OPTIMA (ROAD WEATHER INFORMATIONS DEDICATED TO ROAD SECTIONS) – SIGNIFICANT DEVELOPMENTS TO OPTIMIZE THE ROADS TREATMENTS

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ABSTRACT

The Optima tool developed in 2008 enables road managers to anticipate and follow in real time the meteorological situation over the whole French road network across sections of 5 km. It provides the forecasts of the main meteorological parameters impacting road network for the following hour with a 5' step up to H+30' and 10' after. It provides also an analysis of the past 3 hours with a 15' step.

Since 2008, the addition of the parameters : snow potential (snow height on the road without accounting for melting effects) and snow quality and the improvement of the road surface temperature forecast (PEIR), allowed the road managers to optimize the roads treatments.

In addition to these evolutions, a new specific model IsbaRoute/CROCUS has been developed and will be operational for the winter maintenance 2013/2014. It will permit the prediction of road surface temperature evolution, water and ice content and the behaviour of a snow layer deposited on a road.

1. RECALL ON THE TOOL OPTIMA [1]

1.1. Synthetic diagram

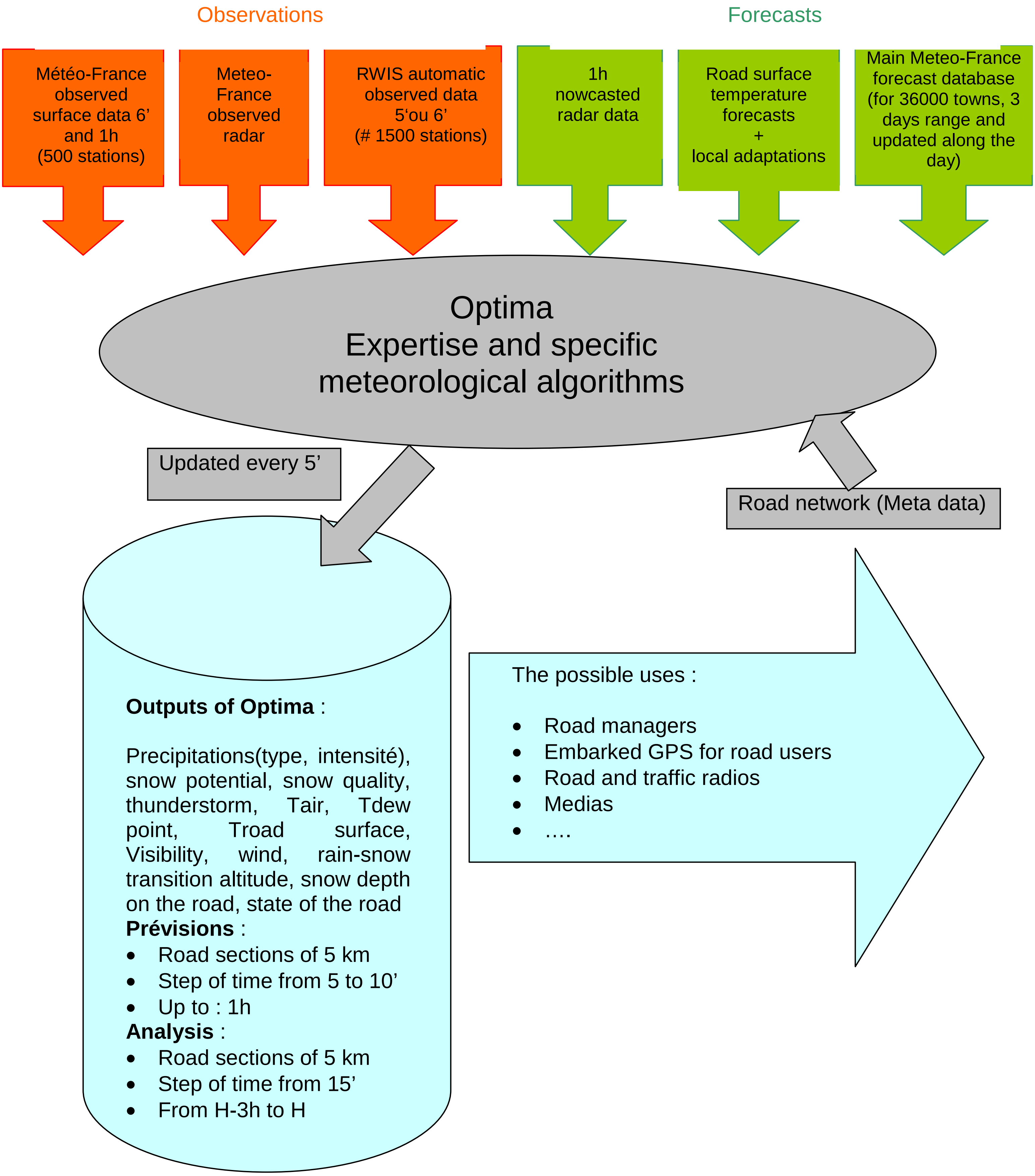


Figure 1 – Optima's synthetic diagram

1.2. Optima's visualisation interface

animations

Analysis (closed to observations)
From H-3h to H

Forecasts
From H to H+1h

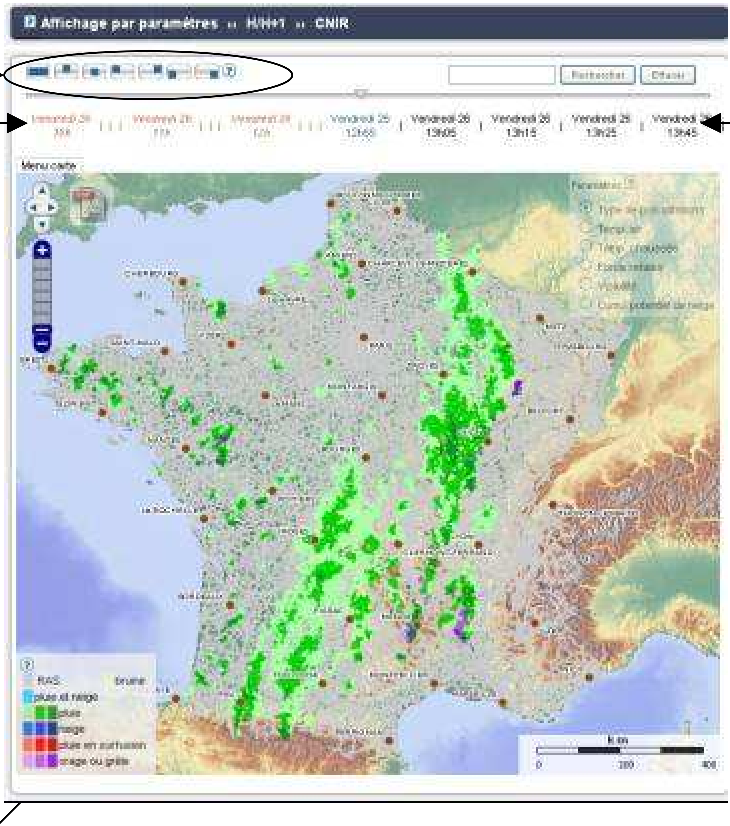


Figure 2 – Map of the different types of precipitation on road sections

Zoom

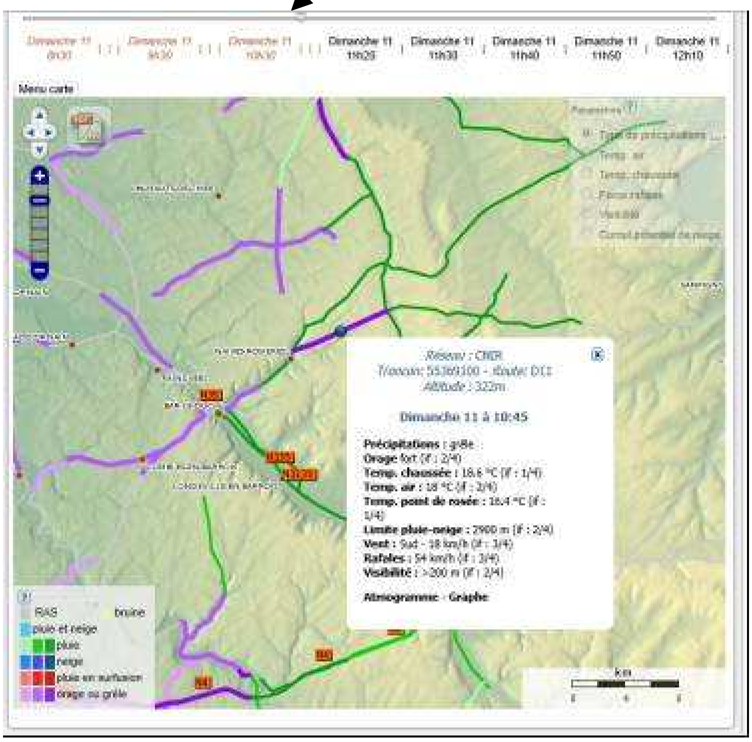


Figure 3 – Zoom on a road section with a tool tip in which each parameter is detailed

