The Danish Road Weather Information System

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ABSTRACT

The Danish Road Weather Information System (VejVejr) is a result of many years of unique cooperation and development between The Danish Meteorological Institute and the Danish Road Directorate in coordination with other road authorities and input from the users. The system includes all the information needed to make proper decisions whether to initiate preventive salting, and to optimize logistics in connection with snow conditions.

Keywords: RWIS, Road Weather Information System, VejVejr, user interface, data presentation, design.

1. INTRODUCTION

When designing an RWIS-system, it is important that the information is promptly accessible and easy for the users to understand. It's well known, that not all users have the same background and education. The Danish RWIS-system has solved this problem with a simple but informative colour coding of the so called alarm-status for the road observations. The same colour coding is used for presentation of the results from the numerical road condition model. Besides the system includes online weatherradar- and satellite images and live web-cams along the roads.

2. BASIC PRINCIPLES OF COLOURCODING

All observations from more than 300 road weather stations are presented in the system, and the observations are updated every 5 minutes.

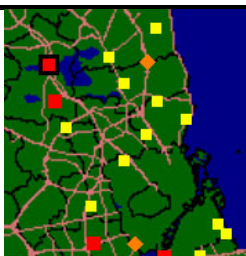| Alarm status	Description	
White	$T_{Road} > +2\ °C$	
Yellow	$0\ °C < T_{Road} \leq +2\ °C$	
Orange	$T_{Road} \leq 0\ °C$ and $T_{Dew} < T_{Road}$	
Red	$T_{Road} \leq 0\ °C$ and $T_{Dew} \geq T_{Road}$ or $T_{Road} \leq 0\ °C$ and $T_{Dew} = T_{Air}$	

Table 1: Definitions of alarm status (Colour coding).

The principle of this colour-coding is, that white alarms indicate no risk of slippery roads. A yellow alarm indicate that the user should be alert and carefully watch the situation, but slippery roads are not present at the moment.

Red and orange alarms can of course both indicate slippery roads, either due to freezing wet roads or hoar frost forming. The distinction between the two types of alarms is made only because of the fact, that orange alarms not necessarily means slippery roads. The fact, that the dewpoint-temperature is below the road-temperature means, that no riming occurs. Then it doesn't matter if the road-temperature is below freezing, as long as the roads are dry and no precipitation occurs. If the roads are wet or precipitation is present, you have a slippery road.

In situations with red alarms hoar frost is forming, because the dewpoint-temperature is higher than the road-temperature. It's probably well known, that freezing fog occurs when air- and dewpoint-temperature are equal and the air-temperature is below freezing. From time to time it happens that fog produces waterparticles which sticks to the road. The (usually freezing) fog is so cold, that the temperature of the fog is colder than the road-

temperature. In these cases we would have an orange alarm, if we hadn't had the second condition in the red alarm definition.

When the users have become familiar with the colour-coding and the concept of alarm-status, they are ready to monitor the current, as well as the forecasted road conditions.

3. CONTENTS OF THE DANISH RWIS-SYSTEM

3.1 Local-map

The "local map" shows alarm-status of the road stations, either in a user chosen area or from all available stations in the system.

