Event Review of Low Temperatures Across the Huntsville CWA on 01/14/2004

Michael Richter

1. Synopsis and Forecast Reasoning

This event review will focus on the key issues leading up to the forecast by the public forecaster during the 4 pm afternoon forecast issuance, and not on any previous or subsequent forecasts or analysis completed by other shifts. A rather challenging temperature forecast took place during the overnight hours of January 13-14th. During this timeframe, the Tennessee Valley remained under a prevailing upper level west-northwest flow (Figure 1). 12Z upper air and model analysis reveal the flow to be a bit more complicated to our north and west. The southeast was actually centered within a split flow pattern, with a northern stream longwave trough extending from the Great Lakes to the Mid Atlantic and a weaker southern stream jet core transitioning eastward across the Southern Plains into the lower Mississippi Valley.

Leading up to this event, the prevailing upper level pattern had produced nothing more than a slowly moderating airmass and the occasional weak disturbance embedded within the southern stream. Colder air associated with the longwave trough across the northeast had made very little progress southward over the previous 48 hours, and there was no hint that it would this night either. In fact, the eastern trough was not forecasted to amplify until the following night, allowing a stronger cold front to move through at that time (which it eventually did).

During the late night/early morning hours the previous day, a weak shortwave trough embedded within the southern stream flow brought a period of broken high/mid level cloudiness and even a few reports of sprinkles. This cloud cover, accompanied by some weak warm air advection, held overnight temperatures in the lower 40s across Northwest Alabama, with some lower 30s reported across the coldest valleys in the east. This shortwave was handled quite well by both the ETA and GFS the previous day.

Analysis of 12Z ETA data overlaid on visible satellite imagery for 18Z (see Figure 2a) showed another weak shortwave trough moving east-southeast along the same path across western Arkansas. The ETA subsequently tracks this trough across north central Alabama by later that night. Based on current observations and the forecasted trajectory of this shortwave, it was determined that clouds would gradually thicken late that night as the northern extent of the shortwave clips the area. This would limit the radiational cooling to the evening hours, before temperatures level off overnight. In addition, observations during the afternoon showed high temperatures in the lower 60s, exceeding projected MOS guidance. Also, dewpoints remained in the lower 40s during the afternoon.

However, a surface analysis completed around 18Z (Figure 2b) shows the main complicating factor in this forecast, which was a weak cold front/surface trough over the Ohio Valley slowly tracking southeast into the base of the eastern trough. There was very little hint of this feature in the model projections and it was admittedly forecasted to remain north and east of the Tennessee Valley overnight.

With all these factors in mind, the forecast preference was given to the weak southern stream system. Since little change in airmass was expected, temperatures were forecasted to occur in a similar fashion as the previous night, with thicker cloudiness across Northwest Alabama keeping this area much warmer. The actual zone text called for lows around 40 across Northwest Alabama, lows 35 to 40 across the I-65 corridor and a minor ridge/valley split from 32 to 37 in the valleys to around 40 on the ridges in the east. MOS guidance was in agreement, but just a tad cooler, which was assumed to be the apparent cold bias which the models had displayed over the previous 36 hours.

2. Verification

By 0Z, the shortwave trough was now located across southeastern Arkansas with an associated area of broken mid/high level cloudiness streaming eastward across parts of MS, AL and TN (Figure 3a). Also, a corresponding surface chart at 0Z (Figure 3b) shows the surface boundary had slipped southward into Tennessee, with dewpoints at BNA falling at least 10 degrees since the afternoon.

Regional observations at 06Z (Figure 4) showed that temperatures had radiated as expected during the evening. Temperatures were now in the lower 40s at MSL, HSV and many other obs across northwest and north central Alabama. Also, the higher elevated sites at Monte Sano and Mentone were at 44 and 45 degrees respectively. However, observations to the north begin to hint at a forecast about to go astray. For example, Fayetteville, Merdianville and Scottsboro had fallen into the mid 30s, with points further north in the lower 30s.

Figure 5a shows that the eventual track of the southern stream shortwave is across central Alabama during the early morning, with the bulk of the cloud cover remaining just to our south. Thus, the area remained under partly cloudy to mostly clear conditions throughout the entire night, rather than the forecasted mostly cloudy conditions. Also, based on the METARS from HSV, MSL and MDQ, it appears that the surface boundary slid through around or just after midnight, before becoming nearly stationary and eventually washing out approximately along a Cullman to Gadsden line by 09Z (Figure 5b). In fact, according to the HSV METARS, after temperatures had quickly fallen during the early evening do to radiational cooling, they actually leveled off for several hours (despite little if any cloud cover), before dropping 3 degrees between midnight and 1 am.

Figures 6 and 7 show the subsequent rapid drop off in temperatures after midnight as weak cold air advection and continued radiational cooling combined to bring an unexpectedly “frosty” start to many locations the next morning. The most extreme

cooling occurred across the northern tier of counties, specifically along and north of a line from MSL to HSV to Scottsboro. The most notable change was shown by the COOP observer in Lynchburg, where the temperature fell to around 20 degrees by morning. A summary of some low temperatures based on the morning RTP, OSO and "best guess" estimates of observations are shown in Figure 8.

