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A HEAVY RAINFALL EVENT OVER COASTAL SOUTH CAROLINA

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1. INTRODUCTION

On June 12, 1992, a small area of southeastern South Carolina received an excessive amount of rain. The locations impacted were southeastern Dorchester County, southwestern Berkeley County, and extreme northwestern Charleston County. Moderate to heavy rain remained stationary over the area for an extended period of time, resulting in the issuance of a flood warning for lower Dorchester County. The heaviest precipitation amounts were concentrated in an area from near Summerville to Ladson (Fig. 1). The flooding occurred along Eagle and Chandler creeks, which flow through Sweetbrier subdivision, just northwest of Summerville in Dorchester County. This subdivision has a history of flooding during heavy rain events. The event closely resembled a frontal flood event described by Maddox et al. (1979). This paper will compare the synoptic conditions on June 12, 1992, to those associated with a "frontal flood event", by using the surface, 850 and 500 mb analyses.

2. A TYPICAL "FRONTAL EVENT"

Maddox et al. (1979) described several different types of convective events that produce flash flooding. One such type is the "frontal event." There are several conditions that typify this type of flooding event. A stationary or very slowly moving synoptic scale frontal boundary, usually oriented west to east, helps to trigger and focus heavy precipitation. Heavy rain occurs on the cold side of the surface front as warm unstable air rises over the front (Fig. 2a). Winds aloft are nearly parallel to the front, allowing frontal waves to develop and move over the same location. At 850 mb, an axis of maximum winds flows north along the western edge of the area of highest 850 mb dewpoints (Fig. 2b). Weak 500 mb meso-alpha scale troughs usually help intensify overrunning and initiate convection (Fig. 3). The heaviest rainfall usually occurs near the synoptic scale ridge position. Sometimes a weak mesolow moves east along the frontal boundary at the surface, increasing small scale convergence into the storm area. Wind speeds increase little between 850 mb and 500 mb, but pronounced veering occurs. Frontal events are found to be almost entirely nocturnal in nature and occur most often during the summer months of May through September.

3. ANALYSIS

a. Surface

At 0000 UTC on June 12, a quasi-stationary front stretched across the Gulf Coast states, and then extended off the coast of northern Florida. High pressure centered over Virginia produced a moist northeast flow of low level air and created an overrunning situation over the southeastern United States. At 0000 UTC on June 12 (Fig. 4), surface dewpoints were in the upper 60s (°F) along the southeast coast between Charleston, SC and Savannah, GA. Drier air was positioned over northeast South Carolina, with dewpoints in the mid 50s. An inverted low pressure surface trough extended from south central Georgia into southern South Carolina. Rain began in the area of interest around 2330 UTC on June 11. By 1500 UTC on June 12, dewpoints had increased over the midlands and the northeast part of South Carolina, but remained steady over the rest of the state. The surface trough then shifted eastward to coastal Georgia and south coastal South Carolina. At 0000 UTC on June 13 (Fig. 5), moist air was still in place over the subject area with dewpoints in the low to mid 60s throughout the state. The coastal trough remained nearly stationary, and the area of heavy rain continued over lower Dorchester and Berkeley counties.

b. 850 mb

At 1200 UTC on June 11, a closed low was located over the southwest corner of Missouri. By 0000 UTC on June 12 (Fig. 6), the low had moved east. At 1200 UTC on June 11, the 15°C isotherm stretched in an east-west line over northern South Carolina. At 1200 UTC on June 12, the 15°C isotherm was over Charleston and was slowly moving to the south. By 0000 UTC on June 13, the 15°C isotherm was located south of South Carolina over southern Georgia (Fig. 7). Hence, slight cooling occurred at 850 mb over the subject area.

c. 500 mb

At 1200 UTC on June 11, the 500 mb flow over the southeastern United States was generally meridional. A broad area of low pressure had formed over the Ohio valley by 0000 UTC on June 12 (Fig. 8), and persisted through 0000 UTC June 13. At 1200 UTC on June 11, a weak vorticity maximum was located over southeast Arkansas. At 0000 UTC on June 12, the maxima moved to east-central Alabama, and by 1200 UTC on June 12, it was well to the east of Charleston. Another weak vorticity maxima moved east right behind the first, reaching the South Carolina coast at 0000 UTC on June 13 (Fig. 9).

d. Upper Air Soundings

Three upper air soundings for Charleston, SC are included in this study. They are for 0000 UTC June 12 (Fig. 10), 1200 UTC June 12 (Fig. 11), and 0000 UTC June 13 (Fig. 12). The 0000 UTC June 12 sounding shows a surface dewpoint depression around 6°C. However, the 1200 UTC June 12, and the 0000 UTC June 13 soundings, show the dewpoint depression had decreased to less than 1°C, indicating an increase in low-level moisture. The vertical wind profile shows an example of an overrunning situation, with a moist easterly flow at the surface, and a wind veering to the southwest aloft. Wind speeds were generally light, especially between 850 and 500 mb. However, a slight increase in wind speed was evident between the 0000 UTC June 12 sounding, and the 0000 UTC June 13 sounding in the lowest 200 mb. The increase in wind speed was associated with an increase in vorticity with height, which aided in the transport of additional moisture into the subject area (Bluestein 1992).

