Road weather forecast in Météo-France

Météo-France
Meteorological Services Division
Weather Support & Consultancy Department
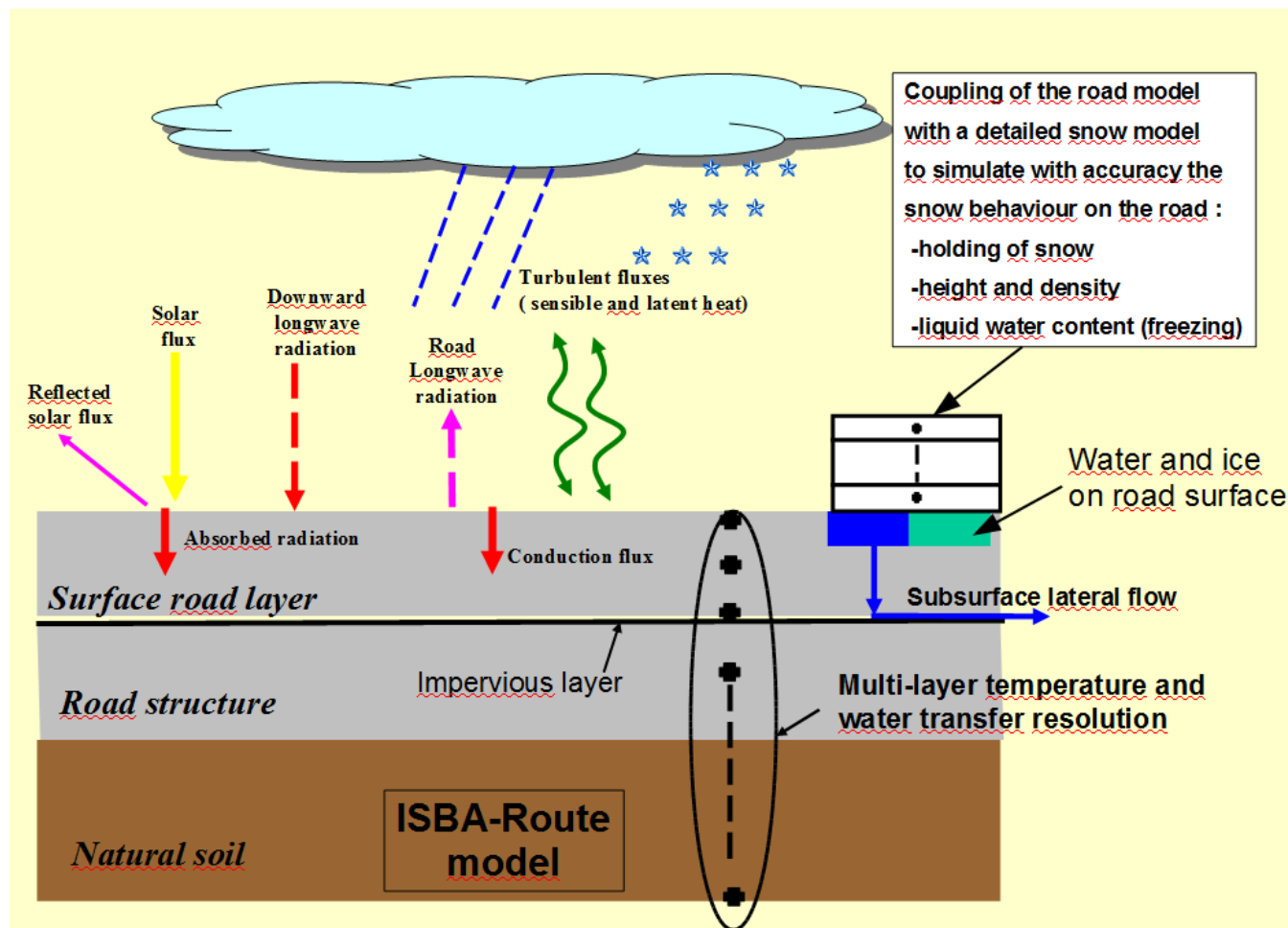
Ludovic Bouilloud (Head of DataScience unit)
Odile Coudert (Head of Transportation and Water Management unit)

Toulouse, December 12, 2019
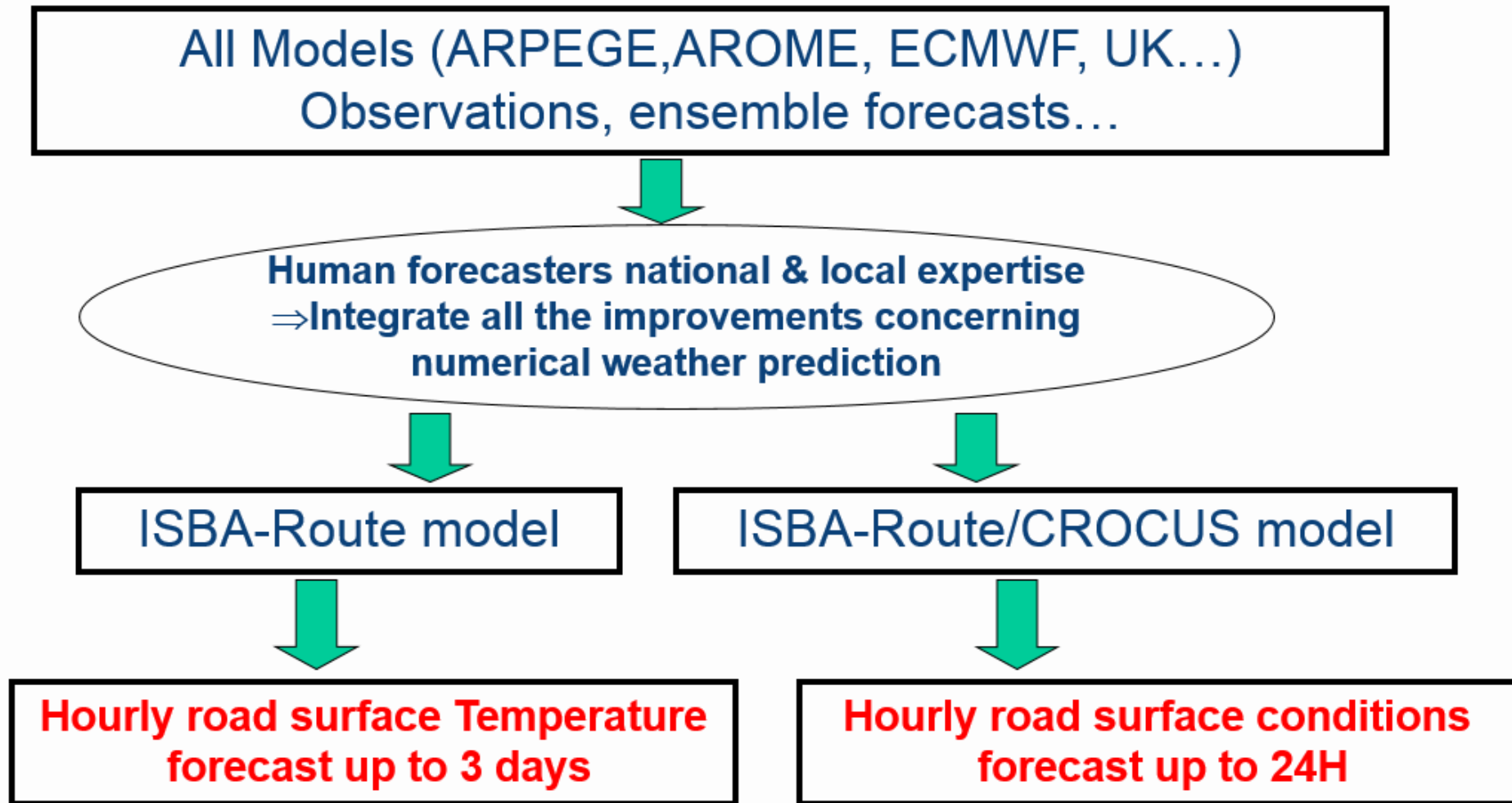
Meteo-France's road weather specific prediction systems

- **Météo-France operational system**

METEO
FRANCE

ISBA-Route/CROCUS model

**Outputs : road surface temperature, ice and water height on raod, snow height and type on the road….**

The PEIR forecast system principle

All Models (ARPEGE,AROME, ECMWF, UK…)
Observations, ensemble forecasts…

⬇

Human forecasters national & local expertise
⇒Integrate all the improvements concerning
numerical weather prediction