Despite the apparent cold air advection, the 12Z obs do reveal that a ridge to valley split did survive this bizarre night. While most valley locations plunged into the upper 20's to lower 30's, the site at Mentone maintained a temperature in the lower 40s throughout the night, while Monte Sano remained in the upper 30s. However, the cold air advection likely played a bigger role across some higher elevations. For example, the Hytop site recorded a low of 32 and some locations further north across the Plateau and along Lookout Mountain dropped into the 20s. 12Z soundings from BMX, and to a lesser extent BNA, (Figure 9) do show a temperature inversion at the lowest levels, thus supporting the ridge to valley differences shown by Monte Sano and Mentone.

3. Final Thoughts/Lessons Learned

This particular night proved once again that forecasting the low temperatures across this region can prove quite challenging. It appears the models had trouble resolving the key features within the split flow pattern, specifically the southern stream energy. These problems likely resulted in the "over forecasting" of the moisture and temperature fields associated with the southern stream shortwave and the severe "under forecasting" of weak cold front/trough diving southward. However, the fact that the models handled a similar southern stream shortwave very adequately the previous night added to the confidence that the subsequent model solution was correct in showing another southern stream shortwave accompanied by increasing clouds and continued mild overnight low temperatures.

Thus, despite the added confidence in the models, caution should always be taken whenever considering situations involving a split flow, where one feature (southern stream shortwave in this case) is likely over-emphasized at the expense of another (weak northern stream cold front). Rely heavily on the latest trends shown in the surface and upper air analysis. In this case, based on the surface analysis from that afternoon, one could've hedged cooler on the temperatures to cover for a possible surface frontal passage and less cloud coverage.

However, in hindsight, I still wouldn't have changed the forecast all that much. Temperatures south of the front across BHM remained in the low/mid 40s all night, and aside from about a 6 hour period after midnight, the temperatures were well within reason across our CWA. In fact, the cold air advection was so weak and brief, temperatures easily recovered to near 60 again the following afternoon (despite some increasing cloudiness). This case just goes to show that even what appears to be a straight-forward situation, with good persistence and model consistency, can go astray at any time and thus constant increased situational awareness is imperative.

