Review of Marginally Severe Hail Event from December 10th, 2004

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An upper-level low of 540 dm was centered over northern Illinois at 1200 UTC on December 10th. Temperatures at 5H ranged from -16°C at KBHM to -27°C at KLIT. The coldest temperatures of -29°C were located along the Kansas and Missouri border. This cold core was forecast to move south and east during the afternoon, affecting the Tennessee Valley between 1800 and 2100 UTC. Per morning soundings from the area, wet bulb zero heights ranged from 5,650 feet ASL at Nashville to 7,343 feet ASL at Birmingham.

Research suggests that WBZ heights below 7,000 feet are not conducive to large hail. Such values imply that the low levels are often too cool and stable to support large hail. However, this is not always the case in cold low patterns. When moisture is sufficient for moderate to strong instability in the vicinity of the cold pool, low-topped thunderstorm development during the afternoon and evening is likely. If instability is sufficient, hail can exceed severe limits. In this situation, the common occurrence of hail at the surface is aided by low WBZ heights and low mean temperatures below this level. However, hail in this situation rarely exceeds 1 ¾ inch (Johns and Doswell, 1992).

This was the case on December 10th. Early morning raobs from KOHX indicated CAPES on the order of 500 J/kg and a steep mid-level lapse rate. Meso-analysis graphics courtesy of SPC showed mid-level lapse rates of 7.5° to 8° c/km had overspread the forecast area by 1600 UTC. An extensive stratus deck present through the early morning began to erode between 1600 and 1700 UTC. This helped destabilize the atmosphere and instability increased as the cold pool moved over during the course of the afternoon.

The first in a series of low-topped thunderstorms developed at 1730 UTC across eastern Madison County. Three distinct cells developed along and east of Highway 431. Development was rapid and within 15 minutes, the first report of penny-size hail was received in southeast Huntsville. This cell was the first (and only) storm to produce severe hail during the afternoon. Another cell near New Market produced dime size hail while the southernmost storm near Owens Crossroads produced pea-size hail. Reflectivity signatures (Figs 1 and 2) indicated a maximum core, on average, of 50 dBZ to a height of 14,000 feet with each storm. The VIL associated with the storm that produced severe hail ranged from 20 to 25 kg/m^2 at its height (Fig.3). Dime-size hail reports were received with VILs of 15-20 kg/m^2. The first severe thunderstorm warning was issued for Madison County at 1750 UTC, based on reflectivity signatures and the aforementioned reports.

Subsequent cells developed over southern Lincoln county and western Jackson county. These storms developed very rapidly (within 15 minutes) and were similar in structure to the Madison County cells. A maximum core of 50 dBZ to a height of 17,000 feet was noted with this storm at 1741 UTC. An associated VIL of 20-25 occurred at 1747 UTC.

This storm showed no signs of weakening with the 1753 UTC scan (Fig. 4). Therefore, based on reports from Madison County and comparisons with reflectivity signatures, a severe thunderstorm warning was issued for Lincoln County at 1755 UTC.

The cell over Jackson County intensified between 1820 and 1825 UTC. Maximum reflectivity cores of 55 dBZ to a height of 9,000 feet, a VIL of 25-30 with an echo top of 20,000 to 25,000 feet resulted in the issuance of a severe thunderstorm warning at 1821 UTC. The only hail report received was pea-size hail in Skyline at approximately 1835 UTC.

At this point, the lack of reports warranted an increase in the warning threshold. Hail ranging from 0.25 to 0.50 inch size was reported across Dekalb County at 1915 UTC with a weaker storm than was noted earlier in the afternoon.

In Franklin County, Tennessee a hailstorm was reported between 1945 and 1955 UTC. Reports of dime-size hail accumulating to a depth of one-quarter to one-half inch in the Capital Hill area of northern Franklin County were received. The information received was second-hand, and the responsible storm did not appear as strong as previous cells which produced dime-size hail. Thus, a warning was not issued for Franklin County and severe hail was never reported.

