THE GEORGIA THUNDERSTORM OUTBREAK OF 22 JULY 1984

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ABSTRACT

An outbreak of severe thunderstorms over Georgia on 22 July 1984 is described. An intruding jet and a small pocket of cold air were the primary triggering mechanisms for the outbreak. There were few advance indications that the storms would be severe.

1. INTRODUCTION

On 22 July 1984 a series of thunderstorms occurred over Georgia. They were unusual in their severity and causal mechanism for this time of year. Normally, late July and early August are known as "hot and dusty" or "dog days" in this part of the world, but on Sunday 22 July a series of thunderstorms broke out. As a result, as many as six DVIP level-6 thunderstorms were present at any one time on the Athens, GA radar (AHN). Over Georgia they produced broken limbs and a lot of marble-size hail. This study was made to evaluate the thunderstorms and to gain a better insight into forecasting such cases in the future.

2. SYNOPTIC SITUATION

a. Surface conditions

At the surface, a high-pressure ridge centered over the Appalachian Mountains with a weak area of low pressure over the Florida panhandle dominated the weather picture (Fig. 1). During the outbreak little change occurred in the surface synoptic pattern.

b. Upper air conditions

A weak inverted low pressure trough at 850 mb (not shown) became a closed Low at 200 mb (Fig. 2a). Temperatures at all levels in the Low over the Georgia-South Carolina area (from

