Forecasting experience with a High Resolution non-hydrostatic model at Italian Air Force Meteorological Service.

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ABSTRACT

A non-hydrostatic limited area model is running over Italian area since 2001 (LAMI now EuroLM). The main characteristics of the model are 7 km of horizontal resolution, a domain size of 63648 points, 35 level for vertical resolution and two runs at 00 and 12 UTC.
Apart from the forecasters daily experience in using this model as a modern tool for forecasting the usual weather parameters for short and very short range forecasts, different important applications of the model products have been carried out in these years. High resolution metgrams, vertical profiles, an Automatic Weather interpretation tools (AWI), are only a few among the most important post-processing outputs. The experience in using high resolution product for punctual specialised forecasts tuned out for the International International Cycling Race "88th Giro d'Italia" for a month over the entire route, is described in this presentation, along with a similar one for Winter Olympic Games. Based on that experience an experiment test concerning some of the main legs of Italian Motorway Network has started in these last months.

Keywords: non-hydrostatic limited area model, meteograms, Automatic Weather interpretation tools .

1. INTRODUCTION

During the last International Cycling Race "88th Giro d'Italia" weather support was daily provided by a team of the Italian Meteorological Service. Among the specific weather products set up for this purpose, conventional high resolution metgrams tailored for cycling-race needs were prepared. A conventional metgram describes the behaviour of a set weather parameters on specific space spot in a predefined future time interval.

2. WORK DESCRIPTION

Due to the extreme localization of the stages routing, our highest resolution limited area model EuroLM was selected for the metgram production. The EuroLM model is a non-hydrostatic model with approximately 7 km horizontal resolution and 40vertical levels. The geographical area in which the model is framed into covers all the European Continent and is being run once a day at 00Z (in the next future will be run twice a day at 00Z and at 12Z and the resolution will be less than 3 kilometres).
In detail, for each stage of the cycling race the scheduled tour was timely associated with a set of waypoints for each of which a conventional metgram was produced for that specific site. The set of primary weather parameters included in the metgram is reported in Tab 1. were derived directly from a hourly model output. Some of them are also combined and post-processed to obtain secondary weather parameters. The "Heat Index" for instance is a secondary parameter and was considered to have a fundamental impact on the cyclists performance.

Primary weather parameters included in the metgrams.	***Units***
MSLP *– Mean sea level pressure.*	***HPa***
2T *– 2 m temperature*	***°C***
2D *– 2 m dew point temperature.*	***°C***
10 U,V *– 10 m wind.*	***Km/h***
TCC *– Total Cloud Cover*	***Oktas***
CCH *– High Cloud Cover.*	***Oktas***
CCM *– Medium Cloud Cover.*	***Oktas***
CCL *– Low Cloud Cover.*	***Oktas***
HTOP *– Conv. Clouds Top Height .*	***m***
HBAS *– Conv. Clouds Base Height.*	***m***
CP – *Convective Precipitation.*	***mm***
TP *– Total Precipitation.*	***mm***

Tab.1 Primary parameters derived from direct EuroLM ouptut.

Secondary weather parameters included in the metgrams..	***Units***
Heat Index(green/amber/red/purple)	***-***
Relative Humidity(%)	***-***
Fog occurrence (y/n)	***-***
Thunderstorm occurrence (y/n)	***-***

Tab.2 Secondary parameters derived from direct EuroLM ouptut.

Since the model depicts the Earth surface as a mesh of grid points equally spaced in the x-y plane, particular attention had to be given in the choice of grid point corresponding to selected waypoint.
In fact, no interpolation of a weather parameter within a cell was being calculated and no adjustment was being performed to account the difference between the real elevation above the sea level and the elevation at which the model describes that point to be. For the grid cells falling along the coastlines care was to be taken to pick-up points representing land respect to those representing sea in order to exploit the right temperature and humidity behaviour.
A sea grid point exhibits smoother thermal behaviour respect to a land grid point. For these reasons the grid point choice was assisted by the NASA WorldWind software, a geographical tool representing the Earth surface in terms of satellite pictures and an internal representation with a horizontal resolution not worse than 250 m.
The combined sets of primary and secondary parameters were used to assemble an interactive WEB page providing with a pictorial view of the weather expected to occur at a given time in certain site (Fig 1).

