Forecast Event Review – Cold Frontal Passage on October 23, 2005

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I. Introduction and Background

One of the greatest forecast challenges that we face during the fall months is the timing and intensity of cold frontal passages. During this time of year, fronts can be fickle creatures and often wreak havoc upon the temperature forecasts across the Tennessee Valley. One such challenging forecast and frontal passage occurred on Sunday, October 23rd. On the previous day (Saturday), an initial surge of cooler air had pushed into the region with substantial cold air advection observed across the region. The surface observation from 00 UTC Saturday evening (Figure 1) shows a weak ridge of high pressure across the Tennessee Valley with general northwest flow and temperatures in the middle 50s.

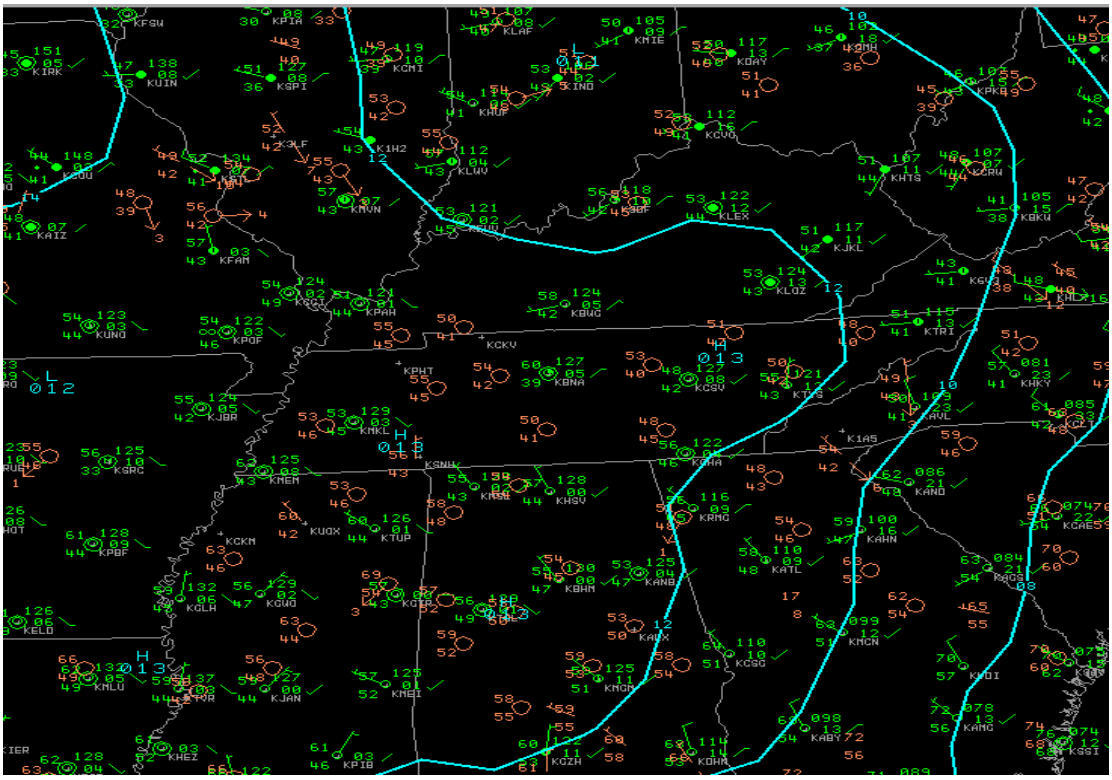

Figure 1. Surface observations from Sunday, October 13th at 00 UTC.

Shortly after midnight, temperatures had dipped into the lower to middle 40s, with a few sheltered locations reporting upper 30s (based on the HUN AFD). The surface analysis from 07z (Figure 2) shows a reinforcing surface front extending from the Ohio Valley

into the mid Mississippi Valley. An area of cloudiness was also advancing east southeast in advance of this frontal system (Figure 3).

Based on the satellite trends and the advancing cold front, the first period was adjusted to include “Mostly Cloudy” wording for the Sunday period. The early morning AFD did not specifically mention the timing of the aforementioned cold front, but judging from the CCF and gridded forecast information, it is implied that either the forecaster expected a quicker frontal passage than the 00Z model guidance or expected an extensive area of opaque cloud cover for much of the day. The MOS guidance forecasted max temps ranging from 65 to 70 degrees, while the official forecast (ZFP) had “lower 60s” areawide.

