# MONITORING AND FORECAST SERVICE FOR ICE FORMATION OVER MOUNTAIN ROAD SURFACE

Salvatore Martorina, Nicola Loglisci

Meteorological Department-ARPA (Regional Agency for Environmental Protection) -Piedmont- Italy
E-mail: salvatore.martorina@arpa.piemonte.it
nicola.loglisci@arpa.piemonte.it

**Abstract:** The Regional Agency for Environmental Protection of Piedmont (Italy) has been provided with a set of products for the monitoring and the forecast of ice formation over the road surface. To get used with the system, the first step has been a thermal mapping of about 100 kilometres of the principal roads, split in three homogeneous climatic areas. The thermal mapping has allowed to identify which sections were relatively warmer and colder compared to the average, and therefore those representative of that particular climatic domain. As a result of that, the next integration with the forecast system has allowed to extend punctual forecast of temperature and of road surface conditions to all the road stretch. This monitoring and forecast temperature and road surface conditions constitutes a Service that reveals itself to be of great importance for a good and careful management of road surface conditions during the winter period.

***Keywords –*** *Thermal Mapping, Ice Forecast, Olympic Winter Games*

## 1. INTRODUCTION

Since 2003 the Meteorological Department of ARPA Piemonte has been provided with a set of products for the monitoring and the forecast of ice formation over the main roads of the Olympic Valleys and over the stretches of regional motorways that join Turin to Milan and Turin to Piacenza, in the framework of Weather Support to Torino 2006 Olympic Winter Games. Fig. 1 shows a chart with the main roads of the Olympic Valleys.


**Figure1.** Topographic chart of the Olympic Area highlighting the main roads

## 2. THERMAL MAPPING

To reach this goal, the first step was a thermal mapping, executed during the months of February and March 2003, of about 100 kilometres of the principal stretches of the roads of Susa Valley, Chisone Valley and Pellice Valley, split in three homogeneous climatic areas. It has been possible to identify, under the same meteorological conditions, which sections were relatively warmer and colder compared to the average through the thermal mapping, that pointed out minimum temperatures variations of road surface, and the thermal maps derived from that. Therefore it has been possible to identify the representative sections of that particular stretch of road or climatic domain. This work has allowed the optimisation of the number and the location of the meteorological stations in some strategic points together with the extrapolation of the road surface temperature along all road network.

The result of the thermal mapping is shown in Fig. 2 with the three Climatic Domains identified and the location of the three meteorological stations advised as representative of each Area. The road surface is characterised by different colours within each Climatic Domain. Each colour indicates road surface temperature above or below the average: for instance the road surface temperature is mainly above the average (red and yellow stretch of road) in the bottom valley of the third Climatic Domain.

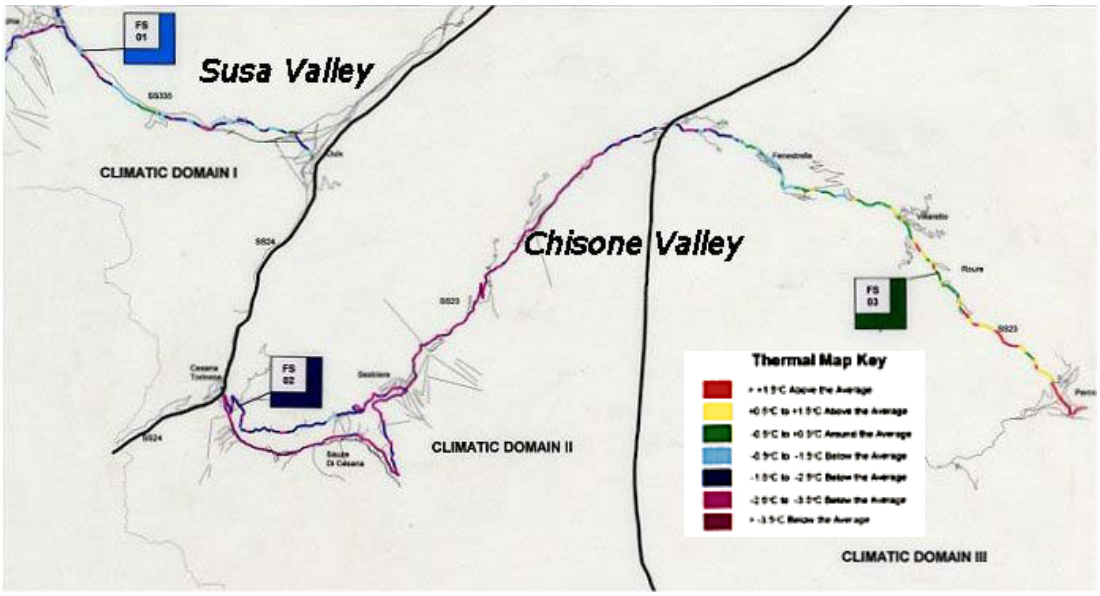


**Figure 2.** Climatic Domains of the Olympic Valleys obtained by thermal mapping

Up to now it has been installed only one meteorological station in the location identified in the third Climatic Domain. Before next winter the remaining two stations will be installed in order to complete the monitoring and forecast system. As a result of that, the following integration with the forecast system has allowed to extend punctual forecast of temperature and of road surface conditions to all the road stretches.

## 3. ICE FORECAST SYSTEM

It has been provided a numerical forecast product of temperature and road surface conditions for the following 24 hours, in order to make the complete ice forecast service efficient. For this purpose a deterministic model has been used, based on thermal balance (temperature = energy received – energy lost): this model receives automatically the observational data coming from the meteorological station representative of a specific site. It works out a forecast for every single site through three-hourly forecast of air temperature [°C], dew-point [°C], relative humidity [%], cloud amount [Oktas], clouds height[Low-Mid-High cloudiness], wind speed[m/s] and precipitation[Light-Moderate-Intense rainfalls, Light or Intense snowfalls] and taking into account the specific characteristics of the site (altitude, latitude,

longitude, sky view factor, traffic flow etc.). Thanks to thermal mapping results the punctual forecast has been extended to the entire road stretch.