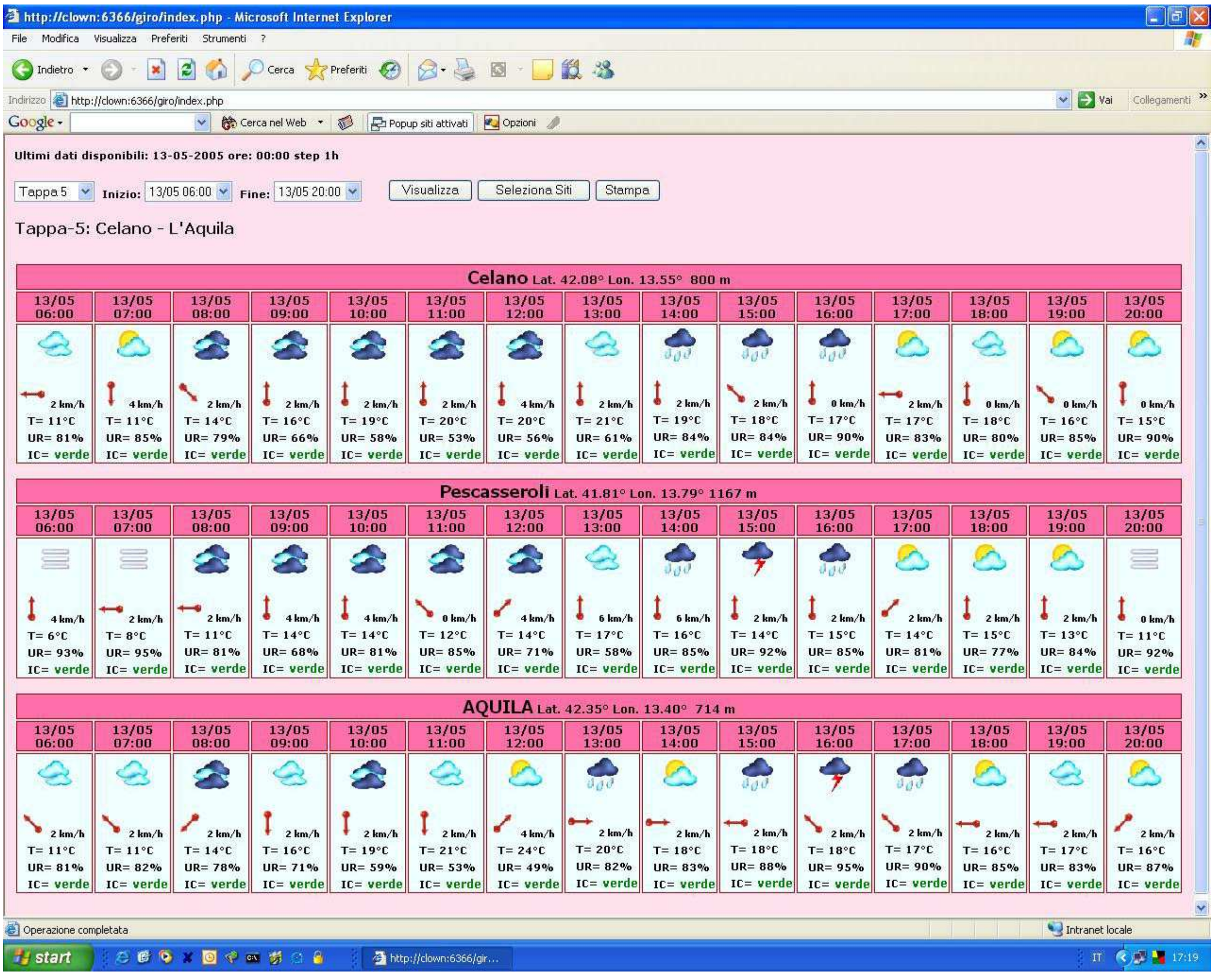


Fig.1 Web page on the internal site of the Italian Air Force Weather Service: MetGrams for 5th stage Celano-L'Aquila of the 88th Giro d'Italia.