e. Rainfall

Hourly overlays of the WSO Charleston WSR-57 weather radar showed that the rain began around 2330 UTC on June 11. Light rain covered a large portion of South Carolina during the period. The area in which flooding occurred received moderate to heavy rain (DVIP level 2 and 3) much of the time. For DVIP level 2, the rainfall amount for convective type precipitation is 0.2 to 1.1 inches per hour, while for DVIP level 3, the rainfall amount is 1.1 to 2.2 inches per hour. Movement of the rain during the heavy rain period was from the west at 10 to 20 knots. The DVIP level 2 and 3 cells tended to be aligned from west to east, producing a "train echo" effect, whereby the heavier echoes repeatedly move over the same area. The heaviest rain (6 inches or greater) was concentrated in an area from Summerville to Ladson. The rain ended shortly before midnight on June 12.

4. CONCLUSION

Beginning on the evening of June 11, 1992, and continuing through most of the day on June 12, parts of southeastern South Carolina received heavy rain. This resulted in flooding over parts of Charleston, Berkeley and Dorchester counties. A quasi-stationary front stretched along the lower Gulf Coast states during this time. A pronounced overrunning situation had developed over the southeastern United States, with low level moisture streaming in from the northeast off the Atlantic Ocean. An upper-level low was located over the southwest corner of Missouri at 0000 UTC on June 12, at 850 and 500 mb. This low moved slowly to the east over the next 24 hours. A large area of light rain developed over much of the state during this time, with cells containing moderate to heavy rain moving west to east across the subject area. The movement of the rain resulted in a "train effect". The scenario described in this study, fits the description of a "frontal type event" flooding scenario as described by Maddox et al. (1979). Meteorologists, especially those new to flood-prone areas, and those who are unfamiliar with various flood scenarios, are strongly encouraged to review the report by Maddox et al. This will enable forecasters to recognize the synoptic and mesoscale conditions necessary for a flood event before it happens. In turn, they should be able to take the necessary action to warn the public, and protect life and property.

ACKNOWLEDGMENTS

My thanks to the Charleston County Mosquito Abatement for providing extensive rainfall records. Thanks also to Dick Shenot, former MIC WSO Charleston, for providing the inspiration for this project and for his encouragement.

REFERENCES

Bluestein, H. B., 1992: *Synoptic-Dynamic Meteorology in Midlatitudes,* Vol. 1, Oxford University Press, NY, 323-390.

Maddox, R.A., C.F. Chappell, and L.R. Hoxit, 1979: Synoptic and meso-alpha scale aspects of flash flood events. *Bull. Amer. Meteor. Soc.*, 60, 2, 115-123.

