PATTERN RECOGNITION OF SIGNIFICANT SNOWFALL EVENTS IN TALLAHASSEE, FLORIDA

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Abstract

Skew-T Log-P diagrams, surface, and standard level upper air charts from four significant snowfall events in Tallahassee, Florida are analyzed. One of these cases is discussed in detail to illustrate the common synoptic patterns associated with these rare occurrences. Since 1895, there have been only seven snowfall events in Tallahassee when measurable snowfall (i.e., accumulations of 0.1 inches or more) were reported. Most of these occurred in February. These snow events shared several common characteristics: (1) long wave ridging over the western Continental United States, (2) a deep trough and/or polar vortex over the Great Lakes, northeast United States, or southeast Canada, (3) a 500-mb short wave trough propagating eastward from the southwest United States across the Gulf Coast, (4) freezing temperatures over Tallahassee and a trough oriented northeast to southwest at the 850-mb level, (5) a cold surface anticyclone over much of the United States, (6) a weak wave of low pressure propagating eastward along a quasi- stationary surface front over the southern Gulf of Mexico, and (7) a classic snow sounding with freezing temperatures throughout most of the troposphere.

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1. Introduction

Pattern recognition is an important tool for operational meteorologists. By recognizing and understanding patterns associated with significant weather events, meteorologists potentially can provide better lead time and more accurately describe the expected impacts of the forecast event to their users. Unfortunately, this skill is difficult to acquire for rare events.

Measurable snowfall events in Tallahassee, Florida are rare. Due to the rarity of snowfall, it does not require much accumulating snow to produce significant impacts; however, it is not practical for businesses and government agencies to maintain a budget for a weather phenomenon that occurs so infrequently. Therefore, this part of the country does not have the dedicated manpower, snow removal equipment, or experience to handle snow storms. Even snow amounts of less than two inches can strain local resources and have an adverse effect on the local economy. Because of these limited resources, officials must resort to closing entire airports, major roads, bridges, businesses, and schools. The roads that do remain open can still be icy, which is particularly dangerous to drivers with little or no experience in such conditions.

The extreme cold that accompanies some snow events can also be dangerous and costly. During the December 1989 snow storm, the maximum temperature at Tallahassee on 23 December only reached 32 °F. The minimum temperature on 24 December was a record 13 °F. This cold wave damaged Florida crops and was blamed for deaths related to hypothermia and house fires caused by the unsafe use of space heaters. An even colder event was the February 1899 snow storm. The all-time minimum temperature for Florida was set in Tallahassee on 13 February. The low was -2 °F (NOAA/NWS Tallahassee 2008). This occurred after an inch of snow fell as a low pressure system moved eastward across the Gulf of Mexico and the Florida peninsula (similar to the evolution of the surface pattern common to the other snow events described in this paper).

With sufficient warning, plans could be made to help mitigate the negative impacts of snow storms and their accompanying cold temperatures. City managers could plan extra staffing ahead of time. Construction equipment and vehicles could be converted into makeshift snow removal equipment before the snow begins, allowing more runways, roads, bridges, and businesses to remain open. Shelters could be open to those with inadequate heating, and farmers and nursery operators could take steps to protect their crops and plants before the onset of freezing temperatures.

Since 1895, there have only been seven instances when measurable snow was recorded at the official reporting station in Tallahassee. Although this is an average of approximately once every 16 years, this statistic can be misleading because there was a 52-year period with no measurable snowfall during the first half of the 20th century (NOAA/NWS Tallahassee 2008). The last measurable snowfall in Tallahassee was in 1989. The average snowfall amount for these seven events was 1.1 inches, with a maximum of 2.8 inches in 1958 and a minimum of 0.2 inches in 1951. Five of the seven snow storms occurred in February. It is interesting that there has never been measurable snowfall in Tallahassee in January, the coldest month of the year. Of the four snow storms since 1955, two occurred during "El Nino" episodes (1958 and 1973), one occurred during a "La Nina" episode (1955), and one occurred during a neutral episode (1989) (NOAA/NWS Climate Prediction Center 2007). Although snowfall in Florida has been discussed in some literature (Henry et al. 1994), little has been written detailing the synoptic patterns that favor such occurrences.