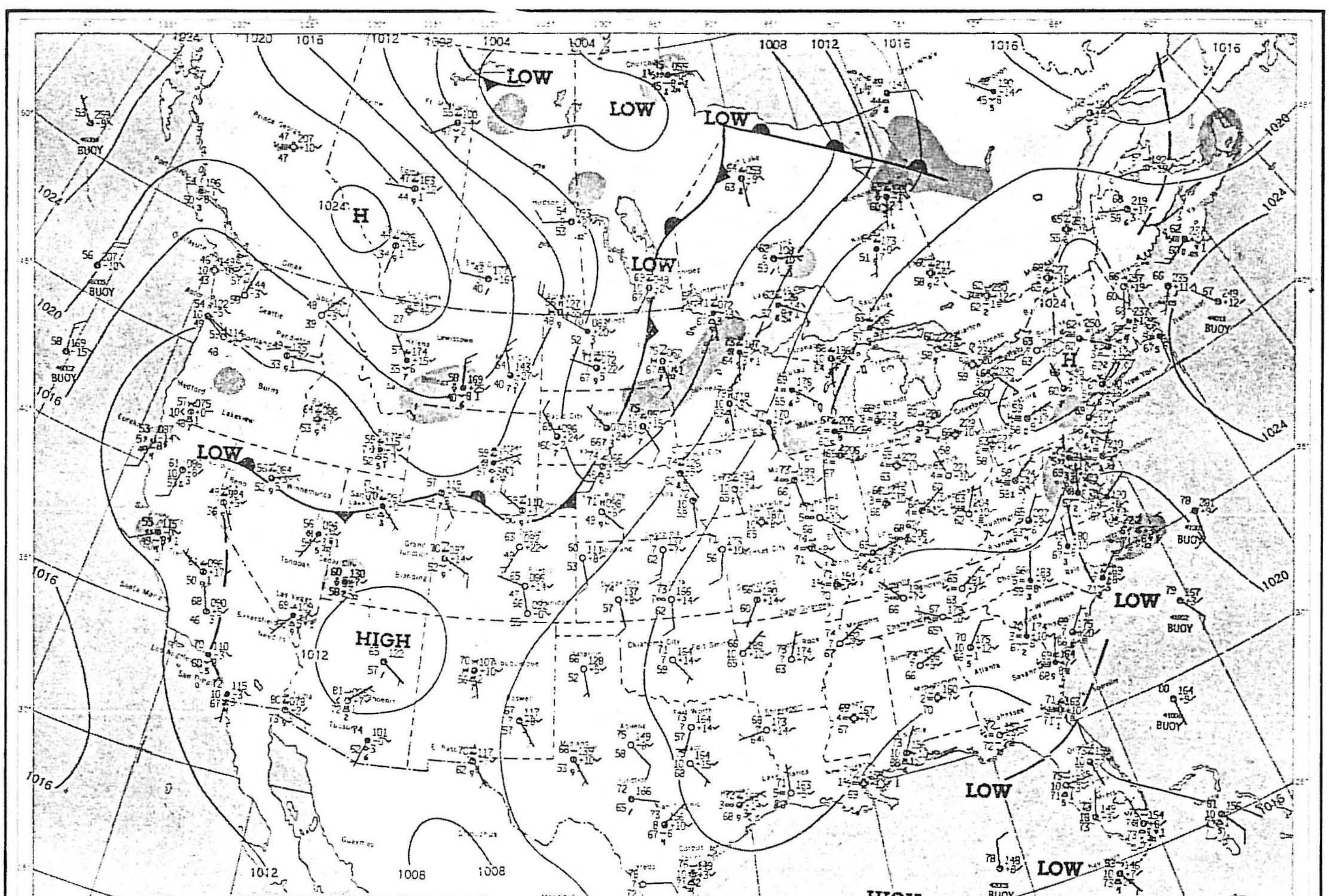

Fig. 1. Surface analysis, 1200 GMT 22 July 1984

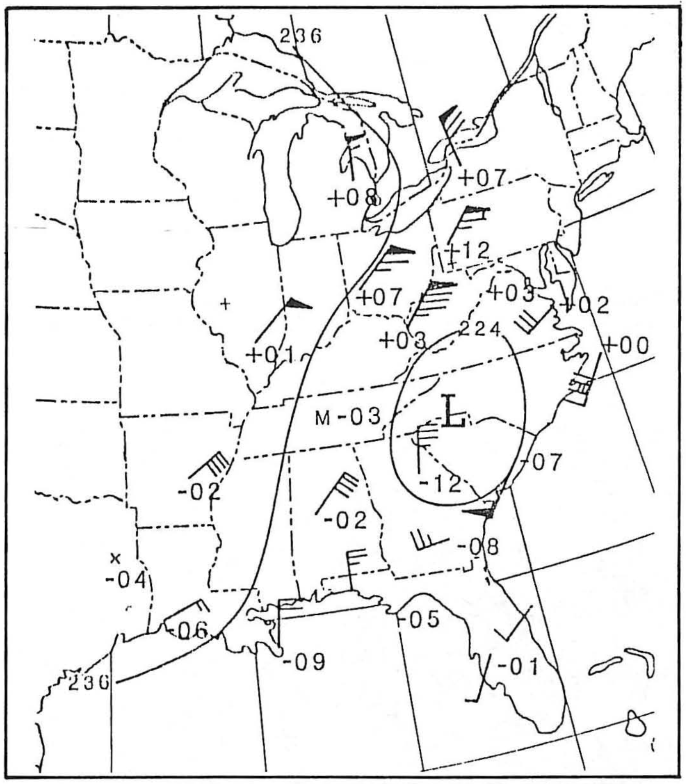

Fig. 2a. Redrawn 200 mb chart 1200 GMT 22 July 1984

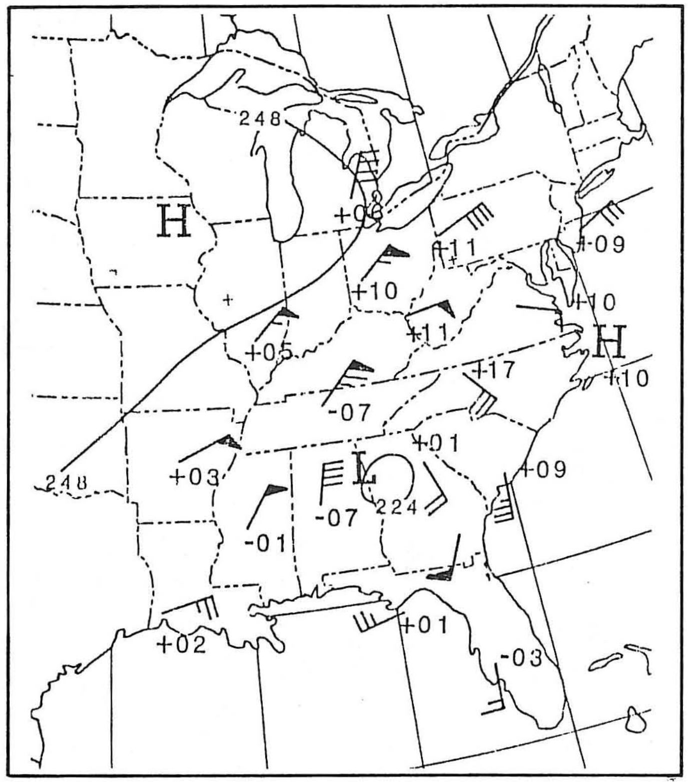

Fig. 2b. Redrawn 200 mb chart 0000 GMT 23 July 1984

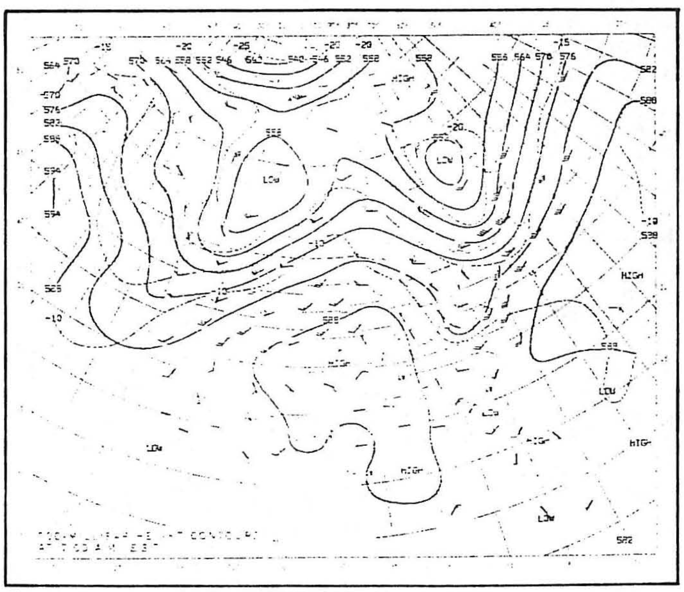

Fig. 3. The 500 mb chart, 1200 GMT 22 July 1984

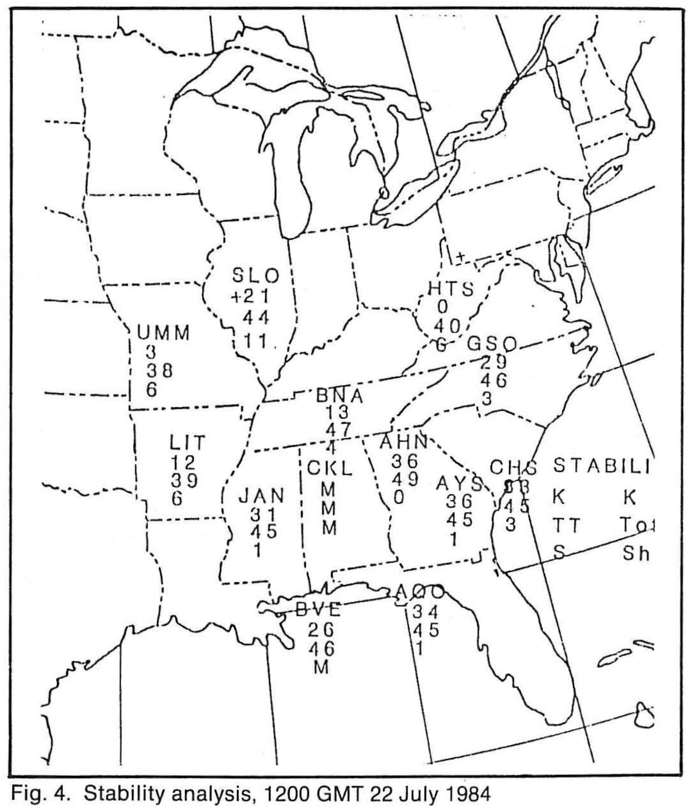

Fig. 4. Stability analysis, 1200 GMT 22 July 1984

850 mb through 300 mb) were lower than their surroundings. At 200 mb the temperatures within the Low were higher than their surroundings (Temperature reversal above the tropopause).

