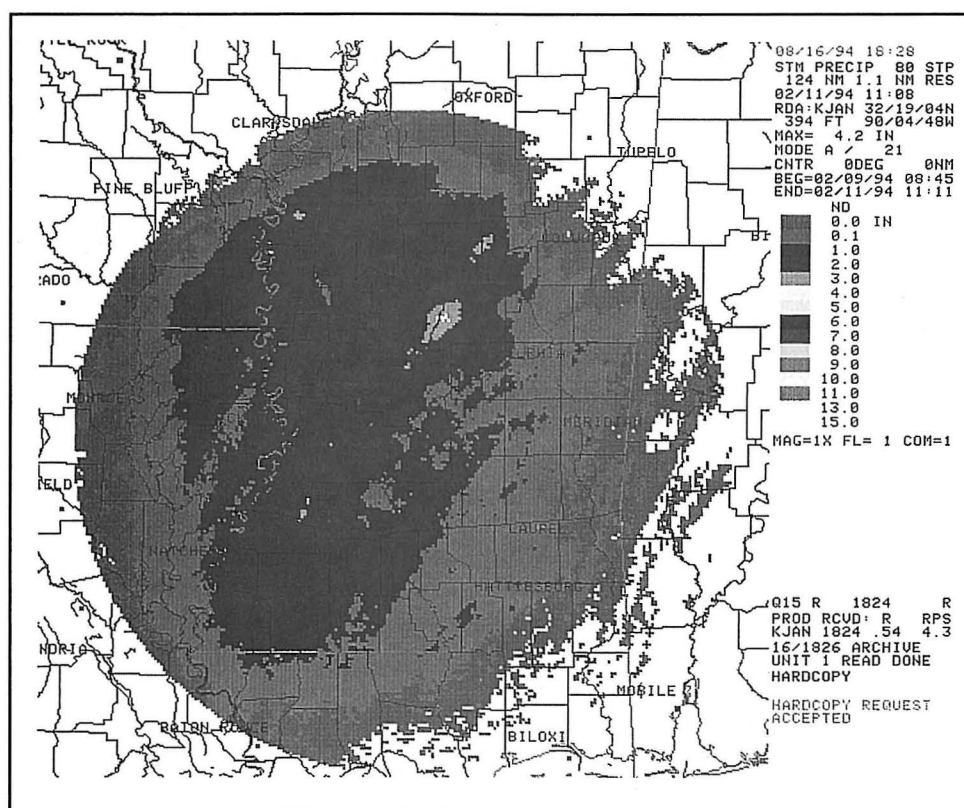


Fig. 16. Storm total precipitation (STP) from Jackson (KJAN) WSR-88D at 1108 UTC 11 February 1994.