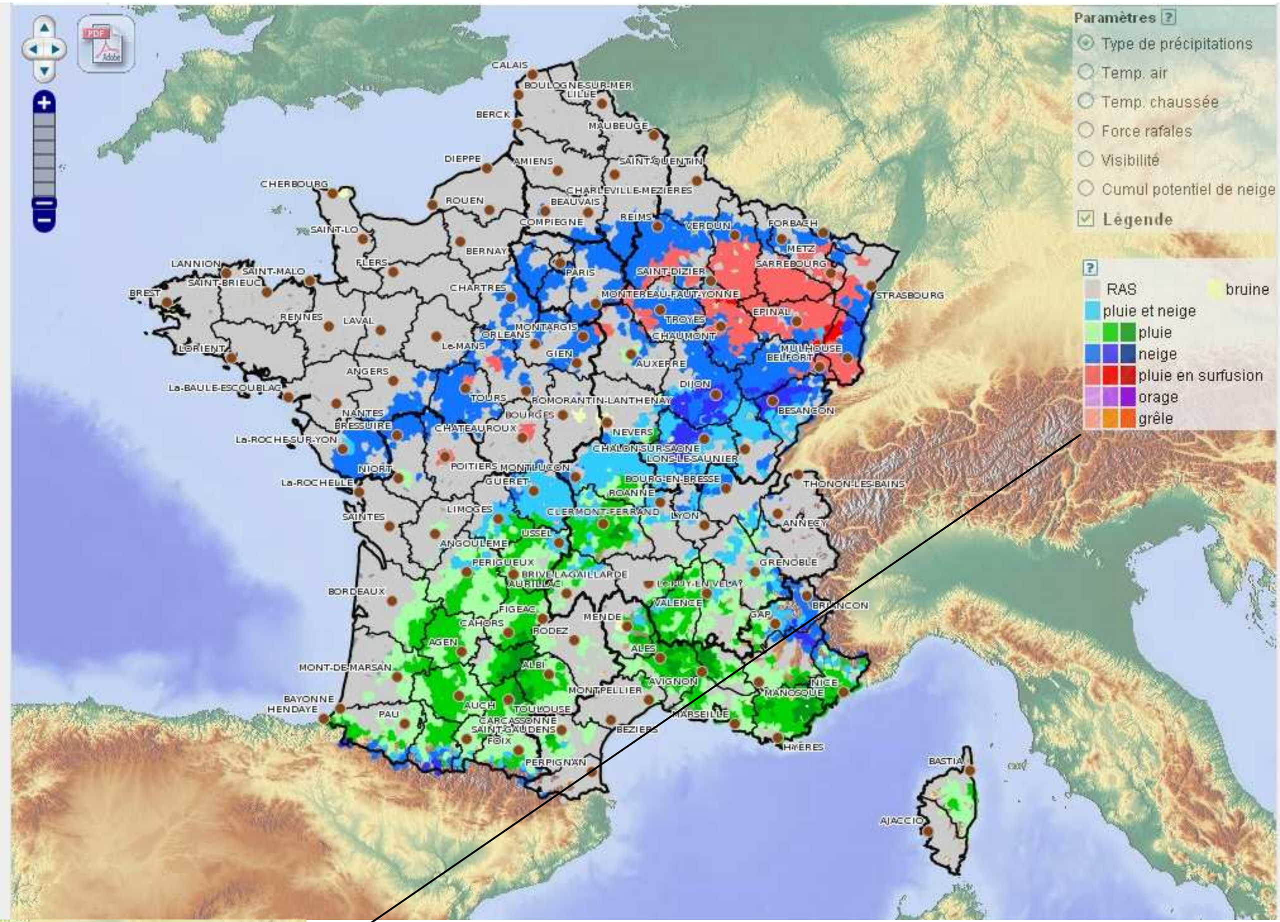


Figure 4 – The different types of precipitation that are discriminated

2. THE EVOLUTIONS IN ORDER TO OPTIMIZE THE TREATMENT OF ROADS

2.1. The new parameters

2.1.1. Snow quality

For road managers, the quality of snow is important as it is closely related to the type of treatment they have to make.
5 different quality of snow were defined, depending on air temperature forecast.

