Road and railway control and protection

Overview

Safe and efficient road transport is adversely affected by the following conditions which affect speed, distance between the vehicles, tyre adhesion and braking efficiency: poor visibility (heavy precipitation, fog, smoke, sand storm), strong winds, surface flooding, land subsidence, snow, freezing precipitation and ice. The effects of these conditions are exacerbated they are combined, especially in the nighttime. Many of the effects of the hazards are well known. There is a variety of possible measures which can be taken to ameliorate their effects: preventive measures prevent or reduce the impact of the hazard on the road user; remedial measures help alleviate the problems once they have occurred (Perry and Symons, 1991).

Road meteorological measurements are of particular value in countries where the serviceability of the transport infrastructure in winter exerts a great influence on the national economy. In some countries there will be other road hazards such as dust storms or volcanic eruptions.

Goals of road meteorology can be defined into the following way: to confine the effects of weather phenomena on driving conditions and road traffic safety, and to optimize winter preventive measures. Solutions for the meteorological tasks are the following:

- inform about road surface state and weather parameters around the road,
- warn of probable hazardous weather phenomena,
- aid effective planning of preventive measures,
- monitor the efficiency of preventive measures,

One of the four main areas in the road meteorology is real-time observation (WMO 1997; 2003). The practical objective is to inform road users of the risks (forecast or real-time) that they are likely to face on designated routes; on the other hand to launch a series of actions aimed at increasing road safety, such as scraping snow or spreading chemical melting agents.

Table 1. Speed limits in dependence on meteorological conditions.

<table>
<tr><th>Time</th><th>Visibility</th><th>Precipitation state</th><th>Surface state</th><th>Speed limit</th></tr>
<tr><td>night</td><td rowspan="2">above 300 m</td><td rowspan="2">no precipitation, light precipitation or moderate precipitation</td><td rowspan="2">no warnings</td><td>90</td></tr>
<tr><td>day</td><td>70</td></tr>
<tr><td rowspan="5">day/night</td><td>between 100 and 300 m</td><td>whatever</td><td rowspan="2">no warnings or splippery surface warning</td><td rowspan="3">50</td></tr>
<tr><td rowspan="2">above 100 m</td><td>heavy rain or heavy snow</td></tr>
<tr><td rowspan="3">whatever</td><td>slippery surface warning</td></tr>
<tr><td>whatever</td><td>slippery surface alarm</td><td rowspan="2">30</td></tr>
<tr><td>below 100 m</td><td>whatever</td></tr>
</table>

Among factors conditioning early black ice warnings (road temperature, concentration of de-icing chemicals, pavement thermal characteristics) is forecasting road surface temperature that can be generated based on radar derived data. Moreover, point variations of road surface temperature (RST) are affected among others by current cloud cover, wind speed and direction, and precipitation.

Example of speed limits to time of the day and weather conditions on dangerous sections of roads are presented in Table 1.

The roadway system of the future will make a diverse collection of observations readily available to users at the exact time and place they are needed. Meteorological data from national and mesoscale in situ networks, satellite platforms, weather radars, and data from other remote-sensing instruments will be included in the observational network. (Committee on Weather Research for Surface Transportation, 2004).

Data usefulness

- Precipitation, kind of precipitation (hail, heavy rain, fog, etc.) – visualised over road maps and in text announcements.
- Real-time and nowcasted ground data.
- Built-in warning system.

Examples of implementations

Nowadays there are different road weather information systems (RWIS) in approximately 25 countries (Committee on Weather Research for Surface Transportation, 2004). These systems are being constantly developed . Many of those countries where a RWIS still has not been implemented have decided to either buy off-the-shelf solution or possibly develop their own national system. Information from field stations (road weather stations) is distributed to road maintenance staff. Information from weather radars and NOAA satellites are examples of other data which can be incorporated into the system.

Monitoring and the forecast of ice formation over the main roads for Torino 2006 Olympic Winter Games (Piedmont, Italy)

In order to make the complete ice forecast service efficient, a numerical forecast product of temperature and road surface conditions for the following 24 hours is provided. (Fig. 1). For this purpose a deterministic model has been used. Input data may be provided by weather radar as well.