A weak 40 kt jet on the northwest side of the 500 mb Low (Fig. 3) increased to 80-90 kt at the 200 mb level (Fig. 2a). The 200 mb jet dug southwestward weakening slightly as central heights increased during the period from 22/1200 to 23/0000 GMT (Figs. 2a, b). The 500 mb Low, in response to the 200 mb jet, moved southwestward from North Carolina to northern Georgia and then westward across Texas into Mexico (2).

c. Moisture

A temperature-dewpoint spread of 5°C or less is used locally as an indicator of available moisture. The 850 mb analysis at 22/1200 GMT indicated that moisture was available over the area but was not particularly deep or widespread. From 700 mb and above, moisture was confined to Alabama, Georgia, and South Carolina.

d. Instability conditions

The K, Total Totals, and Showalter stability indices plotted in Fig. 4, showed Georgia to be the most likely area for thunderstorm occurrence. These stability indices were only at threshold values for isolated or few, weak to moderate thunderstorms (3).

e. Radar analysis

The outbreak of thunderstorm activity, detailed in the radar summaries of Figs. 5a–d, developed near Asheville N.C. and then spread and built southwestward. The AHN radar began to report isolated cells near Asheville and over South Georgia by 1525 GMT. After 1800 GMT, reports of hail, either visible on the radar or observed on the ground, began to appear and after 1900 GMT, thunderstorm-top reports in excess of 50,000 feet were noted. The main area of thunderstorm development was in the left front quadrant of the jet, with two areas of radar DVIP level-5 to -6 intensities developing by 23/0000 GMT. The main activity began in north Georgia but split later in the day; one