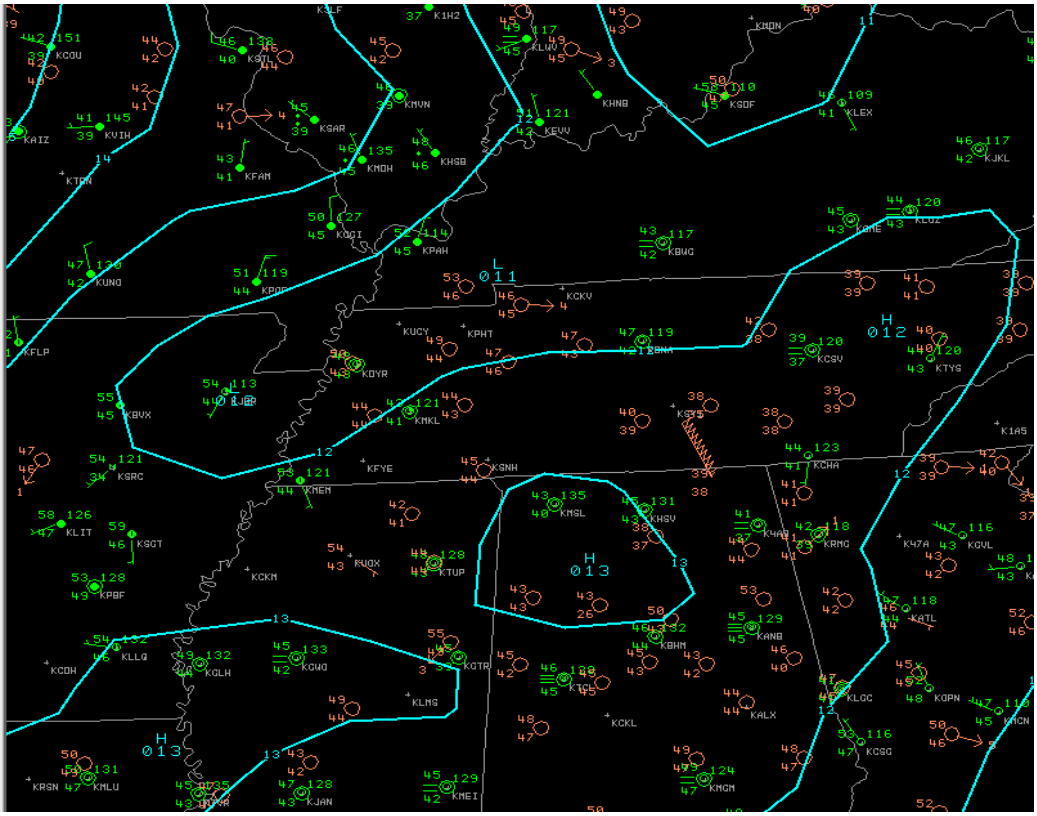

Figure 2. Surface observations from Sunday, October 13th at 07 UTC.

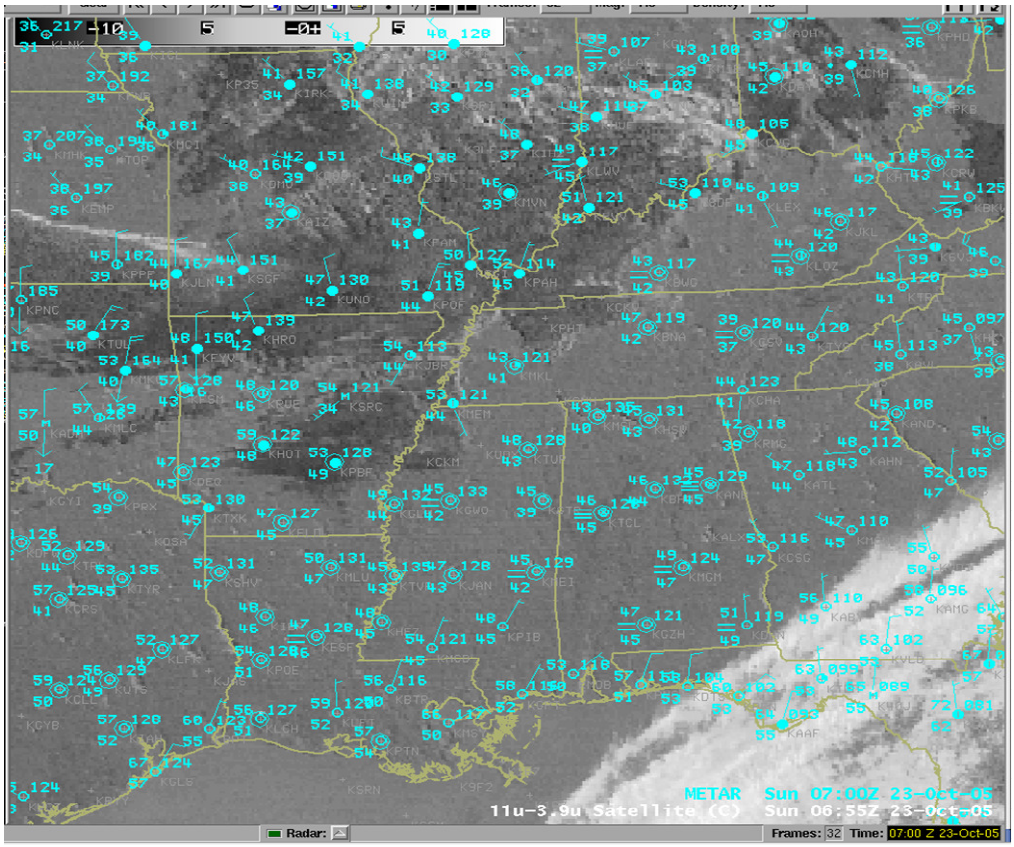

Figure 3. 11-3.9 micron imagery for 0655 UTC on Sunday, October 13th

II. Model Diagnosis

To further diagnose the timing of the front, cloud cover potential, and temperature rise expected for Sunday, October 13th let's look at some additional model diagnostic information. In reviewing the moisture fields from this case, it appeared that both the GFS and 12km Eta/NAM had a pretty good handle on the evolution of the event. In Figure 4, we see the relative humidity forecasts for both the 1000-850 (top image) and 850-500 (bottom image) millibar layers from the Eta12 (left) and GFS (right) models. Both show the bulk of the moisture to the north of the CWA at this time, and both the MSL and HSV ASOS were reporting CLR BLO 120 at that time.