⬇   ⬇

ISBA-Route model   ISBA-Route/CROCUS model

⬇   ⬇

Hourly road surface Temperature
forecast up to 3 days

Hourly road surface conditions
forecast up to 24H

4 runs / day : 0, 6, 12 and 18 UTC

METEO
FRANCE

Last version: PEIR2 forecast system

- 1 km resolution, 96h range, France scale

- Use since 2016 by forecasters and road managers for decision-making

- Significant improvement of the quality of the forecast due to the introduction of human expertise (vs direct forcing with NWP models), example for 2018/2019 winter (1st night):

  — 1.7° of root mean square error (vs.2.3° root mean square error for the numerical AROME-ISBA-Route system)

  — Large bias reduction (from 1.5 to 0.5°)

  — « negative road surface temperature » : Detection 70 % and False alarms 30 %
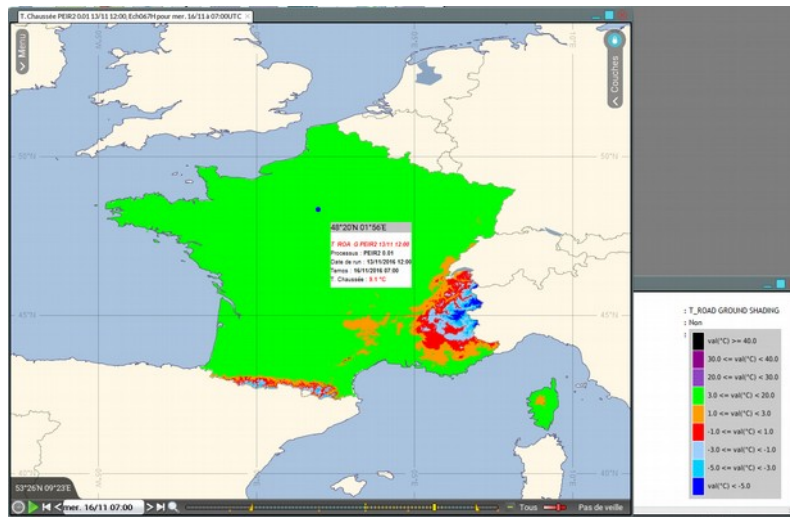

Example of vizualisation within the forecaster tool

Adaptation of the system

- Adaptation of the operational system for specific uses :

    — Bridge temperature forecast

    — Shadow roads forecast

    — Local use with integration of road weather information stations

OPTIMA: decision-making tool for road manager

- Use of road model forecast within the OPTIMA decision-making tool for road managers
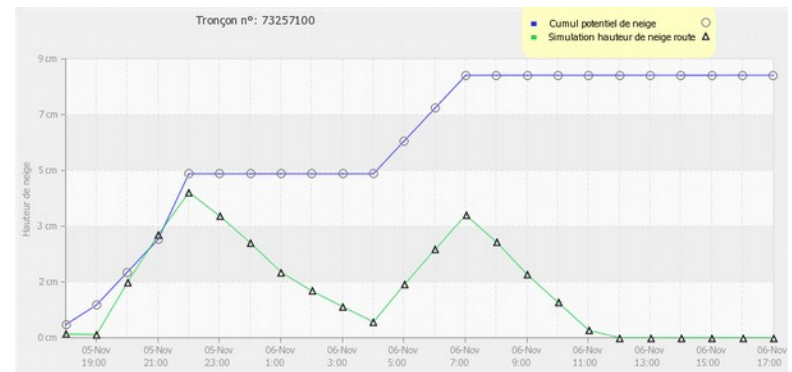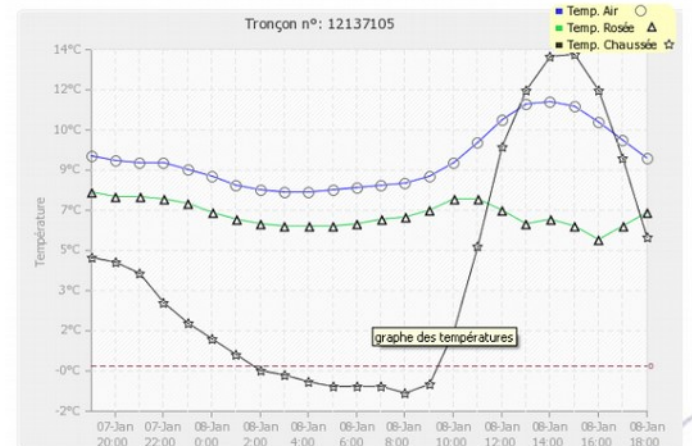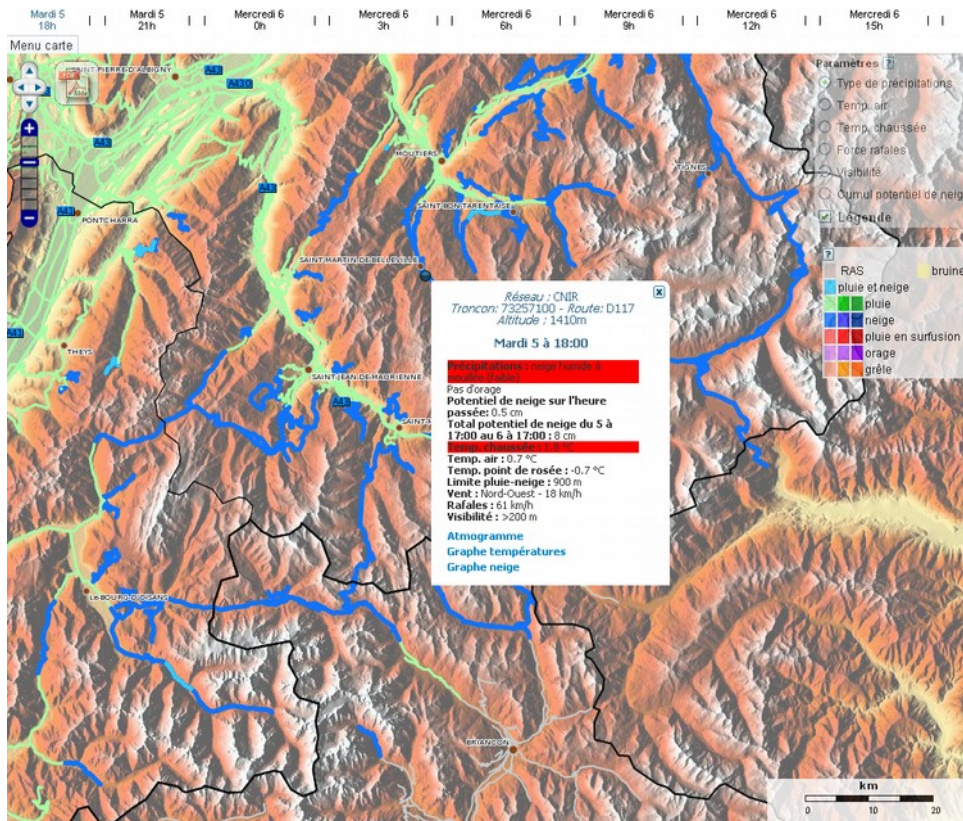
- ■ Perspectives : Ensemble road forecast

