Integrated Modeling for Road Condition Prediction (IMRCP)

FHWA-JPO-17-602

Background

Intelligent transportation system deployments have enabled great advances in operational awareness and response based on the data they gather on the current state of the roadways. Operators have better access to traffic and weather condition information, enabling them to make more informed decisions and respond more quickly to events. Winter maintenance crews have more accurate and complete data on which to base their treatment plans and plow routes allowing them to establish safer roads for travelers though efficient decision-making. Information about traffic and weather events is also provided to travelers, who are enabled to adjust their own travel behaviors.

The next step in decision support is to forecast road conditions and build awareness of potential degradations before problems occur. Real-time traffic simulations and road weather models can forecast network traffic and road weather conditions before they occur, providing a basis for anticipatory and expedited response. These predictive methods can further assess the potential effects of implementing response strategies for traffic and demand management. Travelers could make forecast-enabled travel and routing decisions based on fastest or most reliable travel times.

This convergence of opportunities led the Federal Highway Administration's (FHWA) Road Weather Management Program (RWMP) to initiate research into and demonstration of Integrated Modeling for Road Condition Prediction (IMRCP). IMRCP capabilities could provide a practical tool for state and local transportation agencies to support operational decisions, maintenance planning, and traveler information at strategic and tactical levels.

Objective

The objective of the IMRCP is to demonstrate the integration of traffic, weather, and operational event forecasts to predict integrated road conditions. Elements of the forecast include atmospheric and road weather conditions, hydrology, traffic demand and management strategies, work zones, winter maintenance operations, incidents, and special events.

Evaluation of the IMRCP demonstration assesses the potential application benefits for transportation operators and maintenance providers. It is envisioned that the integrated forecasts may be useful to transportation system operators and travelers in decision support, providing alerts of road conditions, and routing for travel and maintenance.

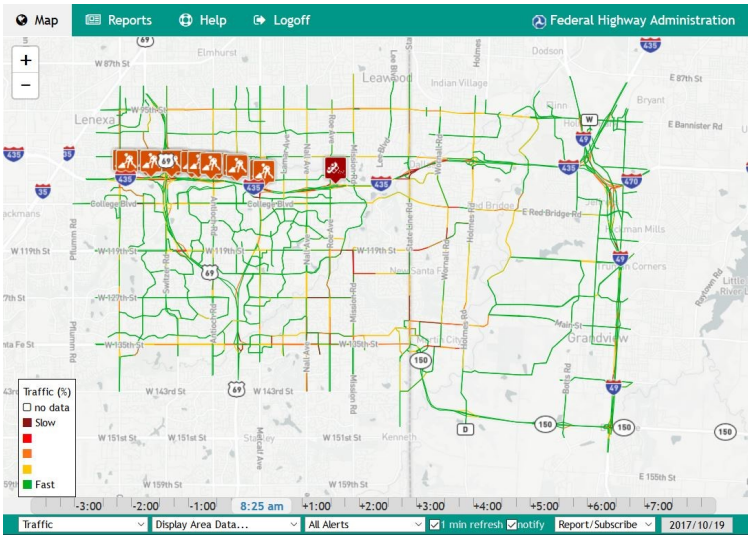
IMRCP System Description

The IMRCP provides an integrated view of forecast road weather and traffic conditions for a given road network. The IMRCP model draws input from hydrological and traffic data sources and a diverse set of weather event sensors to generate estimates of current conditions and forecasts of future conditions. Forecast outputs are available through a web interface on maps, in reports, and in subscriptions.

Traffic data sources such as advanced transportation management systems (ATMS) provide volumes and speeds, freeway control and traffic signal operations data, incident reports, and plans for work zones and special events. Current and forecast atmospheric and hydrological conditions are drawn from National Weather Service sources. State and local agencies provide specialized road weather conditions such as pavement temperatures. Data collected from the various sources are indexed, stored, and archived in a heterogeneous data store.

