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Forecasting Note

Valley to Ridge Temperature Differences in Northeast Alabama

by

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April 4, 2003

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1. Introduction

Significant temperature differences occur at times between valleys and ridges in rugged terrain, particularly at night during dry periods in the fall and winter. In eastern Kentucky, for example, differences of 15°F to 30°F are common in those seasons when conditions are favorable for strong radiative cooling in the valleys. Similarly, large valley to ridge temperature differences occur in northeast Alabama, although limited in magnitude to a small degree by relatively less rugged terrain than in eastern Kentucky.

The average elevation difference between valleys and ridges in Jackson, De Kalb and Marshall counties of northeast Alabama is about 1 000 feet. Based on typical temperature lapse rates in a well mixed atmosphere, this would result in temperatures around 5°F cooler on ridges.

As observed for many years in eastern Kentucky, the most dramatic temperature differences between valleys and ridges occur overnight when the atmosphere is clear and dry, surface winds are light, and a southwest flow of 10-15 knots or more exists near the ridge tops. As winds go calm in the valleys, the surface layer winds actually decouple from the southwest flow aloft, and a strong surface based inversion develops due to radiational cooling in the valleys. As we have seen thus far in northeast Alabama, the resultant temperature difference can be 10°F or more.

2. Illustrative Example from March 12, 2003

Details from a recent case of a significant valley to ridge temperature difference at night in northeast Alabama are given below. It is important to point out that the mesoeta model forecast soundings do a good job of identifying the magnitude of the temperature difference. However, they are usually too warm with the valley lows.

- Mesoeta forecast soundings, from the 11 Mar 2003 18Z run (not shown), indicated an overnight inversion in northeast Alabama, with a valley to ridge temperature difference of 10°F to 15°F.

- The MOS data from the 11 Mar 2003 12Z runs of the NGM and AVN models gave the following overnight lows:

	NGM	AVN
MSL	49	45
HSV	46	45

- Based on the above information, and the overnight lows in the area from the previous night, the afternoon issue of the zone forecasts for northeast Alabama called for morning lows on 12 Mar 2003 to range from the mid 30s in valleys to the mid 40s on ridges.

- On 12 Mar 2003, the 12Z KBMX sounding showed a surface based inversion that ranged from 44˚F at the surface to 59˚F at 1 165 feet above sea level (ASL). See Fig. 1. Similarly, the 12Z mesoeta sounding for Ft. Payne (Fig. 2) showed an inversion that ranged from 40˚F at the surface to 52˚F at 1 500 feet ASL, which is taken as an average ridge top height for the area. Both soundings also showed southwest winds of 15 knots above the surface layer.

- A 10˚F to 15˚F valley to ridge temperature difference was confirmed by a few observed lows (See Figs. 3 and 4). Note, for example, the readings of 32˚F at Ft. Payne and 46˚F at Hytop.

- Note also that due to the dryness of the air mass, the observed lows elsewhere in relatively flat areas were around 40˚F, which was cooler than both the NGM and AVN forecasts.

3. Concluding Remarks

- Significant valley to ridge temperature differences of 10˚F or more occur overnight in the rugged terrain of northeast Alabama, under conditions favorable for radiational cooling. The most impressive differences occur in a clear, dry atmosphere with near calm winds in valleys, and southwest winds of 10-15 knots or more near the ridge tops.

- Mesoeta forecast soundings provide a good estimate of the magnitude of the valley to ridge temperature difference, but are usually too warm with valley lows.

- A more comprehensive review of several cases, collected during a fall through winter season, would provide valuable forecasting information, and data for an expanded paper.