Downslope Winds along the Buffalo Ridge

Jennifer Laflin, NWS FSD
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Overview: The Buffalo Ridge is a narrow area where the elevation is approximately 500-800 feet higher than surrounding areas, and stretches from northeast South Dakota into southwest Minnesota. The ridge is oriented northwest to southeast, impacting the FSD and ABR CWAs, and is steepest on the northeast side. Locally higher wind speeds are often observed along the ridge, which prompted the construction of a large wind farm (600+ turbines) near Lake Benton, MN, denoted by a red star in the topographic image (fig. 1).

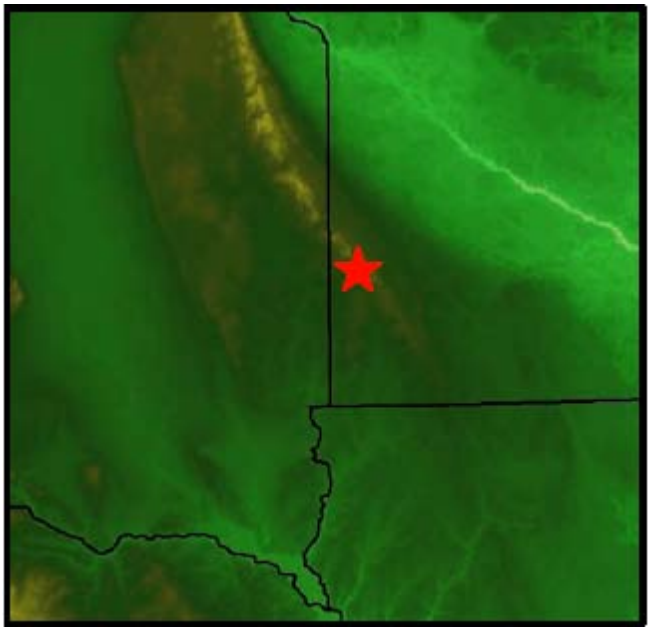

Figure 1. An elevation map where the warmer colors represent higher elevations. The red star indicates the location of the wind farm near Lake Benton, MN.

One particular phenomenon that occurs as a result of the Buffalo Ridge and impacts the FSD CWA is a downslope wind event. In such an event, strong southwest winds that can gust as high as 40 mph will develop on the northeast side of the ridge. Since these events occur in the presence of a strong low level inversion, temperatures to the northeast of the Buffalo Ridge are often 10 to 15 degrees warmer than the surrounding environment as warmer air aloft is brought down to lower elevations by the downsloping winds. These downslope wind events are similar to that seen in the lee of the Colorado Rockies.

Synoptic Ingredients: Downslope winds usually occur in the early morning when a southwesterly low level jet is present above a strong low level inversion. As the jet crosses the topographic ridge, the wind flow is accelerated downward, which creates the locally enhanced surface winds. The juxtaposition of a strong low level inversion and a southwesterly low level jet typically occurs during the overnight hours in the summer when a shortwave trough is located to the west or northwest of the FSD CWA.

Model Performance: All operational models (40 km and smaller grid spacing) detect the presence of the Buffalo Ridge in surface model terrain. Commonly, model output (including MOS products) will show lower nighttime temperatures during surface high pressure situations, and will detect locally enhanced wind speeds as the inversion begins to mix out during the morning. However, model data does not appear to resolve all of the processes necessary to create strong downslope wind events. It is currently unknown whether or not high-resolution operational models like the HRRR have correctly simulated local wind speed enhancement during such an event along the Buffalo Ridge; however, a few downslope wind events have been forecast by a local version of the 4 km WRF, run by WFO ABR.