Together with such spot-focussed forecasts a new post-processing tool named AWI (Automatic Weather Indicator) [1] was used to infer from direct model output where fog, drizzle, showers, thunderstorms and snow can occur in the geographical area covered by the EuroLM model.
AWI is being used at the Italian Air Force Weather Service routinely for aviation purposes, but it proved to be a valuable tool also for the "88th Giro d'Italia".
"Expected synoptic" maps like the one reported in Fig. 2 were produced every three hours and published on the internal web site to be made available to on-site forecasters.

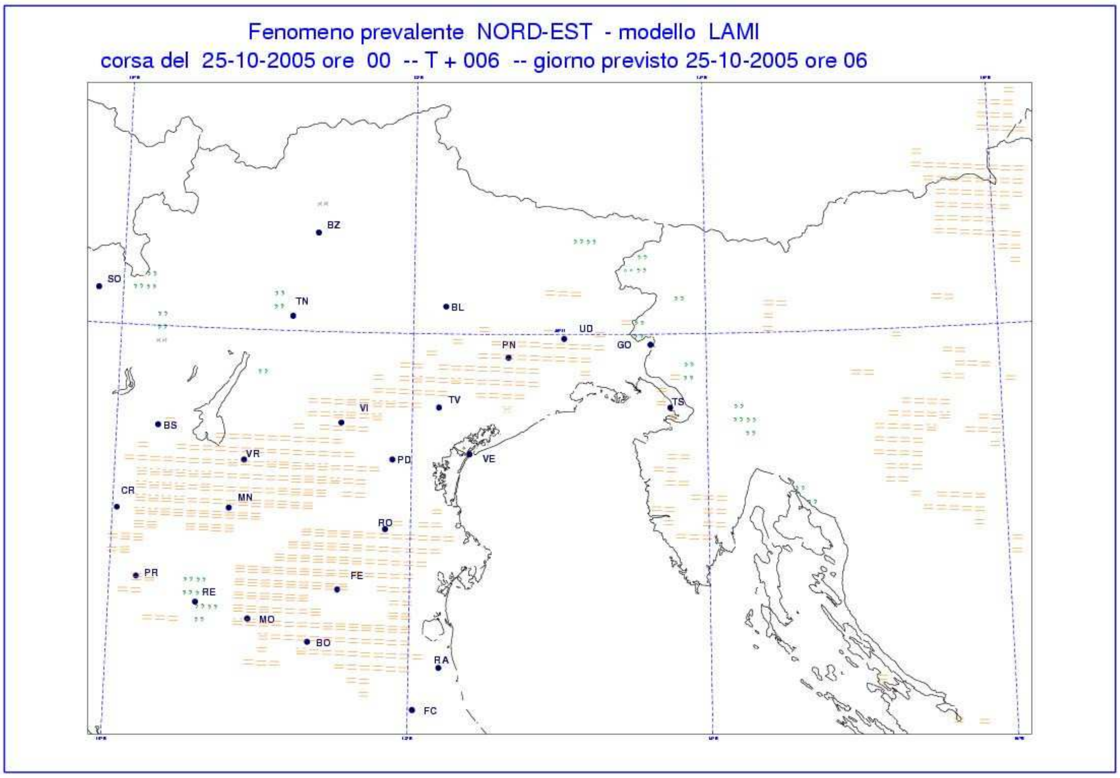


Fig. 2 AWI (Automatic Weather Indicator) for the North-Eastern part of Italy. Fog patches are clearly visible all over the "Pianura Padana" and some rain is predicted across the Italian-Slovenian border.