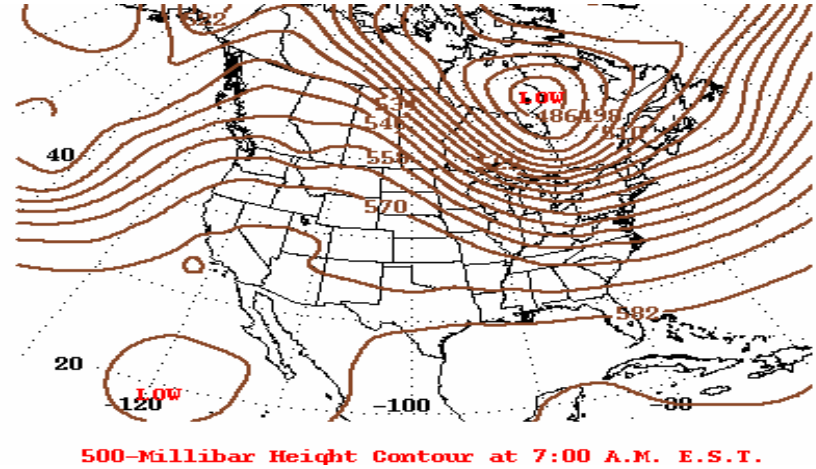
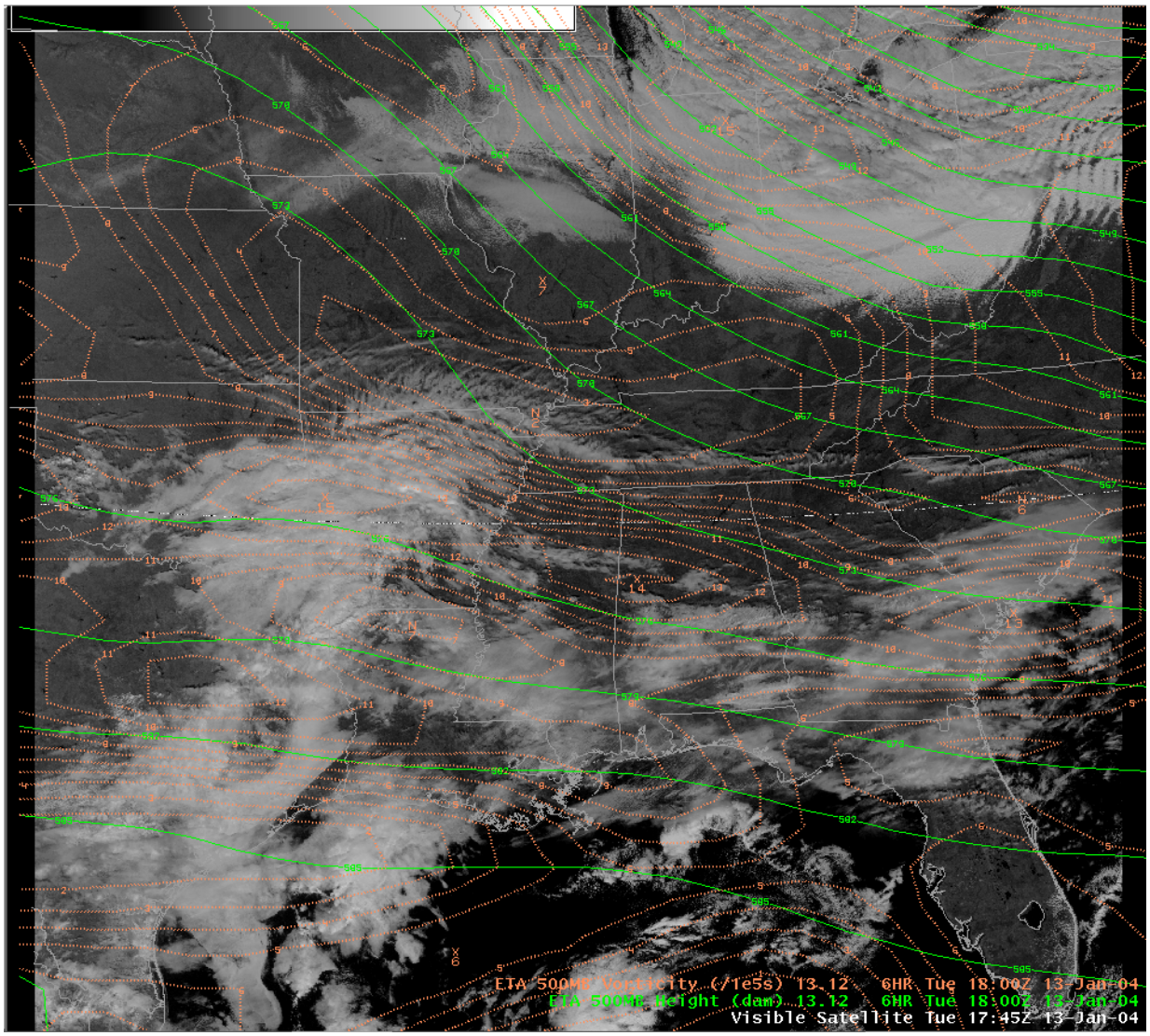
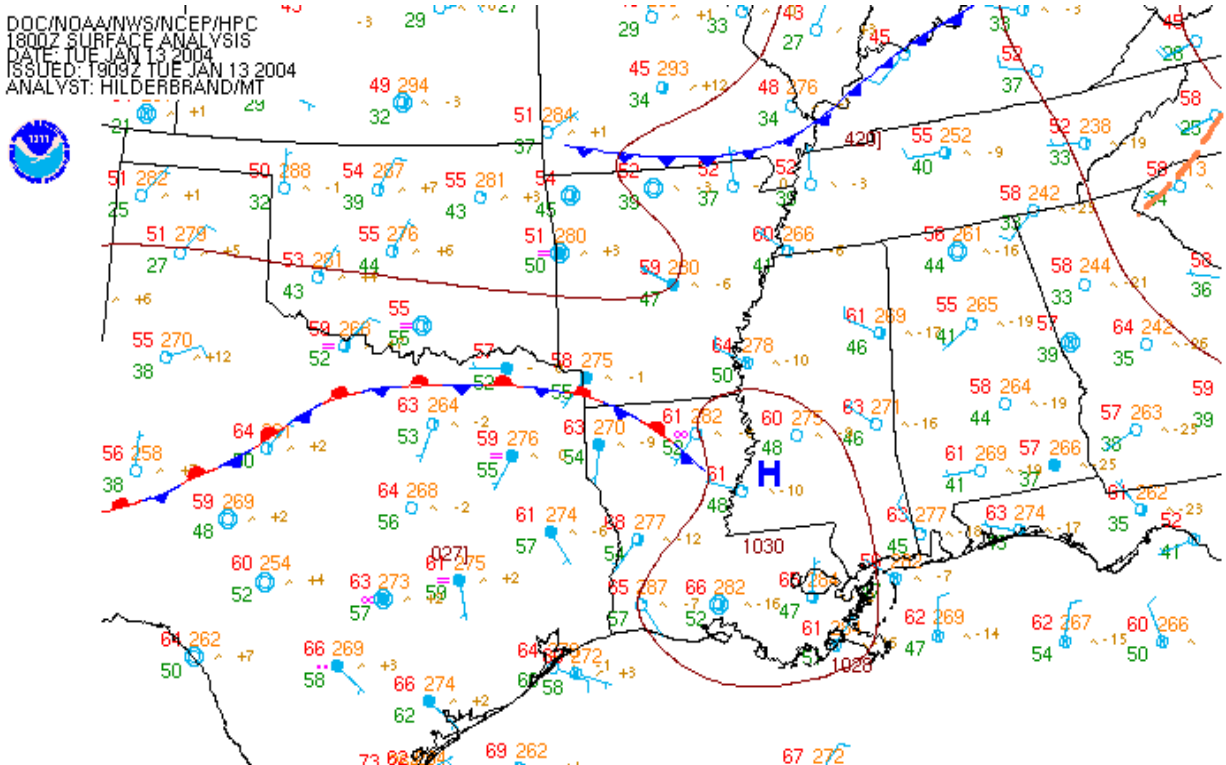
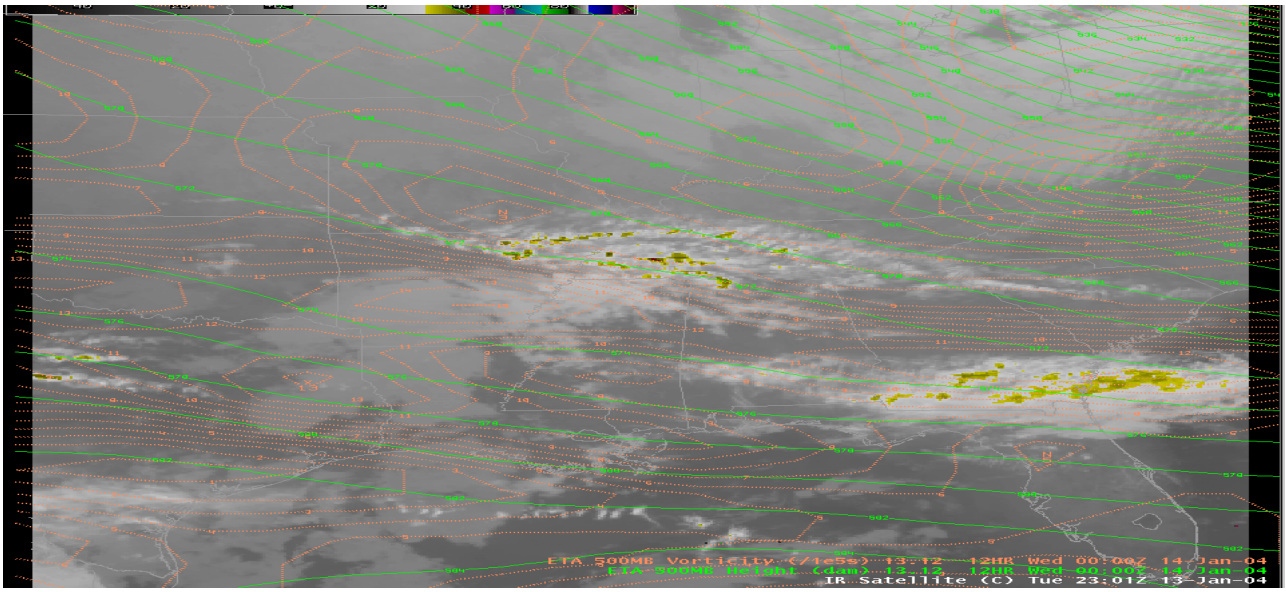


