I.C. 4.3 Microclimate exercise

Temperature trends along the Ozark Mountain range in Northwestern Arkansas

Matthew Clay, Meteorologist Intern WFO LZK
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Overview: Wide ranges of temperatures are observed daily across portions of the Ozark Mountain Range in Northwest Arkansas. As commonly observed with mountainous terrain, a big temperature gradient can be observed over a very short distance. Cooperative observers exist throughout the mountain range, with two such sites located at Deer (DEEA4) at an elevation of 2140 feet MSL and Gilbert (GLBA4) at 850 feet MSL. During most days in the year, GLBA4 will normally be cooler in respect to low temperatures and warmer in respect to high temperatures. However, under certain conditions, these expected scenarios will not always be the case.

Microclimate Ingredients: When a northeast wind is prevalent, cooler air from the valley to the northeast will filter into DEEA4, which will in turn bring cooler low temperatures than those observed at GLBA4. In order to get prevailing northeasterly winds over the Ozarks, surface low pressure must be in place over northeastern Arkansas, or be moving east or northeast out of the state. This pattern tends to occur most commonly behind a cold front before the surface high pressure settles into the region. One of the main reasons for the cooler low temperatures at DEEA4 is the northeast wind will advect dense, and cooler air that has settled in the valleys located to the northeast towards the site as seen in Figure 1. The same setup that advects cooler air towards DEEA4 will mix the air more efficiently at GLBA4, keeping the minimum temperatures slightly warmer than usually expected.

Figure 2 shows the high temperatures comparison between DEEA4 and GLBA4 from January 2000 through December 2011, where positive values are when GLBA4 is warmer. The first thing to note is GLBA4 is generally the warmer of the two sites in regards to high temperatures but on a few occasions throughout the dataset, DEEA4 can have higher maximum temperatures. When comparing the dates when there were warmer high temperatures at DEEA4, a northeast wind was prevailing according to ASOS sites located at Harrison (KHRO), Russellville (KRUE) and Mountain Home (KBPK).

A good example of the situation where temperature can be significantly different would be an event that occurred on September 26, 2000. On this date, an area of high pressure had begun to settle across eastern Arkansas during the early morning hours. Light northwesterly winds were observed over that portion of the state throughout the day. However, afternoon high temperatures at DEEA4 reached 44 degrees, while GLBA4 got up to 74 degrees. Upon the analysis of upper air data, the northwesterly winds quickly shifted southwesterly with height. This allowed for the potential for compressional heating to warm up the lower elevations, while adiabatic cooling was possible in the

elevated regions. When analyzing the patterns that cold fronts traverse across the Ozarks, most cold fronts will end up passing through DEEA4 first, which would lead to cooler temperatures depending on the time of the frontal passage. When the passage occurs at the right time and the front is either quasi-stationary or very slow moving, GLBA4 can be 20 degrees warmer than DEEA4. When looking at the dataset, a very consistent trend was observed for the high temperature comparison between the sites as seen in Figure 2. Throughout the eleven year dataset, GLBA4 has been warmer 97% of the time.

Conditions that support a high temperature at DEEA4 being greater than GLBA4 most often occur when a surface cold front builds through the region behind a cold front. This pattern typically occurs in the winter months when the jet stream dips further south and allows the high pressure to settle into the southern plains. This pattern can also occur in the spring months but the temperature difference is not as great as during the winter months. The colder air associated with the frontal passage and the cold air will settle into the valleys first as winds remain light or calm. For elevated areas such as DEEA4, winds will remain elevated and promote mixing which keeps temperatures warmer and the colder air will tend to favor valleys in these circumstances. The colder is air is denser, which allows the colder temperatures to settle in the valley region.

Figure 3 shows the minimum temperature comparison between DEEA4 and GLBA4 from January 2000 through December 2011. Unlike the comparison between the high temperatures between the two sites, the low temperature variation is much greater. Statistical analysis of the data from 2000-2011 showed that DEEA4 will be warmer at nights over 58% of the time. Upon analysis of synoptic situations, nights when high pressures dominated and calm to light winds are observed, cold air will to settle into the valleys. This will tend to allow temperatures to cool off at GLBA4 faster while keeping DEEA4 warmer as the elevated surfaces had winds which allowed for mixing effects. On the same note, frontal interactions can lead to either of the sites being cooler or warmer and analysis of upper air soundings shows that compressional heating effects play a role on which of the location will be warmer during the overnight hours.

Forecast Considerations: When comparing temperatures for the different COOP sites in the Ozarks, the GFS COOP MOS, MCXUSA, does a very good job in respects to temperatures within the first 48 hour period. These high resolution models do a fairly good job in estimating the terrain effects of the Ozarks due to the statistical analysis implemented within the model. The LAPS and RUC model output has the spatial resolution that allows the effects to be picked up but lack the temporal resolution to do a multi-day forecast. However, the GFS and other MOS products have the temporal resolution to put an extended forecast but at times can lack the spatial resolution to pick the microclimate effects of the Ozarks. As mentioned earlier, these conditions are normally only seen as a surface low pressure system pushed off to the east or northeast, and generally lasts for only several hours before the high pressure moves in and northwesterly flow returning. If the northwesterly flow is expected overnight, then the forecast should incorporate low or high temperatures in elevated regions, while the valleys will see slightly warmer temperatures.