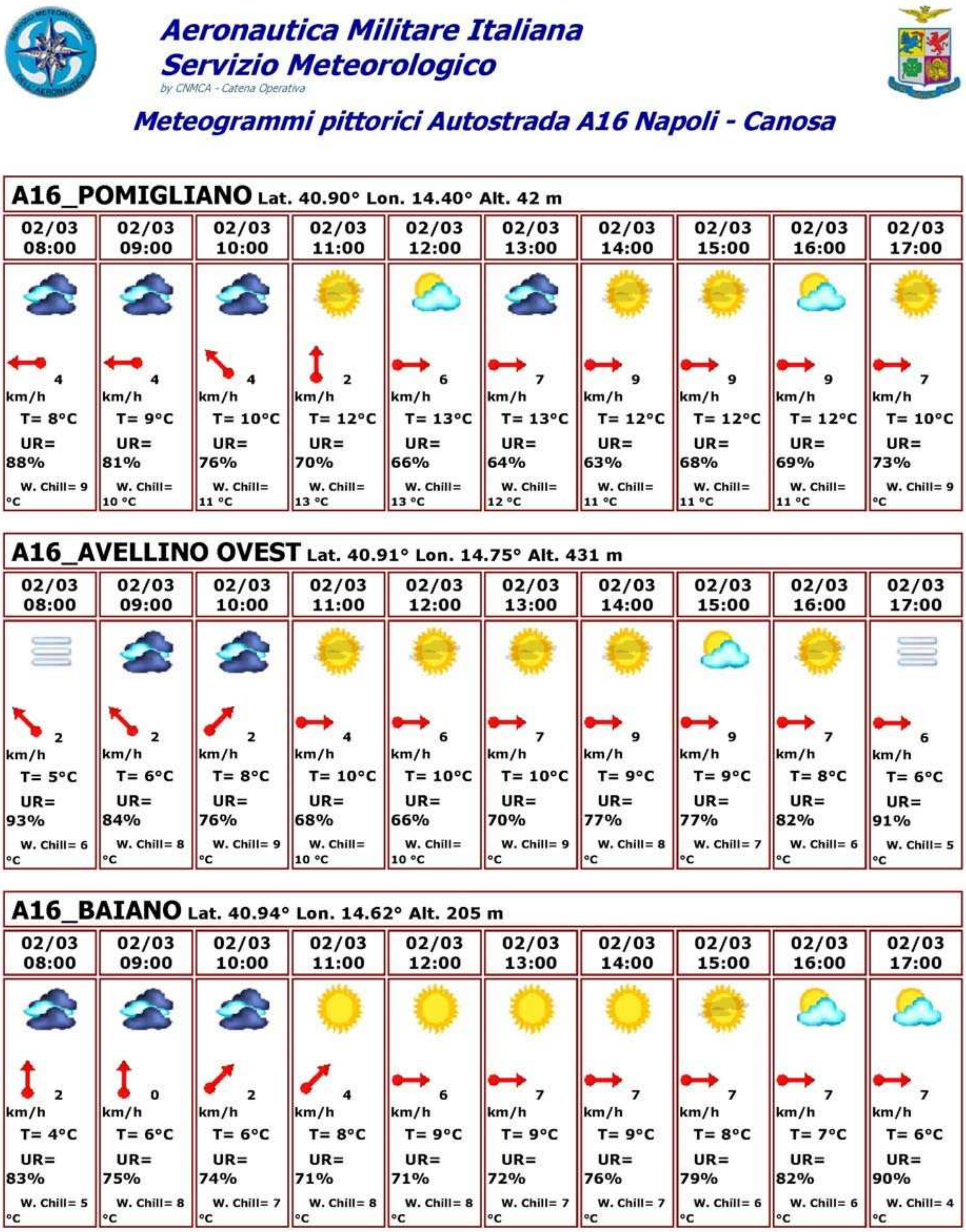
The highly satisfactory results obtained in the "88° Giro d'Italia" cycling race were inviting to consider the possible use of similar products for the weather support in the more general field of traffic management.

For this reason some legs of the Italian motorways network were selected to set up a pilot project with this respect: the Firenze-Bologna leg and the Napoli-Canosa leg.

The former is affected by harsh weather conditions mainly due to heavy precipitation, fog and road icing, while the latter falls inside a very windy area of Italian Peninsula. Therefore, conventional metgrams were set-up for all the pay-toll sites along each motorway leg. The time period covered in metgram forecast was 48 hours with hourly time step and the weather parameters included in the spot forecasts were as reported in Tab. 2.

Also in this case the combined sets of primary and secondary parameters were used to assemble an interactive WEB page providing with a pictorial view of the weather expected to occur at a given time (Fig 3), corresponding to the "pay toll" sites.

Along with this "long period" project another ad-hoc product has been developed and implemented during the past month for the Winter Olympic Games, with the same basic ideas and architecture (Fig 4).



