REPORT

AD-A254 384

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OMB No 0704-0188

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE 1992	3. REPORT TYPE AND DATES COVERED THESIS/DISSERTATION
4. TITLE AND SUBTITLE An Analysis of the Tornado-Producing Raleigh Thunderstorm of November 28, 1988		5. FUNDING NUMBERS
6. AUTHOR(S) Carl Scott Funk, Captain		
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) AFIT Student Attending: North Carolina State University		8. PERFORMING ORGANIZATION REPORT NUMBER AFIT/CI/CIA- 92-045
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) AFIT/CI Wright-Patterson AFB OH 45433-6583		10. SPONSORING/MONITORING AGENCY REPORT NUMBER
11. SUPPLEMENTARY NOTES		
12a. DISTRIBUTION/AVAILABILITY STATEMENT Approved for Public Release IAW 190-1 Distributed Unlimited ERNEST A. HAYGOOD, Captain, USAF Executive Officer		12b. DISTRIBUTION CODE
13. ABSTRACT (Maximum 200 words)		

92-23451

92 8 21 124

14. SUBJECT TERMS			15. NUMBER OF PAGES 124
			16. PRICE CODE
17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT

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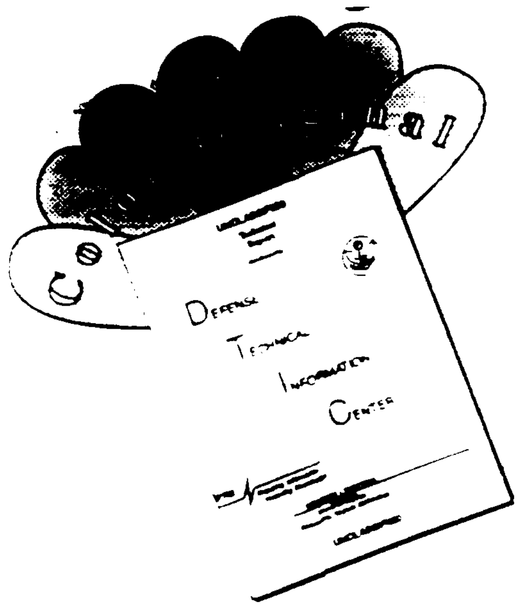

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An Analysis of the Tornado-producing Raleigh Thunderstorm of November 28, 1988

by

Carl Scott Funk

A thesis submitted to the Graduate Faculty of
North Carolina State University
in partial fulfillment of the
requirements for the Degree of
Master of Science

Department of Marine, Earth and Atmospheric Sciences

Raleigh

1992

Approved by:

Chairman of Advisory Committee

Abstract

Funk, Carl S., An Analysis of the Tornado-producing Raleigh Thunderstorm of November 28, 1988 (Under of the direction of Dr. Charles E. Anderson).

The purpose of this research was to document the synoptic and local environment of the North Carolina-Virginia tornado outbreak of November 28, 1988, and to present evidence of the coupling of the existing Raleigh thunderstorm mesocyclone with strong surface vorticity fields as a possible explanation for the sudden spin-up of the very strong (Fujita Scale 4) Raleigh Tornado. Conventional surface, upper-air, and satellite data were analyzed on the **M**an-**C**omputer **I**nteractive **D**ata **A**ccess **S**ystem (McIDAS) computer system at the University of Wisconsin-Madison to study the changes in the synoptic environment prior to the tornado event. Radar data from Volens, Va., Cape Hatteras, NC, and Wilmington, NC were obtained from the National Climatic Data Center (NCDC) and analyzed to determine if characteristic storm signatures were present. In addition, various other types of data from local sources were obtained and used in the analysis.

Results of the analysis indicated that despite marginal severe weather conditions just six hours prior to the Raleigh Tornado, the atmosphere rapidly changed and exhibited the classic severe weather characteristics necessary for tornado production. Also, the thunderstorm associated with the Raleigh Tornado was part of a strong mesolow pressure system, and satellite data indicated the presence of a mesocyclone within the thunderstorm. Finally, strong surface vorticity fields were present in the central-North Carolina region.

This analysis suggests the possibility of the coupling of the existing mesocyclone with strong surface vorticity fields enhanced by convergence along the axis of the storms inflow, and by thermal boundary interaction.

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1. INTRODUCTION

1.1 Background of the Raleigh Tornado

> "Four people were killed and at least 150 were injured in the early morning of Monday, November 28 (1988), when a series of tornadoes sucked up acre after acre of north Raleigh and eastern North Carolina and spat them out like furious giants."
>
> The Raleigh News and Observer
> Special Edition "TORNADO"

When the damage survey was complete and all was accounted for, the tornadoes associated with this outbreak killed four and injured 157 people. The brunt of the storm was felt in Raleigh where it accounted for two of the deaths and 105 of the injured. Little was left undamaged along the tornadoes path. One-hundred and five houses and ten businesses were destroyed, 1,440 homes and 29 businesses damaged, and 800 people left homeless. Of the $77.2 million in damage across eastern North Carolina, $60 million was in Wake County alone (News and Observer, 1988).

Of the seven tornadoes in the outbreak (figure 1), the Raleigh Tornado was the most severe. Rated F4 on the Fujita tornado classification scale, it carved an almost unbroken path 135 kilometers long from just east of the Raleigh-Durham International Airport to near Roanoke Rapids in Northhampton County. Maximum winds were about 94 ms^{-1} and they occurred in Raleigh.

In parts of Raleigh the devastation was so complete, only foundations of houses remained. Given the destructiveness of the tornado, the death toll was amazingly low. This may in part have been due to the hour of night, when the streets were relatively clear of cars and pedestrians. In the final analysis, luck played a large part in keeping the death toll low.

1.2 Justification for the Research

The Raleigh tornado case offers an opportunity to study a rare, and in some aspects unique, tornado event. It was rare because those tornadoes classified as violent in the Fujita tornado classification scheme, rated F4-F5, make up only about three percent of the total tornado population (Fujita, 1981). It was unique that in North Carolina there was no previous climatological record for a violent tornado in the month of November.

Since 1916, records indicate November and December average the fewest tornado occurrences of all months in North Carolina (NOAA, 1989). During the period of record, only 12 tornadoes were reported in the state during November. None of these resulted in fatalities. In December there were only eight tornadoes with a single fatality. None of the 20 tornadoes occurred in the early morning hours. For Wake County, North Carolina the total was one tornado each in November and December with no fatalities.

The development of the Raleigh tornado occurred only six hours after a marginal synoptic environment for severe weather was in place. No tornado or severe thunderstorm watch was in effect when the tornado struck Raleigh (NOAA, 1989). Thus it might seem forecasters were "surprised" by the tornado. The development of severe weather in marginal environments is not a well understood phenomena. Miller (1972) presented a summary of important parameters and suggested guidelines for rating these parameters in his manual on severe storm forecasting. These rules key upon the highly baroclinic synoptic setting that leads to widespread outbreaks of severe thunderstorms and tornadoes. Indeed, these types of situations are handled best by forecasters at the National Severe Storms Forecast Center (NSSFC) (Maddox and Doswell, 1982). Yet, outbreaks of significant severe thunderstorms events often occur in relatively weak large-scale meteorological settings (Maddox et al, 1980; Maddox and Doswell, 1982).

The Raleigh tornado's development also prompts questions about the relationship of the tornado to the thunderstorm cell, and to tornadogenesis. As reviewed by Klemp (1987), a supercell storm may persist in a nearly steady state configuration for up to several hours, yet the transition to tornadic phase is rapid and may take less than ten minutes. The factors responsible for this transition are not well understood. However, some theories exist for this transformation. Mr. Don Burgess of the National Severe Storms Laboratory (NSSL) indicated that of severe storm cells interrogated by the NEXRAD prototype, only about 50 percent of those with tornado vortex signatures (TVS) actually produced a tornado (Anderson, 1990). One can then question the interaction of the severe storm cell with the larger-scale environment and consider what factors in the environment might be present in the 50 percent of the storms which produce tornadoes, and are not present in the other 50 percent.

In his review, Klemp indicates that in severe storm simulations the intensification may be stimulated by the baroclinic generation of strong horizontal vorticity along the low-level cold air pool forming beneath the storm. In this process the horizontal temperature gradients tend to produce horizontal vorticity which is nearly parallel to the low-level inflow. What is generated is horizontal vorticity several times the magnitude of the mean shear. This vorticity is tilted into the vertical as it is swept up into the mesocyclone circulation. In a similar vein, Anderson (1990) suggests that the necessary elements for tornado production are an existing strong surface vorticity field which can be intensified by the low-level wind convergence into the thunderstorm cell. Schrab, et al. (1990) successfully used the surface vorticity field in conjunction with satellite data as a predictor of tornadoes and their intensity. The North Carolina-Virginia tornado outbreak was included in this study.

1.3 Background Research

A number of research projects have enhanced our knowledge and understanding of severe storm events. Also, with each new observational tool we can better understand their complex nature. The tornado, however, being the most dramatic product of the severe storm evolution, still eludes most definitive descriptions because of its scale in comparison to the parent storm and our current observational capabilities.

Tornado is defined in the Glossary of Meteorology (1959) as "a violently rotating column of air, pendant from a cumulonimbus cloud, and nearly always observable as a funnel cloud or tuba (a cloud column or inverted cloud cone, pendant from a cloud base)". It is a violent and destructive, though relatively rare, atmospheric storm responsible for about 100 deaths and $200 million property damage annually (Davies-Jones, 1982). The majority of tornadoes are considered weak and are short lived (Table 1). Consequently, only a small percentage (about three percent) are responsible for almost all of the fatalities and property damage each year.

Tornadoes are produced from a special class of thunderstorms known as supercells. The relationship between tornadoes and mesocyclones was shown by a Doppler radar study of Oklahoma thunderstorms which showed 62% of thunderstorms with mesocyclones produced tornadoes and no tornadoes occurred in thunderstorms without mesocyclones (Brandes, 1984). Another type of tornado associated with gust fronts and shear lines exists but is very weak (it may reach F0 in strength) and short-lived (Wilson, 1986).

Supercell thunderstorms are characterized by being large, long-lived storms which move in a direction to the right of the vector mean wind in the layer occupied by the storm (Barnes and Newton, 1982). Table 6 (page 47) demonstrates this for the Raleigh storm. The typical airmass thunderstorm has a lifetime of about one hour, during which it may move twenty kilometers or so with the atmospheric winds in which it is embedded (Browning, 1982). This is illustrated in figure 2. The supercell in contrast, has a complex structure where the mesocyclone develops an almost steady-state circulation in which an updraft and downdraft coexist (figure 3).

Table 1. Total tornadoes, total path length in miles, and average path length by Fujita-scale strength for all U.S. tornadoes in the 63-year period, 1916-1978. After Tecson, et al, 1979.

F-scale	Total # tornadoes	Total path length (miles)	Mean path length (miles)
0	5,718	8,059	1.41
1	8,645	25,426	2.94
2	7,102	39,459	5.56
3	2,665	27,306	10.25
4	673	12,559	18.66
5	127	3,626	28.55

Severe storms often develop along lines of organized convection or squall lines. Lewis, et al. (1974) and Heymsfield and Schotz (1985) documented non-tornadic, but severe (hail producing), squall lines that moved across the National Severe Storms Laboratory (NSSL) mesoscale data network in Oklahoma. Ogura and Chen (1977) also described the initiation and growth stages of an intense mesoscale system with features similar to these studies.

An important feature in the development of these squall lines was mesoscale boundary layer convergence. Heymsfield and Schotz suggested this mesoscale convergence is a precursor condition to squall line development.

Schlesinger (1983), in model simulations of severe storms, found that without pre-existing mesoscale lifting, the storms would rapidly decay. He concluded that some form of mesoscale forcing was necessary in the initiation and sustenance of severe storms. Another similarity in the squall line case studies was the almost simultaneous rapid development of a number of cells along the squall line. Also, Schrab (1988) discussed a squall line tornadic outbreak which produced 14 tornadoes from five of the 12 total cells. Development along the squall line was fairly uniform and the tornadoes were produced along the entire length of the line, not limited to a specific or preferred region.

With the advent of meteorological satellites, attempts have been made to identify tornadic storms by their characteristic behavior or signature. Adler and Fenn (1981, 1979a) in a study of tornadic thunderstorms as seen in three-to-five-minute-interval, infrared Geostationary Orbiting Environmental Satellite (GOES) data, noted similarities in the behavior of tornadic thunderstorm cells. They found a period of rapid height increase (cell top temperature decrease) 30 to 45 minutes prior to tornado touchdown. A typical value for the temperature decrease was 0.4^{o} $Kmin^{-1}$, or about a 3 ms^{-1} cloud top ascent rate. The height increase was followed by a period of no growth or a drop in cloud-top height preceding or at the time of the tornado touchdown.

Anderson and Schrab (1988) also used satellite imagery to forecast thunderstorm cells which would become tornadic by their characteristic anvil signatures. Using a two-dimensional plume simulation, they input two variables to manipulate the growth rate and direction of the simulation until there was a good fit between the envelope of the simulated and actual plume over several time steps. The two parameters, UMax (the anvil outflow strength) and SDA (storm relative anvil deviation angle to the ambient wind flow), are thought to have a similar physical basis as the local potential buoyant energy and vertical wind shear. Identification of tornadic storms in individual case studies was successful, but the variation of parameter breakpoint values (between tornadic and non-tornadic) among cases hampered the combination of the observations into a single forecast scheme. Perry (1989) attempted to improve their technique by including a third parameter in the statistical model, i.e. the 0 to 4 kilometer mean wind shear. However, because upper air data are collected routinely only twice a day, rapidly changing atmospheric conditions meant the location and time of an upper air winds site was often not representative of the conditions present at the time of the severe local storm. It was not until Anderson included surface vorticity (Schrab, et al., 1990) as the additional parameter that his model was at least partially successful in accounting for the different breakpoint intercepts that occur with each outbreak. The advantage of surface vorticity as a predictor over the 0-4 km wind shear is that as well as being characteristic of the synoptic environment, new values are available hourly, and data are available from a much denser sampling network.

Because of their destructiveness, violent tornadoes (F4-F5) have been popular targets of study. Anderson (1982, 1983, 1985a, 1985b) and Fujita and Stiegler (1985) have studied and documented the particular characteristics of storms producing violent tornadoes. Their findings indicate these storms may be distinguished from their counterparts which produce less destructive tornadoes. Some of their findings include: the necessity of mesoscale convergence in the surface flow to assist the broad upward motion needed for the maintenance of the storm complex (this was also seen in Schlesinger's (1983) numerical modeling studies of severe storms), that these tornadoes are often embedded in a strong mesocyclone evident as a surface mesolow, and these storms form stable meso-vortices which show evidence of 2-cell circulation.

Severe storms develop in environments characterized by large potential instability and vertical wind shear (Miller, 1967). A number of studies documented the relationship of the available potential buoyant energy to the vertical wind shear as a means of discriminating among the various convective storm types and tornado classifications (Leftwich and Wu, 1988; Colquhoun and Shepherd, 1985; Rasmussen and Wilhelmson, 1983; Weisman and Klemp, 1982). The potential buoyant energy (PBE) is defined as the positive area on an upper-air sounding. Vertical wind shear, in this sense, is the mean shear in the lowest four kilometers above ground level. Using the method of Rasmussen and Wilhelmson, the parameters are computed as;

$$\mathrm{PBE} = g \int_{LFC}^{EL} (T_p - T_E / T_E)\, dz$$

PBE: (Potential Buoyant Energy) Positive area of a sounding

Where LFC is the level of free convection, EL the equilibrium level, T_p and T_E the parcel and environmental temperatures respectively. Also,

$$\text{Mean Shear} = \int_{0}^{4km} ((\delta V/\delta z)dz) / \int_{0}^{4km} dz$$

Shear: Low-level (0-4 km) vertical wind shear

Figure 4, Rasmussen and Wilhelmson's plot of PBE vs. mean 0-4 kilometer wind shear shows how they could delineate between tornadic storms, mesocyclones which did not produce tornadoes, and storms which had neither tornadoes or mesocyclones using the two parameters. The results indicated that within certain threshold values, tornadic storm development required large amounts of PBE and mean shear. The study was based on soundings measured at 1200 Coordinated Universal Time (UTC) closest to the tornado event. In situations where large scale processes in the atmosphere rapidly alter the sounding, this technique would have little forecasting application unless the forecaster, in evaluating the parameters, decides the conditions are likely to persist or be found in a different region during the day.

Despite the importance of PBE and wind shear in the production of severe weather and its prediction, other factors have long been recognized as necessary for outbreaks of tornadic storms to occur. In the Raleigh tornado case, the absence of dry mid-level air (700-450 mb), indicated to National Weather Service forecasters that only heavy rains would be expected (NOAA, 1989). Miller (1972) calls the presence or intrusion of dry mid-level air "an essential ingredient for any significant outbreak of tornadic storms." Also, forecast decision trees (e.g. Colquhoun, 1982) absolutely require dry mid-level air as a prerequisite to severe storm forecasts. The dry air ingestion into the storm itself provides for increased negative buoyancy of the downdraft air through evaporative cooling and by the same process may steepen the lapse rate within the storm (Doswell, 1982).

1.4 Description of the Tornado Outbreak

From approximately 0530 UTC to 1049 UTC on Monday, November 28, 1988, seven tornadoes touched down in parts of eastern North Carolina and Virginia (figure 1). In the Fujita tornado classification scheme, one was rated F0, three F1, two F2, and one F4.

As described by NOAA (1989) and others, these are summarized: the first tornado, rated F1, touched down on the southbound lane of Interstate 85 (I-85) about two and a half kilometers north of Virginia route 644 near Meredithville, Virginia around 0530 UTC (Brunswick Times-Gazette, 1988; Anderson, 1989). It moved to the northeast along the southbound lane of I-85 for about five kilometers into the town of Alberta, Virginia before lifting. Soon after the Alberta tornado dissipated, the Raleigh tornado formed just to the southwest of the Raleigh-Durham International Airport. It touched down first around 0600 UTC at the Reedy Creek Section entrance to the William B. Umstead State Park, though, audible and ground damage evidence exists to indicate it was aloft for an unknown amount of time before finally settling to the ground. The tornado moved rapidly to the northeast in excess of 25 ms^{-1}. Rated F4, it devasted parts of north Raleigh before moving out of Wake County into Franklin, Nash, Halifax and Northhampton Counties. After being on the ground continuously for 135 kilometers, it lifted at about 0745 UTC five kilometers north of Jackson in Northhampton County. The same thunderstorm then produced another tornado which struck near the town of Galatia, again in Northhampton County, about fifteen kilometers from where the Raleigh tornado lifted. This tornado, rated F2, was on the ground for about five kilometers shortly after 0750 UTC. The last tornado to be spawned from this thunderstorm touched down north of Franklin, Virginia at about 0820 UTC for 24 kilometers before lifting around 0835 UTC. It was rated F2 and struck the town of Walters, Virginia. Between 0830 UTC and 1049 UTC, three additional tornadoes struck the North Carolina coastal counties of Pamlico, Hyde and Dare. They were rated F1, F1, and F0, and were on the ground for 48, 6.4, and 1.6 kilometers respectively.

Table 2, compiled by the State of North Carolina, is an assessment of the damage, injuries, and deaths caused by this tornado outbreak for the state of North Carolina.

Table 2. Assessment of the damage, injuries and deaths caused by the November 28, 1988 tornado outbreak by the State of North Carolina.

County	Homes Damaged	Homes Destroyed	Businesses Destroyed	Injured	Dead
Hyde	9	1	1	0	0
Dare	11	6	0	0	0
Pamlico	0	5	0	3	0
Northhampton	10	8	4	0	0
Wake	1586	128	35	105	2
Nash	10	11	0	22	2
Franklin	22	30	3	17	0
Halifax	22	13	3	10	0
Totals	1687	199	45	157	4

1.5 Synoptic Setting of the Outbreak Case

The weather system which produced the outbreak case for this study was unremarkable in most aspects. Though it did produce instances of severe weather early in the development of the system, including tornadoes, none was reported in the 24 hours prior to the North Carolina-Virginia outbreak (NOAA, 1989). The synoptic low pressure system developed east of the Rocky Mountains as a dry continental polar airmass and moved southeastward out of Canada. By the evening of November 26, the cold front associated with this weather system reached the Mississippi River Valley. On the evening of the 27th, it had reached the Appalachian Mountains and was poised to move into central and coastal sections of the middle Atlantic states.

In the 72 hours prior to the Raleigh tornado event, the NSSFC recorded 78 instances of severe weather (hail, high winds, and tornadoes) associated with this system. Storms struck first across portions of Oklahoma, Texas, and Arkansas where 64 reports of severe weather in the 24 hours before 0900 UTC, November 26 were received. The system moved eastward and continued to produce violent weather. By 0900 UTC on November 27, another 14 reports of severe weather in Louisiana, Mississippi, and Alabama were recorded. The system did not produce more severe weather until about 0530 UTC, November 28, 1988. This information was summarized from the NOAA (1989) Natural Disaster Survey Report.

By 0000 UTC on November 28, the surface low pressure system was centered near east-central Wisconsin. Its cold front extended through northern Virginia, east of Staunton (SHD) and Roanoke (ROA), into North Carolina west of Hickory (HKY) and Winston-Salem (INT), and continued south through South Carolina, Georgia, and the Florida panhandle. A thermal boundary extended from near Columbia, SC (CAE) northeastward to just west of Fayetteville, NC (FAY) and east of RDU. Figure 5 shows the relative positions of the surface features. Also shown are 5^{o} F contours and the 65^{o} F and greater (shaded area) dewpoint values. Most striking was the temperature contrast across the thermal boundary. South and east of the front, winds were southerly and mostly greater than 5 ms^{-1}.

In the upper air analysis the frontal system was well supported aloft (figures 6(a)-6(d)). The long-wave trough was well defined at the standard levels and a short-wave trough existed between 850 mb and 500 mb. At 700 mb (figure 6(b)) an area of relatively drier air is seen to the west of the Appalachian Mountains. Maximum winds at each level are defined by the jet core speeds, in ms^{-1}, and are given by the enclosed isotachs. At 300 mb (figure 6(d)) a broad area of jet stream winds in excess of 50 ms^{-1} was evident across the upper Mississippi River Valley. Not seen in this figure is another jet core maximum at 200 mb above GSO. Figure 7 gives the stations used in the cross-sectional analysis for figures 8(a) and (b), cross-sections 1 and 2. Cross-section 1, figure 8(a), shows a jet core greater than 55 ms^{-1} to the west of North Carolina in the upper Mississippi River valley. Above GSO, winds at 200 mb were >65 ms^{-1}, creating a double jet condition. These jet winds were analyzed by NOAA meteorologists as the sub-tropical and polar jet streams, respectively. This pattern is favorable for the development of divergence aloft, and divergence aloft is necessary for the enhancement of deep convection (NOAA, 1989; Doswell, 1982). In cross-section 2, figure 8(b), the dry air which would eventually be in a position to intrude into the Raleigh thunderstorm and enhance the severe storm complex was seen in the mid-levels, above 500 mb, to the west of AHN.

Lifted index values (figure 9) at 0000 UTC on November 28 indicated stable conditions prevailed over central and western North Carolina, with increasingly unstable air to the east and south of the Raleigh area. Despite the stable air over central North Carolina, strong veering and increasing winds with height were present in the region. Recalling figure 4, wind shear vs. PBE for the Raleigh case, shear values were very high. This was also evident in the hodographs of CHS, GSO, HAT and AHN (figure 10). GSO displays a classic tornado producing hodograph (see Klemp, 1987).

The situation by 0000 UTC suggested a marginal situation for the development of severe weather. While significant vertical wind shear existed across the region (figure 4 and figure 10), other factors necessary for the production of severe weather were missing. According to Miller (1972), the thermal structure must be conditionally unstable for severe weather to occur. Across eastern North Carolina the Lifted Index values ranged between 0 and -2 (figure 9) and the Total Totals Index from 46 to 49 (table 3). Miller rates these values as weak for the production of severe weather. Additionally, a very moist, nearly saturated air mass was east of the Appalachian Mountains. Figure 11(a), the GOES 0001 UTC water vapor imagery, shows moist air east of the

Appalachians. Also present was the dry air to the southwest of extreme western North Carolina. At the time it seemed doubtful that this air would intrude into the Raleigh storm. This is also seen in cross-section 2, figure 8(b). The GOES IR imagery, figure 12(a), at 0031 UTC shows widespread convection across the region, though, strongest activity at this time was in northern Florida and southern Georgia (NOAA, 1989). However, by 0601 UTC the situation would have changed drastically and can be seen in figure 12(b), the GOES IR imagery for that time, the Raleigh thunderstorm was a well developed and dramatic feature. While some factors suggested severe weather, the situation was not dramatic and forecasters at the local NWS forecast office and Severe Local Storms forecast office at NSSFC felt the potential for severe weather was somewhat limited (NOAA, 1989).

Table 3. Stability indices at 0000 UTC, November 26 1988 for Greensboro (GSO), Cape Hatteras (HAT), Athens (AHN), and Charleston (CHS).

Station	Lifted Index	Sweat	Total Totals	K-Index
72317 (GSO)	-0.14	397	48.8	35.9
72304 (HAT)	-1.34	307	45.6	30.6
72311 (AHN)	6.26	381	49.1	35.5
72208 (CHS)	-3.24	312	47.4	22.9

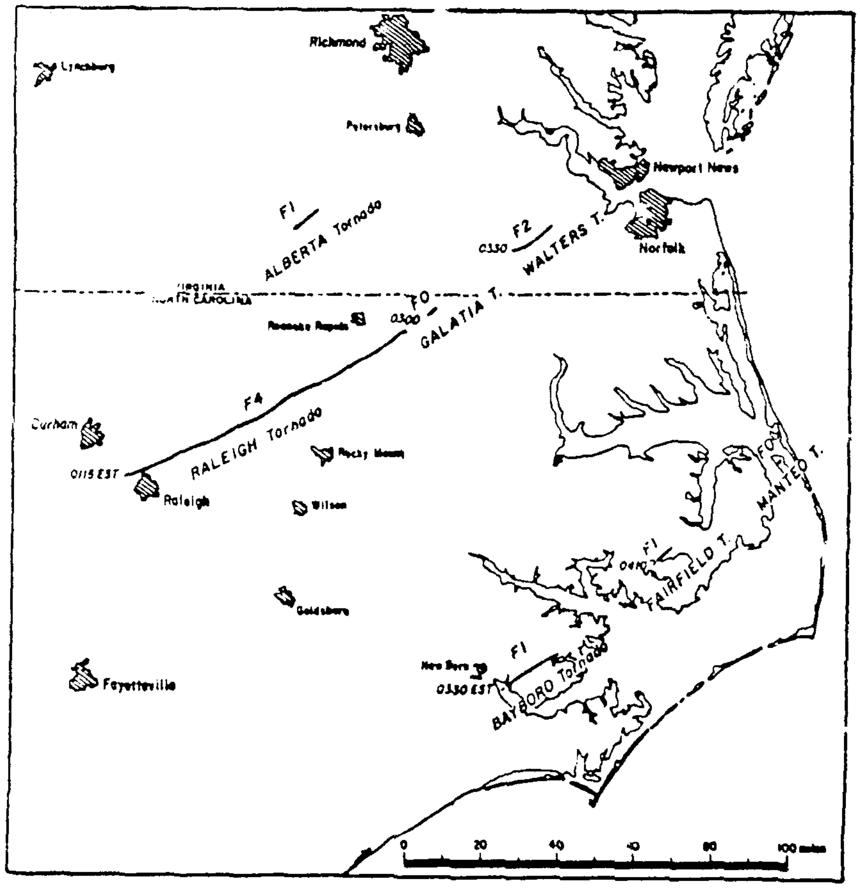


Figure 1. North Carolina-Virginia tornado outbreak of November 28, 1988. Compiled by the Wind Research Laboratory, University of Chicago.

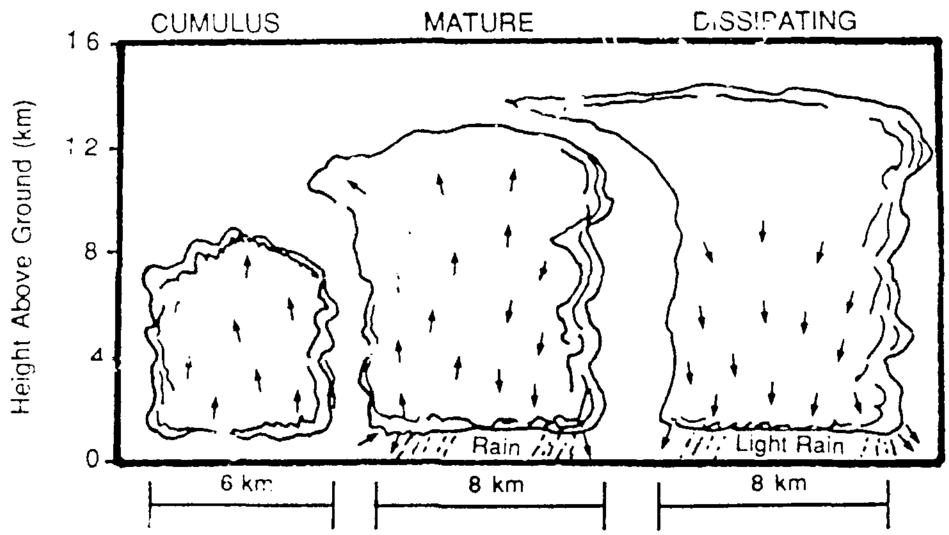


Figure 2. The three stages in the life cycle of an ordinary thunderstorm cell. After Browning (1982), from Byers and Braham.

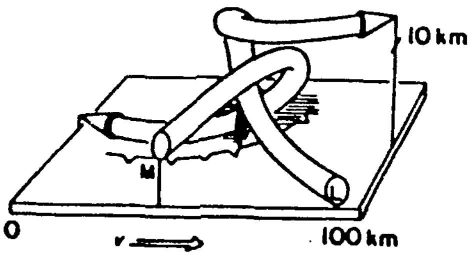


Figure 3. Browning's (1964) conceptual model of the circulation within a severe right-moving storm. This is depicted as a three-dimensional, nearly steady-state circulation (relative to storm motion) in which warm, moist low-level air feeds continuously into a single large updraft. Evaporative cooling within the region of heaviest precipitation just north of the updraft drives the main downdraft which ingests air passing around in front of the eastward-moving storm. The hatched area represents approximate extent of precipitation at the ground, and the gust front boundary is represented by the frontal boundary symbol.

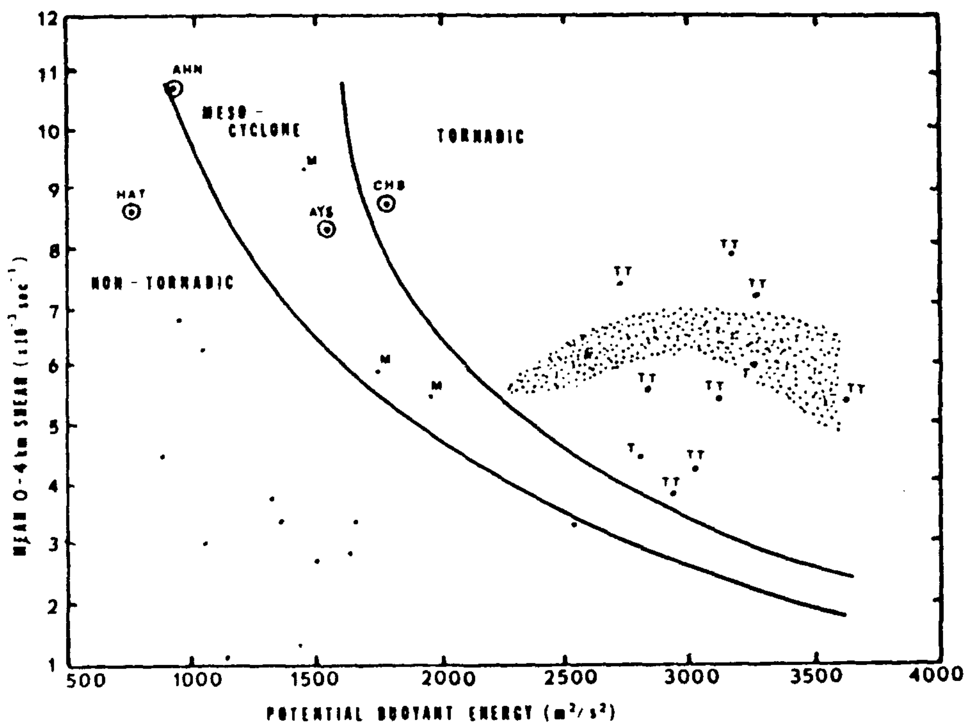


Figure 4. Plot of potential buoyant energy versus the 0-4 kilometer mean shear (after Rasmussen and Wilhelmson, 1983).

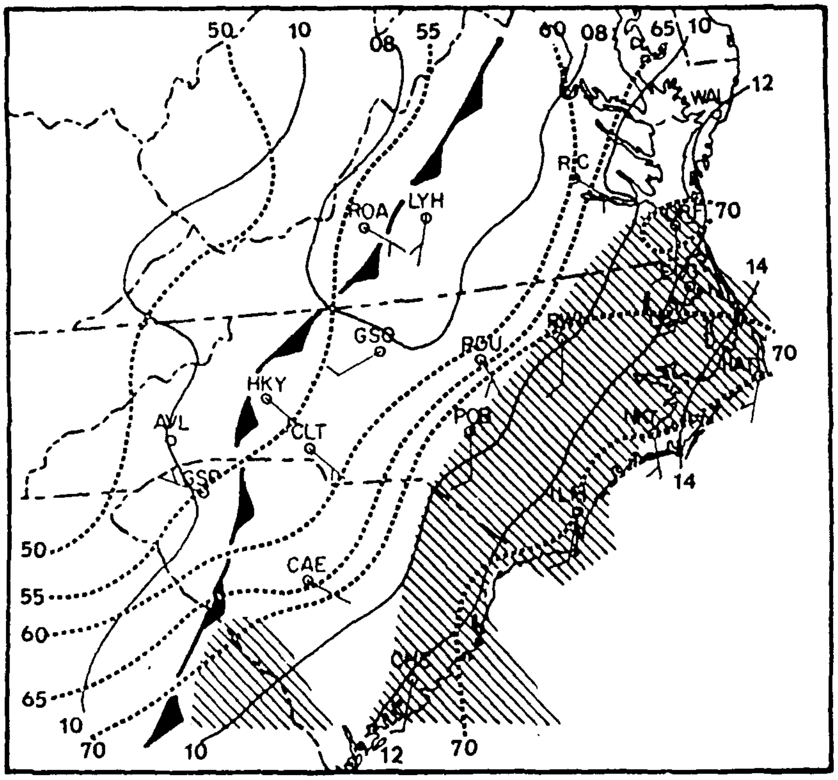


Figure 5. 0000 UTC surface analysis for November 28, 1988. Solid lines are isobars at 2 mb intervals. Dashed lines are isotherms at 5° F intervals. Shaded area represents surface dewpoint values ≥65° F.

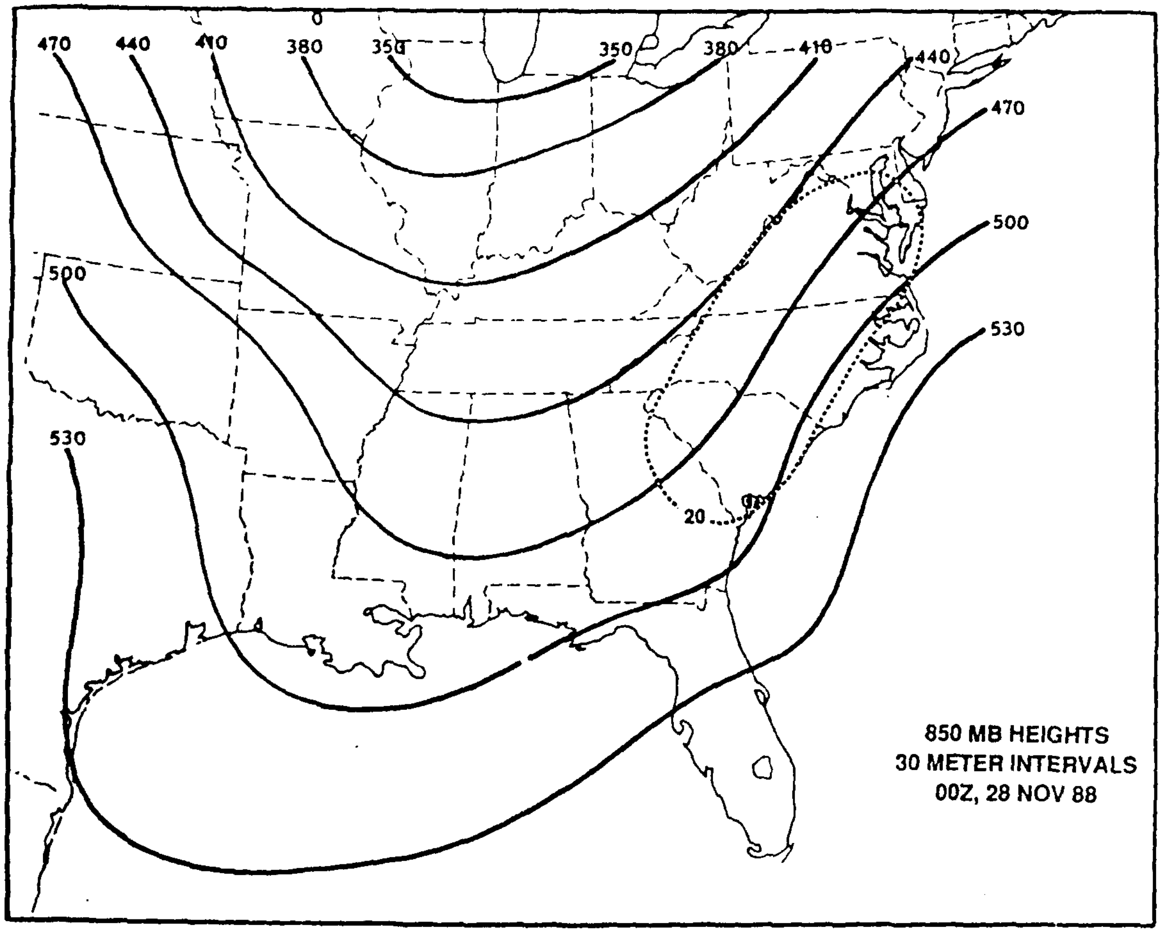


Figure 6a. 850 mb heights and wind speed analysis for 0000 UTC, November 28, 1988. Heights are analysed at 30 meter intervals (solid lines), and wind speeds $\geq$20 mps are represented by the dashed lines.