Ensemble forecast AROME-EPS/ISBA-Route

Implementation (end of 2018) of a high resolution (2.5km) ensemble forecast system for road weather based on convection-permitting ensemble prediction system AROME-EPS :
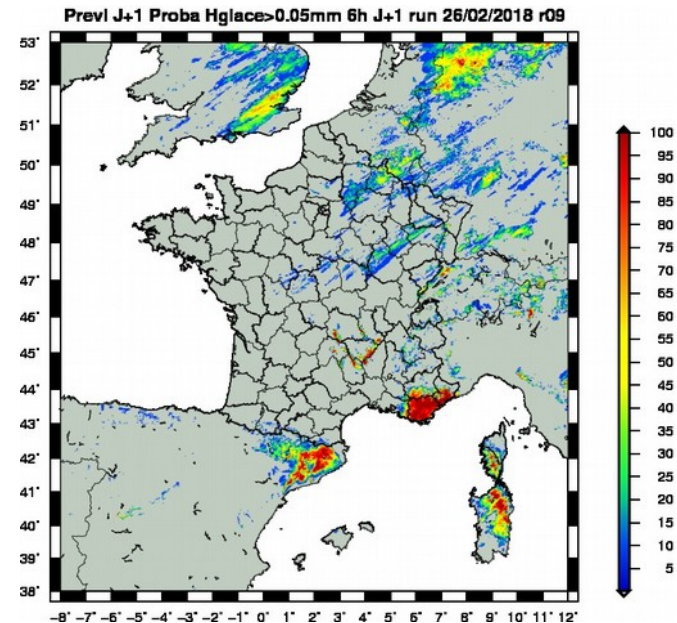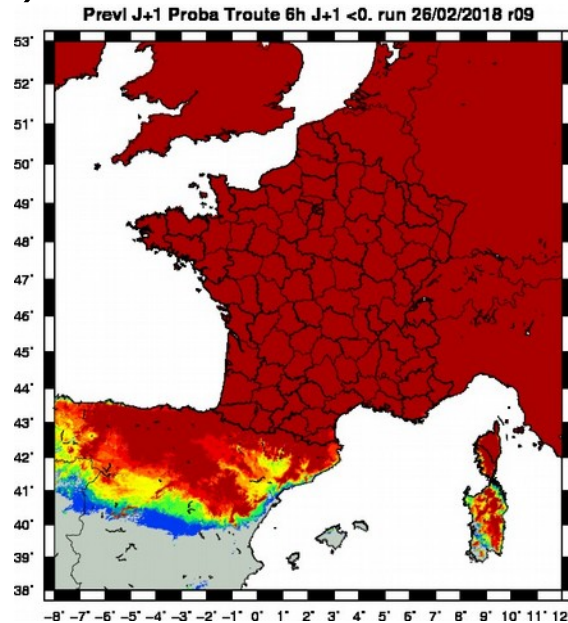
- **2.5 km grid, 45 h range**
- **2 runs/day with 12 members at 9 UTC and 21 UTC**
- **Extension of the ensemble : use of 2 consecutive runs (2x12 members)**
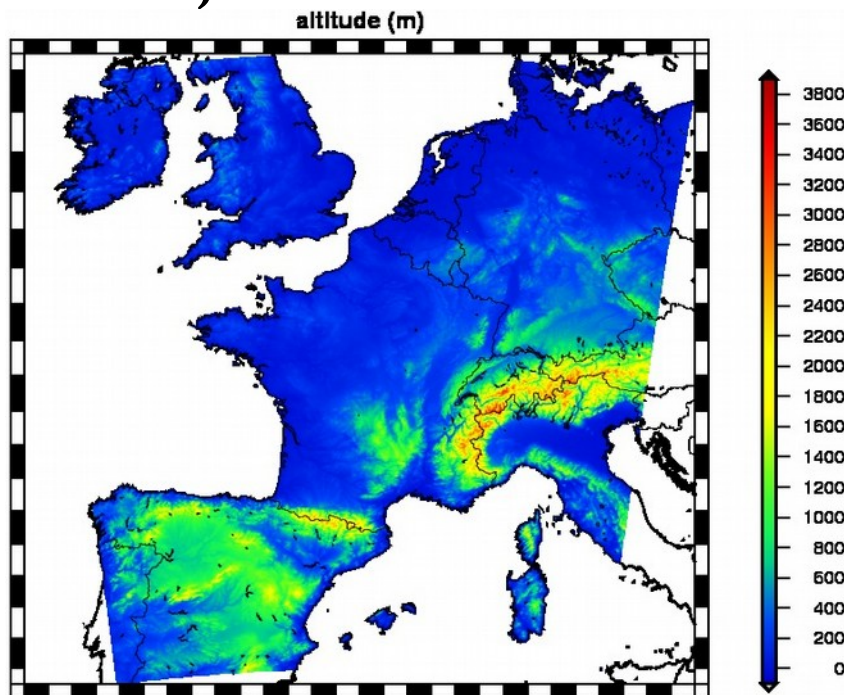

Operational grid

Ensemble forecast AROME-EPS/ISBA-Route

- Example for the 26/02/2018 9 UTC run (forecast for the 27/02 6h)

Probability of negative road surface temperature *Probability of ice presence on road surface*

Significant differences between probability of negative road surface temperature and ice presence : use of water/ice content permits better discrimination of icing events than the only use of road surface temperature

Test (not operational) : use of ISBA-Route/CROCUS for snow events
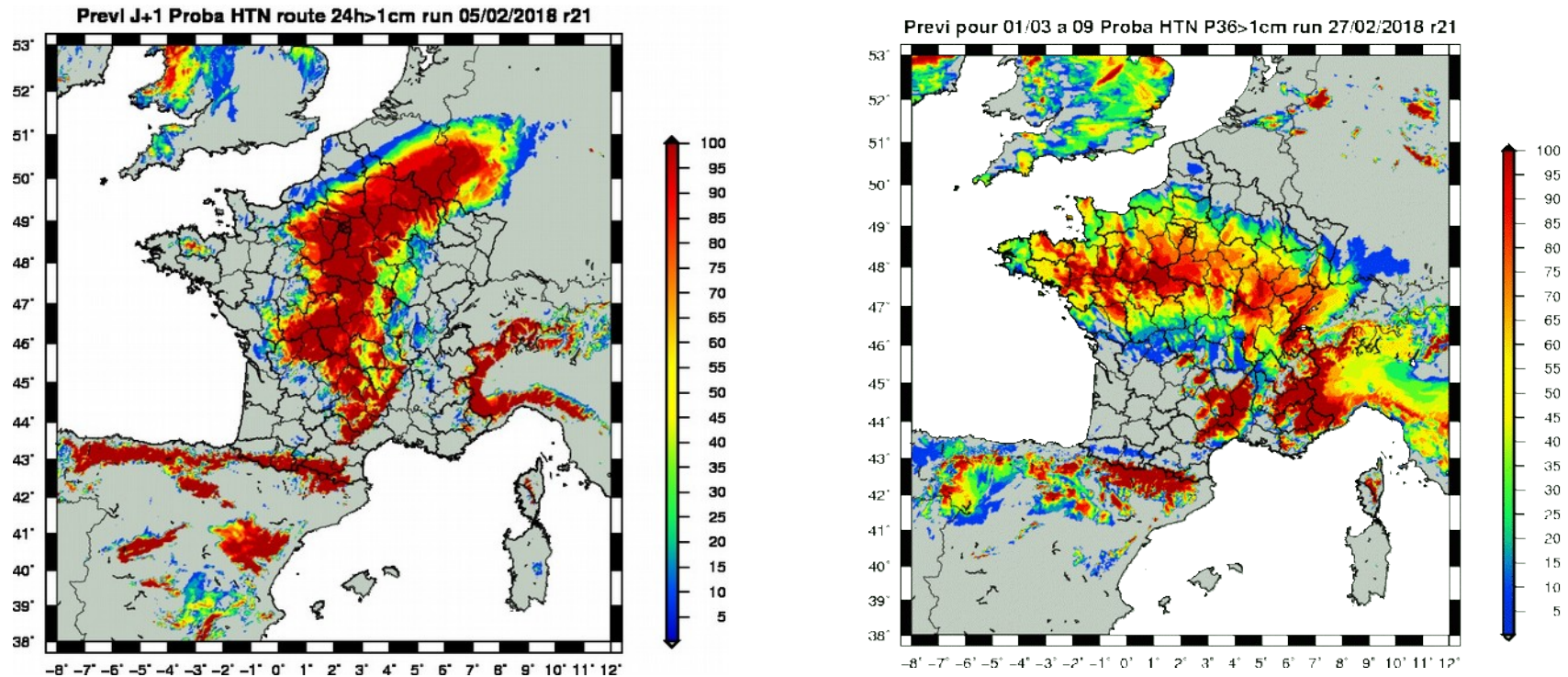
Example of possible use: forecast of probability of snow presence on road (height>1cm) for 2 significant events during the 2017/2018 winter in France (6/02/18 and 1/03/18)

Example of possible exploitation

- Risks computation dedicated to road managers : computation on customers areas (ex road districts) and only with grid points containing the road

- Example : forecast for the 2/10/2018 at 6 UTC (24 members from 30/09 runs) on fictive road districts