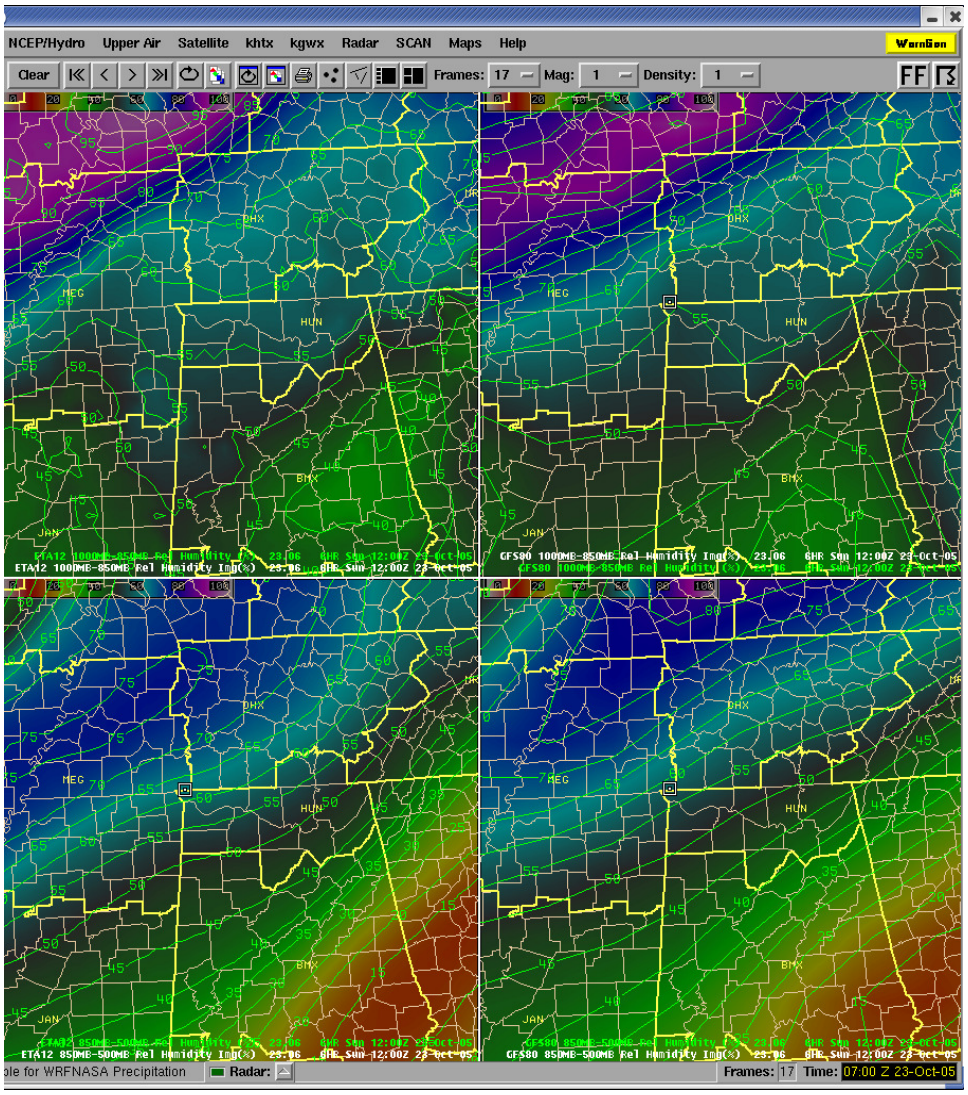

Figure 4. 12km Eta (left) and GFS (right) layer RH for 12 UTC on 10/23/05.

Figures 5 through 6 will show the progression of the moisture axis in these layers through 21 UTC on that Sunday. One can see in figure 5 that the 1000-500 mb layer was clearly moistening across northwest AL by 18z, and this is indeed the time (1758Z) when the first broken layer was observed at 7000 feet AGL. By 21z, the moist layer has advanced eastward toward Huntsville and observations support this with HSV first reporting a broken cloud deck at 1954 UTC. It should also be noted that both models indicated little in the way in the way of measurable precipitation across the Tennessee Valley (QPF images not shown). The HUN forecast of very low PoPs (20%) worked out well in this case.

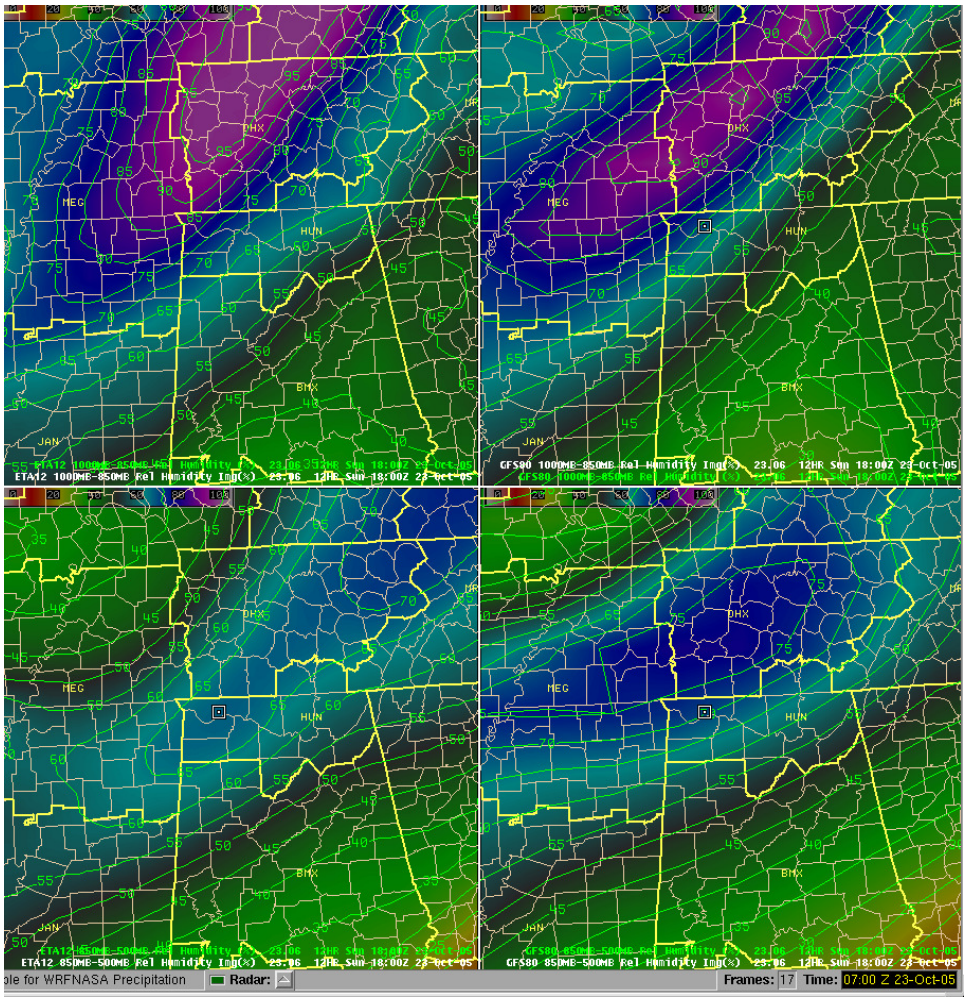

Figure 5. 12km Eta (left) and GFS (right) layer RH for 18 UTC on 10/23/05.