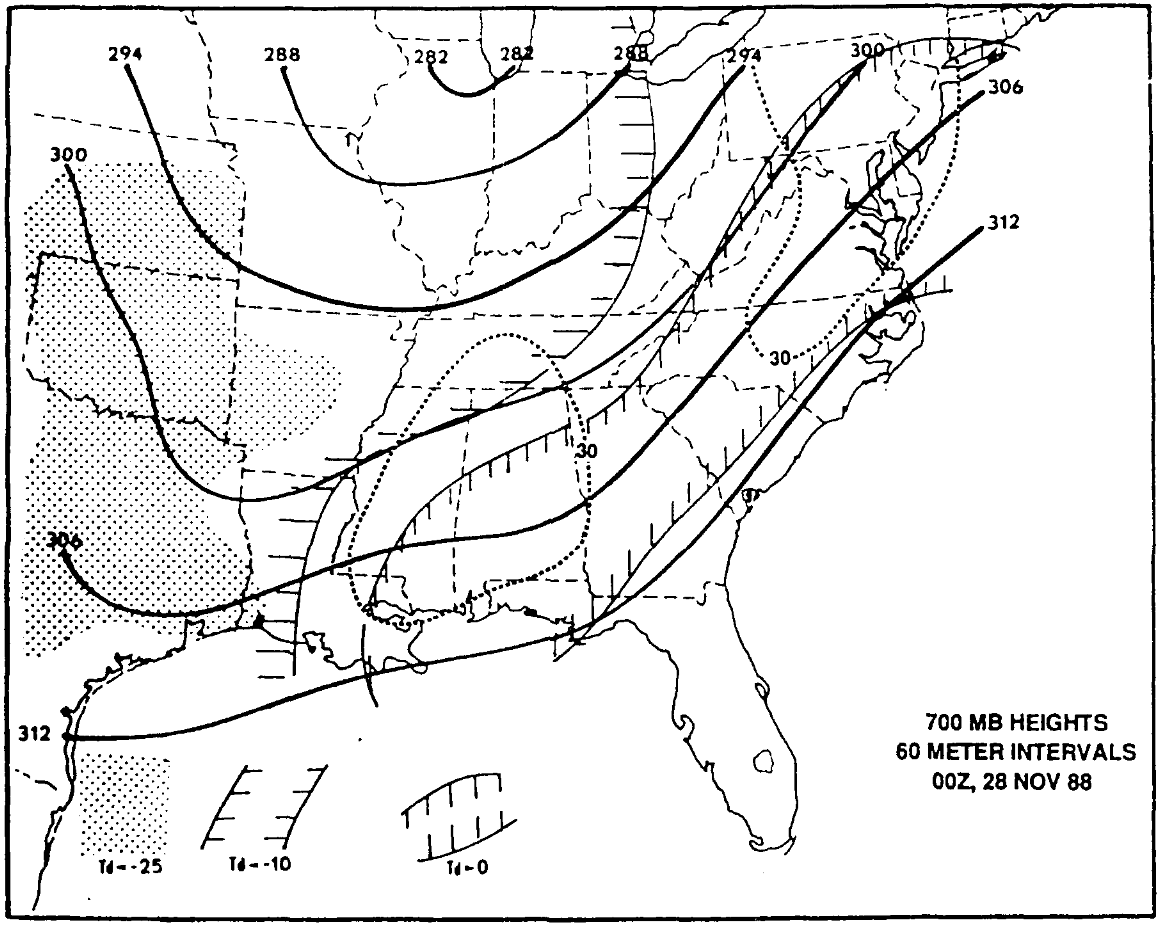


Figure 6b. 700 mb heights and wind speed analysis for 0000 UTC, November 28, 1988. Heights are analysed at 60 meter intervals (solid lines), and wind speed ≥30 mps are represented by the dashed lines. Also, dewpoint temperatures are represented as shown on the figure. Lowest dewpoint values (<-25o C) are in the shaded region.

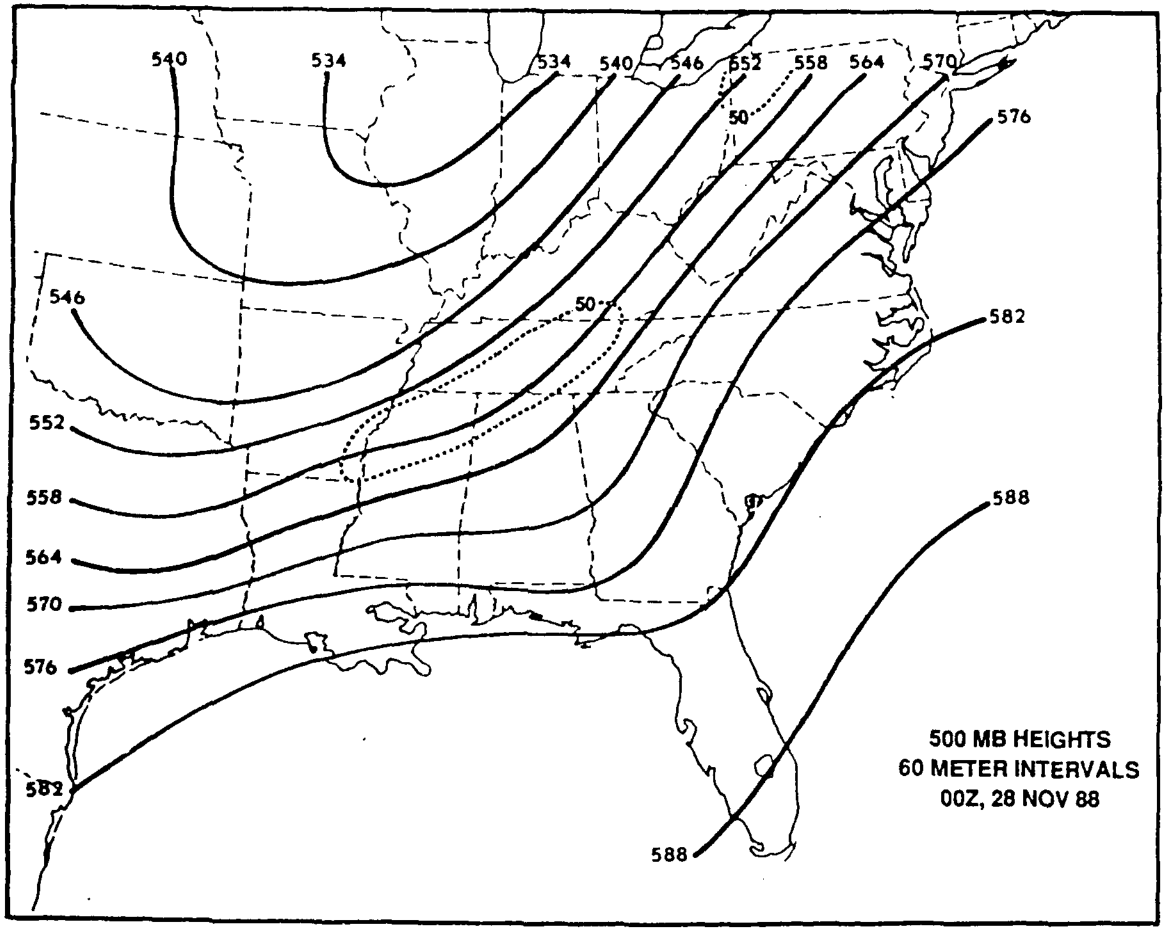


Figure 6c. 500 mb heights and wind speed analysis for 0000 UTC, November 28, 1988. Heights are analysed at 60 meter intervals (solid lines), and wind speed ≥50 mps are represented by the dashed lines.

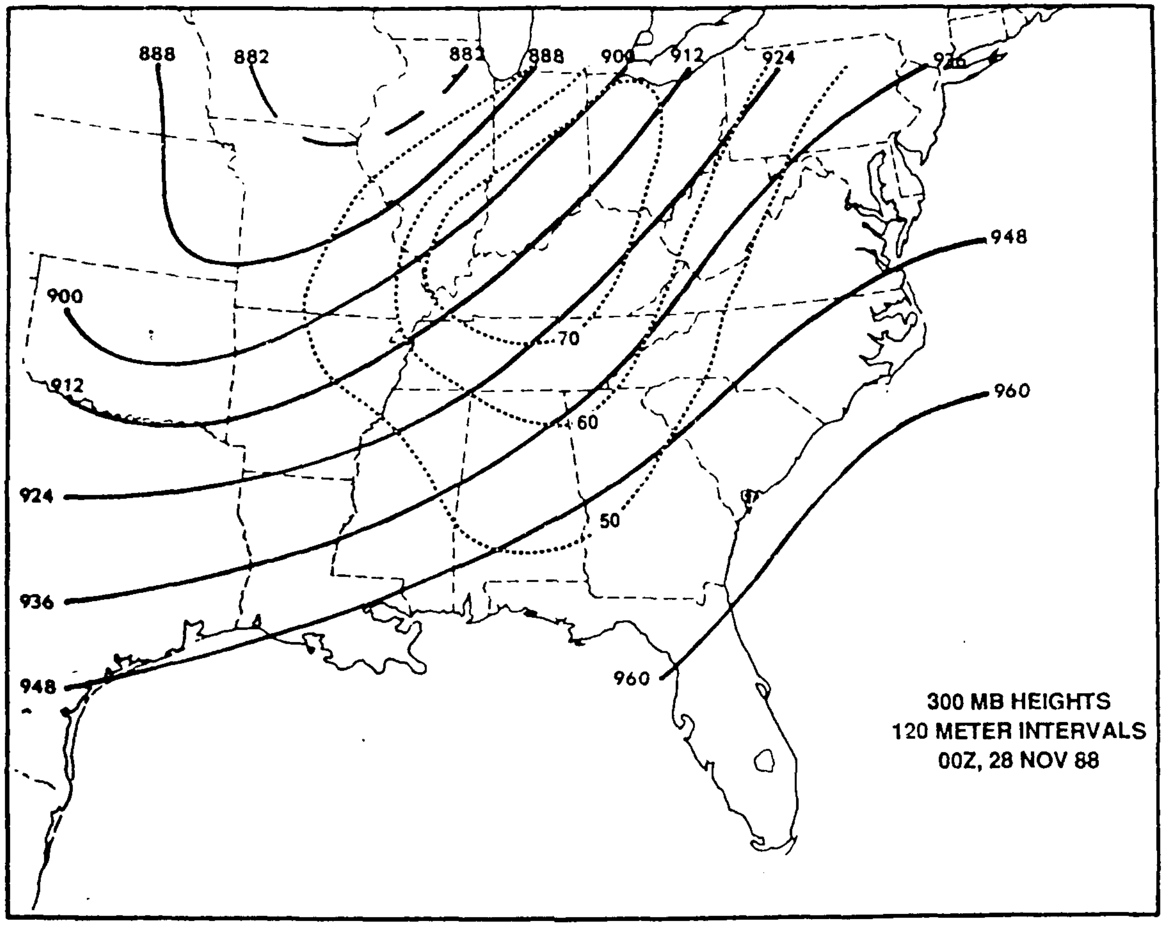


Figure 6d. 300 mb heights and wind speed analysis for 0000 UTC, November 28, 1988. Heights are analysed at 120 meter intervals (solid lines), and wind speed $\geq$50 mps are represented by the dashed lines.

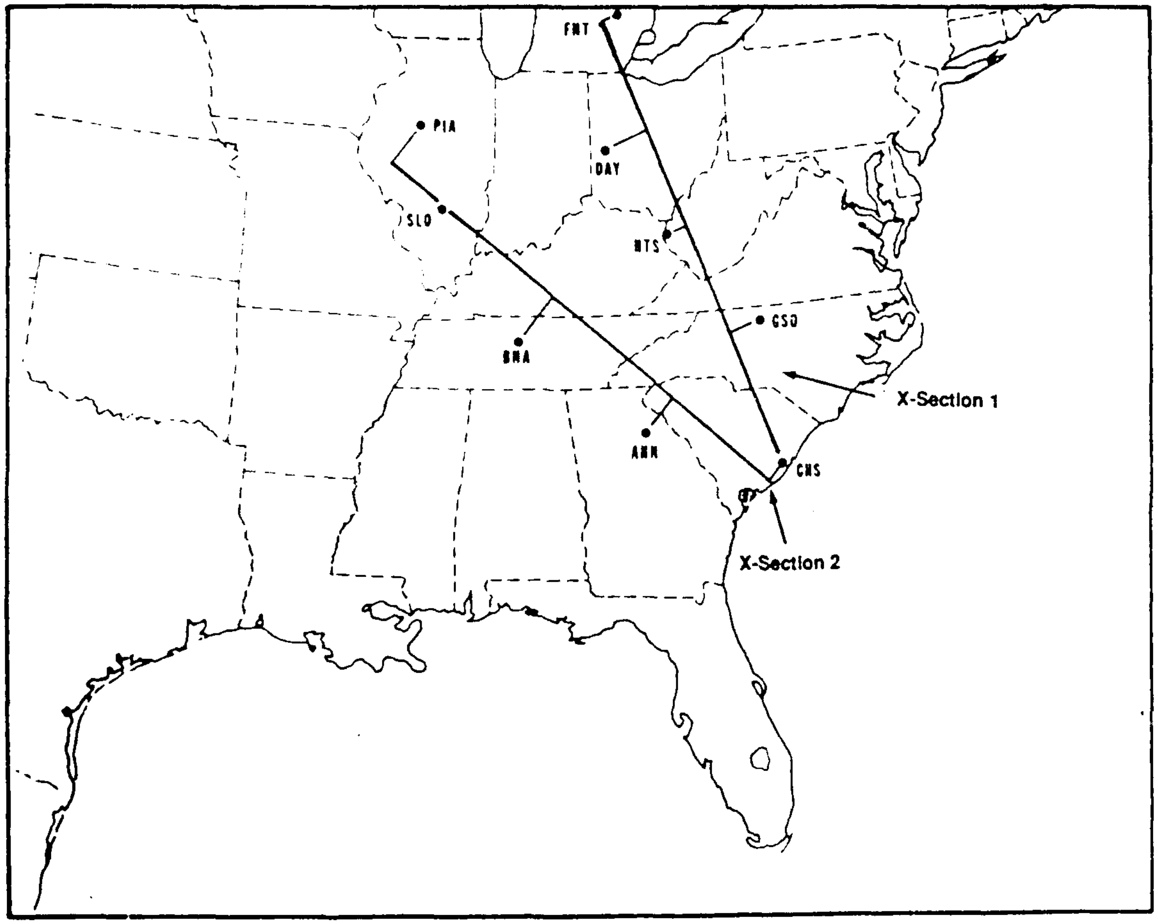


Figure 7. Stations used and area represented by cross-sections 1 and 2 for 0000 UTC, November 28, 1988.

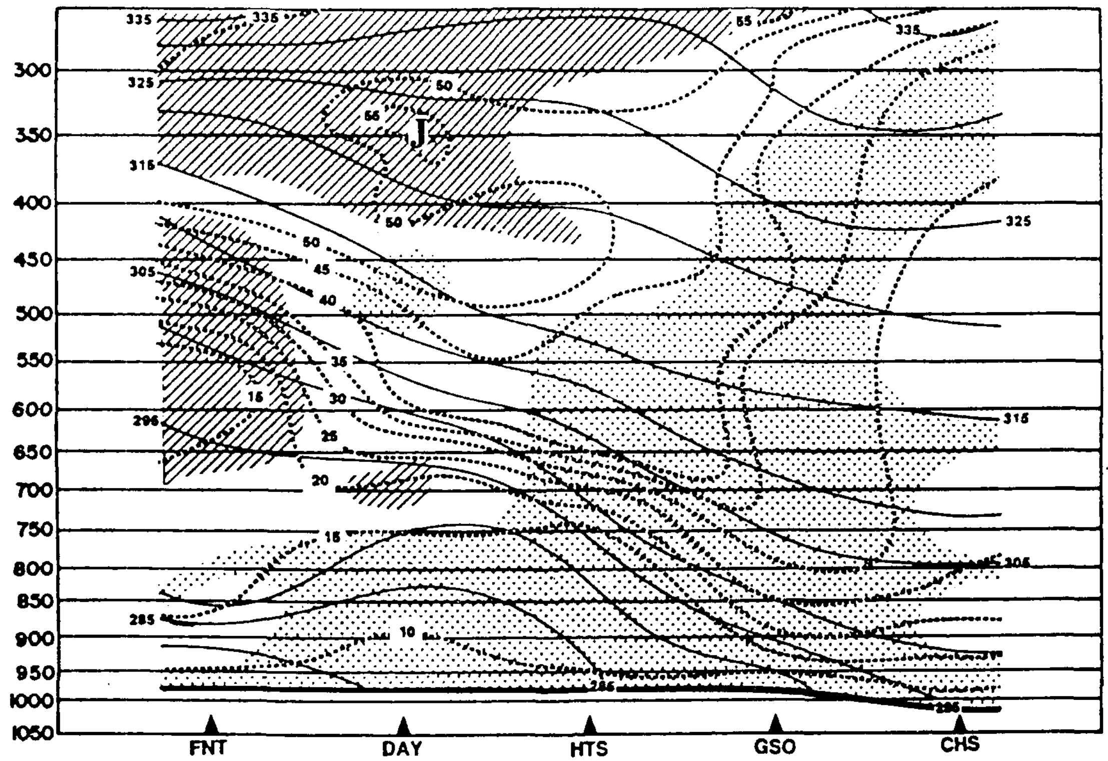


Figure 8a. Cross-section 1 for 0000 UTC, November 28, 1988. Solid lines represent isentropes at 5ø C intervals, dashed lines are isotachs at 5 mps intervals, dot shaded areas represent dewpoint depressions of <5ø C, and cross hatched areas represent dewpoint depressions >30ø C.

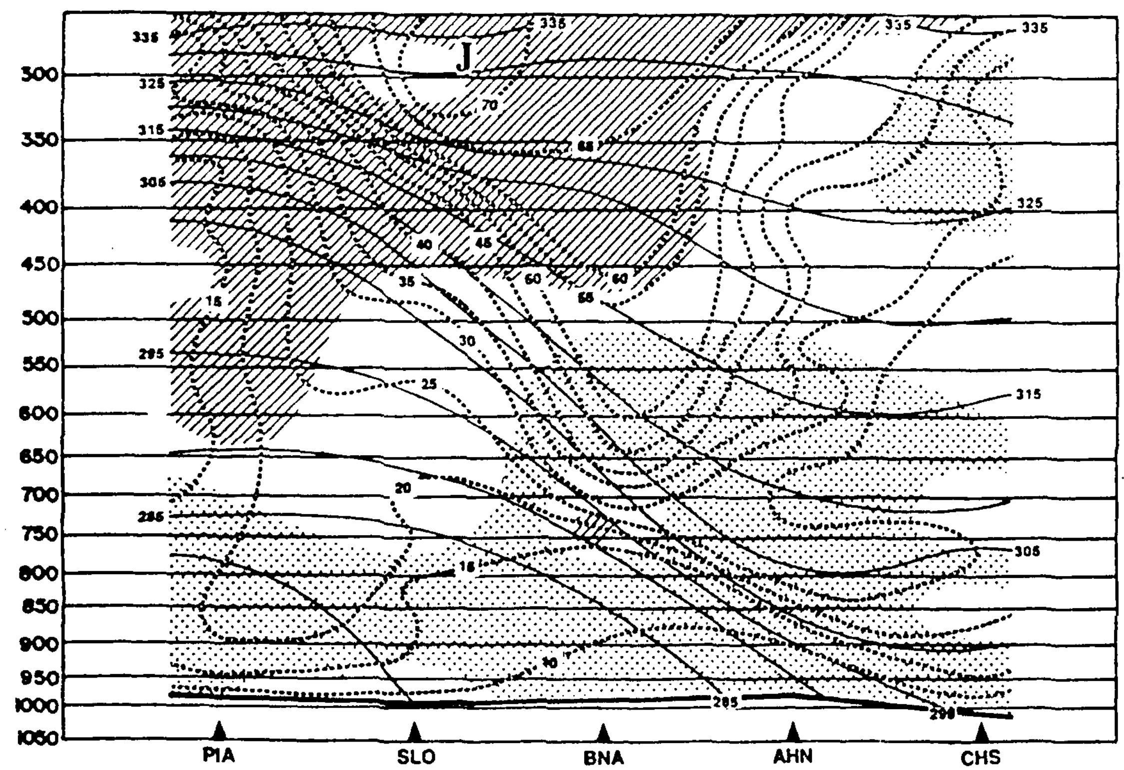


Figure 8b. Cross-section 2 for 0000UTC, November 28, 1988. Solid lines represent isentropes at 5o C intervals, dashed lines are isotachs at 5 mps intervals, dot shaded areas represent dewpoint depressions of ≤5o C, and cross hatched areas represent dewpoint depressions ≥30o C.

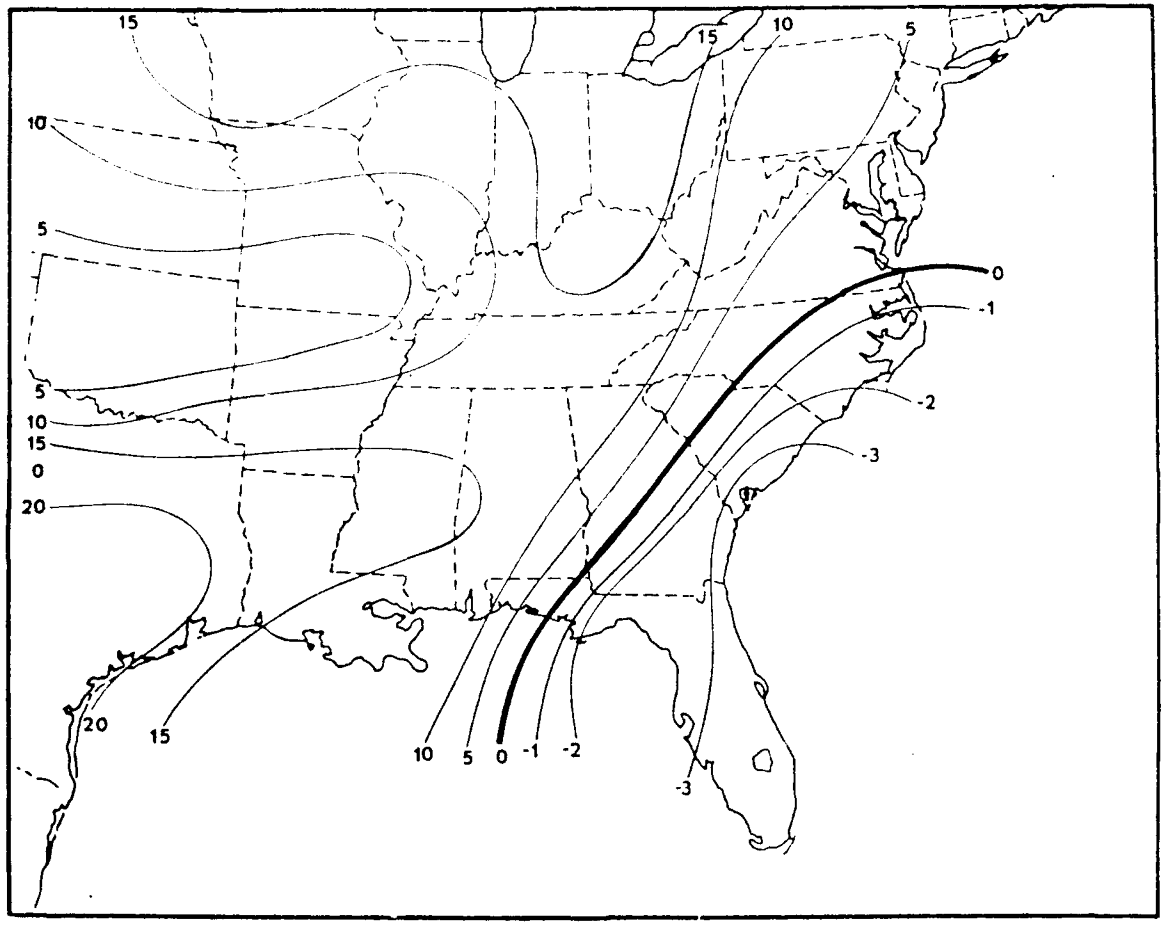


Figure 9. Lifted Index values for 0000 UTC, November 28, 1988. Negative LI values are in single unit intervals and positive LI values are in 5 unit intervals.

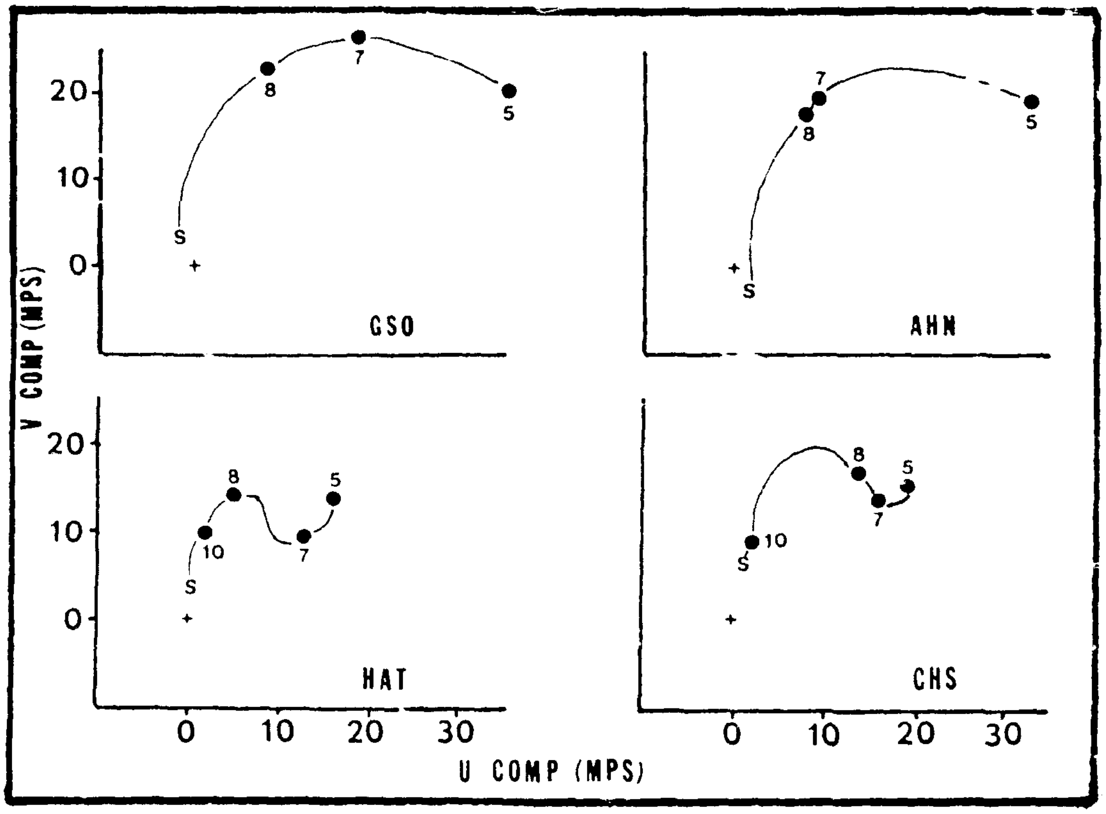


Figure 10. Hodographs for stations 72317 (GSO), 72311 (AHN), 72304 (HAT), and 72208 (CHS) at 0000 UTC, November 28, 1988. Levels are represented by S for surface, 10 for 1000 mb, 8 for 850 mb, 7 for 700 mb, and 5 for 500 mb.

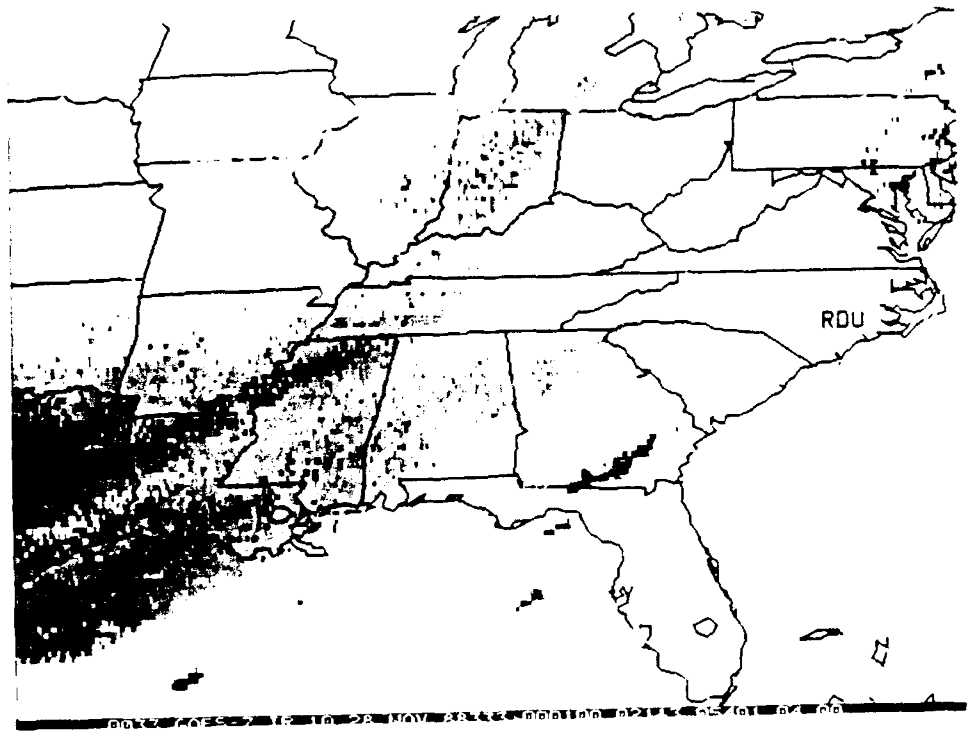


Figure 11a 0001 UTC GOES water vapor imagery for November 28, 1988 Green to yellow shaded areas represent moistest atmosphere, and the drier atmosphere is represented by the darker pink to dark blue shaded areas

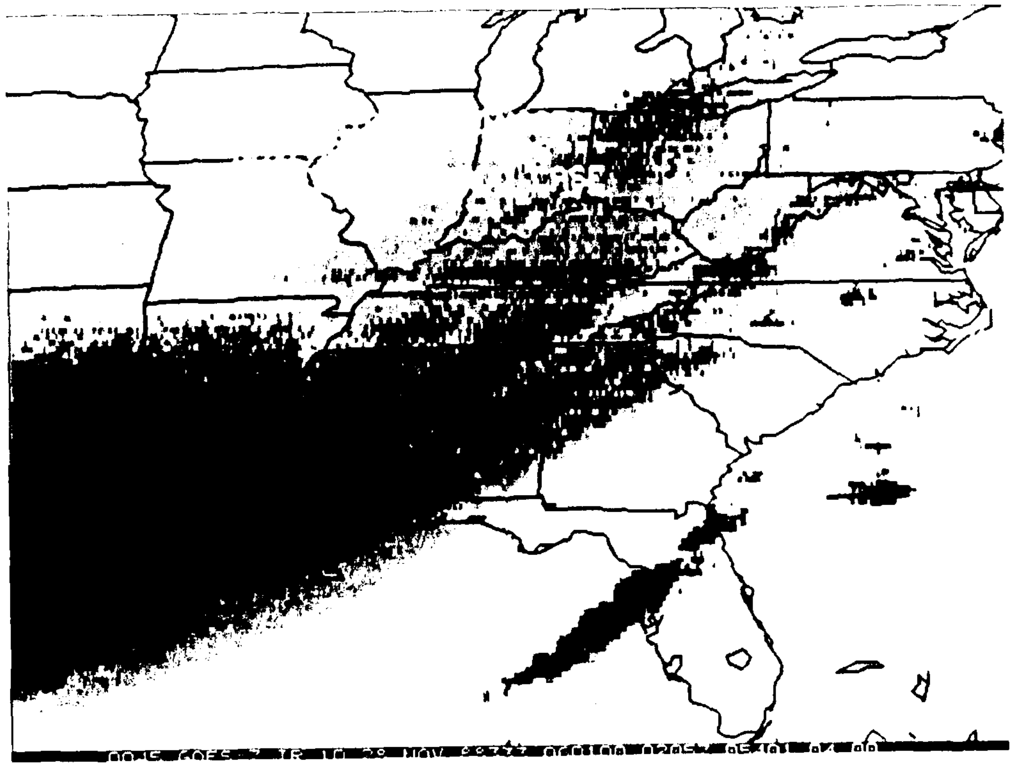


Figure 11b 0601 UTC GOES water vapor imagery for November 28, 1988 Green to yellow shaded areas represent moistest atmosphere, and the drier atmosphere is represented by the darker pink to dark blue shaded areas

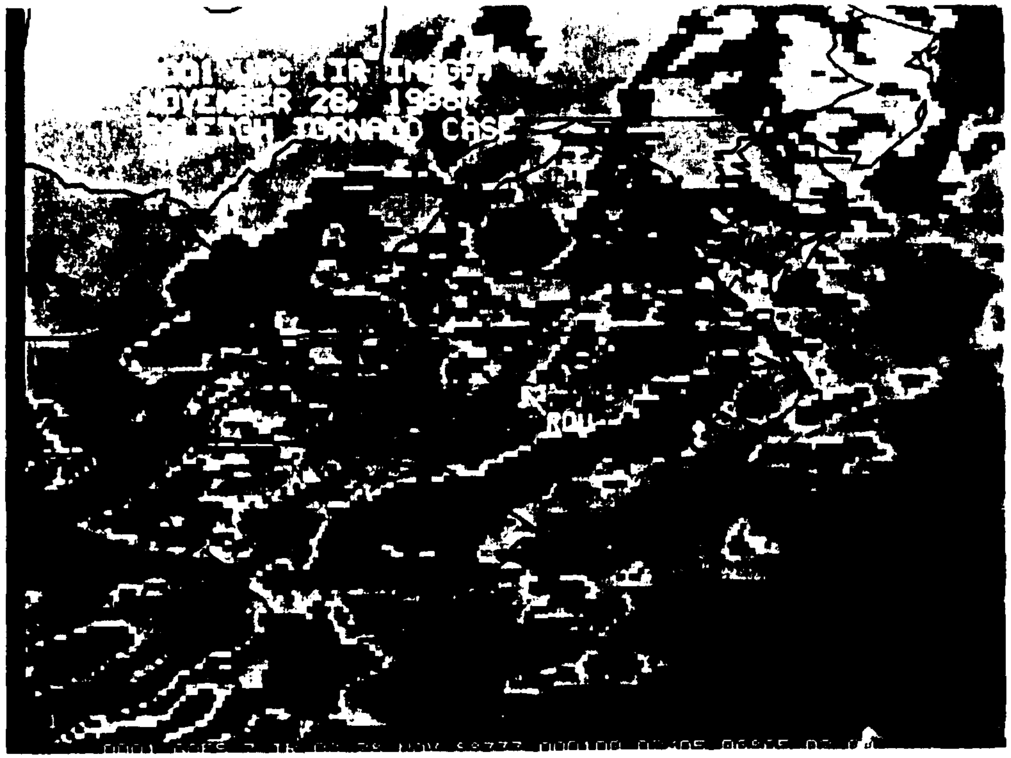


Figure 12a. 0031 UTC GOES infrared imagery for November 28, 1988. Red and black shades represent higher/colder cloud tops.

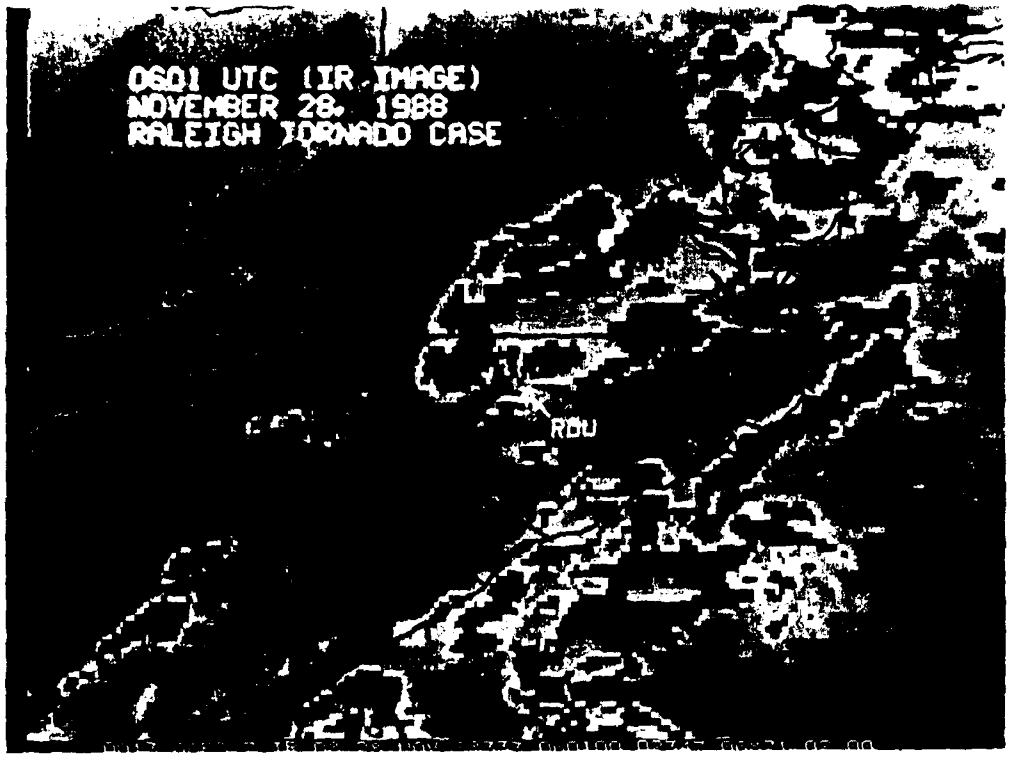


Figure 12b 0601 UTC GOES infrared imagery for November 28, 1988 Red and black shades represent higher/colder cloud tops.

2. RESEARCH OBJECTIVES

2.1 Objectives of the Research

There were two objectives of this research. The first was to document the synoptic and local environment of the North Carolina-Virginia tornado outbreak. Local operational meteorologists were caught off guard by the dramatic changes in the meteorological environment in the six hours prior to the outbreak of severe weather. This was the subject of much debate locally, and culminated in a congressional hearing on March 3, 1989 to assess the operations of the National Weather Service during this severe weather episode.

The second, and most important objective, concerned presenting corroborative evidence for Anderson and Schrab's research (Schrab, et al., 1990) that tornadogenesis results from the coupling of an existing mesocyclone in a thunderstorm with strong surface vorticity fields. At question here is a mechanism for the columnar vortex within the mesocyclone to extend through the surface boundary layer to the ground. In some manner, the tornado funnel must either build up or down in the boundary layer.

2.2 Working Hypothesis

The development of severe weather requires the complex interaction of a number of meteorological parameters. Extensive research by Miller (1972) and others revealed a number of quantifiable and recognizable parameters with forecast applicability to severe weather. Recent numerical simulations have added to our understanding of the severe storm complex. With this basis, it was hypothesized that:

a) Despite the marginal forecast situation for severe weather six hours prior to the event, the development of the Raleigh tornado did not involve any new or unique mechanism. Rather, the same classical environmental factors and conditions found in other tornado cases developed by 0600 UTC. Strong veering winds evident in the 0000 UTC soundings remained in place. Moist and potentially unstable air was available in the low levels for the convective storm to tap when the surface warm thermal boundary moved to the north of the Raleigh area. Finally, mid-level dry air from west and southwest of Georgia moved northeastward with the advancing mid-level trough and was in a position to intrude into the region of storm development.

b) A pre-frontal surface trough developed west of Raleigh in an area of mesoscale convergence. Subsequently, the Raleigh tornado thunderstorm cell formed in the squall line which developed in the pre-frontal trough. Additionally, a strongly baroclinic zone, a surface thermal boundary, was to the west of Raleigh. The squall line intensified the ambient horizontal vorticity through convergence. The surface vorticity was also intensified by the presence of the thermal boundary and the baroclinic generation of horizontal vorticity. The Raleigh tornado then, was the result of the coupling of the mesocyclone within the thunderstorm cell with an area of surface and boundary layer horizontal vorticity.