Farther west near Decatur, another thunderstorm developed around 1950 UTC. This storm also intensified rapidly, with two reports of significant dime size hail received between 2000 and 2005 UTC in Decatur. At that time, a reflectivity core of 52 dBZ extended to only 5,000 feet with an associated VIL ranging from 10-15 kg/m^2. The storm intensified with a maximum core of 50 dBZ extending to 13,000 feet at 2010 UTC, and increasing to 51 dBZ at 17,000 feet at 2015 UTC (Fig. 5). While this storm remained extremely small in size, its rapid intensification and height of the reflectivity core, in relation to what was observed earlier with dime-size hail reports, led to a severe thunderstorm warning being issued for Morgan and Madison counties at 2010 UTC. No further hail reports were ever received.

Conclusion

The environment during this event was conducive to the development of low-topped thunderstorms. With the extremely low wet-bulb zero heights, large hail was a threat with these storms. Initial reports of penny-size hail within rapidly developing cells led to a low warning threshold. Based on reflectivity signatures and prior reports, it is believed that these storms were capable of producing severe hail. The lack of reports most likely existed due to the remote location of the storms, as is often the case with pulse-type, isolated convection.

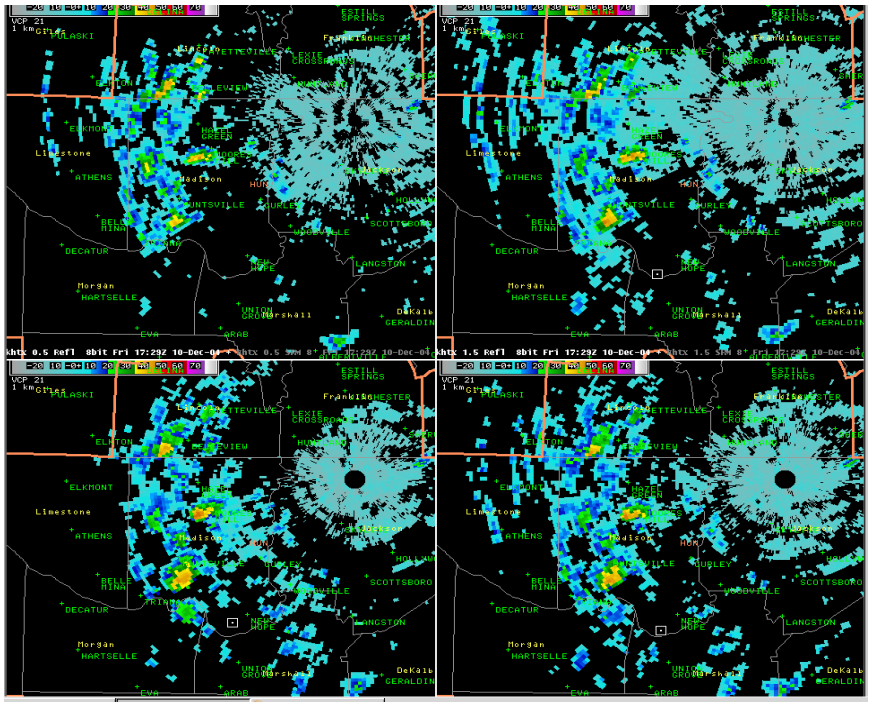

Figure 1: Initial line of storms developed across eastern Madison County at 1729 UTC.

