Road Weather Management Program
Decision Support Tools

Gabe Guevara
Road Weather Management Program
Federal Highway Administration
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Average Annual Fatalities Under Adverse Weather

2004 - 2013

- Flood: 75
- Lightning: 33
- Tornado: 109
- Hurricane: 108
- Heat: 123
- Cold: 27
- Winter: 25
- Wind: 51
- Rip Currents: 48
- Total NWS Tracked*: 599
- Adverse Road Weather: 6062
Weather-Related Crashes

Total Annual Crashes
Average = 6,301,000

- Other Crashes: 76%
- Weather Related Crashes: 24%

Weather Related Crashes By Road Weather Condition*

- Wet Pavement: 75%
- Icy Pavement: 13%
- Snow/Slushy Pavement: 11%
- Fog: 1%

*Crashes that occurred under adverse conditions; additional factors such as rain, snow, and fog are not disaggregated from pavement conditions in this graphic. The percentage due to fog is for those crashes that occur under foggy conditions, but not wet, icy, or snowy pavement conditions.

Source: Road Weather Management Program, Table: Weather-Related Crash Statistics (Annual Averages), Available at: http://www.ops.fhwa.dot.gov/weather/q1_roadimpact.htm
Weather vs Road Weather

Weather

- **Definition:** *The state of the atmosphere* with respect to wind, temperature, cloudiness, moisture, pressure, etc.
- **How will it affect me?** Clothing, utility usage, outdoor activities, etc.
- **The forecast message:** Broad and generalized for any audience.

Road Weather

- **Definition:** *The state of the roadway and driving environment* with a focus on precipitation type, pavement and subsurface temperature, pavement conditions, visibility, wind speed and direction, humidity, etc.
- **How will it affect me?** Closed roads, reduced speeds, hazardous driving, tire friction loss, etc.
- **The forecast message:** Specific to impacts and catered to motorists making decisions.
Connected Vehicles

Windshield Wiper
Head Lights
Outside Air Temperature
Barometric Pressure

ABS/Brakes
Traction and Stability Control
Steering Angle
Throttle Position

Speed
Location
Heading
Elevation

Differential Wheel Speed
Accelerometer
Yaw/Pitch/Roll
Engine Load

Images: USDOT, NCAR
WEATHER DATA ENVIRONMENT (WxDE)
https://wxde.fhwa.dot.gov
The Weather Data Environment (WxDE) & Its Purpose

• The WxDE is a system that collects, quality checks, archives, and disseminates road weather observations.

• The purpose of the Weather Data Environment (WxDE) is to provide a data and interoperability platform to meet the weather-related research needs of the community, especially for Intelligent Transportation Systems (ITS).
Elements in the WxDE

- **Collection of Data**
  - Road Weather Information Systems (RWIS)
  - Mobile Vehicles
  - Weather observations from the National Weather Service (NWS) - used for quality checking
  - Metadata about the contributors, sites, stations, sensors, observations, quality checks, and more

- **Quality Checking of Observations**

- **Dissemination of Data**
  - Map Graphical User Interface (GUI)
  - On-Demand Query
  - Subscription Service
2016 TRB Winter Maintenance & Surface Transportation Weather Meeting
INTEGRATED MOBILE OBSERVATIONS (IMO)
Integrated Mobile Observations (IMO)

Objectives:

- Better understand how to capture, communicate, and process data from the vehicle’s internal codes and external road weather sensors placed on the vehicle
- Identify uses for and incorporation of the data in new and established applications
- Assess the impact and results of utilizing the data in applications

Outcomes:

- Used to enhance decision making by traffic operators, maintenance managers, and travelers
## Integrated Mobile Observations (IMO) Project

Goal: Exploring the feasibility of using vehicle-based data to improve transportation safety & mobility