Table 1 – Snow quality

Snow quality	Tair
Powder snow	Tair is –5℃ or less
Dry snow	Tair in]-5℃ ; -2℃]
Moist snow	Tair in]-2℃ ; 0℃]
Moist to wet snow	Tair in]0℃ ; +1℃]
Wet snow	Tair strictly more than +1℃

2.1.2. *Snow potential*

Based on the snow quality, its density and the forecasted amount of precipitations, a snow potential is calculated, which corresponds to a snow height on the road without accounting for melting effects.
In snow meteorological situations with cold ground and cold air, this snow potential is very close to the “real” snow height on the ground.
During the 2010 December 8th snow event, in the south-west of Paris, a snow potential of 4 cm in the following hour was forecasted. This threshold of “4 or 5 cm in one hour” corresponds to what road managers define as an extreme situation : a situation in which it is difficult, even impossible, to reach the imposed levels of service.

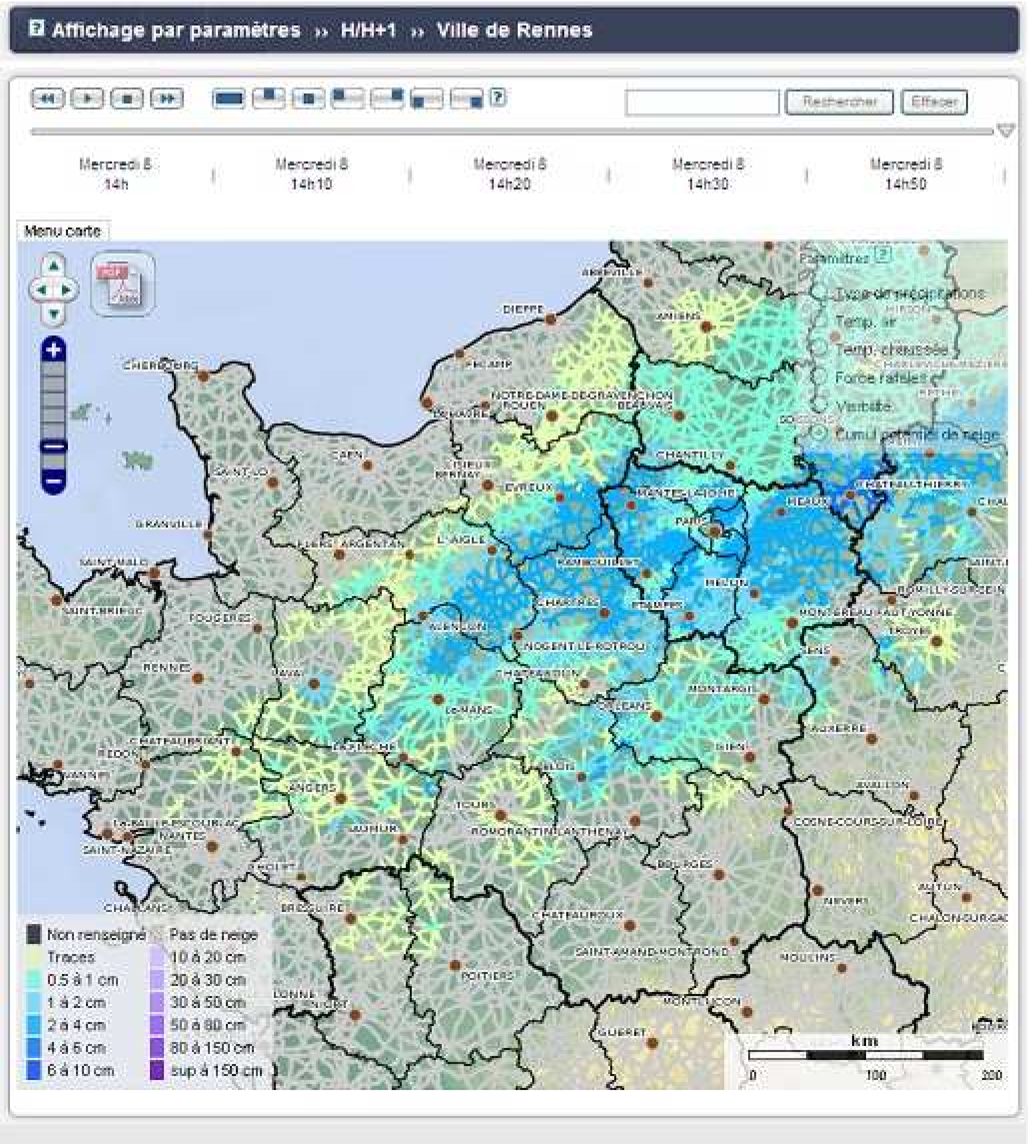


Figure 5 – Map of the cumulative snow potential between 14H and 15H December 8th, 2010

