METEOROUTES : METHODOLOGY OF A NEW CONCEPT IN THE WALLOON REGION

Thierry LEDENT
Attaché
Walloon Ministry of Equipment and Transport
CHARLEROI Motorway District
Rue de la Tombe, 110 - Marcinelle
phone: +32 71 60 10 71
fax: +32 71 60 10 89
e-mail : tledent@met.wallonie.be

SUMMARY

In order to guarantee a maximum safety to road users in wintertime, salt spreading is organised as a precaution. The METEOROUTES programme was set up to optimise salt reaction. This programme allows to determine the spread rate and to plan spreading just before the occurrence of danger. In comparison with the former situation when spreading was decided according to general meteorological forecasts and the experience of the co-ordinators, METEOROUTES has had to prove its usefulness.

This new technology is based on :

- 50 automatic weather stations located alongside the road and motorway network.
- A communication network allowing links between the weather forecasters, the PEREX centre (permanent station for network operation) and the road network managers.
- A forecasting programme for determining road surface temperature up to 16 hours ahead.
- A programme generating instantaneous and forecasting thermal maps.

As METEOROUTES is the main decision tool concerning winter serviceability, it had to be integrated into the general organisation. The validity of the results and the reliability of whole the communication system had also to be ensured.

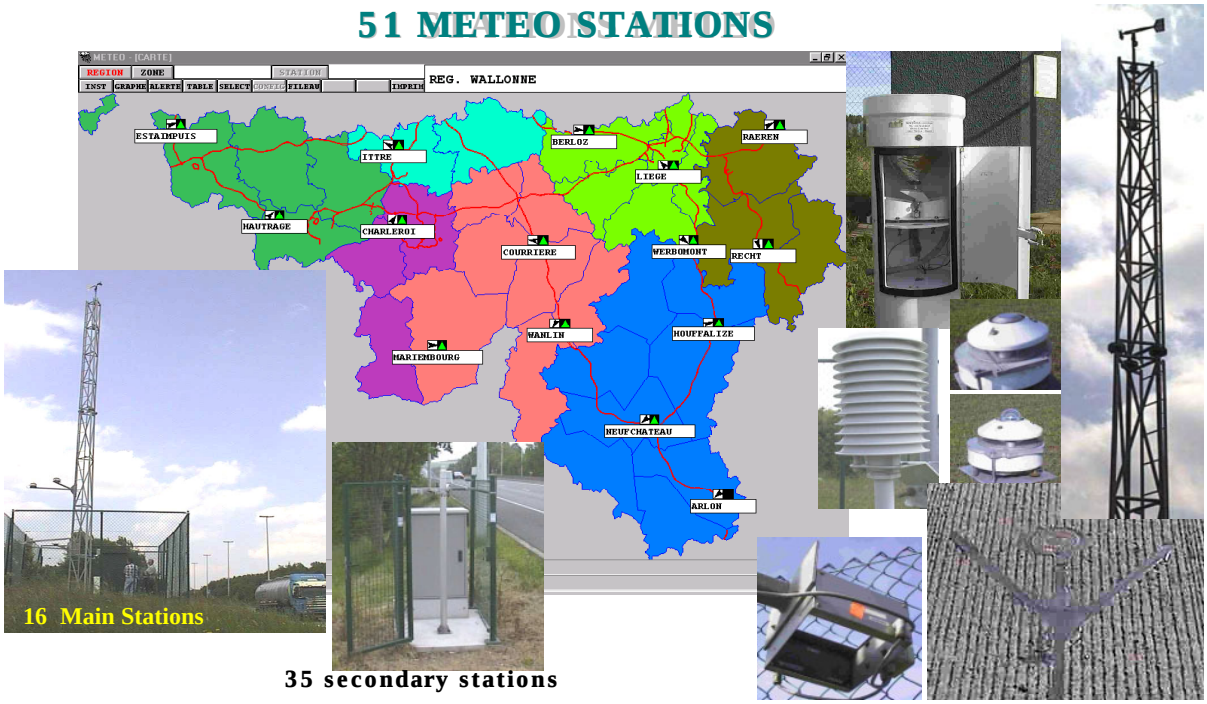
The hereafter mentioned main lines of action have been followed :

1. A continuous data exchange between road managers and PEREX (Traffic Control and Information Centre.).
2. A constant scientific follow-up by a professor of climatology of Liège University.
3. The control of round the clock forecasts by the Air Force METEO WING.
4. A rigorous maintenance contract managed by the Electromechanics Directorate.
5. The use of high performance hardware and software.
6. Training courses in software use.