2.3 Methodology Employed

Conventional data sources were available for the analysis of this case study. Because no Severe Thunderstorm Watch was in effect prior to the Raleigh tornado, no attempt was made to augment any of the conventional data gathering networks (e.g., rapid-scan GOES imagery, or two-minute interval radar imagery). In addition, normal temporal and spatial data arrangements of the data gathering networks were used.

2.3.1 Processing Data on the McIDAS

The McIDAS (Man-computer-Interactive-Data-Access-System) was developed in the 1970's at the Space Science Engineering Center, University of Wisconsin-Madison. It is unique in its capability to ingest real-time geostationary weather satellite data and conventional weather data, and combine the different forms of data in a single analysis. Besides software to plot and contour surface and upper air data, extensive software exists to process satellite sounding data, track cloud motions, or generate statistics of specified geographical areas for a digital image.

2.3.2 Surface and Upper Air Data

Conventional surface, upper air, ship, and buoy data via the WB604 circuit were available for November 27 and 28, 1988. Data were available on the McIDAS in a series of meteorological data (MD) files. Using McIDAS software, we were able to print, plot, contour and access all the normal meteorological parameters (e.g., temperature, pressure, winds, heights) and contour the derived parameters (e.g., vorticity, divergence, advection). Once data was taken from an MD file, the McIDAS software objectively analyzed it to a uniform 1° by 1° grid using the Barnes Analysis scheme. After a grid was created, it was saved in a grid file where it could be manipulated as necessary for larger or smaller unit intervals, advected, averaged, diverged, or any of a number of other arithmetic and meteorological operations. The individual grid point values were also available for inspection and use. Derived parameters were calculated using finite differences on the gridded data, again using the standard McIDAS software. The analyses in this thesis with the exception of surface pressure and upper air heights were produced on McIDAS. Values used in the line graphs of parameter data were taken from the raw grids.

In my analyses, when referring to the **Regional** values in the line graphs, the region is defined along an area from Richmond, VA southwest to near Columbia, SC (figure 13). **Raleigh area** is defined as the grid point value closest to RDU. Regional and Raleigh area values were used to compare local changes with the larger scale processes that were taking place. The regional area as defined approximates the area in which the squall line developed.

2.3.3 Radar Data

Sixteen millimeter radar film from Volens, VA, Wilmington, NC, and Cape Hatteras, NC were obtained from the National Climatic Data Center. Because it was closer and had better resolution, the Volens radar film was of primary interest. Located about 120 kilometers north of Raleigh, the 10 centimeter wavelength WSR-74S radar provided continuous coverage through the event in a series of five minute Plan-Position Indicator (PPI) scans. The images were transferred to radar maps provided by the Volens radar personnel. Measurements of the area of the radar echoes were then done using a planimeter.

2.3.4 Satellite Imagery

Images of the event were available at four kilometer resolution, infrared and eight kilometer resolution, water vapor GOES imagery every half-hour. Archived by the Space Sciences and Engineering Center at the University of Wisconsin-Madison, the data were available via a remote McIDAS workstation at North Carolina State University. Use of the McIDAS in processing the satellite imagery allowed selective enhancement of features and area statistics computations using available McIDAS software commands.

2.3.5 Lightning Data

Lightning activity for the Raleigh thunderstorm was monitored by the SUNY-Albany Lightning Detection Network. The data were available from the Meteorological Office of the Carolina Power and Light Company. The system detects cloud-to-ground positive and negative lightning strokes. Data was analyzed in five-minute-interval periods from 0545 UTC to 0609 UTC (e.g., 0545-0549). Lightning activity prior to 0545 UTC was minimal in the central North Carolina area. Also analyzed was the flash density for the period 0530 UTC to 0629 UTC for the same region.

2.3.6 Other Data

A number of other data sources were found in the Raleigh area to help evaluate the mesocyclone which accompanied the storm. These were all surface data and included; two barograph traces from private citizens (one within one mile of the tornado's path), a barograph tracing from WRAL-TV and North Carolina State University in Raleigh, wind and temperature traces from the Environmental Protection Agency (EPA) sensors located in the Research Triangle Park (RTP), and tower data from Carolina Power and Lights' Shearon-Harris Nuclear Plant (SHNP) located on B. Everett Jordan Lake. Figure 14 is a map of the general area.

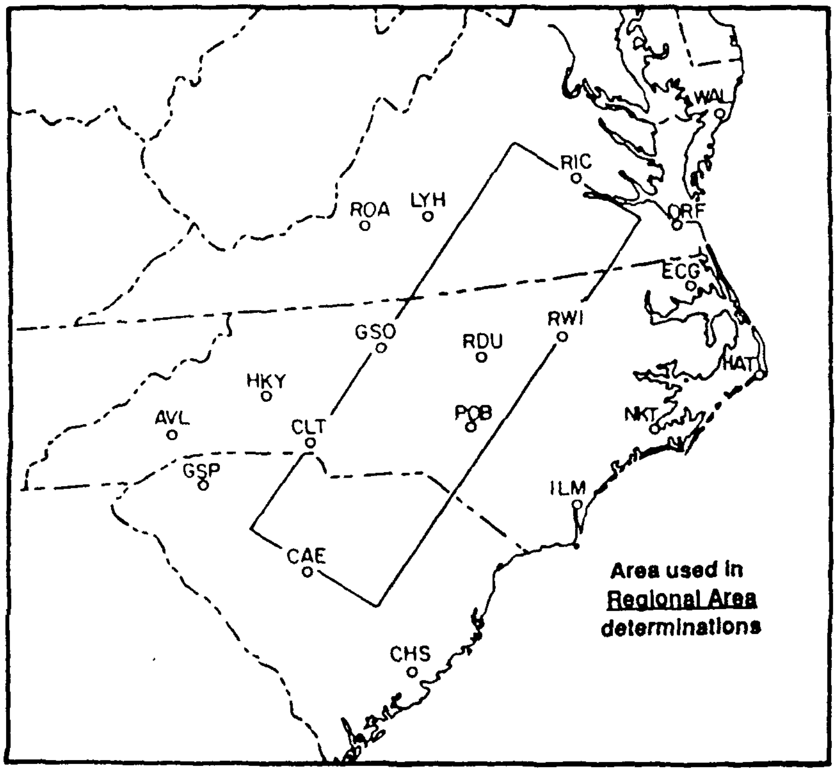


Figure 13. Area used in determining regional values for graphic analysis of surface meteorological parameters.

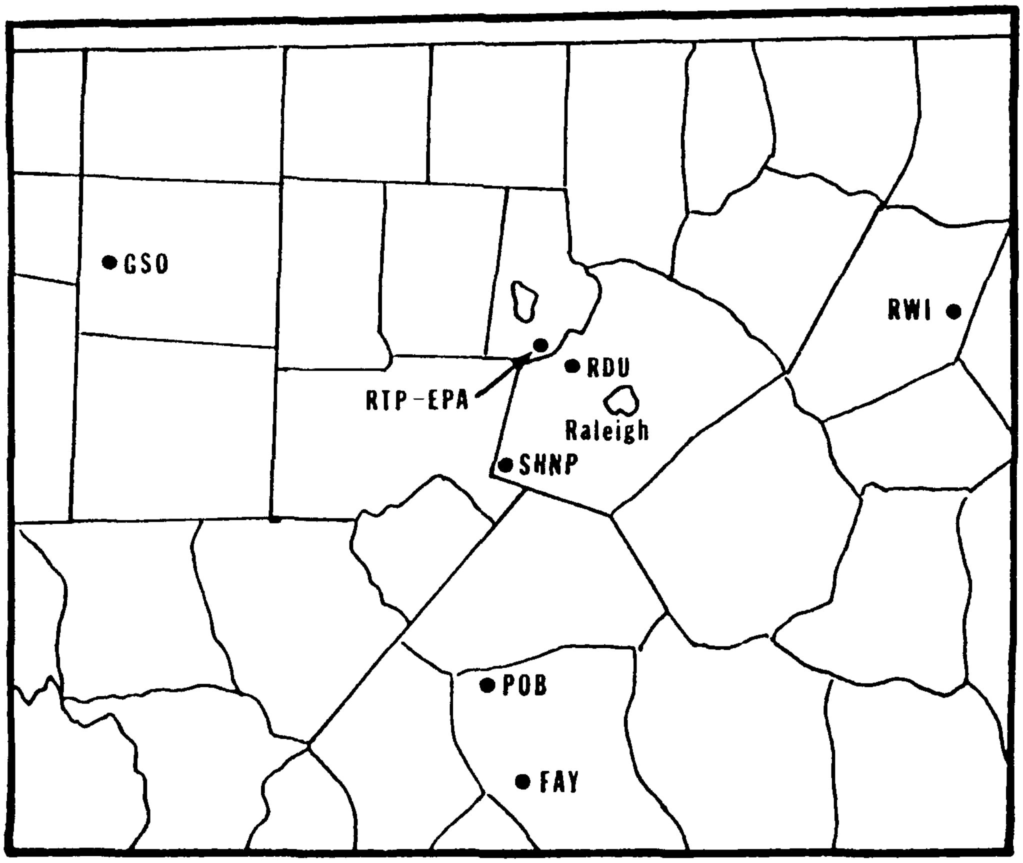


Figure 14. Map of the central North Carolina area. SHNP is the Shearon-Harris Nuclear Plant and RTP-EPA represents the Environmental Protection Agency sensor site at the Research Triangle Park. Both were local sources of data.

3. **RESEARCH RESULTS**

3.1 The Developing Environment - Surface

One of the most dramatic aspects in the evolution of the environment prior to the Raleigh thunderstorm was the development of the surface low pressure trough ahead of the cold front. Figure 15 shows the development of the pre-frontal trough from 0000 UTC through 0600 UTC. This trough was accompanied by areas of mesoscale convergence and vorticity (see Figs 16 and 21), the axis of which was west of Raleigh. The area of convergence was evident as early as 0000 UTC (figure 16(a)). Recalling Heymsfield and Schotz's (1985) suggestion that the convergence area is important in initiating the squall line, we see in this case it was also coincident with the development of the surface trough. Also, figure 15(d), the 0600 UTC surface pressure field, shows the mesolow associated with the Raleigh storm. Figure 21(d), surface vorticity field, shows the surface vorticity field was also maximized at 0600 UTC, coincident with the Raleigh tornado thunderstorm cell.

While the pre-frontal trough deepened through the region from 0000 - 0600 UTC, the greatest one-hour decrease in the surface pressure occurred between 0500-0600 UTC as the Raleigh thunderstorm developed and approached RDU. Figure 17 shows the Regional and RDU one-hour pressure change in graphic form. At 0700 UTC, after the mesolow accompanying the Raleigh thunderstorm had passed RDU, there was a sharp rise in the surface pressure.

The presence of the mesoscale surface convergent area, figures 16(a)-(d), was evident for several hours before the outbreak of convection. Another interesting feature of the divergence pattern was at 0500 UTC when the maximum values of convergence were coincident with the Raleigh thunderstorm cell. Also, in a plot of the minimum divergence values for each hour in the region and at RDU (figure 18), we see maximum convergence occurring during the life-cycle of the Raleigh thunderstorm cell.

Another aspect of the low-level convergence is the effect on the supply of moisture for the area under examination. Doswell (1982) states that two of the primary factors in developing severe weather potential are low-level convergence and a supply of moisture. The combination of these factors gives the moisture convergence field. For the Raleigh case, moisture convergence fields are shown in figures 19(a)-(d). Where negative values imply convergence, it can be seen that moisture convergence was evident as early as 0000 UTC. The axis of the moisture convergence field was coincident with the axis of the mesoscale convergence area and the development of the surface trough. At 0500 UTC, figure 19(c), the centers of relative maxima were located with the developing Raleigh and Alberta thunderstorm cells. By 0600 UTC, figure 19(d), the Raleigh thunderstorm was again located near the maximum values of moisture convergence. The plot of the moisture convergence values by hour in the region and at RDU, figure 20, showed a steady influx of moisture to the region for several hours prior to the outbreak of severe weather.

The surface vorticity fields, shown in figures 21(a)-(d), were consistent with the results of the previous analyses of sea level pressure and divergence. A positive surface vorticity field in the vicinity of a surface pressure trough was expected. The axis of the positive vorticity values was along the developing surface trough. In figure 21(c), at 0500 UTC, the maximum vorticity values were associated with the Alberta storm, and in 21(d) maximum values were associated with the Raleigh storm. Figure 22, the plot of largest regional and RDU vorticity values by hour, shows that throughout the region the surface vorticity values were positive. At RDU the maximum value was presumably associated with the approach of the Raleigh thunderstorm mesocyclone and accompanying mesolow.

At the time of the 0000 UTC upper air sounding, surface conditions in the Raleigh area were similar to those at Greensboro. Raleigh was east of the advancing cold front, yet in the cool air behind the thermal boundary (figure 5). To the south and east of RDU at Pope Air Force Base (POB) and Rocky Mount-Wilson (RWI), respectively, temperatures were 5.5^{o} C to 8.3^{o} C warmer and dewpoints were about 5^{o} C higher. In the next two hours, temperatures at RDU increased over 5.5^{o} C and dewpoints nearly 4^{o} C as the thermal boundary moved to the north and west of the Raleigh area. Figures 23(a)-(c) shows the change in surface temperature and dewpoint ($\geq$65^{o} F) patterns between 0000 UTC and 0600 UTC. By 0600 UTC, figure 23(c), the strongest thermal gradient was to the southwest of RDU. The Shearon-Harris Nuclear Plant tower data, about 14 miles southwest of RDU indicated the warm air was at least that far west of Raleigh as the temperature was 22.7^{o} C/73^{o} F and the dewpoint temperature was 17.8^{o} C/64^{o} F.

With the introduction of warm, moist air at the surface to the Raleigh area it was possible to estimate expected changes in the stability of the atmosphere there. In evaluating the 0000 UTC upper air soundings for Cape Hatteras, Athens, Charleston, and Greensboro for PBE and mean shear, only the Charleston sounding had adequate values of PBE and mean shear to fall into the tornadic region as defined by Rasmussen and Klemp's work. The results are shown in figure 24; each sounding is identified by its three letter station identifier. The Greensboro sounding is not indicated on figure 24 because the PBE value was less than the minimum scale value of this figure. However, the shear value was the highest of the soundings evaluated. Table 4 gives the calculated values of PBE and mean shear for each sounding.

Two additional points are identified on figure 24. The first considers the source region of the low-level air in the Raleigh area by 0600 UTC as the South Carolina coast, and combines the lower tropospheric sounding data (≤850 mb) of Charleston with the upper-level air (>850 mb) of Greensboro. The result is plotted as CMB. The second was a mean shear value using winds derived from time averaged grids of McIDAS wind data to estimate a 0600 UTC standard level profile above RDU. This was combined with the PBE value of the combined case (CMB) and is plotted on the figure as DER. Both points are located well within the tornadic region of figure 24, and may indicate the changes which occurred with the introduction of the warm, moist air to the Raleigh area.

Table 4. Values of PBE and 0-4 km mean shear for Greensboro (GSO), Charleston (CHS), Athens (AHN), and Cape Hatteras (HAT). Also, values were calculated for the combined lower (≤850 mb) CHS and upper (>850 mb) GSO soundings (as CMB). A shear value was calculated for winds derived from time averaged McIDAS wind grids for 0600 UTC (as DER).

Station	Shear (s^{-1})	PBE (m^2s^{-2})
GSO	1.45×10^{-2}	317
CHS	8.74×10^{-3}	1725
AHN	1.07×10^{-2}	498
HAT	8.57×10^{-3}	723
CMB	1.10×10^{-2}	2384
DER	9.53×10^{-3}	

An analysis of the barograph traces for Charlotte and Greensboro showed, in addition to the steady pressure fall caused by the approach of the synoptic scale system, a series of pressure perturbations were evident. Figure

25, the pressure traces for Greensboro, Charlotte and Raleigh, indicates the pressure jump activity occurred west of the Raleigh area. The Raleigh trace reveals no evidence of the kind of pressure jump activity seen at Charlotte or Greensboro. It is possible these pressure perturbations were channeled along a track that ran to the west of Raleigh near the area where the pre-frontal surface trough developed and the squall line formed.

3.2 Development as Seen in Radar Imagery

Between 0432 UTC and 0634 UTC on November 28, other than the normal hourly radar observations, only a single special observation was disseminated. Table 5 gives the criteria for special observations of convective cells. The squall line did not meet criteria for line development until 0528 UTC. The only special was taken at 0603 UTC for the Raleigh cell when it came within 5,000 feet of the tropopause. The highest D/VIP level was four (this level of radar return is considered very strong - see table 5), but none of the signatures normally associated with severe weather were evident. No hook echo was seen with this storm, but given the distance of the radar from the tornado it was not likely to be detected. Radar observed hook-shaped appendages are small and change rapidly. As a result, they have been found only at short ranges where the radar resolution is high (Battan, 1973).

Table 5. The criteria for taking and disseminating special observations of radar observed meteorological phenomena, from the Federal Meteorological Handbook #7, Weather Radar Observations, Part A (1987).

Criteria for Special Observations (Sect. 10.2.2): **a)** echoes of extreme intensity (D/VIP 6) are observed. **b)** echoes of very strong (D/VIP 4) or intense (D/VIP 5) intensity are observed in or near a severe weather forecast area.

c) convective echoes observed having hooks, holes, appendages or other features that are characteristic of severe weather.
d) convective echoes are observed whose projected paths will intersect within the next 30 minutes.
e) convective echoes with severe weather potential are observed whose tops are within 5,000 feet of the tropopause, exceed the tropopause, or reach at least 50,000 feet above MSL.
f) convective echoes with intensity greater than *strong (D/VIP 3) persist* at the same location for an hour or more.
g) a line echo wave pattern (LEWP) is observed.
h) a tornado or severe thunderstorm has been reported within radar range during the past hour. Take a special observation whether or not the report is verified.
i) the eye or center of a hurricane or tropical storm is observed.
j) flash flooding is reported near observed echoes. Take a special observation whether or not the report is verified.

The radar development of the storm as compiled from radar logs and interviews of station personnel (NOAA, 1989) is summarized:

0528 UTC - VQN observed level 3 DVIP (Digital/ Video Integrator and Processor) intensity with tops below 35,000 feet located 30 miles west of Raleigh. The area was moving east-northeast at 35 mph, while individual cells were moving northeast at speeds greater than 45 mph.

0603 UTC - VQN transmited a special radar observation for the cell over Raleigh (the information had been called to the forecaster at RDU a few minutes prior to dissemination). The maximum top was now at 45,000 feet with a level four DVIP intensity to 16,000 feet. This satisfied special criteria for a convective cell with echo tops within 5,000 feet of the tropopause (46,900 feet at GSO).

0616 UTC - RDU meteorologists called VQN concerning the Raleigh cell. Radar observer indicated the cell was now a DVIP level three and tops had lowered by approximately 8,000 feet.

(The thunderstorm top remained near 37,000 feet and did not again meet any of the criteria for a special observation. The result - the Raleigh thunderstorm cell was not identified as being tornadic until 0702 UTC)

The behavior noted in the previous paragraph where the thunderstorm top lowered by several thousand feet has been frequently observed in a number of tornadic thunderstorms. Radar observations indicate that tornado touchdown was often accompanied by a decrease in echo maximum height and a decrease in the height of the Bounded Weak Echo Region (BWER) (e.g., Lemon et al., 1978).

The evolution of the squall line and the Raleigh thunderstorm cell is shown in figures 26(a)-(f). Only DVIP level 2 and greater returns are depicted. Radar imagery showed the line of D/VIP level 2 echoes which developed into the squall line became distinct around 0415 UTC. In general, a much larger area of rain and thunderstorms was occurring from the Gulf of Mexico northward along the eastern seaboard. The Raleigh cell reached level 4 D/VIP intensity near 0530 UTC, and no characteristic severe storm radar signatures were seen.

The squall line appears to have developed along the axis of the surface pre-frontal trough. Figures 26(b) and 26(e) show agreement in the position of the axis of the surface trough, figures 15(c) and (d), and the location of the squall line at 0500 and 0600 UTC. During the time from beginning of the squall line to the development of the Raleigh tornado, either the Alberta or Raleigh thunderstorm cell was the dominant cell along the line. When the radar echo growth of the squall line was measured in terms of DVIP level 2 and greater returns for areal coverage, there was initially a single broad area of level 2 returns at 0415 UTC. The line then began to take on cellular characteristics and areal coverage decreased slightly. The first cell to dominate the squall line in terms of areal coverage was the Alberta tornado thunderstorm cell between

0500-0530 GMT. Figure 27 shows the changes which occurred in the extent of the squall line areal coverage. For the Alberta cell we see an increase in areal extent of the squall line followed by a decrease near or just after tornado development. The Raleigh storm shows similar behavior between 0530-0630 UTC. First, it became the dominant cell along the squall line and areal coverage of the line reached its maximum value soon after the Raleigh tornado had touched down, 0621 UTC. After the Raleigh tornado developed there was a decrease in areal coverage.

Movement of the storm as determined by radar was 245^{o} at 26 ms^{-1}. When this is compared with the mean wind of the environment, we see that the Raleigh thunderstorm cell was a right mover. This, as well as tornado production, are characteristics of supercell storms. In table 6, we see the storms movement was some 15^{o} to the right of the mean wind.

Table 6. Mean wind as defined by the vector mean of the 850, 700, 500 and 300 mb levels for Greensboro (GSO), Athens (AHN), and Raleigh (RDU) in comparison to the radar derived direction and speed of the Raleigh storm. Directions are in degrees, speed in mps. The Raleigh mean wind was estimated from time averaged upper air winds on McIDAS.

	GSO		AHN		RDU (est)	
Level	Dir	Spd	Dir	Spd	Dir	Spd
850	200	24	205	19	230	19
700	215	32	205	21	230	32
500	240	40	240	38	220	40
300	245	44	235	53	233	42
Mean Wind	229	33	227	32	228	31

Storm motion (from radar): 245^{o} /26ms^{-1}

3.2.1 A Special Feature of the Raleigh Thunderstorm as Seen by Radar

As noted previously by radar and following in satellite imagery, the Raleigh thunderstorm cell top collapsed from 45,000 feet to 37,000 feet after the time of tornado production. This behavior is not unusual. NOAA Technical Memorandum NWS TC 1 (1982) describes research results of tornadic thunderstorms seen by radar as:

> "10.17 Fujita noted tornado occurrence after the collapse of overshooting thunderstorm tops.
>
> 10.17.1 Radar Characteristics
>
> Lemon found the echo top generally:
>
> A. Lowers from 2 to 7 km (about 7-23 kft).
>
> B. Shifts back near the low level echo area."

However, it is interesting to note that while the tornado was on the ground continuously for about 105 minutes (0600 UTC-0745 UTC), radar logs indicate the storm top never regained its former height, staying between 37,000 and 40,000 feet in height.

3.3 Development as Seen in Satellite Imagery

Despite only 30-minute interval GOES IR imagery for this case, similar trends in behavior were seen for the Raleigh storm as in other severe storm cases (Adler and Fenn, 1981, 1979a). Reynolds (1980), in a study of hailstorms as seen in satellite imagery, also found 30-minute satellite data was sufficient to observe the characteristic signature of the hailstorms. Figure 28, cloud top temperature vs. time for the Raleigh cell, shows a rapid decrease in cloud top temperature began about an hour prior to the Raleigh tornado. After reaching its lowest temperature, 211^{o} K, in the 0601 UTC satellite image, at the time of tornado production, the storm top temperature increased (cell top height lowered) slowly through the life of the tornado. Storm top collapse was also verified by the radar data (see Section 3.2).

The divergence of a cloud top is extremely important in determining vertical velocity within a severe thunderstorm. Anderson (1982), in a storm-scale study of the top of the thunderstorm which produced the Wichita Falls tornado, found maximum divergence values associated with the tornado producing mesocyclone. In this case study, divergence of the Raleigh thunderstorm cell top was determined using the McIDAS area statistics capability.

Using McIDAS, area statistics were calculated for IR pixel values corresponding to a cut-off temperature for each image. The cut-off value used for the areal cloud top change calculations was $\geq 223^{o}$ K. This was similar to Adler and Fenn's (1979a) value of 226^{o} K used in their case studies, and seemed a reasonable estimate of the anvil edges based on visual inspection of the data. The statistic was found by defining a search area on the satellite image. Then McIDAS counted the number of pixels with corresponding brightness values less than or equal to the cut-off value (for higher/colder cloud tops). The data was output as the number of pixels meeting the criteria and an average earth area for pixels within the defined region was given for area calculation. Results are shown in figure 29.

If the chosen blackbody temperature isotherm nearly coincides with the edge of the thunderstorm anvil, then expansion of the area within the isotherm is a measure of outflow divergence. A value of the divergence for the cloud top can be estimated by (after Adler and Fenn, 1979a),

$$\text{DVG (divergence)} = (1/A)\ dA/dt$$

$$\overline{\text{DVG}} = \overline{(1/A)}\ \overline{(\Delta A/\Delta t)}$$

where $\overline{\Delta A/\Delta t}$ for the period 0400-0700 UTC is calculated by,

$$\overline{\Delta A/\Delta t} = \text{constant} = 9638\text{km}^2 - 383\text{km}^2/10800\text{sec} = 0.86\text{km}^2\text{s}^{-1}$$

$\overline{DVG}$ for the Raleigh storm for the period 0600-0630 UTC,

$$\overline{A} = (8541\text{km}^2 + 5613\text{km}^2)/2 = 7077\text{km}^2$$

$$\overline{DVG}_{0600\text{-}0630} = (1/7077\text{km}^2)(0.86\text{km}^2\text{s}^{-1}) = 1.2 \times 10^{-4}\text{s}^{-1}$$

The value of divergence for the period 0600-0630 UTC, $1.2 \times 10^{-4}\text{s}^{-1}$, was of the same order of magnitude but less than Adler and Fenn found as the average of non-severe weather elements. This was also an order of magnitude less than Anderson (1982) found for the divergence at the top of the Wichita Falls tornado mesocyclone ($1.0 \times 10^{-3}\text{s}^{-1}$).

It is also possible to relate **w**, the vertical velocity of a thunderstorm cloud top, to the rate of temperature change of the cloud top. The vertical velocity is calculated by dividing the time rate of change of the temperature at the cloud top by the lapse rate through the layer of the atmosphere in which this occured (after Adler and Fenn, 1979a):

$$\mathbf{w} = (\partial T/\partial z)^{-1}\, dT/dt$$

We calculated a vertical velocity for the Raleigh thunderstorm cloud top for the interval between the 0531 and 0601 UTC satellite images. A lapse rate was determined for the layer from 230 mb to 150 mb using the Greensboro sounding and the vertical velocity was calculated as:

$$-\partial T/\partial z = -55.7^\circ - (-64.5^\circ)/2672\text{m} = 3.3^\circ\ \text{Kkm}^{-1}$$

$$dT/dt = 214^\circ - 211^\circ\ \text{K}/30\ \text{min} = 0.1^\circ\ \text{Kmin}^{-1}$$

$$\mathbf{w} = 0.1^\circ\ \text{Kmin}^{-1}/3.3^\circ\ \text{Kkm}^{-1} = 0.03\ \text{kmmin}^{-1} = 0.5\ \text{ms}^{-1}$$

This result is less than we would expect for a severe storm cell. Adler and Fenn described an average of $2.7\ \text{ms}^{-1}$ for 11 tornadic cases, with ascent rates up to 8 ms^{-1} for very intense convection (Adler and Fenn, 1979b). However, given only 30-minute resolution, it is not suprising we did not find the dramatic, short time-scale changes that a rapidly developing supercell thunderstorm experiences.

Figure 28 shows the plot of cloud top temperature versus time for the Raleigh storm. From 0400-0600 UTC there was an 11^{o} K drop in temperature for the Raleigh thunderstorm cell top as seen in satellite imagery. Again, as in the calculations of the cloud top divergence, 30-minute imagery does not accurately represent the rapid changes that can occur in a severe storm cell top. The Raleigh storm top temperature decrease of 11^{o} K/120 min, or 3^{o} K/30 min between the 0530 and 0600 UTC images, is in stark contrast to the 4.3^{o} $Kmin^{-1}$ change that Adler and Fenn (1981) and Mack, et al., (1983) found in a study of tornadic storms using three to five minute GOES imagery.

This is not to say however, that satellite imagery of the Raleigh storm did not give us a clue to its intensity or nature. Quite the contrary, research by both Perry (1989) and Schrab, et al., (1990) indicate the probable presence of a mesocyclone associated with the Raleigh thunderstorm. Using the method of Anderson (described in Section 1.3), it was found the Raleigh storm was well within the intensities measured as tornadic for this outbreak, and compared favorably when combined with case studies of other tornadic outbreaks.

3.4 Lightning Activity of the Raleigh Thunderstorm

Figure 30 is a histogram of the cloud-to-ground lightning activity for the period 0545-0609 UTC, in Wake County, North Carolina. The scale of the graph makes it appear as though there was a significant increase in the cloud-to-ground lightning rate during the last five-minute period (25 flashes per five minutes). However, a number of studies have documented electrically active storms with peak sustained flash rates of 2,000 per hour (Goodman and MacGorman, 1985; Holle, et al., 1985).

3.5 Assessment of the Mesoscale Supporting Feature

By 0600 UTC, the Raleigh thunderstorm cell was associated with a mesoscale low. Figure 15(d) shows mesolows associated with both the Raleigh and Alberta thunderstorm cells. Tower data from Shearon-Harris Nuclear Plant (SHNP) was used to assess the mesolow. The SHNP data was used because its format as 15-minute interval data makes it possible to accurately evaluate the timing of the passage of the feature.

When tracing backwards from the track of the Raleigh tornado cell. SHNP was located along the axis of the storm's path. It is likely the storm center passed near the meteorological tower at the SHNP site. Figure 31, a plot of the 15 minute averaged pressure data at SHNP, shows the pressure began to drop rapidly just after 0515 UTC and did not recover until 0630 UTC. This indicated some form of mesoscale feature existed about 45 minutes before the Raleigh tornado was produced.

If the Raleigh thunderstorm and the mesolow were moving at the same rate of speed, and if the feature were in steady state we can estimate its size. From the radar data the thunderstorm's calculated speed was 26 ms^{-1} or 1.56 $kmmin^{-1}$. It was seen in figure 31, it took about 75 minutes for the mesolow to completely pass the SHNP meteorological tower. Multiplying the thunderstorm's speed by the amount of time it took for the mesolow to pass by the SHNP tower gives an estimate of the size of the mesolow,

$$(1.56 \text{ km/min})\ (75 \text{ min}) = 117 \text{ km}$$

The RDU and local barograph traces show the same general trend and timing for the mesolow. The coarseness and resolution of these data made it difficult to determine an accurate time for the passage of the mesoscale feature from the traces. They were used, however, to corroborate the SHNP tower data.

Also from SHNP, a trace of the wind speed and direction at the 60 meter level showed a very interesting association with the mesolow. Figure 32 shows the general features of each trace. The wind direction veered steadily with time begining at about 0550 UTC until about 0620 UTC. What is absent in this picture is the sudden windshift from a southerly direction to a westerly direction that normally accompanies the passage of a thunderstorm outflow boundary. In this case there was not a sudden windshift, but one which took some thirty minutes to complete. This is an indication of a mesolow rather than a squall-line passage. Just as interesting was the trace of the wind speed. Again, there was no jump in wind speed as would be expected with a passing gustfront. Rather, wind speed steadily increased starting from about 0530 UTC, reached a peak about 0556 UTC when the pressure gradient force was presumably greatest, and decreased until about 0620 UTC. At the point of its closest pass, steady state winds were near 40 kt with gusts to 50 kt.

The veering winds indicate the mesolow center passed north of the Shearon-Harris Plant. Also, since radar indicated the thunderstorm cell was north of the tower, the wind speed supports the notion of very vigorous inflow into the storm.

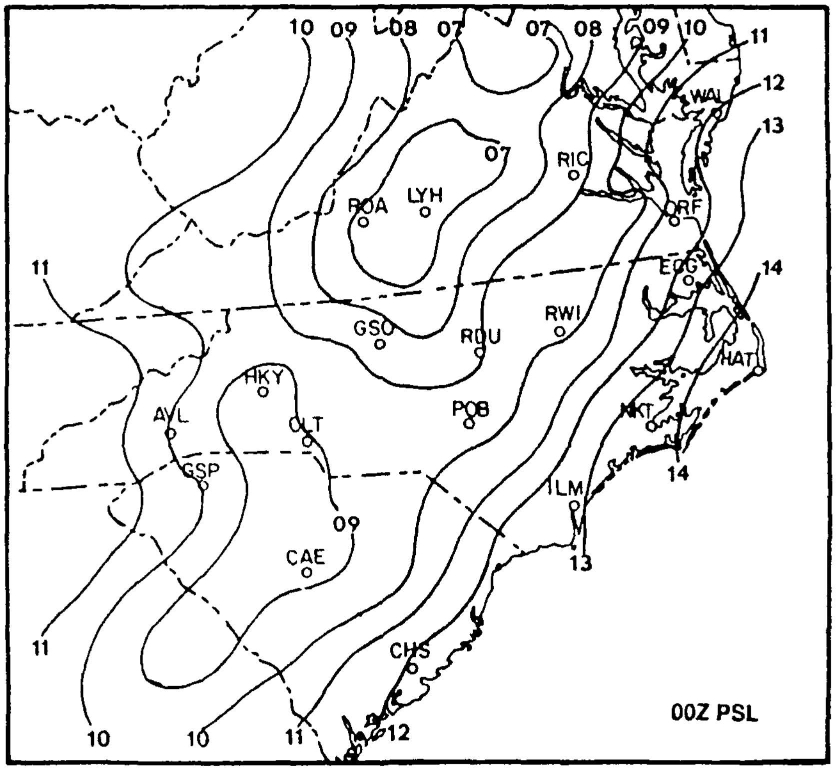


Figure 15a. 0000 UTC surface pressure analysis at 1 mb intervals for November 28, 1988.

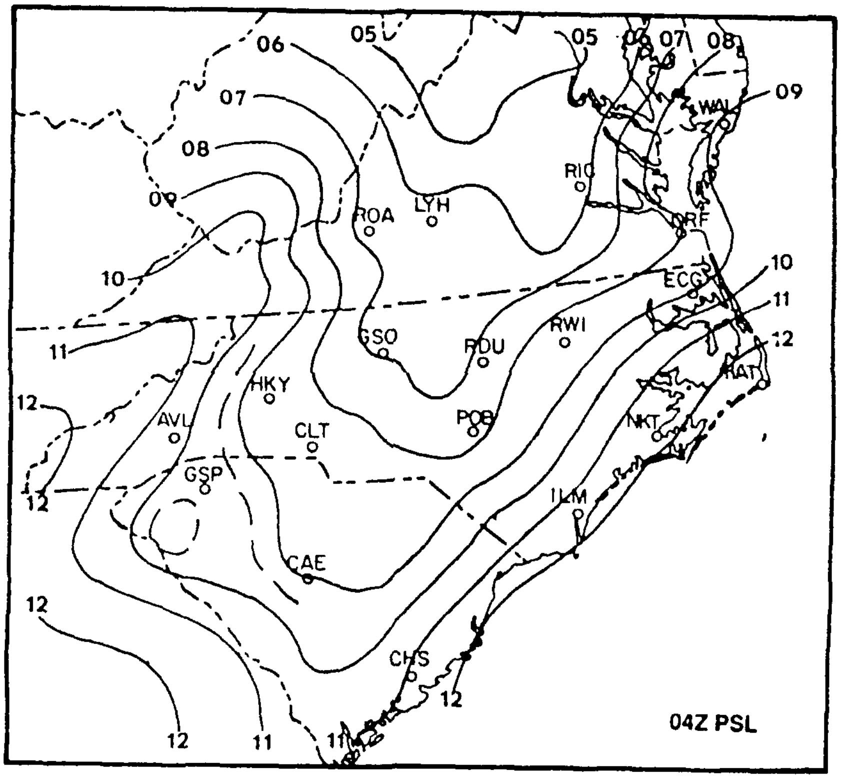


Figure 15b. Same as 15(a) except at 0400 UTC.

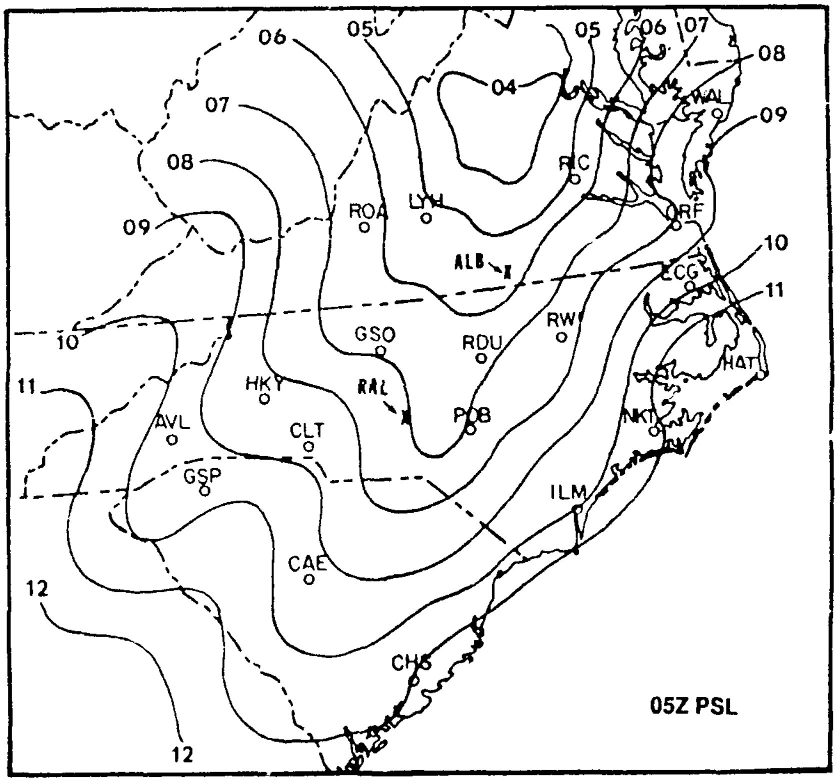


Figure 15c. Same as 15(a) except at 0500 UTC. Note the positions of the Raleigh (RAL) and Alberta (ALB) thunderstorm cells are represented by the respective "X".

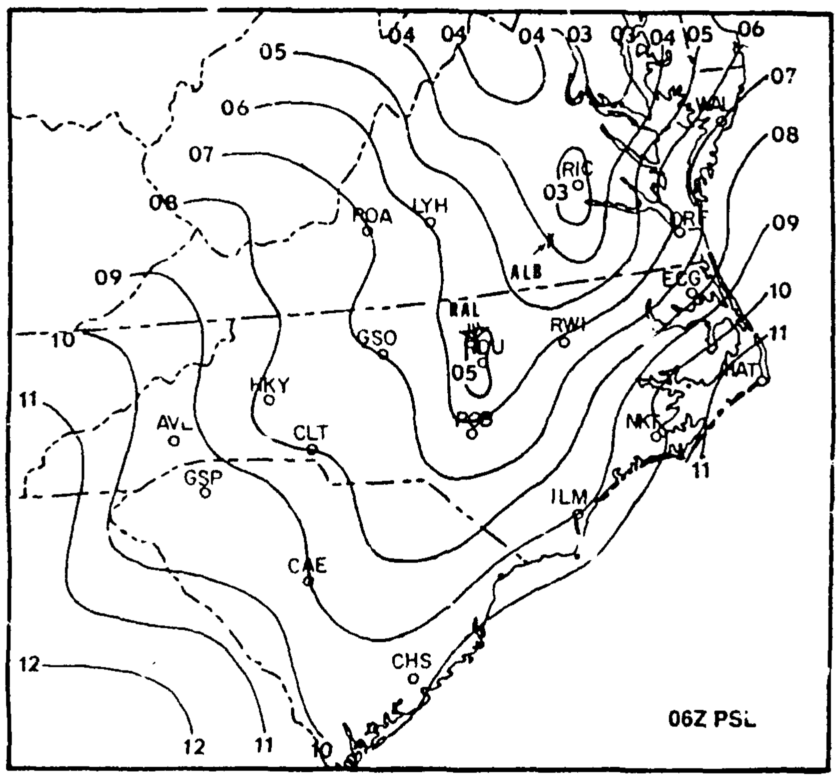


Figure 15d. Same as 15(a) except at 0600 UTC. Note the positions of the Raleigh (RAL) and Alberta (ALB) thunderstorm cells are represented by the respective "X". Also, we see the Raleigh thunderstorm was associated with a mesolow pressure feature.