2. Methodology

The results of this paper are based on analyses of data from the four most recent measurable snowfall events in Tallahassee, Florida. These cases were chosen because of the availability of upper air data:

- 28 March 1955 — 0.4 inches
- 12-13 February 1958 — 2.8 inches
- 10 February 1973 — 0.4 inches
- 22-23 December 1989 — 1 inch

The surface, 850 mb, and 500 mb weather charts were analyzed using "Christopher Godfrey's National Centers for Environmental Prediction Reanalysis Plotter" available online at http://weather.ou.edu/~cgodfrey/reanalysis/. This tool allows the user to plot analyses of several meteorological parameters at most of the standard reporting levels from the surface to 200 mb. Skew-T Log-P diagrams were analyzed for each case using the nearest available RAOB site. For the March 1955 and February 1958 storms, the nearest site was Eglin Air Force Base, Florida (VPS). This RAOB site is located near the coast of the Florida Panhandle, 150 miles west of Tallahassee. For the February 1973 storm the nearest RAOB site was Waycross, Georgia (AYS). Waycross is located in southeast Georgia, 150 miles northeast of Tallahassee. Apalachicola, Florida (AQQ) was the nearest available RAOB site for the December 1989 storm. Apalachicola is located on the coast of the Florida Big Bend, 70 miles southwest of Tallahassee. The Skew-T Log-P diagrams for the March 1955 and February 1973 storms were obtained from the "Radiosonde Data of North America" CD-ROM prepared by the Forecast Systems Laboratory and the NOAA/National Climatic Data Center (FSL and NCDC 1999). The other diagrams were obtained using the "Plymouth State Weather Center" website (Plymouth State Weather Center 2007). Archived daily weather maps from the National Oceanic and Atmospheric Administration Central Library Data Imaging Project's "U.S. Daily Weather Maps Project" (NOAA Central Library 2007) were used to view 1200 UTC and 0000 UTC surface observations around the country.

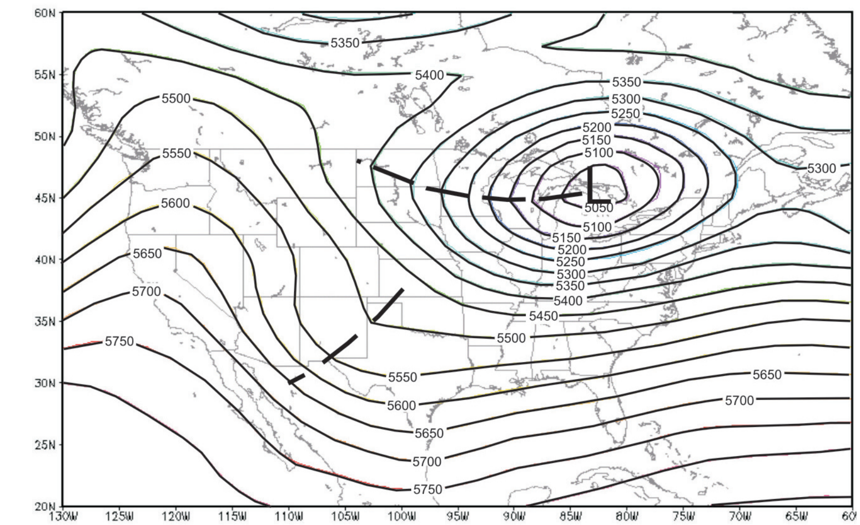

Fig. 1. 500-mb analysis valid for 0000 UTC 12 February 1958. Geopotential heights (every 50 meters) are indicated by black solid lines. Analyzed troughs are shown using standard symbols.

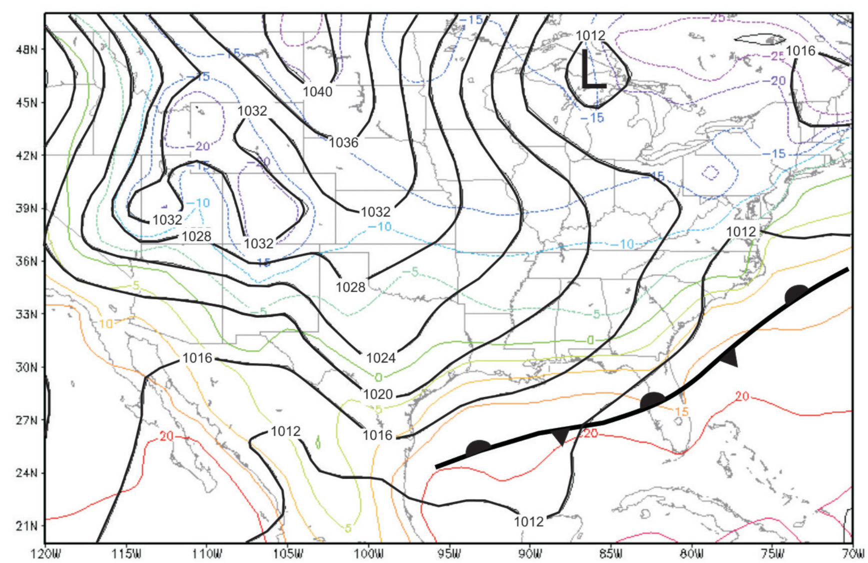

Fig. 2. Surface analysis valid for 0000 UTC 12 February 1958. Mean sea level pressure is every 4 mb (solid black lines). Temperatures every 5 degrees C are indicated by shaded lines. Surface highs, lows, and fronts are analyzed using standard symbols.