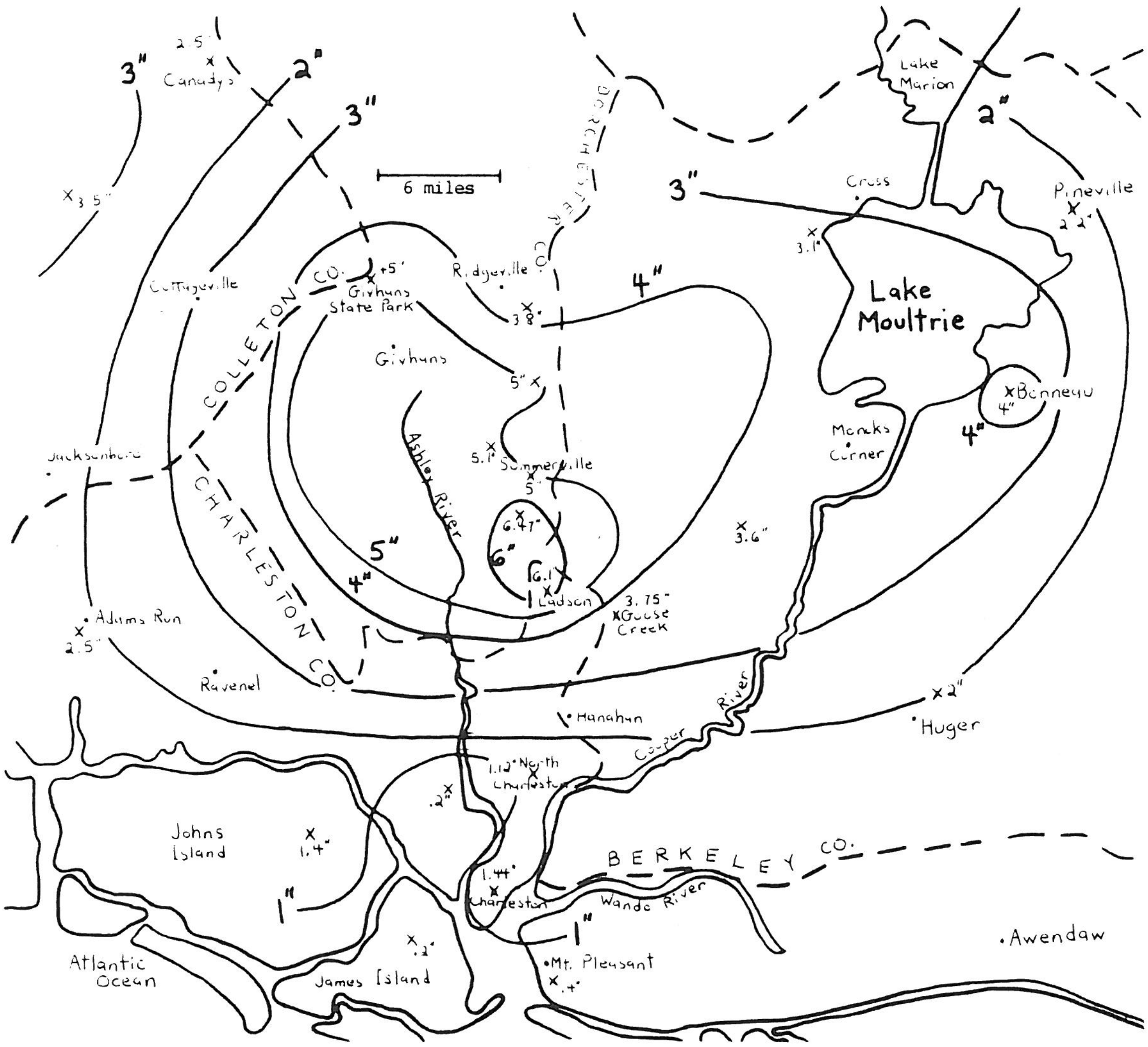
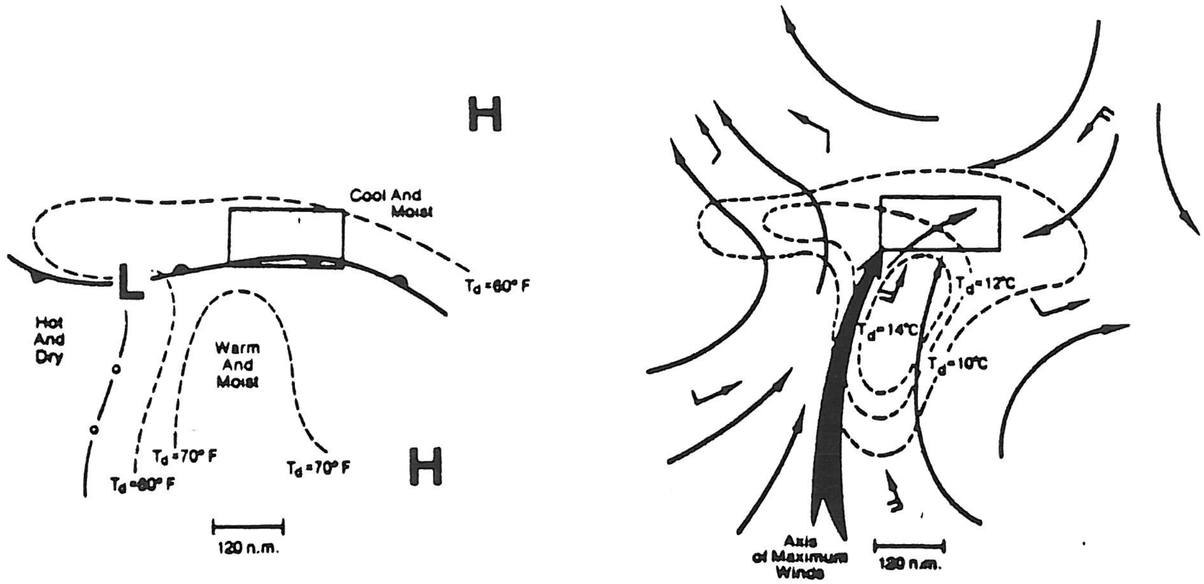


Figure 1. Rainfall totals (inches) for June 12, 1992 across southeastern South Carolina.



a. b.

Figure 2. Typical surface (a), and 850 mb (b) synoptic patterns for a frontal type flood event (from Maddox et al. 1979).

