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SUMMARY

The development of high levels of service on very circulated road networks requires a good control of the decision-making which must combine, in a sustainable development aim :

- Service to users
- Safeguarding of the environment
- Cost for the community

Optima, as a very precise decision-making tool for anticipation and real-time follow-up of meteorological situations on road sections, answers these problems.

So it fits naturally into the third phase called "fine analysis of the road risks and decision of intervention" described in the technical guide "Anticipation of the winter road risks" published by SETRA[1].

Optima provides forecasts:

- Between the hour H and the hour H+1h
- on all the French road sections of 1 km
- By step of time:
 - 5' between H and H+30 '
 - 10' between H+30 ' and H+1h
- the forecasts are updated every 5'

The forecasted parameters inform on the weather conditions along the roads as well as on the state of the roadway.

KEY WORDS

METEOROLOGY/ROADS/ROAD SECTION/FORECASTS/

1. INTRODUCTION

For now, we have different sources of weather forecasts :

- Forecasts resulting from the digital models (appraised then by the forecasters)
- For precipitations: forecasts resulting from the radar observations extrapolated on one hour or a little more.

The first source of weather forecasts covers the period D (day) to D+5 with steps of minimal time of one hour. These forecasts are updated four times a day. The second source of weather forecasts cover, for the moment, only the period H (hour) to H+1h with steps of time of 5' and 10'. These forecasts are updated every 5'.

Optima positions on the same field as the second source of forecasts that is to say the very short term forecasts (H/H+1h) resulting from the observations with, as additional objectives:

- To discriminate the type of forecasted precipitations
- To forecast other parameters and specially those which could affect road traffic.

Thus, Optima makes it possible to synthesize the various informations coming from observations and forecasts in order to provide the best possible forecasts between H and H+1h .

2. PRESENTATION OF OPTIMA

2.1. Synthetic diagram



With the various sources of observed and forecasted data (cf figure 1), Optima provides, every 5', updated forecasts for the parameters listed at 4.1:

- Between the hour H and the hour H+1h
- on all the French road sections of 1 km
- By step of time:
 - 5' between H and H+30 '
 - 10' between H+30 ' and H+1h

The more Optima will have of observed data on the roads, the better its forecasts will be. It is also the dialogue with the road owners which will allow, for specific parameters like the state of the roads, the improvement of the algorithms for the determination of the future state of the road knowing the current one.



Figure 2 – Classic forecast of showers on a road network

The classic forecast announces showers all along the road during one hour.



Figure 3 – Optima's forecasts of showers on a road network

Compared to a classic forecast for showers, Optima makes it possible to distinguish the road sections really impacted by the rain with a precision of 5'. For the first section, we are able to say that at H, it will rain and that at H+10 ' there will be no more showers whereas with the classic forecast we forecast showers during one hour for all the road sections. Moreover, Optima makes it possible to know the exact geographical areas impacted by the showers at a given hour : one sees, in this example, that, at H, the zone of showers exceeds slightly, in the north as in the south, the zone of showers forecasted by the classic forecast.

3. DATA USED IN ENTRY

- 3.1. Observed data
 - Observed data from Météo-France every one hour or 6': approximately 500 stations
 - Observed data from road meteorological stations, every 5 or 6' : approximately 600 stations
 - Observed data from the radars which cover the whole France
 - Impacts of the lightning

These data are taken into account in real time, as soon as they are passed on : every 5', 6' or one hour.

In order to be able to use the observed data from road meteorological stations in real time, a chain for the "real time" acquisition of these data was organized. These data are very important as they give the best possible information on the state of the road in particular by providing the parameters "State of the ground", "Height of snow on the ground", "Temperature of roadway" and "Temperature of congelation" (this last temperature is the temperature from which the water or the salt solution that is on the roadway will freeze).

3.2. Forecasted data

- Extrapolation on 1 hour of the observed data from the radars
- Hourly forecasts resulting from the digital models and appraised by the forecasters.

4. TREATMENTS

- 4.1. Forecasted parameters given by Optima
 - Occurrence of precipitations
 - The type of precipitations: freezing rain, snow, rain and snow together, hail, rain, drizzle
 - The intensity of precipitations: light, moderate or strong
 - Storm: occurrence and intensity
 - Air temperature (T)
 - Dewpoint temperature (Td)
 - Temperature of surface of the road (Ts)
 - Rain-snow boundary
 - Wind (direction and strenght)
 - Squalls of wind
 - Visibility lower than 200 m
 - Height of snow on the road
 - State of the road : dry, wet or frozen

4.2. The treatment of the forecasted parameters

First step

We initialize the forecasted parameters with the best source of available weather forecasts :

- Observed data from radars, extrapolated on 1 hour for the parameter "precipitations"
- Weather forecasts appraised by the forecasters for the parameters T, Td, rain-snow boundary, Wind and Visibility

• Forecasts resulting from the specific digital model for the temperature of the surface of the road Ts

In the first version of Optima, the parameters Storm, State of the road and Height of snow on the road will be indicated only by using the observed data and only on the first 15'. In the next version of Optima, the parameter "Storm" will be initialized with the observed data from radars extrapolated on 1 hour.