Figure 1: Upper level pattern on 01/13/04


ETA 500MB Vorticity (/1e5s) 13.12 6HR Tue 18:00Z 13-Jan-04
ETA 500MB Height (dam) 13.12 6HR Tue 18:00Z 13-Jan-04
Visible Satellite Tue 17:45Z 13-Jan-04


DOC/NOAA/NWS/NCEP/HPC
1800Z SURFACE ANALYSIS
DATE: TUE JAN 13 2004
ISSUED: 1909Z TUE JAN 13 2004
ANALYST: HILDERBRAND/MT
H
1030
1028



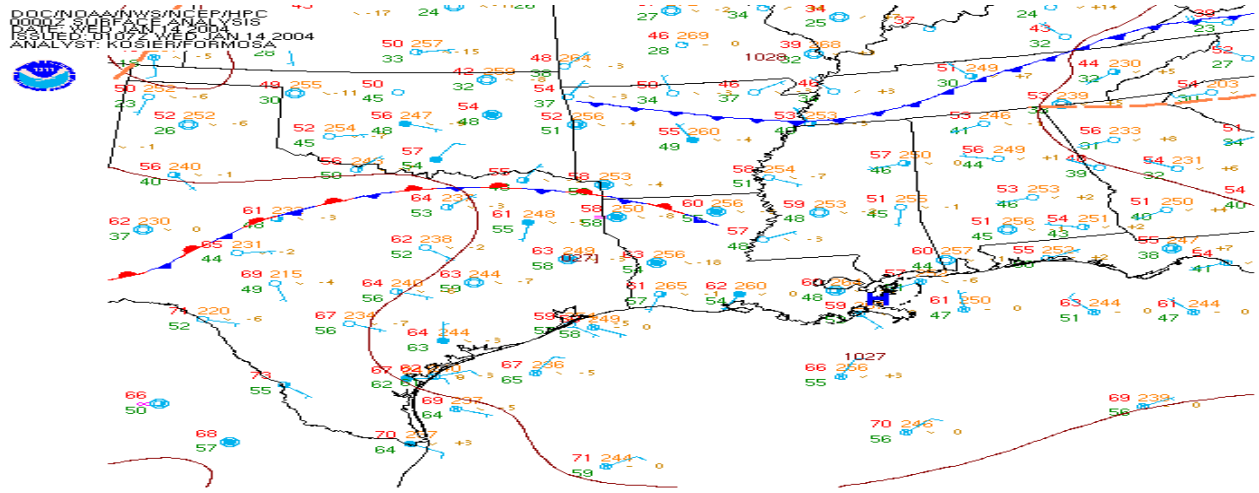


Figure 3: (a) 0Z visible imagery and ETA 500mb vorticity and height (b) 0Z HPC surface analysis.