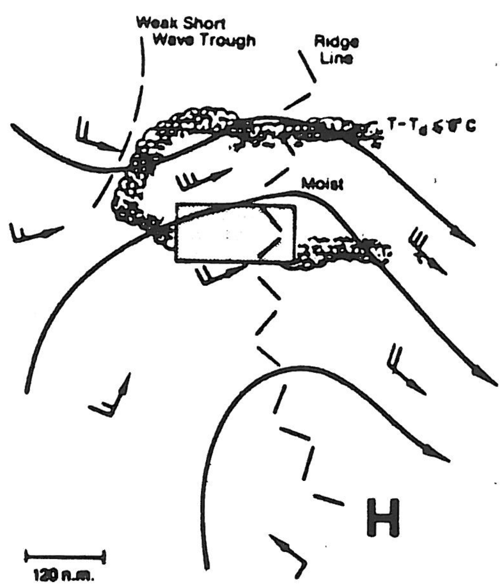


Figure 3. Typical 500 mb synoptic pattern for a frontal type flood event (from Maddox et al. 1979).

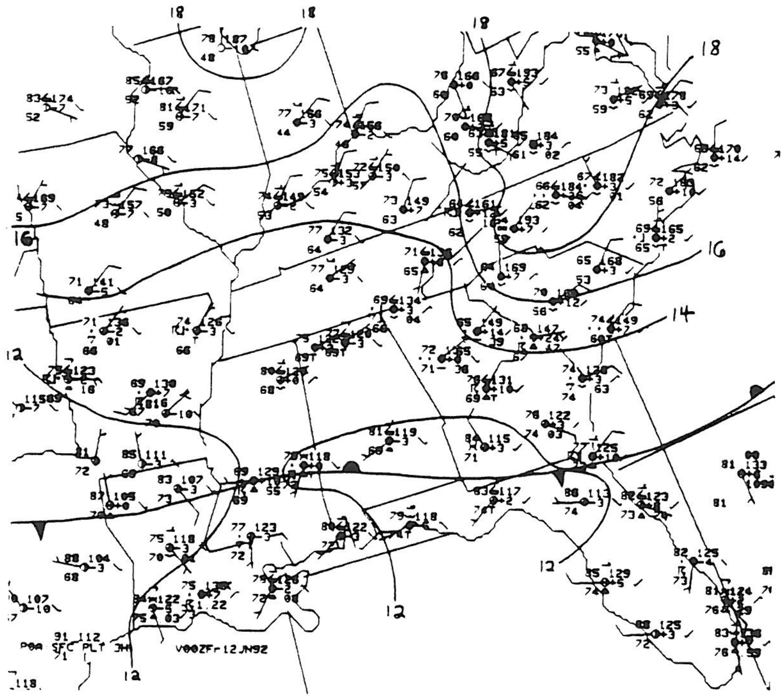


Figure 4. 0000 UTC June 12, 1992 surface analysis.

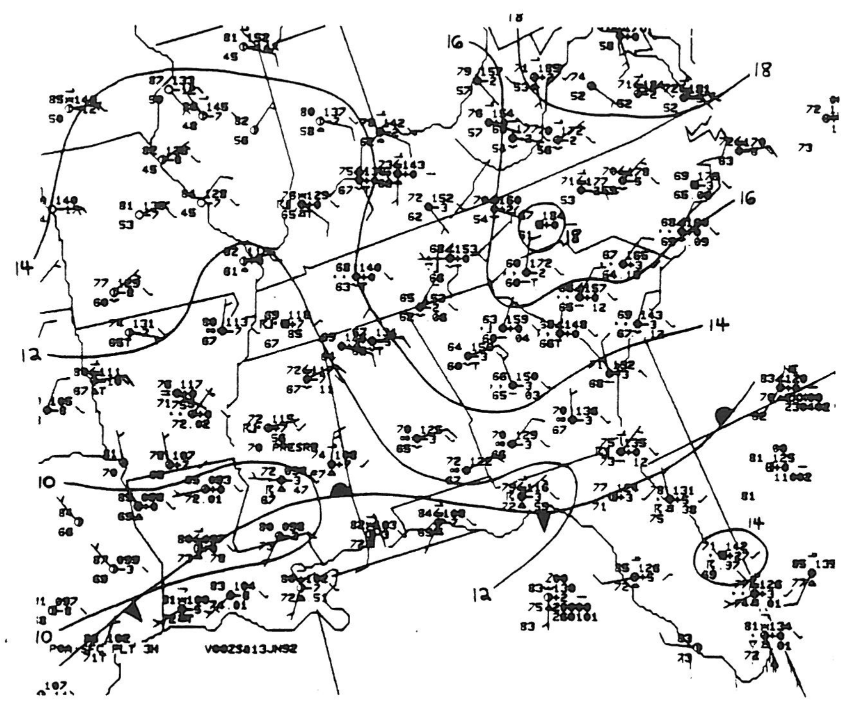


Figure 5. 0000 UTC June 13, 1992 surface analysis.