To help the reader understand the synoptic pattern common to these snow storms, the February 1958 case is presented in detail. This case is similar to the ones not shown in this paper, and provides the reader with a good template of the large scale weather patterns associated with Tallahassee snow storms. The figures shown from this event give sufficient vertical structure and continuity for the reader to develop general pattern recognition without being overwhelmed by details. The evolution of this event is described, from approximately 24 hours prior to the beginning of snow in Tallahassee, to the approximate end of the snow event. This encompasses a period of 36 hours. Skew-T Log-P diagrams from Eglin Air Force Base (VPS) are also included.

3. The February Snow Storm of 1958

The all-time 24-hour record snowfall for Tallahassee, Florida occurred on 12 and 13 February, 1958. The official total was 2.8 inches at Mabry Field (2.4 inches on 12 February, and 0.4 inches on 13 February). Nearly twenty-four hours before snow began in Tallahassee at 0000 UTC on 12 February, there was a polar vortex at the 500-mb level over Lake Huron, with a trough axis extending westward to North Dakota (Fig. 1). There was a long wave ridge over the western United States and an embedded short wave trough over New Mexico (Fig. 1). At the surface, a quasi-stationary front was oriented east to west over the central Gulf of Mexico (Fig. 2). At 0600 UTC 12 February several stations in Texas reported snow, even as far south as San Antonio (reports not shown). Figures 2 and 3 show the large, cold anticyclone that covered much of the United States and the cold 850-mb temperatures approaching Tallahassee. By 1200 UTC 12 February (approximately twelve hours before the snow began in Tallahassee), the 500-mb short wave trough had propagated from New Mexico to east Texas (Fig. 4) and a weak frontal wave had developed at the surface over the south central Gulf of Mexico (Fig. 5). Strong cold air advection ahead of the approaching 850-mb trough (Fig. 6) allowed much of the lower troposphere to cool to near or below freezing (Fig. 7).

At 0000 UTC 13 February, there was a marked increase in deep layer moisture compared to twelve hours earlier (Figs. 7 and 11) as the northern portion of the precipitation zone in the Gulf of Mexico reached the Florida Panhandle, and the entire troposphere had cooled below freezing. The 500-mb short wave trough was over Louisiana and the western Gulf of Mexico (Fig. 8). The weak surface frontal wave was located over the southeast Gulf of Mexico (Fig. 9). The 850-mb 0 degree C isotherm was over Tallahassee (Fig. 10) and the 850-mb trough axis was oriented northeast to southwest over the area. The snow ended on the morning of 13 February as surface cyclogenesis occurred off the southeast United States coast (Fig. 12).

4. Summary and Conclusions

Seven measurable snowfall events have occurred in Tallahassee since 1895. Four of the latest events, from the period 1955-1989, were examined. These cases provided a subjective composite of a measurable snowfall event in Tallahassee. The 1958 snow storm was found to be especially representative of the composite.

Our study revealed insights about the evolution of the surface, 850-mb, and 500-mb meteorological features as well as the typical vertical thermal and moisture characteristics associated with the relatively rare occurrence of measurable snow in Tallahassee. The large scale 500-mb heights are relatively low for the eastern United States. There is a long wave ridge axis between the Pacific Coast and the Rocky Mountains, and a deep trough and/or polar vortex over the Great Lakes, northeast United States, or southeast Canada. A 500-mb short wave trough propagates eastward from the southwest United States to the central Gulf Coast, keeping Tallahassee under moist southwest flow in the middle to upper troposphere. This differs from the more common arctic outbreaks that

