JOINT TRANSPORTATION RESEARCH PROGRAM

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Assessment and Recommendations for Using High-Resolution Weather Information to Improve Winter Maintenance Operations

Introduction

Winter weather hazards (snow, freezing rain, bridge deck icing, etc.) often degrade road conditions and can result in substantial increases in travel time and accident frequency without proper treatment. The resources required for the Indiana Department of Transportation's (INDOT's) winter maintenance operations are currently estimated for the 2012–2013 season at over \$30M. A large number of decisions related to treatment must be made given available information regarding the previous, current, and future weather conditions that often contain considerable uncertainty. It is expected that more accurate and precise weather information will help to reduce the uncertainty related to winter weather, resulting in improved decision-making and significant cost savings for winter operations.

In this project, state-of-the-art weather information from radar and meteorological data analysis systems were evaluated to determine which would provide accurate high-resolution (~5 km scale) information to assist with after-action review of previous seasons as well as the analysis of current weather situations. In addition, detailed weather forecasts were provided to INDOT by Purdue students, utilizing a high-resolution numerical weather prediction model. These forecasts were in the form of probabilistic maps and timelines of winter weather hazards for each INDOT district, along with a written discussion for each forecast. The outcome of this research is a set of recommendations regarding implementation of more detailed weather information related to winter weather decision-making at INDOT. By working directly with INDOT “customers,” a large number of Purdue meteorology students have gained a rich learning experience by executing a complete “forecast process.”

Indianapolis (KIND) (a) base reflectivity and (b) HCA with mPING reports data for 2147Z 5 March 2013.

Findings

Several state-of-the-art weather analyses were evaluated and compared against surface weather station observations to determine which system would generate weather hour estimates that were both accurate and spatially detailed. The RTMA-based analyses underestimated weather hours and also contained analysis artifacts (circular patterns) that were unrealistic. The NMQ-based analyses over-estimated weather hours, especially within ~75 miles of a radar site, except for a narrow circle centered at each NWS radar location. The NWS dual-pol radar products were found to be immature with the precipitation type classification algorithm containing several major errors. The RAP-based weather hour analyses matched up well against the surface station data and also provided more realistic spatial detail. These analyses are recommended for use for after-action review both for previous and upcoming winter seasons.

Daily winter weather forecasts were provided to INDOT by Purdue students (under the supervision of Professor Baldwin). These forecast products were evaluated and found to be skillful and unbiased in predicting the occurrence of snow in particular. Purdue students (and professors) gained a rich learning experience as a result of their interaction with their INDOT “customers.” It is recommended that Purdue continues to communicate this kind of weather forecast information to INDOT for upcoming winter seasons.

High-resolution numerical weather prediction model output was also incorporated into these experimental forecast products. These numerical forecasts were found to be very useful by the Purdue student forecasters. It is recommended that Purdue continues to evaluate and develop numerical weather forecasts for road weather purposes, working with INDOT’s weather vendor to provide direct access to this alternate source of forecast information, resulting in increased confidence and improved decision-making for winter maintenance.

Implementation

New spatially detailed datasets for analyzing winter weather hours across the state will be provided to INDOT in a form that will allow easy implementation into INDOT operations. We recommend that INDOT begin using the more detailed analysis datasets to analyze the performance of maintenance operations for upcoming and previous winter seasons.

Numerical forecast information from the high-resolution weather prediction model run at Purdue should also be made accessible to INDOT via MDSS. Student-generated weather forecasts designed for direct use in INDOT winter maintenance decision-making will continue, taking into account the forecast information available from multiple sources.

One of the main results from the evaluation of Purdue’s experimental weather forecasts was that these forecasts were, on average, unbiased in terms of the frequency of occurrence of snow at the district level. Unbiased forecasts, or forecasts that neither over-forecast nor under-forecast the frequency of winter weather conditions, should help to minimize unnecessary costs due to extra man hours/overtime. In addition, it should improve analysis of costs per lane mile per weather hour, allowing the potential for more uniform (and cost-effective) operations statewide.

Recommended Citation

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