All these management approaches fit in with a well-defined scheme enabling the decision-makers to refer to a tool which is as reliable as possible. A group of specialists form a follow-up committee and join their efforts with a view to ensuring the continuity of all the system developments.
METEOROUTES thus constitutes an essential component of the Walloon policy as regards the improvement of the service to the users, in the same way as the traffic management carried out within the framework of the W.H.I.S.T. programme (Walloon Highway Information System for Traffic).

The Walloon road network managers have been working with the METEOROUTES programme since 1998 in order to optimise preventive road salting in wintertime.

Investments were made in the installation of 16 main weather stations and 33 secondary stations.
The aim pursued is to set up a system for forecasting soil surface temperature nearby each main station, providing 16 different forecasts. A communication network transfers the values automatically measured by the sensors of the weather stations to the Meteorological Wing of the Belgian Air Force, to the PEREX centre (Permanent station for network operation) as well as to the local district managers of the Walloon Ministry of Equipment and Transport.
Every 6 minutes, the communication network processes the data from the road sensors as well as the average values resulting from following measurements : air temperature and humidity, wind speed and direction, global and atmospheric radiation, nature and amount of precipitation.
The soil sensors which are of utmost importance to our services detect the temperatures at the road surface as well as the temperatures at 5, 10 and 20cm depth in order to take account of the thermal inertia of the road layers.
Moreover, they indicate whether the traffic lanes are dry, moist or wet.



This programme is completed by a software for forecasting road surface temperature up to 16 hours ahead.
An evolution chart of road surface temperature is linked to each station and completed by a weather forecast every three hours. These forecasts concern the risk of precipitation, wind strength and cloudiness.

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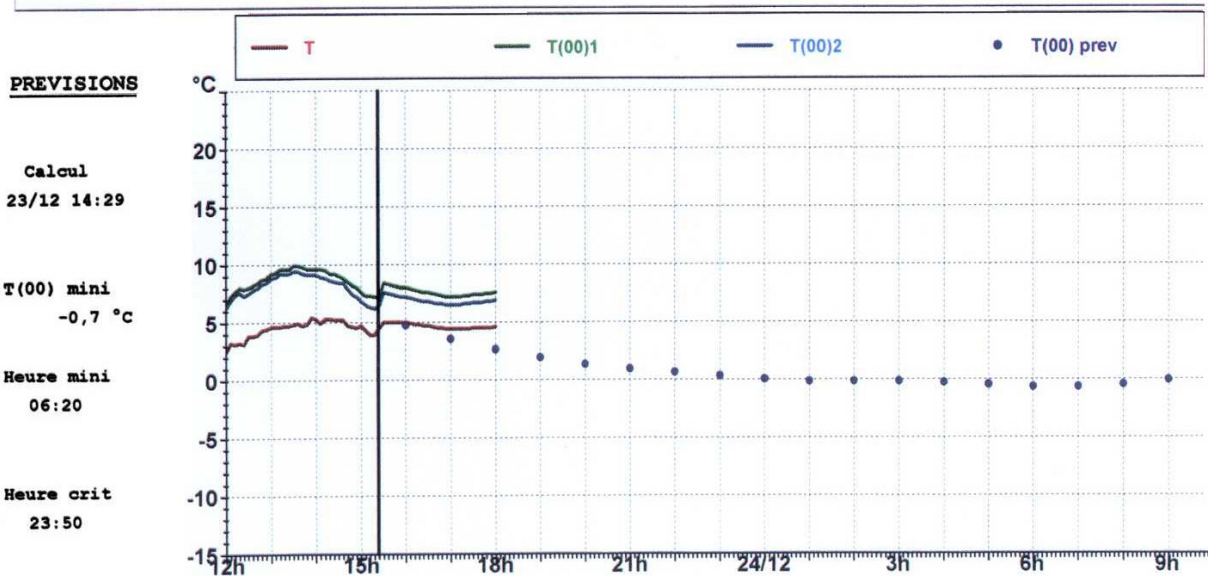
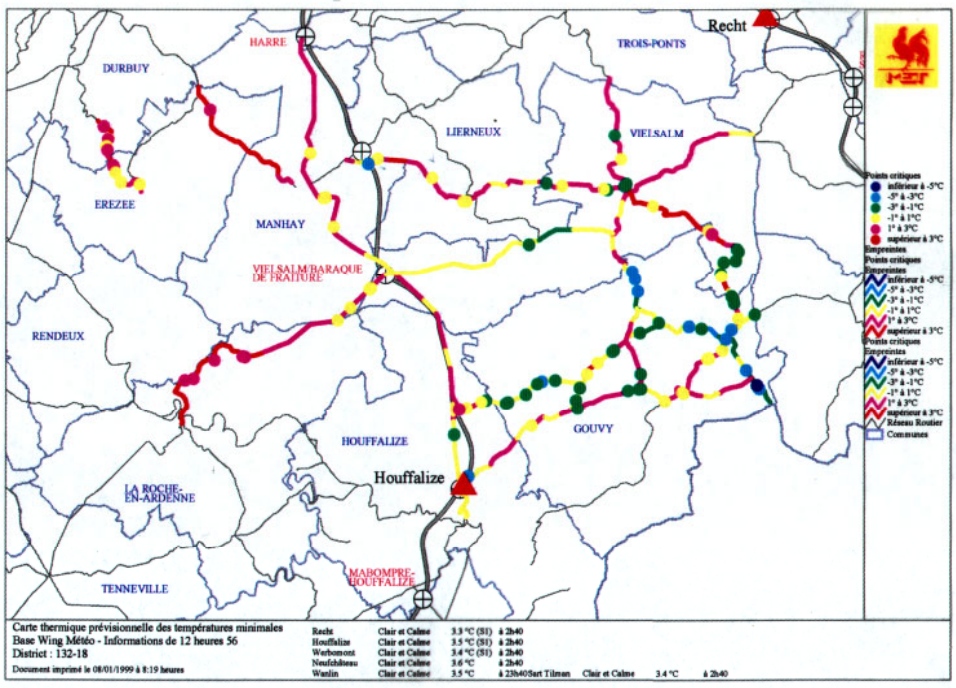
PREVISIONS	12-15	15-18	18-21	21-00	00-03	03-06	06-09	09-12
VENT	FAIBLE	FAIBLE	FAIBLE	FAIBLE	FAIBLE	FAIBLE	FAIBLE	FAIBLE
CIEL	NUAGEUX	NUAGEUX	NUAGEUX	NUAGEUX	TRES NUAGEUX	TRES NUAGEUX	TRES NUAGEUX	NUAGEUX
RISQUE DE PPN					NEIGE FAIBLE	NEIGE FAIBLE	NEIGE FAIBLE	