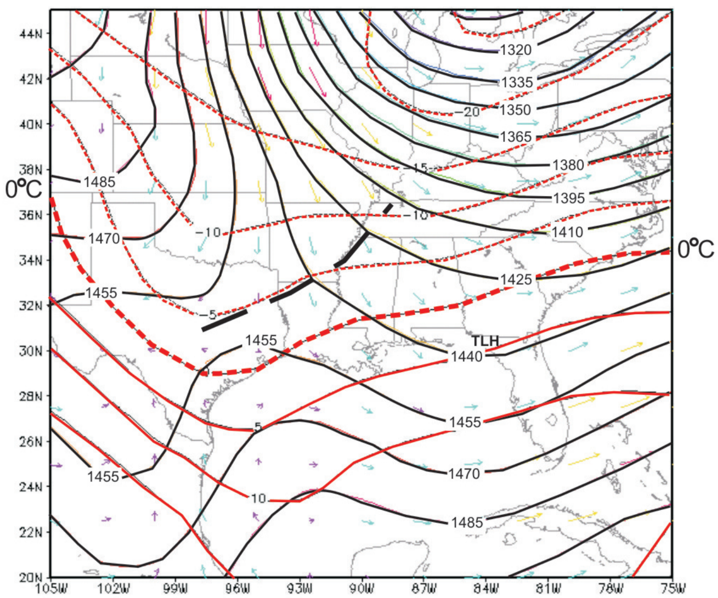

Fig. 3. 850-mb analysis valid for 0000 UTC 12 February 1958. Geopotential heights (every 15 meters) are indicated by solid black lines while analyzed troughs are shown using standard symbols. Temperatures are indicated by red lines for every 5 degrees C. The 0 degree C isotherm is displayed as the thick dashed red line. Wind vectors (m s^{-1}) are also plotted (vector scale not shown).

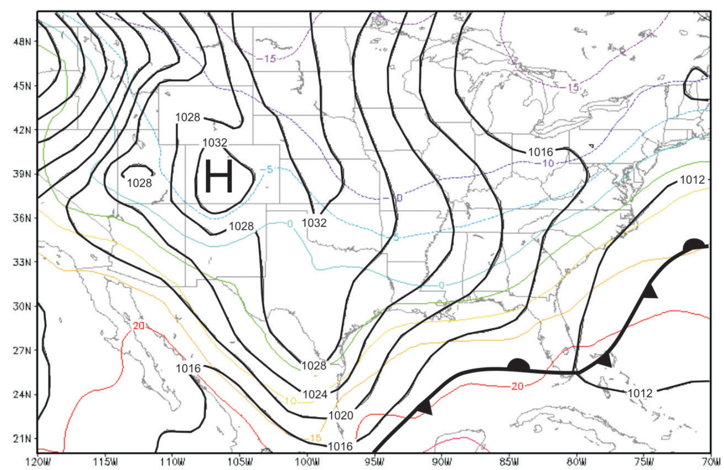

Fig. 5. As in Fig. 2, except for 1200 UTC 12 February 1958.

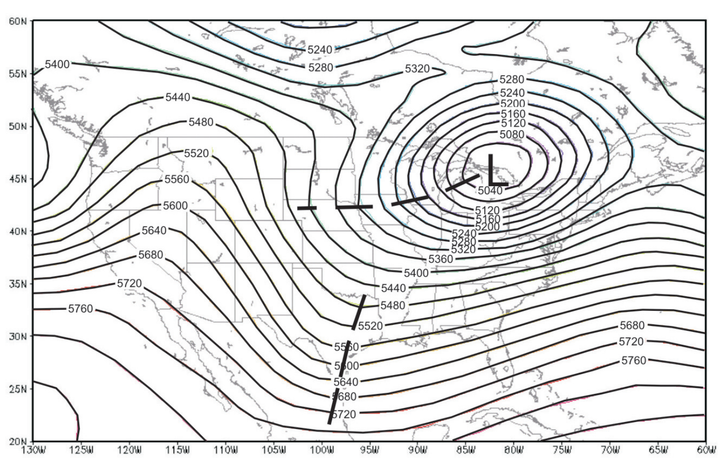

Fig. 4. As in Fig. 1, except for 1200 UTC 12 February 1958.