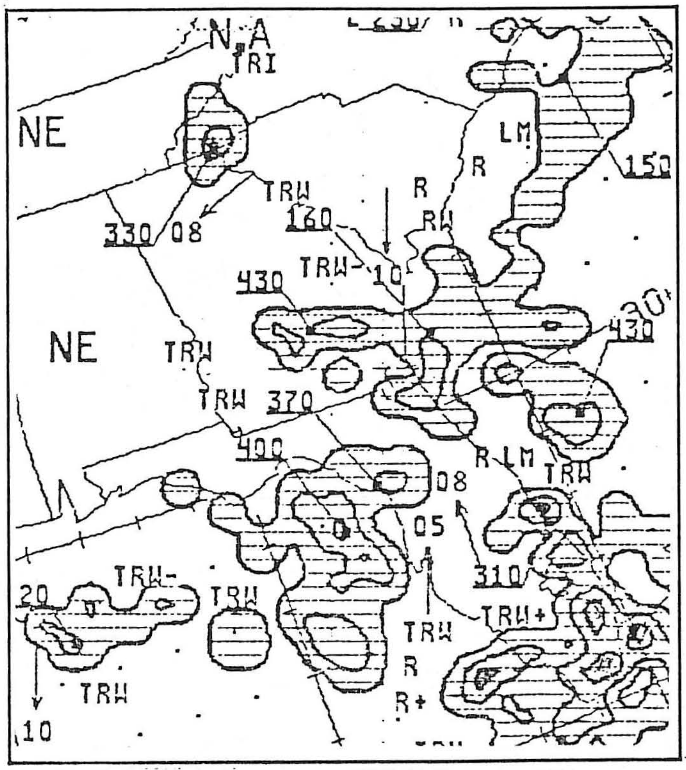

Fig. 5a. Radar analysis summary, 1635 GMT 22 July 1984

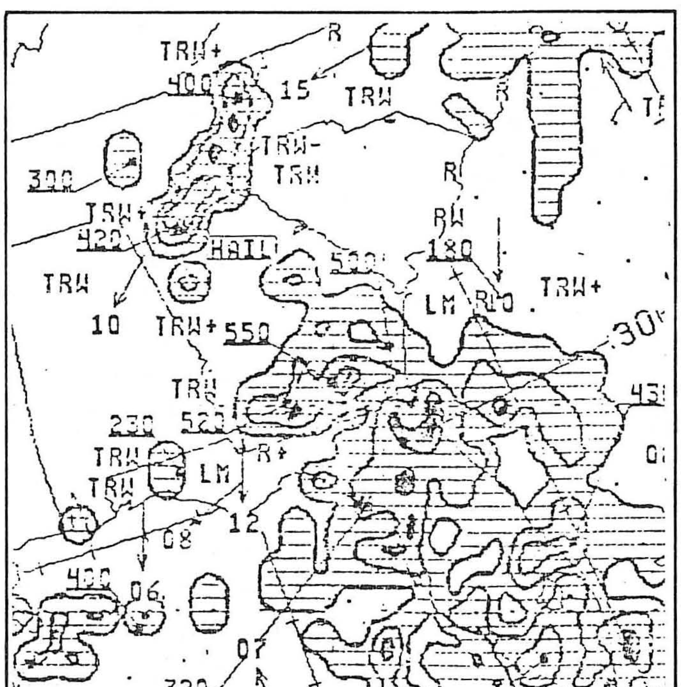

Fig. 5b. Radar analysis summary, 1835 GMT 22 July 1984

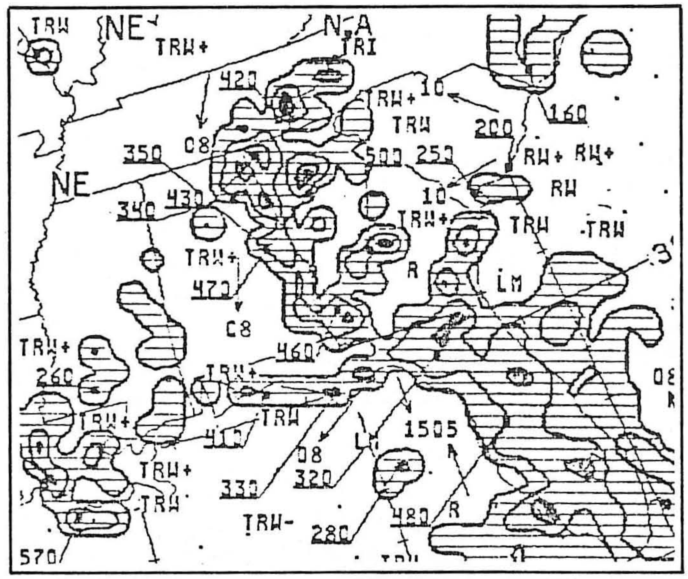

Fig. 5c. Radar analysis summary, 2135 GMT 22 July 1984

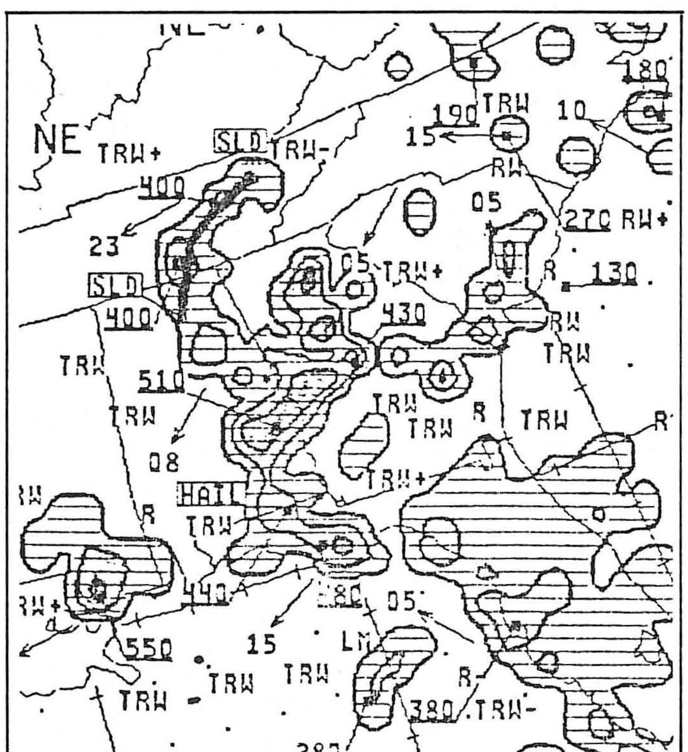

Fig. 5d. Radar analysis summary, 0035 GMT 23 July 1984

area centered south and west of Atlanta and the other over and west of Chattanooga.

f. Satellite data

Satellite pictures were available from approximately 1200 GMT to 1900 GMT. At 1200 GMT, clouds associated with a nearly stationary vorticity center were viewed over western South Carolina and by 1300 GMT had moved southwestward toward northern Alabama. Still, at 1431 GMT (Fig. 6a) little convective development was noted. After 1600 GMT, cumulus clouds began to develop on the east and southeast sides of the Appalachian Mountains and appear to have formed in a low-level convergence zone. As a result of the vorticity center movement and jet intrusion, thunderstorm activity began to develop near this zone. However. as the jet dug southwestward, the activity moved from the initial formation area in the Carolinas into Georgia (Fig. 6b).

3. ANALYSIS

The LFM 1200 GMT analysis (Fig. 8a) and the 12-hr forecast (Fig. 8b) were available by mid morning on 22 July. A Low pressure trough off the east coast and a ridge of high-pressure over the Appalachians were expected to persist while the 500 mb Low was forecast to move southwestward.

The vorticity center was forecast to move southwestward and weaken slightly from 16×10^{-5} to 14×10^{-5} by 23/0000 GMT (Fig. 8b). The verifying analysis, however, showed no change in the central value (Fig. 8c).

The AHN 22/1200 GMT sounding (Fig. 7) showed a convective temperature of 84°F, an equilibrium level near 35,000 ft, a tropopause level of 53,200, and a Showalter stability index of 0. None of the stability indices from the 1200 GMT sounding indicated severe thunderstorms (Fig. 4). However, the sounding