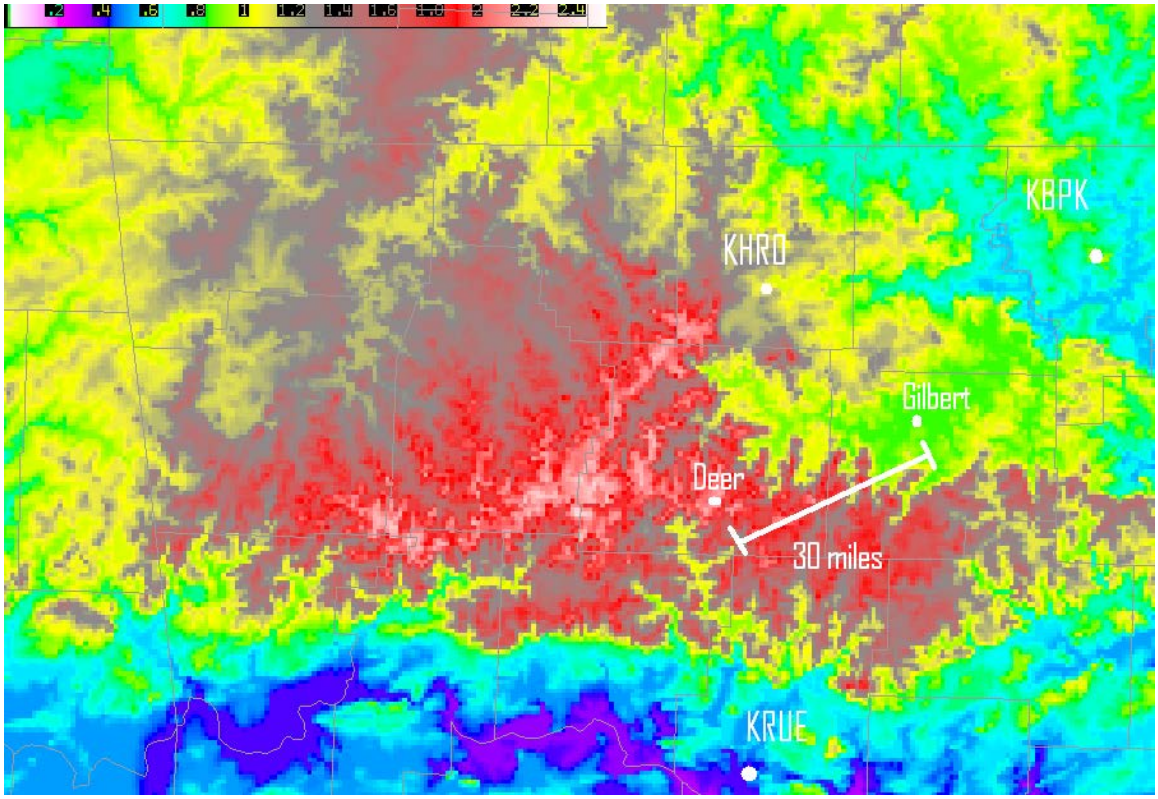

Figure 1 Topography map for the Ozarks in northwest Arkansas. Deer and Gilbert are plotted on the map to show the location of the two sites.