The left side of the screen shows the actual status and the observations are updated every 5 minutes. The right side of the screen shows output from the numerical road condition model. A new forecast is available every hour. The forecasted alarm status is the "worst case" status, at any time within the next 5 hours. 5 hours are chosen as the length of the forecasted period, because in Denmark 5 hours is the typical time needed to make a decision to initiate and complete preventive salting. The definitions of "worst case" alarm status are: red before orange, orange before yellow and yellow before white.
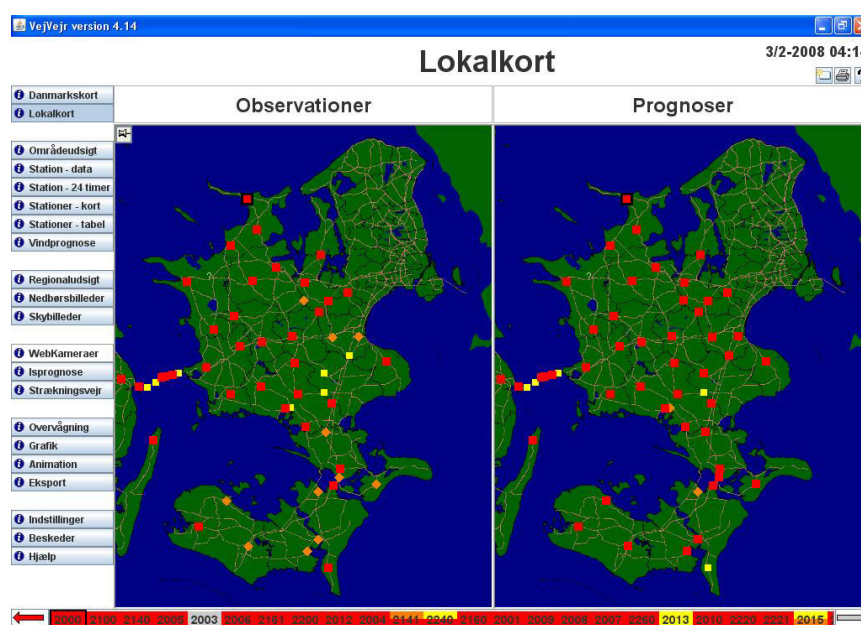

Fig. 1: Local map

3.2 Station – data

It's possible to obtain detailed information for all the road weather stations included in the system. For each station there's a unique screen displaying the data. The left side of the screen shows observations for the previous 3 hours. The air temperature measured in 2 meter is shown as a blue curve. The dewpoint temperature measured in 2 meter is shown as s green curve and the road temperature is shown as a red curve. If the station also measures the freezing temperature (depending on the salt amount present), it's presented as a black curve (not shown on the figure). Below the curves representing the temperatures, you find the measured surface state: dry/wet/ice/snowcover etc. The colour of bar above the temperature curves indicates the actual status. The bar colour refers to the alarm state in the "local map" (Fig. 1).
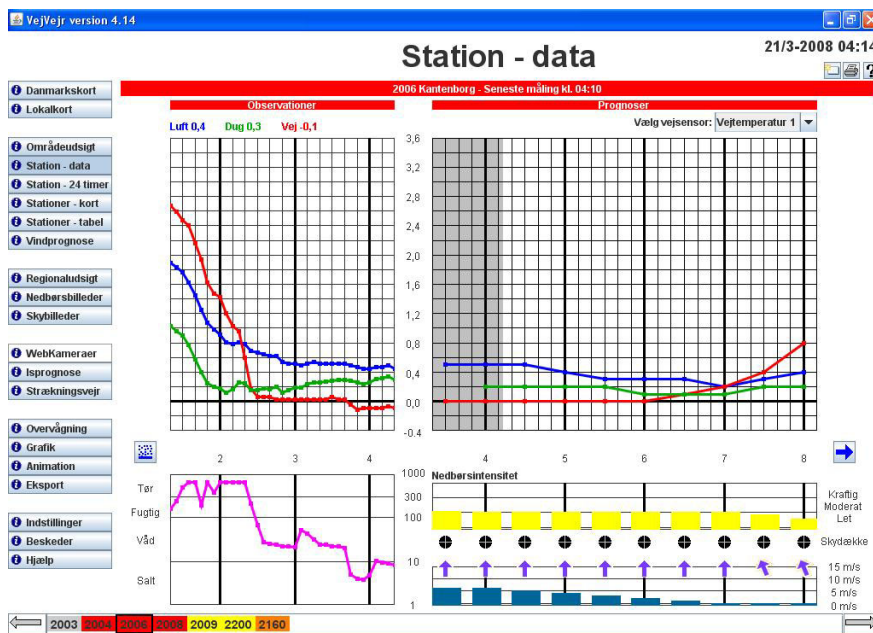
Fig. 2: Station - data