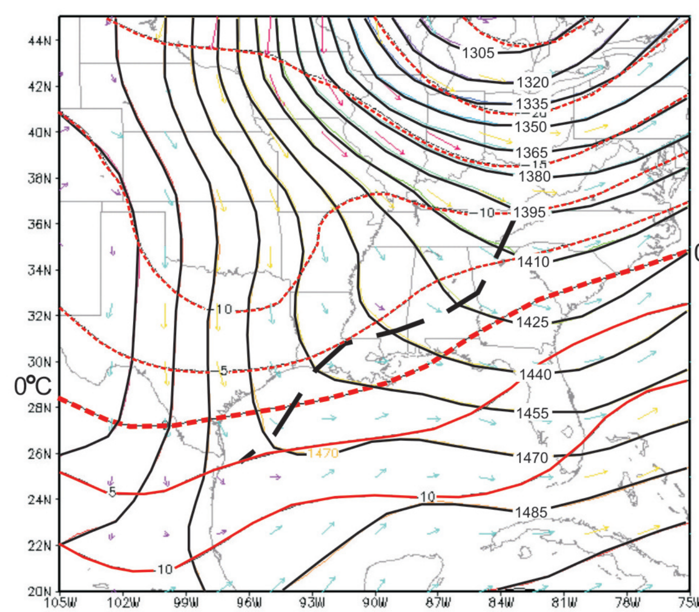

Fig. 6. As in Fig. 3, except for 1200 UTC 12 February 1958.

occasionally affect the Gulf Coast. In these non-snow cases a long wave 500-mb trough is positioned farther east over the eastern United States, so that very dry northwest flow prevails over the northeast Gulf Coast.

At the surface, a quasi-stationary front is oriented east to west over the southern Gulf of Mexico. A large, cold anticyclone covers much of the United States with a 1045-mb center (average value) over the central part of the

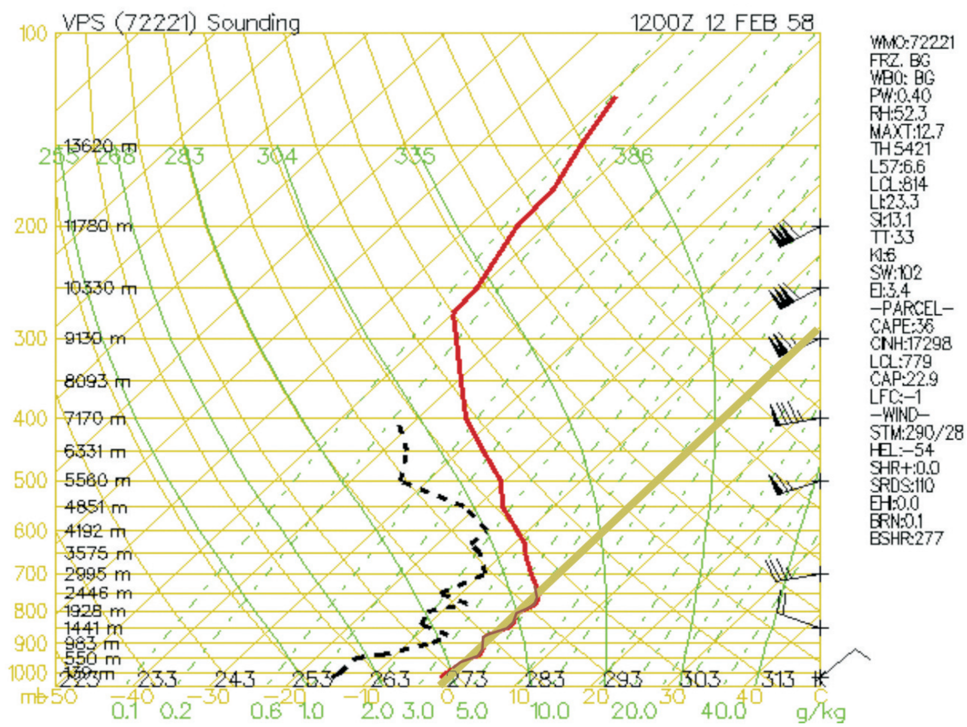

Fig. 7. Skew-T Log-P diagram for Eglin Air Force Base, FL valid at 1200 UTC 12 February 1958. Pressure appears as the y-axis variable, ticked every 100 mb from 1000-100 mb. Temperature is shown on the x-axis variable for every 10 degrees C. Environmental temperature (degrees C) is shown as a red line and dew point in black. Temperatures to the left (right) of the thick yellow-green line are below (above) freezing. Environmental winds are plotted on the far right side of the diagram.