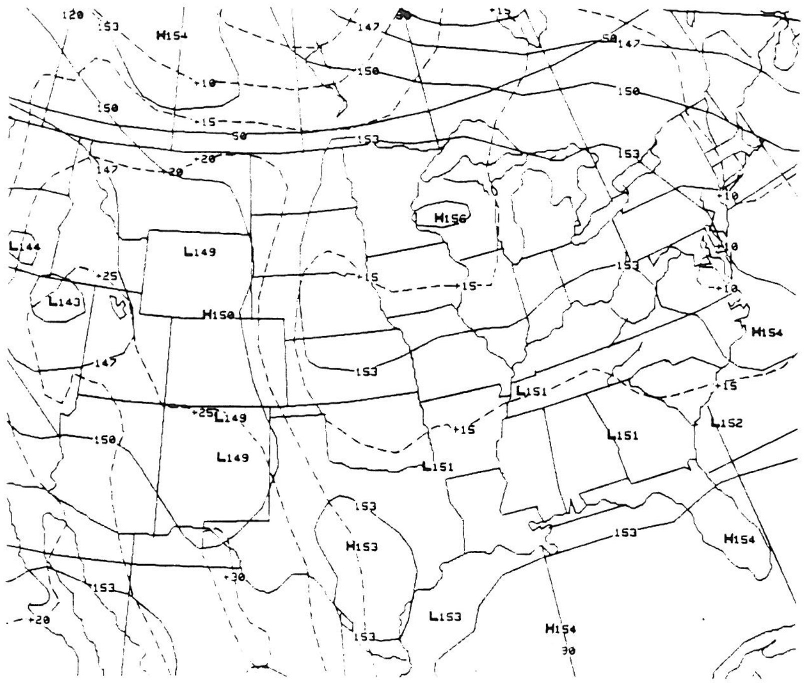


Figure 6. 0000 UTC June 12, 1992 850 mb analysis.

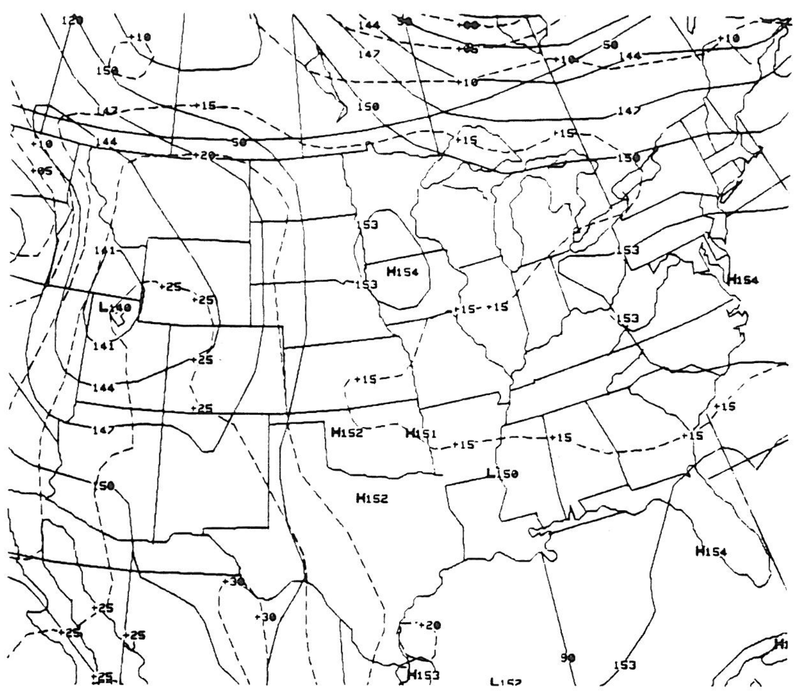


Figure 7. 0000 UTC June 13, 1992 850 mb analysis.

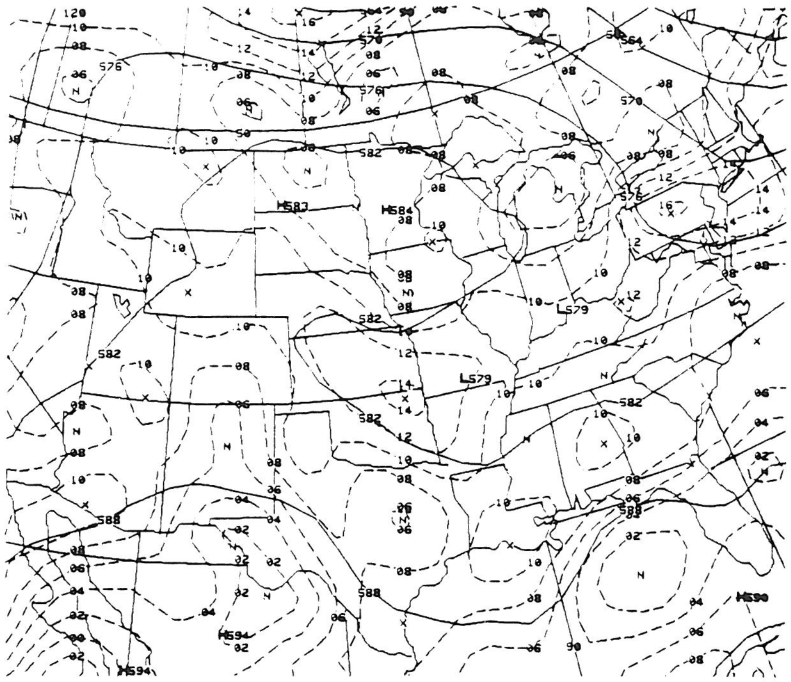


Figure 8. 0000 UTC June 12, 1992 500 mb analysis.