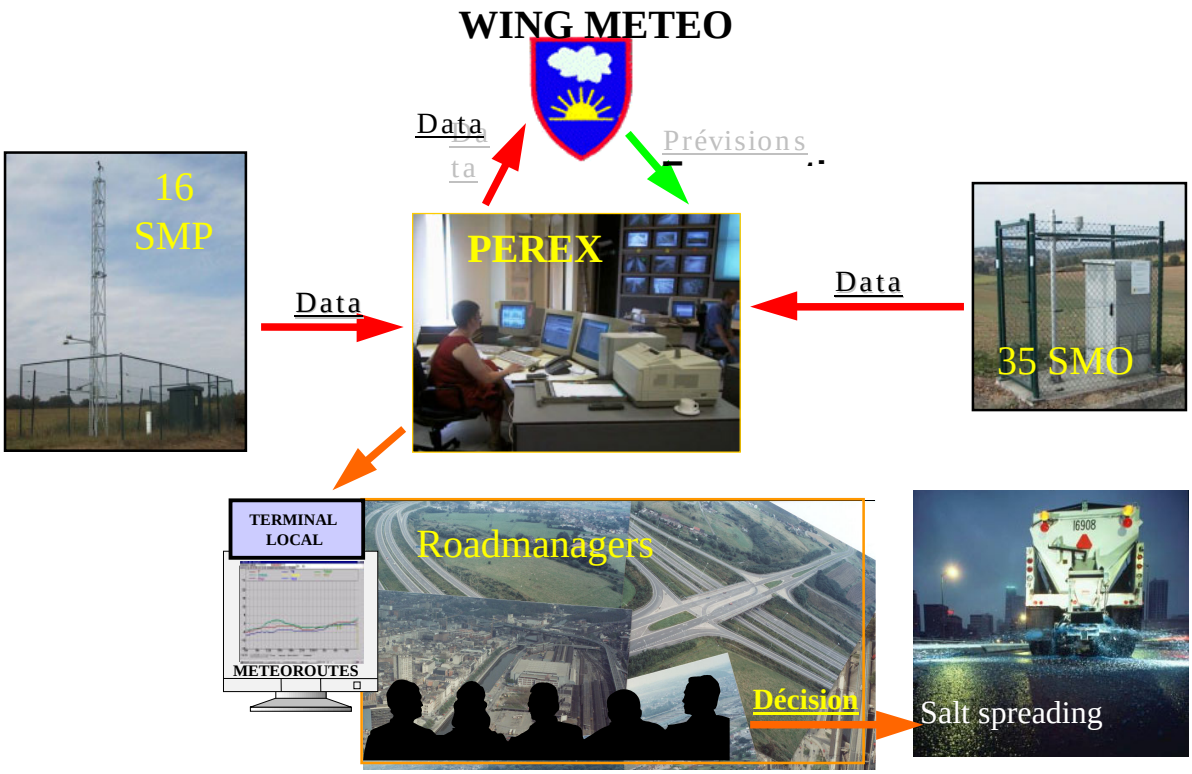
Thanks to a programme that establishes a spatial relation – either instantaneously or predictively - between road surface temperatures nearby a weather station, each local manager can receive a map of temperatures along his network on his Meteo terminal.