The right side of the screen shows output from the numerical road condition model. The forecasted values of air-, dewpoint- and road temperature are shown as curves in similar colours as the observations. Below the temperature forecasts you find the precipitation forecast. Again we use a colour coding; red in case of snow or freezing rain, green in case of rain and yellow in case of mixed precipitation. The size of the bars corresponds to the intensity of the precipitation. Further below you find the forecasted amount of clouds in eighths, and the wind in 10 meters, direction by arrows and strength in bars. For all parameters, the "mouse over" function will give you the exact forecasted value of precipitation, wind etc. The bar above the forecasts is coloured in the "worst case" alarm status colour forecasted in the period, and the same colour is seen on the right side of the screen in fig. 1.

For each road weather station a long forecast is also calculated. The forecast length is 24 hours and the forecast is mainly used for planning purposes. The parameters are presented in similar way as in the 5 hour forecast.
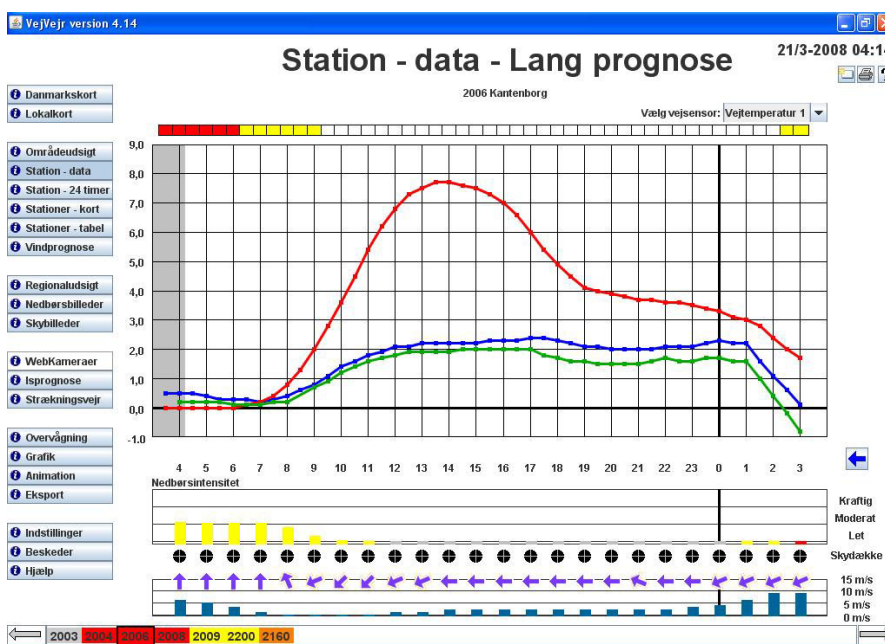