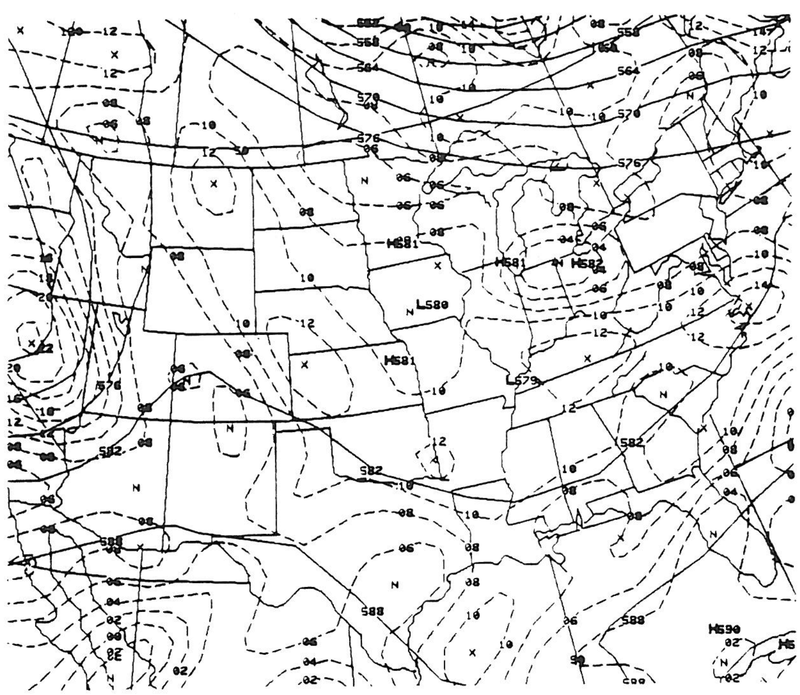


Figure 9. 0000 UTC June 13, 1992 500 mb analysis.

