Aware Today. Alive Tomorrow.

by Sheldon Drobot*, Michael Chapman**, Paul Pisano***, William Mahoney III****, and Benjamin McKeever*****

Adverse weather conditions continue to plague the transportation network, but ongoing research and development promise a new system to improve driver safety and mobility.

On a snowy morning this past winter, a driver lost control of his vehicle and collided with a tractor-trailer traveling the opposite direction, resulting in his untimely death. This particular crash occurred on Highway 287 in Colorado, but the script is repeated again and again across our nation. Every year, there are 1.5 million weather-related vehicle crashes in the United States, leading to 673,000 injuries and nearly 7,400 fatalities (Pisano et al., 2008). Adverse weather and the associated poor roadway conditions are responsible for 554 million vehicle-hours of delay per year in the country, with associated economic costs reaching into the billions of dollars (FHWA, 2010).

Can these weather-related crashes be prevented? We believe they can, at least some of them, and a revolutionary new initiative called IntelliDriveSM — spearheaded by the U.S. Department of Transportation’s (USDOT) Research and Innovative Technology Administration (RITA) — will lead the way. IntelliDriveSM (www.intellidriveusa.org) is a multimodal initiative to enable wireless communications among vehicles, infrastructure, and personal communication devices. It offers the promise of enhancing our safety, mobility, and quality of life, while also helping to reduce the environmental impact of surface transportation.

In the past few years, several studies described weather-related data elements that are already, or will soon be, available from vehicles. Table 1 (see p. 11) lists the most common elements, categorized as either “input” or “observed”. The “observed” category includes direct observations of specific atmospheric variables (e.g., barometric pressure, temperature) that should benefit the weather community as input for weather models and as data at high spatial and temporal resolution data for improved situational awareness. The “input” category includes both logistical information (e.g., date, time, location) and vehicle system status observations (e.g., windshield wiper state, traction control, stability control), which can be used in conjunction with other data sets to infer weather and road conditions.

The challenge for the weather community is to harness

(continued on page 10)

In This Issue

Geospatial Visualization 2
StormReady in the Classroom 3
Forecasting Impacts 4
Data Rescue Saving Lives 6
Jobs & Opportunities 7
Conferences & Opportunities 9
About WSW & Contact Us 11
the promise of these mobile observations and provide useful applications to the driving public. To meet this challenge, RITA, the Federal Highway Administration (FHWA) Road Weather Management Program, and the National Center for Atmospheric Research (NCAR) are collaborating on a multi-year study. The main foci of this project are to (1) assess the accuracy and bias of mobile sensors; (2) develop algorithms and capabilities to translate mobile data into usable weather and road hazard products; and (3) incorporate these observations into effective weather–responsive roadway management systems and advanced decision support tools.

Early results (e.g., Chapman et al. 2010) suggest that vehicle-based measurements of air temperature are reasonably accurate (mean absolute errors around 1°C). More importantly, there is little evidence to suggest that variations in environmental conditions, such as wind speed, the occurrence of precipitation, or ambient air temperature affect the accuracy or bias of vehicle measurements.

With respect to developing algorithms, preliminary research confirms that vehicle data can be combined with traditional meteorological observations in intelligent ways to produce road and atmospheric hazards. However, two key data challenges remain. With 230 million vehicles on the nation’s roads logging 3 trillion miles driven annually, the sheer volume of data could be overwhelming if even a fraction of them are transmitting data. Additionally, a foundational component of the IntelliDriveSM program is ensuring anonymity for drivers, which could present a challenge for data integrity. Both of these issues must be addressed before these data will be broadly usable and acceptable. One solution for these issues is to statistically process and generate derived observations, which are valid along a given length of roadway. In prototype work performed by our team (Drobot et al. 2009), these derived observations consist of all observations of one parameter (e.g., temperature, atmospheric pressure) aggregated on a road segment over a designated period. In other words, the derived observations provide synthesized atmospheric and road conditions for a specific area and time. The default setting for the road segment length is one mile and the default setting for the period is five minutes, but these settings are configurable.

As previously noted in this journal, our science is only as good as society’s ability to use it (Hooke, 2007). Even after developing ways to use vehicle data, we must ensure that the applications are usable for society. It is not enough to think our job ends when the information is released; rather, we need to understand what happens next. Actualizing the integration of vehicle-based road and atmospheric hazard applications for the public will not be an easy task. Only as a unified enterprise, consisting of all creators and users of data, can we develop the necessary tools that can be transferred to the public and utilized in ways that will lead to increased safety and mobility. This is particularly true when focusing on ways to introduce information to the driver without also adding a dangerous distraction. Fortunately, the weather enterprise has considerable experience in this regard.

Even with the existing caveats and concerns, we anticipate that vehicle data will be valuable in positively contributing to the generation of improved weather and road condition products because of the uniqueness of this potentially large volume of data, the wide-ranging distribution of observations, and the frequency with which the observations occur. The weather community is encouraged to participate in this exciting endeavor.

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References


Hooke, W., 2007: Our Science is only as Good as Society’s Ability to use it. Weather and Society Watch. 1:1,8.

### Observed Data Elements

<table>
<thead>
<tr>
<th>Barometric Pressure</th>
<th>Rain (Rain Sensor)</th>
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<tbody>
<tr>
<td>Ambient Air Temperature</td>
<td>Sun (Sun Sensor)</td>
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### Input Data Elements

| Date (Year, Month, Day) | Brake Status |
| Time (Hour, Minute, Second) | Brake Boost |
| Location (Lat/Lon) | Accelerometer (lateral, longitudinal) |
| Elevation | Yaw Rate |
| Vehicle Heading | Headlight Status |
| Vehicle Velocity | Traction Control |
| Hours of Operation | Stability Control |
| Wiper Status | Rate of Change of Steering |
| Anti-lock Braking System Status | Impact Sensor |
| Adaptive cruise control radar | Ambient Noise Level |
| Short-range wide beam radar | Camera imagery |

Table 1. Weather-Related Vehicle Data Observations.

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The purpose of *Weather and Society Watch* is to provide a forum for those interested in the societal impacts of weather and weather forecasting to discuss and debate relevant issues, ask questions, and stimulate perspective. The newsletter is intended to serve as a vehicle for building a stronger, more informed societal impacts community.

Any opinions, findings, and conclusions or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the views of NSF or other sponsors. Contributions to *Weather and Society Watch* are subject to technical editing at the discretion of SIP staff.

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