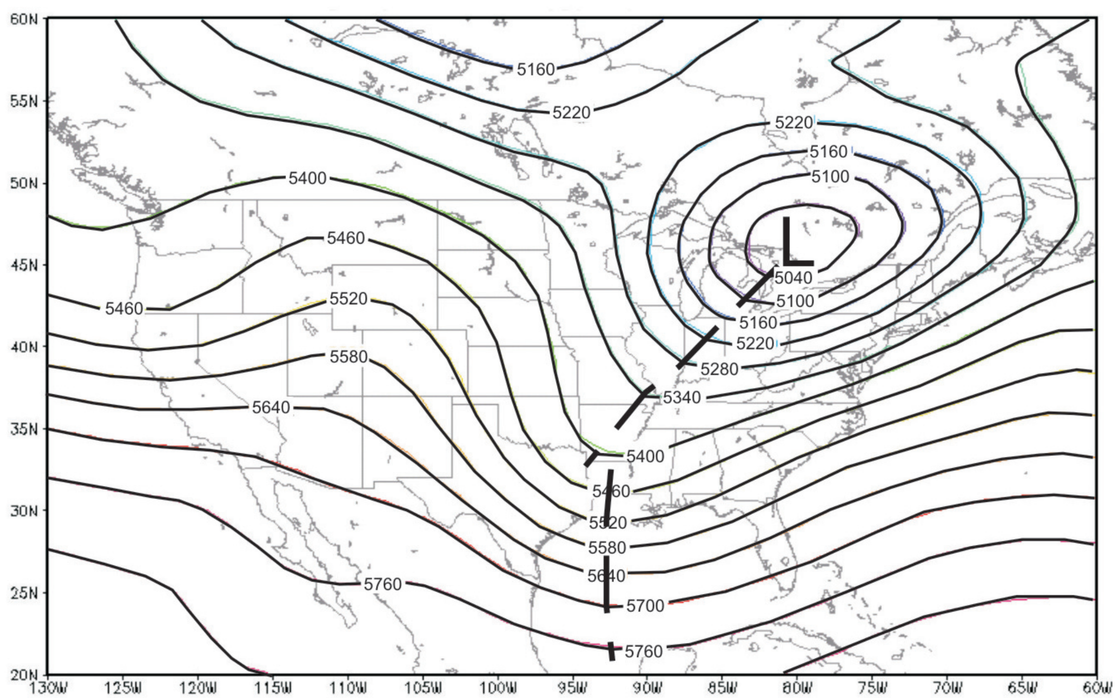

Fig. 8. As in Fig. 1, except for 0000 UTC 13 February 1958.

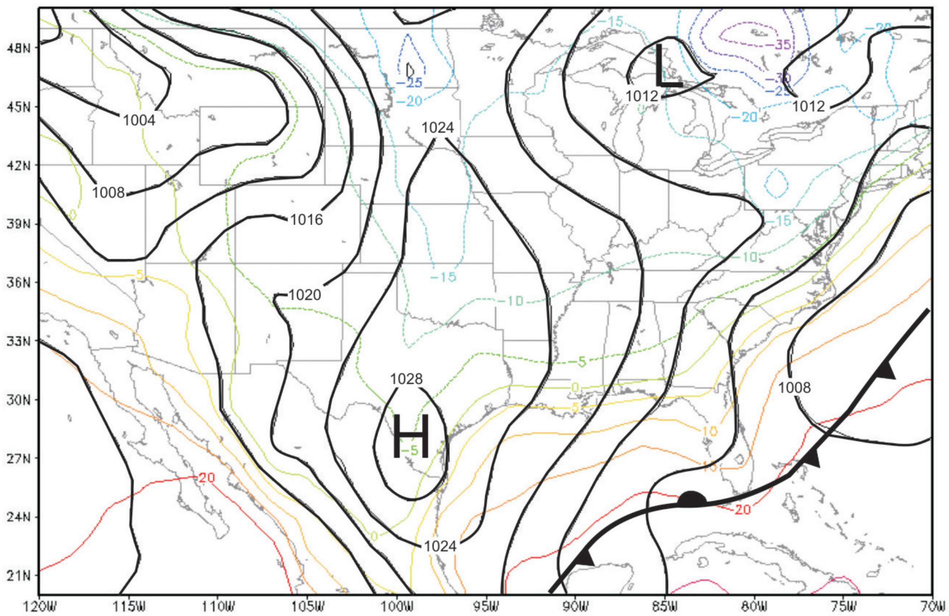

Fig. 9. As in Fig. 2, except for 0000 UTC 13 February 1958.