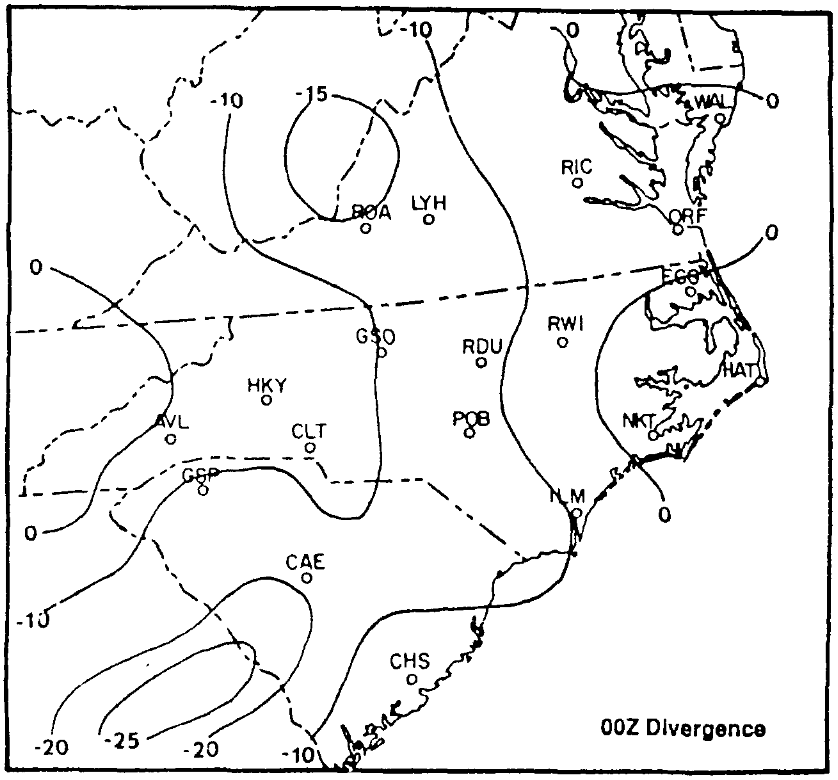


Figure 16a. 0000 UTC surface wind convergence analysis for November 28, 1988. Units are x10^{-5} s^{-1}.

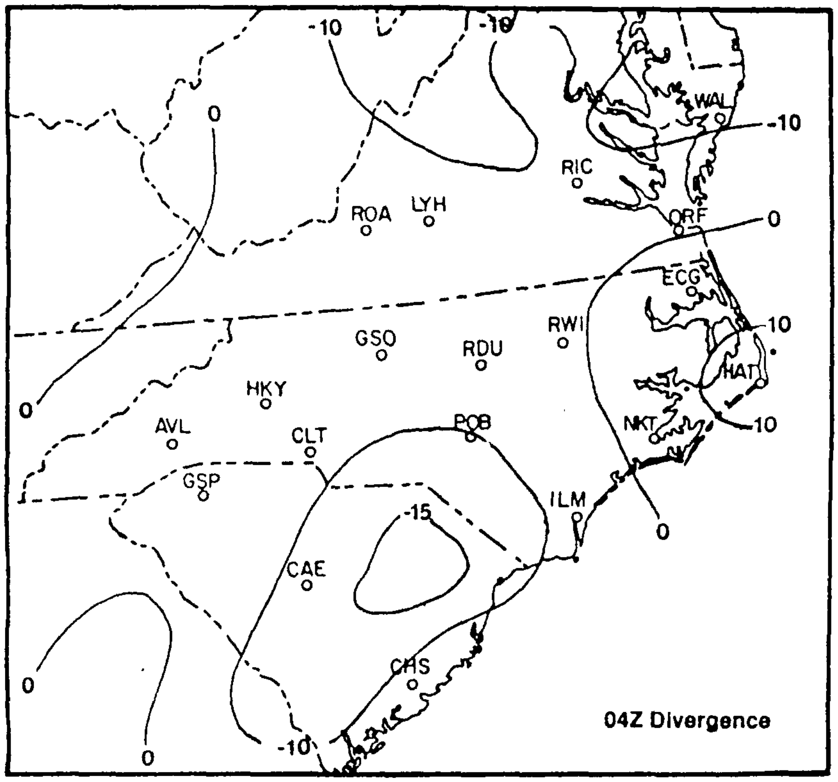


Figure 16b. Same as 16(a) except at 0400 UTC.

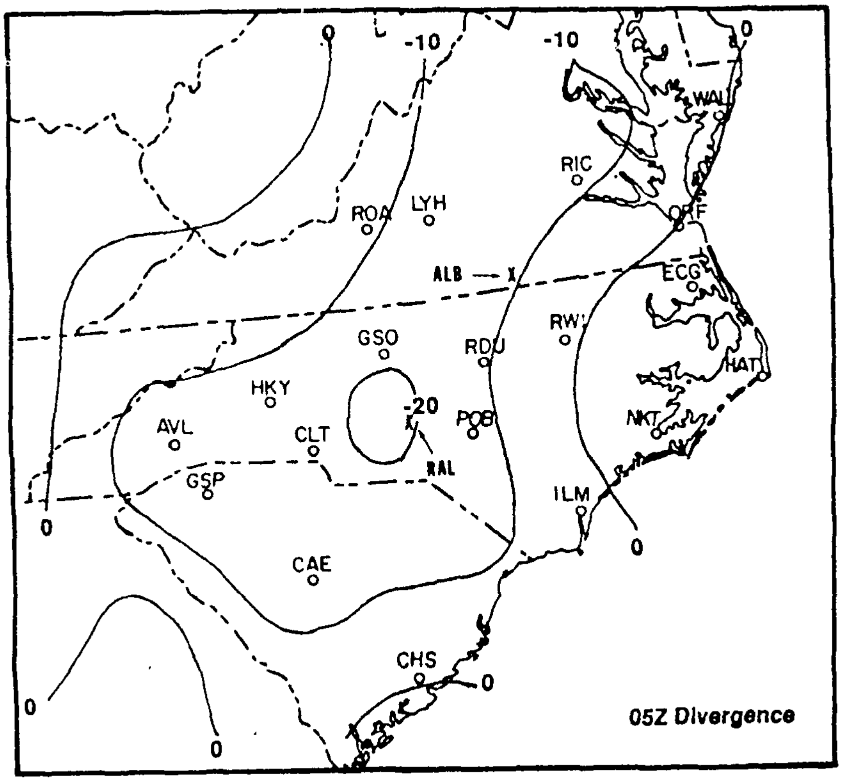


Figure 16c. Same as 16(a) except at 0500 UTC. Note the positions of the Raleigh (RAL) and Alberta (ALB) thunderstorm cells are represented by the respective "X". Also, the Raleigh thunderstorm was within the area of maximum convergence.

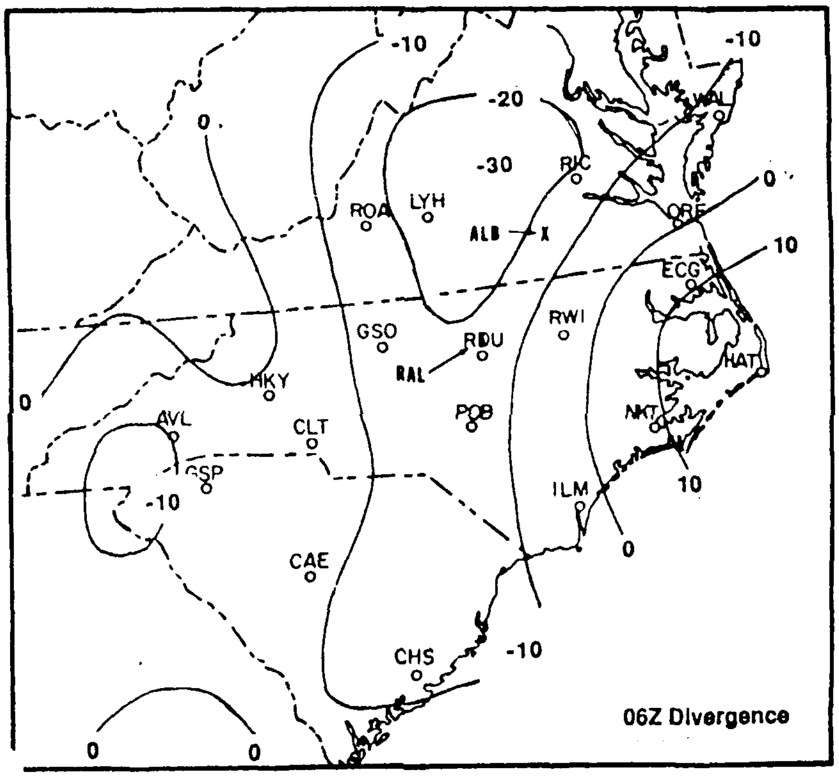
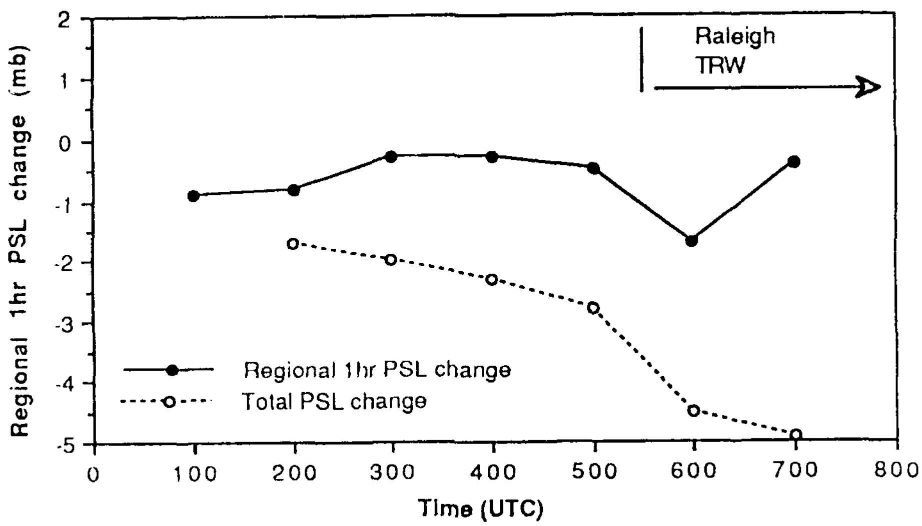


Figure 16d. Same as 16(a) except at 0600 UTC. Note the positions of the Raleigh (RAL) and Alberta (ALB) thunderstorm cells are represented by the respective "X".



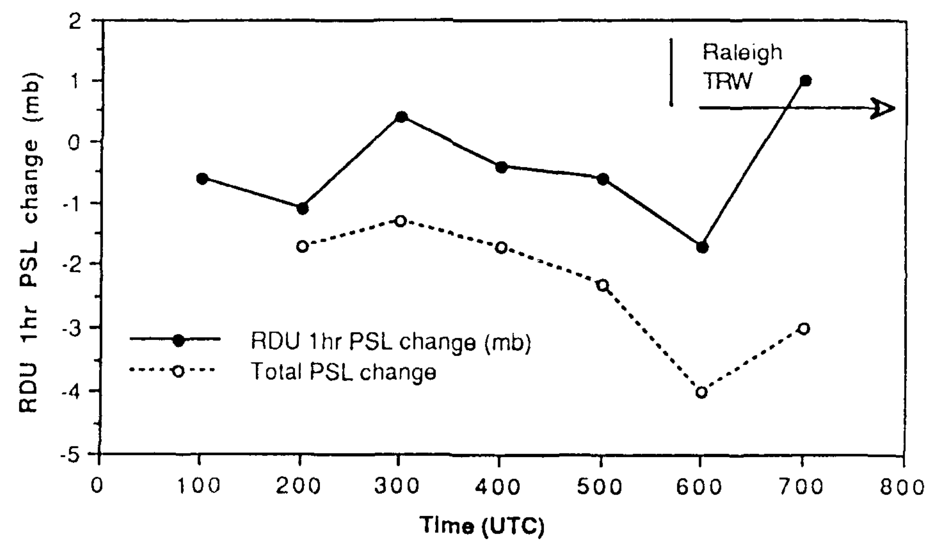


Figure 17. Regional and local are 1 hour pressure change in mb, and total pressure change for the period 28/0100-0700 UTC, November 1988.

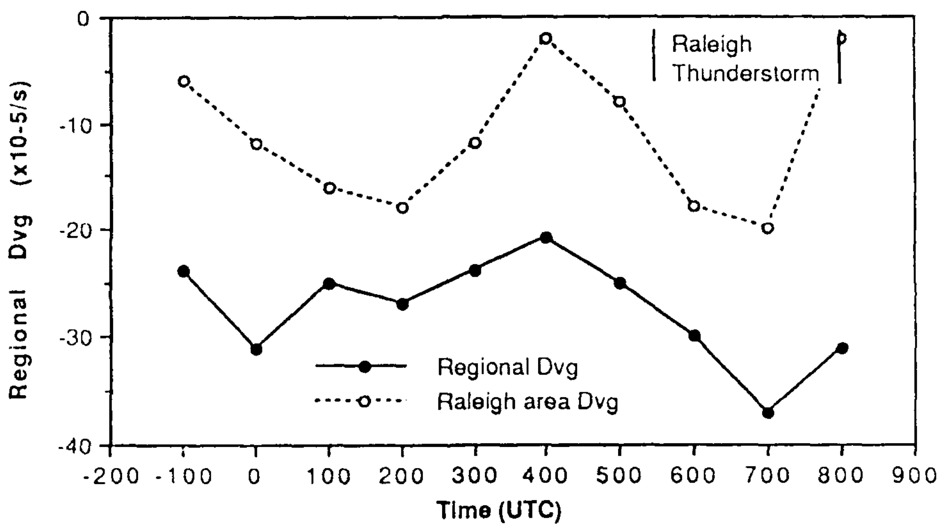


Figure 18. Regional and local area minimum divergence (convergence) values for the period 27/2300-28/0700 UTC, November 1988.

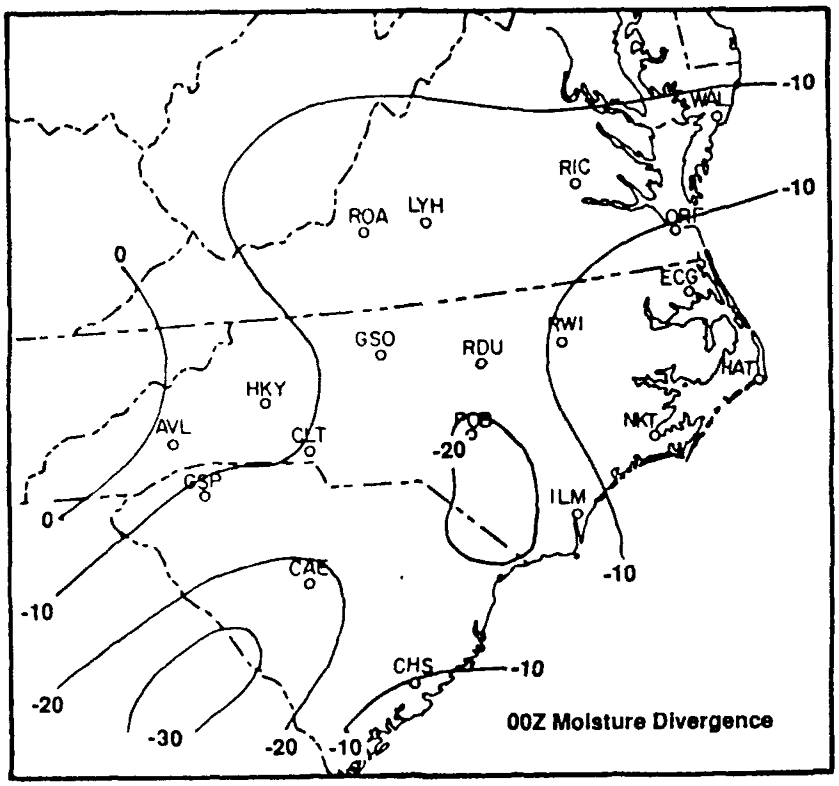


Figure 19a. 0000 UTC moisture divergence analysis for November 28, 1988. Units are g/kg/hr.

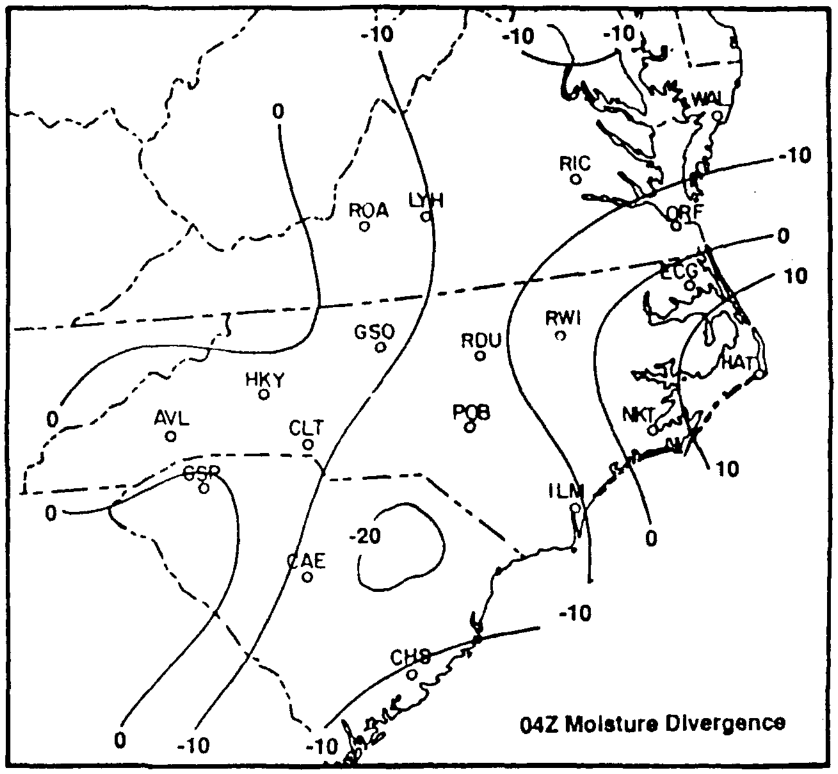


Figure 19b. Same as 19(a) except at 0400 UTC.

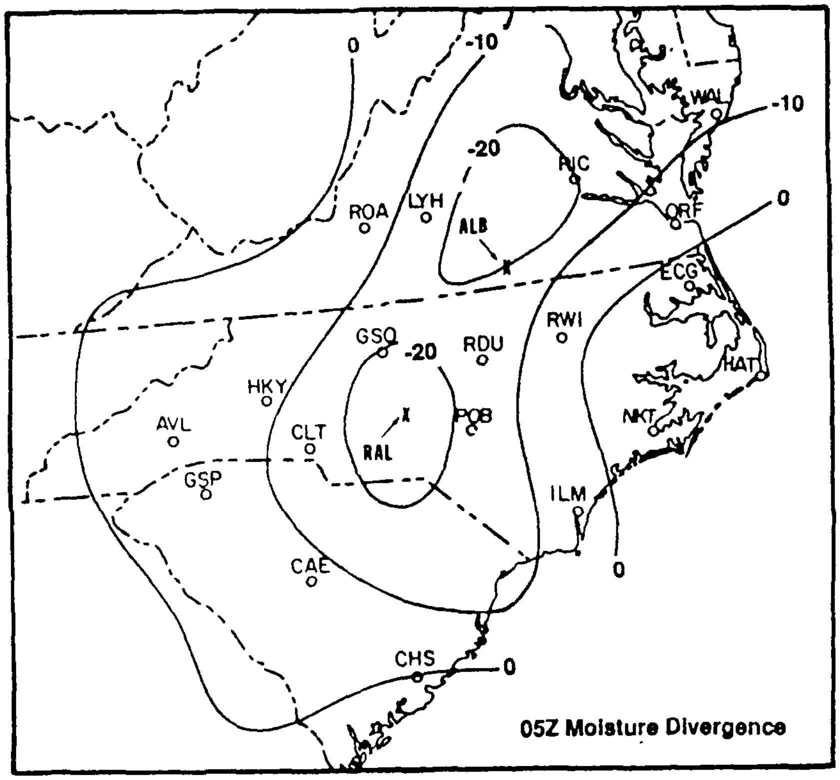


Figure 19c. Same as 19(a) except at 0500 UTC. Note the positions of the Raleigh (RAL) and Alberta (ALB) thunderstorm cells are represented by the respective "X". Also, note cells were located near areas of maximum moisture convergence.

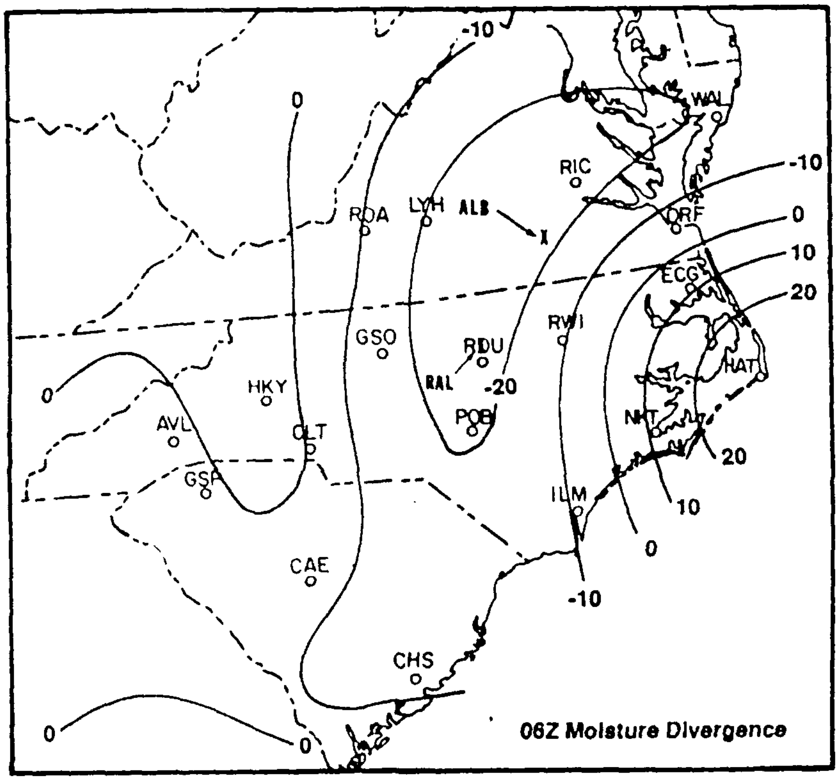


Figure 19d. Same as 19(a) except at 0600 UTC. Note the positions of the Raleigh (RAL) and Alberta (ALB) thunderstorm cells are represented by the respective "X". Note again that the cells were within the region of maximum surface moisture convergence.

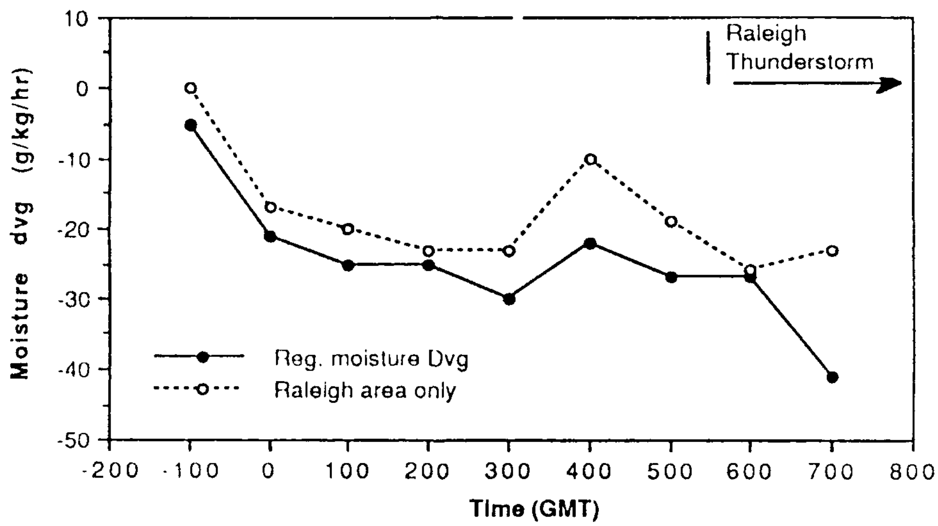


Figure 20. Regional and local area minimum moisture divergence (convergence) values for the period 27/2300-28/0800 UTC, November 1988.

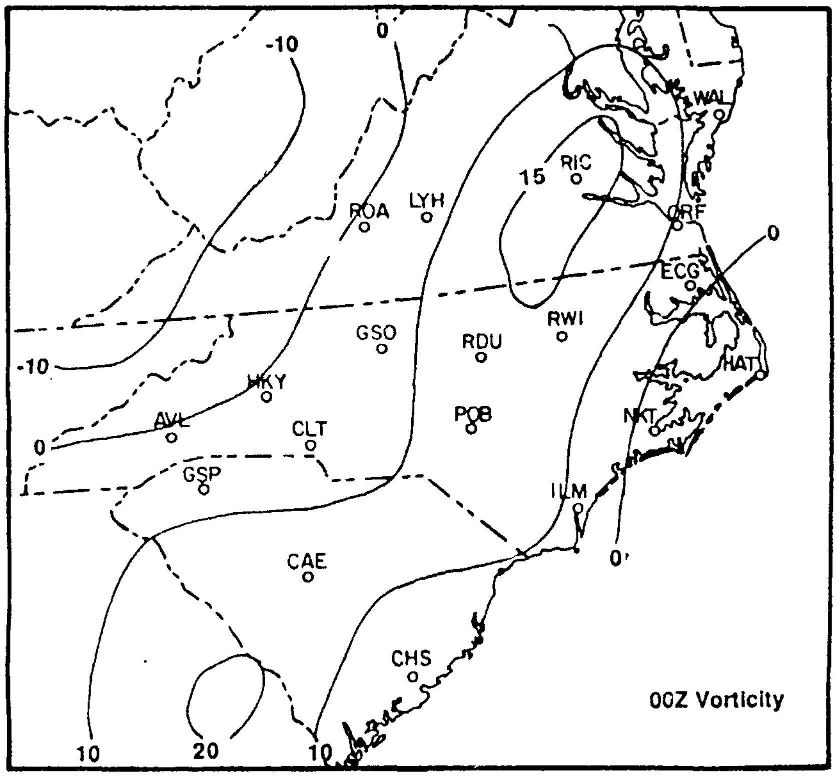


Figure 21a. 0000 UTC surface vorticity analysis for November 28, 1988. Units are $x10^{-5}$ s^{-1}.

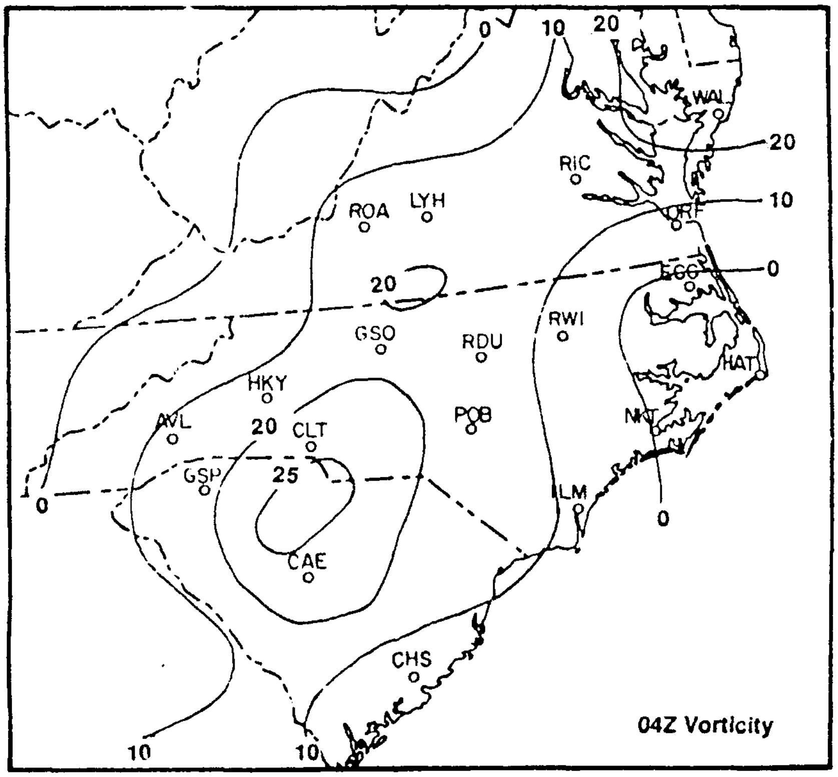


Figure 21b. Same as 21(a) except at 0400 UTC.

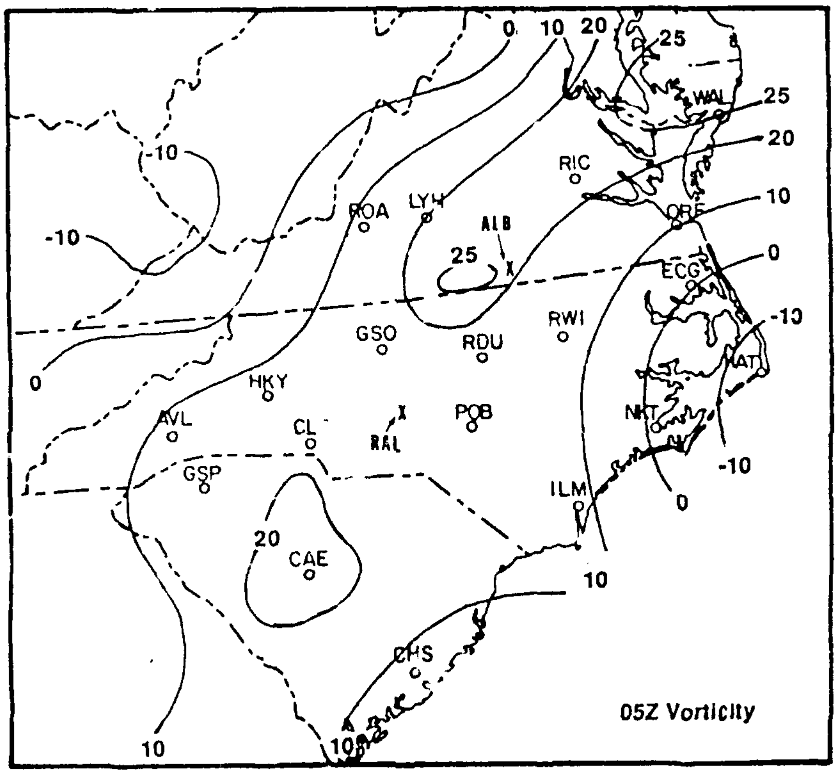


Figure 21c. Same as 21(a) except at 0500 UTC. Note the positions of the Raleigh (RAL) and Alberta (ALB) thunderstorm cells are represented by the respective "X".

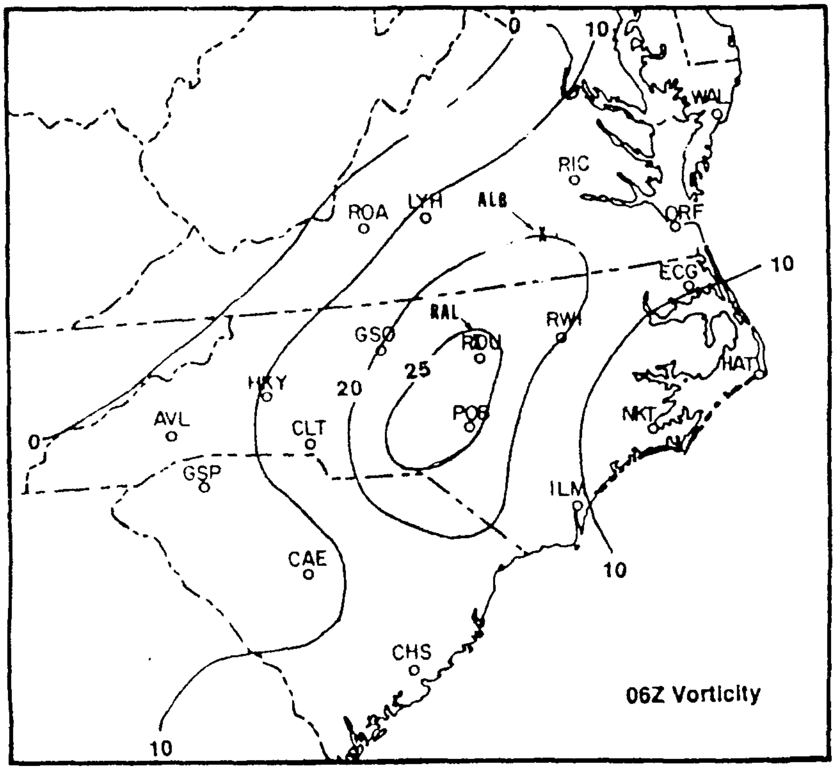


Figure 21d. Same as 21(a) except at 0600 UTC. Note the positions of the Raleigh (RAL) and Alberta (ALB) thunderstorm cells are represented by the respective "X". Also, the Raleigh thunderstorm cell and associated mesolow were within the region of maximum positive surface vorticity.

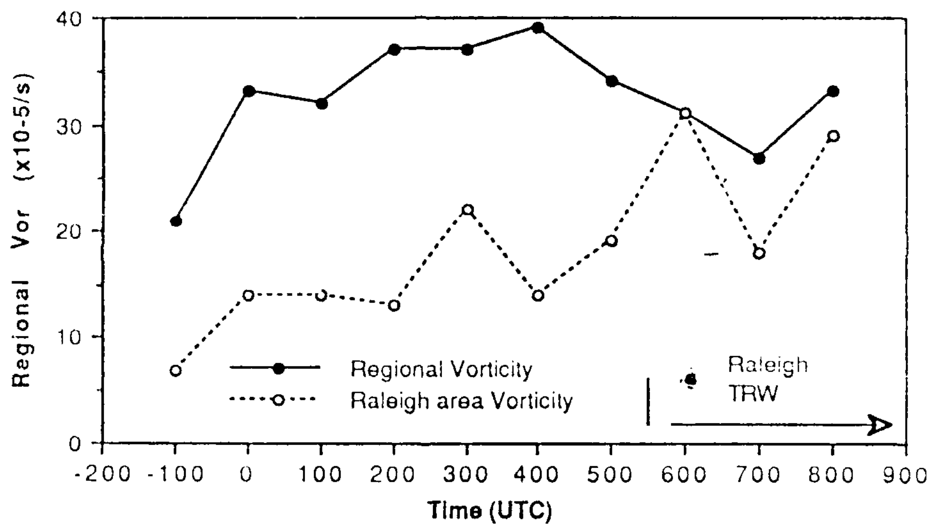


Figure 22. Regional and local area maximum vorticity values for the period 27/2300-28/0800 UTC November 1988.

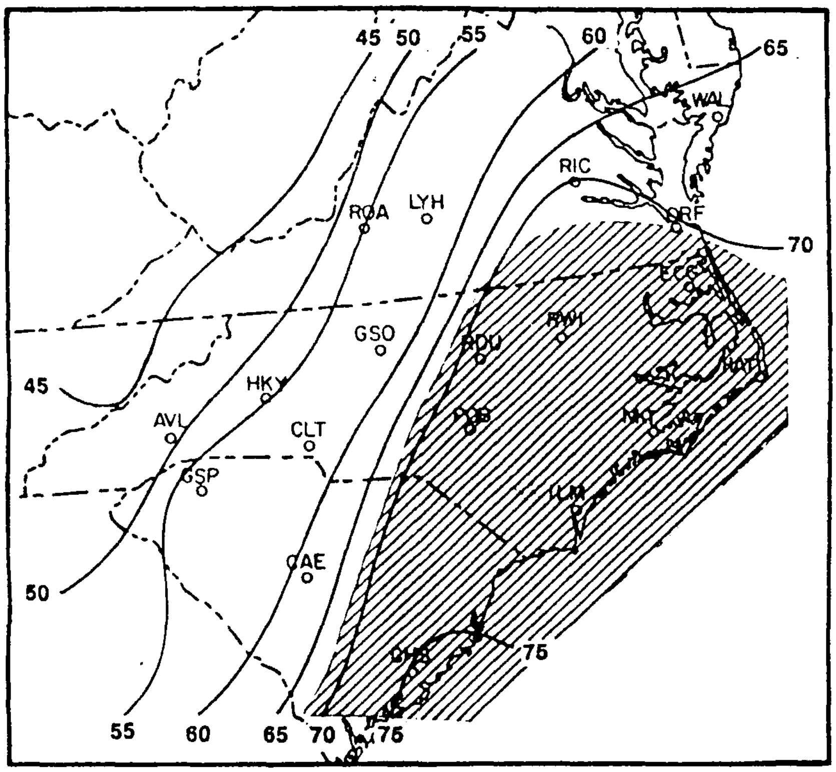


Figure 23a. 0400 UTC surface thermal analysis for November 28, 1988. Contours are in 5^{o} F intervals. Surface dewpoint values $\geq$65^{o} F are represented by the hatched area.

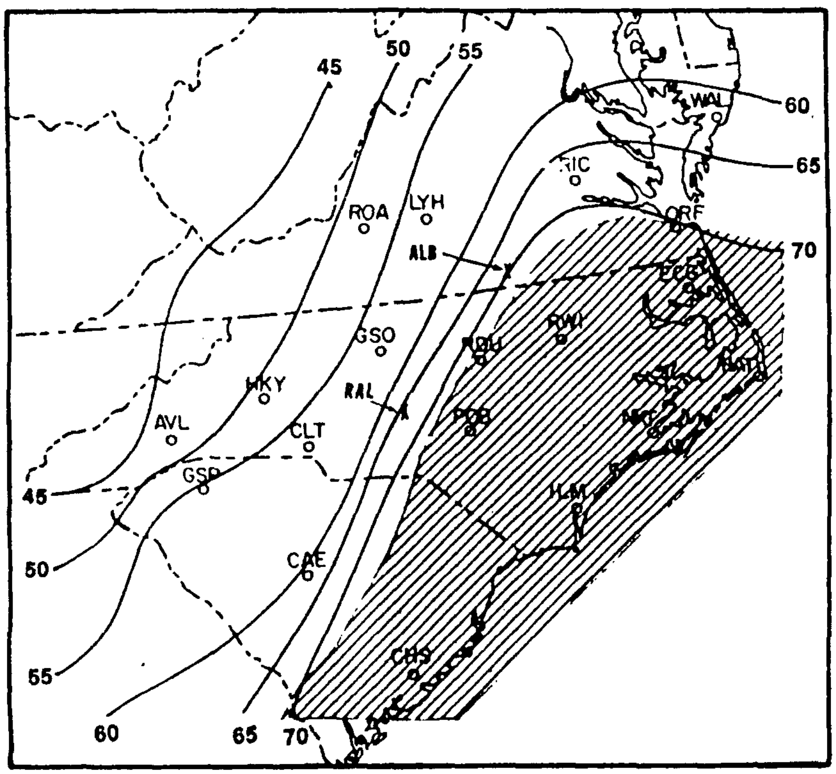


Figure 23b. Same as 23(a) except at 0500 UTC. Note the positions of the Raleigh (RAL) and Alberta (ALB) thunderstorm cells are represented by the respective "X". Also, the Alberta cell was almost in the warm sector across the thermal boundary (it produced a tornado at approximately 0530 UTC).