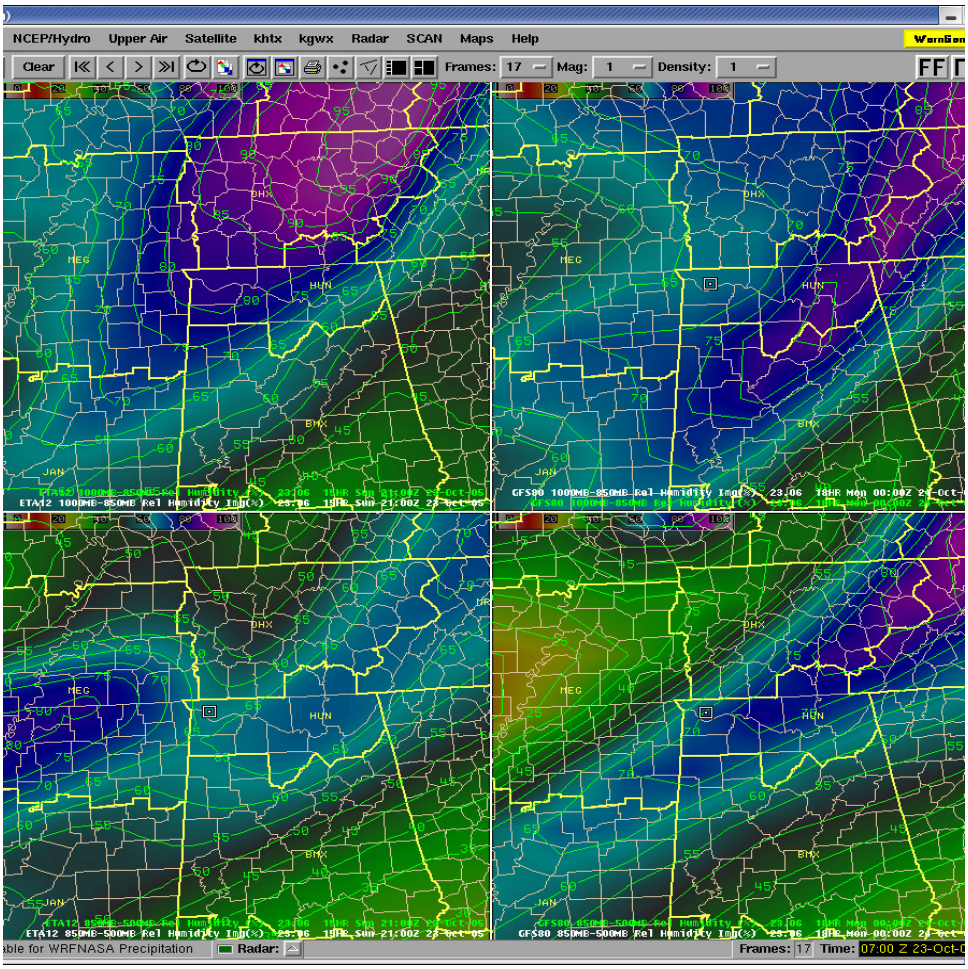

Figure 6. 1km Eta (left) for 18z and GFS (right) for 00Z layer RH on 10/23/05.

With the models seemingly having a good handle on both the moisture and QPF fields, it's probably a decent assumption that the temperature fields from the models may also be of utility. During the WRF assessment last fall, Kate LaCasse found that the model temperature biases were generally related to their poor forecast(s) of cloud cover. In other words, when they forecasted the moisture fields fairly well, they normally did well with their "surface" (2m) temperatures.

In Figures 7-9, we see the 12km Eta (from the 00z/Sun cycle) depiction of the 2m temperature forecasts for 15Z, 18Z and 21Z respectively. By 18Z and 21Z, the front is relatively easy to pick out and is reflected by the sharp thermal gradient propagating southeast through northern Alabama. From this, one can infer a frontal passage at MSL around or shortly before 18Z and at Huntsville around before 21Z. The maximum 2m temperature observed at both HSV and MSL was 67F. There were some 68 to 69 degree 2m temperatures in southern Marshall and Cullman counties. This also matches up fairly well with the 18Z 2m temperatures from the GFS (Figure 10).