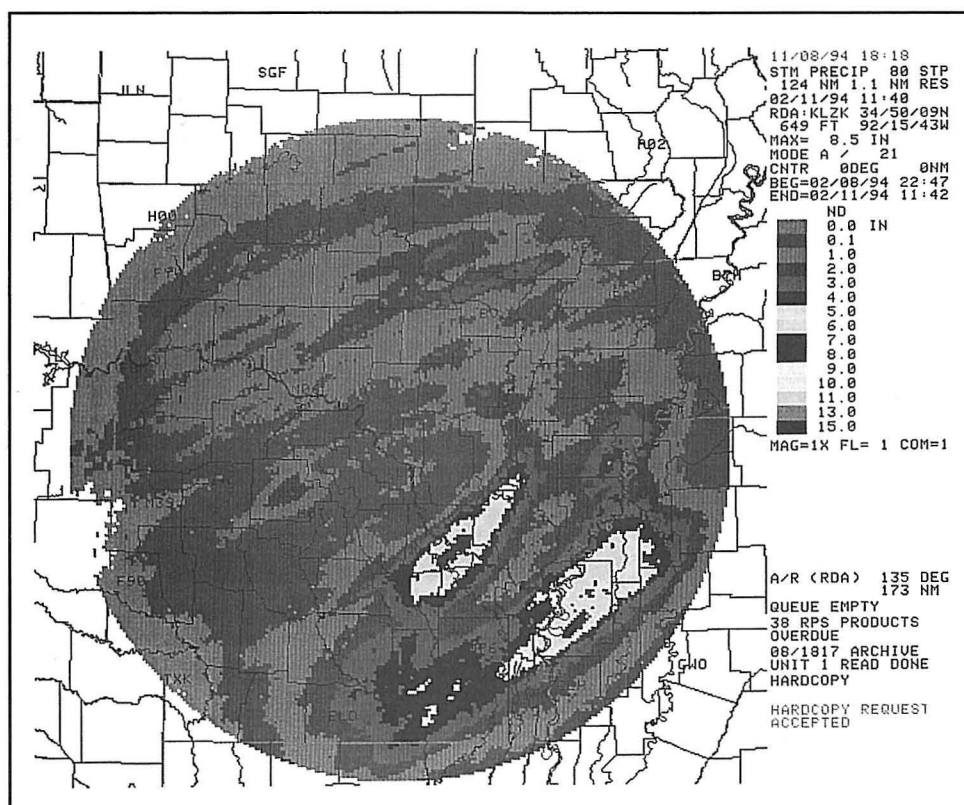


Fig. 17. Storm total precipitation (STP) from Little Rock (KLZK) WSR-88D at 1140 UTC 11 February 1994.

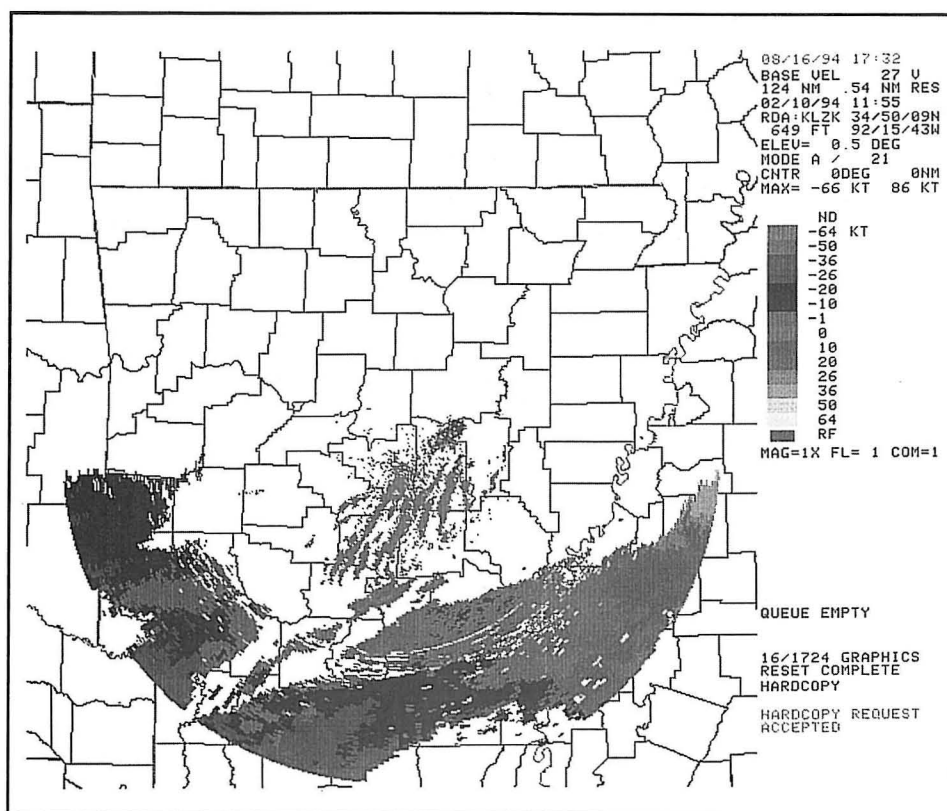


Fig. 18. Velocity (0.5 deg) from the Little Rock (KLZK) WSR-88D at 1155 UTC 10 February 1994.