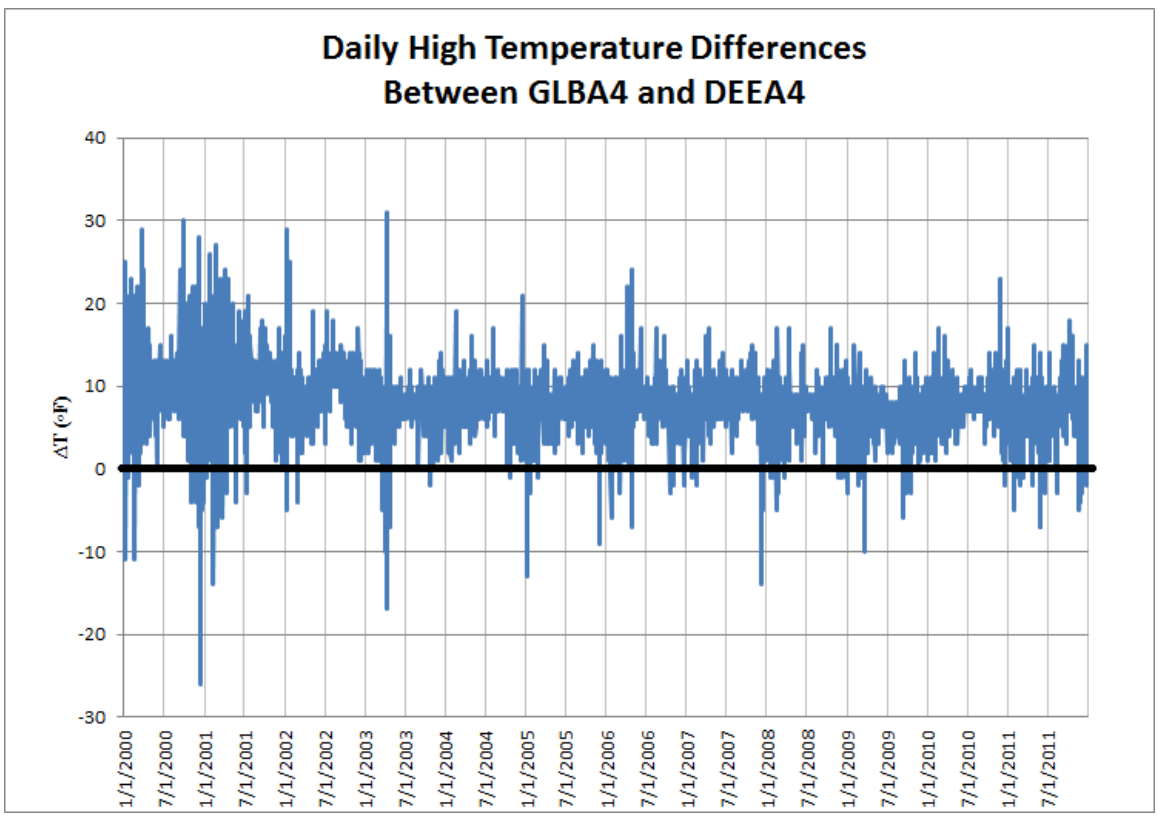

Figure 2 shows the maximum temperature comparison between DEEA4 and GLBA4 from 2000 through 2011. Positive values indicate warmer temperatures at GLBA4 while negative values indicated warmer temperatures at DEEA4.

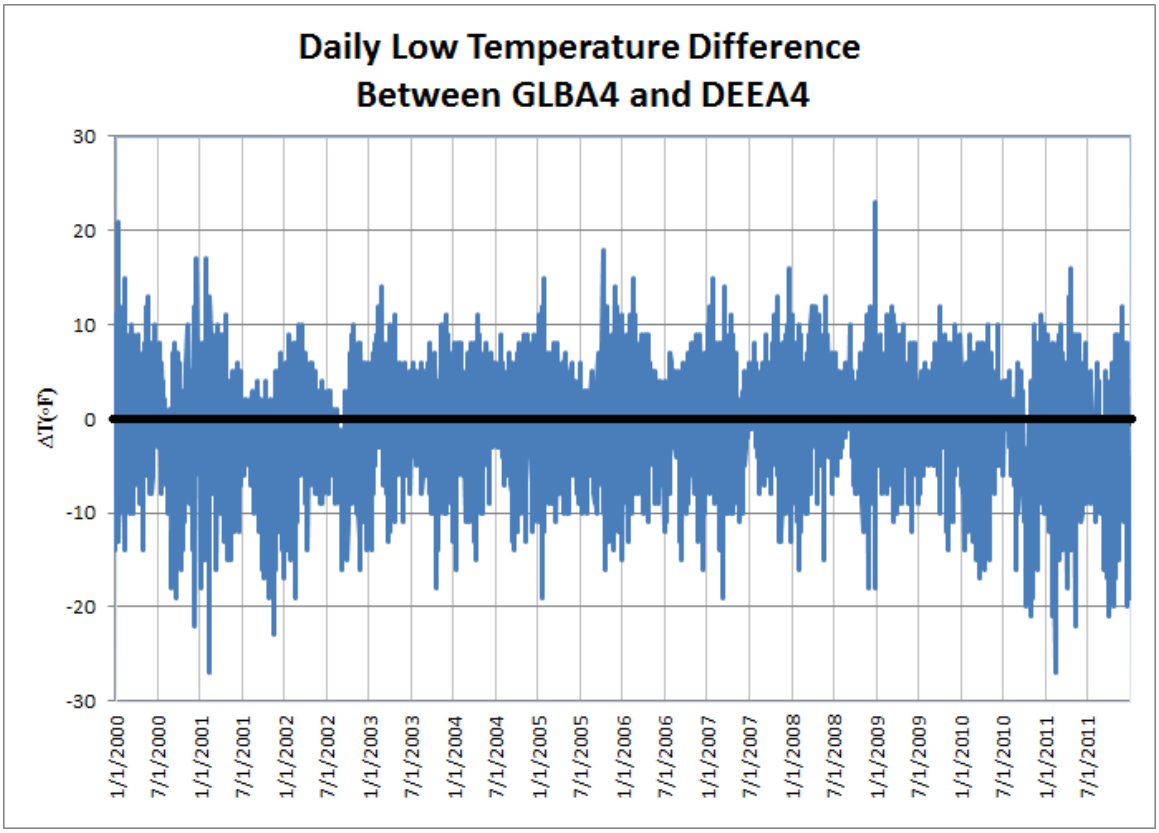

Figure 3 shows the minimum temperature comparison between DEEA4 and GLBA4 from 2000 through 2011. Positive values indicate warmer temperatures at GLBA4 while negative values indicated warmer temperatures at DEEA4.