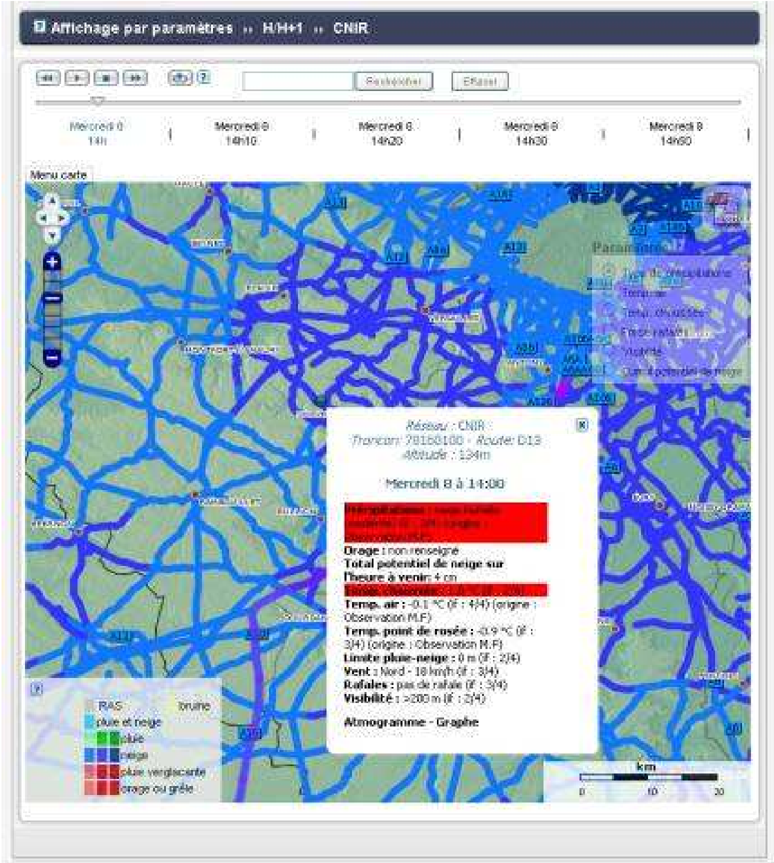


Figure 6 – Forecasted snow potential for the next hour : 4 cm on the secondary road D13 in the south-west of Paris

The introduction of the two new parameters snow quality and snow potential, allows us to provide road managers with a crucial information for decision making for road treatment. Indeed, road treatment (type and concentration of deicer…) depends on the type of snow (dry, moist or wet), its intensity (ie snow potential) and the duration of the event. These informations, both for road managers and state departments in charge of winter crisis centers, improve their knowledge of the event and consequently make decision making and coordination of concerned services easier.

2.2. The new road surface temperature prediction system [2]

2.2.1. Comparison of previous system AIR – new system PEIR

For the previous road surface temperature prediction system AIR (Arome Isba Route), the ISBA-Route road model was forced by the high-resolution numerical weather prediction model Arome (2,5 km grid). With the AIR system, in spite of good scores, a positive mean error (equivalent to a cold bias) was observed. This cold bias was responsible for a quite poor quality of the forecast of the event “negative road surface temperature” with a very good probability of detection (95%) but with a quite high probability of false alarm (38%). For the new road surface temperature prediction system PEIR (PrevExp-Isba Route), the use of human appraisal of the forecasters of Meteo-France* for the initialization of the

* The role of the operational forecasters is to synthesize all the available information (atmospheric models, observations, ensemble forecasts, local expertise…) and to actualize all day long the atmospheric “reference” french forecast data base for all the 36 000 main towns and cities over France.

atmospheric parameters is an important source of improvement. The scores of this new system PEIR are better than those of the previous one and the cold bias has been removed.