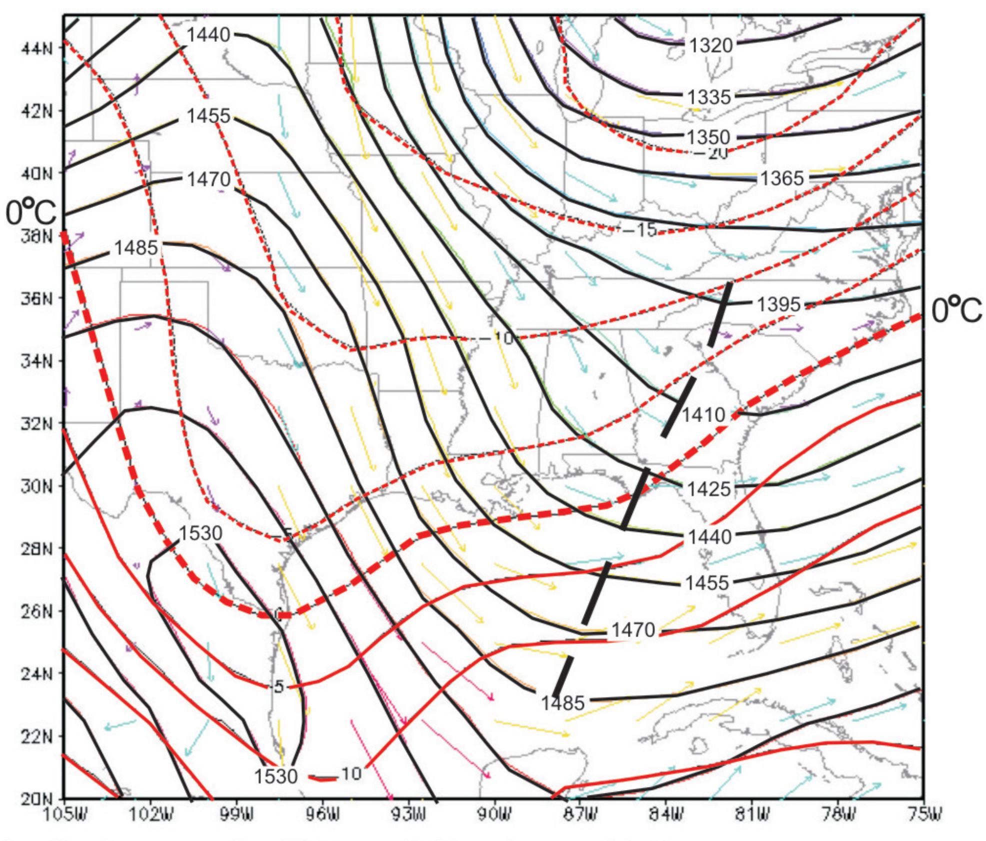

Fig. 10. As in Fig. 3, except for 0000 UTC 13 February 1958.

country. A ridge extends southward from this high to northeast Mexico, and another ridge extends from the high to the United States east coast. As the 500-mb short wave trough propagates eastward across Texas, a weak wave of low pressure forms along the front in the southern Gulf of Mexico. On the surface chart with isobars at 4-mb increments, there is no closed center with this feature. As the wave develops, large scale ascent and deep layer moisture combine to produce a large frontal cloud band with areas of mostly light precipitation. Freezing rain or snow often occurs along portions of the northwest Gulf Coast less than twenty-four hours prior to snow beginning in Tallahassee. The frontal wave propagates eastward along the front, ahead of the approaching 500-mb short wave trough. The snow in Tallahassee typically lasts 24 hours or less, and ends soon after a closed surface low develops off the southeast United States coast. This coincides with deep layer drying over northwest Florida.

The 850-mb freezing isotherm traditionally has been used by operational meteorologists as first guess line that distinguishes snow from rain. In all the cases analyzed for this paper, this isotherm is near Tallahassee at the time of snow. This happens as an 850-mb trough forms over the southeast United States. This trough, which is oriented northeast to southwest, is initially north of Tallahassee. As it propagates southeastward, strong cold air advection on the eastern side of the trough brings the 850-mb freezing line far enough south to allow the northern portion of the precipitation zone to change to snow. At this point the skew-T Log-P diagram shows the classic snow sounding, with freezing temperatures throughout much of the troposphere and an increase in deep layer moisture.