<table>
<thead>
<tr>
<th>Minnesota DOT</th>
<th>Michigan DOT</th>
<th>Nevada DOT</th>
</tr>
</thead>
<tbody>
<tr>
<td>~550 Vehicles</td>
<td>~50 Vehicles</td>
<td>~20 Vehicles</td>
</tr>
<tr>
<td>Data</td>
<td>Data</td>
<td>Data</td>
</tr>
<tr>
<td>- Air Temperature</td>
<td>- Air Temperature</td>
<td>- Air Temperature</td>
</tr>
<tr>
<td>- Relative Humidity</td>
<td>- Relative Humidity</td>
<td>- Relative Humidity</td>
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<tr>
<td>- Surface Temperature</td>
<td>- Surface Temperature</td>
<td>- Surface Temperature</td>
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<tr>
<td>- Wiper Status</td>
<td>- Brake Status</td>
<td>- Wiper Status</td>
</tr>
<tr>
<td>- Brake Status</td>
<td>- Accelerometer</td>
<td>- Maintenance Status</td>
</tr>
<tr>
<td>AVL &amp; Cellular</td>
<td>Bluetooth &amp; Cellular</td>
<td>Radio &amp; Cellular</td>
</tr>
</tbody>
</table>
PIKALERT SYSTEM
Diagrammatically, this looks like...

Data is wirelessly transmitted from vehicles

Data is QC’d and processed

Vehicle Data Translator

Road Weather Info. is disseminated

Content Providers

Road Weather Info. is fed into Decision Support Systems
Vehicle Data Translator
(Pikalert® VDT)

- Software that creates highly detailed weather and road condition nowcasts and forecasts

- Inputs:
  - Vehicle-based measurements (vehicle actions, pavement conditions, atmospheric measurements)
  - Traditional weather data sources

Image: NCAR
Enhanced Maintenance Decision Support System (EMDSS)

- Produces road weather forecasts and winter maintenance treatment recommendations
- Aids maintenance managers and other personnel in key decisions of treatment type, timing, rates, and locations
- The plow truck becomes a connected vehicle.

Image: USDOT
EMDSS Display - Vehicle Locations, Radar, Road Segment Trouble Areas
Motorist Advisory and Warning (MAW) System

- Displays road weather alerts and hazard forecasts to decision makers ranging from DOT personnel to the traveling public
- Uses VDT output and a road weather forecast to provide these alerts
- Pre-trip: web-based display
- On the road: mobile application
MAW Web-based Display

<table>
<thead>
<tr>
<th>Time</th>
<th>Conditions</th>
</tr>
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<tbody>
<tr>
<td>Mon 11/30 11:00 am</td>
<td>Advisory: Precip: light snow, Pavement: wet, Visibility: normal</td>
</tr>
<tr>
<td>Mon 11/30 12:00 pm</td>
<td>Advisory: Precip: light snow, Pavement: wet, Visibility: normal</td>
</tr>
<tr>
<td>Mon 11/30 1:00 pm</td>
<td>Clear</td>
</tr>
<tr>
<td>Mon 11/30 2:00 pm</td>
<td>Clear</td>
</tr>
<tr>
<td>Mon 11/30 3:00 pm</td>
<td>Clear</td>
</tr>
<tr>
<td>Mon 11/30 4:00 pm</td>
<td>Clear</td>
</tr>
<tr>
<td>Mon 11/30 5:00 pm</td>
<td>Clear</td>
</tr>
<tr>
<td>Mon 11/30 6:00 pm</td>
<td>Warning: Precip: moderate snow, Pavement: slick, icy, Visibility: low</td>
</tr>
<tr>
<td>Mon 11/30 7:00 pm</td>
<td>Warning: Precip: heavy snow, Pavement: slick, icy, Visibility: heavy snow</td>
</tr>
<tr>
<td>Mon 11/30 8:00 pm</td>
<td>Warning: Precip: light snow, Pavement: slick, icy, Visibility: normal</td>
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<tr>
<td>Mon 11/30 9:00 pm</td>
<td>Warning: Precip: light snow, Pavement: slick, icy, Visibility: normal</td>
</tr>
<tr>
<td>Mon 11/30 10:00 pm</td>
<td>Warning: Precip: light snow, Pavement: slick, icy, Visibility: normal</td>
</tr>
</tbody>
</table>
MAW Mobile Application

- No alert.
- Icy roads possible ahead. Drive slowly and use caution.
- Light snow ahead. Snowy, slick roads. Delay travel, seek alternate route, or drive slowly and use extreme caution.