Table 3 – Comparison previous system AIR – New system PEIR

	AIR	**PEIR**
Points of forecast	Grid points of 2,5 km	36 000 cities
Runs of the system	0h, 6h, 12h et 18h TU	6h, 12h et 16h TU
Forecast range	30h	J+3
Step of time	hour	hour
Scores for the 30h prediction		
Mean error	0,735	-0218
Root Mean Square (RMS)	2,714	2,512
Probability of detection	95,8%	83,3%
Probability of false alarm	35,9%	20,8%
Hedke Skill Score (HSS)	0,627	0,722
Scores for the night prediction (18h – 6h)		
Mean error	1,468	0,096
Root Mean Square (RMS)	2,284	1,653
Probability of detection	95,8%	83,4%
Probability of false alarm	35,9%	20,8%
Hedke Skill Score (HSS)	0,626	0,722

2.2.2. *Scores of the new road surface temperature prediction system PEIR*

Table 4 – Scores of the new road surface temperature prediction system PEIR

Scores PEIR run of 12h for J/J+1	
Mean error	-0,16
Root Mean Square (RMS)	2,35
Hedke Skill Score (HSS)	0,73
Scores PEIR run of 12h for J+1/J+2	
Mean error	0,05
Root Mean Square (RMS)	2,46
Hedke Skill Score (HSS)	0,703
Scores PEIR run of 12h for J+2/J+3	
Mean error	0,17
Root Mean Square (RMS)	2,58
Hedke Skill Score (HSS)	0,695

2.3. Test of the new model for the forecasts of the road surface evolution

2.3.1. *Description of the model*

Also based on the human appraisal of the forecasters of Meteo-France for the initialization of the atmospheric parameters, the model Isba-Route/CROCUS [3] [4] [5] [6] [7] consist in two coupled one-dimensional models : the road model ISBA-Route and the snow model CROCUS. It permits to describe the road surface temperature evolution, the water and ice content and the behaviour of a snow layer deposited on a road (snow density, snow quality, snowmelt).

The forecast range is 24h with a step of time of one hour on a natural road (i.e. without accounting for de-icing and traffic effects). The initial condition of the road is considered as snow free.
The validation of this model was done in a pre-operational use during the 2012/2013 winter. The forecasts were compared with the snow potential and an analysis consisting in a run of the ISBA-Route/CROCUS model with analysed atmospheric parameters (based on data fusion of numerical weather models, radar data and soil observations). However, the lack of observations of snow depth on the roads prevent us to compute statistical scores.

2.3.2. The a*nalysis of an automnal episode (October 27-28th, 2012)*

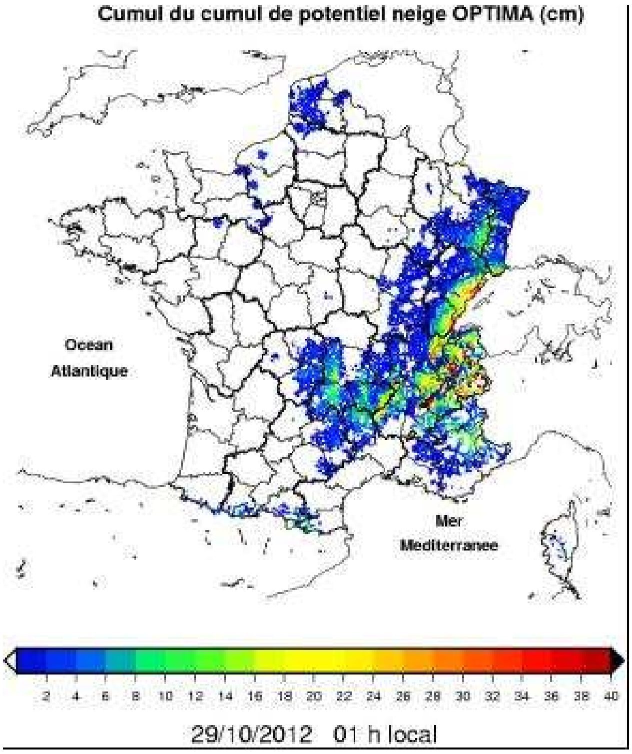


Figure 7 – Optima's cumulative snow potential (cm) during the episode (potential snow depth on the road)