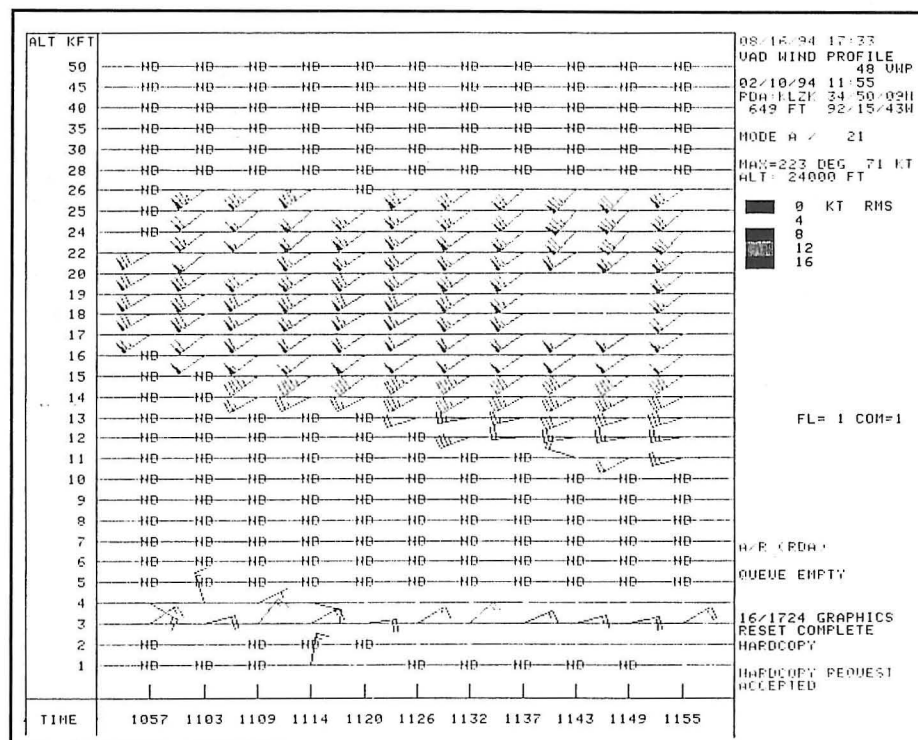


Fig. 19. Velocity Azimuth Display (VAD) wind profile (VWP) from Little Rock (KLZK) showing the period from 1057 to 1155 UTC 10 February 1994.