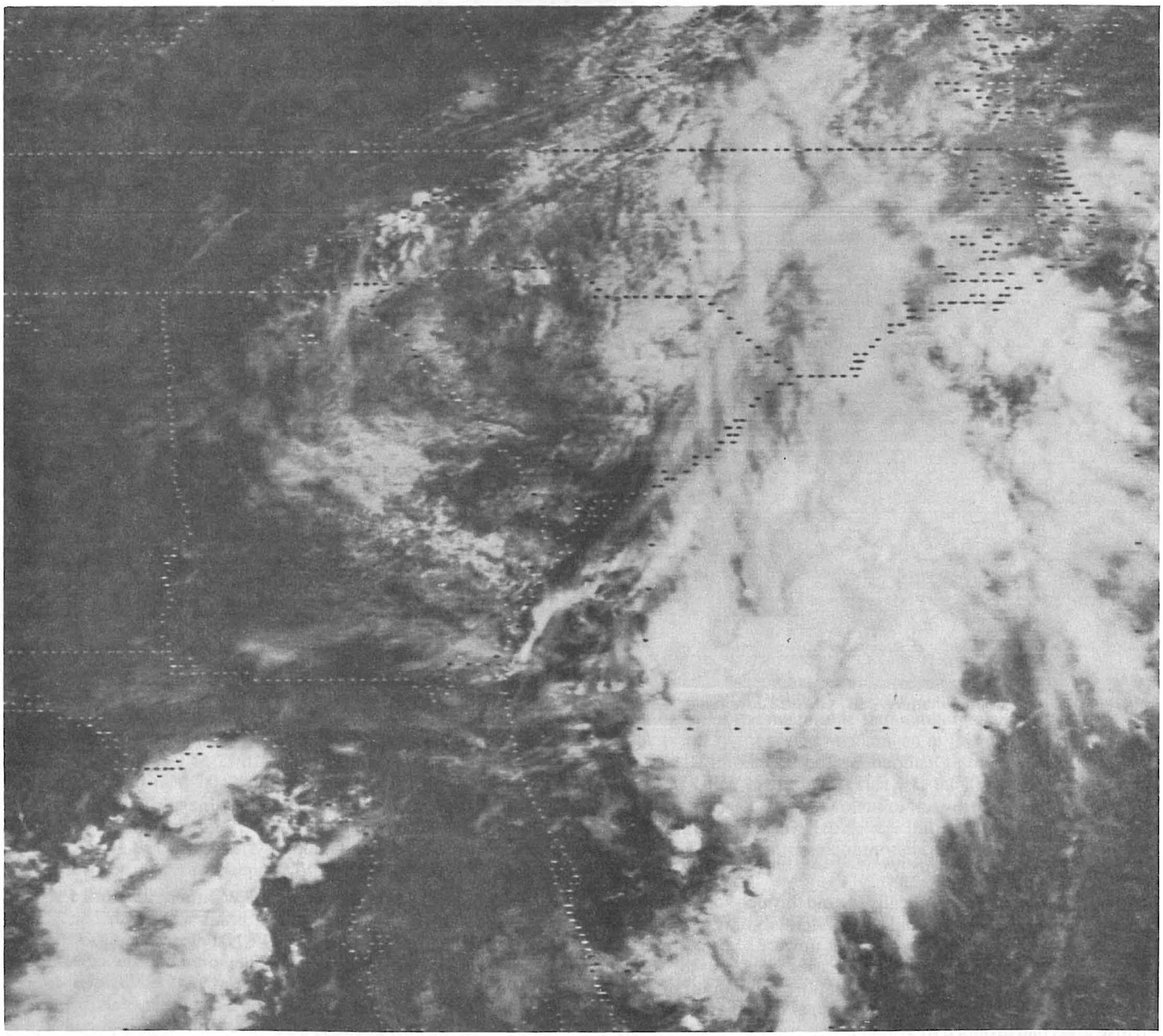

Fig. 6a. Visible satellite imagery, 1431 GMT 22 July 1984

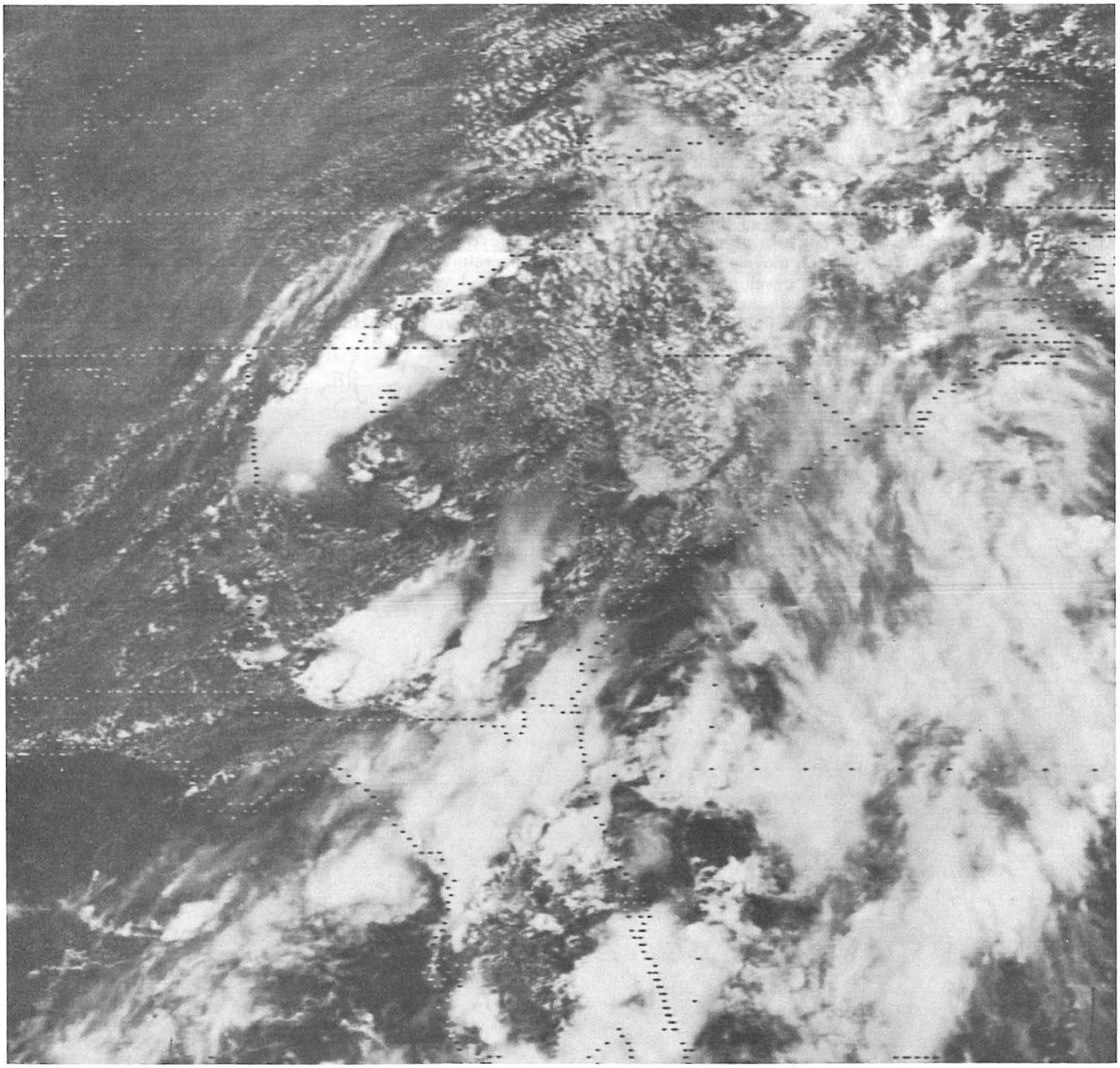

Fig. 6b. Visible satellite imagery, 1931 GMT 22 July 1984

was conditionally unstable and a triggering mechanism could produce thunderstorms.