]75%;100 %

]50%;75 %]

]25%;50 %]

]0%;25 %]
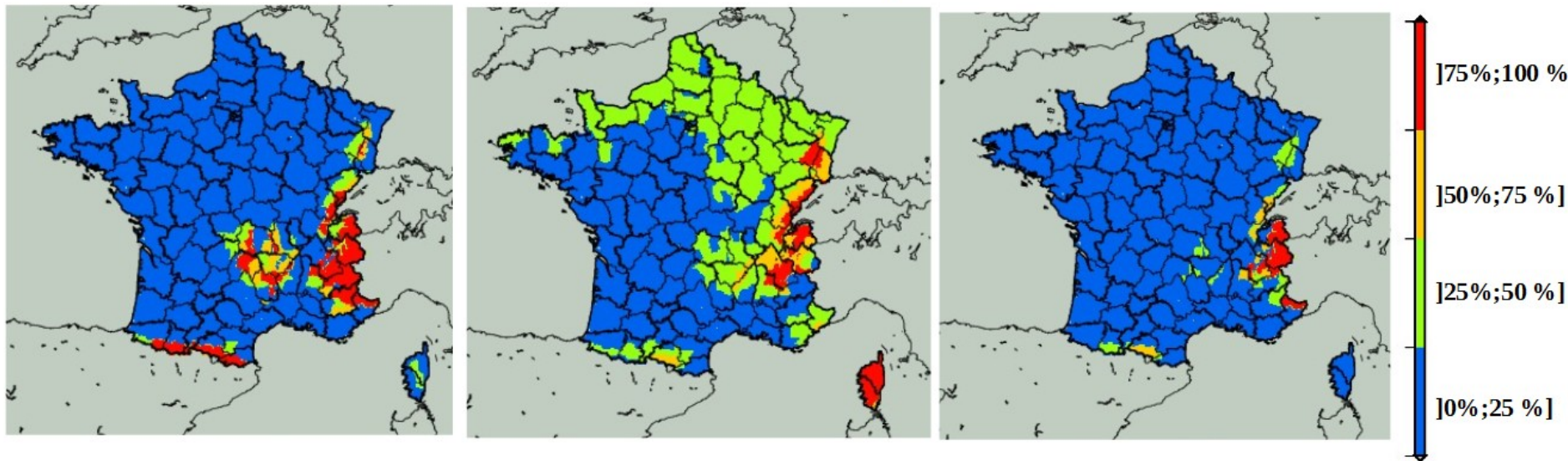
Results of internal tests during 2018/2019 winter

- The system is too alarmist

- Cold bias associated to this system : the raw ensemble could not be used directly

- Require further works dedicated to the calibration of the ensemble:

    — Easier for road surface temperature (many road surface temperature measurements available in France)

    — Harder for road water and ice content

- Need for objective evaluation: require water and ice height measurement : quite rare. Could require specific experimentation

Meteo-France's operational road meteorological assistance

Meteo-France's road meteorological web sites with a specific part for winter maintenance

- Automatic alarms based on customers' criteria

- Specific road weather bulletins

- Road weather stations' observations visualized on :
  - Chart
  - Map

- A Road Weather Information System (RWIS) : Optima

- Focus on snow parameters

Example of automatic alarms : various types of representations
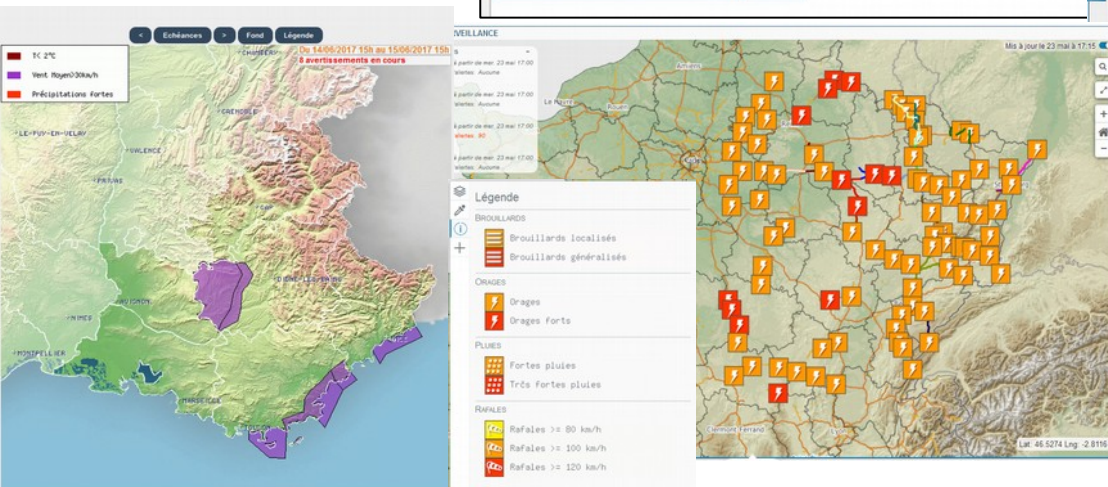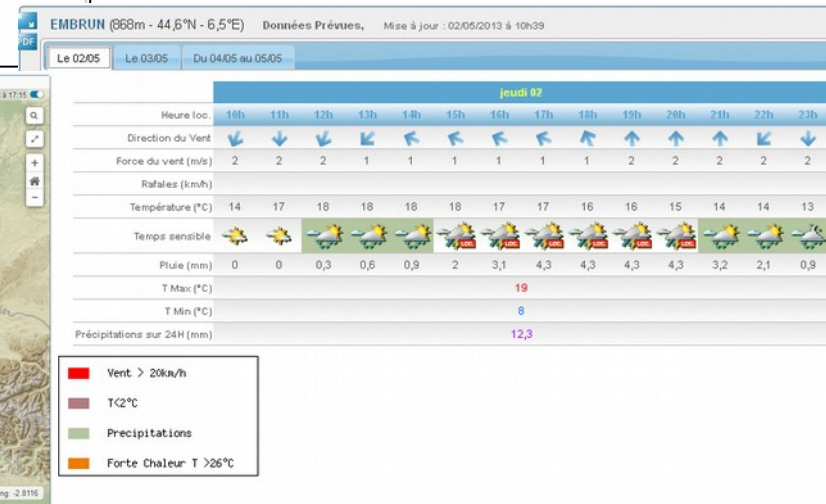
Email or SMS towards customers

Specific assessed road weather report

Forecaster's text for each phenomena

Details on the next 24h

Trend : up to D+9

We monitore the meteorological phenomena that impact roads :
- *black ice (hoar frost, rime, freezing of pre-existing water)*
- *Snow, freezing rain*
- *Snowdrifts*
- *Heavy rain*
- *Rain on frozen road*
- *Freezing fog that precipitates*
- *Dense fog*
- *Wind*
- *Thunderstorm and hail*

Color/level of alert chosen by the customer for each phenomena

OPTIMA

OPTIMA (Road weather informations dedicated to road sections), is a global approach of <u>data fusion</u> and specific road weather algorithms implementation, to obtain the best road weather information, according to the state of art, at 5 km resolution, on the road network.