Fig. 3: Station – data, long forecast

3.3 Radar images

Online radar images are available in the system and they are updated every 10 minutes. As default a composite image with data from four weather radars are shown. It's also possible to choose single radar alone. You can choose either filtered or unfiltered images, and you can also choose colour coding of precipitation type. As input for the precipitation type image we use radar data combined with output from the numerical model, which in principle means that location and intensity of the precipitation are radar observations, but the type is forecasted.
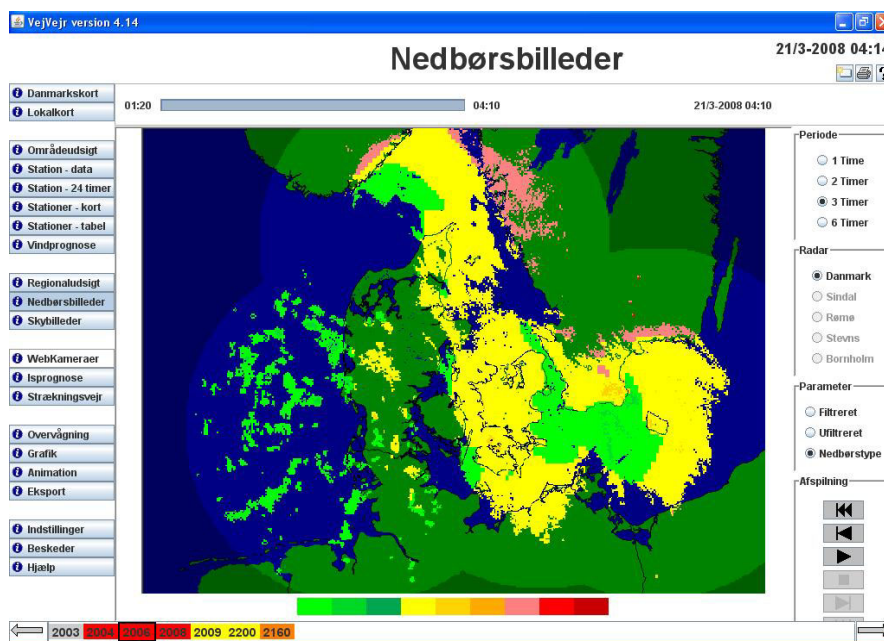

Fig. 4: Precipitation radar presentation

3.4 Satellite imagery

Images from Meteosat Second Generation are opdated in the system every 15 minutes. We use the cloudtype/cloudmask products from SAFNWC to make the classification, and the clouds are coloured so dense and deep clouds are in grey scale and cirrus clouds and scattered clouds are in colours. The purpose is to visualize the cloud cover and movement. To recognize situations with increased radiation and the following cooling of the roads, it is essential to have access to these images, as they describe density of -, and variation in cloudcover. The visualization is defined, so that colours indicate "unsafe" cloudcover and greys means "safe" clouds, unless of course they produce precipitation.
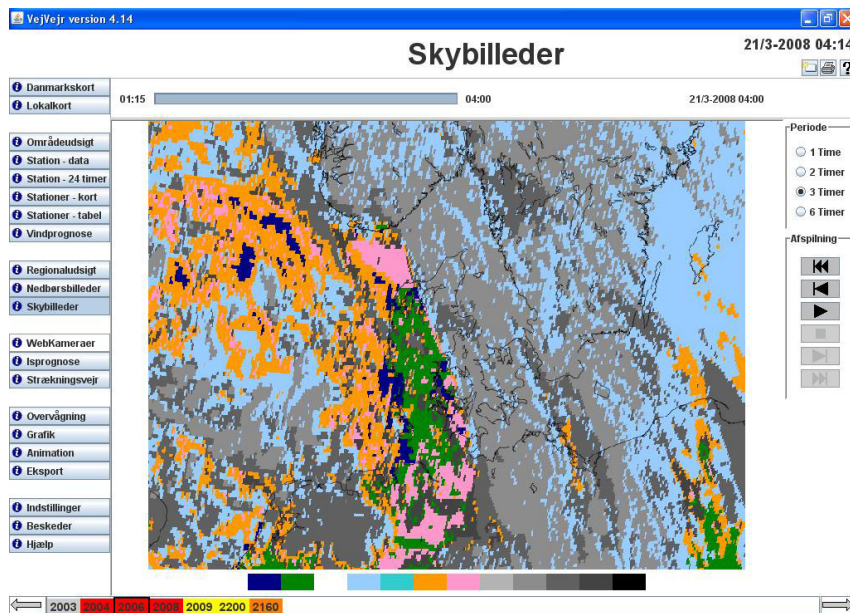

Fig. 5: Satellite cloudcover presentation.