That way, the planning of salt spreading occurs as closely as possible to the moment danger is likely to appear so that a greater safety be ensured to road users and the operations be carried out in the most economical way.



The integration of this new tool into general winterserviceability operations proves to be a rather complex task.
Actually numerous factors must be taken into account : the network managers' working habits, the possibilities of the communication media, sensor performance, and traffic management centre requirements …

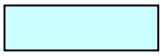
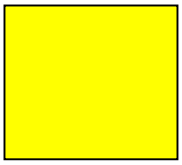
The first step taken was to implement this tool around the Walloon Region's TIC (Traffic Information Centre) called PEREX (Permanent station for network operation).
All the data coming from measurements carried out at the stations pass through a server located at PEREX and are dispatched to the METEO WING, on the one hand, and to the local managers, on the other hand.



The second step was to analyse the different causes of the failures we experienced.
With the help of Professor Erpicum of Liège University, solutions were found to the scientific problems related to road meteorology. A few examples are given hereafter.

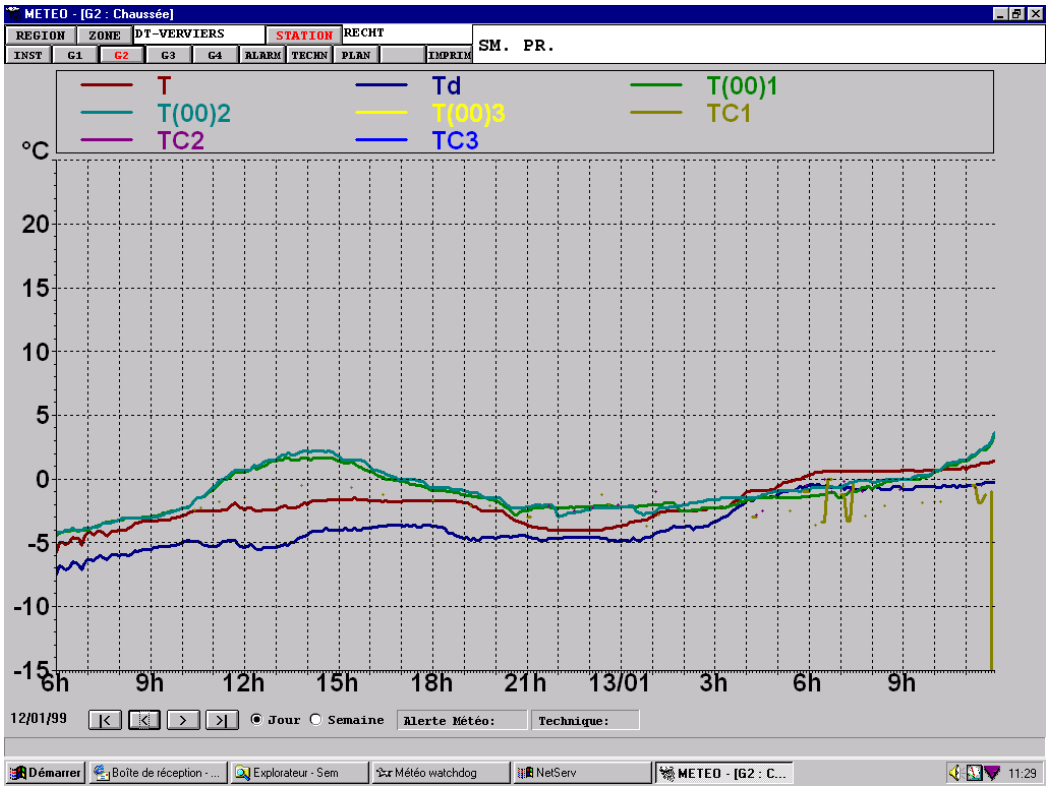
Setting up of meteorological alarms nearby each station.