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Meteogrammi pittorici Autostrada A16 Napoli - Canosa

A16_POMIGLIANO Lat. 40.90° Lon. 14.40° Alt. 42 m

02/03 08:00	02/03 09:00	02/03 10:00	02/03 11:00	02/03 12:00	02/03 13:00	02/03 14:00	02/03 15:00	02/03 16:00	02/03 17:00
4 km/h	4 km/h	4 km/h	2 km/h	6 km/h	7 km/h	9 km/h	9 km/h	9 km/h	7 km/h
T= 8°C	T= 9°C	T= 10°C	T= 12°C	T= 13°C	T= 13°C	T= 12°C	T= 12°C	T= 12°C	T= 10°C
UR= 88%	UR= 81%	UR= 76%	UR= 70%	UR= 66%	UR= 64%	UR= 63%	UR= 68%	UR= 69%	UR= 73%
W. Chill= 9 °C	W. Chill= 10 °C	W. Chill= 11 °C	W. Chill= 13 °C	W. Chill= 13 °C	W. Chill= 12 °C	W. Chill= 11 °C	W. Chill= 11 °C	W. Chill= 11 °C	W. Chill= 9 °C

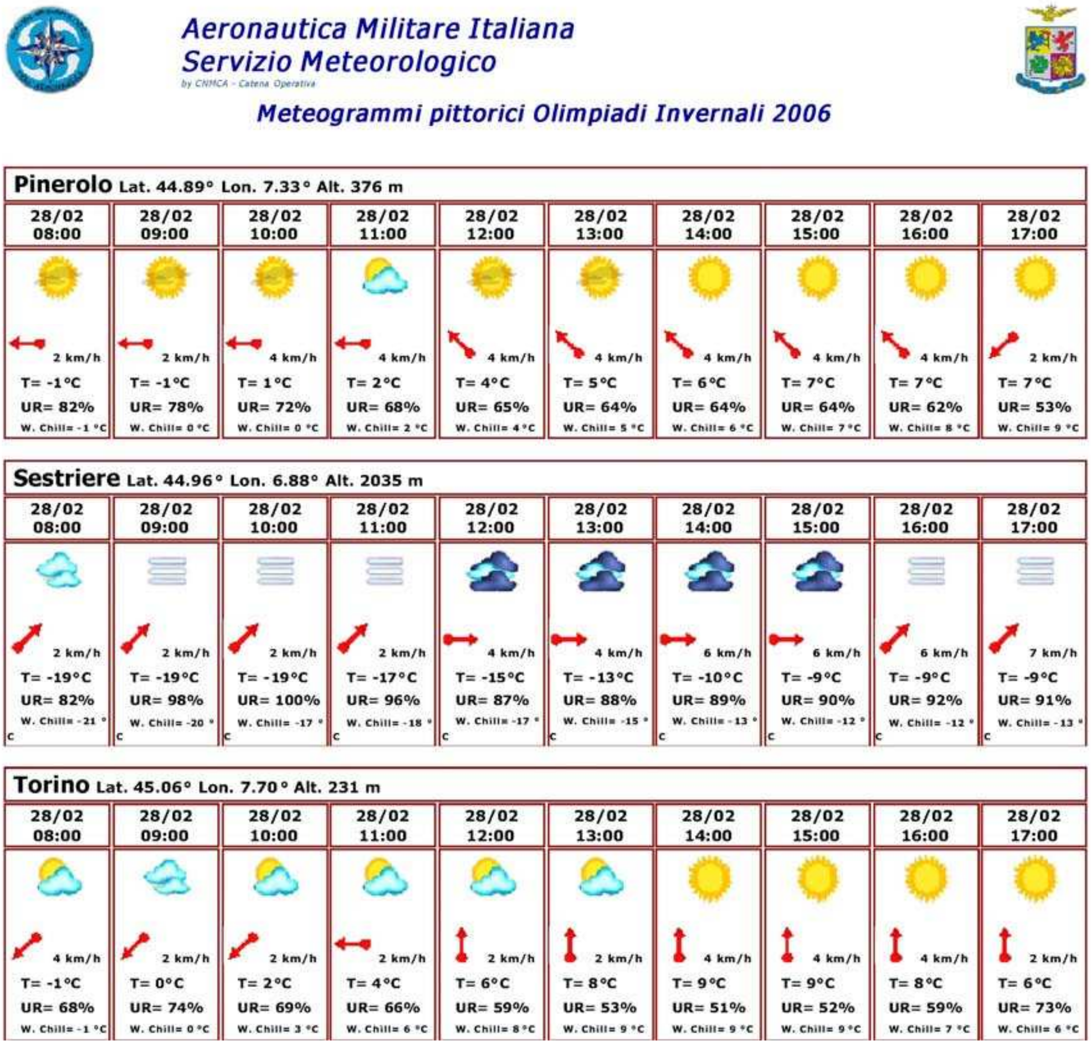
A16_AVELLINO OVEST Lat. 40.91° Lon. 14.75° Alt. 431 m