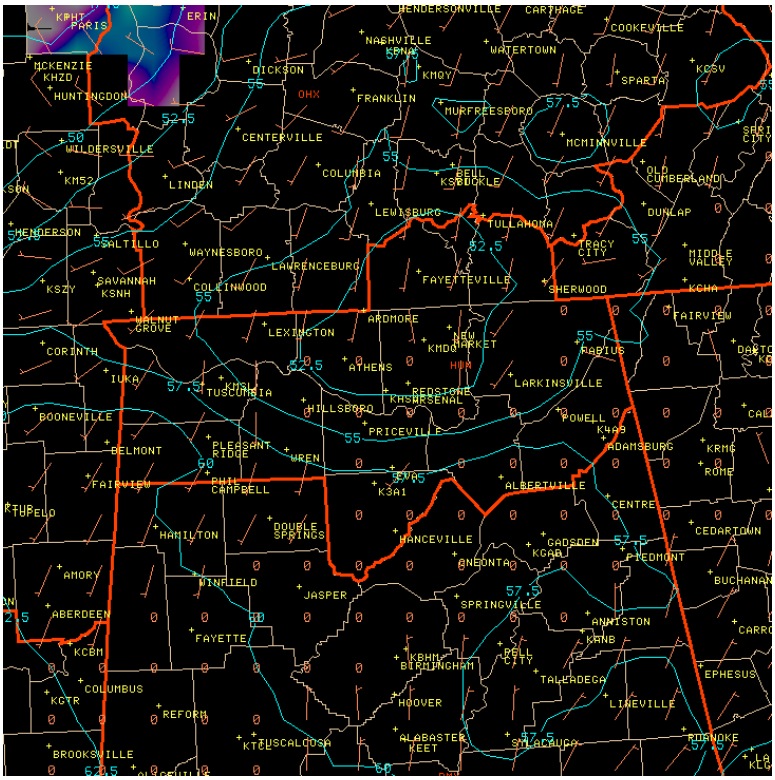

Figure 7. Eta12 2m temperature for 15Z on 10/23/05.

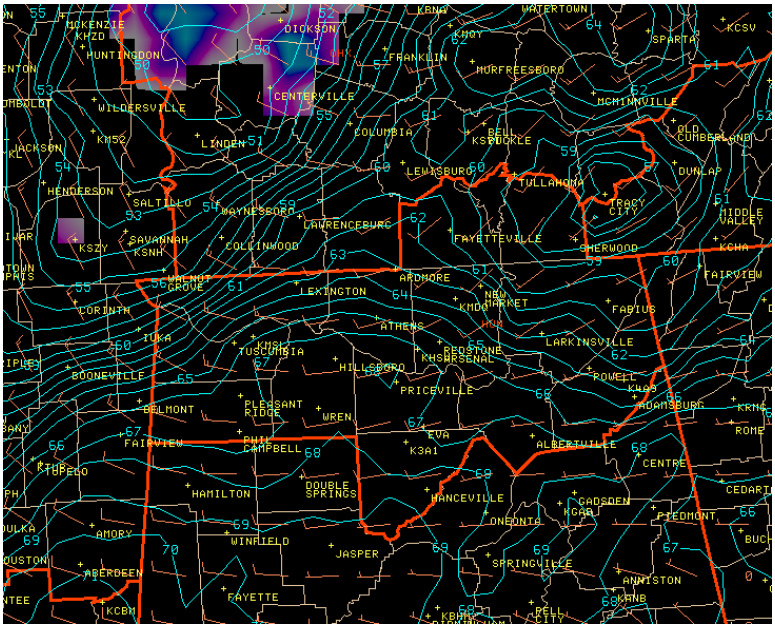

Figure 8. Eta12 2m temperature for 18Z on 10/23/05.

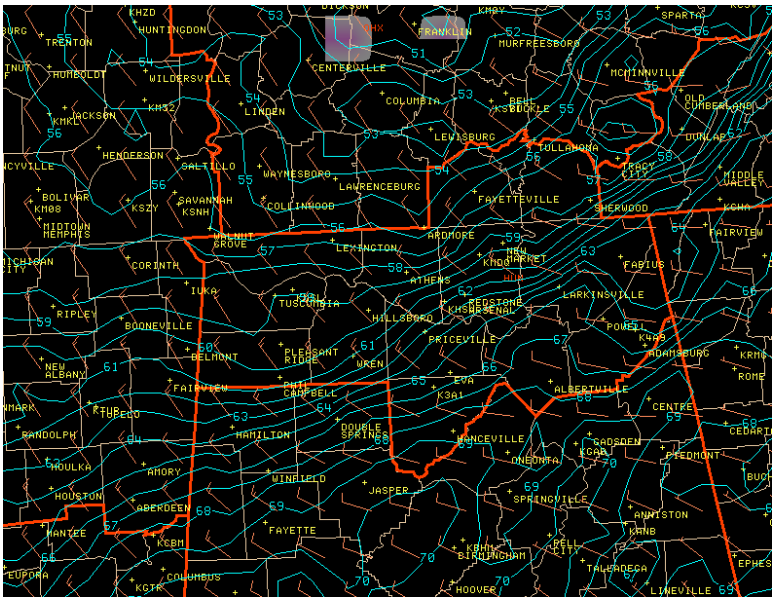

Figure 9. Eta12 2m temperature for 21Z on 10/23/05.

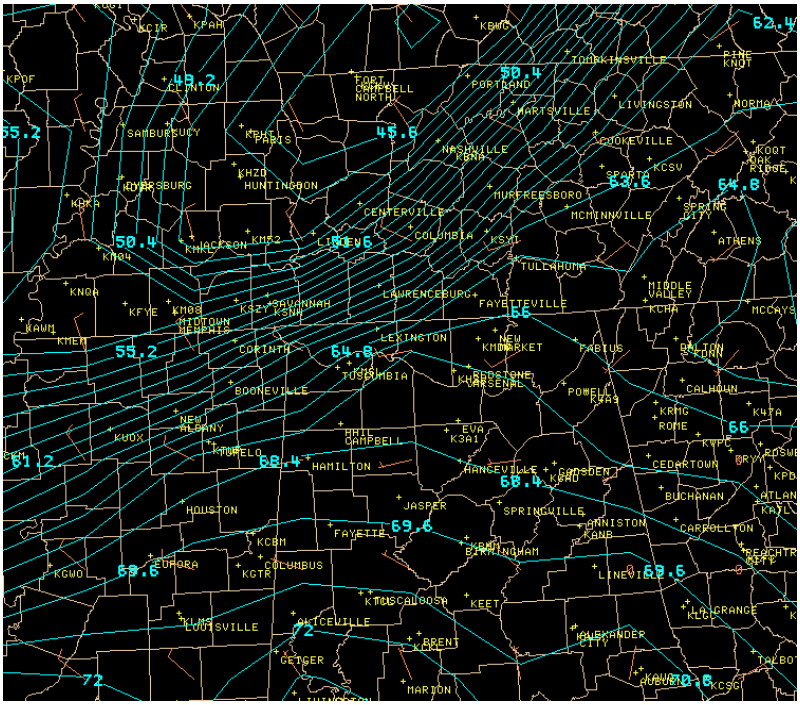

Figure 10. GFS 2m temperature for 18Z on 10/23/05.