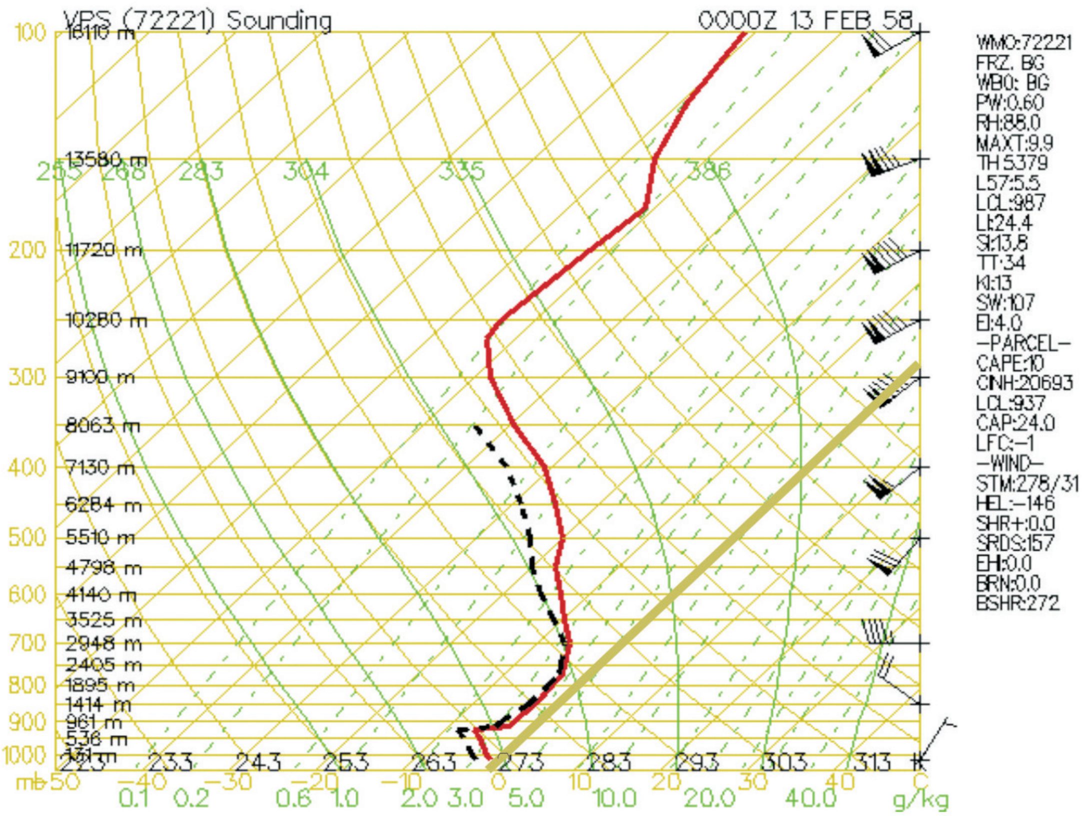

Fig. 11. As in Fig. 7, except for 0000 UTC 13 February 1958.

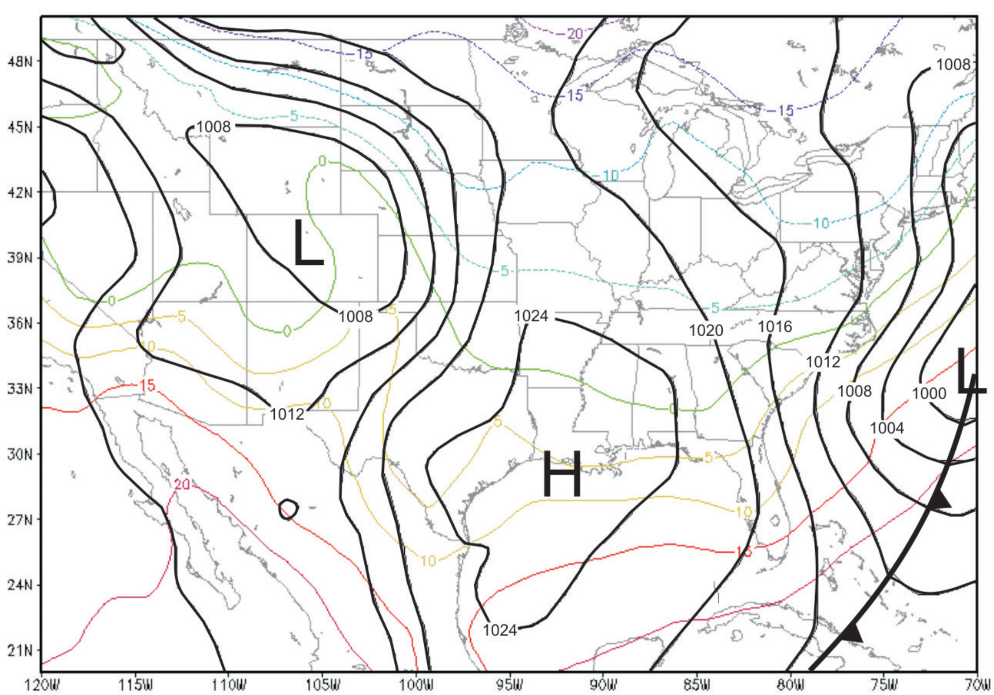

Fig. 12. As in Fig. 2, except for 1200 UTC 13 February 1958.

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