OPTIMA is a 1h (next year 3h) nowcasting application of data fusion: link between in-situ reality and forecast It is completed with standard road weather forecasts on road sections from H+1h to D+3

OPTIMA : real time analysis and nowcasting of weather for the next hour

| Human forecasters expertise	Numerical Prediction models	Radar data (Observation & nowcasting)	Météo-France weather stations	Road weather stations

OPTIMA Nowcasting Computation (5 minutes frequency) on each road segment (5 km)

Precipitations (type and intensity)	Road surface temperature	Other parameters: wind, air temperature…
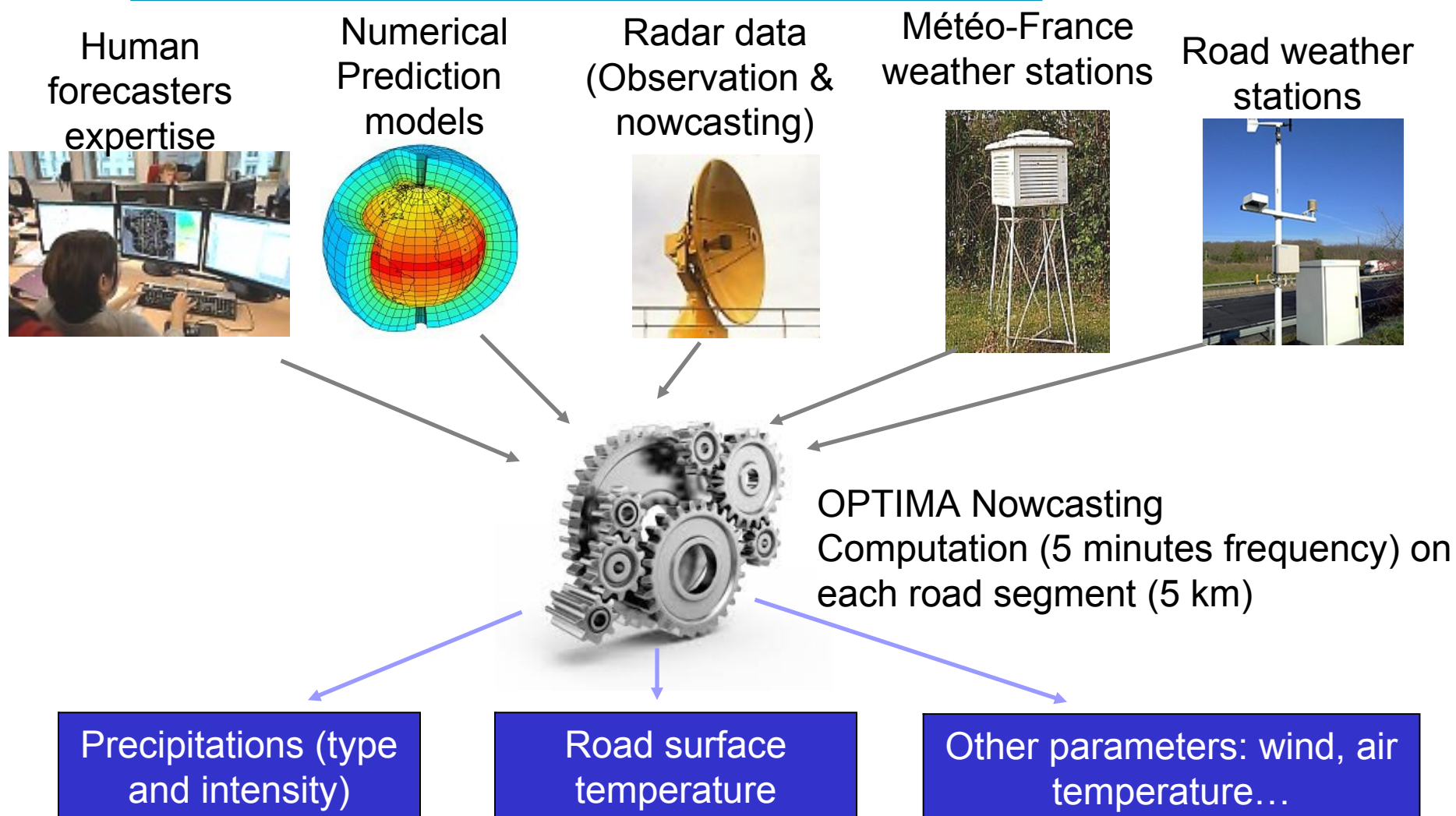
⇒ *Same product for 3 days forecasting without the use of radar and observation data*