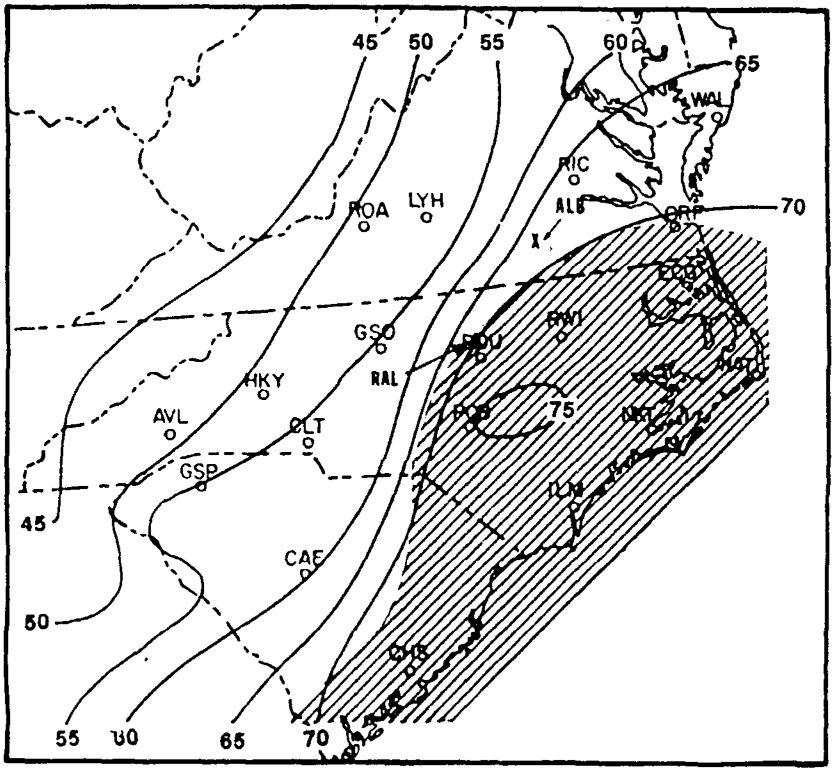


Figure 23c. Same as 23(a) except at 0600 UTC. Note the positions of the Raleigh (RAL) and Alberta (ALB) thunderstorm cells are represented by the respective "X". Also, the Raleigh thunderstorm was in the warm sector across the thermal boundary and produced a tornado at 0600 UTC.

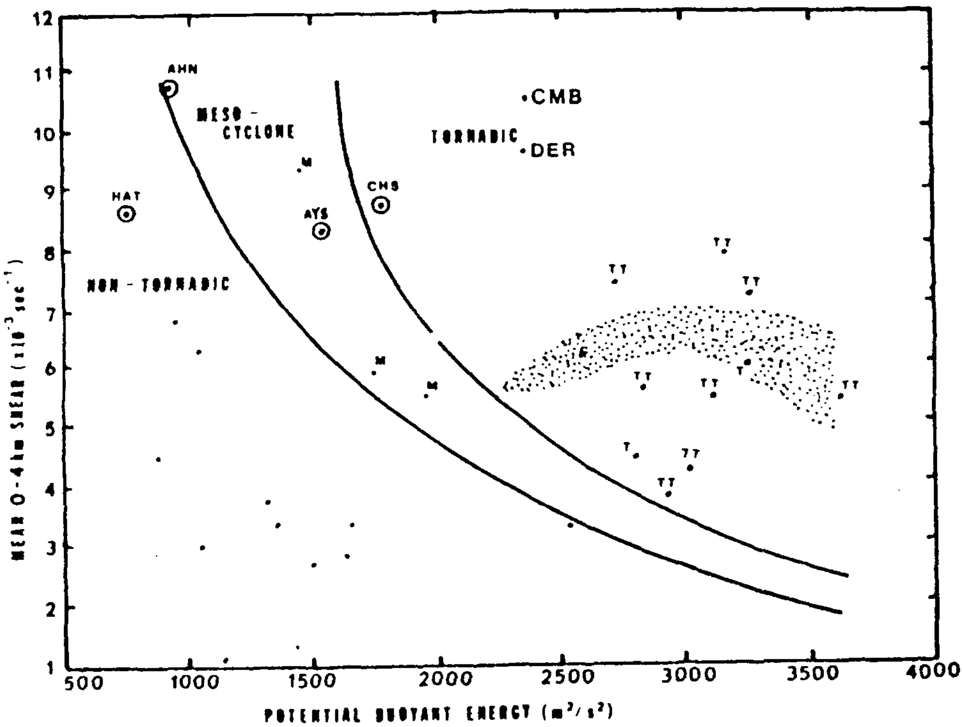


Figure 24. Plot of potential buoyant energy (PBE) and 0-4 kilometer mean wind shear (after Rasmussem and Wilhelmson, 1983). Included are the stations for the Raleigh tornado case (HAT, AHN, AYS, and CHS), a combined sounding (as CMB) using the Greensboro and Charleston upper air soundings, and a value derived from the time averaged upper-air wind grids (as DER).

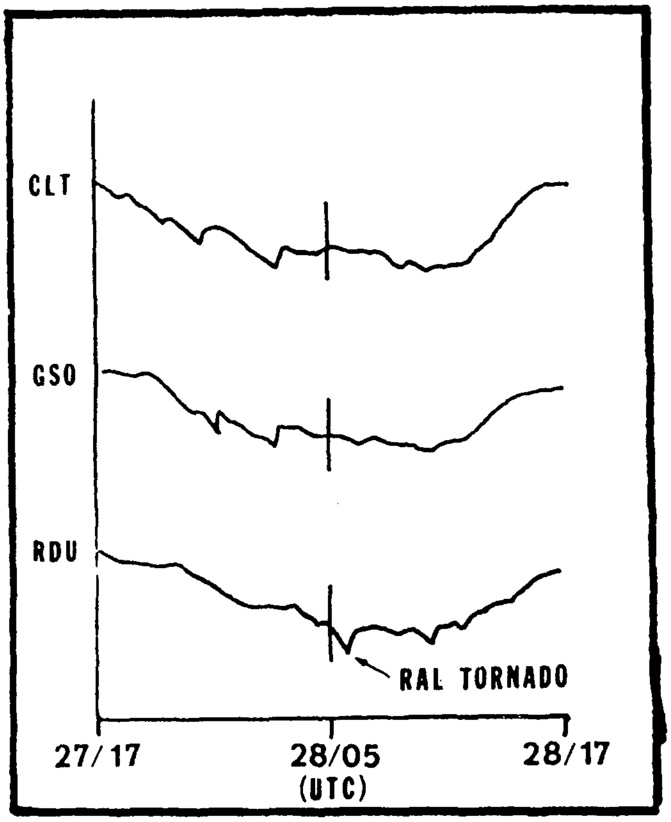


Figure 25. Pressure traces from Charlotte (CLT), Greensboro (GSO), and Raleigh (RDU) for the period 27/1700-28/1700 UTC, November 1988.

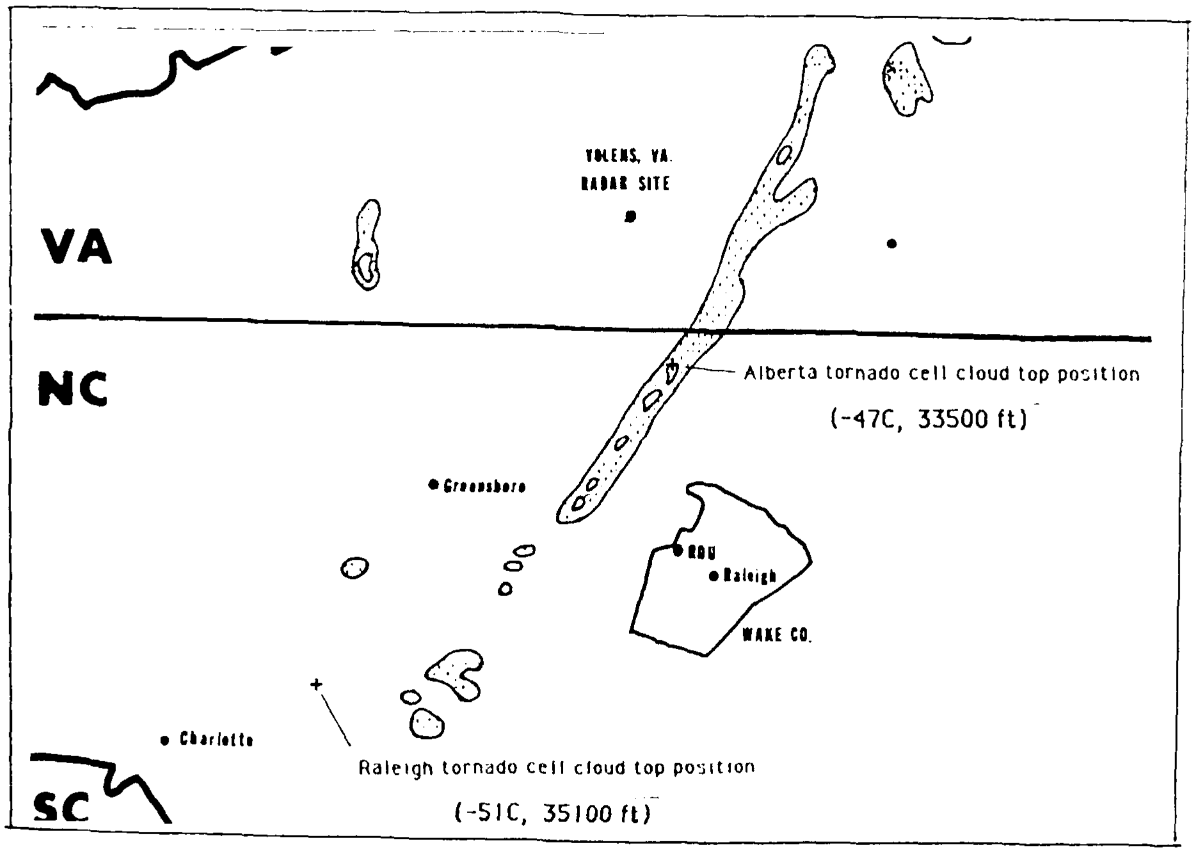


Figure 26a. Radar depiction of the squall line at 0431 UTC, November 28, 1988 from the Volens, VA radar. Only DVIP level 2 and greater returns are represented.

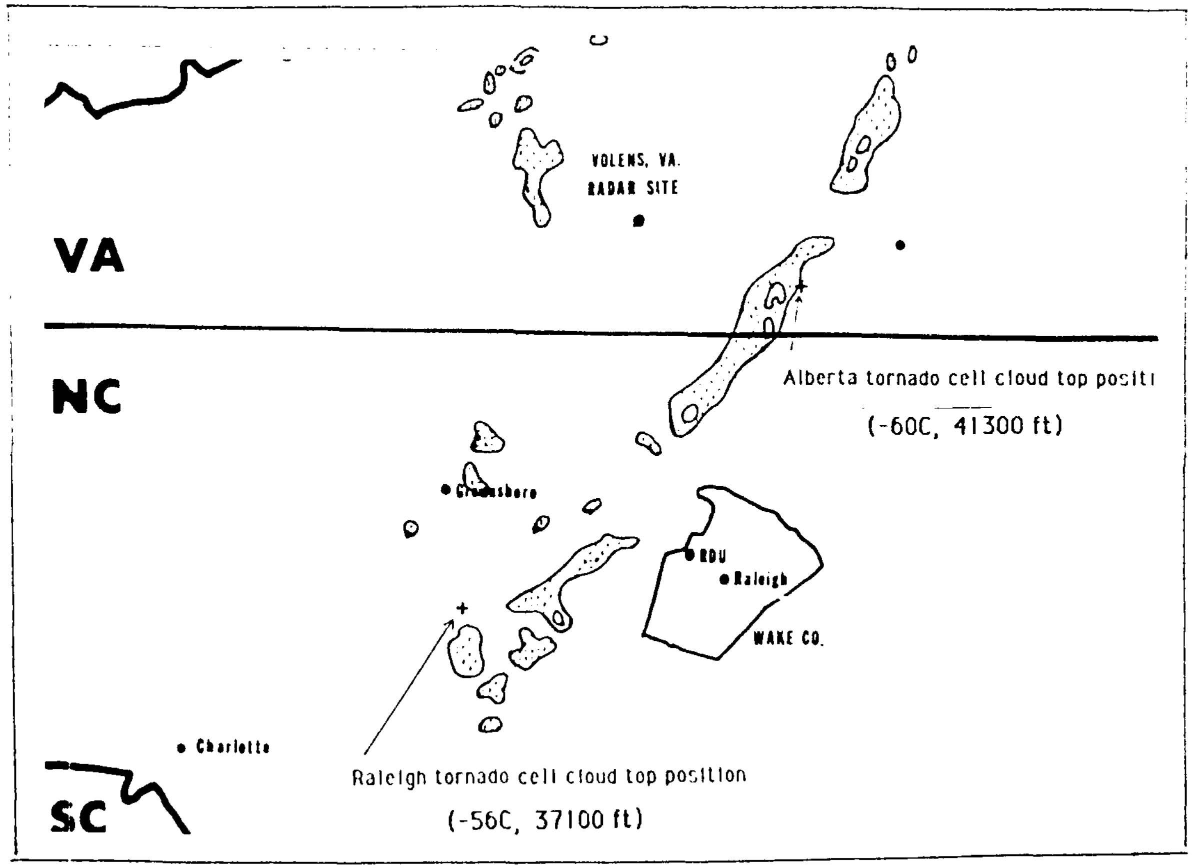


Figure 26b. Same as 28(a) except at 0501 UTC.

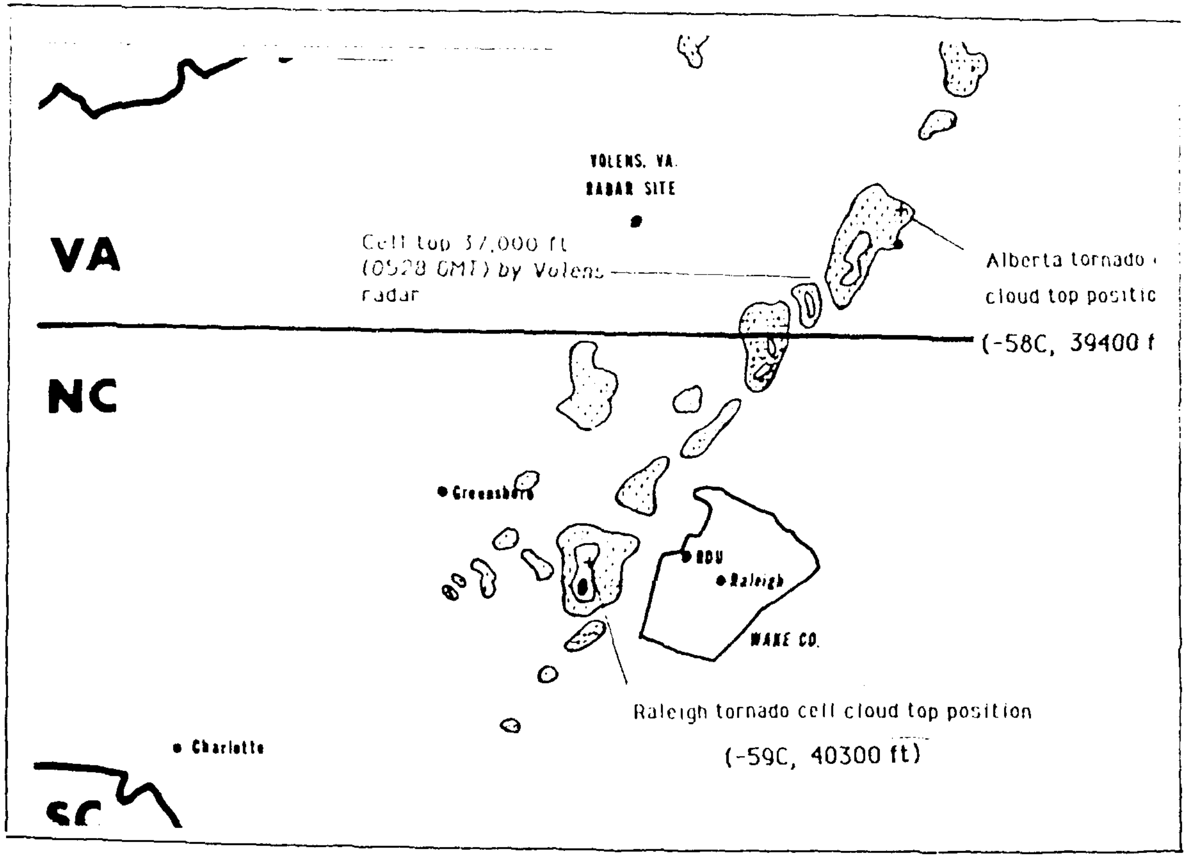


Figure 26c. Same as 28(a) except at 0533 UTC.

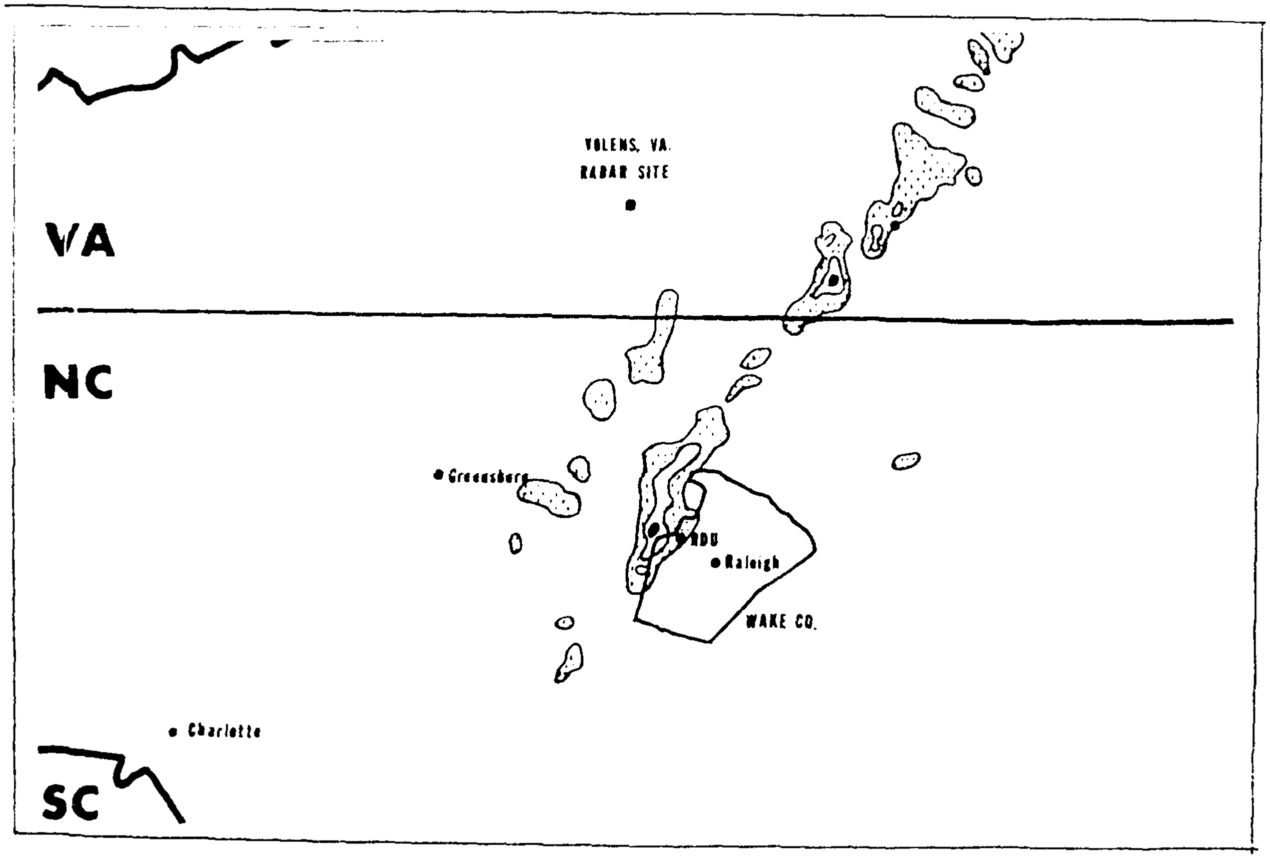


Figure 26d. Same as 28(a) except at 0556 UTC.

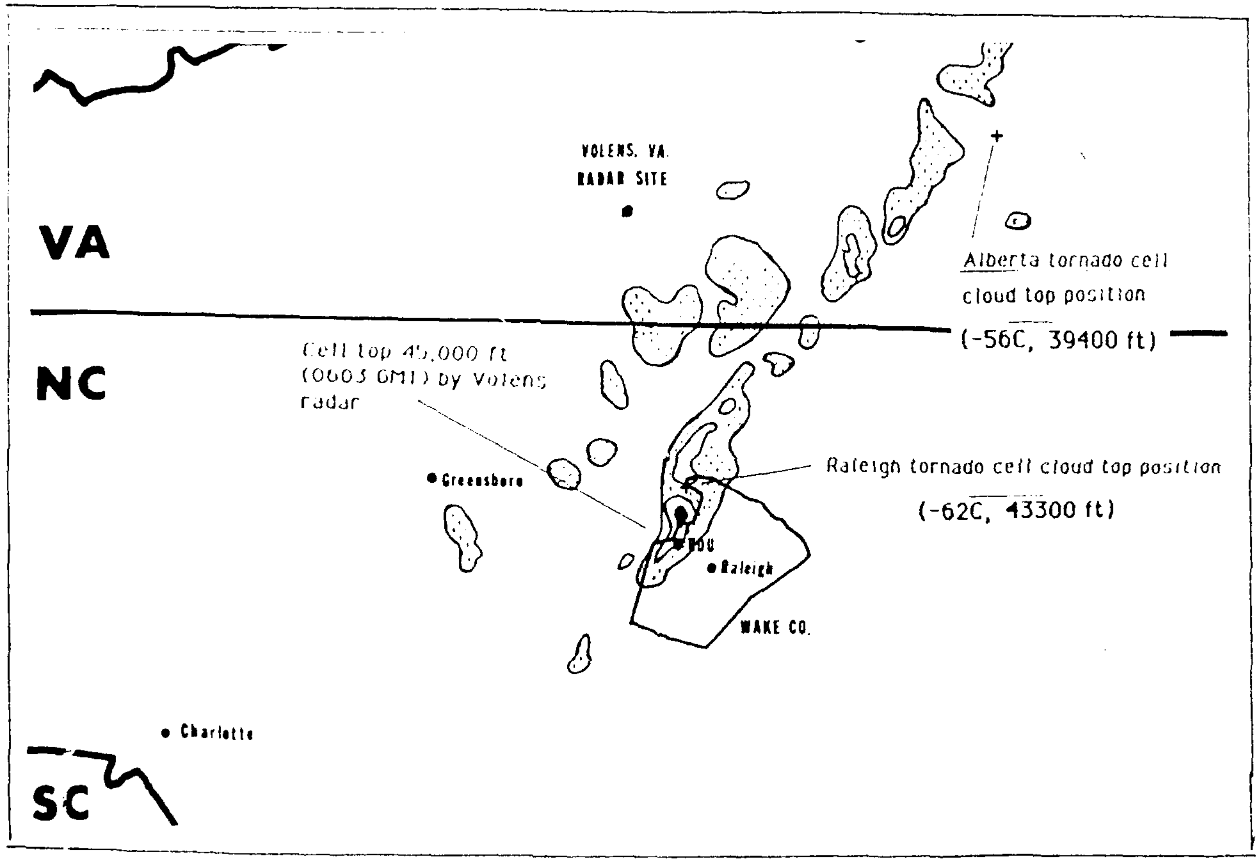


Figure 26e. Same as 28(a) except at 0604 UTC.

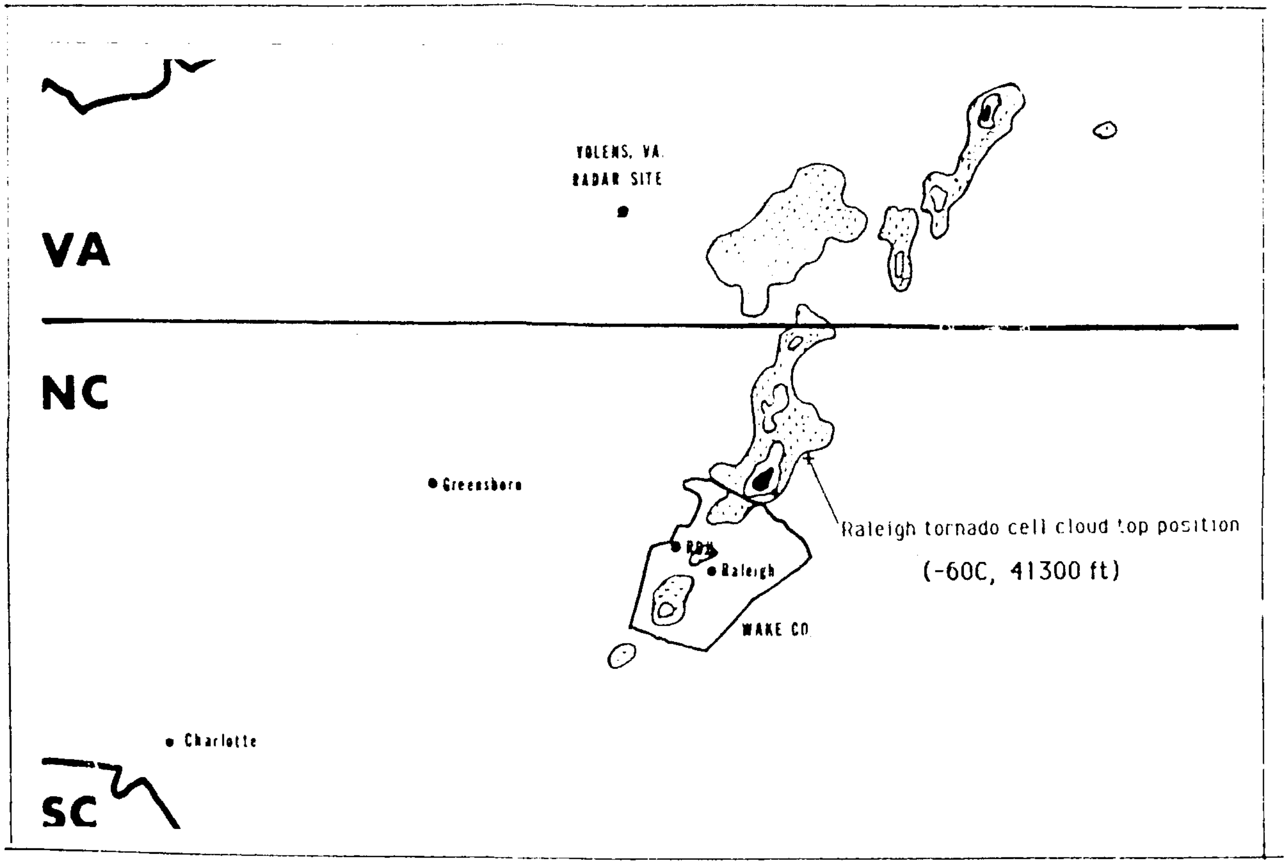


Figure 26f. Same as 28(a) except at 0628 UTC.

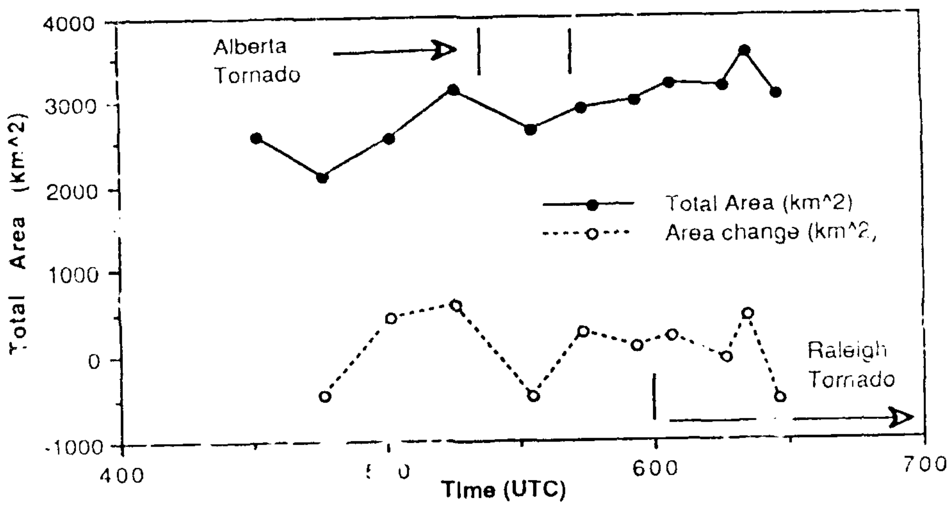


Figure 27. Total area of the radar coverage of DVIP level 2 and greater returns for the Raleigh thunderstorm squall line. Also represented is the change in area between radar images.

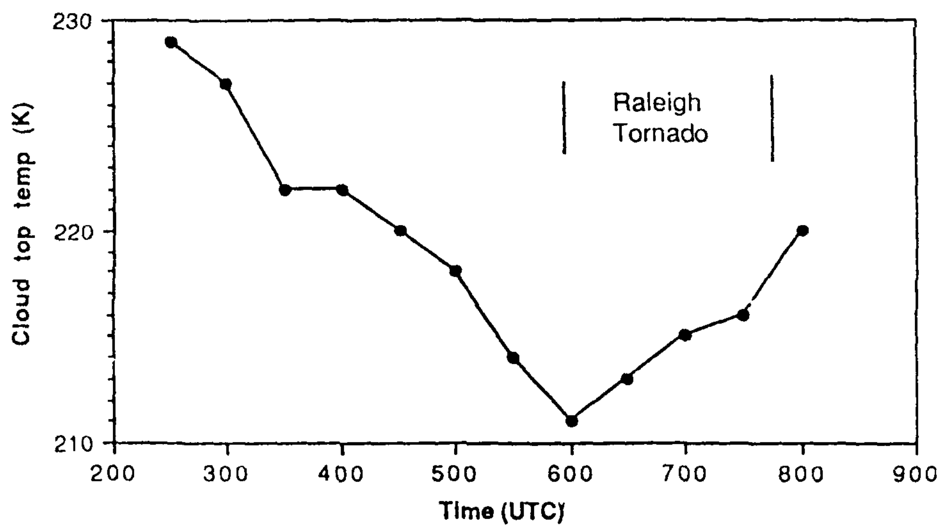


Figure 28. Cloud top temperature versus time for the Raleigh thunderstorm cell from GOES IR imagery for the period 28/0230-0800 UTC, November 1988.

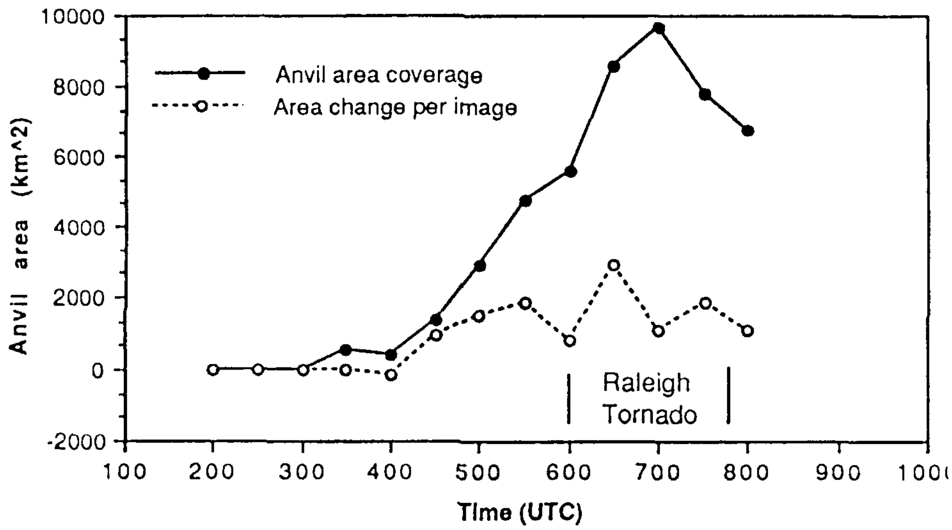


Figure 29. Cloud top anvil area growth for the Raleigh thunderstorm cell from GOES IR imagery for the period 28/0230-0800 UTC, November 1988.

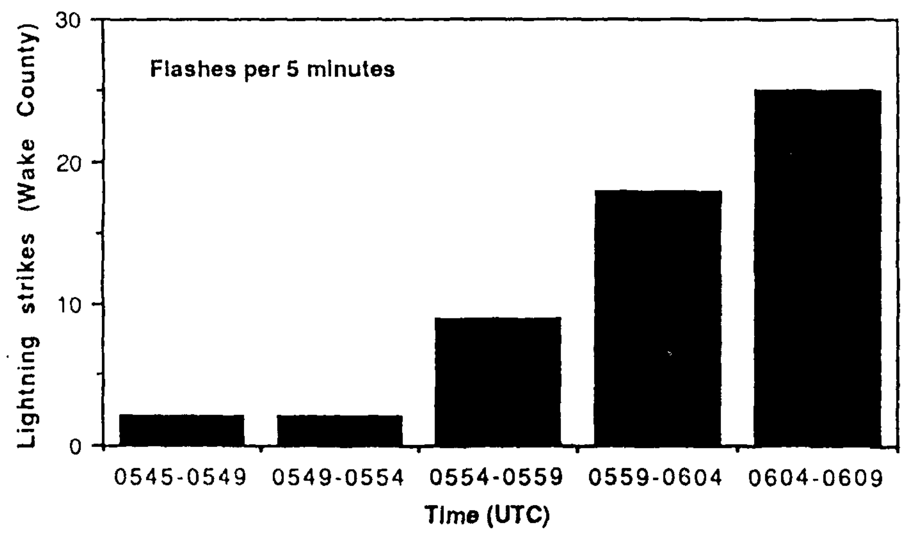


Figure 30. Histogram of the cloud-to-ground lightning activity for the Raleigh thunderstorm cell from the SUNY-Albany Lightning Detection Network for the period 28/0545-0609 UTC, November 1988, in five-minute increments.

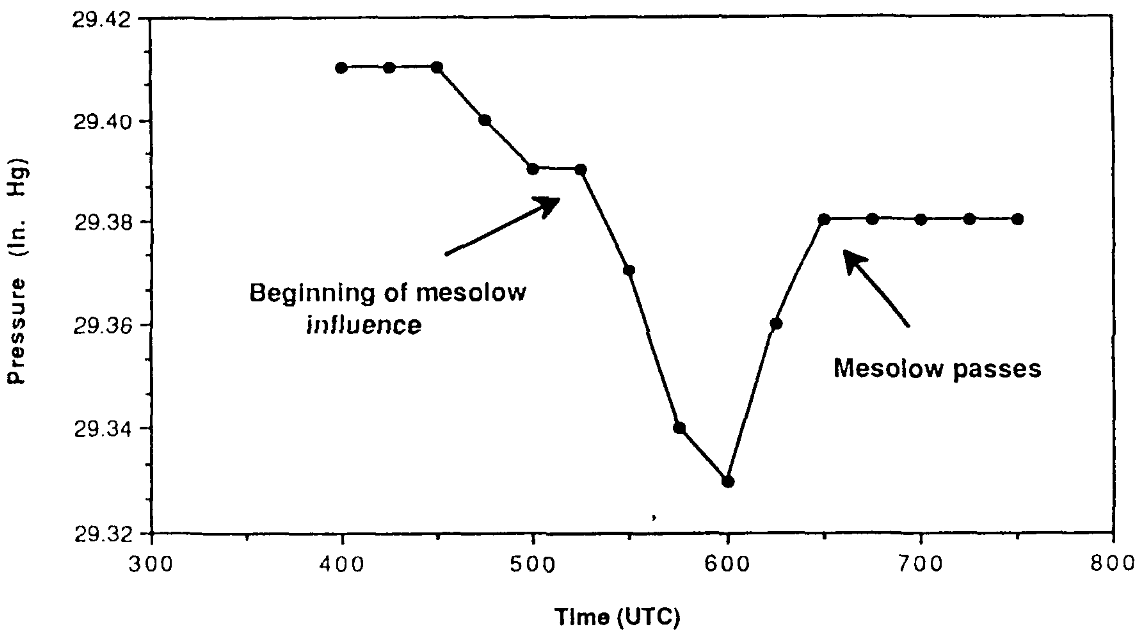


Figure 31. Plot of the 15-minute averaged pressure (inHg) at the Shearon-Harris Nuclear Plant for the period 28/0400-0730 UTC, November 1988.

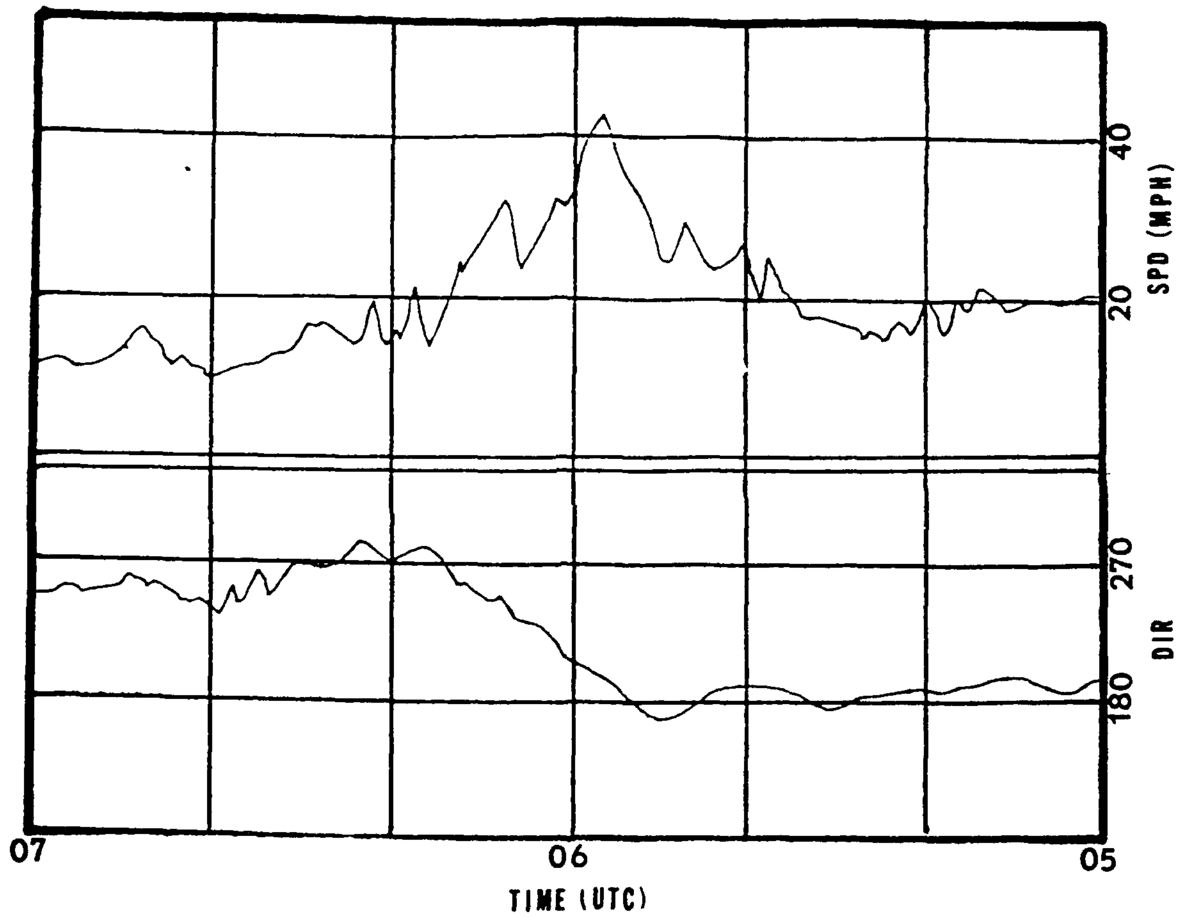


Figure 32. Plot of the wind speed and direction traces at the Shearon-Harris Nuclear Plant for the period 28/0500-0700 UTC November 1988. Wind direction is in degrees, speed in miles per hour.