It has been shown theoretically (4) and through some empirical work (5) that the left front and right rear quadrants of jets (wind maximums) are favorable areas for upward vertical motion. Examining the series of radar summaries (Figs. 5a–d), we can see the weather development in the left front quadrant of the jet as it moved southwestward. By 23/0000 GMT the AHN tropopause level had dropped to 37,600 which confirmed the approach of the jet and positive vorticity advection.

4. WARNINGS

Coordination on the issuance of Weather Advisories (CWA) and Convective Sigmets on the outbreak was good. The Atlanta Center Weather Service Unit (CWSU) began briefing the Atlanta Air Route Traffic Control Center personnel on the cells around 1710 GMT and issued its first CWA at 1845 GMT after coordinating with the National Aviation Weather Advisory Unit (NAWAU). Subsequently, NAWAU issued its first convective Sigmet on the outbreak around 1955 GMT. During the same

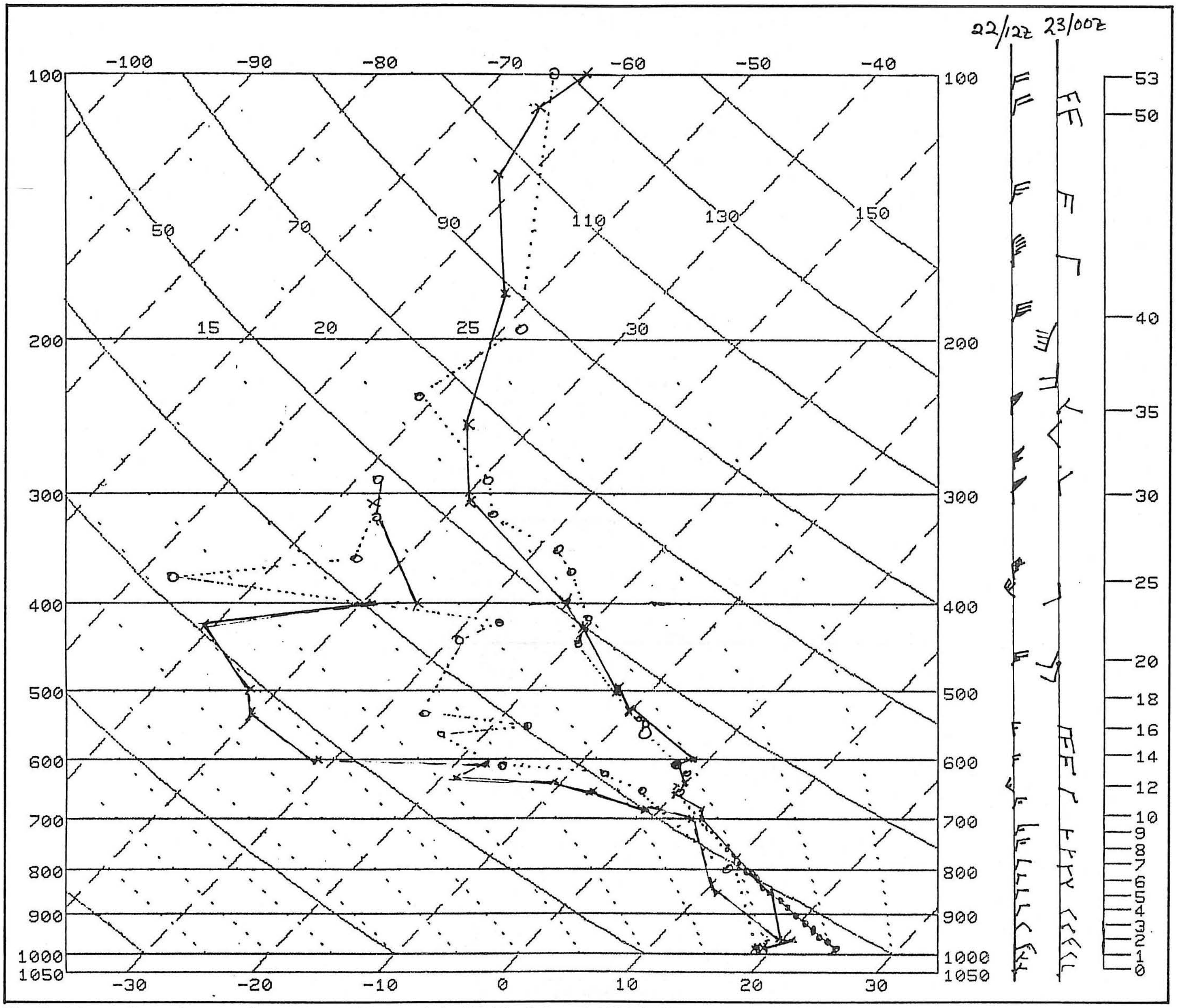

Fig. 7. Athens, Georgia soundings at 1200 GMT 22 July 1984 (solid) and 0000 GMT 23 July 1984 (dotted)

time, the Atlanta Weather Service Forecast Office (WSFO) was contacted by CWSU as reports of hail and level-6 thunderstorms appeared.

The CWSU issued its last CWA on the outbreak at 23/0125 GMT, and NAWAU at 23/0255 GMT. The CWSU'S as a rule operate only during 0700–2200 local time.

Atlanta WSFO began issuing severe weather statements on the thunderstorms around 1800 GMT and continued them until 23/0050 GMT. Several severe thunderstorm warnings were also issued. During the period, reports of marble to golf ball-size hail, downed trees and gusty surface winds were received by the WSFO. Storm damage reports are summarized in Table 1. Damage locations are given in Fig. 9.

5. CONCLUSION

In the weather situation described, a meteorologist having just come on duty and evaluating the available described data, might have forecast a few isolated thunderstorms on the outbreak area. However, the data would not have initially suggested forecasting an outbreak of the magnitude that actually occurred.

The primary triggering mechanism in this case was the intrusion of a jet into an otherwise marginal thunderstorm situation. The 12-hr LFM vorticity forecast was the key forecast tool as it correctly forecast the movement of the vorticity maximum (and coincidentally the jet). However, initial indicators would not have called for an outbreak of thunderstorms of this severity for this time of year.