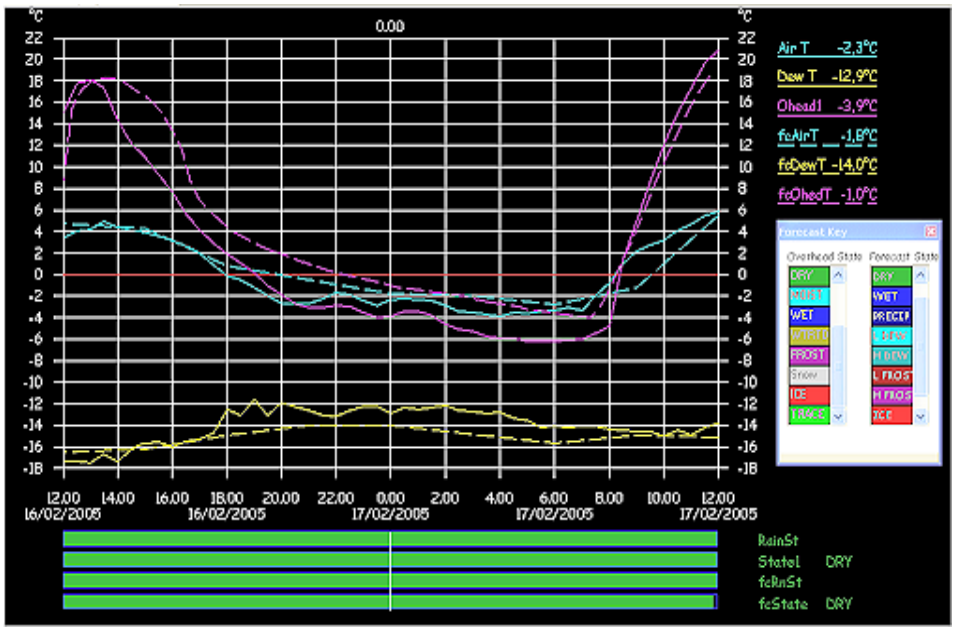


**Figure 3.** 24-hours ice-forecast (State and Temperature of the Road Surface)

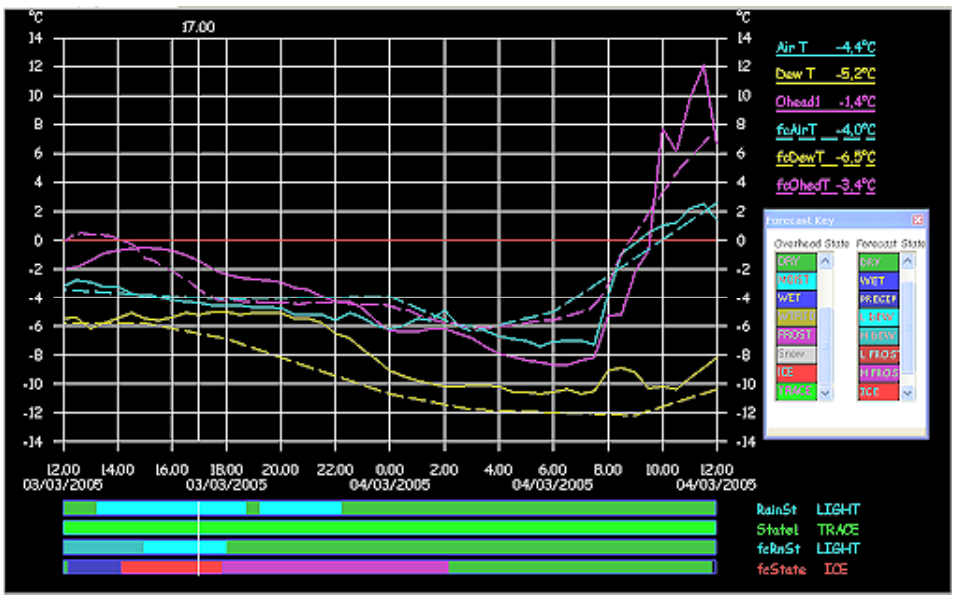


**Figure 4.** A good Weather Forecast is useful to prevent ice formation on the road surface

Fig. 3 shows an example of 24 hours ice forecast for the site identified as FS03 in the previous figure. A comparison between observed and forecast data about road surface temperature (respectively continuous and dotted purple line) and road surface state (rectangular green areas below the graph) is possible in the graph. Moreover, the comparison between observed and forecast meteorological parameters, for instance temperature (with the blue lines) and dew point (with the yellow lines) in the graph, allows to pay attention to the errors that can determine a more or less good ice-forecast, in order to improve the reliability of the forecast.

A good example of an useful weather forecast to prevent ice formation on the road surface is well-highlighted in Fig. 4: light snowfalls was forecast during the afternoon and the preventive use of salt favoured an increase in Freezing Point, avoiding ice formation that was forecast as represented in red area of the forecast State.

## 4. CONCLUSION

This monitoring and forecast of temperature and road surface conditions constitutes a Service that reveals itself to be of great importance for a good and careful management of road surface conditions during the winter period, minimising the discomforts and the costs both of material and of personnel assigned to the road safety and efficacy.

Moreover, the damages to the civil works and to the environment, due to the excessive and indiscriminate use of salt and de-icing agent, are minimised through the identification and the localisation of the de-icing chemical spreading areas.