While atmospheric and hydrological forecasts, work zones, and special events are taken from external sources, the IMRCP synthesizes road weather and traffic condition predictions with embedded best-in-class forecast models. In the current implementation, road weather conditions are estimated across the network using field measurements of conditions and are predicted from atmospheric forecast conditions using the METRo model. Current traffic conditions are similarly estimated from detector stations and demand models and are predicted from road weather, incident, and demand forecasts using the TrEPS/DYNASMART model.

The IMRCP provides prediction data on web-based maps, reports, and subscriptions. The map enables users to select layers for roadway, regional atmospheric, and point-specific alert data. A traffic-focused map, for example, could display traffic, precipitation intensity, and traffic incident alerts. Available map layers also include select route travel times, weather radar, NWS advisories and warnings, and local road condition alerts. All data are available in reports and subscriptions that can be accessed by other systems. Maps and reports can also display archived data.



Demonstration Study Area

A portion of the Kansas City metro area along a congested interstate corridor and surrounding arterials has been used for a demonstration study and evaluation area. The Kansas City area is subject to highly variable weather conditions and local recurring congestion typical of U.S. urban/suburban settings. The I-435 corridor along the southern part of the metro carries heavy commuter traffic in both directions and for much of its length runs along a streamway with historically significant flood risk. The corridor is well-instrumented for traffic, weather, and hydrology.

Study Area Traffic and Weather Features	
2006 Road Network Links	870 Road Network Nodes
205 Traffic Signals	20 StormWatch Sites
1 Automated Surface Observing System (ASOS) Station	5 Advanced Hydrological Prediction Service (AHPS) Stations
141 Vehicle Detectors	53 Ramp Detectors
15 Dynamic Messaging Signs	

Evaluation

A core national group of stakeholders monitored and provided input to the concept development and demonstration. Smaller work groups of stakeholder representatives and subject matter experts also assisted in identifying and resolving technical questions.

The Kansas City area stakeholders for the IMRCP included Kansas City Scout, Operation Green Light, and the City of Overland Park. These agencies provided a high-level assessment of the value of advanced notification provided by integrated prediction and identified gaps and opportunities for system improvement.

System Functions

The IMRCP system allows users to view forecasts and observations through several means. After logging in, users are directed to the map interface where they can view data as layers on a map. Several road condition, weather, and alert layers can be selected to be projected on the map where the layers can be viewed for a specified time domain. Road segments, areas, and alerts can be selected on the map to view more specific data. Users can also collect observations and forecasts by creating a report or subscribing to data.

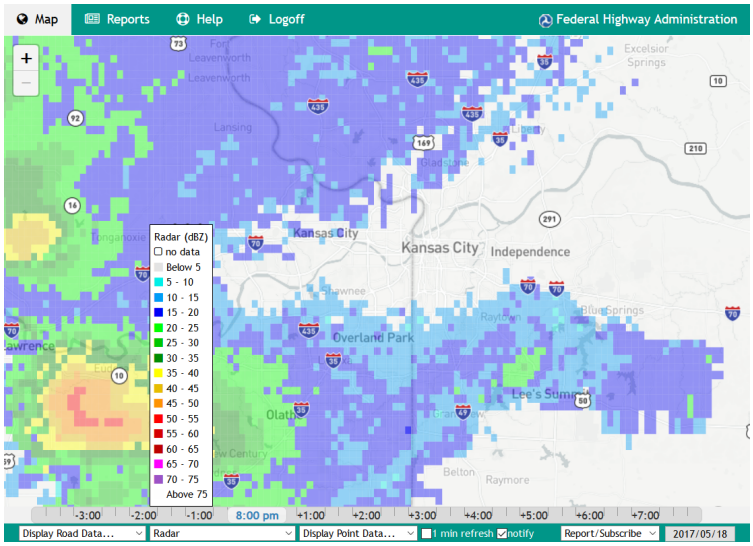
Selecting a Time Domain

The time selector at the bottom of the map interface allows users to select a time in the near future, present, or immediate past to view forecasts or observations for that time. Users can also use the date/time selector to view archive forecasts and data by clicking on the date in the lower right corner of the map interface.