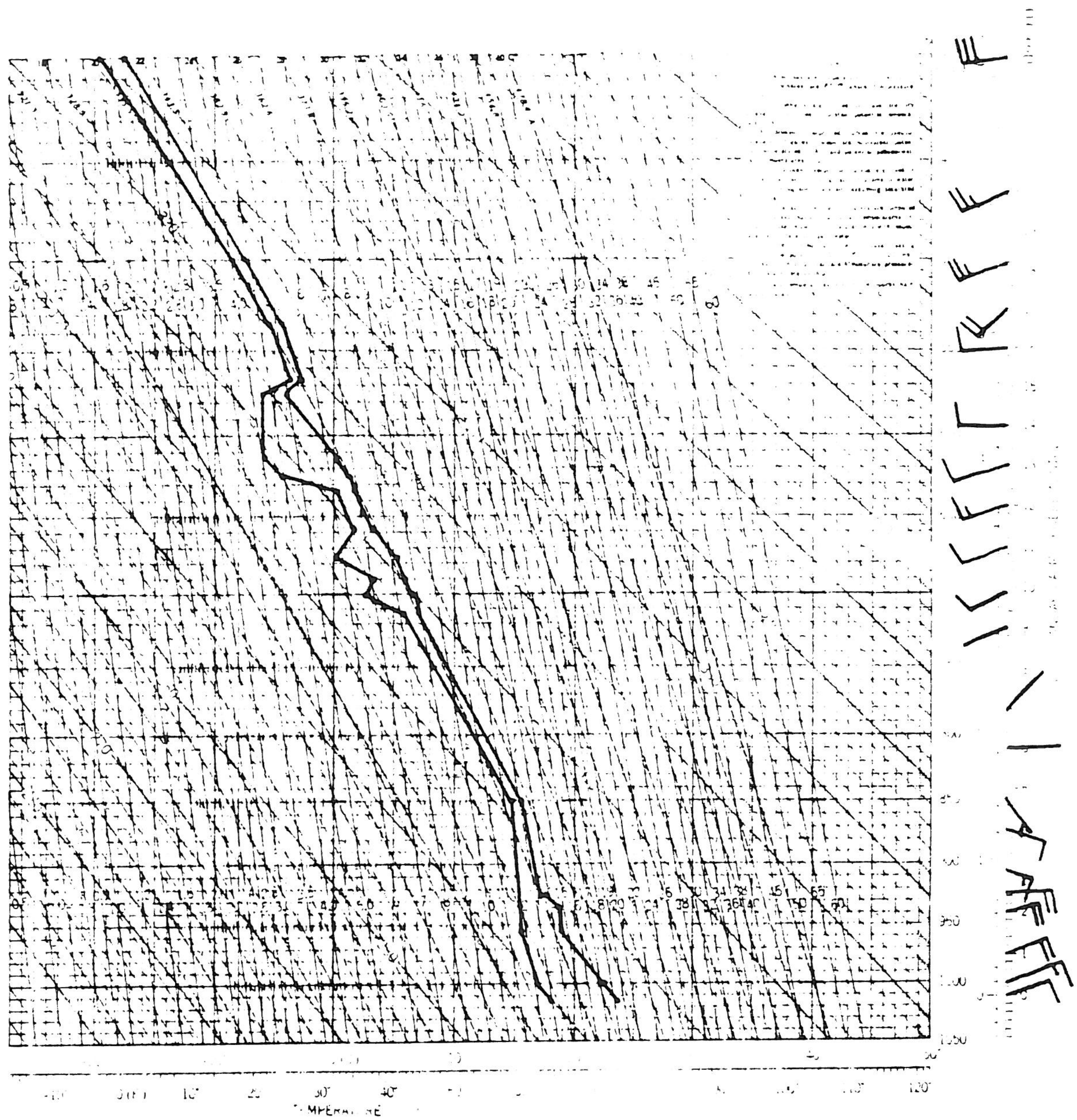


Figure 10. 0000 UTC June 12, 1992 Charleston, SC upper-air analysis.