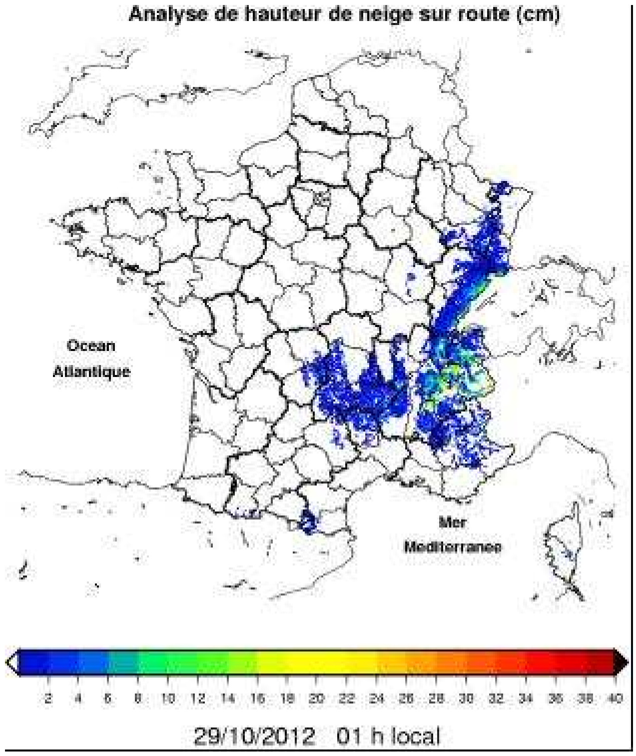


Figure 8 – The analysis of snow depth (cm) on the road during the episode (snow depth remaining on the road)

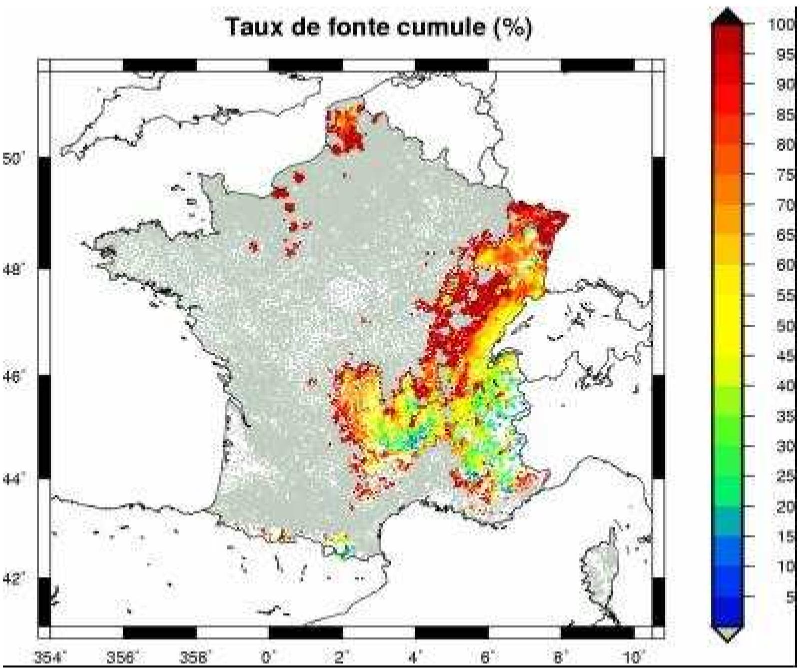


Figure 9 – Melting rate during the episode

During this episode, there is a significant melting rate that is responsible for the large differences between the cumulative snow potential and the snow depth on the road (extension and height).

2.3.3. *Comparison of analysis and forecasts for a winter episode (December 7th 6h – 8th 6h, 2012)*