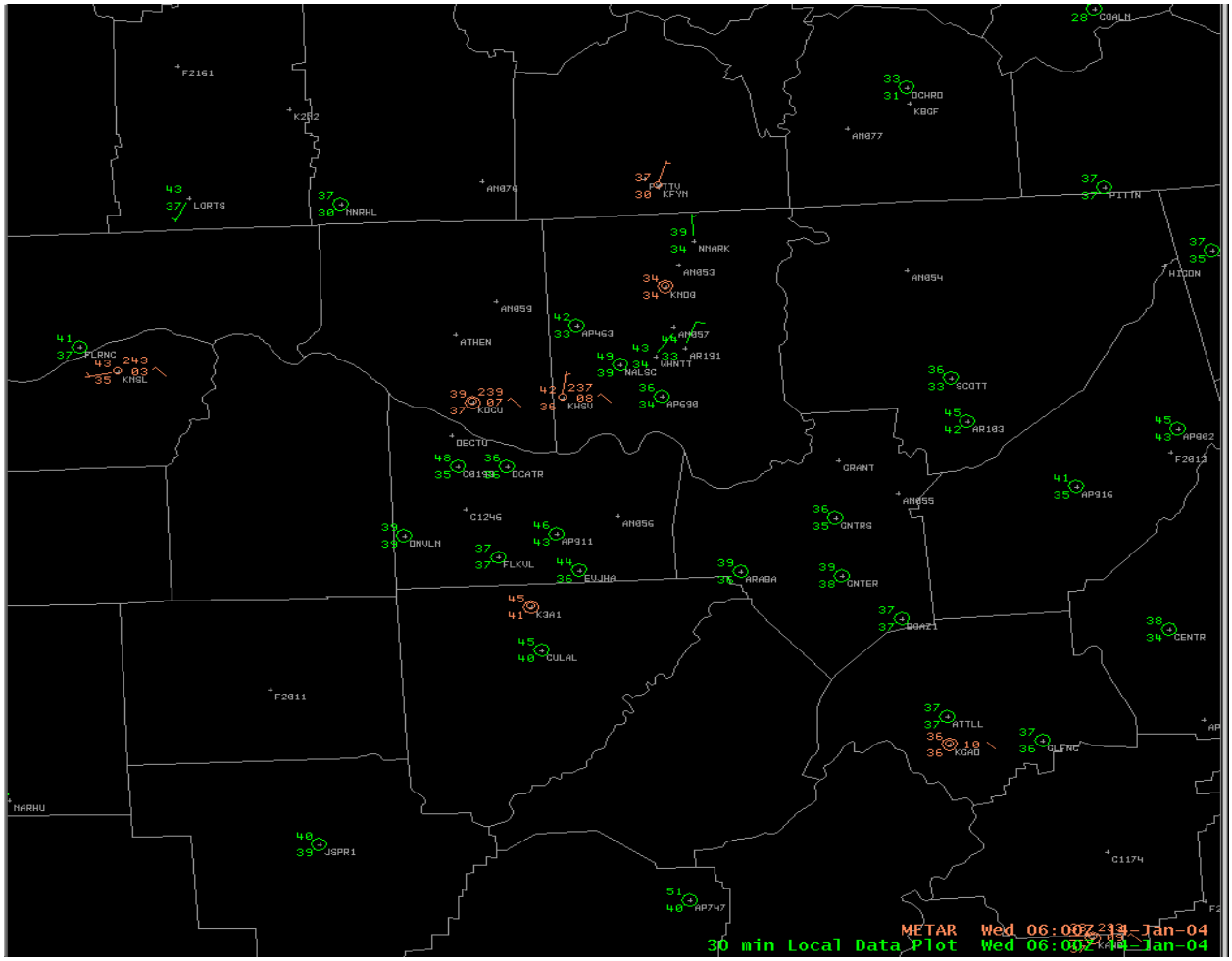
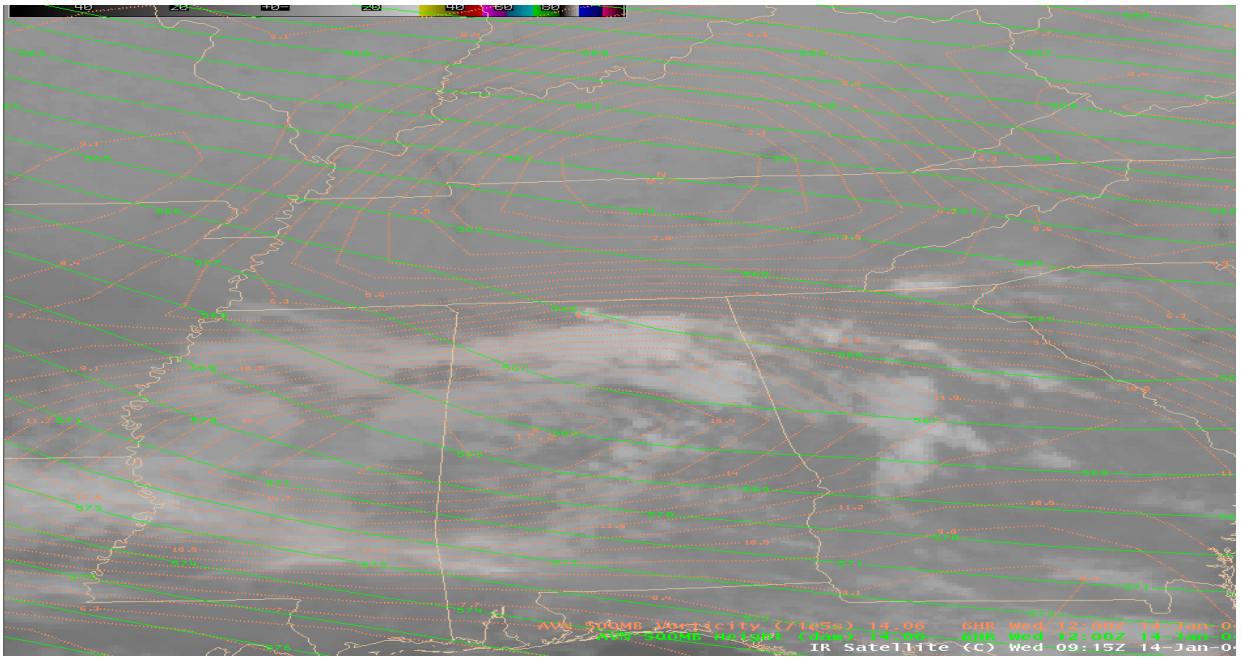