Another useful tool for assessing boundary layer thermodynamic conditions along with moisture profiles is the Eta Bufr forecast soundings. In the following figures, we'll look at the Eta Bufr soundings from the 00Z Sunday model run. The progression of images shows a gradual warming of the lower troposphere throughout the afternoon. In fact, the 19z Bufr sounding (Figure 13) shows a nearly dry adiabatic temperature profile up to 850

millibars capped off by a very shallow moisture layer between 800 and 750 millibars. The surface temperatures from the soundings also show temperatures well into the 60s by 19z.

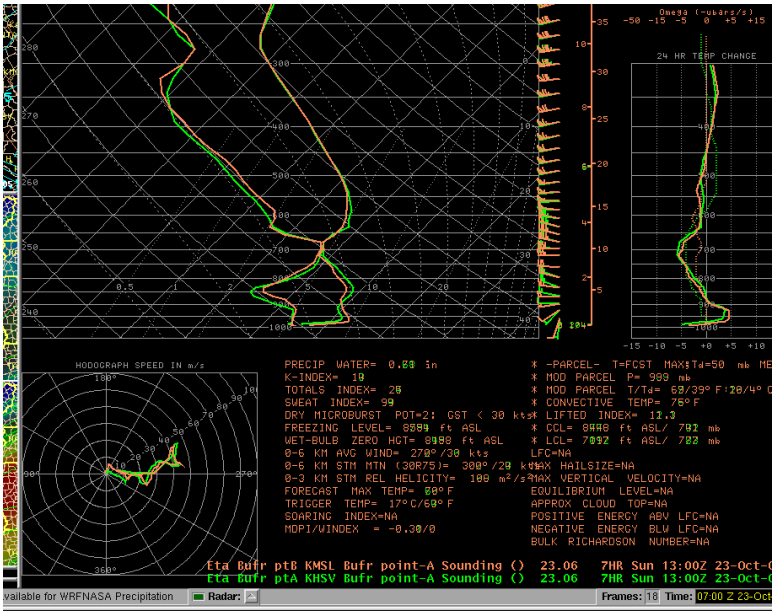

Figure 11. Eta Bufr Sounding for 13z for HSV (green) and MSL (orange).

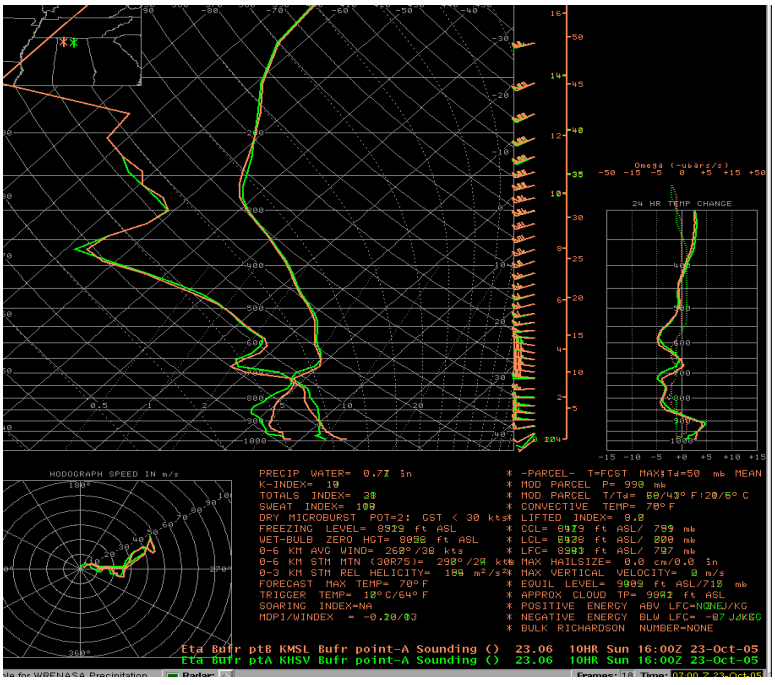

Figure 12. Eta Bufr Sounding for 16z for HSV (green) and MSL (orange).

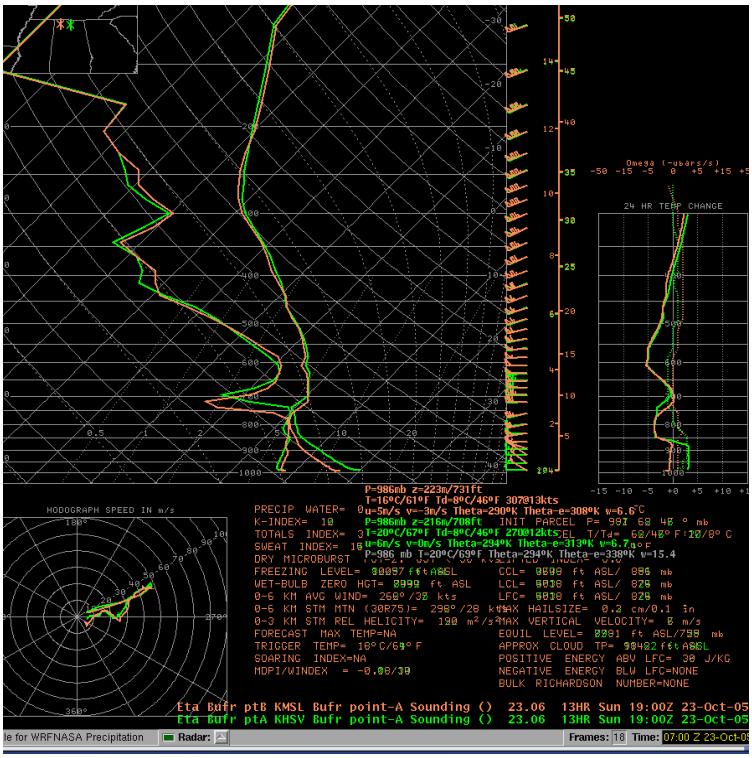

Figure 13. Eta Bufr Sounding for 19z for HSV (green) and MSL (orange).

