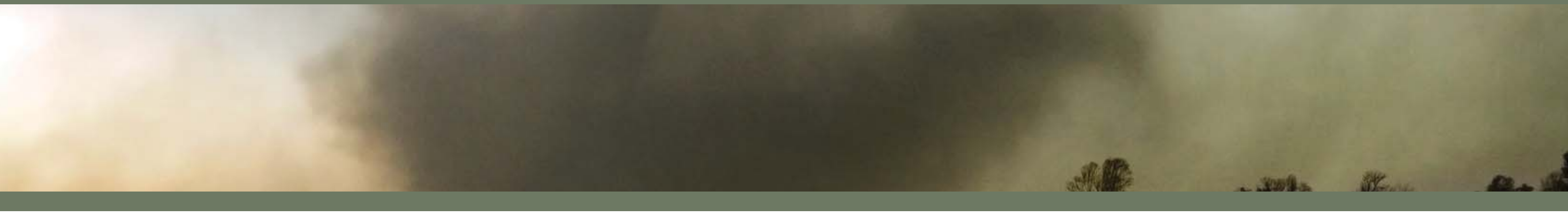
Research Studies on Weather and Traffic Flow

Modeling Traffic Response to Adverse Weather



Weather causes a variety of impacts on the transportation system. While severe winter storms, hurricanes, or flooding can result in major stoppages or evacuations and cost millions of dollars, the day-to-day weather events such as rain, fog, snow, and freezing rain can have a serious impact on the mobility and safety of users.

The application of IntelliDrive™ technologies, Road Weather Information Systems (RWIS), and weather/traffic data collection and forecasting technologies, presents new opportunities to improve the safety and mobility of the traveling public through improved knowledge and understanding of how individual drivers behave during adverse weather, and analyzing how their decisions collectively impact traffic flow.

This information can then be used to support weather-responsive traffic management strategies such as real-time modification of traffic signal and ramp meter timings, automated deicing systems, and variable speed limits. Despite the documented impacts of adverse weather on transportation, understanding the linkages between inclement weather conditions and traffic flow remain tenuous.

Impacts on Traffic Flow

The first phase of FHWA research involved macroscopic analysis, which focused on the impact of adverse weather on aggregate traffic flow. This analysis quantified changes in traffic speed, capacity, and density during adverse weather.

Data was gathered from Traffic Management Centers in Baltimore, Seattle and the Twin Cities of Minneapolis-St. Paul, and the National Weather Service stations at airports in those cities. The research found the impact varied with precipitation intensity, and both rain and snow impacted free-flow speed, speed-at-capacity, and capacity.

Driver Behavior

The second phase of research analyzed the impacts of adverse weather on microscopic traffic behavior. Microscopic analysis describes individual driver responses to weather conditions, such as changing lanes, merging onto a freeway, making left turns across traffic at an intersection, or adjusting the distance behind a lead vehicle.

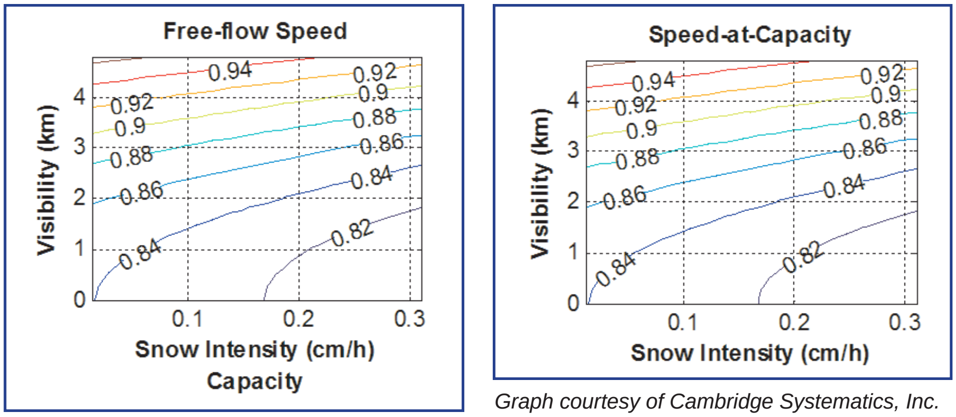
Video tape studies on individual vehicle movements at intersections or freeway merge locations provide a rich source of data for microscopic analysis.