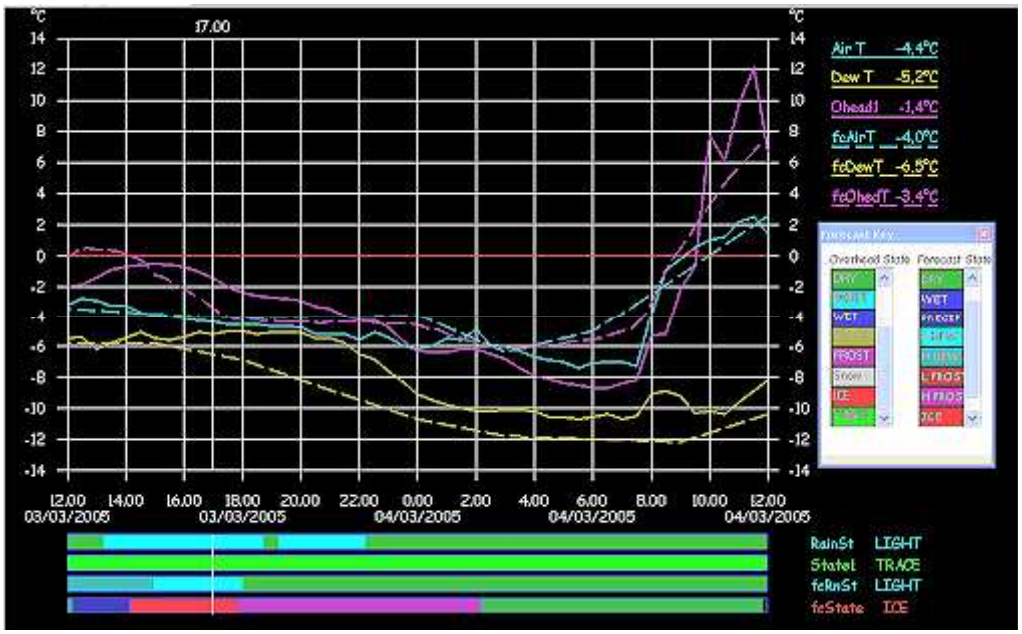

Fig. 1. Example of ice formation on the road surface forecast (state and temperature of the road surface) basing on meteorological forecasts (Martorina and Loglisci, 2005).

Winter road conditions monitoring systems

A variety of methods are available for communicating weather information to drivers. These include television, radio, and web sites used to communicate weather information more generally, as well as mechanisms currently being developed to deliver targeted road weather information through web sites, satellite radio, and the telephone, among others (Fig. 2).

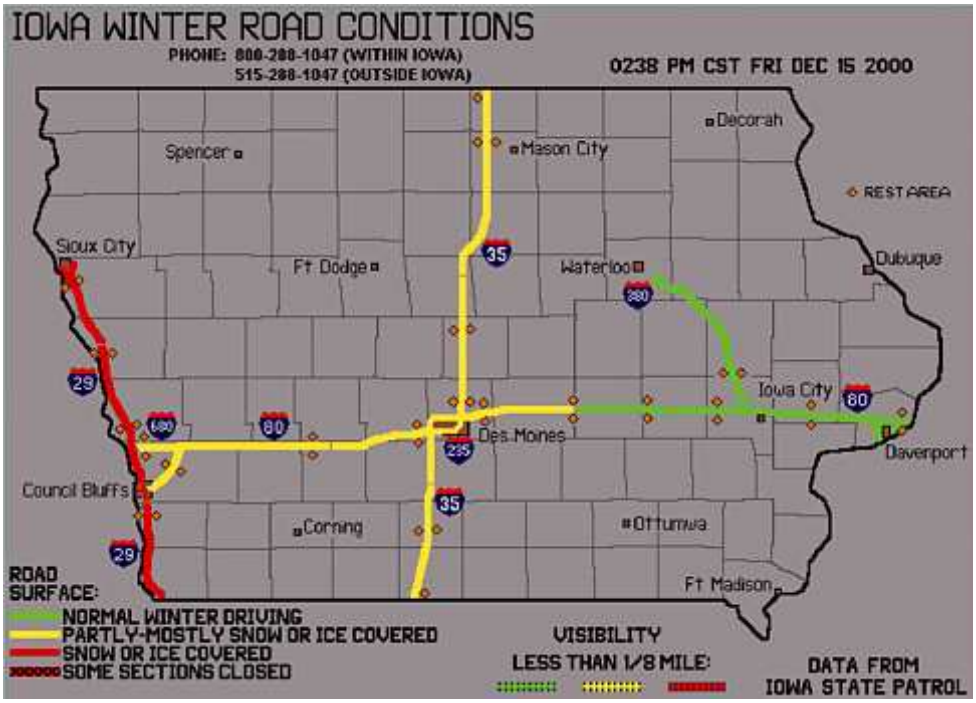

Fig. 2. Example of a map from the Iowa Winter Road Conditions Web site (http://www.iowaroadconditions.org).

Remarks

Weather radar observations can provide nearly continuous monitoring of precipitation, including severe weather with ability to determine winds and detect blowing dust. They can be applied to road meteorology as input into numerical weather prediction models.

However there are limitations: in most cases scans below 0.5° above horizon are not permitted so areas distant from radar are not fully monitored, the radar network not dense enough presently, the observations cannot discriminate precipitation phase (liquid or frozen) in the case of not dual-polarimetric radars, excessive ground clutter contamination from anomalous beam propagation are observed near ground, and conflicting other user requirements.

Literature

Martorina, S. and Loglisci, N., 2005. Monitoring and forecast service for ice formation over mountain road surface. ICAM/MAP 2005 Conf., Zadar, Croatia, 23-27 May 2005 (http://www.map.meteoswiss.ch/map-doc/icam2005/pdf/poster-sesion-c/C23.pdf).

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