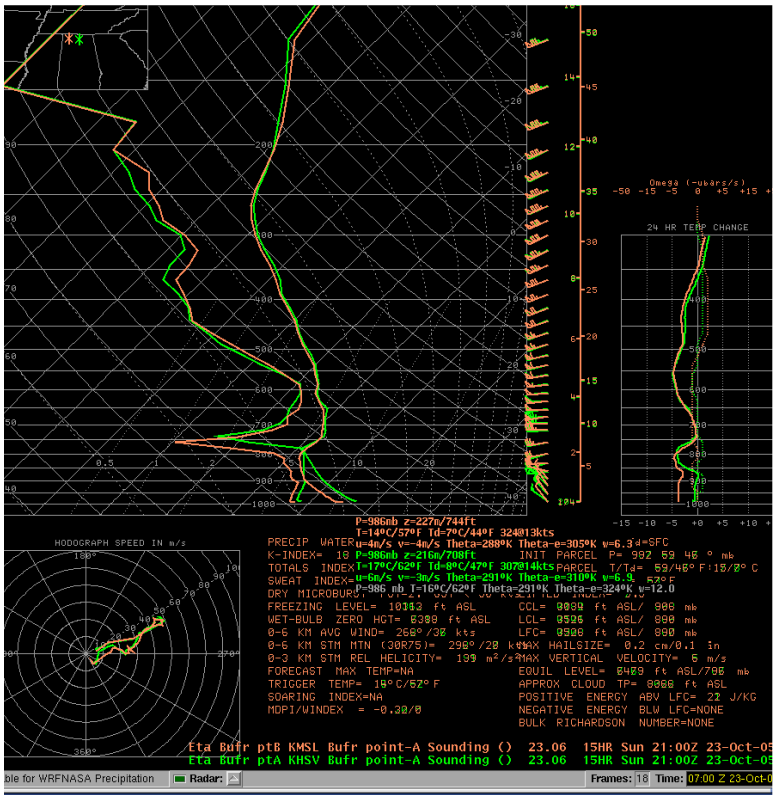

Figure 14. Eta Bufr Sounding for 19z for HSV (green) and MSL (orange). Cooling noted at both HSV and MSL indicating frontal passage has taken place (or forecast to take place) by this time.

III. Analysis and Summary

In the end, temperatures warmed rapidly during the morning and early afternoon hours on Sunday October 13th. The combination of partly cloudy skies and low level warm air advection ahead of the approaching frontal boundary allowed temperatures to warm well into the upper 60s to lower 70s across north Alabama. The temperature rise was a bit more variable ahead of the front across southern Tennessee due to cloud cover and proximity to the front, but the majority of reporting sites topped out in the lower to middle 60s.

A review of the HUNOSOHUN issued Monday morning revealed high temperatures ranging from 60F at Lynchburg to 75F at Arab. This temperature gradient is also evident in the metar/observational plots in Figures 15 through 17 below.

In summary, forecasters should be alert for rapid temperature rises ahead of approaching cold fronts. This is especially true when there is a relative absence of low level clouds to inhibit diurnal heating and when there is not a real strong push behind the cold front. Figures 2 and 3 show only 10 knot northwesterly winds behind the front early Sunday morning. In this particular case, both the GFS and Eta12 did a fair job with the timing and strength of the surface front and associated moisture fields. In fact, the attendant MOS guidance was only 2-3 degrees off for HSV. On the other hand, MSL did warm significantly more than the MOS guidance predicted (~7 degrees) on the 00Z Sunday cycle. It should also be noted that once the front moved through Sunday night, clear skies and light winds allowed temperatures to drop well below (6-7 degrees) MOS predictions at HSV Monday morning.

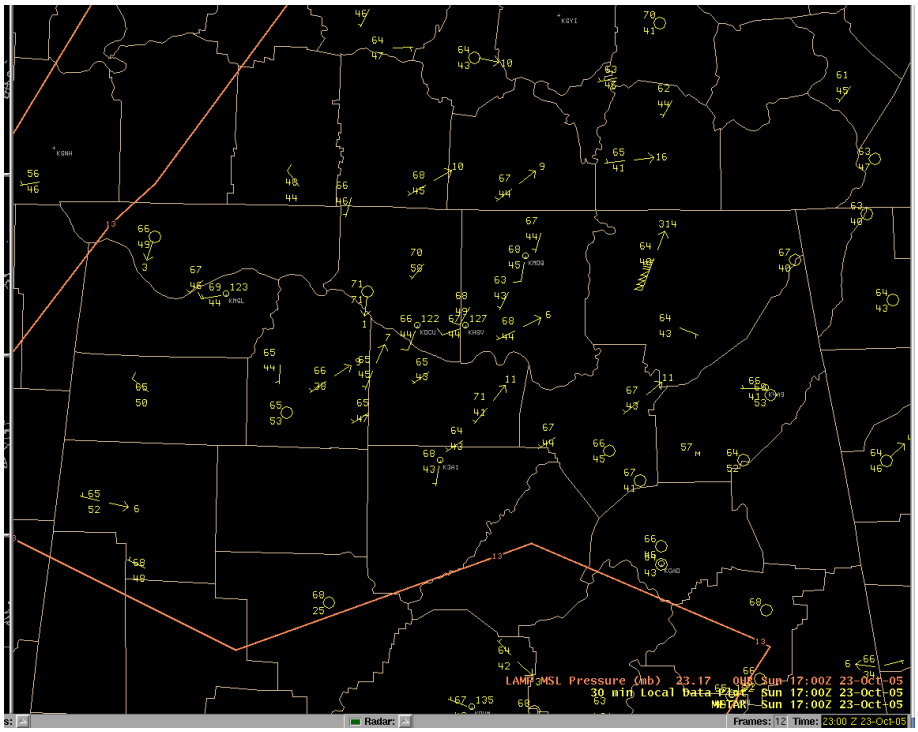

Figure 15. Surface Plot for 17Z on Sunday October 23rd.