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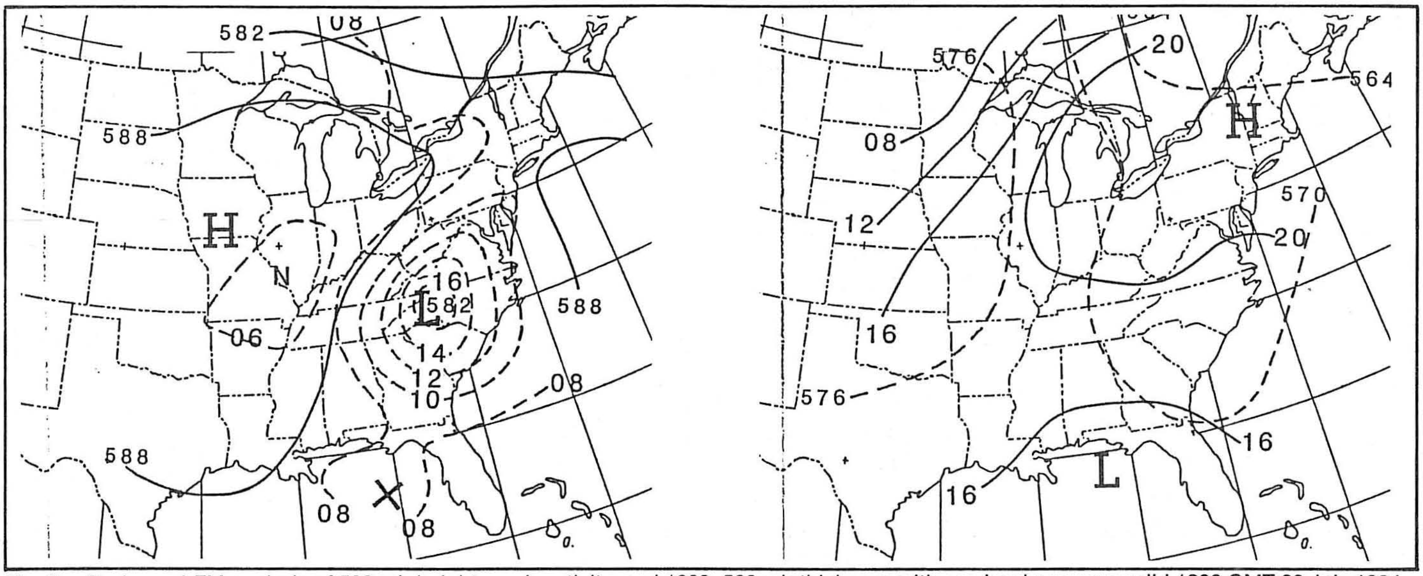

Fig. 8a. Redrawn LFM analysis of 500 mb heights and vorticity, and 1000–500 mb thickness with sea-level pressure valid 1200 GMT 22 July 1984

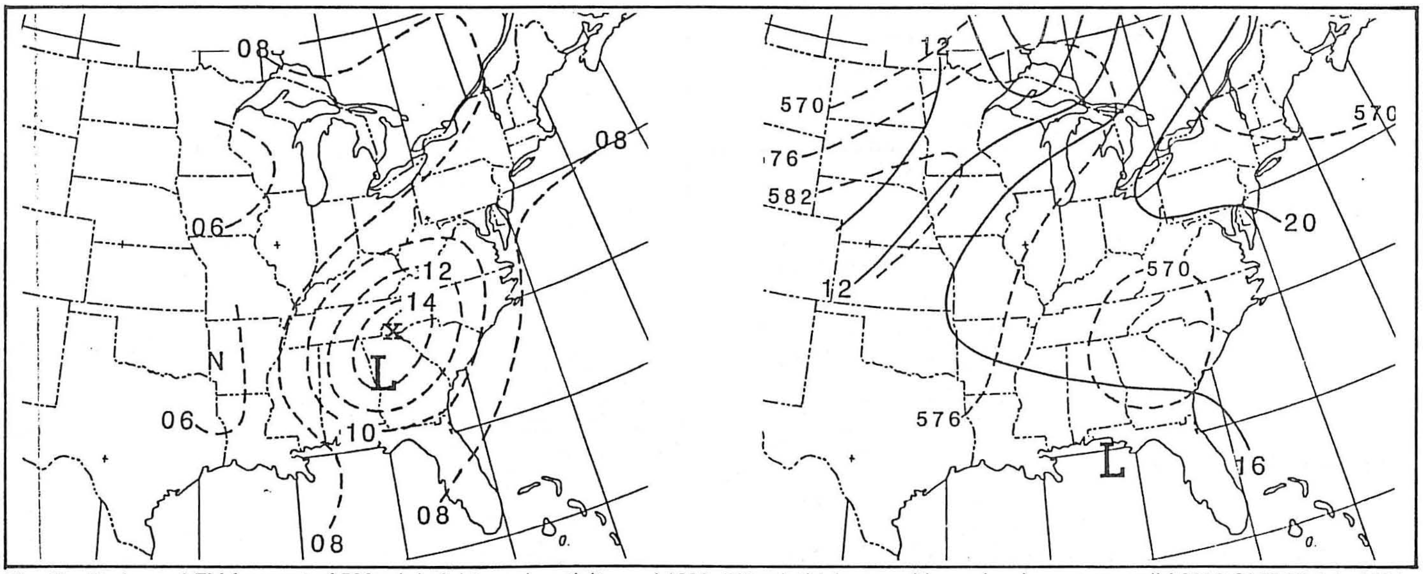

Fig. 8b. Redrawn LFM forecast of 500 mb heights and vorticity, and 1000–500 mb thickness with sea-level pressure, valid 0000 GMT 23 July 1984