Optima : nowcasting

Discriminated radar and road surface temperature superposition

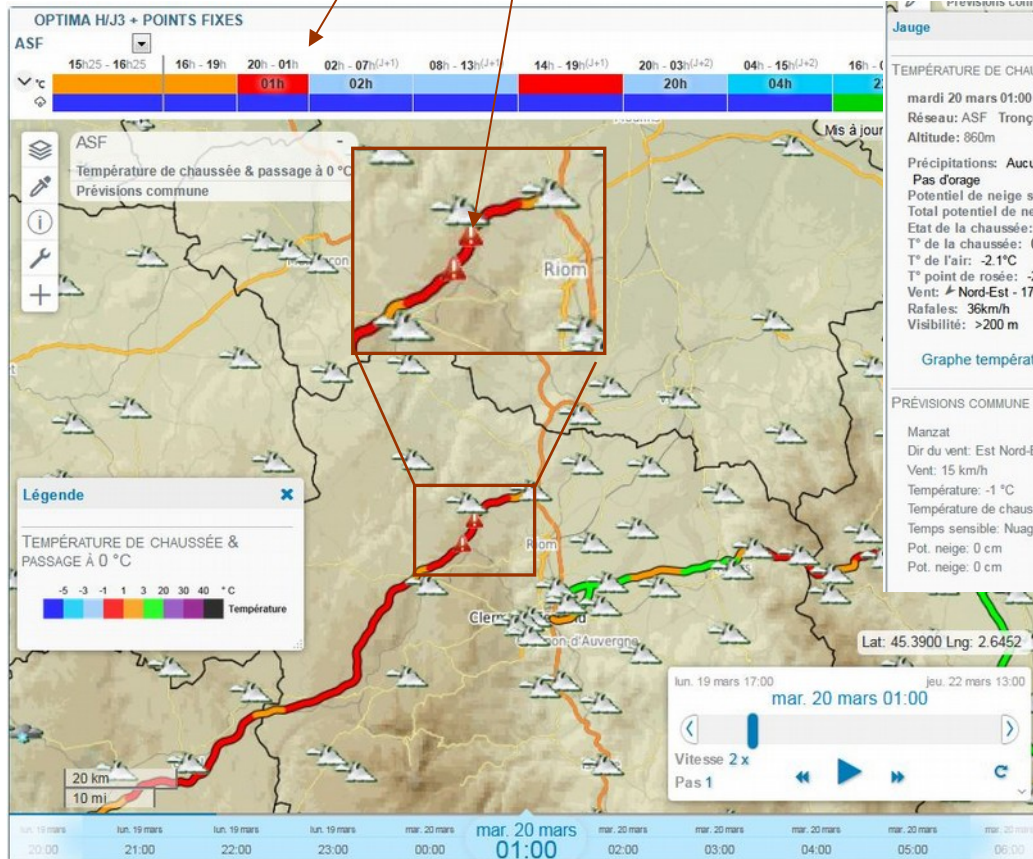Tooltip : detailed forecasts for one step of time and one road section
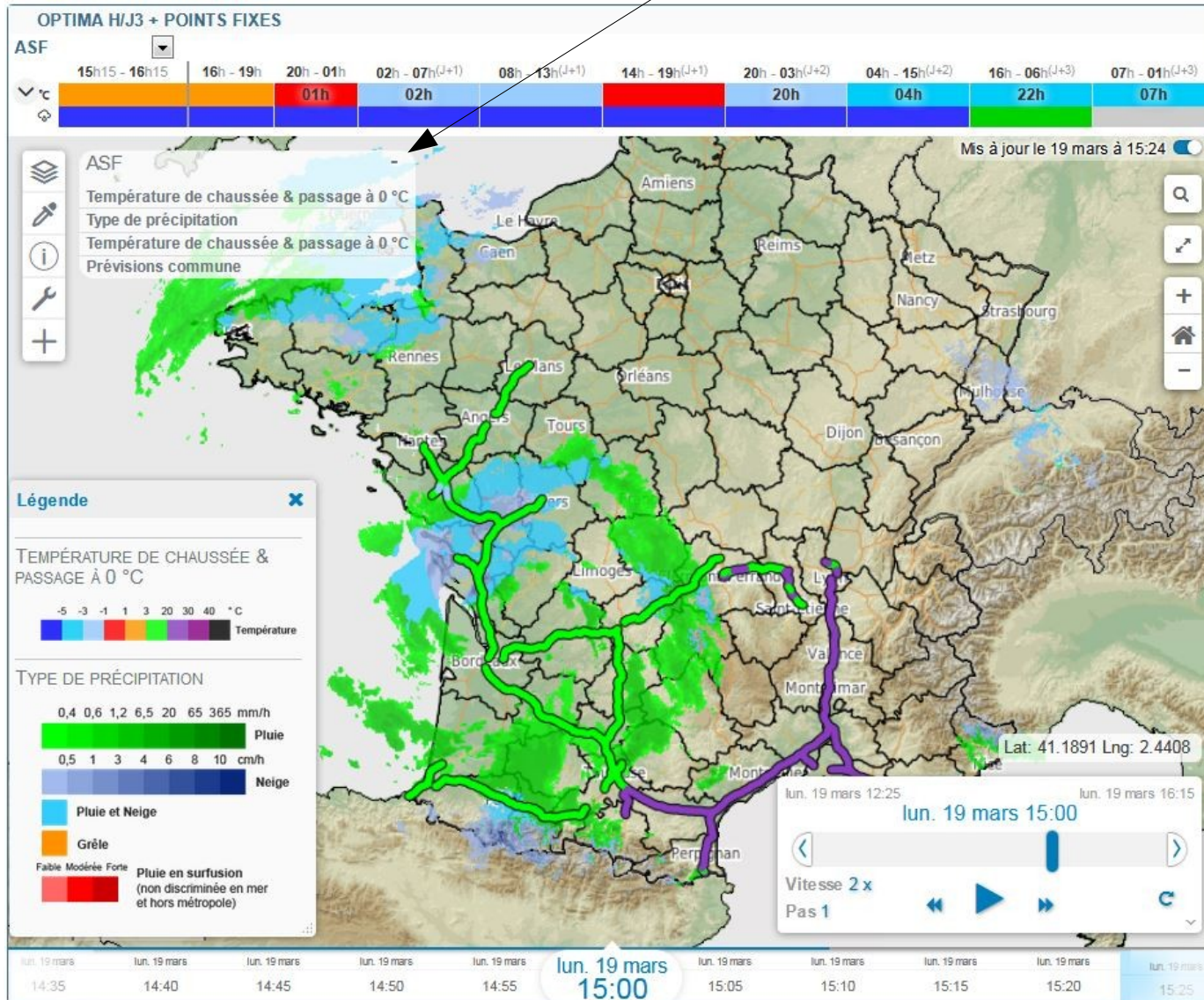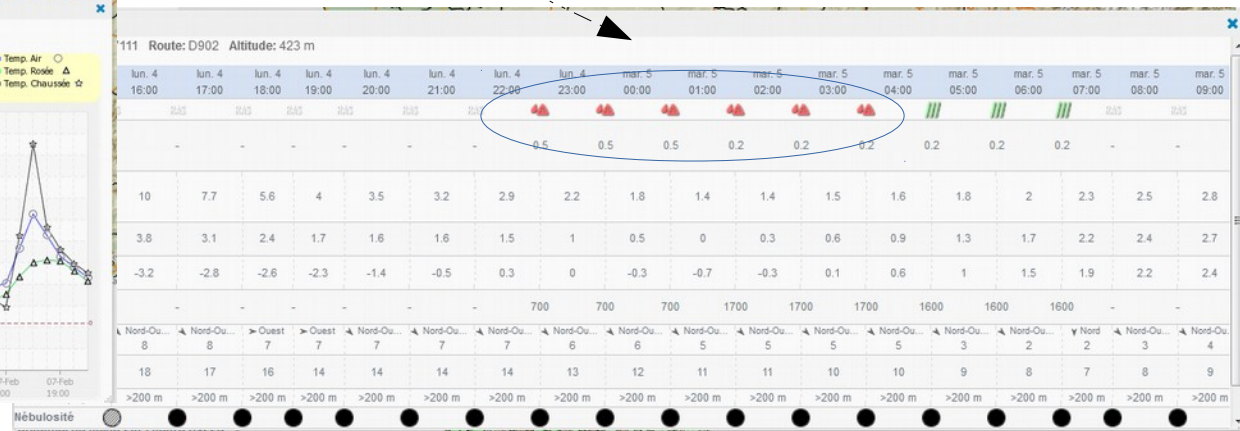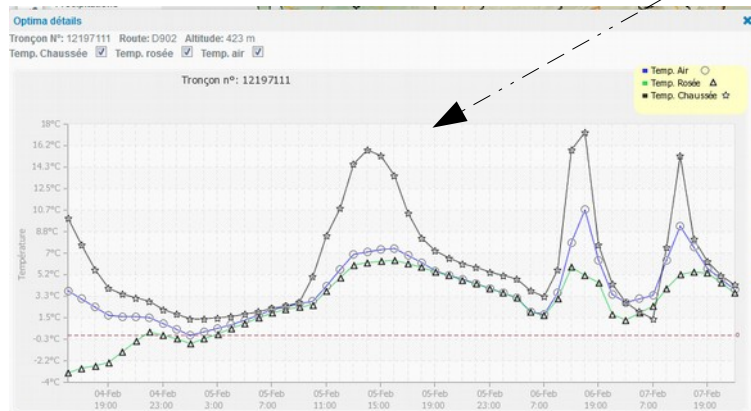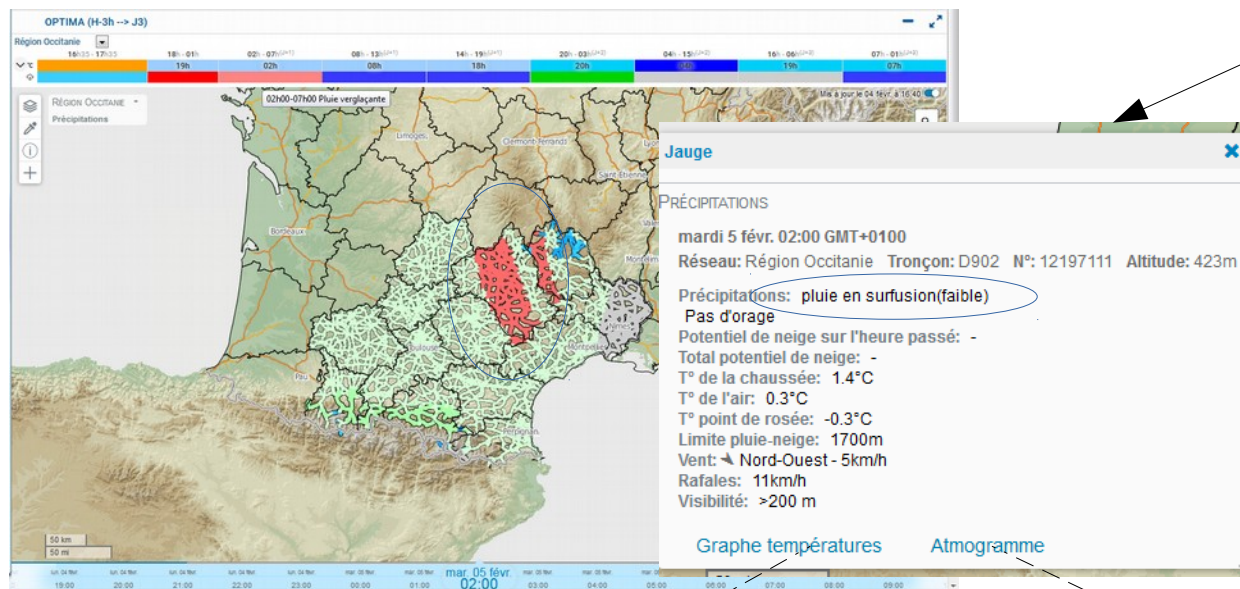
Detailed forecasts on each 5 km road section (2)