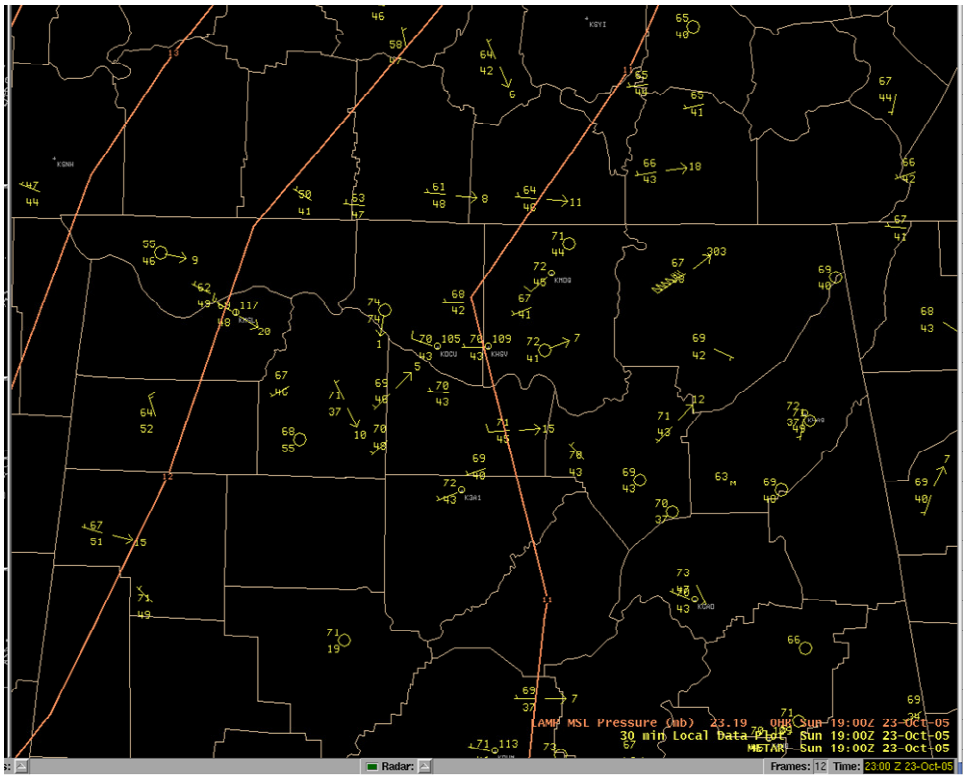

Figure 16. Surface Plot for 19Z on Sunday October 23rd.

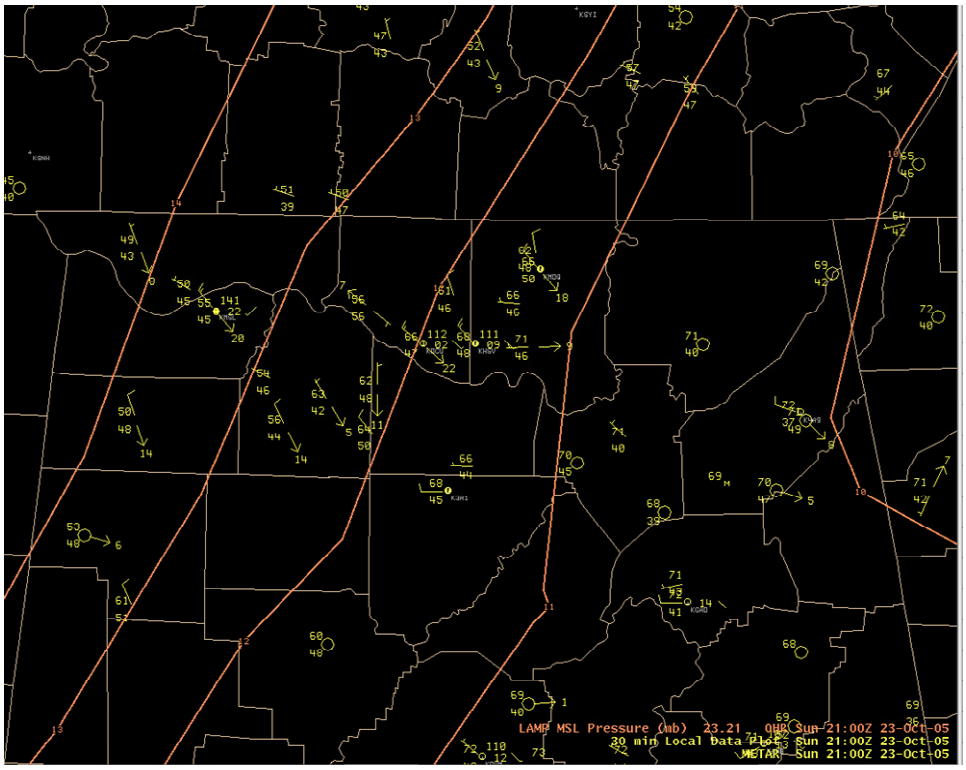

Figure 17. Surface Plot for 21Z on Sunday October 23rd.