Alarms give real-time warning to the managers about danger or coming danger and follow the conditions below, which are displayed on the local terminal by different colours appearing on a map.

Alarm no.	Colour code	Meteorological parameters
0		
1		T air or road surface ≤ 3°C **AND** extrapolated T road surface ≤ 1°C
2		T air ≤ 0°C
3		1st condition T road surface ≤ 1°C Or extrapolated T road surface ≤ 0°C Or T pavement at -5cm ≤ 0°C Or T pavement at -10cm ≤ -1°C Or T pavement at -20cm ≤ -2°C And 2nd condition Carriageway is not dry Or at least one precipitation in the past hour Or relative air humidity ≥ 95% Or T road surface – T dew point ≤ 1°C
4		T road surface ≤ 0°C And detected state : frost or black ice
5		1st condition Detected precipitation = snow or hail And 2nd condition T air ≤ 2°C Or T road surface ≤ 0°C

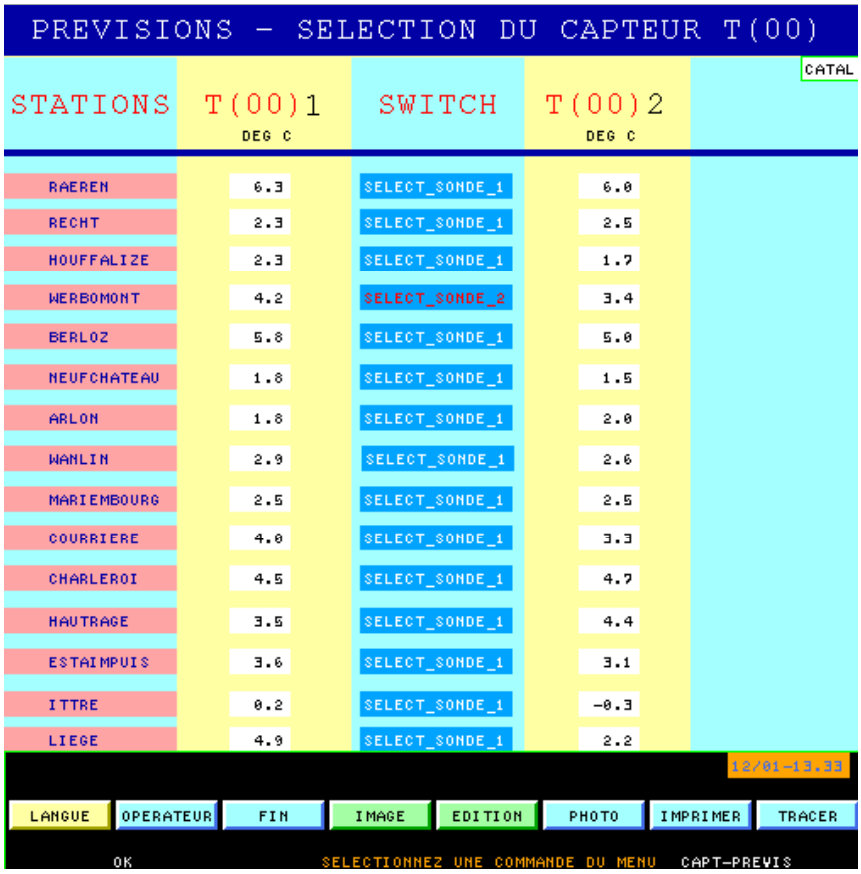
Prediction archiving

Road surface temperature predictions may show some imprecision.
When the difference between the measured and expected temperature exceeds 15°C, an alarm must urge the forecaster to reconsider his calculation.
An history file is created and the storage of all the prediction modifications allows the work to be analysed and qualified in fine.