4. **DISCUSSION OF RESULTS**

The development of the Raleigh thunderstorm has been described in terms of the data available to document its environment and the unique circumstances which contributed to the tornadoe's development. Evidence was presented to show the changes in the environment which occurred prior to tornado development, and demonstrated the coupling of the Raleigh thunderstorm mesocyclone with a strong, localized surface vorticity field and subsequent production of the Raleigh tornado.

The Raleigh thunderstorm cell was classified as a supercell or mesocyclone because it met the following criteria:

a) it was long-lived. Considering the time from when the cell was recognized as part of the developing squall line until it produced its final tornado, 0528-0835 UTC, it had lasted more than three hours.

b) it was a right mover. It was found the storm deviated to the right of the mean wind by about 15^{o} (Table 6).

c) the storm produced three tornadoes, one rated F4, and two F2's.

Severe storms, like the Raleigh thunderstorm, are known to develop in environments characterized by large potential instabilities and vertical wind shear. As well, the basic building blocks of unstably stratified, and moist, convergent airflow are vital to the development of severe storms. It was our working hypothesis that all these elements were in place by 0600 UTC despite the marginal situation for severe weather which existed at 0000 UTC.

Evidence was presented to show that all the known factors required for severe storm production were in place by 0600 UTC and the atmosphere was conducive for the severe storms. Analysis of the 0000 UTC soundings showed very strong vertical wind shear was present through the entire middle and southern Atlantic coast region. By 0600 UTC over the Raleigh region, the wind profile derived from time-averaged upper-air wind grids indicated the vertical wind shear was still present. At the surface, with the north and westward movement of the thermal boundary, the Raleigh area was then exposed to the warm, moist, more convectively unstable air behind the thermal boundary. In addition, strong southerly flow from the South Carolina coast and off-shore Gulf Stream provided a steady and abundant supply of moisture for the maintenance of convection.

Another factor considered essential for the development of severe weather was the presence of dry air in the middle-levels of the upper atmosphere. By 0600 UTC it was clearly evident in the water vapor imagery that drier air was present in upper atmosphere and the Raleigh storm formed on the boundary of the moist and dry air regimes.

Convection, in the form of a squall line, developed west of the Raleigh area along a pre-frontal surface trough. The region in which the trough formed was coincident with a surface mesoscale convergence area. Supporting the surface convergence was a short-wave trough in the mid-levels of the atmosphere. This provided for the removal of the accumulating mass at the surface, and the trough deepened over time.

The radar observation at 0528 UTC showed the Raleigh thunderstorm was about 30 miles southwest of RDU with a radar-observed height of 35,000 feet. By 0603 the thunderstorm had grown to 45,000 feet and produced a tornado. The storm top then collapsed some 8,000 feet and remained near this height for nearly two hours while producing the long-tracked, long-lived Raleigh Tornado. The tornado and thunderstorm cell then moved parallel to the thermal boundary until the tornado dissipated in northeastern North Carolina. It has long been recognized that where a line of thunderstorms intersects such a baroclinic zone is a favored location for the occurrence of tornadic storms (Maddox and Doswell, 1982). It has also been observed that in environments considered weak or marginal for the production of severe weather, tornadic storms have developed along or near an existing thermal boundary (Maddox, et al.,1980). In addition, characteristics of these tornadic storms are that tornadoes which move across the thermal boundary are short-tracked and intense (rated F2 or greater), and those which move parallel to the boundary are long-tracked and intense. Our evidence shows the Raleigh tornado developed, then moved parallel to the thermal boundary as a long-tracked violent tornado.

When the Raleigh thunderstorm moved through the Raleigh area it was embedded in a mesolow which was probably more than 100 kilometers in extent. Tower data from the SHNP southwest of Raleigh and along the thunderstorms path suggested that a mesolow feature passed with windspeeds in excess of 20 ms^{-1}.

Satellite data supprted the existence of a mesocyclone with the Raleigh thunderstorm (Perry, 1989; Schrab, et al., 1990) prior to the Raleigh tornado. This is important when one considers that in a survey of Doppler observations using the NEXRAD prototype (Anderson, 1990), only about 50 percent of storms with the tornado vortex signature actually produced tornadoes. As this indicates, the presence of a mesocyclone does not guarantee a tornado will develop. In the Raleigh tornado case, a number of environmental parameters were maximized in the Raleigh area at the time of the Raleigh tornado.

The figures showing convergence, surface vorticity, and surface pressure suggest ample low-level horizontal vorticity was present at the time of the Raleigh tornado development. This coupled with the existing mesocyclone produced a situation where both a mesocyclone and a surface vorticity field which could be intensified by the wind convergence into the thunderstorm cell were present for tornado production.

We can accept our working hypothesis that although the 0000 UTC environment was marginal for the development of severe weather, by 0600 UTC the atmosphere had evolved all the conditions known to be necessary for severe weather production (actually the atmosphere was ready for severe weather by 0530 UTC if one considers the Alberta tornado). Also, it was seen that the mesocyclone intensification and tornado production occurred in the region of a pre-existing thermal boundary.

Finally, the Raleigh tornado case demonstrated an association of, and the possible coupling of an existing mesocyclone with strong surface vorticity enhanced by convergence fields and a nearby thermal boundary to produce a tornado. The timing of these events strongly suggests a cause-effect relationship. Additionally, remarkable evidence was presented to show the Raleigh tornado persisted, continuously on the ground for nearly 2 hours, despite being imbedded in a thunderstorm of only modest height (near 40,000 feet).

5. CONCLUSIONS

5.1 Minor Findings

The Raleigh thunderstorm exhibited features of severe thunderstorms which collaborate the findings of other researchers. These are:

a) The storm intensified as it moved across a surface thermal boundary.

b) Rapid storm growth occurred in the vicinity of the thermal boundary, and prior to producing the F-4 rated Raleigh Tornado. The tornado path was extremely long, approximately 135 kilometers, and was parallel to the thermal boundary.

c) The storm cell top collapsed some 8,000 feet as it produced the Raleigh Tornado. Subsequently, the F-4 tornado was maintained for some 135 km despite existing in a thunderstorm complex of only modest extent.

5.2 Major Findings

The Raleigh tornado and thunderstorm represent one of the rarest, yet most violent of atmospheric storms - the "killer tornado." It was extremely violent, long-lived, and had a lengthy damage path. In some manner, the quasi-steady tornado vortex and its parent mesocyclone developed in a rapidly changing and complex environment, possibly the result of the coincidence of an existing mesocyclone with strong, low-level horizontal vorticity.

There were three major findings as a result of this research. These were:

a) The environment evolved severe storm potential. Despite marginal conditions for severe storm production at 0000 UTC, as evidenced by severe weather indices and the weather forecast, all the known factors for severe storm production were in place by 0600 UTC.

b) The Raleigh thunderstorm was associated with a strong mesolow. The surface mesolow was between 100 and 120 kilometers in extent, and its influence began to be felt in the area some 45 minutes prior to the production of the tornado.

c) There was evidence for the coupling of an existing mesocyclone with a surface vorticity field enhanced by convergence along the axis of the storms inflow, and by thermal boundary interaction.

This finding dealt with the complex atmospheric interactions required to produce a tornado. Noting Anderson's (1990) hypothesis that an existing mesocyclone must couple with an enhanced surface vorticity field to build a tornado through the surface boundary layer, the Raleigh tornado case offers evidence for such a coupling. Satellite imagery indicated the presence of a mesocyclone within the Raleigh thunderstorm prior to tornado development. At the surface, a number of factors were present to enhance the horizontal surface vorticity. Our data shows ambient surface vorticity was maximized in the Raleigh area at the time of the Raleigh tornado as a result of the squall line convergence. Additionally, strong thermal contrast to the west of the Raleigh area was also responsible for mesoscale intensification of the surface vorticity. Maddox, et al., 1980, developed a physical model of the boundary-layer wind fields across thermal boundaries. According to the model, winds veer slowly with height on the cool side of the thermal boundary, while winds veer rapidly through the subcloud layer in the hot, moist air mass. In this model, when the mean subcloud winds are considered, the meso-scale moisture convergence and cyclonic vorticity are maximized across a narrow mixing zone along the thermal boundary.

Also, Klemp and Rotunno (1983) found that large low level vorticity is generated through the tilting and intense stretching of air from the inflow side of the storm. Analysis of their simulation results showed this vertical vorticity to be derived from the horizontal vorticity of the environmental shear, and the horizontal vorticity generated solenoidally as low-level air is swept into the storms inflow along the storms cold outflow boundary. Their results showed the vorticity generated by these interactions could be three times the magnitude of the synoptic horizontal vorticity. They attained low-level vorticities exceeding $2x10^{-2}$ s^{-1}. In the Raleigh study, the synoptic scale vorticity values never exceeded $2.5x10^{-5}$ s^{-1}, however, storm scale values were probably much greater.

When coupled with the existing mesocyclone of the Raleigh thunderstorm, the already strong horizontal cyclonic vorticity field was intensified by the wind convergence along the axis of the low level inflow into the Raleigh supercell. Apparently, some threshold value was reached which allowed the spin-up of the tornado through the boundary layer to the surface.

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7. APPENDIX

This appendix contains the detailed surface observations for the period 28/0000 UTC to 28/1200 UTC November, 1988, for the southern United States, including the states of Alabama, Georgia, Kentucky, North Carolina, South Carolina, Tennessee, and Virginia. Special criteria observations are prefaced with an "S." All other observations are routine hourlies. Format is as specified:

Date/ Time	St	Stn ID	T	TD	Wind	Gst	Stn Pres	Cld Amt	Vis	Wx	Cld Hgt Low/Mid/Hi			Precip Amt
272355	AL	HSV	48	46	2708		1013.8	310	8.0		75	15		.25
272355	AL	MSL	45	42	2908		1014.8	310	7.0		18	11		.14
272349	AL	ANB	51	50	2508		1014.8	310	7.0	R-	20	10		.06
272338	AL	BHM			2608		1015.1	213	8.0	RW-	60	12	250	
272355	AL	TCL	49	48	3006		1015.5	213	6.0	R-	28	4	60	.35
272354	AL	MGM	54	50	3406		1014.1	300	7.0	R-	45			.10
272350	AL	DHN	61	58	3412		1012.4	300	7.0		12			.06
272350	AL	MOB	53	49	3408		1015.1	300	10.0		34			.34
272358	AL	OZR	54	52	3412	23	1013.1	300	6.0	RW-	10			.02
272355	AL	MXF	56	50	3608		1014.1	311	6.0	R-F	46	7	28	.05
280052	AL	HSV	47	44	3112		1014.1	213	10.0		30	10	75	
280052	AL	MSL	44	39	3106		1015.5	310	7.0		70	18		
280050	AL	ANB	51	48	0000		1012.4	310	7.0		50	10		
280050	AL	BHM	48	46	2808		1015.1	310	4.0	R-	65	10		
280053	AL	TCL	49	47	2904		1015.8	310	7.0		60	5		
280053	AL	MGM	53	51	3006		1014.1	310	7.0		50	20		
280051	AL	DHN	57	51	3412		1013.1	300	7.0		25			
280050	AL	MOB	54	48	3610		1015.5	300	10.0		40			
280056	AL	OZR	54	51	3408	16	1013.8	300	7.0		30			
S280117	AL	OZR			3408	16	1014.5	310	7.0	R-	30	24		
280055	AL	MXF	55	49	3206		1013.8	310	7.0		46	28		
280150	AL	HSV	46	42	3014		1014.5	213	12.0		33	15	75	
280158	AL	MSL	43	39	3008		1016.1	010	10.0			70		
280150	AL	ANB	50	49	2804		1013.1	310	7.0		50	8		
280150	AL	BHM	47	45	3208		1015.5	310	8.0		75	10		
280148	AL	TCL	48	47	2804		1016.5	311	7.0		65	5	25	
280153	AL	MGM	53	49	3108		1015.1	300	7.0		55			
280153	AL	DHN	56	48	3310		1014.5	300	7.0		31			
280153	AL	MOB	53	47	3610		1016.1	300	10.0		46			
280156	AL	OZR	53	51	3508	14	1014.5	310	6.0	R-	30	20		
280155	AL	MXF	55	49	3008		1014.8	310	7.0		50	28		
280251	AL	HSV	44	39	3012		1015.1	200	15.0		90			.00
280250	AL	BHM	47	45	3004		1015.8	310	10.0		90	10		.04
280250	AL	TCL	48	46	3004		1017.2	310	7.0		70	10		.00
280251	AL	MGM	52	48	3108		1015.8	310	7.0		60	20		.00
280250	AL	DHN	54	51	3106		1014.5	300	7.0		31			
S280320	AL	DHN			3206		1014.5	300	5.0	R-F	25			
280252	AL	MOB	52	48	3310		1017.2	300	10.0		50			.00
280256	AL	OZR	53	50	3504		1015.1	300	6.0	R-F	30			.00
280255	AL	MXF	54	49	2904		1015.8	311	7.0		50	10	28	.00
280352	AL	HSV	43	39	3112		1015.8	200	15.0		90			
280351	AL	MSL	40	37	2602		1016.8	000	10.0					
280350	AL	ANB	47	45	2910		1014.8	230	2.0	R-F	10	30		
280352	AL	BHM	46	44	2606		1016.5	310	10.0		90	10		
280352	AL	TCL	47	44	2904		1017.5	200	7.0		70			
280352	AL	MGM	51	45	3110		1016.5	311	7.0		70	15	40	
280350	AL	DHN	53	51	3204		1014.5	300	7.0		35			
280351	AL	MOB	52	46	3408		1018.5	300	10.0		60			

Date/ Time	St	Stn ID	T	TD	Wind	Gst	Stn Pres	Cld Amt	Vis	Wx	Cld Hgt Low	Mid	Hi	Precip Amt
280356	AL	OZR	53	51	3502		1015.1	300	6.0	L-F	35			
280355	AL	MXF	53	42	3216	21	1016.1	311	7.0		60	10	28	
S280423	AL	MXF			3212		1016.8	310	7.0	RW-	60	10		
280450	AL	HSV	41	38	2908		1016.5	010	15.0			90		
280456	AL	MSL	38	36	2404		1017.2	000	10.0					
280452	AL	ANB	46	43	2808		1015.5	310	7.0		35	10		
280451	AL	BHM	45	42	2810		1017.2	310	10.0		100	10		
280450	AL	TCL	45	41	3106		1018.5	200	7.0		80			
280453	AL	MGM	49	45	3008		1017.5	310	7.0		80	50		
280450	AL	DHN	53	50	3104		1015.5	300	7.0		55			
280451	AL	MOB	51	44	3410		1018.9	200	10.0		65			
S280435	AL	OZR			3004		1015.5	310	7.0		35	8		
280455	AL	OZR	53	50	3306		1015.5	311	7.0		35	8	20	
S280529	AL	OZR			3006		1016.1	230	7.0		10	20		
280455	AL	MXF	51	43	3008		1017.2	300	7.0		60			
280549	AL	HSV	39	38	2808		1016.5	010	15.0			90		.00
280548	AL	MSL	37	36	2404		1017.2	000	10.0					.00
280550	AL	ANB	46	43	2810		1015.5	200	7.0		18			
280550	AL	BHM	44	40	2906		1017.5	011	10.0			10	100	.04
280550	AL	TCL	42	39	2906		1019.2	000	7.0					
280552	AL	MGM	49	45	3110		1017.5	310	7.0		85	20		.00
280553	AL	DHN	53	49	3008		1015.8	300	7.0		18			.06
280550	AL	MOB	51	43	3212		1019.5	210	10.0		70	23		.00
280555	AL	OZR	52	50	3208		1016.1	230	7.0		10	16		.10
280555	AL	MXF	51	44	2810		1017.2	210	7.0		60	40		.02
280650	AL	HSV	40	38	2508		1016.5	010	15.0			250		
280650	AL	MSL	39	36	2706		1017.2	000	7.0					
280655	AL	ANB	45	37	2906	14	1016.5	210	7.0		80	20		
280250	AL	TCL	48	46	3004		1017.2	310	7.0		70	10		.00
280649	AL	TCL	41	39	2804		1019.2	000	7.0					
280650	AL	MGM	48	43	3112		1017.5	310	7.0		85	40		
280650	AL	DHN	53	47	3210		1016.1	300	7.0		21			
280652	AL	MOB	49	35	3314		1020.2	200	15.0		75			
280655	AL	OZR	50	45	3212		1016.8	223	7.0		10	20	40	
280655	AL	MXF	51	43	3012		1017.5	210	7.0		60	30		
280750	AL	HSV	39	37	2706		1016.8	000	15.0					
2807:7	AL	MSL	39	35	2710		1017.5	000	7.0					
280752	AL	ANB	44	36	2810		1016.8	212	7.0		80	20	250	
280752	AL	BHM	39	38	2604		1018.2	010	10.0			80		
280751	AL	TCL	41	39	2806		1019.2	010	7.0			100		
280750	AL	MGM	47	41	3210		1018.9	200	7.0		90			
280755	AL	DHN	51	41	3112		1016.8	300	7.0		55			
280752	AL	MOB	45	36	3208		1020.9	000	15.0					
S280735	AL	OZR			3212		1017.2	213	7.0		20	10	40	
280755	AL	OZR	50	42	3214	19	1017.5	213	7.0		20	10	40	
280755	AL	MXF	49	37	3114		1018.9	210	7.0		60	40		
280850	AL	HSV	39	37	2808		1017.2	000	15.0					.00
280855	AL	MSL	38	34	2708		1018.2	000	7.0					.00
280858	AL	ANB	40	37	2506		1017.5	011	7.0			20	250	.00
280851	AL	BHM	39	37	2606		1019.5	000	10.0					.00
280849	AL	TCL	40	38	2906		1019.9	000	7.0					
280850	AL	MGM	44	38	3008		1019.5	010	7.0			100		.00
280855	AL	DHN	50	42	3012		1017.8	210	7.0		60	20		.00
280851	AL	MOB	44	37	3208		1021.6	000	15.0					.00
280855	AL	OZR	50	42	3212		1018.2	213	7.0		22	10	40	.00
280855	AL	MXF	46	37	3004		1019.2	000	7.0					.00
280951	AL	HSV	38	36	2910		1017.8	000	15.0					
280955	AL	MSL	37	33	2708		1018.9	000	7.0					
280951	AL	ANB	39	37	2606		1017.8	010	7.0			250		
280948	AL	BHM	39	37	2708		1019.2	000	10.0					
280950	AL	TCL	40	38	2908		1020.9	000	7.0					
280950	AL	MGM	41	32	3008		1020.2	000	7.0					

Date/ Time	St	Stn ID	T	TD	Wind	Gst	Stn Pres	Cld Amt	Vis	Wx	Cld Hgt Low/Mid/Hi			Precip Amt
280951	AL	DHN	49	40	3008		1018.5	210	7.0		60	25		
280952	AL	MOB	42	38	3206		1022.2	000	15.0					
280955	AL	OZR	49	40	3214	19	1019.2	230	7.0		25	40		
280955	AL	MXF	45	37	2704		1019.9	000	7.0					
281050	AL	HSV	39	33	2814	19	1018.5	000	15.0					
281055	AL	MSL	38	32	2810		1019.2	000	7.0					
281050	AL	ANB	37	36	2404		1018.9	000	7.0					
281053	AL	BHM	38	36	2606		1020.2	000	10.0					
281047	AL	TCL	38	36	2706		1021.9	000	7.0					
281050	AL	DHN	48	38	3112	16	1019.9	210	7.0		100	30		
281051	AL	MOB	41	38	3004		1022.9	000	15.0					
281055	AL	OZR	47	37	3212		1020.5	220	7.0		25	40		
S281108	AL	OZR			3210		1020.9	011	7.0			25	40	
281055	AL	MXF	45	38	2704		1020.5	000	7.0					
281152	AL	HSV	36	32	2710		1019.5	000	15.0					.00
281150	AL	MSL	37	32	2608		1020.2	000	10.0					.00
281152	AL	ANB	37	36	2404		1019.9	000	7.0					.00
281150	AL	BHM	38	35	2506		1021.2	000	7.0					
281153	AL	TCL	37	36	2804		1022.2	000	7.0					.00
281150	AL	MGM	41	31	3006		1022.2	000	7.0					.00
281150	AL	DHN	46	36	2910		1020.9	010	7.0			40		.00
281154	AL	MOB	41	38	3204		1023.6	000	15.0					.00
281155	AL	OZR	45	35	3206		1021.9	010	7.0			40		.00
281155	AL	MXF	44	38	2806		1021.9	000	7.0					.00
272348	GA	RMG	51	45	2404									
S272335	GA	FTY			2910		1012.4	213	6.0	F	16	5	23	
272351	GA	FTY	51	49	3110		1012.8	213	6.0	F	16	5	23	.46
S272331	GA	ATL			3110		1011.7	223	6.0	L-F	3	11	25	
272354	GA	ATL	53	49	3112	19	1012.1	310	7.0		18	3		.28
S280002	GA	AHN			3304		1010.4	300	1.5	TRWF	3			
S280002	GA	AHN			3304		1010.4	300	1.5	TRWF	3			
272350	GA	AHN	55	54	2906		1010.0	230	3.0	R-F	3	20		.15
272349	GA	AGS	70	66	1810		1008.7	213	10.0		100	55	250	.07
S280020	GA	CSG			3212	19	1013.1	310	7.0		33	8		
272350	GA	CSG	58	56	3214	16	1012.8	230	4.0	R-F	7	19		.13
S280021	GA	MCN			3108		1010.4	310	7.0		17	6		
272347	GA	MCN	62	60	3112		1010.0	230	7.0		6	17		.08
S272332	GA	ABY			1810		1009.4	213	8.0	T	45	25	150	
S280025	GA	ABY			2925		1010.4	310	5.0	TRWF	45	225		
272349	GA	ABY	69	69	1714		1009.7	212	8.0	T	45	25	150	.08
272353	GA	SAV	72	69	1812		1011.4	310	20.0		250	130		.00
272352	GA	AMG	76	65	1806		1010.7	220	7.0		55	250		.00
272347	GA	SSI	70	68	1014		1012.4	200	7.0		37			.00
S280015	GA	VLD			2719	25	1010.7	300	.1	TRW+	14			
272351	GA	VLD	76	71	2110		1011.4	213	7.0	TRW-	23	16	65	.00
272355	GA	ISF	58	55	2904		1012.8	310	7.0		15	9		.18
272357	GA	MGF	51	43	3008		1012.4	310	7.0	L-	28	12		.16
S280015	GA	VAD			1710	23	1011.4	213	2.0	TRW	70	20	100	
272355	GA	VAD	78	71	1708		1011.1	213	7.0	TRW-	100	20	250	
S280020	GA	WRB			3410		1010.4	310	7.0	RW-	18	8		
272355	GA	WRB	63	63	3112		1010.0	230	3.0	RW	8	24		
272347	GA	PDK	55	52	3012		1011.1	310	15.0		13	4		
280048	GA	RMG	50	45	2302									
280053	GA	FTY	51	48	3506		1012.8	310	7.0		25	16		
S280125	GA	FTY			3004		1012.1	300	7.0		40			
280051	GA	ATL	51	48	3108		1012.8	300	10.0		25			
280050	GA	AHN	55	54	2606		1010.4	310	7.0	R-	26	3		
S280115	GA	AHN			2708		1010.7	300	4.0	R-F	10			
280049	GA	AGS	69	66	1810		1008.0	311	10.0		250	49	90	
280050	GA	CSG	55	49	3110		1013.8	310	7.0		33	8		
280051	GA	MCN	59	57	3110		1011.4	310	7.0	RW-	17	6		

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280049	GA	ABY	60	60	3114		1011.1	310	9.0	T	45	25		
S280126	GA	ABY			3212		1011.7	310	10.0		45	25		
280051	GA	SAV	72	69	1914		1011.4	310	20.0		250	130		
280048	GA	AMG	73	68	1306		1011.1	230	6.0	R-	50	250		
280047	GA	SSI	70	68	1710		1012.4	200	6.0	F	31			
280054	GA	VLD	74	72	2806		1011.7	300	3.0	TRW-	14			
S280107	GA	VLD			2808		1012.1	300	1.0	TRW	14			
S280124	GA	VLD			2208		1011.7	310	7.0	TRW-	75	15		
280055	GA	LSF	56	47	3108		1013.4	310	7.0		32	10		
280055	GA	MGE	50	43	3206		1012.1	310	7.0	L-	35	12		
280057	GA	VAD	73	70	2204		1012.1	213	7.0	TRW-	50	20	90	
280055	GA	WRB	60	59	3108		1011.1	310	7.0	RW-	20	8		
280047	GA	PDK	53	48	2908		1011.4	213	15.0		13	4	30	
280148	GA	RMG	50	46	2502									
280150	GA	FTY	51	48	0000		1012.1	300	7.0		40			
280152	GA	ATL	51	47	3006		1011.7	300	10.0		28			
S280140	GA	AHN			2514		1011.1	310	6.0	R-F	20	9		
280153	GA	AHN	53	49	2912		1011.1	310	7.0		22	9		
S280217	GA	AHN			2812		1010.7	310	7.0		30	9		
280152	GA	AGS	70	66	1910		1008.4	223	10.0		39	80	250	
280154	GA	CSG	54	49	3306		1013.8	300	7.0		28			
S280132	GA	MCN			3108		1011.7	230	6.0	RW-F	8	15		
280153	GA	MCN	57	56	3110		1012.4	230	6.0	RW-F	8	15		
280148	GA	ABY	58	58	3409		1012.1	310	10.0		45	25		
280151	GA	SAV	72	69	1812		1011.7	213	20.0		130	40	250	
S280224	GA	AMG			1504		1010.4	220	7.0	T	50	156		
280147	GA	SSI	70	68	1610	17	1012.1	230	5.0	FH	100	250		
280150	GA	VLD	74	72	1906		1011.7	230	7.0	T	31	75		
S280212	GA	VLD			1806		1011.7	310	7.0		60	30		
S280220	GA	LSF			2706		1015.1	300	7.0	R-	30			
280155	GA	MGE	50	43	3004		1011.4	310	7.0	L-	38	12		
S280210	GA	MGE			3004		1011.7	310	7.0		38	9		
S280229	GA	MGE			3004		1011.7	310	7.0	L-	38	9		
280155	GA	VAD	71	78	1802		1011.4	300	7.0	TRW-	50			
S280212	GA	VAD			1404		1011.7	300	7.0		50			
280155	GA	WRB	58	58	3208		1011.7	310	7.0	RW-	20	8		
280147	GA	PDK	52	48	3104		1010.7	311	15.0		45	4	10	
280248	GA	RMG	49	43	3004									
280250	GA	FTY	50	48	1806		1012.4	230	7.0		11	40		
S280302	GA	FTY			2706		1013.1	300	2.0	R-F	11			
S280315	GA	FTY			2304		1013.1	230	3.0	R-F	11	50		
280249	GA	ATL	51	47	2804		1011.7	300	10.0		28			.00
280249	GA	AHN	52	48	2708		1010.7	300	7.0		30			.16
S280232	GA	AGS			3117	21	1009.7	300	5.0	RW-F	17			
280253	GA	AGS	60	60	2914		1010.4	310	6.0	RW-F	31	11		.03
280254	GA	CSG	53	50	3004		1014.1	300	6.0	R-	28			.05
S280239	GA	MCN			3108		1013.1	310	7.0		20	8		
280253	GA	MCN	53	51	3204		1012.8	310	7.0		25	10		.12
280248	GA	ABY	58	57	3306		1012.4	210	10.0		45	25		.00
280252	GA	SAV	71	69	1908		1011.4	213	20.0		130	40	250	.00
S280317	GA	SAV			2012		1011.4	223	10.0	RW-	15	130	250	
280250	GA	AMG	71	69	1804		1010.7	010	7.0	T		50		
S280232	GA	SSI			1714		1012.1	300	4.0	TFH	50			
280247	GA	SSI	70	69	1614		1012.1	300	4.0	TFH	50			
280250	GA	VLD	74	72	1804		1011.4	010	7.0			30		
S280235	GA	LSF			3002		1014.5	300	7.0		30			
280255	GA	LSF	54	48	3002		1014.1	300	7.0		30			.00
280255	GA	MGE	50	43	3104		1011.7	310	7.0	R-	35	8		.00
280255	GA	VAD	70	68	1504		1011.7	200	7.0		30			.00
280247	GA	PDK	52	48	2804		1011.1	311	15.0		60	4	10	
280348	GA	RMG	48	42	3002									
S280335	GA	FTY			2606		1012.8	230	5.0	F	6	45		

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280350	GA	FTY	49	48	2506		1012.4	230	5.0	F	11	45		
280353	GA	ATL	50	47	2804		1012.4	310	7.0		28	8		
280349	GA	AHN	51	49	2408		1011.4	300	7.0	R-	34			
280349	GA	AGS	58	56	2908		1010.7	230	10.0		27	100		
280346	GA	CSG	53	49	2706		1014.1	300	6.0	R-	28			
280348	GA	MCN	53	51	3005		1013.4	310	7.0	R-	28	12		
280348	GA	ABY	54	52	3410		1013.8	311	10.0		40	15	25	
S280415	GA	ABY			3309		1014.5	212	10.0	R-	20	15	40	
280354	GA	SAV	72	70	1914	19	1011.1	213	20.0		130	15	250	
280349	GA	SSI	71	69	1910	19	1012.4	310	6.0	TF	50	19		
S280401	GA	SSI			2316	27	1013.1	230	4.0	TRW-F	19	50		
S290424	GA	SSI			2114		1012.8	310	6.0	TL-F	40	19		
S280337	GA	VLD			2208		1011.7	200	4.0	F	7			
280350	GA	VLD	74	72	2210		1011.7	200	6.0	F	7			
280355	GA	LSF	54	48	2802		1014.5	300	7.0		30			
280355	GA	MGE	49	43	2808		1012.1	310	4.0	L-F	35	8		
280355	GA	WRB	54	52	3404		1013.1	300	7.0		20			
S280426	GA	WRB			3304		1012.8	230	6.0	L-F	22	32		
280347	GA	PDK	51	47	3006		1011.1	230	8.0		5	40		
280448	GA	RMG	47	41	3004									
280450	GA	FTY	48	47	2910		1013.1	230	7.0		14	45		
280451	GA	ATL	49	46	3010		1012.4	310	7.0		28	8		
280447	GA	AHN	51	49	2409		1011.4	300	5.0	R-	37			
280448	GA	AGS	57	56	2910	17	1010.4	300	10.0	RW-	15			
280447	GA	CSG	52	50	2506		1015.1	300	7.0		16			
280450	GA	MCN	53	51	2704		1012.8	310	5.0	R-F	28	12		
280448	GA	ABY	53	52	3602		1013.8	310	10.0		26	15		
S280502	GA	ABY			3106		1014.1	230	2.0	TRW	15	26		
S280524	GA	ABY			3004		1014.1	310	3.0	RW-F	26	15		
280452	GA	SAV	74	71	1816	23	1011.1	210	20.0		110	15		
280452	GA	SSI	68	67	2510		1012.4	310	6.0	TL-F	40	12		
S280521	GA	SSI			3004		1012.1	300	6.0	TRW-F	29			
S280436	GA	VLD			3006		1012.1	210	7.0		250	7		
280450	GA	VLD	65	63	3412		1012.4	230	7.0		9	250		
280455	GA	LSF	54	48	3008		1014.8	300	7.0		30			
280455	GA	VAD	67	63	3008		1012.8	212	7.0		70	25	250	
280455	GA	WRB	54	52	2804		1013.1	213	6.0	L-F	20	12	32	
280548	GA	RMG	47	39	3004									
280550	GA	FTY	46	44	2810		1013.8	230	7.0		[illegible]	45		.07
S280539	GA	ATL			3010		1012.4	310	8.0		14	9		
280551	GA	ATL	48	44	2910	17	1013.1	300	8.0		13			.00
280551	GA	AHN	50	48	2408		1010.7	300	7.0		37			
280548	GA	AGS	55	51	2704		1010.4	300	15.0		28			
280551	GA	CSG	51	47	2910		1015.1	310	12.0		21	15		.05
280552	GA	MCN	53	51	2704		1013.1	310	5.0	R-F	28	12		.13
S280538	GA	ABY			2904		1014.1	310	5.0	R-F	30	26		
280549	GA	ABY	51	51	2802		1014.1	300	5.0	R-F	30			.18
280551	GA	SAV	73	70	2014		1010.7	211	10.0		250	15	90	.01
S280534	GA	SSI			2506		1012.1	230	3.0	TRWF	13	29		
S280534	GA	SSI			2506		1012.1	230	3.0	TRWF	13	29		
280551	GA	SSI	68	67	2408		1012.1	230	3.0	TRW-F	13	29		.17
280553	GA	VLD	63	61	3408		1012.4	230	7.0		9	250		1.80
280555	GA	LSF	52	44	3008			300	7.0		30			.00
280558	GA	VAD	65	60	3106		1012.8	300	7.0		30			.60
S280540	GA	WRB			2704		1013.1	230	6.0	F	24	35		
280555	GA	WRB	54	52	2904		1012.8	230	6.0	F	24	35		.00
280648	GA	RMG	46	36	2108									
280647	GA	FTY	45	43	3110		1013.1	230	6.0	R-	20	45		
280650	GA	ATL	46	44	2910		1013.1	310	8.0	R-	11	8		
S280722	GA	ATL			2910		1012.4	310	8.0		22	12		
280647	GA	AGS	53	51	2708		1010.4	300	6.0	RW-	29			
280651	GA	CSG	48	42	3014	19	1015.8	310	15.0		28	20		

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S280716	GA	CSG			3012		1015.8	310	15.0		45	18		
280654	GA	MCN	53	50	2808		1013.1	311	6.0	F	32	9	13	
280648	GA	ABY	51	51	2704		1014.1	300	7.0		23			
280650	GA	SSI	68	67	1906		1011.4	310	6.0	F	40	26		
280651	GA	VLD	61	58	3510		1012.8	230	7.0		9	250		
S280723	GA	VLD			3510		1012.8	300	7.0		12			
S280645	GA	LSF			2910		1015.5	300	7.0		24			
280655	GA	LSF	50	40	3010	16	1015.8	230	7.0		24	45		
280658	GA	VAD	61	56	3210		1013.4	300	5.0	L-F	25			
280655	GA	WRB	54	51	2812		1013.1	230	6.0	F	25	35		
280748	GA	RMG	44	32	3004									
280751	GA	FTY	45	42	2912		1014.1	220	7.0		20	50		
280749	GA	ATL	45	42	2908		1013.8	213	10.0		18	12	80	
280752	GA	AHN	49	44	2712		1011.1	300	10.0		14			
280748	GA	AGS	52	51	2306		1010.4	300	8.0	RW-	32			
280750	GA	CSG	48	42	2910		1016.1	310	15.0		50	18		
280750	GA	MCN	52	48	2706		1013.8	310	6.0	F	45	14		
S280742	GA	ABY			2606		1014.8	300	10.0		14			
S280742	GA	ABY			2606		1014.8	300	10.0		14			
280749	GA	ABY	51	51	2606		1014.8	300	10.0		14			
280750	GA	SAV	70	68	2310		1010.0	212	10.0		30	10	250	
S280805	GA	SAV			2410		1010.0	300	10.0		9			
280749	GA	SSI	69	67	2006		1011.1	200	6.0	F	40			
280752	GA	VLD	57	52	3410		1013.8	300	7.0		12			
S280733	GA	LSF			3010		1016.1	310	7.0		50	24		
280755	GA	LSF	50	40	2908		1016.1	200	7.0		50			
280755	GA	VAD	59	52	3006		1014.1	300	5.0	R-F	25			
280755	GA	WRB	53	48	2910		1013.4	230	6.0	F	28	35		
S280821	GA	WRB			3010	16	1013.4	310	6.0	F	32	22		
280848	GA	RMG	42	32	2906									
280850	GA	FTY	43	38	2814		1014.5	200	7.0		25			
280851	GA	ATL	44	38	3012		1014.1	310	12.0		80	20		.02
S280837	GA	AHN			2912	17	1011.7	300	10.0		19			
280854	GA	AHN	47	42	2912	17	1012.1	300	10.0		22			
280849	GA	AGS	52	51	2108		1010.4	300	15.0		40			
280850	GA	CSG	48	41	3012		1016.8	310	15.0		50	21		.00
280853	GA	MCN	50	43	3216	21	1014.5	310	7.0		45	25		.00
S280836	GA	ABY			3012		1015.1	310	10.0		40	4		
280849	GA	ABY	50	46	2914		1015.5	310	10.0		40	4		.00
280850	GA	SAV	63	59	2812		1011.4	230	15.0		12	30		.00
S280920	GA	SAV			2914		1011.7	300	15.0		20			
280847	GA	SSI	71	69	2210		1011.1	300	6.0	F	50			.00
S280921	GA	SSI			2308		1010.7	230	5.0	F	11	50		
280852	GA	VLD	54	53	3306		1014.1	300	5.0	R-F	14			.00
280855	GA	LSF	49	39	2908		1017.2	230	7.0		30	50		.00
280855	GA	VAD	58	53	3006		1014.8	200	5.0	R-F	15			.00
280855	GA	WRB	52	45	3114		1014.1	310	7.0		30	22		.00
280948	GA	RMG	40	32	2704									
280950	GA	FTY	42	37	2812		1015.5	200	7.0		40			
280950	GA	ATL	43	36	3010		1015.1	200	12.0		80			
280950	GA	AHN	46	38	2810	17	1012.4	300	10.0		28			
S281026	GA	AHN			2712	19	1012.8	310	10.0		55	28		
280947	GA	AGS	52	50	2008		1010.7	310	15.0		55	15		
280952	GA	CSG	46	37	3014		1018.2	200	15.0		60			
280950	GA	MCN	50	44	3212	17	1015.1	310	7.0		45	25		
280948	GA	ABY	48	43	3012		1016.5	300	10.0		40			
280951	GA	SAV	60	53	2914		1012.1	300	15.0		23			
280950	GA	SSI	65	63	2810		1011.4	230	4.0	RW-F	13	40		
S281015	GA	SSI			3010		1012.1	230	3.0	F	5	13		
S281027	GA	SSI			2910		1012.4	300	3.0	F	8			
280951	GA	VLD	54	52	3306		1014.8	300	6.0	RW-F	16			
280955	GA	LSF	48	38	3012		1018.2	200	7.0		60			