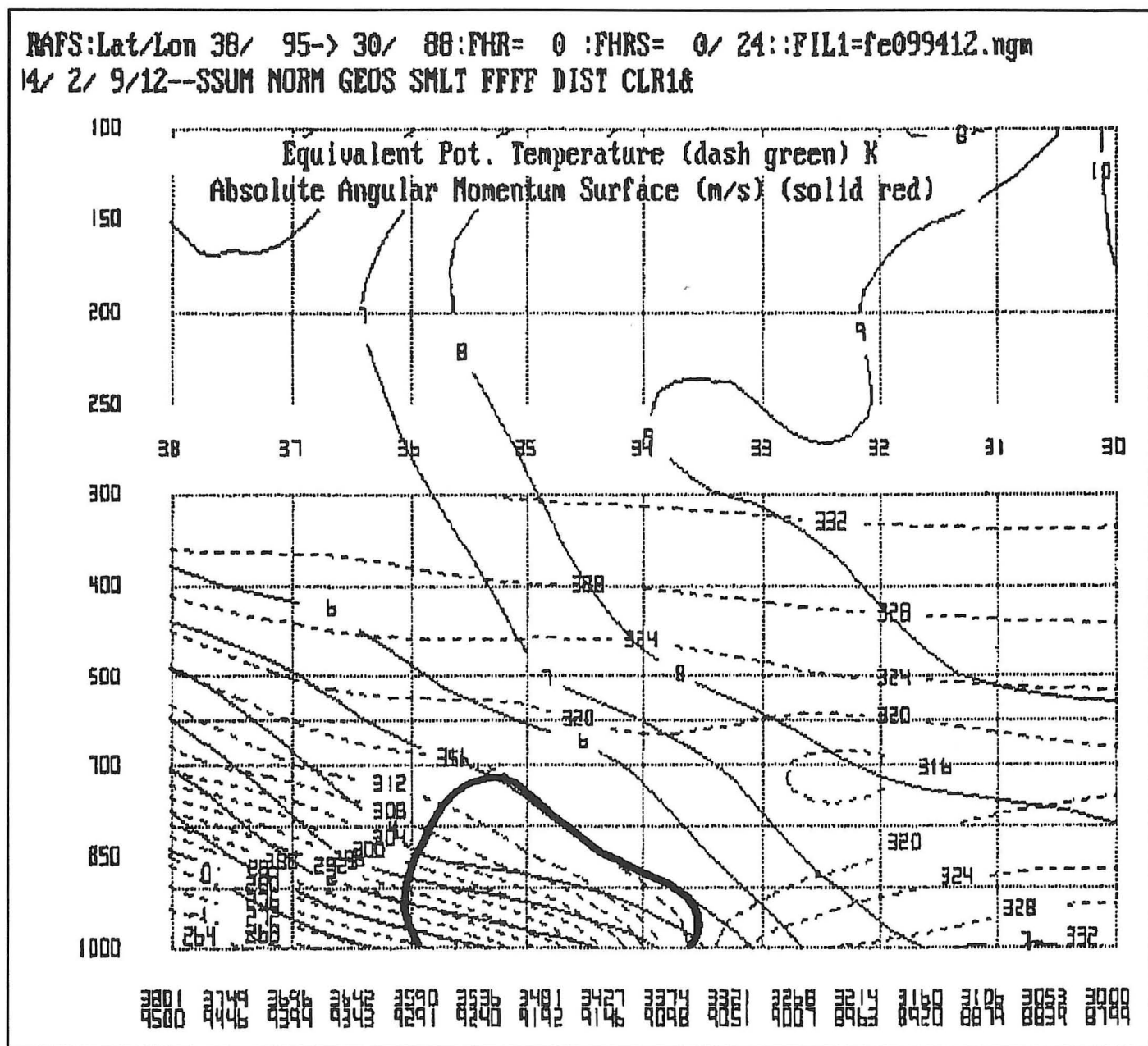


Fig. 20. Vertical cross section from 38N 95W (approx. MKC) to 30N 88W (approx. Mobile Bay) showing equivalent potential temperature (θ_e ; dashed) in degrees Kelvin and absolute angular momentum ($m s^{-1}$; solid). Region of CSI is outlined with broad solid line.

storms). Bradshaw (1994) applied this CSI diagnosis to help explain the "Storm of the Century" thundersnows in Birmingham, Alabama, in March of 1993. Lightning data, examined at 6-hourly increments from 1800 UTC 9 February to 1200 UTC 11 February, shows a number of flashes in the ice storm area between 1200 UTC 10 February and 0000 UTC 11 February (most active times, 1200 UTC 10 February through 0000 UTC 11 February, shown in Figs. 21 and 22). A significant number of the flashes were positive, and a study by Studwell and Orville (1994) has suggested a relationship between positive cloud-to-ground lightning and the location of freezing rain.

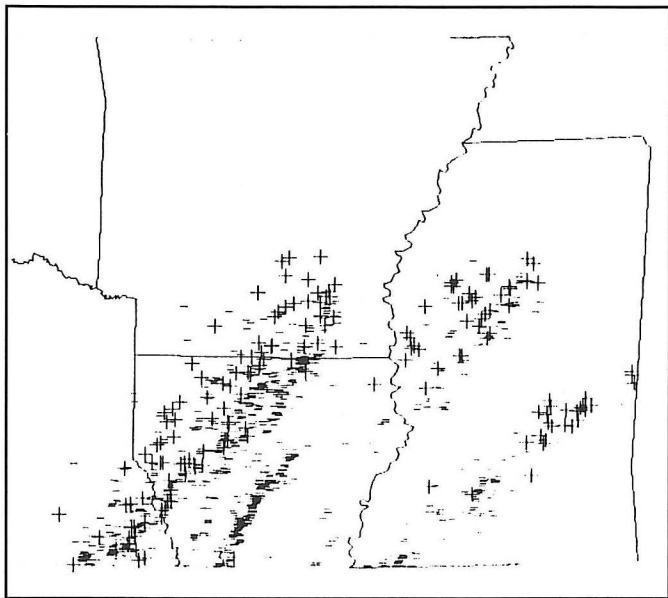


Fig. 21. Lightning strikes from 1200 to 1800 UTC 10 February 1994 (positive and negative polarity shown).