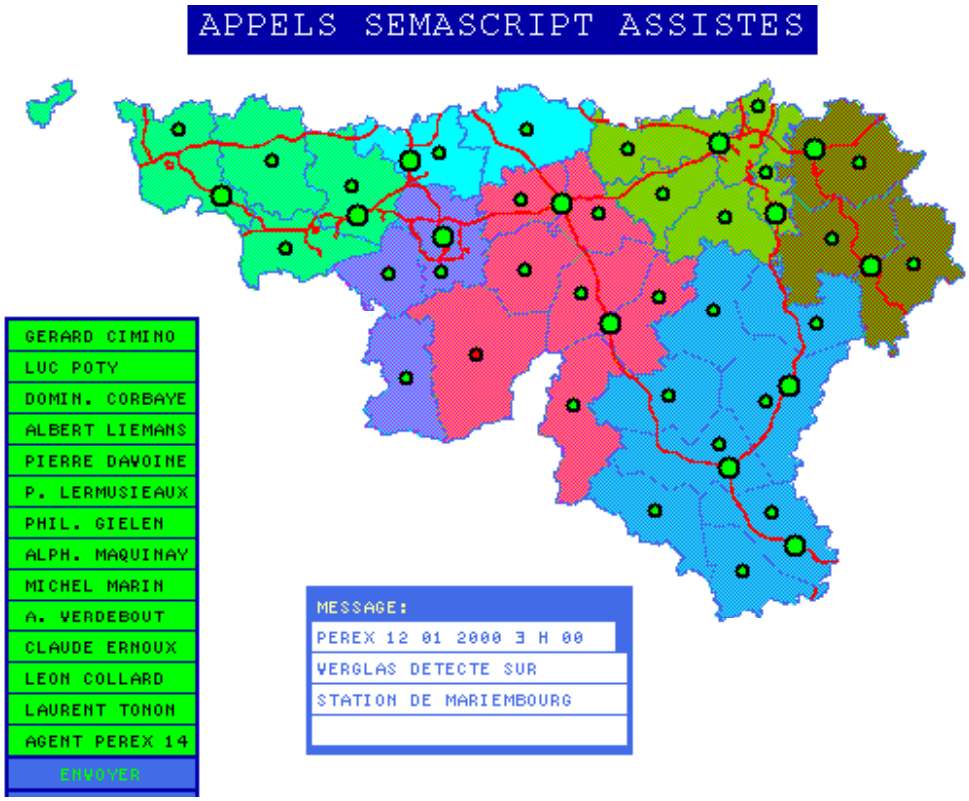
Forecasting sensors' switching

The forecasting system rests upon the measurement of the (far right) slow lane temperature. When the sensor is defective, a switching is programmed and can be key-actuated at PEREX.
This programme allows the prediction calculation to be based on the sensor situated on the (far-left) fast lane.



Sending of assisted semascript messages

In case of communication problems or sudden meteorological changes likely to disturb traffic, the public servants in charge of co-ordinating the winter maintenance service can be contacted by means of a message handling system dispatching messages through the telephone server.
When an unforeseen meteorological event occurs, the public servants on duty around the clock at the Perex centre compose a message they send to the geographic points concerned.
It goes without saying that in case of meteorological danger, it would be a nonsense to warn only one district in such a small territory.
That is why the servant on duty picks the points he deems concerned by the problem. Each of these points corresponds to a co-ordinator who will confirm receipt of the message by returning a phone call.



Fog alarm

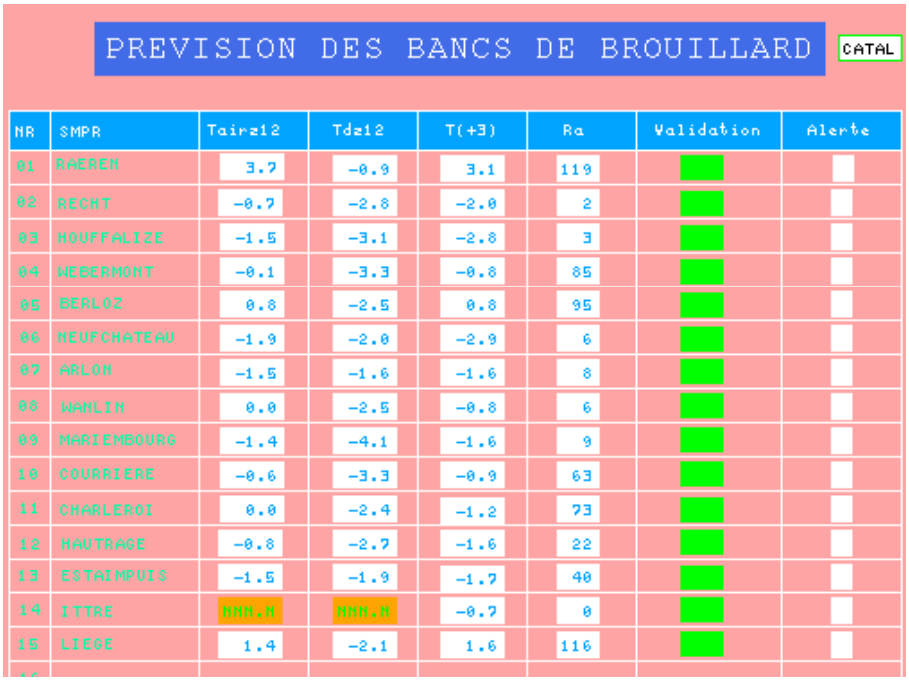
By adapting the empirical method developed by Craddock and Pritchard for forecasting fog, we have been able to calculate a risk of fog appearing nearby the main weather stations.
The principle is based on the calculation of the reference temperature T *fog.*
T *fog* is calculated once a day for each forecasting station.
Calculation time is 12:00 UTC.
NB : 12:00 Zulu time = 14:00 in summer and 13:00 in winter, that is to say 12:00 UTC