Latitude: 45.62103
Longitude: -94.22256

Latitude: 45.62094
Longitude: -94.20521

Latitude: 45.57586
Longitude: -94.20521
INTEGRATED MODELING FOR ROAD CONDITION PREDICTION (IMRCP)
Integrated Model for Road Condition Prediction (IMRCP)

Incorporates real-time and/or archived data and results from an ensemble of forecast and probabilistic models:
- atmospheric and road weather
- traffic
- work zones
- incidents
- special events
- demand

Weather & Traffic Model Review - Complete
Concept of Operations - Complete
Detailed Requirements – Almost Complete

- Travelers
- Transportation operators
- Maintenance providers
Potential Opportunities for Change

- Improve the precision of road weather condition effects (e.g., wet, slushy, icy) in traffic models
- Enable link-specific traffic impacts on road weather condition forecasting (e.g., mechanical wear/packing)
- Forecast network traffic conditions for operations
- Forecast route travel times and reliabilities
- Estimate incident likelihood based on current and forecast conditions
- Enable forecast-aware routing for travelers
- Identify strategies for forecast-aware traffic management

- Identify strategies for pre-positioning of emergency response assets based on forecasts and incident likelihoods
- Identify strategies for winter maintenance route prioritization based on weather and traffic forecasts
- Integrate new data sources and types of data
  - Data from social media
  - Trajectory/probe data
- Reduce the time needed for TMC/maintenance operations to analyze and respond to changing conditions
Example Application Scenarios

- Enhanced transportation system management and operations
  - Forecast-aware variable speed limits
  - Enhanced motorist advisories and warnings
  - Enhanced intelligent signal controls
- Traffic-aware winter maintenance decision support
- Traffic- and traffic-aware routing optimization
  - Commuters
  - Long-haul freight
  - Emergency responders
ROAD WEATHER PERFORMANCE MEASURES (RW-PM) TOOL
Road Weather Performance Measures (RW-PM) Tool

- Integration of traffic mobility, road weather maintenance and motorist advisory analysis and information with real-time continuous data.
- Continuous updating of traffic control, RdWx maintenance and motorist advisory recommendations as RdWx conditions evolve throughout weather events.
- Publish traveler information into vehicles.

Real-time Continuous Data → Traffic Operation & Maintenance → Traveler Info: Queue Warning Speed, & Pavement Conditions
Road Weather Maintenance

- Displays the Road Treatment Recommendations from Pikalert
- Each site shows an icon based on its current pavement condition
Traffic Control

- Displays the Traffic Backups (Queues) and Recommended Speeds (Speed Harm) Advisories. (Also sent to the connected vehicle application.)
- Displays the speed sensor information from MnDOT.
Sample Motorist Advisories

Icy Conditions Ahead With Speed Recommendation

Caution! Icy Road. Reduce Speed

Backup (Queue) with Speed Recommendation (Speed Harm) and Snow Covered Roads

Reduce Speed Backup I-35W at Mile 13.2 Caution! Snow Covered Roads
## Road Weather Management Team

### Contact Information

<table>
<thead>
<tr>
<th>Name</th>
<th>Position</th>
<th>Phone Number</th>
<th>Email Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paul Pisano</td>
<td>Team Leader</td>
<td>(202) 366-1301</td>
<td><a href="mailto:Paul.Pisano@dot.gov">Paul.Pisano@dot.gov</a></td>
</tr>
<tr>
<td>Roemer Alfelor</td>
<td></td>
<td>(202) 366-9242</td>
<td><a href="mailto:Roemer.Alfelor@dot.gov">Roemer.Alfelor@dot.gov</a></td>
</tr>
<tr>
<td>Gabe Guevara</td>
<td></td>
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<td><a href="mailto:Gabriel.Guevara@dot.gov">Gabriel.Guevara@dot.gov</a></td>
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