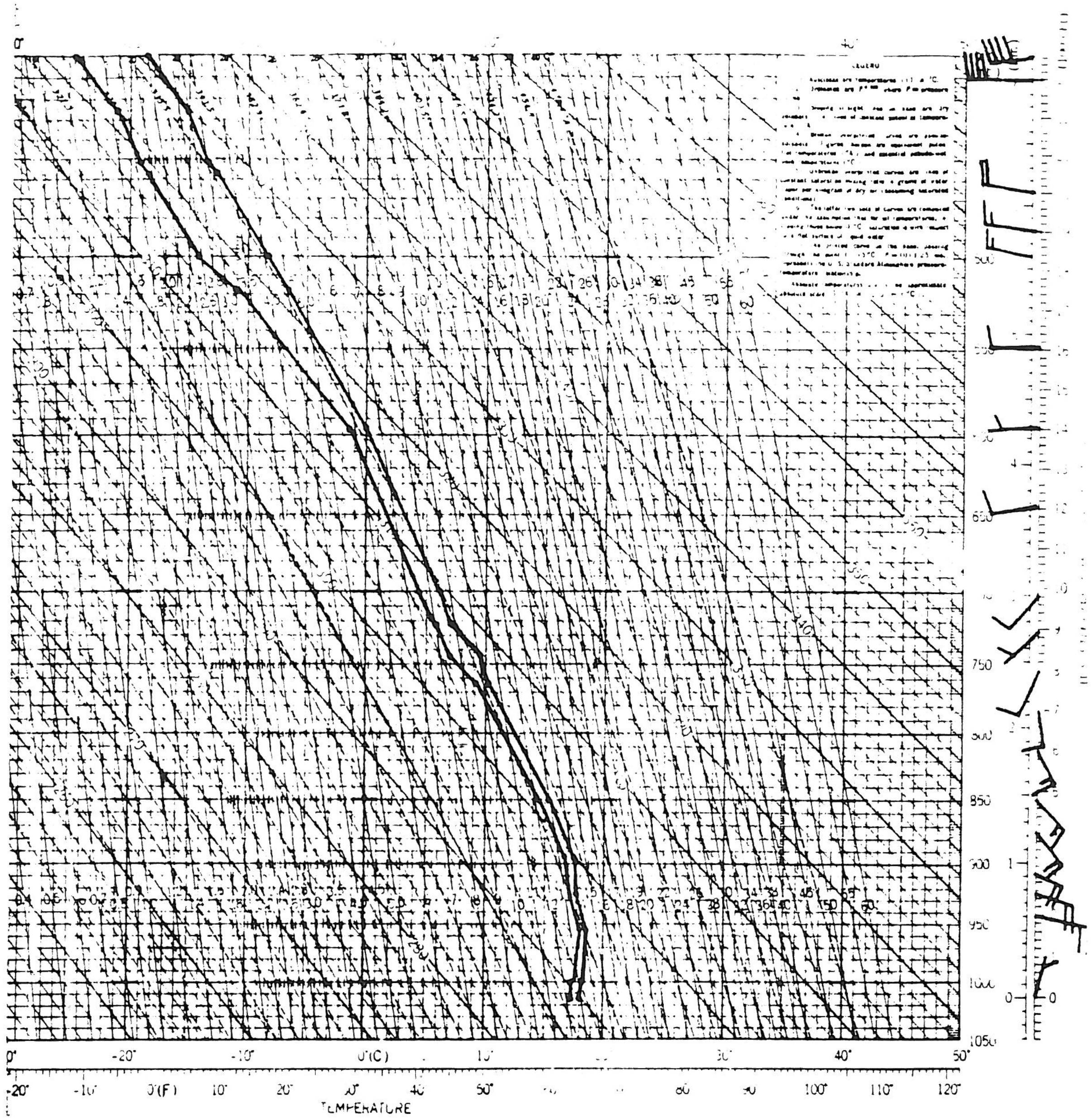


Figure 11. 1200 UTC June 12, 1992 Charleston, SC upper-air analysis.

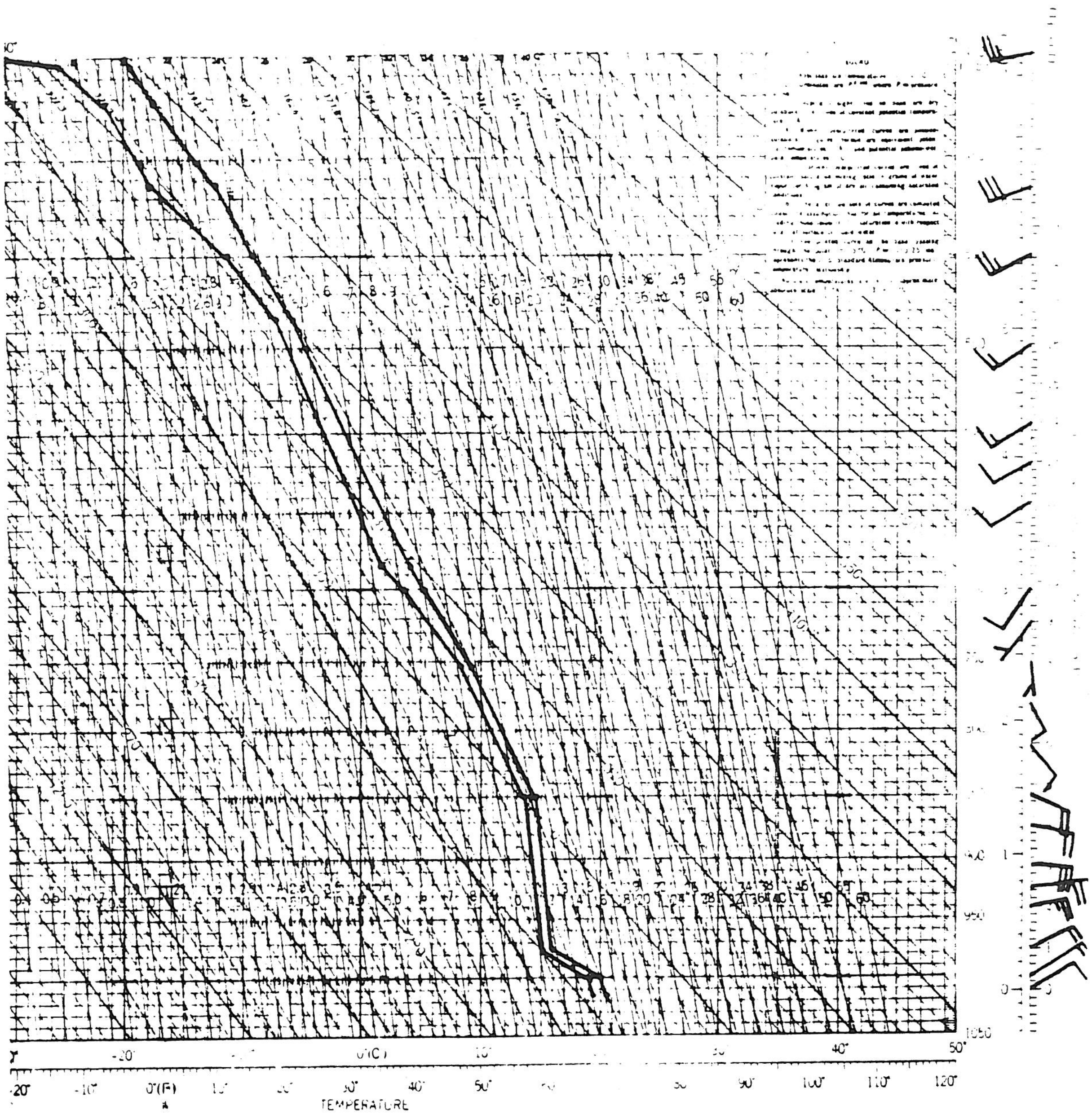


Figure 12. 0000 UTC June 13, 1992 Charleston, SC upper-air analysis.