Using the *Clarus* System to Improve the Use of Mobile Data

Mobile observation systems may help to enhance the quantity of information available on our nation's road weather conditions and augment existing road weather information systems. Such improvements may lead to increased passenger safety through better awareness of current and impending weather conditions. Thus, understanding the full impact of mobile observations on routine weather analyses and numerical weather prediction models is critical.

The *Clarus* Initiative is a research effort of the U.S. Department of Transportation Intelligent Transportation Systems Joint Program Office and the Federal Highway Administration (FHWA) Road Weather Management Program to develop and demonstrate an integrated weather observation data management system that can reduce the impact of adverse weather conditions on surface transportation. In early 2010, the FHWA issued a Broad Agency Announcement (BAA) soliciting proposals to use the *Clarus* System in new, transformative ways. The goal of the BAA was to support research and scientific study on the use of *Clarus* data to improve surface transportation weather management and operations, create innovative interfaces, and/or develop new applications including weather-responsive traffic management tools. One of the awarded projects was the University of North Dakota Surface Transportation Weather Research Center's Application of *Clarus* System Data to the Improvement of Mobile Environmental Sensor Station Utilization. The project investigated methods to:

- Determine the quality of mobile observations
- Determine the use of mobile observations in weather analysis and forecasting
- Assess the acceptance of mobile observations by transportation agencies.

Quality Determination of Mobile Observations

A quality-checking algorithm was developed to assess the quality of mobile observation data. Several tests were developed that determined various parameters of data quality. By sequentially applying these tests to the mobile data, quality thresholds could

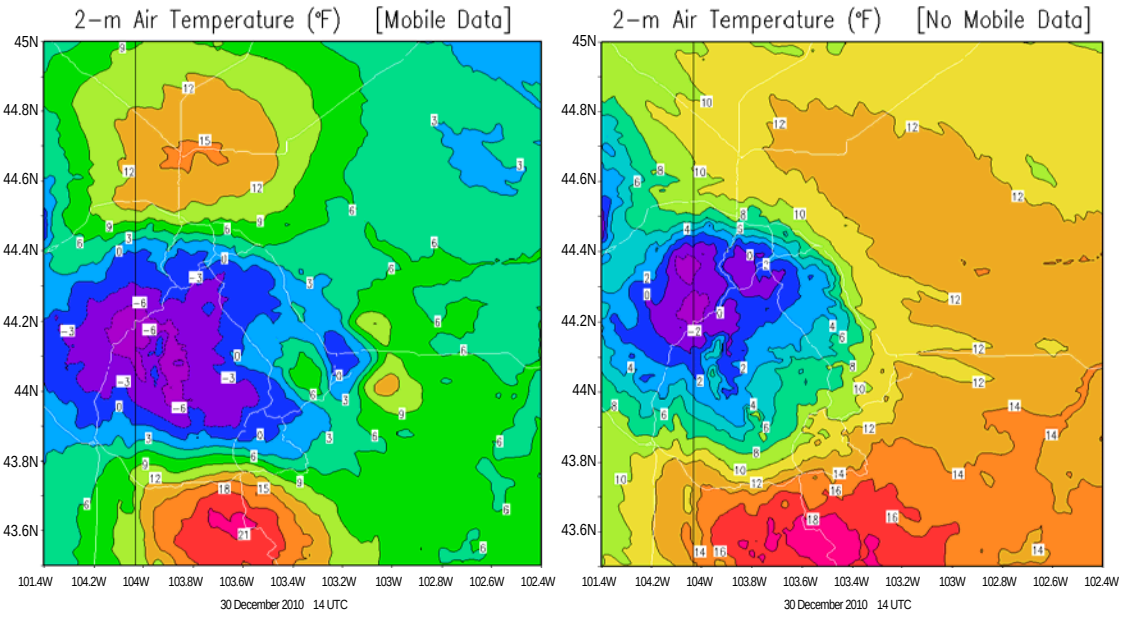

Figure 1. LAPS 2-meter temperature analyses for 14 UTC Dec. 30, 2010 for the Black Hills region. Left figure includes mobile observations and the right does not include these data. Temperature is in degrees Fahrenheit. Solid vertical black line is the South Dakota/Wyoming border. White lines are U.S. and State highways.

be developed and used as a standard for accepting or rejecting the quality of the data. These thresholds are known as “quality check flags.”

Automated Interpretation and Application of ESS Quality Check Data

Manually applying the quality check flags to real-time mobile data is a time-consuming process. A process was developed to allow automated application of the quality check flags in real time. The filtered data was of sufficient quality for input directly into a weather analysis system.

Optimization of Mobile and Fixed ESS Observation Integration

Case studies were conducted using the automated quality checked mobile data as input in hourly weather analyses. These analyses were then used to initialize mesoscale weather prediction models to evaluate improvement gained in short-range surface weather forecasts.

Figure 1 illustrates the visible effect that mobile observations have on the observed temperature field, based on the Local Analysis and Prediction System (LAPS). This analysis indicates the temperature gradient in the northern Black Hills region is stronger using the mobile data, and the southeastward progression of a cold pool is much more prominent using the analysis with mobile ESS.

Differences diminished in the mesoscale weather prediction model outputs as time progressed, despite inputting mobile data for initial conditions. The models converged when making temperature predictions one or more hours into the future, regardless of the inclusion of mobile data.

The results of the data assimilation and mesoscale modeling provided important results regarding the future use of mobile observations in an operational road weather forecasting process. While improved mesoscale weather prediction model output was not shown from the use of mobile surface observations, the case studies found that it is possible to improve the detail found in hourly analyses of surface temperature. The ability of these enhanced hourly analyses to identify subtle features could benefit human-generated road weather forecasts. Their use would provide forecasters engaged in subjective reviews of analyzed data fields with more frequent data for near-term forecasts. In the studies performed, it was possible to produce analysis products within 20 minutes of ingesting the mobile observations into the data assimilation system.

Baselining of Quality Attributes of Mobile Observations for Road Weather Management

To understand how well mobile data applications will be adopted by transportation agencies, it is important to understand the agencies’ perception of data quality. Interviews were conducted with winter maintenance personnel in Minnesota, North Dakota, and South Dakota to identify the adequacies and deficiencies of the mobile data. In these interviews, all incoming and outgoing data from the experimental, sensor-equipped maintenance trucks were considered to be mobile data.

Some of the more beneficial data and activities were weather radar data displayed in the vehicle and truck-observed mobile sensor data, such as air and road temperature. Some of the data and information considered deficient were treatment recommendations, road weather forecasts, and cellular communication connections.

The results of the interviews show current mobile data use meets the overall expectations of users. Winter maintenance personnel believe most of the data available to the truck are relevant, exhibit adequate quality, and are useful in their current operations. According to winter maintenance personnel, the mobile data improves operator decision-making. Mobile data will continue to be used and further adopted in the future.

Conclusion

Providing the highest quality road weather analyses and forecasts to the road weather user community requires a steady supply of reliable observations of both atmospheric and pavement conditions be available to the road weather service provider. While fixed ESS have been the staple for such observations for the past four decades, the presence now of mobile observations collected from maintenance vehicles provides even greater detail on current roadway conditions and the actions taken by winter maintenance personnel on their snow-fighting efforts. The inclusion of quality-checking elements with these data enables the road weather service provider to ensure that only the best data possible are included in the generation of products they provide.

All photos unless otherwise attributed are courtesy of the Federal Highway Administration Road Weather Management Program.

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“Anytime, Anywhere Road Weather Information”

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Publication #: FHWA-JPO-12-076