Figure 4: 06Z area observations



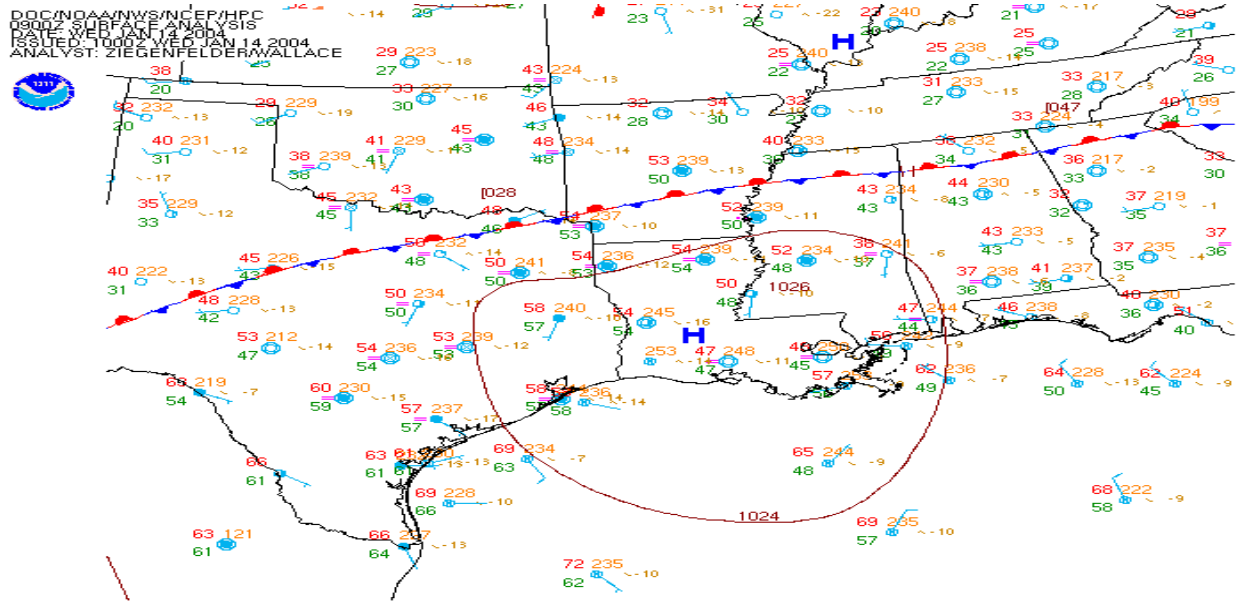


Figure 5: (a) 09Z visible imagery and 12Z ETA 500mb vorticity and height (b) 09Z HPC surface analysis.