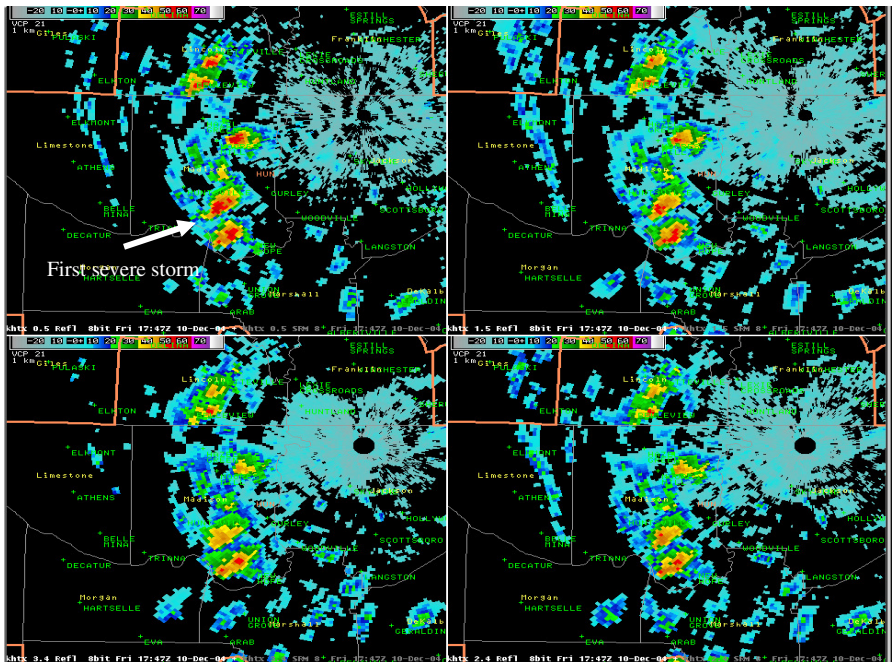

Figure 2: Reflectivity signatures with cells in eastern Madison County at 1747 UTC, two minutes after the first hail report was received in Madison County.

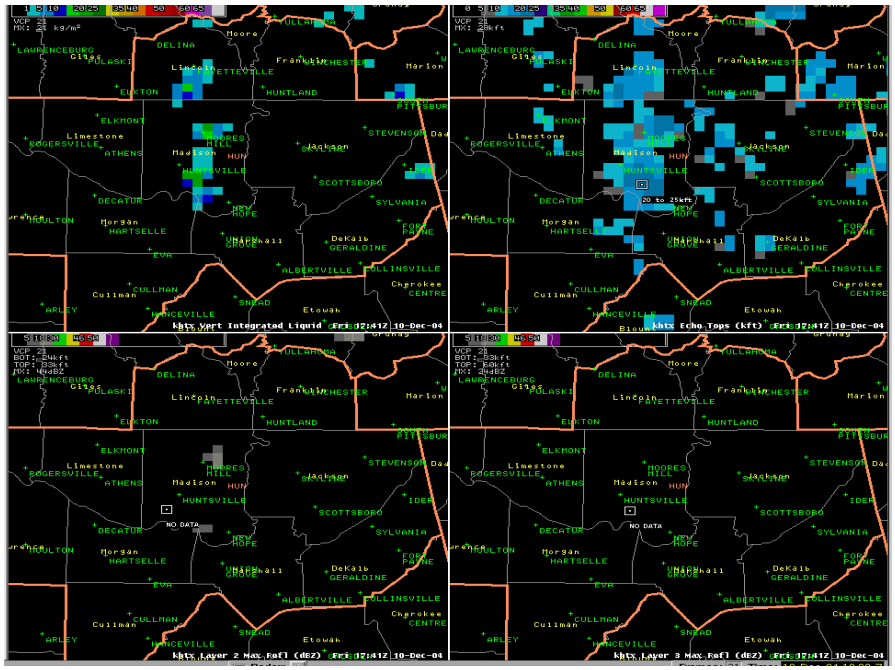

Figure 3: VIL and Echo Tops associated with cells in eastern Madison County at 1741 UTC. These were the largest VILS recorded with these storms, and occurred just minutes prior to the first severe hail report.