Viewing Forecasts & Observations

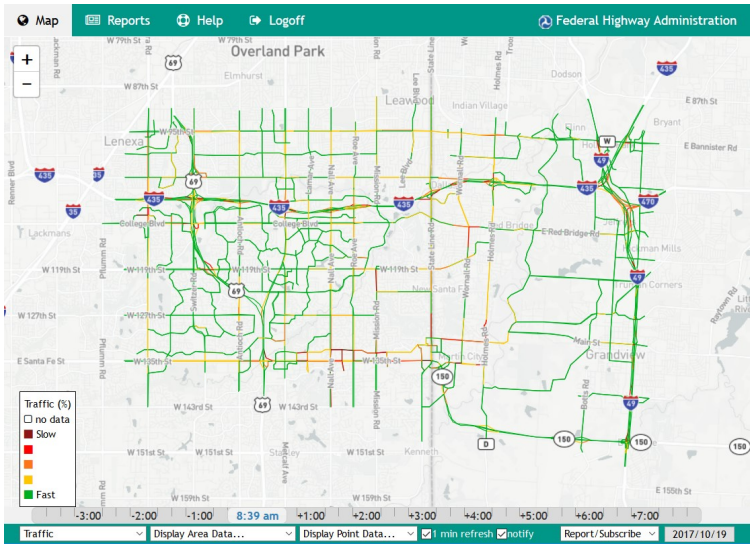
Users can view forecasts and observed road and weather conditions at specified time frames by selecting layers from the drop-down menus at the bottom of the map interface. Road segments and area polygons with data pertaining to the selected layer are color-coded according to the legends displayed above the drop-down menus. Users can select a road segment or area polygon to view forecasts or observations specific to that segment or polygon.

Road Condition Data Layers	
Road Network Model	Routes
Pavement State	Traffic
Pavement Temperature	Traffic Speed
Pavement Flood Depth	Traffic Density
Pavement Snow Depth	Traffic Flow
Weather Data Layers	
Air Temperature	Surface Visibility
Wind Gust Speed	Wind Speed
Precip. Rate & Type	NWS Alerts
Radar	



Lat, Lon: 38.9100031, -94.6252441 Elevation: 271

ObsType	Source	Start Time	End Time	Value	Units
air temperature	RTMA	10-19 08:00 am	10-19 09:00 am	50.14	F
wind speed gust height above ground	RTMA	10-19 08:00 am	10-19 09:00 am	12.97	mph



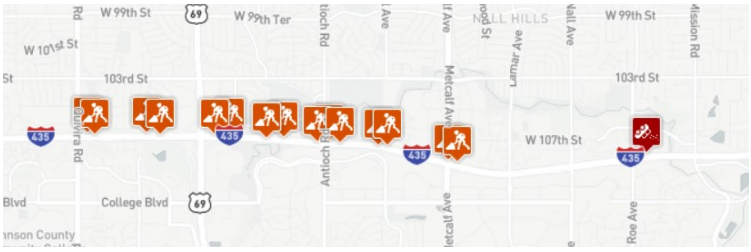
I-435 E @ Metcalf Ave
Lat, Lon: 38.931364, -94.664760 Elevation: 279

ObsType	Source	Start Time	End Time	Value	Units
average speed of vehicles on each link	TREPS	10-19 08:34 am	10-19 08:35 am	64.42	mph
average density of vehicles on each link	TREPS	10-19 08:34 am	10-19 08:35 am	18.77	%

Viewing Alerts

Alerts can be displayed on the map by selecting an alert layer from the point data drop-down menu located at the bottom of the map interface. Specific details about an alert or point are displayed when the object is selected.