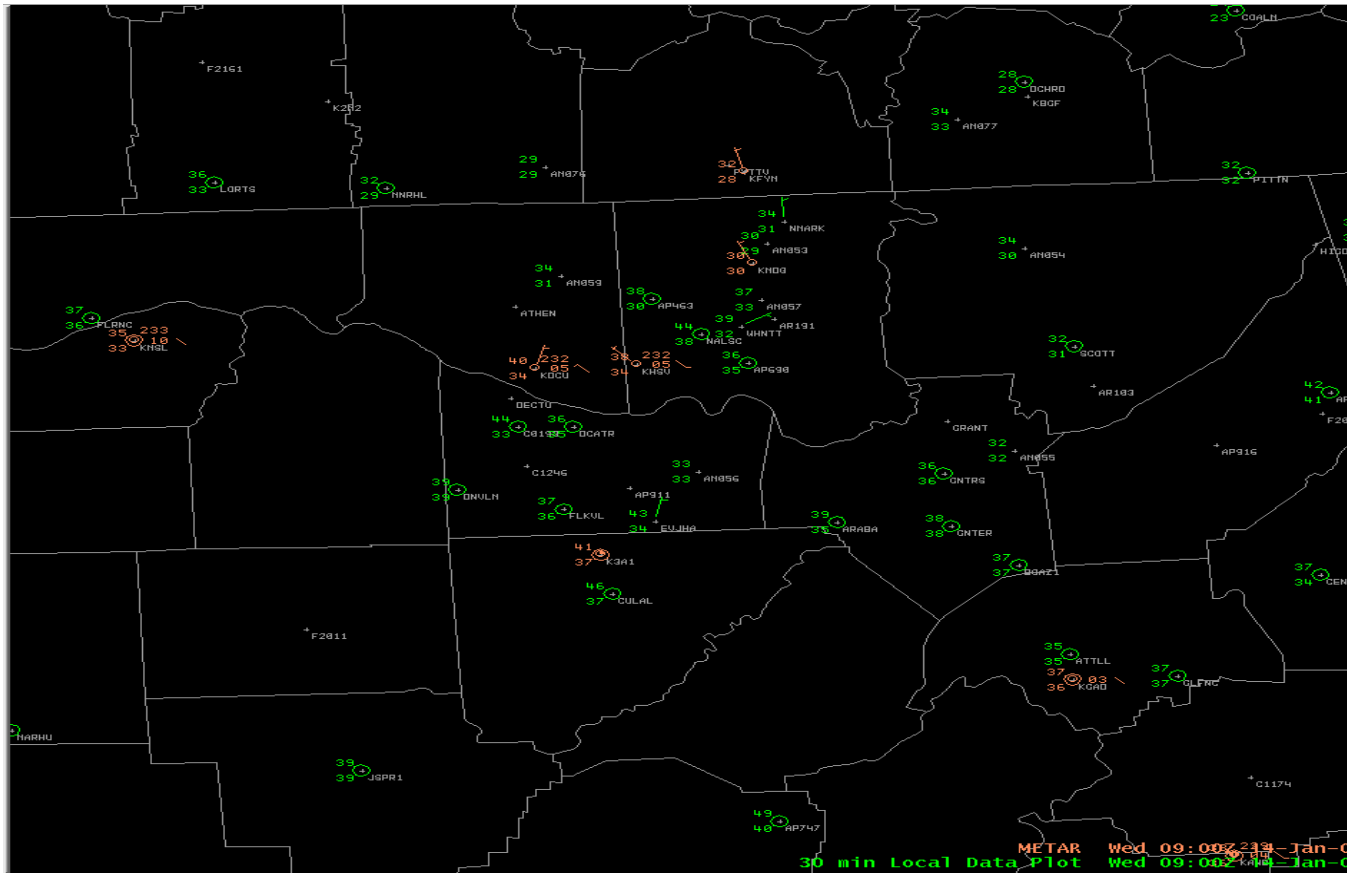


Figure 6: 09Z area observations

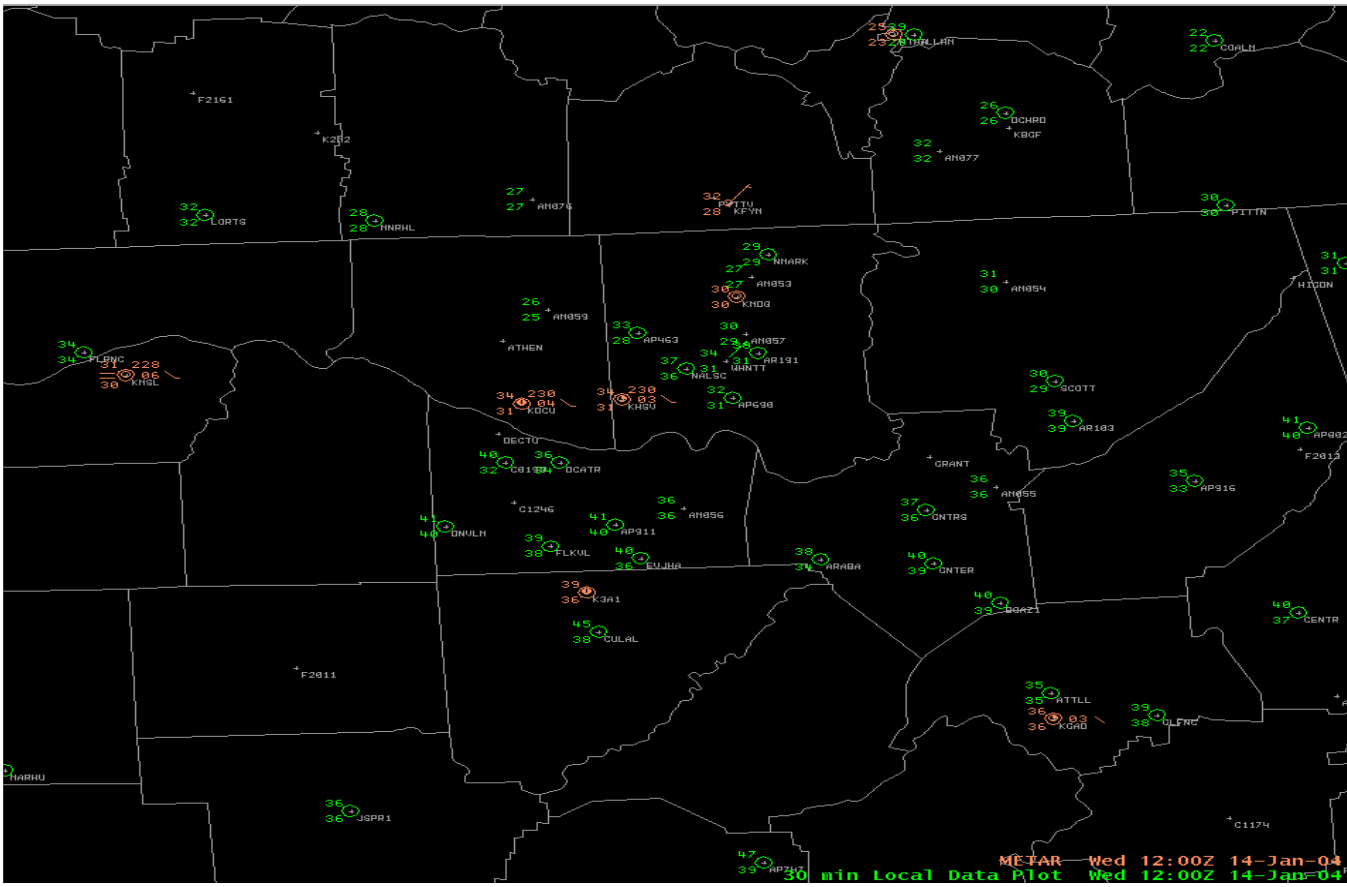


Figure 7: 12Z area observations

West

Muscle Shoals		30
Russellville		38

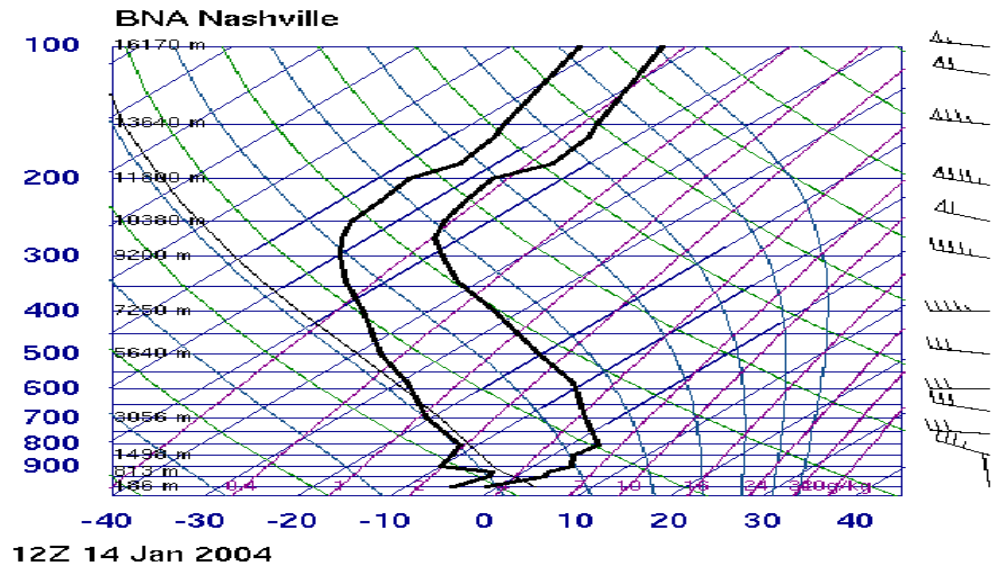
Central

Lynchburg		20
Meridianville	28	
Decatur		32