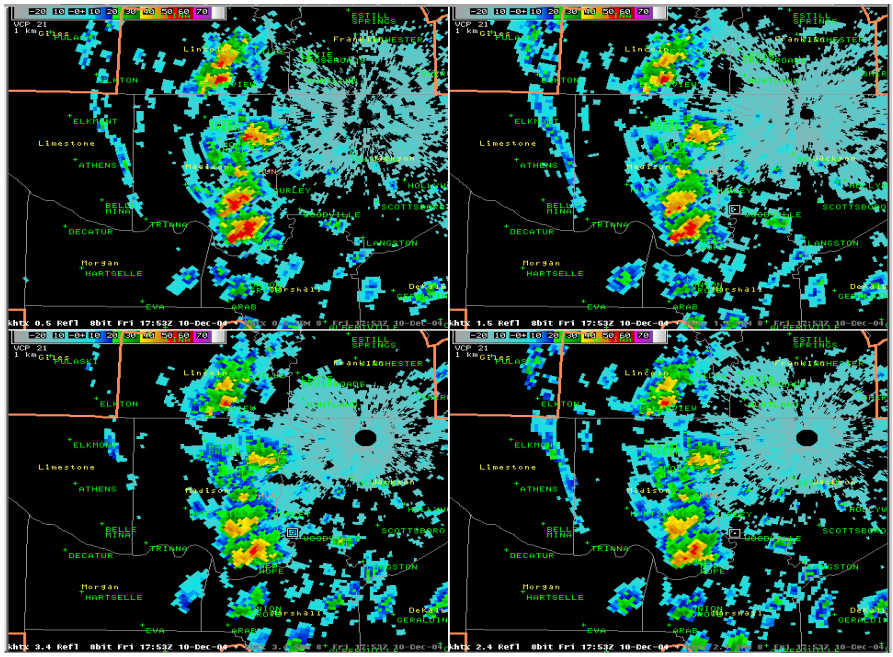

Figure 4: Reflectivity signatures with cell in Lincoln County Tennessee at 1753 UTC. The height and strength of the reflectivity maximum was similar to the Madison County storms.

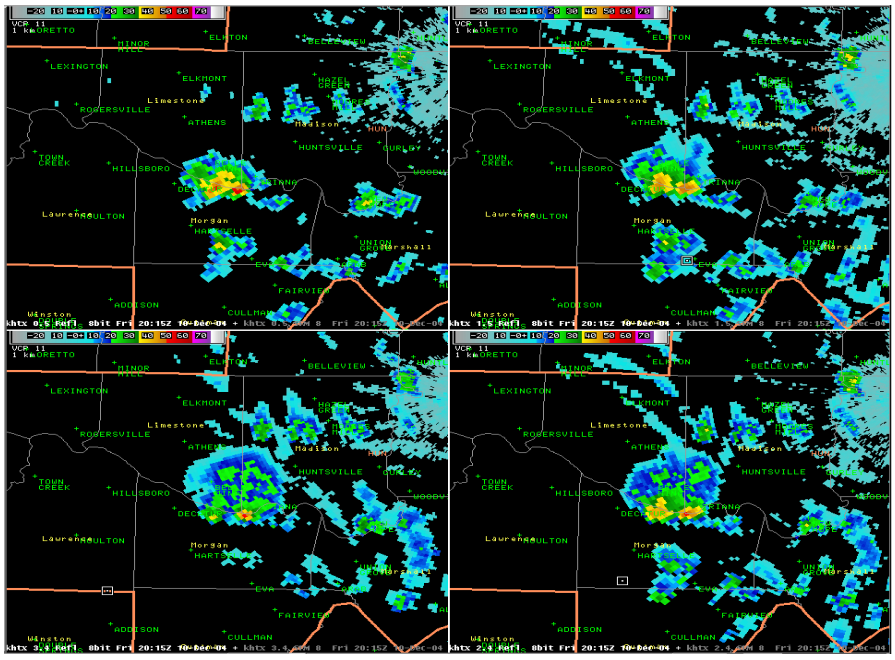

Figure 5: Strongest reflectivity signature seen with cell over Morgan County at 2015 UTC. Weaker signatures were seen while this storm was producing dime-size hail in Decatur.