The Craddock and Pritchard simplified method gives following formula :

$$T_{fog} = 0.044 * T12z + 0.844 * Td12z - 0{,}55$$

NB : 12:00 UTC is the time when the difference between air temperature and dew point temperature probably is maximal.

The identification of the risk of fog occurs automatically thanks to an algorithm which compares the air temperature extrapolated over three hours (that is to say the predicted temperature that the air will have 3 hours after the present moment) to T fog.
This programme will generate an alarm, the receipt of which will have to be confirmed by the PEREX personnel.


PREVISION DES BANCS DE BROUILLARD

CATAL

NR	SMPR	Tairz12	Tdz12	T(+3)	Ra	Validation	Alerte
01	RAEREN	3.7	-0.9	3.1	119		
02	RECHT	-0.7	-2.8	-2.0	2		
03	HOUFFALIZE	-1.5	-3.1	-2.8	3		
04	WEBERMONT	-0.1	-3.3	-0.8	85		
05	BERLOZ	0.8	-2.5	0.8	95		
06	NEUFCHATEAU	-1.9	-2.0	-2.9	6		
07	ARLON	-1.5	-1.6	-1.6	8		
08	WANLIN	0.0	-2.5	-0.8	6		
09	MARIEMBOURG	-1.4	-4.1	-1.6	9		
10	COURRIERE	-0.6	-3.3	-0.9	63		
11	CHARLEROI	0.0	-2.4	-1.2	73		
12	HAUTRAGE	-0.8	-2.7	-1.6	22		
13	ESTAIMPUIS	-1.5	-1.9	-1.7	40		
14	ITTRE	NNN.N	NNN.N	-0.7	0		
15	LIEGE	1.4	-2.1	1.6	116		

Measurement validation

In practice, it appears that certain sensors indispensable to the road network managers had technical faults.
Technical faults such as communication or lack of measurements are detected by the alarm generation system described under a).
It is very difficult for a road manager to detect erroneous measurements.
A real-life case provides a good illustration of the problem. During three days wind speed had been equal to zero nearby a main station. This measurement influences the forecasts. Actually, the anemometer's vane had come apart and there was no physical wind measurement any more.
A software was written in order to validate the essential measurements and to set aside the phoney ones.
The working of the validation system rests upon a statistical examination of measure evolution over time. The standard deviation of the last n values is compared to a parametrisable threshold.
Algorithms are as follows :

Test on AR = atmospheric radiation (cloud cover)

Refusal : if : AR < 130 W/m²
if : H% > 97% and AR > 10
if : H% ≥ 90% AR < 10 4 times on end.

Test on GR = global radiation (solar energy)
from 23:00 UTC + 1 to 04:00 UTC :

GR must be < 10 otherwise refusal

Test on all temperatures
The standard deviation of the last 30 values
must be ≥ 0.2°C otherwise refusal

Test on wind speed
The standard deviation of the last 20 values
must be ≥ 1 km / h otherwise refusal