Huntsville		34
Cullman		37

East

Valley Head	27	
Scottsboro		29
Hytop		32
Collinsville		32
Crossville		35
Guntersville	37	

Figure 8: Low temperatures across the Huntsville CWA for 01/14/2004



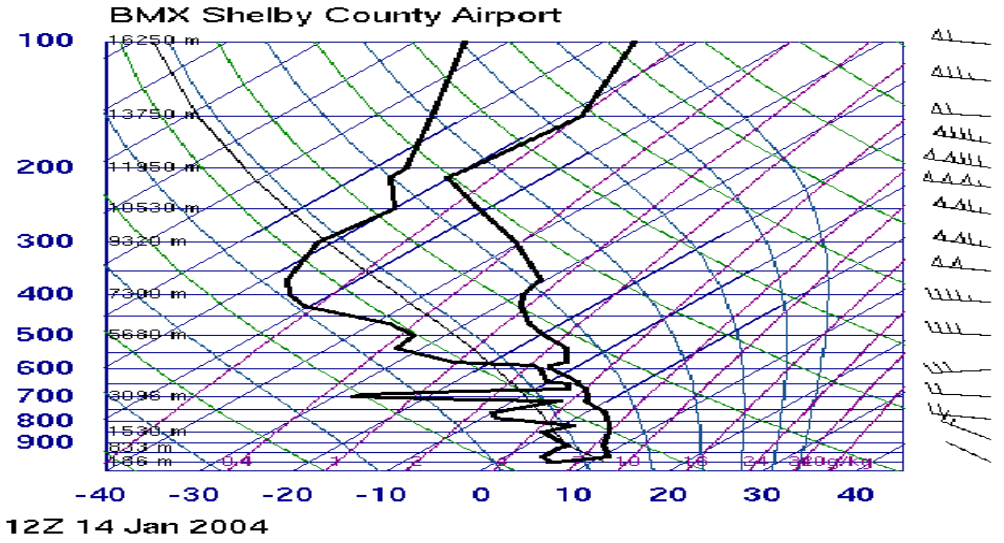


Figure 9: 12Z soundings for BNA and BMX