02/03 08:00	02/03 09:00	02/03 10:00	02/03 11:00	02/03 12:00	02/03 13:00	02/03 14:00	02/03 15:00	02/03 16:00	02/03 17:00
2 km/h	2 km/h	2 km/h	4 km/h	6 km/h	7 km/h	9 km/h	9 km/h	7 km/h	6 km/h
T= 5°C	T= 6°C	T= 8°C	T= 10°C	T= 10°C	T= 10°C	T= 9°C	T= 9°C	T= 8°C	T= 6°C
UR= 93%	UR= 84%	UR= 76%	UR= 68%	UR= 66%	UR= 70%	UR= 77%	UR= 77%	UR= 82%	UR= 91%
W. Chill= 6 °C	W. Chill= 8 °C	W. Chill= 9 °C	W. Chill= 10 °C	W. Chill= 10 °C	W. Chill= 9 °C	W. Chill= 8 °C	W. Chill= 7 °C	W. Chill= 6 °C	W. Chill= 5 °C

A16_BAIANO Lat. 40.94° Lon. 14.62° Alt. 205 m

02/03 08:00	02/03 09:00	02/03 10:00	02/03 11:00	02/03 12:00	02/03 13:00	02/03 14:00	02/03 15:00	02/03 16:00	02/03 17:00
2 km/h	0 km/h	2 km/h	4 km/h	6 km/h	7 km/h	7 km/h	7 km/h	7 km/h	7 km/h
T= 4°C	T= 6°C	T= 6°C	T= 8°C	T= 9°C	T= 9°C	T= 9°C	T= 8°C	T= 7°C	T= 6°C
UR= 83%	UR= 75%	UR= 74%	UR= 71%	UR= 71%	UR= 72%	UR= 76%	UR= 79%	UR= 82%	UR= 90%
W. Chill= 5 °C	W. Chill= 8 °C	W. Chill= 7 °C	W. Chill= 8 °C	W. Chill= 8 °C	W. Chill= 7 °C	W. Chill= 7 °C	W. Chill= 6 °C	W. Chill= 6 °C	W. Chill= 4 °C

. **Fig.3** Web page on the internal site of the Italian Air Force Weather Service: MetGrams for A16 Motorway Napoli - Canosa (example on three pay-toll sites).



. **Fig.4** As in Fig 2, but tailored for the Winter Olympic Games sites.

3. CONCLUSION

The use of the Italian Air Force Meteorological Service non-hydrostatic limited area model for high specialized forecasts can be thought as a powerful tool to support the forecasters when a "high definition" forecasts in space and time is needed.

Of course to assess the quality of such a forecast the real performance has to be investigated. To do this a high density observation network is needed, again in space and time. For this purpose an exchange of observed and forecasts data has begun between Italian Motorway Company and IAF Meteorological Service. In particular the observed data come from the Italian Motorway Company network composed by pay-toll site meteorological stations with 15 minutes of resolution in time.

So a verification procedure has been based (and the quality of the results is under test), on the comparison between available basic synoptic data, high-resolution metgram forecasts and Italian Motorway Company high density observation network. Early results are encouraging.

4. REFERENCES

[1] Ciciulla, F. 2003. *A deterministic post-processing program applied to the Local-Model output fields*. Proceedings of the 2nd SRNWP- Workshop on statistical and Dynamical adaptation.