3.5 Web-cams and historical database

Images from web-cams give the user visual impressions from all over Denmark. The web-cam images are the only type of data which are not saved in the database due to legislation. All other types of data including observations, forecasts and satellite and radar images are saved, and the users have online access to the historical database whenever they prefer. The historical database is of great value in insurance cases and for education purposes.
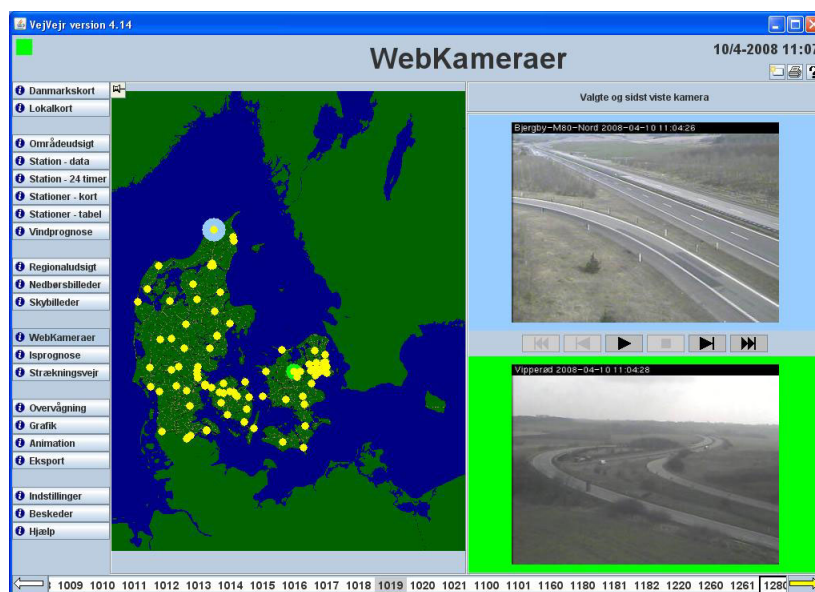

Fig. 6: Web-cam presentation.

3.6 About model function.

The DMI Road condition model runs every hour and is based on measurements of meteorological parameters from all road stations. These measurements and specific measurements of the road conditions are used to initialize the surface and soil conditions of the road in the model. The model calculates all fluxes at the road surface and solves the heat equation for the soil, which is divided into 16 layers. Furthermore, freezing and melting of water/ice on the road as well as deposition of frost and dew are all considered, as well as shadow conditions. Observations for the last 3 hours are used to initialize the temperature in the soil layers. Besides cloud information from satellite (MSG) is assimilated into the model. From 2008 the model resolution is 5km.

3.7 The users, - education demands.

The system is build for anyone with interests in preventing and clearing slippery roads. This means road authorities at all levels: State roads, county roads, city roads, airports and local institutions like hospitals etc. The users are people with highly varying levels of education and background. Still, with just a little knowledge you can make good decisions.

The basics are that you understand the effects of a freezing road combined with wet conditions, and/or the effects of freezing roads combined with higher dewpoints. Then the graphics will provide the needed information. You only need to know the colour coding by heart, and remember that the green curve should not be "above" the red one, if the red curve is, or later goes, below zero.

Of course some additional knowledge about basic meteorology is desirable. Therefore 2 one-day courses targeting road weather conditions are provided by the Road Directorate Organization, one for beginners and one for advanced users.

3.8 Feed back from users

The forecast performance is being monitored and verified continuously. These results are every year, in the post winter season, presented in connection with a day-seminar, where all the users of the system are invited to participate. At the same time user feed back and other input regarding functionality is invited. Beforehand feedback questionnaires are sent out, scrutinized and relevant subjects are then discussed at the seminar.

4. CONCLUSIONS

The Road Weather Information System VejVejr is appreciated for its content, layout, accessibility and reputable forecast quality. The tool as it is today, is a result of very productive development, based on outstanding cooperation between the involved parties: Users and providers.