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280956	GA	MGE	42	31	3008		1014.8	210	13.0		60	15		
260955	GA	VAD	58	51	2904		1015.1	230	6.0	R-F	15	30		
S281006	GA	VAD			2904		1015.5	230	6.0	F	15	30		
280955	GA	WRB	50	43	3012	17	1014.8	213	7.0		30	12	80	
281048	GA	RMG	39	32	2904									
281050	GA	FTY	40	36	2810		1016.5	000	10.0					
281049	GA	ATL	41	36	3010		1016.1	000	15.0					
281051	GA	AHN	44	36	2712	17	1013.4	200	15.0		55			
281049	GA	AGS	51	48	2510		1012.1	310	12.0		65	22		
281050	GA	CSG	45	36	3012		1019.2	010	15.0			60		
281050	GA	MCN	48	38	3012		1016.1	211	10.0		85	25	45	
281048	GA	ABY	47	42	2714		1018.2	300	10.0		32			
281050	GA	SAV	55	53	2908		1012.8	300	7.0	R-	30			
281102	GA	AMG	54	51	2706		1014.5	300	6.0	R-	12			
281047	GA	SSI	58	55	3114		1012.8	310	4.0	F	12	8		
S281110	GA	SSI			3010		1013.4	230	4.0	F	10	170		
281052	GA	VLD	53	51	3206		1016.5	300	6.0	RW-F	18			
S281111	GA	VLD			3210	19	1016.8	310	7.0		60	18		
281055	GA	LHW	54	51	2906		1013.4	213	3.0	F	25	15	100	
S281120	GA	LHW			2804		1013.8	213	3.0	R-F	25	15	100	
281055	GA	LSF	46	34	2908		1019.9	010	7.0			60		
281055	GA	MGE	40	30	2908		1015.8	011	13.0			15	70	
S281040	GA	VAD			2706		1015.8	213	4.0	R-F	15	5	30	
281055	GA	VAD	57	52	2908		1016.5	213	5.0	R-F	15	5	30	
S281115	GA	VAD			2910		1017.2	213	6.0	F	15	5	30	
281055	GA	WRB	50	39	3116		1016.5	213	7.0		30	12	80	
281149	GA	RMG	39	32	2704									.07
281151	GA	FTY	39	36	2812		1017.5	000	7.0					.01
S281200	GA	ATL			2910		1012.4	310	8.0		22	12		
281151	GA	ATL	40	35	2906		1017.2	000	15.0					.02
S281200	GA	AHN			2712	19	1012.8	310	10.0		55	28		
281153	GA	AHN	43	34	2912	19	1015.1	010	15.0			55		.00
281151	GA	AGS	50	43	2912		1013.8	230	10.0		25	75		.00
281152	GA	CSG	44	36	2808		1020.2	000	15.0					.00
281152	GA	MCN	46	34	3012		1018.2	210	10.0		75	25		.00
281149	GA	ABY	47	39	3208		1019.5	200	10.0		40			.00
281151	GA	SAV	54	51	2910		1013.8	213	7.0	R-	35	15	100	.07
281151	GA	AMG	53	51	2710		1015.8	300	7.0		12			
S281225	GA	AMG			2712		1016.8	310	7.0		40	15		
281150	GA	SSI	56	52	3012	17	1014.5	230	7.0		10	25		.05
S281230	GA	SSI			3012	19	1015.5	230	7.0		5	10		
281152	GA	VLD	51	42	3210	17	1017.8	300	7.0		60			.84
S281140	GA	LHW			2908		1014.1	211	3.0	R-F	40	15	25	
281155	GA	LHW	54	50	2806		1014.1	213	3.0	R-F	40	15	80	
S281210	GA	LHW			2810	14	1014.8	223	3.0	R-F	17	40	80	
281155	GA	ISF	43	32	2702		1020.5	010	7.0			60		.00
281156	GA	MGE	39	30	2908		1016.8	011	13.0			15	65	.00
281155	GA	VAD	55	46	2909		1017.8	213	7.0		25	15	40	.03
S281210	GA	VAD			3110		1018.5	211	7.0		40	15	25	
281155	GA	WRB	49	34	3010		1017.8	212	7.0		30	20	80	.00
281153	GA	PDK	42	37	2506		1019.5	010	11.0			8		
272350	KY	CVG	42	37	2314		1010.0	310	10.0		45	24		.02
272350	KY	SDF	43	38	2706		1011.1	300	7.0		28			.01
272348	KY	BWG	43	41	2508		1012.8	210	7.0		80	30		.06
272347	KY	LOZ	47	45	2310		1011.7	230	7.0	R-	10	30		.27
272350	KY	PAH	42	33	2104		1013.4	010	12.0			80		.00
272355	KY	FTK	46	37	2406		1011.4	230	7.0		30	80		
272355	KY	HOP	42	37	2402		1013.8	210	7.0		80	40		.00
272355	KY	LOU	44	37	2610		1012.4	213	7.0		25	8	40	
272350	KY	OWB	42		2306		1012.4	010	10.0			26		
272350	KY	5I3	52	45	2804									

Date/ Time	St	Stn ID	T	TD	Wind	Gst	Stn Pres	Cld Amt	Vis	Wx	Cld Hgt Low/	Mid/	Hi	Precip Amt
280050	KY	CVG	42	34	2610		1010.4	310	10.0		40	27		
280050	KY	SDF	43	36	2508		1011.4	200	7.0		28			
280052	KY	LEX	41	38	2508		1010.7	230	8.0		15	37		
280053	KY	BWG	42	41	2504		1013.4	011	7.0			30	80	
280049	KY	LOZ	47	44	2406		1011.4	310	5.0	R-F	25	10		
280050	KY	PAH	38	33	2006		1013.8	010	12.0			80		
280055	KY	HOP	38	35	2104		1013.8	011	7.0			80	250	
280054	KY	LOU	44	36	2506		1012.8	200	7.0		25			
280050	KY	OWB	41		2308		1012.4	000	10.0					
280049	KY	5I3	51	44	2504									
280150	KY	CVG	40	33	2410		1010.4	220	10.0		33	55		
280150	KY	SDF	41	34	2406		1011.4	010	7.0			28		
280152	KY	LEX	41	37	2710		1010.7	213	8.0		35	14	100	
280150	KY	BWG	40	39	2504		1013.4	010	7.0			30		
280150	KY	PAH	37	33	2106		1014.1	000	12.0					
280155	KY	HOP	38	35	0000		1014.1	011	7.0			100	250	
280155	KY	LOU	42	35	2408		1012.8	200	7.0		25			
280150	KY	OWB	40		2308		1012.4	000	10.0					
280149	KY	5I3	49	44	1300									
280250	KY	CVG	40	33	2510		1010.4	200	10.0		49			.00
280250	KY	SDF	38	34	2208		1011.1	000	7.0					.00
280254	KY	LEX	39	35	2406		1011.4	210	8.0		100	45		.00
280248	KY	BWG	39	38	2406		1013.4	000	7.0					.00
280250	KY	PAH	38	29	2506		1014.5	000	12.0					.00
280255	KY	FTK	41	33	2104		1011.7	000	7.0					.00
280255	KY	HOP	37	35	2104		1014.1	010	7.0			250		.00
280252	KY	LOU	40	35	2106		1012.8	010	7.0			25		
280250	KY	OWB	40		2408		1012.8	000	10.0					
280249	KY	5I3	49	44	0000									
280350	KY	CVG	39	31	2312		1010.0	010	10.0			55		
280350	KY	SDF	40	34	2408		1011.1	000	7.0					
280354	KY	LEX	37	34	2406		1011.1	000	10.0					
280346	KY	BWG	39	38	2404		1013.4	000	7.0					
280352	KY	PAH	40	27	2506		1014.8	000	12.0					
280355	KY	HOP	37	34	2404		1014.1	010	7.0			250		
280350	KY	LOU	40	35	2406		1012.8	000	7.0					
280350	KY	OWB	38		2408		1012.8	000	10.0					
280349	KY	5I3	49	45	2902									
280446	KY	CVG	38	29	2514		1010.4	010	10.0			60		
280450	KY	SDF	39	34	2506		1011.4	000	7.0					
280450	KY	LEX	37	34	2308		1011.1	000	10.0					
280446	KY	BWG	38	37	2506		1013.4	000	7.0					
280450	KY	PAH	38	28	2704		1015.1	000	12.0					
280455	KY	FTK	41	33	2304		1011.7	000	7.0					
280455	KY	HOP	38	35	2406		1014.5	010	7.0			250		
280450	KY	LOU	39	34	2408		1012.8	000	7.0					
280449	KY	5I3	47	43	2904									
280551	KY	CVG	36	30	2208		1010.4	200	10.0		60			.00
280550	KY	SDF	39	33	2408		1011.4	000	7.0					.00
280550	KY	LEX	36	33	2508		1011.1	000	10.0					.00
280546	KY	BWG	37	36	2404		1013.4	000	7.0					.00
280549	KY	PAH	38	28	2808		1015.5	000	12.0					.00
280555	KY	FTK	41	32	2304		1011.7	000	7.0					.00
280555	KY	HOP	38	34	2404		1014.8	000	7.0					.00
280551	KY	LOU	38	34	2208		1012.4	000	10.0					
280555	KY	5I3	41	36	2906									
280650	KY	CVG	36	30	2208		1009.7	200	10.0		55			
280650	KY	SDF	38	33	2308		1011.1	010	7.0			28		
280650	KY	LEX	36	34	2210		1010.7	010	10.0			40		
280651	KY	BWG	37	35	2606		1013.4	000	7.0					
280648	KY	PAH	38	28	2706		1015.5	000	12.0					
280655	KY	FTK	41	31	2506		1011.7	000	7.0					

Date/ Time	St	Stn ID	T	TD	Wind	Gst	Stn Pres	Cld Amt	Vis	Wx	Cld Hgt Low	Mid	Hi	Precip Amt
280655	KY	HOP	39	32	2704		1014.5	000	7.0					
280650	KY	LOU	37	33	2108		1012.4	000	10.0					
280649	KY	5I3	42	35	2802									
280750	KY	CVG	36	30	2210		1009.7	200	10.0		55			
280750	KY	SDF	37	30	2612		1011.4	010	7.0			28		
280750	KY	LEX	35	33	2306		1010.7	000	10.0					
280752	KY	BWG	35	33	2804		1013.8	000	7.0					
280747	KY	PAH	37	28	2908		1016.1	000	12.0					
280755	KY	FTK	40	28	2606		1011.7	000	7.0					
280755	KY	HOP	38	31	2706		1015.1	000	7.0					
280750	KY	LOU	37	32	2410		1012.8	010	10.0			30		
280749	KY	5I3	42	35	2604									
280851	KY	CVG	36	29	2512		1009.4	200	10.0		55			.00
280850	KY	SDF	36	28	2710		1011.4	010	7.0			25		.00
280850	KY	LEX	35	32	2408		1010.7	000	10.0					.00
280849	KY	BWG	35	31	2504		1014.1	000	7.0					.00
280848	KY	PAH	37	27	2908		1016.5	310	12.0		46	33		.00
280855	KY	FTK	39	27	2406		1011.7	000	7.0					.00
280855	KY	HOP	36	30	2404		1015.1	000	7.0					.00
280850	KY	LOU	36	29	2508		1012.8	010	10.0			30		
280849	KY	5I3	43	35	2500									
280950	KY	CVG	36	29	2512	17	1009.7	300	10.0		55			
280950	KY	SDF	37	29	2808		1011.7	230	7.0		22	45		
280950	KY	LEX	34	31	2510		1010.7	000	10.0					
280955	KY	BWG	34	31	2504		1014.1	000	7.0					
280947	KY	PAH	36	23	2917	29	1016.5	300	10.0		43			
280955	KY	FTK	39	27	2504		1012.1	010	7.0			30		
280955	KY	HOP	37	30	2706		1015.5	010	7.0			36		
280950	KY	LOU	37	29	2612		1012.8	300	10.0		30			
280949	KY	5I3	41	35	2700									
281050	KY	CVG	35	26	2816		1010.0	300	7.0		38			
281050	KY	SDF	36	26	2814		1012.1	230	7.0	SW-	22	38		
281050	KY	LEX	33	29	2408		1011.1	000	10.0					
281050	KY	BWG	35	28	3506		1014.5	300	7.0		30			
281055	KY	LOZ	34	32	2206		1013.1	010	7.0			10		
281048	KY	PAH	35	22	2814	23	1017..	00	10.0		37			
281055	KY	FTK	40	26	2706		1012.8	200	7.0		30			
281055	KY	HOP	37	31	2606		1015.8	200	7.0		40			
281052	KY	LOU	37	28	2710		1013.4	230	10.0		19	30		
281049	KY	5I3	42	33	2300									
281151	KY	CVG	33	26	2716		1010.7	300	7.0	SW-	40			.00
281150	KY	SDF	35	25	2916		1013.1	300	5.0	SW-	28			.00
281150	KY	LEX	33	28	2408		1011.4	200	10.0		40			.00
281153	KY	BWG	35	31	2604		1015.1	300	7.0		30			.00
281150	KY	LOZ	34	32	2308		1014.1	010	7.0			5		.05
281148	KY	PAH	34	23	2916		1018.2	300	10.0		34			.00
281155	KY	HOP	38	29	2712	21	1016.5	310	7.0		40	25		.00
281155	KY	LOU	34	27	2910		1014.5	300	6.0	SW-	30			
281152	KY	OWB	33		2912	21	1015.5	300	10.0	SW-	35			
281150	KY	5I3	40	32	2402									.85
272349	NC	ECG	66	66	1916		1012.4	300	4.0	RF	50			
S272334	NC	GSO			2512		1009.0	213	4.0	R-F	20	7	45	
272350	NC	GSO	58	57	2410		1008.7	230	4.0	R-F	7	20		1.11
272346	NC	INT	58		2308		1009.4	230	3.0	R-F	4	10		
S280019	NC	HKY			2104		1009.0	230	1.0	TRF	4	15		
272353	NC	HKY	54	53	1304		1008.7	230	1.5	R-F	4	15		.23
S280025	NC	AVL			0210		1010.0	213	6.0	R-F	15	5	22	
272350	NC	AVL	53	52	3104		1010.0	213	3.0	R-F	11	4	22	.12
272350	NC	RDU	61	59	1506		1009.0	220	7.0		35	47		.04
272350	NC	HAT	70	65	1906		1014.8	230	7.0		15	90		.00
272350	NC	EWN	70	66	2012		1013.8	213	7.0		29	20	200	.25

Date/ Time	St	Stn ID	T	TD	Wind	Gst	Stn Pres	Cld Amt	Vis	Wx	Cld Hgt Low	Mid	Hi	Precip Amt
272346	NC	FAY	72	69	1808		1010.0	200	7.0		250			
272355	NC	CLT	57	56	1304		1009.0	310	4.0	F	32	3		.15
272352	NC	ILM	70	68	1912		1012.4	213	7.0		25	8	250	.05
272355	NC	FBG	74	66	1602		1009.7	012	7.0			50	250	.00
272355	NC	GSB	71	67	1808		1010.7	230	7.0		15	100		
272356	NC	NCA	69	65	1516		1013.1	213	6.0	F	20	10	70	.33
272355	NC	NKT	70	65	1706		1013.4	230	5.0	F	4	70		
272355	NC	POB	74	65	1704		1009.4	210	7.0		250	30		
272350	NC	RWI	71	67	1810	14	1010.0	220	7.0		15	25		.00
280046	NC	ECG	66	66	1714		1011.4	300	10.0		10			
280053	NC	GSO	58	57	1904		1007.3	230	7.0		7	20		
280045	NC	INT	57		2310		1007.7	300	2.5	F	3			
280100	NC	HKY	54	53	2908		1043.6	300	1.0	TRWF	13			
280050	NC	AVL	53	52	3610		1009.4	213	6.0	R-F	15	5	24	
280052	NC	RDU	69	66	1912		1008.4	230	7.0		60	150		
280050	NC	HAT	70	67	2016		1014.5	230	7.0		15	90		
280050	NC	EWN	70	67	2014	19	1013.1	213	7.0		75	9	200	
280046	NC	FAY	71	69	1912		1009.7	210	7.0		250	15		
280050	NC	CLT	58	56	1404		1008.0	230	3.0	F	3	40		
280050	NC	ILM	70	68	1814		1012.1	310	7.0		17	9		
280055	NC	FBG	73	66	1804		1009.4	211	7.0		250	20	50	
280055	NC	GSB	72	67	1710	17	1010.0	230	7.0		15	100		
280056	NC	NCA	70	65	1514	23	1012.8	213	7.0	R-	23	10	70	
280055	NC	NKT	70	66	2114		1012.8	312	5.0	F	3	4	6	
280057	NC	POB	71	67	2008		1009.0	012	7.0			20	250	
280145	NC	ECG	67	66	1819		1010.7	230	10.0		10	150		
280150	NC	GSO	58	57	1804		1006.7	230	5.0	R-F	5	16		
S280207	NC	GSO			1304		1006.0	230	5.0	TR-F	5	20		
280145	NC	INT	57		2008		1006.7	300	2.0	RF	2			
S280205	NC	INT			3012	25	1008.0	300	.1	TR+F	0			
280150	NC	HKY	54	53	1706		1009.0	230	3.0	R-F	5	30		
280150	NC	AVL	50	48	3617		1010.4	213	6.0	R-F	15	7	20	
280150	NC	RDU	69	66	1808		1007.3	200	7.0		12			
280150	NC	HAT	70	67	2010		1013.4	011	7.0			15	90	
280151	NC	EWN	71	67	2112	21	1012.4	223	7.0		9	30	65	
280149	NC	FAY	71	69	1814		1008.7	210	7.0		200	15		
S280134	NC	CLT			1404		1007.0	310	4.0	F	40	3		
280150	NC	ILM	71	69	1814	21	1010.7	210	7.0		24	10		
280155	NC	FBG	73	67	1804		1008.7	310	7.0		250	30		
280155	NC	GSB	72	67	1710	17	1009.7	230	7.0		15	100		
S280135	NC	NCA			1516	23	1012.1	213	7.0		23	12	70	
280156	NC	NCA	71	66	1612	23	1011.7	311	7.0		250	13	30	
280155	NC	NKT	71	66	1808	19	1012.1	213	5.0	F	6	4	30	
S280218	NC	NKT			1710	16	1011.7	210	5.0	F	30	4		
280158	NC	POB	71	68	1810		1008.4	210	7.0		250	20		
280245	NC	ECG	67	66	1819		1010.4	230	10.0		10	150		
S280238	NC	GSO			2712		1008.0	300	1.5	TR+F	5			
280250	NC	GSO	57	56	3008		1007.3	300	1.5	TRF	5			.40
S280315	NC	GSO			2708		1007.7	300	7.0		35			
S280300	NC	INT							25.0					
280245	NC	INT	56		2006		1007.7	300	5.0	RF	6			
280250	NC	HKY	54	53	0000			213	7.0		20	5	35	.00
S280324	NC	HKY			2406		1009.4	233	2.0	F	2		32	
280250	NC	AVL	47	45	3514		1010.7	213	6.0	R-F	15	8	24	.25
280250	NC	RDU	70	66	1910		1007.7	230	7.0		14	70		.00
280250	NC	HAT	71	66	2010		1012.8	230	7.0		15	90		.02
280250	NC	EWN	72	67	1912	19	1011.7	211	7.0		200	13	28	.00
280250	NC	CLT	58	55	2404		1008.7	310	6.0	RW-F	23	3		.11
280250	NC	ILM	71	69	1814	21	1011.1	300	7.0		28			.00
280255	NC	FBG	73	67	1808		1009.0	213	7.0		30	10	250	.00
S280310	NC	FBG			1902		1009.0	213	7.0		19	10	250	
280255	NC	GSB	72	68	1808	16	1009.4	230	7.0		18	100		.00

Date/ Time	St	Stn ID	T	TD	Wind	Gst	Stn Pres	Cld Amt	Vis	Wx	Cld Hgt Low	Mid	Hi	Precip Amt
280256	NC	NCA	72	66	1716	27	1011.1	213	7.0		28	12	250	.00
280255	NC	NKT	72	67	1708		1011.4	212	5.0	F	45	6	100	.00
S280245	NC	POB			1908		1008.4	220	7.0		18	250		
280255	NC	POB	71	68	1814	19	1008.7	220	7.0		18	250		.00
280350	NC	GSO	57	56	2406		1007.0	300	7.0	R-	20			
S280402	NC	GSO			2304		1007.0	230	7.0	R-	5	20		
280355	NC	HKY	54	54	0000		1008.7	233	2.0	R-F	3		32	
280350	NC	AVL	46	44	3610		1010.4	213	6.0	R-F	15	8	22	
280350	NC	RDU	71	66	2012		1007.3	230	7.0		20	55		
280350	NC	HAT	72	66	2012		1012.8	300	7.0		15			
280350	NC	EWN	73	68	1914	23	1011.7	223	7.0		15	27	75	
280346	NC	FAY	73	69	2008		1008.7	220	7.0		15	250		
280350	NC	CLT	58	56	2204		1008.4	310	6.0	RW-F	29	3		
280350	NC	ILM	73	69	2014	19	1011.1	300	7.0		14			
280355	NC	FBG	74	67	1704		1008.4	230	7.0		17	250		
280355	NC	GSB	73	68	1910		1008.7	220	7.0		20	100		
280356	NC	NCA	73	67	1714	27	1011.4	310	7.0		16	10		
S280401	NC	NCA			1716	23	1011.4	310	7.0	R-	16	10		
280355	NC	NKT	73	67	1810	17	1011.4	300	7.0		33			
280355	NC	POB	72	68	2012		1008.0	213	7.0		18	10	250	
280450	NC	GSO	56	56	2606		1007.0	230	4.0	RF	4	20		
280445	NC	INT			2404		1007.7	310	2.0	R-F	4	1		
S280433	NC	HKY			2802		1008.7	230	2.0	F	7	22		
280456	NC	HKY	54	53	2706		1008.7	212	7.0		7	2	22	
280450	NC	AVL	46	44	3408		1009.7	310	5.0	R-F	22	8		
280450	NC	RDU	71	66	1914		1006.7	230	7.0		19	60		
280450	NC	HAT	73	67	2010		1011.7	300	7.0		15			
280446	NC	EWN	74	68	2014	23	1011.1	223	6.0	R-	16	29	100	
280446	NC	FAY	73	69	2010		1008.0	212	7.0		30	15	250	
S280435	NC	CLT			2006		1008.4	310	3.0	RW-F	29	3		
280450	NC	CLT	57	56	2008		1008.7	230	3.0	RWF	5	35		
280450	NC	ILM	73	69	1914		1010.0	300	7.0		14			
280455	NC	FBG	74	68	1704		1007.7	230	7.0		23	250		
280455	NC	GSB	74	68	1910	17	1008.0	200	7.0		25			
280456	NC	NCA	72	67	1816	23	1010.7	230	7.0		13	250		
S280440	NC	NKT			1812	17	1011.1	310	6.0	R-	30	20		
280455	NC	NKT	74	67	1914	21	1010.7	310	7.0		30	20		
280455	NC	POB	73	68	1808	19	1007.3	222	7.0		18	70	250	
S280535	NC	GSO			2604		1006.7	300	4.0	TR-F	5			
280555	NC	GSO	56	55	2604		1007.0	230	4.0	TR-F	5	32		.87
S280627	NC	GSO			2404		1006.3	230	7.0	R-	5	40		
280545	NC	INT			2804		1007.0	310	2.5	TR-F	4	1		
280555	NC	HKY	54	53	2704		1008.4	230	5.0	F	5	30		.48
280551	NC	AVL	46	44	3510		1009.4	300	10.0		32			.28
280552	NC	RDU	71	65	1508		1005.0	230	6.0	TRW-	20	70		.01
S280604	NC	RDU			2919	33	1004.6	310	.2	TRW+	19	2		
280552	NC	HAT	73	67	2116	19	1011.1	300	7.0		15			.02
280550	NC	EWN	70	69	1912	21	1010.0	230	7.0		17	25		.00
280555	NC	CLT	56	54	2608		1008.0	300	3.0	RW-F	5			.18
280550	NC	ILM	74	70	1910	19	1008.7	300	7.0		14			.00
S280603	NC	ILM			1910	19	1008.4	300	7.0	T	14			
280555	NC	FBG	75	68	2010	17	1006.7	230	7.0		23	250		.00
280555	NC	GSB	74	68	1912	19	1007.0	200	7.0		20			.00
280556	NC	NCA	53	67	1817	27	1009.4	230	7.0	R-	13	250		
S280630	NC	NCA			1816	23	1008.7	230	7.0		12	250		
280555	NC	NKT	74	68	1910	16	1009.4	310	7.0		30	20		.00
280555	NC	POB	74	67	2214	23	1006.7	220	7.0		18	250		.00
280650	NC	GSO	55	55	3006		1006.0	230	4.0	R-F	5	35		
280645	NC	INT			2504		1007.0	310	2.0	R-F	4	1		
280655	NC	HKY	53	51	3204		1008.4	300	5.0	L-F	5			
280650	NC	AVL	46	44	3308		1009.0	300	10.0		50			
S280638	NC	RDU			2710		1006.3	213	7.0	TR-	29	7	70	

Date/ Time	St	Stn ID	T	TD	Wind	Gst	Stn Pres	Cld Amt	Vis	Wx	Cld Hgt Low/Mid/Hi			Precip Amt
280655	NC	RDU	64	62	2404		1006.0	310	7.0		24	8		
280650	NC	HAT	73	68	2019	25	1010.0	300	7.0		15			
280650	NC	EWN	74	69	2212		1009.0	300	7.0		15			
S280725	NC	EWN			2112		1008.4	230	5.0	TR-	10	35		
280655	NC	CLT	56	54	2708		1007.7	300	3.0	RW-F	5			
280650	NC	ILM	74	70	1914	21	1007.3	300	7.0	T	14			
280655	NC	FBG	76	68	2108	14	1006.0	220	7.0		23	250		
280655	NC	GSB	75	69	1910	17	1006.3	222	7.0		21	40	250	
280656	NC	NCA	73	68	1812	19	1008.4	230	7.0	T	10	250		
S280705	NC	NCA			1816	21	1008.4	300	7.0	RW-	10			
S280705	NC	NCA			1816	21	1008.4	300	7.0	TRW-	10			
280655	NC	NKT	74	68	1712	23	1008.4	310	7.0		30	20		
S280730	NC	NKT			1716	27	1007.7	310	7.0	T	30	20		
S280632	NC	POB			2116		1006.0	200	7.0	R-	18			
280655	NC	POB	74	68	2116		1005.6	200	7.0	R-	18			
S280741	NC	GSO			3114		1006.7	310	6.0	R-F	24	10		
S280741	NC	GSO			3114		1006.7	310	6.0	R-F	24	10		
280750	NC	GSO	53	50	3112		1006.7	310	7.0	R-	24	10		
280745	NC	INT			3106		1007.0	300	1.5	R-F	2			
280755	NC	HKY	51	49	3204		1007.3	300	5.0	L-F	5			
280750	NC	AVL	44	42	3414		1008.4	310	6.0	R-	60	30		
280750	NC	RDU	62	61	2408		1006.3	310	10.0		24	11		
280755	NC	HAT	73	68	2016		1008.7	230	7.0		15	150		
280750	NC	EWN	73	69	2112	17	1007.7	300	2.0	TR	13			
S280820	NC	EWN			2512	19	1007.3	300	.2	TR+	1			
280750	NC	CLT	55	54	2408		1007.7	300	3.0	F	5			
S280823	NC	CLT			2104		1007.3	310	5.0	F	48	5		
280752	NC	ILM	73	71	1914	25	1006.7	300	7.0	TRW-	13			
S280810	NC	ILM			2117	25	1006.7	300	1.5	TRW+	9			
280755	NC	FBG	71	65	2914		1005.6	220	7.0		16	250		
S280820	NC	FBG			2504		1005.6	011	7.0			16	250	
280755	NC	GSB	75	68	2010	16	1005.3	222	7.0		25	40	250	
280756	NC	NCA	73	68	2208		1006.3	300	6.0	TRW-	12			
280755	NC	NKT	74	68	1814	23	1006.7	210	7.0	T	30	20		
S280818	NC	NKT			1714	23	1006.0	213	3.0	TRW-F	15	5	30	
S280736	NC	POB			2812		1005.6	210	7.0		14	5		
280755	NC	POB	67	63	2808		1005.6	210	7.0		14	5		
280850	NC	GSO	51	49	3206		1006.3	300	15.0		25			.09
280845	NC	INT			0000		1006.0	300	15.0		14			
280855	NC	HKY	51	48	3204		1007.0	310	7.0		50	5		.00
280850	NC	AVL	41	39	3416		1008.7	310	7.0	R-	32	7		.04
S280838	NC	RDU			2506		1006.0	310	10.0		11	4		
280854	NC	RDU	61	59	2806		1005.6	311	10.0		21	8	15	.49
280853	NC	HAT	74	69	2119	23	1008.0	230	7.0		15	150		.00
280850	NC	EWN	71	69	2312	19	1006.7	300	.5	TR	1			
280851	NC	CLT	55	54	1806		1006.3	310	5.0	F	48	5		.20
S280836	NC	ILM			2212	19	1006.7	300	7.0	TRW-	12			
280850	NC	ILM	72	70	2114	21	1006.7	300	7.0	RW-	12			.00
S280840	NC	FBG			2506		1005.6	200	7.0		24			
280855	NC	FBG	68	61	2606		1005.6	200	7.0		24			.00
280855	NC	GSB	74	68	1808		1004.6	222	7.0		25	40	250	.00
280856	NC	NCA	72	68	2112	19	1006.3	330	.5	TRW	10			.00
S280915	NC	NCA			1916	21	1006.3	210	2.0	TRW-	23	7		
S280915	NC	NCA			1916	21	1006.3	210	2.0	TRW-	23	7		
S280836	NC	NKT			1814	27	1005.3	213	5.0	TF	15	5	30	
280855	NC	NKT	74	68	1814	29	1006.0	213	6.0	F	15	5	30	.00
S280923	NC	NKT			2016	27	1006.0	213	4.0	TRW-F	15	5	30	
280855	NC	POB	66	61	2706		1005.6	300	7.0		14			.00
S280940	NC	GSO			0000		1005.6	300	15.0		31			
280950	NC	GSO	51	48	0000		1005.6	300	15.0		32			
280945	NC	INT	53	51	0000		1005.3	300	15.0		40			
280955	NC	HKY	50	48	2704		1007.7	310	7.0		50	5		

Date/ Time	St	Stn ID	T	TD	Wind	Gst	Stn Pres	Cld Amt	Vis	Wx	Cld Hgt Low	Mid	Hi	Precip Amt
280950	NC	AVL	40	37	3619		1009.4	310	10.0		32	10		
280950	NC	RDU	59	58	2804		1005.3	310	5.0	TRW-	35	20		
S281029	NC	RDU			2306		1006.0	311	5.0	TR-	40	4	11	
280955	NC	HAT	74	69	2017	23	1007.0	213	7.0		50	15	150	
280950	NC	EWN	73	71	2212		1006.7	010	7.0			40		
S280942	NC	CLT			2108		1006.7	230	4.0	F	5	60		
280954	NC	CLT	55	53	2210		1007.0	230	4.0	F	5	60		
280950	NC	ILM	72	70	1914	21	1006.3	300	7.0		13			
280955	NC	FBG	66	59	2610		1005.6	300	7.0		20			
S281012	NC	FBG			2708		1006.3	300	7.0	R-	20			
280955	NC	GSB	74	68	2008	17	1004.3	220	7.0		25	40		
S281024	NC	GSB			2810	19	1004.3	220	6.0	RW-	22	40		
S281024	NC	GSB			2810	19	1004.3	220	6.0	RW-	22	40		
280956	NC	NCA	73	68	1812	21	1006.0	220	7.0		19	30		
S280938	NC	NKT			1814	31	1005.6	213	1.0	TRWF	15	5	30	
280955	NC	NKT	73	68	1819	31	1004.3	213	2.0	TRW-F	15	5	30	
S281009	NC	NKT			1914	35	1006.0	213	7.0		15	5	30	
280955	NC	POB	64	59	2610	16	1005.6	230	7.0		14	30		
S281007	NC	POB			2610	16	1006.0	213	7.0	R-	25	14	50	
S281013	NC	POB												
281053	NC	GSO	50	48	2804		1006.3	230	15.0	R-	38	75		
281045	NC	INT	51	50	2906		1005.6	300	15.0	R-	40			
281055	NC	HKY	48	45	3208		1008.4	310	7.0		30	5		
281050	NC	AVL	37	32	3417		1010.0	300	10.0		75			
281053	NC	RDU	58	57	2610		1006.0	311	5.0	R-F	22	5	9	
281052	NC	HAT	75	69	2023	27	1006.7	310	7.0		50	15		
281050	NC	EWN	73	69	2212	17	1006.7	230	7.0		17	35		
281055	NC	FAY	60	60	2610		1006.7	300	3.0	TR-	7			
S281035	NC	CLT			2310		1007.3	213	5.0	F	13	5	60	
281051	NC	CLT	53	49	2412		1007.3	310	7.0		10	5		
281053	NC	ILM	71	67	2314	23	1006.3	310	7.0		70	16		
281055	NC	FBG	62	57	2608		1006.3	300	6.0	R-	20			
S281116	NC	FBG			2608		1006.7	230	4.0	R-F	12	20		
281055	NC	GSB	67	63	2608		1005.0	213	7.0		40	25	70	
S281100	NC	GSB			2512	17	1005.0	223	7.0		20	40	70	
S281100	NC	GSB			2512	17	1005.0	223	7.0		20	40	70	
281056	NC	NCA	72	66	2016	25	1006.3	220	7.0		12	30		
S281042	NC	NKT			1812	31	1006.0	011	7.0			15	80	
281055	NC	NKT		54				011	7.0			15	80	
281055	NC	POB	60	58	2710		1006.3	213	5.0	R-F	25	4	50	
S281102	NC	POB			2708		1006.3	213	3.0	TRW-F	25	4	50	
S281126	NC	POB			2508		1006.3	230	6.0	RW-F	5	25		
281050	NC	RWI	65	61	2910		1005.0	310	7.0		24	17		
281149	NC	ECG	70	67	1819		1002.9	223	10.0		10	80	150	
S281215	NC	ECG			2019		1002.9	223	12.0	T	10	80	150	
S281200	NC	GSO			0000		1005.6	300	15.0		31			
281150	NC	GSO	50	46	2908		1006.7	300	10.0		36			.09
281151	NC	INT	50		2910		1008.0	200	7.0	L-	35			
S281219	NC	INT			3212		1008.0	300	2.5	RF	8			
281155	NC	HKY	47	43	3212	19	1009.7	300	25.0		40			.02
281150	NC	AVL	36	27	3414		1011.7	011	10.0			40	80	.04
S281138	NC	RDU			3106		1006.3	310	7.0		50	12		
281153	NC	RDU	55	54	3106		1006.7	310	7.0		55	19		.70
S281229	NC	RDU			2904		1007.0	230	2.0	R-F	20	50		
281150	NC	HAT	75	69	2021	27	1007.0	223	7.0		15	50	200	.00
281159	NC	EWN	73	68	2117	23	1006.3	220	7.0		17	65		.85
281146	NC	FAY	58	58	2304		1007.3	300	.7	R	4			
S281200	NC	CLT			2310		1007.3	213	5.0	F	13	5	60	
281152	NC	CLT	52	48	2410		1008.7	300	7.0		10			.20
281150	NC	ILM	70	66	2112		1006.3	213	7.0		80	37	250	.55
S281228	NC	ILM			2312		1006.3	300	7.0		12			
281155	NC	FBG	61	56	2304		1007.0	230	6.0	R-F	12	20		.25

Date/ Time	St	Stn ID	T	TD	Wind	Gst	Stn Pres	Cld Amt	Vis	Wx	Cld Hgt Low	Mid	Hi	Precip Amt
281155	NC	GSB	64	61	2714	19	1006.3	230	7.0	RW-	22	38		.03
S281216	NC	GSB			2610		1006.3	213	2.0	RW-	14	11	35	
S281216	NC	GSB			2610		1006.3	213	2.0	RW-	14	11	35	
S281135	NC	NCA			1810	19	1006.3	211	7.0		80	7	12	
281156	NC	NCA	71	66	1814		1006.0	213	6.0	F	12	7	80	.35
S281226	NC	NCA			2012		1006.0	212	6.0	F	80	12	250	
S281132	NC	NKT			2017	29	1005.6	212	7.0		20	15	200	
281155	NC	NKT	74	66	2217	29	1006.0	212	7.0		20	15	120	
S281132	NC	POB			2408		1006.3	213	7.0		25	5	50	
281155	NC	POB	59	57	2508		1006.7	230	7.0		7	30		.34
S281218	NC	POB			2606		1007.0	230	7.0	L-	7	30		
281150	NC	RWI	61	61	2906		1005.3	310	3.0	RF	11	7		.12
S281230	NC	RWI			3308		1005.6	310	2.0	RF	8	4		
S272338	SC	GSP			2808		1009.4	300	1.0	TRW+	3			
272350	SC	GSP	55	55	2906		1010.0	300	2.0	TRW-	2			.70
S280029	SC	AND			2704		1009.4	310	5.0	F	25	4		
S280029	SC	AND			2704		1009.4	310	5.0	F	25	4		
272350	SC	AND	56	55	2706		1010.0	300	1.0	TRW+	4			
272355	SC	FLO	73	66	2012		1010.4	300	7.0		250			.00
272351	SC	CAE	64	59	1202		1008.7	213	10.0	R-	70	40	250	.00
272350	SC	CHS	73	69	1912		1012.1	311	7.0		120	17	70	.00
272355	SC	MYR	69	65	1910		1012.1	213	5.0	F	10	2	80	.00
272355	SC	NBC	72	65	1910	14	1011.1	213	7.0		80	30	250	.00
272355	SC	SSC	70	64	1806		1009.4	212	9.0		80	50	120	.00
280050	SC	GSP	55	55	2306		1010.0	230	2.5	RW-F	4	27		
S280126	SC	GSP			2308		1009.7	310	5.0	R-F	34	4		
S280100	SC	AND			2504		1009.7	230	4.0	F	5	22		
280100	SC	FLO	73	66	2012		1010.4	300	7.0		250			
280051	SC	CAE	71	66	1608		1007.7	012	10.0			40	250	
280050	SC	CHS	74	70	1914		1011.7	311	7.0		120	17	70	
280055	SC	MYR	68	64	1908		1011.7	213	5.0	F	10	2	20	
280055	SC	NBC	73	66	2004		1011.1	311	7.0		250	30	80	
280055	SC	SSC	70	65	1910	16	1008.7	220	9.0		80	250		
280152	SC	GSP	56	56	2504		1009.7	230	10.0		4	43		
S280142	SC	AND			2406		1010.0	320	2.0	RF	20	55		
280155	SC	AND	55	55	2504		1009.7	230	2.0	RF	5	20		
280155	SC	FLO	73	67	1914		1009.4	220	7.0		17	250		
280151	SC	CAE	71	66	1910		1008.4	212	10.0		55	15	250	
280150	SC	CHS	74	70	2114	19	1011.7	311	7.0		120	17	33	
S280144	SC	MYR			1810		1011.1	213	5.0	F	5	2	10	
280155	SC	MYR	68	63	1908	16	1011.1	230	5.0	F	5	10		
280155	SC	NBC	73	66	2014	21	1011.1	311	7.0		250	15	80	
280155	SC	SSC	70	65	1910		1008.7	013	9.0			80	250	
280253	SC	GSP	56	55	2608		1009.4	230	10.0	R-	4	41		.25
280300	SC	AND	56	55	2708		1009.4	300	2.0	F	30			
280255	SC	FLO	73	67	1914		1009.4	200	7.0		19			.00
280252	SC	CAE	72	66	1712		1008.0	212	10.0		85	48	250	.00
280250	SC	CHS	75	70	2016	23	1011.4	311	7.0		120	15	33	.00
280255	SC	MYR	70	65	2010	19	1011.7	230	6.0	F	5	10		.00
280255	SC	NBC	72	66	2008		1010.7	213	6.0	R-F	15	5	80	.00
280258	SC	SSC	70	65	2010		1009.0	211	9.0		80	20	50	.00
280350	SC	GSP	56	55	2206		1009.7	300	10.0		5			
280350	SC	AND	55	55	2710		1009.7	300	2.0	F	30			
280355	SC	FLO	73	67	2014		1009.4	300	7.0		19			
S280340	SC	CAE			2916	25	1008.7	230	7.0	R-	17	40		
280351	SC	CAE	64	60	2916	23	1009.0	213	10.0	R-	17	12	40	
S280405	SC	CAE			2910	19	1009.4	212	10.0		60	17	250	
280350	SC	CHS	75	71	2116	23	1011.4	213	7.0		33	15	120	
S280402	SC	CHS			2014	23	1011.4	230	7.0	R-	16	100		
280355	SC	MYR	70	63	2010	16	1011.1	230	4.0	F	5	10		
280355	SC	NBC	72	66	1904		1010.7	230	6.0	F	15	80		
280357	SC	SSC	71	66	2012		1008.7	210	9.0		50	20		