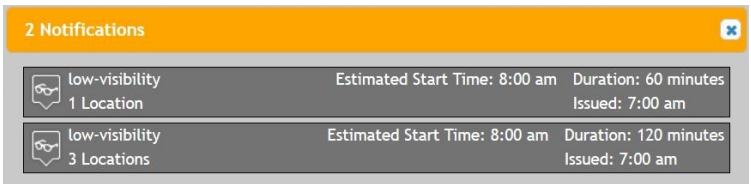
Alert/Point Data Layers	
All Alerts	Traffic Alerts
Road Condition Alerts	Weather Alerts
Detector Data	



2 VEHICLE COLLISION I-435 WB AT ROE AVE RIGHT SHOULDER EST. CLEARANCE TIME: 8:28 AM
Lat, Lon: 38.932940, -94.637632

ObsType	Source	Start Time	End Time	Value	Units
event	SCOUT	10-19 07:43 am	10-19 09:08 am	incident	

Notifications based on a subset of alerts can be viewed by selecting the notify checkbox located at the bottom of the map interface. The notification box pops up and shakes when new notifications are available based on predicted and current alerts. Clicking on notifications in the pop-up box centers the map on the alert area.



Viewing Routes

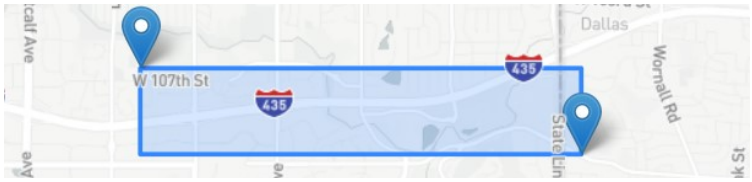
The IMRCP allows users to view travel times for routes within the study area through the Route road data layer. Users can select a route on the map and view the predicted travel time for that route.

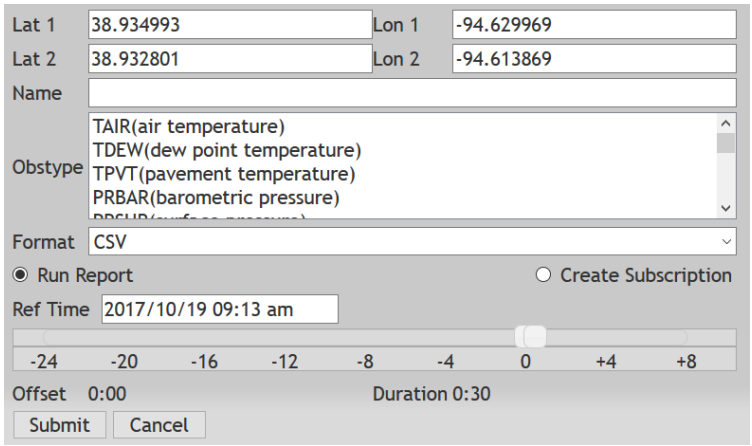
I-435 EB before Quivira to I-470
Lat, Lon: 38.932520, -94.639502 Elevation: 265

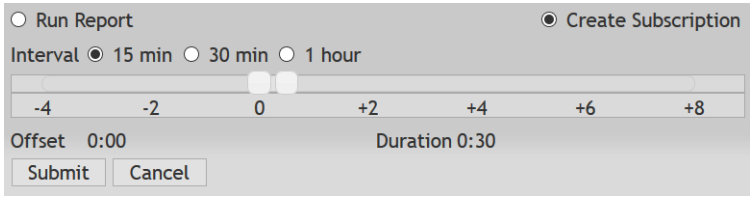
ObsType	Source	Start Time	End Time	Value	Units
route time	TREPS	10-19 09:22 am	10-19 09:23 am	10.1	min

Creating a Report or Subscription

Users can create reports or subscriptions (recurring reports) as an additional means of obtaining data from the system. Reports can be generated through the map interface by selecting the Report/Subscription button, drawing a box around the area from which data will be collected or selecting a road segment or detector, and following the instructions on the wizard. Users can select the observation type(s), format, and time specifications for their reports.







U.S. Department of Transportation
Road Weather Management

1200 New Jersey Avenue, E86-205
Washington, DC 20590
Paul Pisano
202-366-1301
E-mail: paul.pisano@dot.gov
http://ops.fhwa.dot.gov/Weather/index.aps