Second step

We improve the initial forecasts by taking into account the interactions between the various parameters and the environmental conditions :

- We discriminate between rain and snow according to the forecasted air temperature
- The forecast of freezing rain depends on the forecasts appraised by the forecasters, the occurrence of precipitations and the forecasted air temperature.
- If necessary, we correct the forecasted air temperature according to the difference of height between the road section and the reference point of the forecast.

In a future version of Optima, in this step, we will improve the forecasts of "State of the road" and "Height of snow on the road" : initialized with the observed data, we will forecast their evolution by taking into account the other forecasted parameters as air temperature, temperature of the surface of the road and occurrence and type of precipitations.

Third step

We update the forecasts with available observations using specific algorithms for each parameter.

5. EXAMPLES OF THE PRODUCTION OF OPTIMA FOR THE PRECIPITATIONS

This production was realized for an internal need : the quality validation of Optima. It does not represent the final production which will look quite different.

5.1. Discrimination between the different types of precipitations



Figure 4 – Discrimination between "No precipitation", "Rain or showers", "Snow" and "freezing rain" in Optima with, on background, the observed data from radars – Meteorological situation of December 17th, 2008 at 8H15 am. The forecasted types of precipitations are represented on each one kilometer long road sections. On this example we have:

- Rain in grey
- Snow in blue
- freezing rain in red

5.2. The arrival on Paris and its suburbs of a snow-covered disturbance

Nothing



Figure 5 – Situation of February 12th, 2009 at 09H45 pm : no precipitation



Figure 6 –February 12th, 2009 at 10H15 pm: the arrival of snow from the West.



Figure 7 – February 12th at 11H15 pm: snow expands to the west of Paris



Figure 8 – February 13th at 00H15 am: Generalization of snow in the west of Paris



Figure 9 – February 13th at 01H15 am : Generalization of snow. We can see rain (no snow) on Paris (bubble of heat upon the city).

6. FEEDBACK FROM ROAD MANAGERS

During the first half of the year 2009 Optima was presented to many French road managers :

 Régional Directions of Roads : Ile-de-France, Centre-Ouest, Atlantique, Massif-Central

• Managers of Motorways : ASF (Motorways of the South of France), Cofiroute For the real time follow-up of the meteorological situation on their network, the managers explained us that, until now, they looked both at the image of the radar and at the observations of their meteorological road weather stations in order to forecast the evolution of precipitations and type of precipitations (snow, freezing rain) in very short term : it is exactly what Optima does automatically.

The aim of Optima is not to replace the classic forecasts with longer term (from 1 to 7 days) helping the manager to proportion, in advance, the number of necessary persons to treat the roads but it completes the classic forecasts in particular for the real-time followup of the situation and the exact forecast of the return to normal conditions. With Optima, the manager of a network knows at any time, what is the meteorological situation on its network.

7. CONCLUSION AND PROSPECTS

The way Optima has been developed, will allow it to integrate all new developments concerning road weather information on the French territory. OPTIMA is a Road Weather Information System on France.

It will be able to take into account :

- Headways in weather, very short time, forecasts. Thus, Optima will follow the state of the art in very short time forecasts (evolution of the present limited term of one hour to two and three hours, improvement of the intrinsic quality of the forecasts, use of the data of the road meteorological stations etc...)
- Headways in the determination of the slipperiness of the roadways. Météo-France works on it in partnership with the Laboratoire Central des Ponts et Chaussées (action PALM[2]).

The geographical referencing of data opens way to taking into account descriptive data of road sections (type of road surface, environment, sunniness etc...), and also the nature of the treatments.

Thus, Optima is a good tool to manage the third step of the anticipation of winter road risks (cf technical guide SETRA[1]) which is "Fine analysis of the risks on the road and decision of intervention".

REFERENCES

[1] Technical guide "Anticipation of winter road risks", elements of reflexion. February 2006. SETRA

[2] PALM: joint research project between Météo-France and the LCPC (Laboratoire Central des Ponts et Chaussées) on Forecasts and Alarms for degraded meteorological situations.