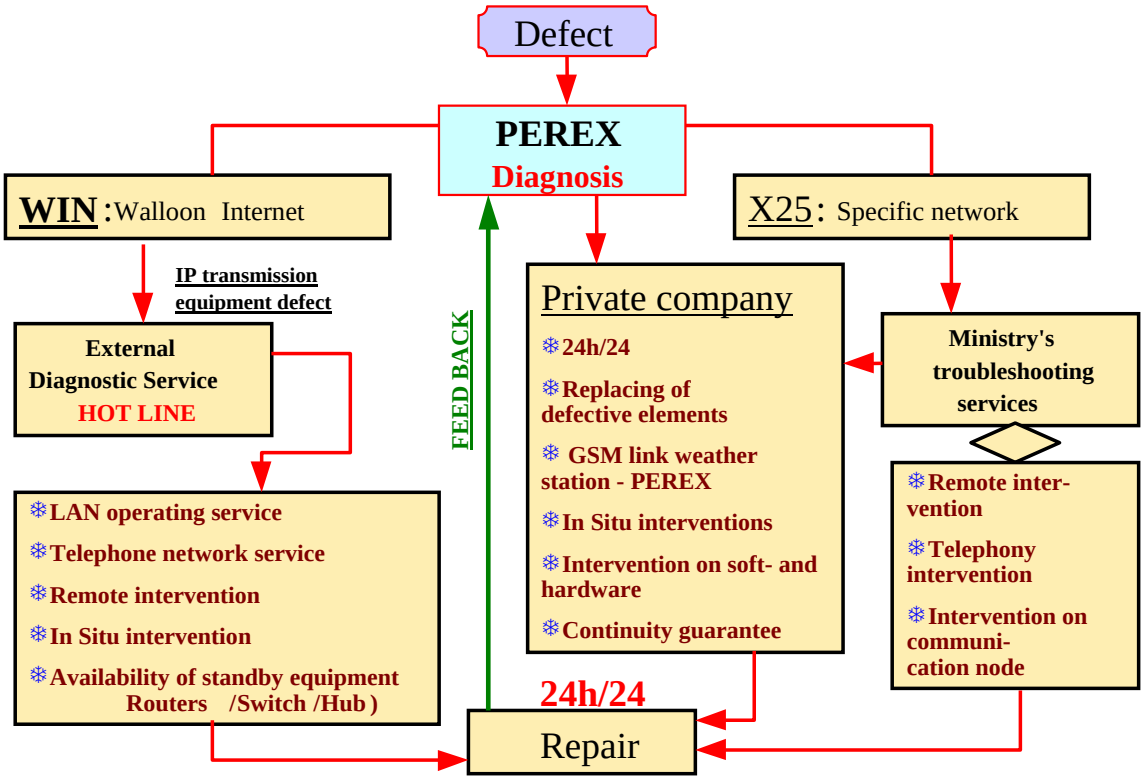
Test on wind direction
The standard deviation of the last 30 values must be ≥ 10° otherwise refusal.

Test on pluviograph
Carried out once a day to determine an historical account, average precipitation and to compare it to relative air humidity.

Test on snow cover
No snow if T air > 4°C.

The sensor's measurement reliability assurance is associated with a maintenance programme that allows us to guarantee continuity in system operation. A contract has been notified to a private company which plays a part in the network flowchart specific to METEOROUTES.

Interventions have to occur at very short notice and according to following table. The contractor must be able to deal with 3 simultaneous failures on 3 different locations.



Finally, the METEOROUTES programme evolution foresees the award of a study contract so as to improve it and make it independent from the existing type of system.

INVENTORY OF FIXTURES

- Measurement sensors
- Weather stations
- Data acquisition system
- Application softwares

PROPOSALS TO IMPROVE THE SYSTEM

- Measurement sensors
- Weather stations
- Data acquisition system
- Application softwares

MARKET SURVEY CONCERNING REPLACEMENT EQUIPMENT
ECONOMIC ASSESSMENT
CONSOLIDATED RECORD

In conclusion, the Walloon Region has acquired a high-performance tool that not only supports the decisions of the winter maintenance service co-ordinators but also allows for all kinds of future system developments. The increase in network and weather measurements reliability is such that nowadays the Hydrological Service of the Walloon Ministry of Equipment and Transport integrates the data pertaining thereto in their waterways surveillance system. Moreover, the Royal Meteorological Institute studies the possibility of integrating all of the measurements carried out by means of our system

The weather data collected by the METEOROUTES programme will be very soon used to carry out climatic and environmental studies and to confirm the weather forecasts within the framework of winter serviceability as well as within the framework of general public information.

As an integral part of the W.H.I.S.T. programme (Walloon Highway Information System for Traffic), METEOROUTES provides the information necessary to ensure safety on the road and motorway network of the Walloon Region.