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280450	SC	GSP	55	55	2308		1010.0	300	8.0		5			
280446	SC	AND	56	55	2608		1010.0	310	4.0	R-F	22	6		
280455	SC	FLO	74	68	2019		1008.7	300	7.0		21			
S280500	SC	CAE			2706		1009.0	230	7.0		20	60		
280450	SC	CAE	60	57	2604		1009.4	213	10.0		60	20	250	
S280436	SC	CHS			2112		1011.1	230	7.0		14	100		
280450	SC	CHS	74	71	2216		1011.1	230	7.0		12	100		
280455	SC	MYR	70	66	2008		1010.0	213	6.0	RW-F	10	5	20	
280455	SC	NBC	72	66	2106		1010.4	230	6.0	F	15	80		
280455	SC	SSC	71	65	2012		1008.4	210	13.0		50	20		
S280512	SC	SSC			2110		1008.0	210	13.0	RW-	40	20		
280551	SC	GSP	55	53	2206		1009.7	300	6.0	RW-	5			.27
S280622	SC	GSP			2006		1008.7	310	10.0		40	5		
280550	SC	AND	56	55	2203		1009.7	230	5.0	L-F	8	12		
280550	SC	FLO	74	68	2012	21	1008.0	300	7.0		21			.00
280551	SC	CAE	59	56	2506		1009.0	300	7.0		20			.01
280554	SC	CHS	74	70	2212		1010.0	300	7.0		14			.00
S280540	SC	MYR			2108	12	1009.7	213	6.0	F	10	5	20	
280555	SC	MYR	71	68	2110		1009.4	211	5.0	RW-F	10	5	8	.00
280555	SC	NBC	73	67	2012	19	1009.4	211	6.0	F	250	15	80	.00
S280547	SC	SSC			2210		1008.7	200	13.0		40			
280555	SC	SSC	62	57	2910		1008.4	200	13.0		40			.00
280650	SC	GSP	53	51	2208		1008.4	310	12.0		46	5		
280650	SC	AND	56	55	2708		1008.4	212	5.0	F	12	8	100	
280650	SC	FLO	73	67	2214		1007.0	200	7.0		19			
280650	SC	CAE	59	55	2706		1008.4	310	7.0		20	10		
280650	SC	CHS	74	70	2116	25	1009.0	300	7.0		14			
280655	SC	MYR	71	68	1808		1008.4	212	6.0	R-F	10	5	30	
280655	SC	NBC	72	67	2310		1009.0	310	6.0	F	250	15		
280655	SC	SSC	60	54	2916		1008.0	010	13.0			25		
S280705	SC	SSC			3002		1007.7	200	13.0		20			
280751	SC	GSP	-9	979				310	15.0		55	5		
S280828	SC	GSP			2506		1008.4	230	15.0		8	60		
280750	SC	AND	56	55	2610		1008.7	310	5.0	F	100	8		
280755	SC	FLO	66	60	2814		1007.0	220	7.0		20	100		
280750	SC	CAE	59	52	2912		1008.7	310	7.0	R-	18	10		
S280741	SC	CHS			2312		1008.7	210	7.0		100	14		
S280741	SC	CHS			2312		1008.7	210	7.0		100	14		
280750	SC	CHS	72	67	2214		1008.4	210	7.0		100	14		
280755	SC	MYR	69	65	1808		1008.0	211	5.0	F	30	10	20	
280755	SC	NBC	72	64	2306		1008.7	211	7.0		250	15	80	
S280830	SC	NBC			2810	16	1009.4	230	7.0		10	80		
280755	SC	SSC	59	53	2706		1008.0	300	13.0		20			
280854	SC	GSP	51	49	2408		1008.4	230	15.0		9	60		.01
S280907	SC	GSP			2510		1008.7	300	15.0		10			
280850	SC	AND	55	55	2714		1009.0	310	5.0	F	100	8		
280855	SC	FLO	63	57	2914		1008.0	300	7.0		16			.00
280850	SC	CAE	55	53	2304		1008.4	230	7.0	R-	18	40		.04
280854	SC	CHS	72	67	2514		1008.7	310	7.0		100	14		.00
280855	SC	MYR	70	65	1910	17	1007.0	011	6.0	F		10	30	.00
280855	SC	NBC	65	56	2908		1009.7	230	7.0		15	80		.00
S280843	SC	SSC			2706		1008.0	300	13.0	RW-	25			
280855	SC	SSC	59	51	2906		1008.0	300	13.0	RW-	25			.00
S280925	SC	SSC			2906		1009.0	300	2.5	TRW-F	25			
280953	SC	GSP	51	48	2510		1008.7	300	15.0		13			
280950	SC	AND	55	55	2710	16	1009.7	210	7.0		100	8		
280950	SC	FLO	60	54	2717		1008.7	300	7.0	TRW-	20			
S281030	SC	FLO			2714		1008.7	310	7.0	RW-	33	8		
280950	SC	CAE	54	51	2408		1009.0	230	7.0		14	35		
280951	SC	CHS	67	61	2914		1009.7	300	7.0		19			
280955	SC	MYR	68	63	1806		1007.3	212	6.0	F	30	10	80	
280955	SC	NBC	61	53	2910		1010.0	300	7.0		10			

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280955	SC	SSC	54	50	2304		1009.0	310	3.0	RW-F	40	15		
S281025	SC	SSC			2408		1009.0	310	13.0	RW-	25	15		
S281037	SC	GSP			2708		1009.4	310	15.0		75	15		
281052	SC	GSP	50	47	2608		1009.7	230	20.0		15	75		
S281116	SC	GSP			2608		1010.0	310	20.0		75	16		
281050	SC	FLO	56	54	2614		1009.0	310	3.0	RW-	33	8		
281050	SC	CAE	54	49	2608		1009.7	230	7.0		14	35		
S281130	SC	CAE			2512	17	1010.4	213	7.0	RW-	19	11	48	
S281130	SC	CAE			2512	17	1010.4	213	7.0	RW-	19	11	48	
281051	SC	CHS	62	53	3016		1010.7	300	7.0		23			
S281039	SC	MYR			2004		1007.3	212	6.0	F	20	15	50	
281059	SC	MYR	69	63	2708		1008.0	212	6.0	F	20	15	50	
281055	SC	NBC	59	48	2808		1011.1	310	7.0		15	5		
S281117	SC	NBC			2808		1011.7	230	6.0	L-	8	15		
S281040	SC	SSC			2612		1009.0	310	9.0	T	25	10		
281055	SC	SSC	54	49	2610		1008.7	230	9.0	TRW-	12	25		
S281110	SC	SSC			2510		1009.4	230	13.0		14	25		
281150	SC	GSP	49	46	2906		1011.4	310	20.0		75	16		.01
281150	SC	AND	45	41	2710	17	1012.4	230	7.0		12	100		.66
281151	SC	FLO	55	52	2110	16	1009.4	230	4.0	RW-	11	33		.22
281150	SC	CAE	53	46	2614	19	1010.7	300	7.0	RW-	48			.04
S281213	SC	CAE			2710	19	1011.4	310	15.0		70	20		
281152	SC	CHS	60	51	2916		1011.7	300	7.0		27			.00
281155	SC	MYR	65	56	2508	12	1008.7	212	6.0	F	20	15	50	.00
S281135	SC	NBC			2912	19	1012.4	310	4.0	RW-	10	5		
281155	SC	NBC	54	47	2808	16	1012.4	213	6.0	L-	15	5	250	.00
S281215	SC	NBC			2906		1012.8	213	2.5	RW-	11	2	30	
281155	SC	SSC	53	47	2810		1009.7	230	13.0		14	25		.11
S280020	TN	TRI			0000		1009.0	230	3.0	RF	12	20		
272353	TN	TRI	54	53	2508		1010.7	310	5.0	R-F	20	10		.00
272357	TN	DYR	43	35	2306		1014.5	000	12.0					.00
272350	TN	MKL	41	36	2104		1014.5	000	15.0					.00
272352	TN	BNA	45	42	2710		1013.8	311	15.0		100	40	65	.03
S280020	TN	TYS			1708		1011.4	311	7.0	R-	40	7	25	
272347	TN	TYS	49	48	1810		1012.4	310	5.0	R-F	25	7		.22
272352	TN	CSV	45	42	2704		1011.7	230	7.0	RW-	6	15		.40
272349	TN	CHA	51	48	2802		1012.4	310	7.0	R-	45	24		.13
272352	TN	MEM	45	36	2504		1016.8	000	15.0					.01
272355	TN	NQA	46	33	2302		1015.1	010	7.0			40		.00
280052	TN	TRI	53	50	2812	19	1010.4	213	5.0	R-F	12	5	24	
S280130	TN	TRI			2714	21	1011.4	310	5.0	R-F	22	12		
280058	TN	DYR	44	35	2508		1014.8	010	12.0			33		
280053	TN	MKL	40	36	2104		1014.8	000	12.0					
280051	TN	BNA	44	39	2812		1014.1	300	15.0		100			
280047	TN	TYS	49	48	1906		1011.4	310	7.0	R-	40	15		
280049	TN	CSV	44	42	2602		1011.7	230	7.0	RW-	6	15		
280048	TN	CHA	50	46	3502		1012.4	310	7.0	R-	50	24		
280051	TN	MEM	45	36	2406		1016.8	200	20.0		60			
280055	TN	NQA	45	33	2602		1015.1	010	7.0			40		
280151	TN	TRI	48	45	2610		1011.4	213	6.0	R-	22	12	37	
S280224	TN	TRI			2506		1010.7	310	7.0	R-	37	12		
280154	TN	DYR	45	34	2708		1015.1	010	12.0			35		
280152	TN	MKL	39	36	2106		1015.1	000	12.0					
280150	TN	BNA	42	39	2708		1014.5	200	15.0		100			
S280137	TN	TYS			1910		1011.7	230	7.0	R-	15	40		
280150	TN	TYS	49	48	1906		1011.7	230	5.0	R-	15	40		
S280220	TN	TYS			2010		1011.7	310	7.0	R-	40	15		
280148	TN	CSV	42	40	2704		1011.7	230	7.0		6	15		
280148	TN	CHA	50	48	2802		1012.4	310	7.0	R-	50	15		
S280211	TN	CHA			3204		1012.1	230	7.0	R-	10	50		
280150	TN	MEM	43	37	2706		1017.5	010	20.0			60		

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280155	TN	NQA	45	33	2402		1015.8	010	7.0			40		
280253	TN	TRI	48	45	2406		1011.1	310	7.0		50	15		.30
280252	TN	DYR	44	33	3010		1015.8	000	12.0					.00
280250	TN	MKL	40	35	2306		1015.5	000	12.0					.00
280250	TN	BNA	41	39	2606		1014.8	010	15.0			100		.00
280247	TN	TYS	48	47	2212		1011.7	310	7.0	R-	50	15		.14
280250	TN	CSV	41	39	2806		1012.1	230	7.0		6	15		.00
S280242	TN	CHA			3110		1012.1	230	10.0	R-	16	50		
280249	TN	CHA	49	45	3312		1012.8	230	10.0	R-	16	50		.07
S280317	TN	CHA			3310		1012.8	300	10.0	R-	32			
280251	TN	MEM	42	37	2806		1018.2	010	20.0			60		.00
280256	TN	NQA	45	32	2702		1016.5	010	7.0			40		.00
280354	TN	TRI	48	44	2406		1010.7	213	7.0	R-	45	15	60	
S280417	TN	TRI			2204		1010.7	230	7.0	R-	12	25		
280350	TN	DYR	43	34	2608		1016.1	000	12.0					
280353	TN	MKL	39	35	2306		1015.8	000	15.0					
280351	TN	BNA	39	37	2406		1014.8	000	15.0					
280347	TN	TYS	48	47	3110		1011.4	213	10.0	R-	25	7	50	
280353	TN	CSV	39	36	2808		1012.8	230	10.0		15	25		
280353	TN	CHA	47	42	3306		1013.1	300	10.0		32			
280350	TN	MEM	42	36	2708		1018.5	000	20.0					
280355	TN	NQA	44	31	2702		1016.5	000	7.0					
280452	TN	TRI	47	45	2102		1010.0	230	7.0	R-	10	70		
280452	TN	MKL	39	33	2406		1016.1	000	15.0					
280451	TN	BNA	39	36	1804		1014.8	000	15.0					
280447	TN	TYS	45	42	2712		1011.7	230	10.0		25	50		
280500	TN	CSV							25.0					
280448	TN	CHA	47	41	3110		1013.8	310	10.0		45	30		
280451	TN	MEM	40	34	2906		1018.9	000	20.0					
280455	TN	NQA	44	31	2904		1017.2	000	7.0					
280553	TN	TRI	46	45	0000		1009.4	230	6.0	R-F	10	44		.31
280550	TN	MKL	38	33	2506		1016.5	000	15.0					.00
280550	TN	BNA	41	37	2512		1014.8	000	15.0					.00
280550	TN	TYS	45	42	2812		1012.4	230	15.0		16	35		.17
S280612	TN	TYS			2906		1012.1	230	15.0		13	37		
280550	TN	CSV	36	33	2706		1013.1	230	10.0		15	25		.06
S280617	TN	CSV			2604		1013.1	011	10.0			25	250	
280551	TN	CHA	45	36	3406		1013.8	300	15.0		50			.09
280550	TN	MEM	41	334	2806		1019.5	000	20.0					.00
280556	TN	NQA	42	30	2802		1017.5	000	7.0					.00
280652	TN	TRI	46	44	2704		1009.0	230	6.0	R-F	12	34		
280653	TN	MKL	39	31	2606		1017.2	000	15.0					
280648	TN	BNA	39	36	2508		1014.8	000	15.0					
280648	TN	TYS	44	38	2812		1012.1	310	15.0		40	13		
280650	TN	CSV	35	32	2706		1012.8	011	10.0			25	250	
280651	TN	CHA	44	34	3208		1014.5	011	15.0			50	100	
280650	TN	MEM	40	34	2908		1019.9	000	20.0					
280655	TN	NQA	42	30	2904		1017.5	000	7.0					
280800	TN	TRI	43	40	2912	17	1009.0	230	7.0	R-	14	36		
280753	TN	MKL	38	30	2706		1017.8	000	15.0					
280748	TN	BNA	39	35	2610		1015.1	000	15.0					
280749	TN	TYS	42	36	2710		1012.9	230	15.0		25	45		
280750	TN	CSV	34	32	2504		1012.8	010	10.0			25		
280750	TN	CHA	41	33	2904		1014.8	010	15.0			50		
280751	TN	MEM	40	34	2908		1020.5	000	20.0					
280755	TN	NQA	42	29	2904		1018.5	000	7.0					
280854	TN	TRI	40	38	2914	21	1010.7	230	7.0	R-	12	32		.03
280854	TN	MKL	38	30	2710		1018.2	000	15.0					.00
280849	TN	BNA	38	34	2510		1015.5	000	15.0					.00
S280835	TN	TYS			2914		1013.1	210	15.0		50	25		
280851	TN	TYS	41	35	2510		1013.1	200	15.0		50			.00
280850	TN	CSV	35	33	2406		1013.1	010	10.0			30		.00

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280848	TN	CHA	40	34	2608		1015.1	000	15.0					.00
280852	TN	MEM	40	34	3012		1021.2	000	20.0					.00
280856	TN	NQA	41	27	3006		1019.2	000	7.0					.00
280954	TN	TRI	39	35	2708		1011.1	310	10.0		49	15		
280954	TN	MKL	37	29	2810		1018.5	000	15.0					
280949	TN	BNA	38	33	2512		1015.8	000	15.0					
280950	TN	TYS	39	35	2606		1013.8	011	15.0			22	50	
280950	TN	CSV	34	31	2708		1013.1	010	10.0			30		
280951	TN	CHA	40	34	2706		1015.5	000	15.0					
280950	TN	MEM	37	27	2914		1021.9	000	20.0					
280955	TN	NQA	38	25	2806		1019.9	000	7.0					
281053	TN	TRI	39	32	2610		1011.4	300	10.0		60			
281054	TN	MKL	36	28	2712		1019.2	000	15.0					
281048	TN	BNA	37	32	2810		1016.1	000	15.0					
281050	TN	TYS	39	34	2408		1014.5	010	15.0			21		
281050	TN	CSV	33	31	2808		1014.1	010	10.0			30		
281051	TN	CHA	40	33	3108		1016.1	000	15.0					
281051	TN	MEM	36	27	3112		1022.9	000	20.0					
281055	TN	NQA	37	23	2706		1020.9	000	7.0					
S281200	TN	TRI			2610		1011.1	210	10.0		46	12		
281150	TN	TRI	38	31	2610		1012.8	011	10.0			45	70	.04
281200	TN	DYR	35	25	2810	19	1020.9	000	10.0					.00
281155	TN	MKL	34	26	3012		1020.5	000	15.0					.00
281149	TN	BNA	36	32	2612		1016.5	000	15.0					.00
281150	TN	TYS	37	33	2208		1015.1	010	15.0			21		.00
281150	TN	CSV	33	30	2608		1014.1	010	10.0			30		.00
S281216	TN	CSV			2512		1014.8	300	10.0		8			
S281200	TN	CHA			3310		1012.8	300	10.0	R-	32			
281149	TN	CHA	39	33	2908		1017.2	000	15.0					.00
281153	TN	MEM	34	24	3010		1023.3	000	20.0					.00
281156	TN	NQA	36	22	2906		1021.2	000	7.0					.00
S272340	VA	IAD			1704		1007.3	223	8.0		11	44	90	
272354	VA	IAD	60	58	1804		1006.7	311	8.0	RW-	80	9	44	.05
272345	VA	SHD	56		0000		1007.0	230	15.0		50	100		
272344	VA	CHO	59	57	2004		1007.3	230	7.0		18	25		
272350	VA	RIC	60	60	1204		1008.7	310	8.0		40	25		.18
272353	VA	LYH	57	57	1906		1041.5	300	5.0	F	5			
272352	VA	PHF	69	65	1914		1010.7	210	7.0		80	20		.00
272350	VA	ORF	70	66	2019	25	1011.1	300	7.0		10			.00
S280005	VA	ROA			0000		1006.7	230	2.0	RF	27	50		
S280027	VA	ROA			2804		1008.0	310	2.0	R-F	25	3		
272350	VA	ROA	58	58	1206		1006.7	230	10.0	R-	27	60		.08
S280016	VA	DAN			2904		1007.3	230	7.0	TRW-	20	50		
272349	VA	DAN	58	58	0000			230	15.0	R-	20	50		.66
272355	VA	DAA	62	55	1602		1007.7	213	7.0	RW-	40	6	80	.18
272355	VA	LFI	69	65	1810	16	1010.0	211	7.0		80	16	40	.00
272355	VA	NGU	69	65	1814	19	1010.4	213	7.0		15	11	80	.00
272355	VA	NTU	68	64	1810	17	1011.4	213	7.0		10	6	30	
272357	VA	NYG	59	54	2002		1007.3	213	7.0	R-	25	15	50	.22
280050	VA	IAD	60	58	2004		1006.0	211	8.0		75	9	28	
280045	VA	SHD	55		0000		1006.0	200	10.0		50			
280045	VA	CHO	58	56	1404		1006.3	300	7.0		14			
S280115	VA	CHO			2406		1005.6	230	7.0	TR-	6	30		
280050	VA	RIC	61	59	1408		1007.7	300	8.0		19			
280051	VA	LYH	58	58	2108		1007.7	300	2.5	RW-F	2			
280058	VA	PHF	69	65	1916		1009.7	300	7.0		14			
280050	VA	ORF	70	65	1916		1010.4	300	7.0		11			
280051	VA	ROA	57	57	0000		1007.3	213	2.0	R-F	14	4	30	
280050	VA	DAN	59	59	2404		1008.0	230	7.0		30	100		
280055	VA	DAA	61	55	0000		1006.7	213	7.0		40	12	80	
S280110	VA	DAA			1302		1006.7	213	7.0		20	6	40	

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S280110	VA	DAA			1302		1006.7	213	7.0		20	6	40	
280055	VA	LFI	68	66	1912		1009.4	230	7.0		15	40		
280100	VA	NGU	69	65	1916	23	1009.0	213	7.0		15	11	80	
280055	VA	NTU	68	63	1814	23	1010.7	230	7.0		10	30		
280056	VA	NYG	59	55	1902		1006.7	230	7.0		3	10		
S280119	VA	NYG			1604		1006.0	300	7.0	R-	3			
280150	VA	IAD	60	58	1904		1005.0	213	8.0		36	11	80	
S280208	VA	IAD			2204		1005.0	223	5.0	RW-	8	28	80	
S280208	VA	IAD			2204		1005.0	223	5.0	RW-	8	28	80	
280145	VA	SHD	55		0000		1007.3	300	5.0	R-	50			
280145	VA	CHO	58	57	2504		1006.7	233	1.5	TRF	3		8	
S280219	VA	CHO			2004		1006.0	232	1.5	R-F	3		39	
280150	VA	RIC	62	60	1508		1006.3	230			19	30		
280150	VA	LYH	58	58	2106		1006.7	300	3.0	F	3			
S280230	VA	LYH			2208		1007.3	300	1.5	TRWF	2			
280157	VA	PHF	69	65	1814	19	1008.7	230	7.0		14	40		
280150	VA	ORF	70	65	1921	27	1009.0	300	7.0		14			
S280137	VA	ROA			3504		1006.7	331	1.0	R-F	15		3	
280150	VA	ROA	57	57	3604		1006.7	230	2.0	RF	5	15		
S280224	VA	ROA			2506		1006.3	213	5.0	R-F	14	5	100	
280150	VA	DAN	58	58	3504		1007.0	230	7.0		16	30		
S280222	VA	DAN			3202		1006.7	230	7.0	TR-	16	30		
S280147	VA	DAA			0000		1005.6	213	7.0	R-	4	2	10	
280155	VA	DAA	60	55	1302		1005.3	310	6.0	R-F	4	2		
S280224	VA	DAA			1604		1005.3	310	3.0	R-F	4	2		
280155	VA	LFI	69	65	1812	17	1008.4	230	7.0		15	35		
280155	VA	NGU	69	65	1816	27	1008.7	213	7.0		15	11	80	
280155	VA	NTU	69	63	1910	21	1009.7	230	7.0		10	30		
280155	VA	NYG	55	52	1600		1004.6	300	4.0	R-F	4			
S280226	VA	NYG			2202		1004.6	300	2.0	TR+F	2			
S280226	VA	NYG			2202		1004.6	300	2.0	TR+F	2			
S280236	VA	IAD			2204		1006.0	213	4.0	TRW-F	5	4	12	
S280319	VA	IAD			0000		1004.6	312	7.0		4	6	19	
280245	VA	SHD	54		0000		1006.0	230	5.0	L-	50	80		
280245	VA	CHO	57	57	2504		1006.0	233	1.5	R-F	3		40	
S280236	VA	RIC			1714		1005.3	200	8.0		45			
280253	VA	RIC	66	63	1916	23	1005.3	210	8.0		40	20		.00
280252	VA	LYH	58	58	1810		1006.7	300	2.0	RF	1			
280252	VA	PHF	70	65	1814	27	1008.7	230	7.0		14	40		.00
280250	VA	ORF	71	65	1919	27	1008.7	300	7.0		14			.00
280249	VA	ROA	56	56	2906		1006.3	230	5.0	R-F	20	40		.22
280250	VA	DAN	58	58	1204		1006.3	300	1.5	TRW-F	17			.00
280255	VA	DAA	60	55	2904		1006.0	310	.2	TRW-F	4	2		.00
S280302	VA	DAA			0000		1005.3	310	1.2	TRW-F	3	2		
S280302	VA	DAA			0000		1005.3	310	1.2	TRW-F	3	2		
280256	VA	LFI	69	65	1910	17	1008.4	230	7.0		15	35		.00
280255	VA	NGU	69	65	1917	21	1008.0	213	7.0		15	11	80	
280256	VA	NTU	69	64	1814	23	1008.7	223	7.0		10	30	80	.00
S280240	VA	NYG			2000	12	1005.3	300	1.0	TR+F	2			
280256	VA	NYG	59	56	3204		1005.0	330	1.0	TR+F	2			.00
S280317	VA	NYG			0000		1004.6	232	3.0	TRF	2		14	
S280337	VA	IAD			0000		1004.6	311	10.0		55	7	20	
280350	VA	IAD	59	58	2204		1005.0	310	7.0	RW-	55	20		
280345	VA	CHO	58	57	1808		1005.0	233	1.5	R-F	3		22	
280350	VA	RIC	70	61	2114	21	1005.6	310	8.0		35	25		
S230430	VA	RIC			2014		1005.6	310	2.0	TR-	30	20		
280352	VA	LYH	58	58	2108		1006.3	300	3.0	TRWF	2			
280350	VA	PHF	70	65	1814	19	1008.4	230	7.0		15	40		
280350	VA	ORF	71	65	2221		1008.0	300	7.0		14			
280352	VA	ROA	55	54	2604		1006.3	310	7.0		50	20		
280355	VA	DAA	60	55	0000		1005.3	310	1.5	TRW-F	30	2		
S280408	VA	DAA			0000		1005.0	213	1.5	RW-F	3	2	30	

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280355	VA	LFI	70	66	2012	19	1007.7	200	7.0		15			
280355	VA	NGU	70	65	2017	25	1007.7	213	7.0		15	9	80	
S280403	VA	NGU			1919	29	1007.7	213	6.0	RW-	15	9	80	
S280425	VA	NGU			1919	27	1007.7	213	7.0		15	9	80	
280355	VA	NTU	70	64	1917	23	1008.0	230	7.0		10	30		
280355	VA	NYG	58	55	0000		1005.0	331	1.0	RF	25		2	
S280410	VA	NYG			1404		1004.6	233	1.0	RF	2		25	
S280410	VA	NYG			1404		1004.6	233	1.0	RF	2		25	
280450	VA	IAD	57	56	0000		1004.6	213	6.0	RW-	50	20	90	
280450	VA	RIC	69	61	2012		1005.0	310	2.0	TR-	25	15		
S280506	VA	RIC			1812		1004.0	310	5.0	TRW-	23	15		
280500	VA	PHF	70	65	1814	19	1008.4	230	7.0		15	40		
280450	VA	ORF	72	66	2223	29	1008.0	300	7.0		15			
280450	VA	ROA	54	53	3106		1006.3	310	7.0	R-	70	20		
S280432	VA	DAA			0000		1003.6	213	1.0	RW-F	2	1	30	
280455	VA	DAA	60	54	0000		1004.0	213	1.0	RW-F	2	1	30	
S280513	VA	DAA			0000		1004.6	213	1.0	RW-F	4	2	30	
S280445	VA	LFI			2016		1007.7	200	7.0	RW-	15			
280455	VA	LFI	70	66	2016		1007.3	010	7.0			15		
280455	VA	NGU	71	66	1919	27	1007.3	210	7.0		15	9		
280455	VA	NTU	71	64	2014	23	1008.4	300	7.0		10			
280456	VA	NYG	58	54	2102		1004.0	233	.7	TRF	2		25	
S280535	VA	IAD			0000		1004.0	213	2.5	RW-F	35	20	90	
280550	VA	IAD	57	56	0000		1004.0	213	2.5	RW-F	35	20	90	.82
S280550	VA	IAD			0000		1003.3	330	1.0	RW-F	38			
280545	VA	CHO	57	57	2304		1004.6	330	3.0	F	30			
280550	VA	RIC	69	61	1714		1002.9	230	5.0	TRW-	23	50		.03
S280609	VA	RIC			2319	33	1003.3	213	5.0	TRW	23	5	50	
280550	VA	PHF	70	65	1814		1006.7	222	7.0		20	80	250	.00
280550	VA	ORF	72	66	2023		1006.3	220	10.0		15	22		.00
280550	VA	ROA	51	45	2708		1007.0	230	7.0	R-	32	70		.27
S280537	VA	DAA			0000		1003.6	213	1.0	RW-F	3	2	30	
280555	VA	DAA	60	54	0000		1003.3	233	.2	RW-F	3		5	1.13
S280620	VA	DAA			0000		1003.3	213	.7	F	2	1	9	
280555	VA	LFI	70	65	1912		1005.6	010	7.0			15		.00
280555	VA	NGU	71	66	1816	21	1005.6	210	7.0		15	9		
280555	VA	NTU	71	65	2017	27	1006.7	300	7.0		10			
S280545	VA	NYG			0000		1003.3	232	.5	F	2		25	
S280545	VA	NYG			0000		1003.3	232	.5	F	2		25	
280557	VA	NYG	58	55	0000		1003.3	233	1.0	F	2		25	1.05
280650	VA	IAD			0037		1034.8	330	1.5	RW-F	38			
S280701	VA	IAD			3108		1004.0	310	3.0	RW-F	30	20		
280655	VA	RIC	65	62	2708		1002.6	310	5.0	RW-	23	5		
280654	VA	PHF	71	66	1816		1005.3	230	7.0		20	80		
280650	VA	ORF	72	66	1819	27	1006.0	300	7.0	R-	15			
280650	VA	ROA	49	47	2606		1006.3	230	7.0		40	70		
S280640	VA	DAA			0000		1003.6	213	1.5	RW-F	3	1	5	
S280640	VA	DAA			0000		1003.6	213	1.5	RW-F	3	1	5	
280655	VA	DAA	59	54	0000		1004.3	213	2.0	RW-F	10	3	30	
S280646	VA	LFI			2016		1005.0	310	7.0	RW-	35	16		
280655	VA	LFI	70	66	2016		1005.0	310	7.0	RW-	35	16		
280655	VA	NGU	71	66	1817	21	1006.0	211	7.0		30	9	20	
280655	VA	NTU	72	65	2016	27	1006.0	300	7.0		10			
S280639	VA	NYG			0000		1002.9	330	1.0	RF	2			
280656	VA	NYG	58	54	3302		1002.9	330	1.0	RF	2			
280750	VA	IAD	55	54	3506		1004.0	300	7.0	RW-	30			
280750	VA	RIC	63	60	2608		1004.0	310	5.0	RW-	21	10		
S280830	VA	RIC			2608		1003.6	230	7.0		10	25		
280750	VA	PHF	72	66	1814		1004.6	230	7.0		20	40		
280750	VA	ORF	72	67	1819	25	1004.6	300	10.0		15			
280750	VA	ROA	49	47	2306		1005.6	300	7.0		40			
280755	VA	DAA	59	54	0000		1003.6	311	5.0	RW-F	40	10	15	

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280755	VA	LFI	71	67	2012	21	1004.0	230	7.0		16	20		
280755	VA	NGU	71	67	1817	35	1004.0	211	7.0		30	9	20	
S280830	VA	NGU			1912	19	1003.3	211	7.0	T	30	9	20	
280755	VA	NTU	72	65	1916	27	1005.0	230	7.0		12	30		
280755	VA	NYG	58	55	0000		1002.9	230	2.5	RF	2	25		
280850	VA	IAD	53	53	3404		1004.0	230	7.0	R-	33	70		.05
280850	VA	RIC	62		2708		1003.6	310	7.0	RW-	25	10		.57
280850	VA	PHF	69	67	1912		1003.6	230	4.0	TRW-	15	20		.00
S280920	VA	PHF	68	67	2808		1003.6	300	4.0	TRW-	20			
280850	VA	ORF	73	67	1621	31	1002.9	310	10.0		55	15		.00
S280926	VA	ORF			2014		1002.3	230	7.0	T	15	22		
280850	VA	ROA	49	46	2406		1006.0	310	7.0		70	40		.00
280855	VA	DAA	56	48	3404		1002.9	212	7.0	RW-	40	20	80	.00
S280907	VA	DAA			3206		1003.6	213	2.0	RW-F	5	2	23	
S280907	VA	DAA			3206		1003.6	213	2.0	RW-F	5	2	23	
S280832	VA	LFI			2010		1003.6	230	7.0	TRW-	16	20		
S280838	VA	LFI												
280859	VA	LFI	68	68				213	6.0	TRW-	16	5	20	.00
280855	VA	NGU	72	68	1821	33	1002.3	212	7.0	T	30	9	80	.00
S280920	VA	NGU			1914	17	1002.3	212	6.0	RW-	20	9	80	
S280925	VA	NGU												
280855	VA	NTU	72	66	1916	23	1004.0	230	7.0		10	30		
S280903	VA	NTU			1916	21	1003.6	212	7.0		30	10	80	
280856	VA	NYG	55	49	3106		1002.6	213	4.0	RF	11	2	25	.00
280950	VA	IAD	51	51	3504		1003.3	300	7.0	R-	40			
280950	VA	RIC	61	57	2606		1003.6	310	7.0		50	10		
S281010	VA	RIC			2706		1004.0	230	7.0		12	23		
S281008	VA	LYH			2508		1005.0	300	15.0		45			
S280940	VA	PHF	66	65	2904		1004.0	213	4.0	RW-	20	10	40	
280953	VA	PHF	65	64	2906		1003.3	011				20	50	
S280939	VA	ORF			1821	33	1000.6	230	10.0		15	22		
280950	VA	ORF	72	67	2717	35	1002.9	300	2.0	R+	13			
S281007	VA	ORF			2721	33	1003.6	300	1.0	TR+	12			
280950	VA	ROA	48	46	2804		1005.6	300	7.0		31			
S280936	VA	LFI			2512		1003.3	300	.1	TRW+	20			
280955	VA	LFI	66	65	2710		1002.3	210	7.0		50	20		
S280945	VA	NGU			2510	25	1002.3	213	.2	TRW	15	9	80	
280955	VA	NGU	72	67	2112		1003.6	213	7.0	T	15	8	80	
S281001	VA	NGU			2108		1002.6	213	6.0	TRW-	15	8	80	
280955	VA	NTU	72	66	1919	29	1002.9	212	7.0		30	10	80	
S280940	VA	NYG			0504		1002.9	310	5.0	R-F	23	11		
280957	VA	NYG	53	48	0104		1002.9	310	6.0	R-F	23	11		
281050	VA	IAD	51	51	3504		1004.0	300	7.0	R-	42			
281045	VA	SHD	49		3004		1004.6	300	1.0	R-F	24			
281045	VA	CHO	51	47	2506		1004.3	310	10.0	R-	65	30		
281050	VA	RIC	58	53	3012	16	1004.3	300	5.0	RW-	12			
281050	VA	LYH	50	48	2306		1004.6	300	15.0		45			
281058	VA	PHF	63	62	2810		1004.0	230	7.0	RW-	14	30		
281050	VA	ORF	66	64	2514		1003.6	300	4.0	R-	20			
281050	VA	ROA	43	37	2910		1007.3	300	7.0		38			
281050	VA	DAN	52	50	2704		1005.3	300	25.0		20			
281055	VA	DAA	53	46	0000		1003.6	213	3.0	RW-F	5	2	23	
281055	VA	FAF	63	62	2710		1003.3	212	7.0		40	12	80	
S281112	VA	FAF												
281055	VA	LFI	65	63	2504		1003.6	311	7.0		50	8	20	
S281035	VA	NGU			2208		1003.3	213	6.0	RW-	30	8	80	
281055	VA	NGU	72	67	2410		1003.6	213	6.0	RW-	23	8	80	
S281110	VA	NGU			2708	16	1003.6	213	7.0		14	8	80	
281055	VA	NTU	71	65	2610	25	1003.3	212	7.0		10	5	30	
S281101	VA	NTU			2508	19	1003.6	212	.7	RW	8	5	10	
S281125	VA	NTU			2306	16	1003.6	212	4.0	RW-F	10	5	30	
281056	VA	NYG	53	48	0102		1003.3	310	6.0	L-F	11	3		

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281150	VA	IAD	49	47	3214	23	1005.0	213	10.0		38	25	80	.16
281145	VA	SHD	44		3010		1006.0	300	13.0	R-	35			
281145	VA	CHO	51	46	2704		1004.0	310	10.0	R-	60	30		
S281200	VA	RIC			2706		1004.0	230	7.0		12	23		
281150	VA	RIC	55	52	3006		1004.6	310	5.0	R-	38	10		.61
S281200	VA	LYH			2508		1005.0	300	15.0		45			
281153	VA	LYH	46	41	2812		1006.0	310	10.0	RW-	45	27		.08
S281200	VA	PHF							25.0					
281155	VA	PHF	62	60	2406		1004.0	213	7.0		28	10	250	.15
S281219	VA	PHF			2706		1004.3	230	1.5	RF	8	20		
S281200	VA	ORF			2721	33	1003.6	300	1.0	TR+	12			
281150	VA	ORF	65	62	2606		1003.3	230	7.0		22	45		.08
281150	VA	ROA	41	33	3008		1008.4	210	10.0		80	40		.00
281149	VA	DAN	52	49	2906		1006.3	230	25.0		20	30		
S281137	VA	DAA			0000		1004.3	310	4.0	RW-F	23	5		
281155	VA	DAA	53	45	0000		1004.3	213	5.0	RW-F	29	5	80	.58
S281140	VA	FAF			3004		1002.9	211	7.0	RW-	40	5	12	
281158	VA	FAF	61	60	3008		1003.3	213	1.0	TRW-	12	5	40	
S281225	VA	FAF			2706		1004.0	213	2.5	TRW-	7	5	12	
281155	VA	LFI	63	61	2808		1002.9	213	7.0		20	8	35	1.03
S281214	VA	LFI			2810		1003.6	213	6.0	RW-	12	5	30	
281155	VA	NGU	64	60	2710		1003.6	211	7.0		14	4	8	
S281210	VA	NGU			2708		1003.6	211	6.0	RW-	14	4	8	
S281230	VA	NGU			2710		1004.0	213	5.0	RW-F	29	8	60	
281155	VA	NTU	65	61	2506		1003.6	213	4.0	RW-F	10	5	30	.26
S281230	VA	NTU			2306		1004.6	213	5.0	TF	10	5	30	
281155	VA	NYG	52	47	0102		1004.0	230	9.0	R-L-	11	23		.44
281150	VA	WAL	64	64	2506		1002.6	213	4.0	RW-F	30	5	70	