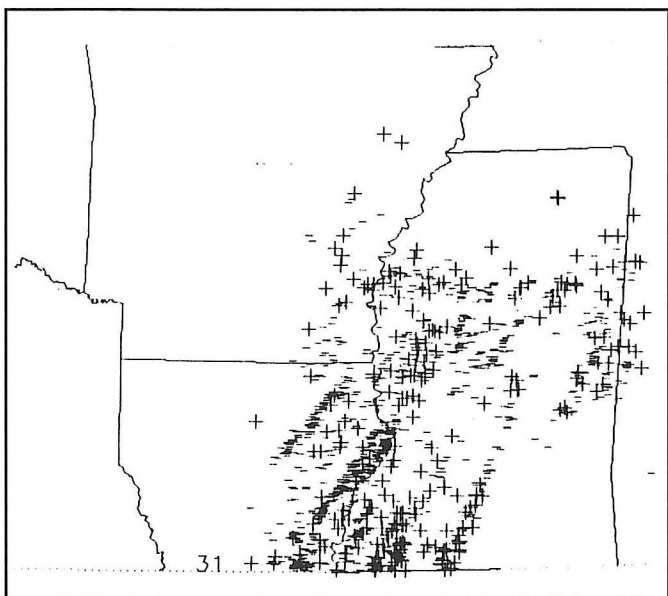


Fig. 22. Lightning strikes from 1800 UTC 10 February to 0000 UTC 11 February 1994 (positive and negative polarity shown).

Thus the environment just north of a slow moving or nearly stationary cold front including:

- 1) a sharp, shallow inversion,
- 2) little or no convective available potential energy (CAPE) above the inversion,
- 3) slightly positive lifted indices within the layer,
- 4) neutral or weak stability with respect to CSI, and
- 5) presence of lightning

all point to an example of elevated thunderstorms as discussed by Colman (1990a, b). The best explanation, as concluded by Colman, of the convection, subsequent heavy rains and ice accumulations associated with this storm, is that enhanced vertical circulations (as a result of strong frontogenetical forcing) existed in the presence of weak or neutral symmetric stability.

5. Summary and Conclusions

Several synoptic and mesoscale features worked in tandem to enhance ice accumulations across north Mississippi during the period of 9–11 February 1994.

- a. Positive Isothermal Vorticity Advection ahead of weak short waves and ultimately the major vorticity maxima moving east from southern California.
- b. Mechanical lift of the warm, moist air overrunning the shallow, cold air at the surface.
- c. Thermally direct circulation under the right rear entrance region of the 300-250 mb jet.
- d. Mesoscale anticyclonic circulation aloft imposed on the mean synoptic flow.
- e. Frontogenesis in a region of weak or neutral symmetric stability.

As far as the new technology available to field forecasters, the WSR-88D was an effective tool in diagnosis of the bright banding structure, but was somewhat inadequate for rainfall amounts, underestimating from one radar site and overestimating from another radar site. Dual Radar analysis, through the Little Rock and Jackson WSR-88Ds, verified the presence of the melting level near 3,230 m. The VAD Wind Profile product from Little Rock showed the frontal structure well, and gave continuous updates on its depth and movement. The profiler network was not as helpful as it could have been, due to power failure from ice accumulation at Okolona, Mississippi, but did provide continuous updates on the depth and movement of the colder air at Winnfield, Louisiana; Dequeen, Arkansas; and Palestine, Texas.

Model forecast soundings should be made available to field personnel in these critical situations. Had model soundings been available, watch and warning decisions would have been easier and issue times could have been earlier. This would have provided the public and power companies a much longer lead time. The advent of the Science Applications Computers (SAC) as workstations for NWS offices, and ultimately the Advanced Weather Interactive Processing System (AWIPS), will provide the capability to analyze model soundings in the near future.

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