Cold Season Low Temperature Forecast Considerations for Central Ohio

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Overview: Urban environments and variable terrain across central Ohio can have a significant impact on low temperature forecasts during the cold season. Forecasters at WFO Wilmington, OH must be conscious of the urban heat island effect surrounding the Columbus metropolitan area, as well as cold air drainage that affects observing stations at Lancaster (KLHQ) and Newark (KVTA). Figure 1 shows an average temperature bias (created with the BOIVerify software verification package) for central Ohio over the course of a week during the cold season for NDFD low temperature forecasts made 24 hours in advance.

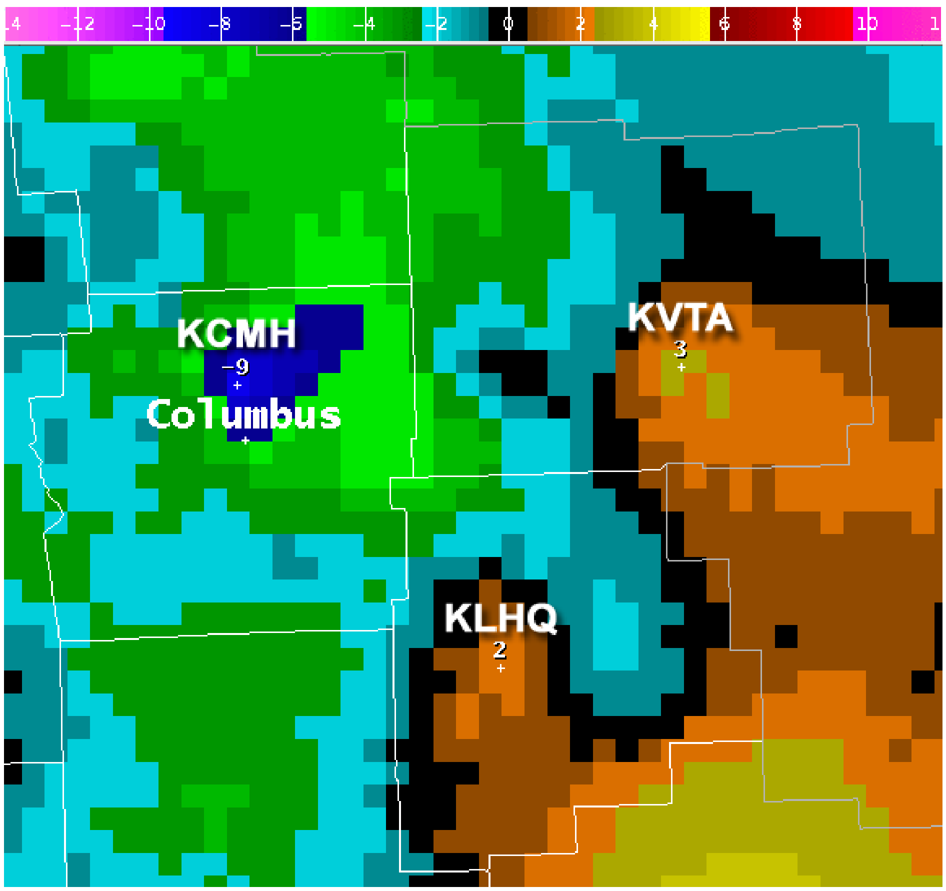

Figure 1: A cold-season average temperature bias over the course of a week (ending February 28, 2012) for NDFD low temperature forecasts made 24 hours in advance.

One can easily spot a cold bias over the Columbus metropolitan area, with low temperature forecasts for KCMH averaging nine degrees too cold 24 hours in advance. This would indicate that the NDFD low temperature forecasts are not accounting for Columbus' urban heat island effect and are thus trending too cool. Nearby, there is a warm bias of two to three degrees over KLHQ and KVTA. Examining the topographic map in Figure 2, one can see that both KLHQ and KVTA are located in shallow river valleys in the foothills of the Appalachians. Elevations range from around 900-1300 feet across Licking County and 800-1100 feet across Fairfield County. These elevation differences, though seemingly minor, can impact nighttime temperatures considerably at KLHQ and KVTA via cold air drainage in the valleys. In fact, low temperatures at these sites often run 5 to 10 degrees colder than surrounding stations during the cold season. This most commonly occurs on nights with strong radiational cooling (clear skies and light winds) due to high pressure over the region.

