

## Evaluation of Winter Weather in Wyoming based on Numerical Weather Modeling for Snow Fence System Design

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Blowing snow causes serious hazards for travelers on Interstate 80 (I-80) situated in a cold and windy high prairie of Wyoming. Low visibility and frozen road surface have often triggers multi-vehicle accidents such as the car crash accident happened on April 16, 2015, at 342 mile post on I-80. It has been recognized that snow fence improves the driver's visibility as well as the road surface condition. As such, total of about 440-mile long snow fence system has been installed in Wyoming. The snow fence has typically been designed based on the winter weather condition including wind fields and annual snow amount, which were measured manually. The weather data clearly plays a crucial role in winter hazard prediction and prevention for the surface transportation. The objective of this study is to develop better wind and winter precipitation information for snow fence design using a numerical weather model during a sufficiently long period so that it can capture the evolving climate effect. The new model-based continuous weather data is complementary to the existing observation data.

The numerical weather model simulated the historical weather condition during the period 1980-2014 at 12 km spatial resolution over Wyoming. The simulation was carried out using the Weather Forecast and Research (WRF) model with the boundary conditions estimated from the North American Regional Reanalysis (NARR) data. The wind field was visualized using a frequency distribution histogram and a wind rose, which is a wind direction and speed diagram. The modeled wind field was validated by the observed wind records at five airport sites from SCRAM (Support Center for Regulatory Atmospheric Modeling) Surface Meteorological Archived Data (1984-1992). The comparisons of simulated and observed wind statistics showed good agreement at those five locations. The animated model outputs showed that a wind field was extremely dynamic even during single winter storm event. Moreover, the wind appeared to be very heterogeneous in Wyoming as the wind roses at several locations were different from each other in last 33 years. Considering these high variabilities of the wind, this model simulation was considered to be realistic for engineering practice especially at sparsely observed sites.

The modeled long-term wind field was used to assess the climatic evolution effect on wind in Wyoming. The time series of the computed Wyoming-average wind speed showed a slight upward trend with a rate of 0.138 m/s per decade. In addition, the number of days that wind speed exceeds 12 miles per hour was computed every 5 year period from 1980 through 2014. The analysis revealed that Wyoming recently has roughly 20 more windy days than the 80s.

Numerical weather model can provide the historical long-term and seamless wind field data, which can be used for winter weather hazard protection planning. According to the wind simulation using the WRF model with the NARR data, Wyoming has gotten windier over the last three decades. As a next step, the available snow amount to be blown on ground will also be quantified using this model product. We also plan to analyze the blowing snow events using a finer resolution model since the model errors in the current model may be due to the local topography effects.