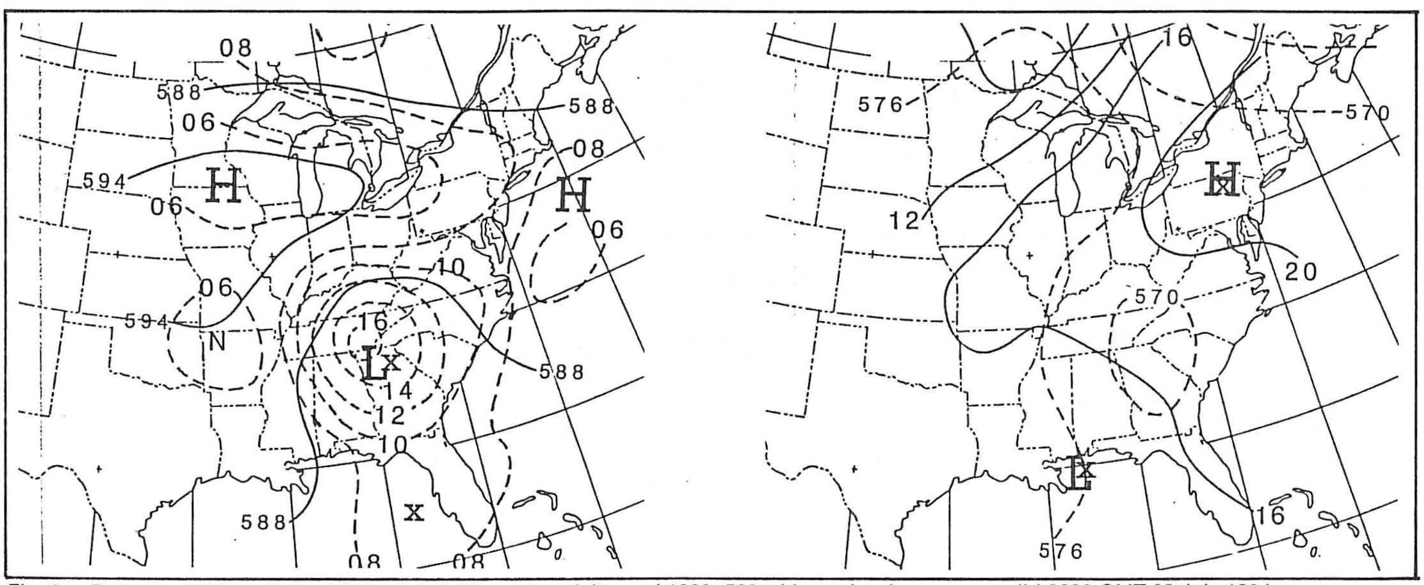

Fig. 8c. Redrawn LFM analysis of 500 mb heights and vorticity, and 1000–500 with sea-level pressure, valid 0000 GMT 23 July 1984

Table 1. Storm damage reports on 22–23 July 1984. (Locations are given by number on Fig. 7.)

Time of occurrence	Place	Damage description
1. 1930 GMT	Marshall Madison County North Carolina	Rain, flooding. The French Broad River rose 16 feet in 45 minutes at Bailey Branch. Crop damage and three bridges washed out.
2. 2127 GMT	Fulton County Georgia	Golf-size hail in Northeast Atlanta.
3. 2230 GMT	Arab Marshall County Alabama	Thunderstorm winds downed a large tree.
4. 2315 GMT	Upson County Georgia	Thunderstorm winds downed a few trees and power lines. One tree fell on a house.
5. 2340 GMT	Meriwether County Georgia	Thunderstorm winds downed several power lines near Greenville. Hail covered the ground near Pine Mountain.
6. 0445 GMT	Bibb County Georgia	Hail to 1½ inches dropped along Barr Road in northern part of County.
7. 0125 GMT	Monroe County Georgia	Thunderstorm winds downed a few power lines.

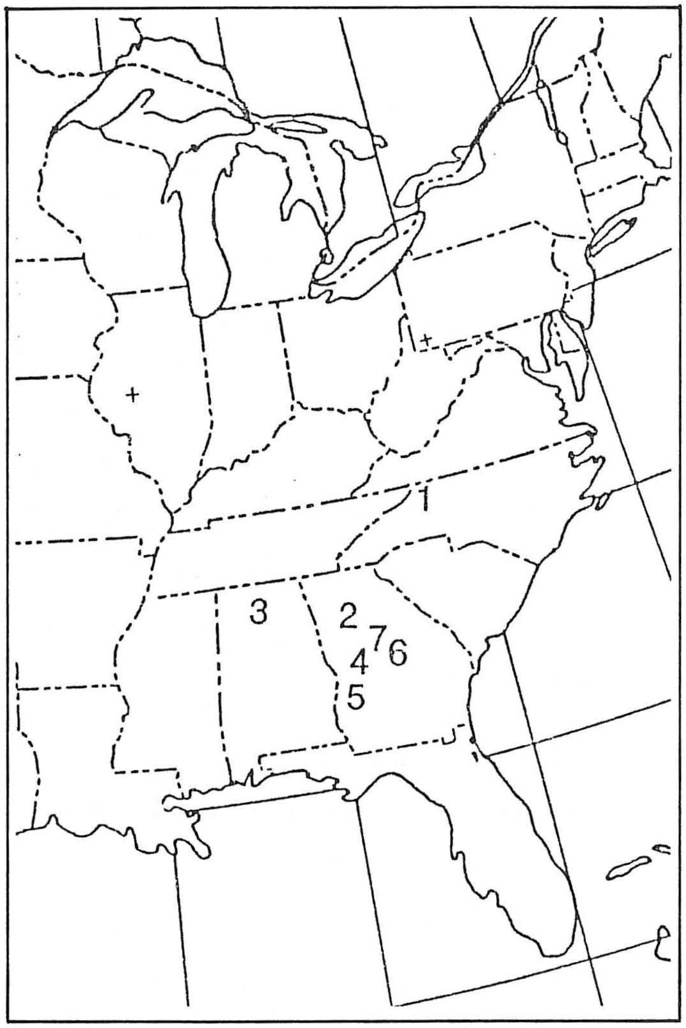

Fig. 9. Storm damage locations given by numbers. Numbers correspond to damage reports in Table 1

NOTES AND REFERENCES

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