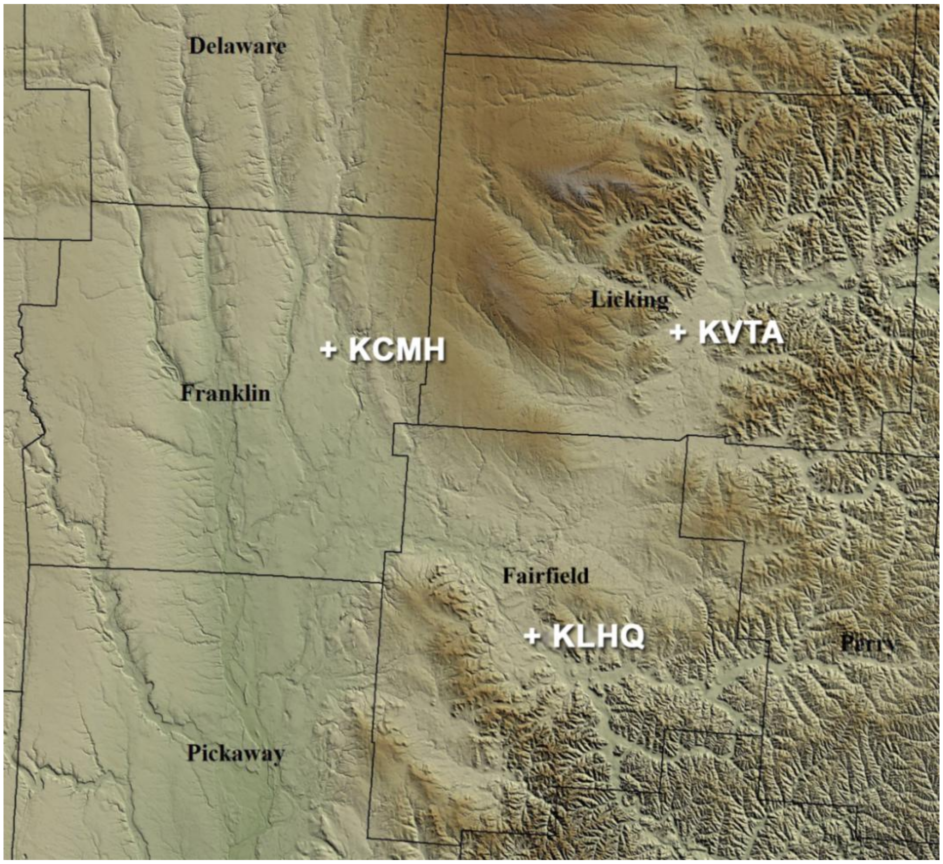

Figure 2: Topographic map showing the elevation of central Ohio. Elevations range from around 900-1300 feet across Licking County and 800-1100 feet across Fairfield County.

Model Shortcomings: Raw synoptic model guidance often struggles to capture the small-scale terrain features that impact low temperature forecasts at these observing stations. For example, Figure 3 shows the 12 km NAM's average temperature bias for forecasted low temperatures over the same weeklong period. One can see that the NAM's low temperature forecasts for KVTA and KLHQ were slightly better than the NDFD forecasts, but the NAM did not very well account for the urban heat island effect at KCMH. Although the bias data in Figure 3 is rather noisy, one can see that it does exhibit large-scale temperature bias features similar to those seen in Figure 1. One would expect that models with coarser resolution than the 12 km NAM (e.g. the GFS) would handle these small-scale terrain features poorly, while MET/MAV MOS might be expected to perform better because they account for climatology and local effects. In fact, in a supporting analysis not included here, MOS also exhibited a warm bias for KVTA and KLHQ but performed slightly better than the NDFD forecast biases for these observing stations.