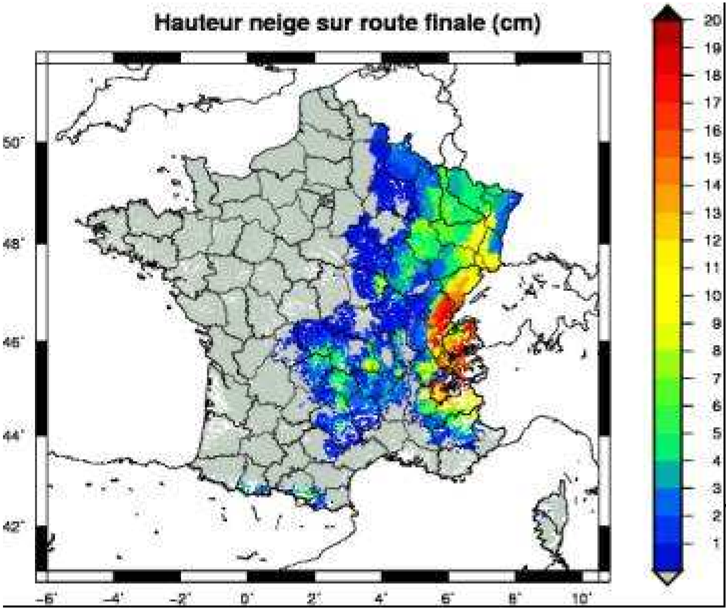


Figure 10 – Forecasts of snow depth on the road, 24H range

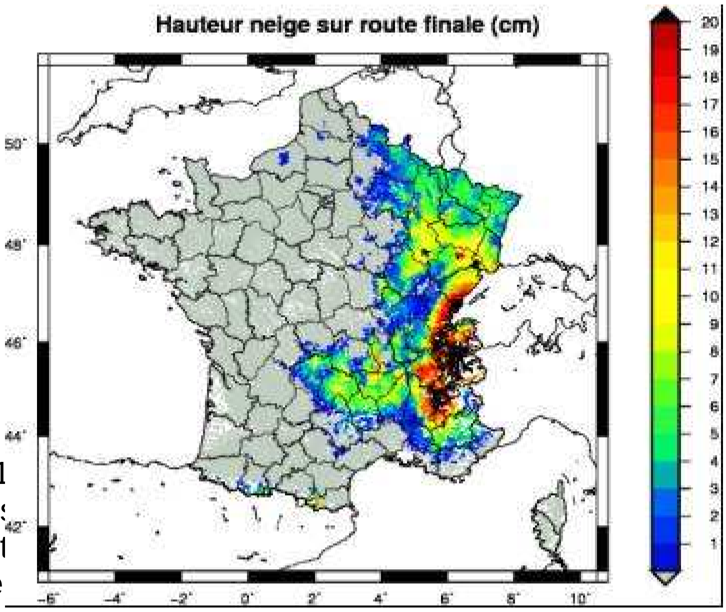


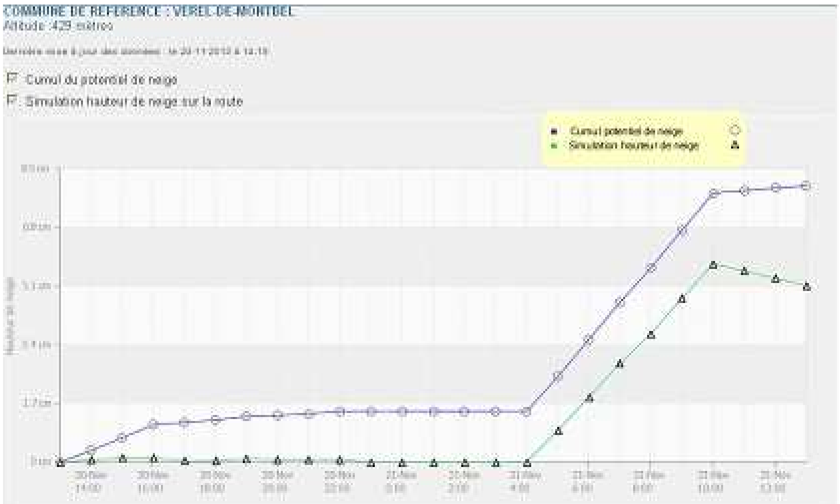
Figure 11 –snow depth on the road analysis for the same period.

24 hours snow height on road forecasting (Fig 10) is quite close to the analysis of the event (Fig 11). Indeed, especially for plain areas, the spatial extension of the event, for example in East of France, and the snow height magnitude order are quite close to their own analysis for this event (even if some discrepancies exists, especially in mountainous areas).

2.3.4. *Some results for winter 2013/2014 (November the 20th, 2013)*

Graph 1 – Snow depth on the road (green) and cumulative snow potential (blue) in Saint-Priest

On Graph 1 we can see that snow hold on the road at the very beginning of the event, it rises about 2 cm at 10 o'clock and then it melts up to 15 o'clock when there is nothing left.



Graph 2 – Snow depth on the road (green) and cumulative snow potential (blue) in Verel-de-Montbel

On Graph 2 we can see two distinct parts during the snow event :

- During the first part of the event the snow doesn't hold on the road or with a negligible snow height (lower than 0.3cm) ;
- During the second part (from 4 AM to the end), the snow hold on the road since the beginning of the snowfall. Snow height rises approximately 5cm, before melting.

Conclusion : compare to the snow potential that inform us about the snow event (beginning, duration, magnitude), the snow depth on the road gives further essential informations :

- Will the snow hold on the road ? If yes, when?
- How long will the snow hold on the road?

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