For the FHWA study, video recorded data was utilized to accomplish two primary goals:

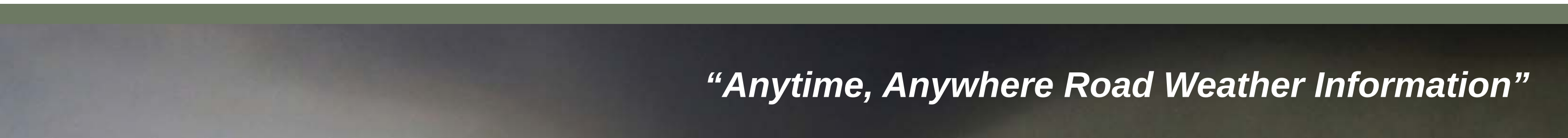
- To achieve a better understanding on how drivers respond to adverse weather, focusing on three types of driving behavior: car following, gap acceptance, and lane changing.

Figure 1 shows the adjustment factors calculated using Twin Cities data for free flow speed and capacity during various snow intensity and visibility levels. The complete report is available from the FHWA web site http://ops.fhwa.dot.gov/publications/weatherempirical/index.htm.

Figure 1. Variation in Weather Adjustment Factors as a Function of Visibility and Snow Intensity



Graph courtesy of Cambridge Systematics, Inc.



"Anytime, Anywhere Road Weather Information"

- To incorporate microscopic models in existing microsimulation tools, so they can be used to model and evaluate weather-responsive traffic management strategies.

The microsimulation packages evaluated include CORSIM, VISSIM, AIMSUM2, Paramics, and INTEGRATION.

The study was most successful in modeling gap acceptance behavior. Research used video collected at three intersections in Blacksburg, Virginia, one of which is shown in Figure 2, to determine whether drivers altered gap acceptance behavior during rainy weather.

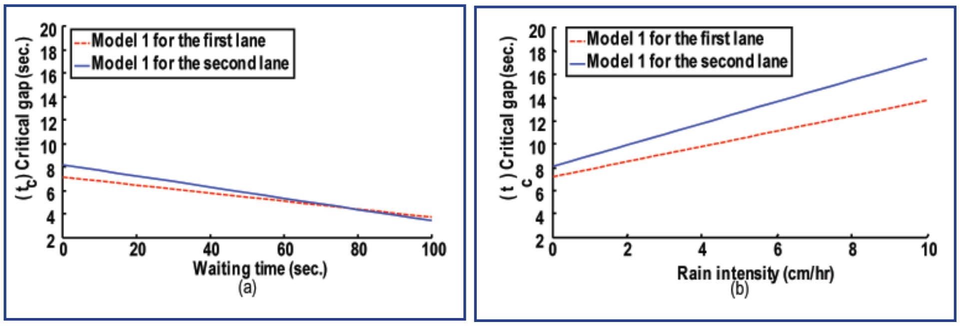
Figure 2. Site for Intersection Gap Acceptance Analysis, Blacksburg, Virginia

Photo courtesy of Cambridge Systematics, Inc.

Findings indicate a more cautious approach to left turn gap acceptance during rainy weather, a factor that would influence the effectiveness of signal timing plans. Figure 3 shows how the critical gap changes as the wait time and rainfall intensity change at the intersection.

FHWA is currently conducting research on car following behavior using a

Figure 3. Critical Gap as a Function of Waiting Time and Rain Intensity Levels



Graph courtesy of Cambridge Systematics, Inc.

dataset obtained from Hokkaido University in Japan that observed individual drivers on a test track. Collection and analysis of data on gap acceptance behavior at intersections during snowy conditions is also planned.

Other activities include a national and international search to identify additional datasets, and the development of three macroscopic datasets using data from IntelliDrive™ systems and weather stations. Better analysis is possible because the quality and quantity of available data have improved substantially over the past few years.

Microsimulation Models

Research indicates most of the microsimulation packages evaluated could accommodate weather-related adjustment factors for lane-changing behavior. In some cases, this requires adjusting complex vehicle dynamics models and in others the impact of the adjustment may be limited due to assumptions inherent in the model structure.

It was concluded that gap acceptance behavior under adverse weather could be incorporated in most microsimulation models while inadequate data were available to draw conclusions about incorporating lane-changing behavior.

Additional research currently underway involves development of specific procedures for incorporating weather-related factors in CORSIM and VISSIM models.

All photos courtesy of Road Weather Management Program

U.S. Department of Transportation
Road Weather Management
1200 New Jersey Avenue, E84-422
Washington, DC 20590

Roemer M. Alfelor
202-366-9242
E-mail: roemer.alfelor@dot.gov
http://ops.fhwa.dot.gov/Weather/index.aps

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