On nights when strong radiational cooling is expected, forecasters should keep in mind the shortcomings of raw synoptic model guidance. While MOS will likely have somewhat of a warm bias in these types of situations, it is recommended to use MOS as a starting point because it accounts for climatology and some local effects and therefore usually performs reasonably well. From there, the forecast can be further refined by referencing higher-resolution model data, which would presumably have a better grasp of small-scale terrain features that impact low temperatures. In fact, prototype 500 m resolution model data available to forecasters from Oklahoma University (Dr. Matthew Haugland) has shown increased skill in temperature prediction for these very small and localized microclimates, removing much of the warm bias seen in NDFD forecasts, coarser raw model output, and even GFS/NAM-based MOS predictions.

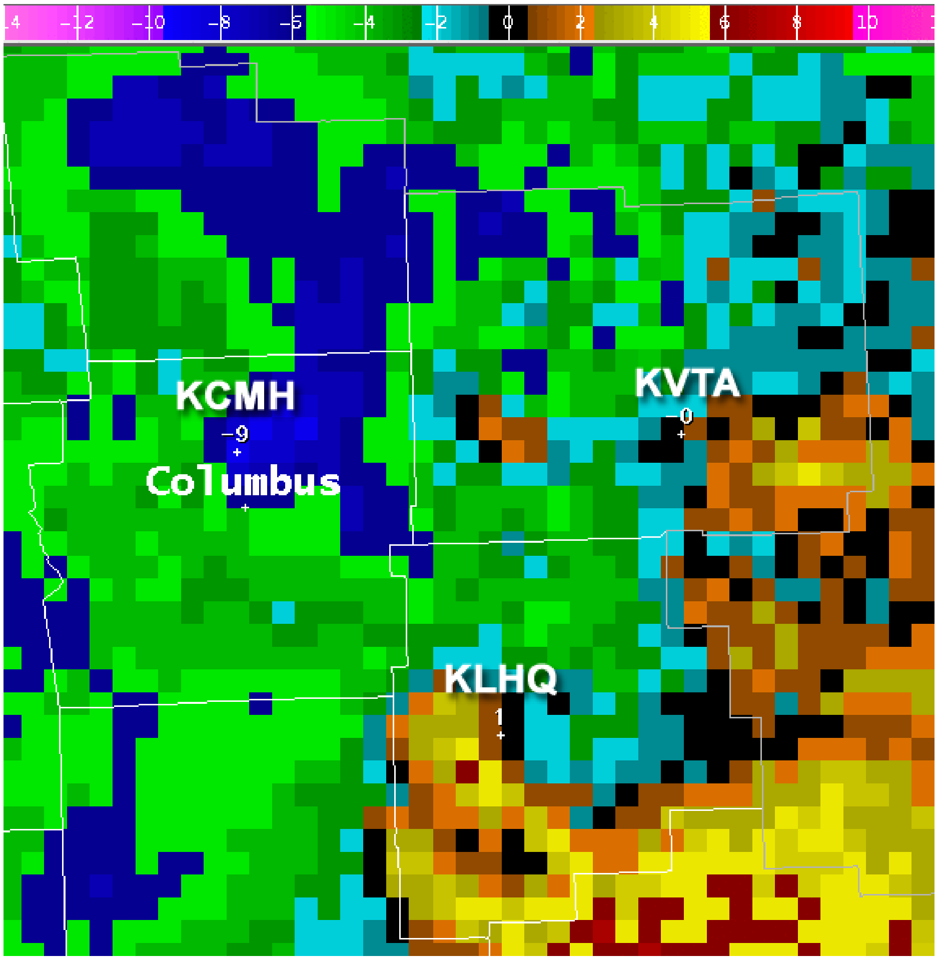

Figure 3: The 12 km NAM's average temperature bias over the course of a week (ending February 28, 2012) for low temperature forecasts 24 hours in advance.