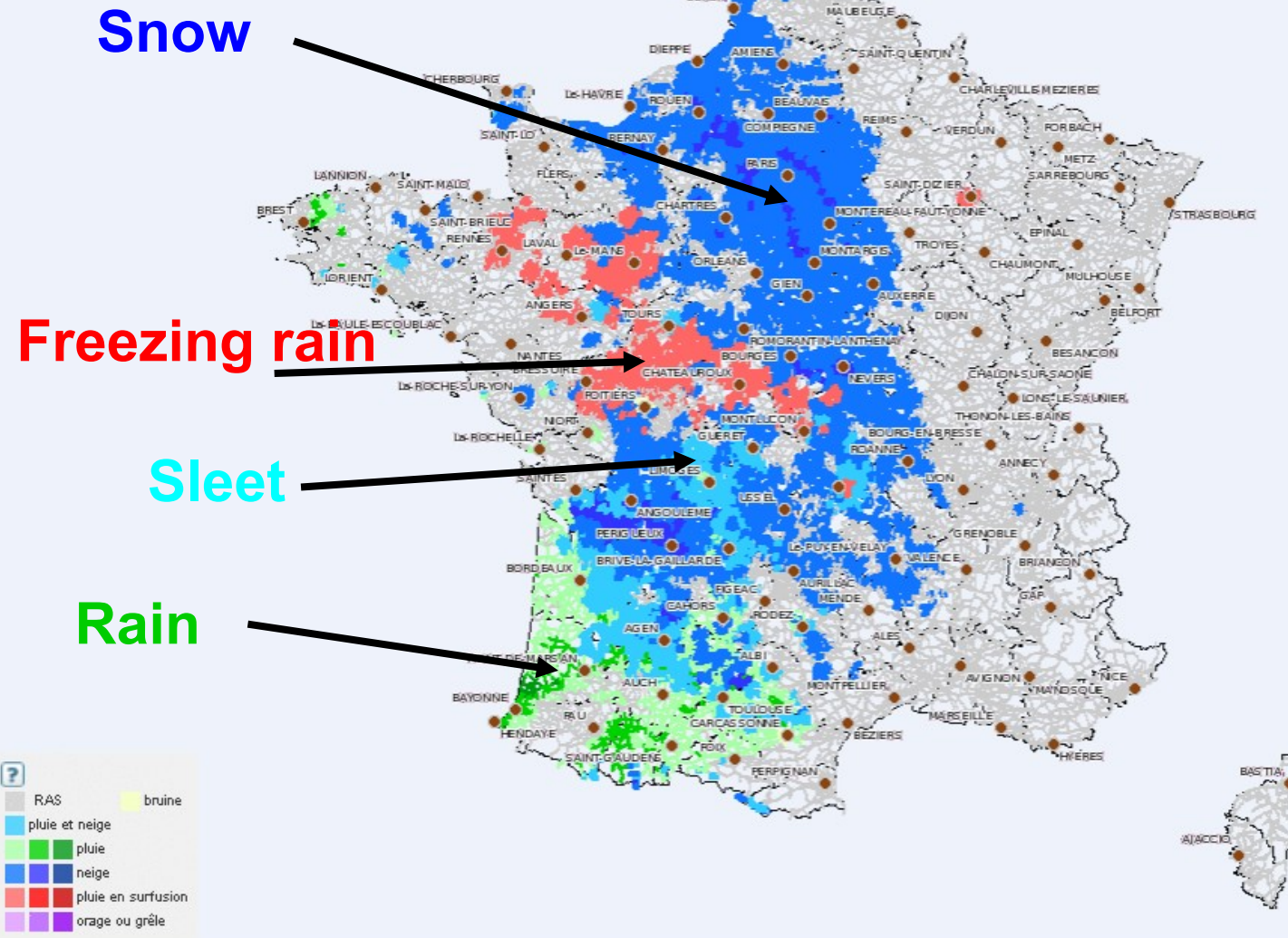**Alarm when road surface temperature drops below 0°C with the pictogram**

Tooltip

Graph of temperatures and forecasts chart for each 5 km long road section

Parameters are displayed with a colour code
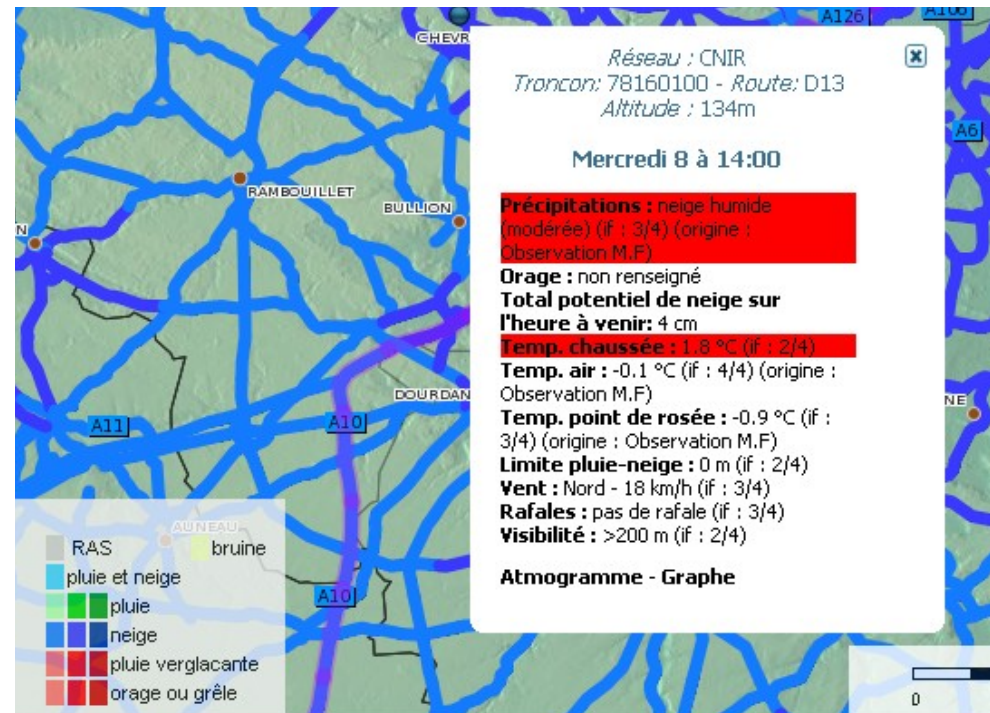
Zoom on snow forecasts

• We defined 5 different qualities (density) of snow depending on air temperature forecasts : Powder, dry, moist, moist to wet, wet.

• Snow potential : It represents the potential snow height on the road without accounting for melting, metamorphism or mechanical effects …

Allows to identify Critical snow events

Road network monitoring : automatic alarms
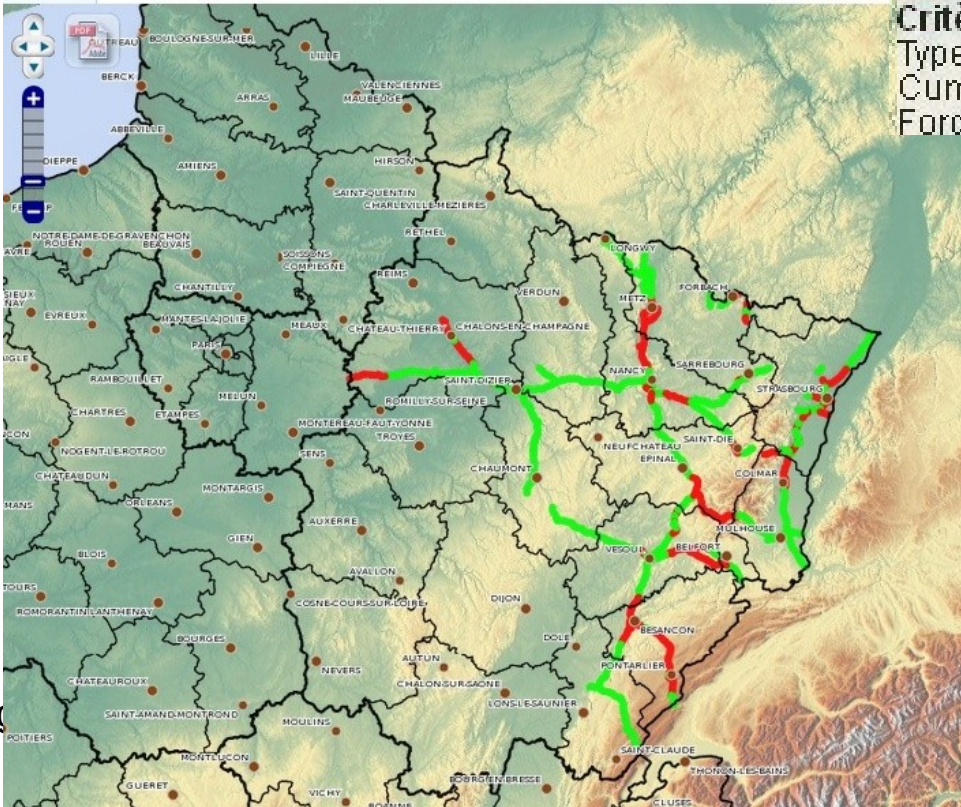
Based on criteria defined on each specific part of the road network

Critères :
Type de précipitations : Neige et temp. chaussée <= 0°C
Cumul neige HH1 >= 4cm
Force rafales > 80km/h

Can be changed by road operators

Perspective : use of vehicle data

- Commercial collaboration in aim to develop an embedded alarm system within vehicles, using in real time data from all vehicles

- Long-term project with a faisability step (2016-2017) which treats separately the 2 data fluxes : upstream and downstream

- R&D project : ~450 instrumented vehicles

Use of vehicle data in Météo-France systems

Diffusion of alarms and forecast within the vehicle

Upstream :
Vehicle as a sensor

Downstream :
Vehicle as HMI

23° ↓   ↓ 23°

Continental

METEO FRANCE
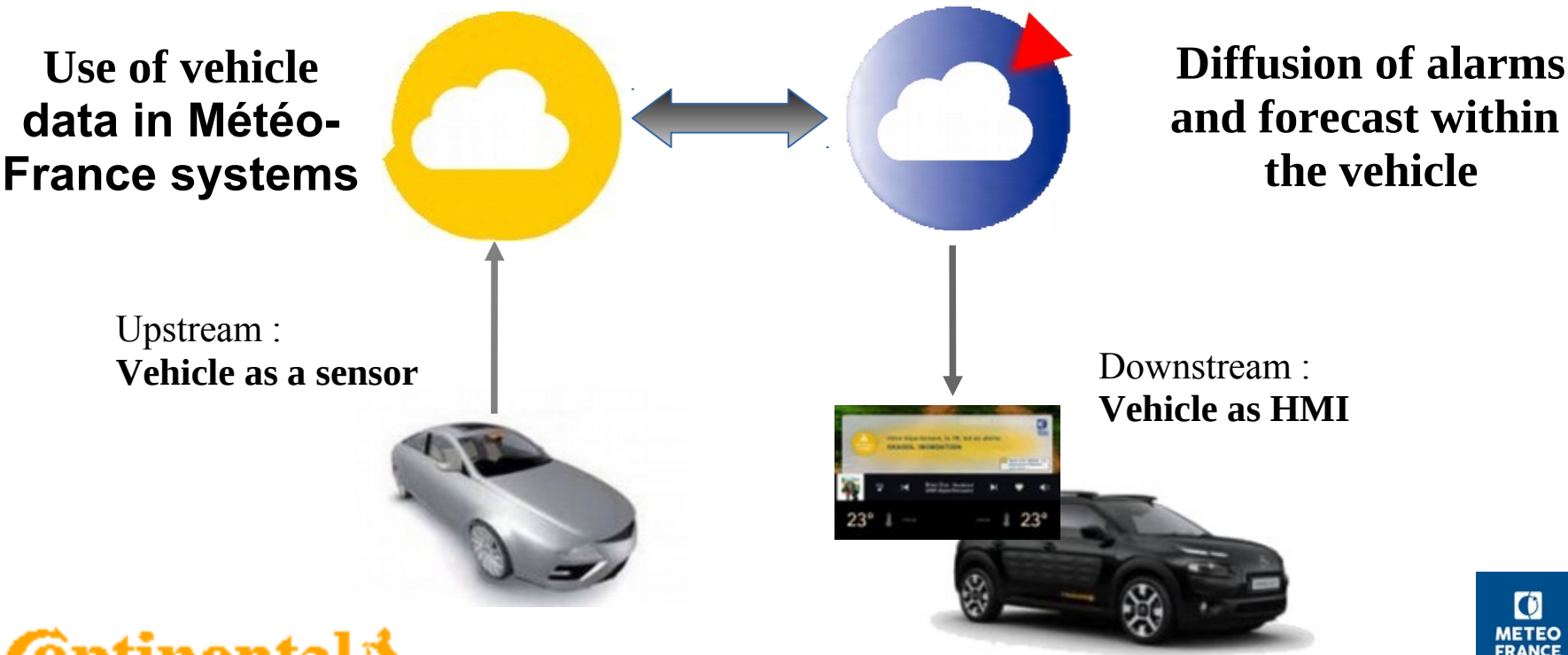
Perspective : use of vehicle data

- The experience with the living-lab allows us to conclude on :

  — A good quality of vehicle air temperature for a road weather use

  — Difficulties to get the information « precipitation/no precipitation » or « slipperiness/ no slipperiness » only with wipers and ESP data when there are just a few vehicles

- The downstream flow sending meteorological alarms already exists but without the use of data vehicles : The first version of these embedded vocalized alarms on itinery was computed with mean path and mean speed on 30 mn range ;

- Work in progress for the construction of reference data fusion products integrating data vehicles : precipitation, state of road.

METEO FRANCE

Perspective : use of vehicle data
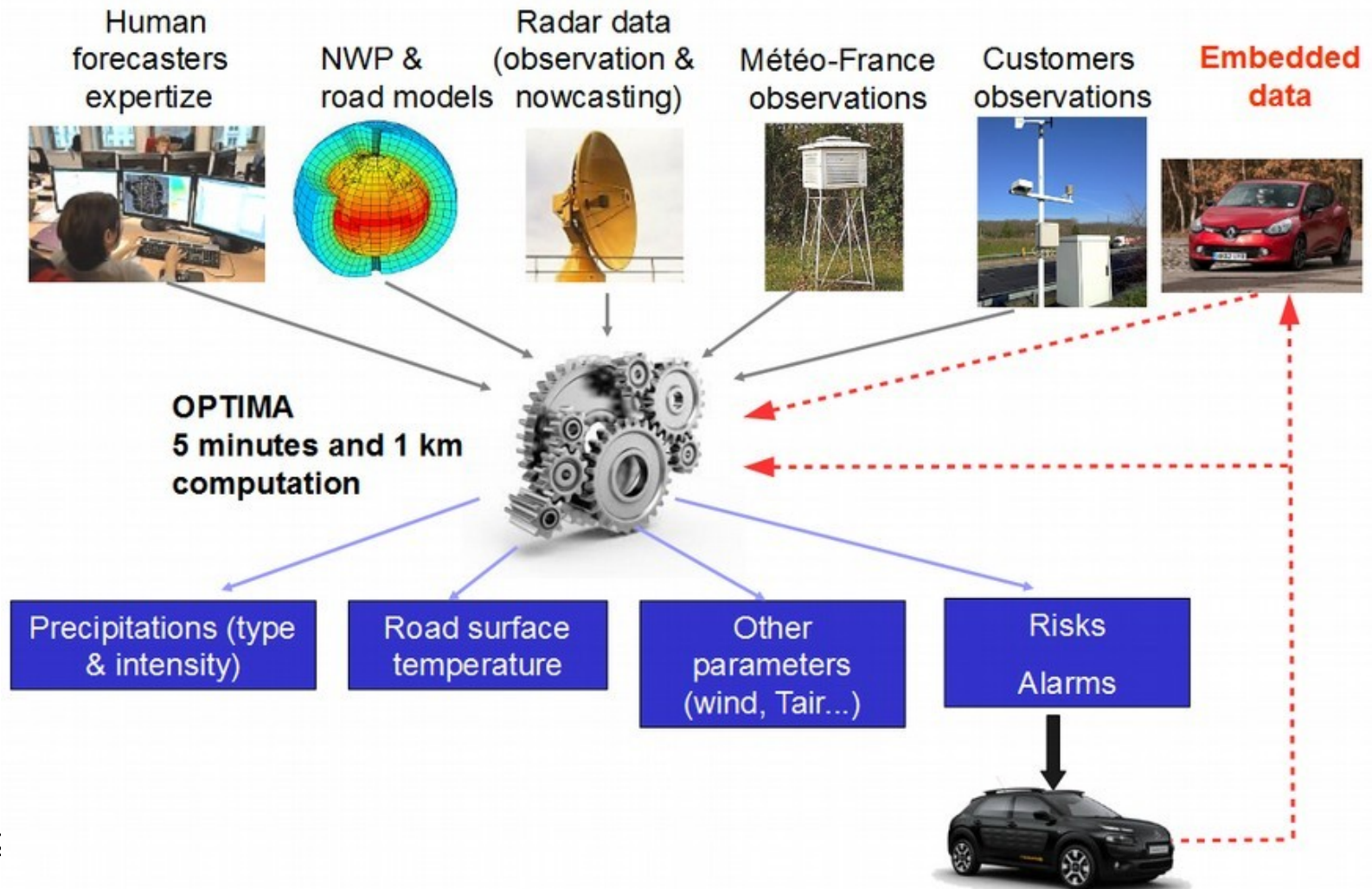
Thank you for your attention