SIMULATIONS OF THE DISPERSION FROM A WASTE INCINERATOR IN THE TURIN AREA IN THREE DIFFERENT METEOROLOGICAL SCENARIOS

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INTRODUCTION

This paper presents a numerical modelling study for the assessment of the air quality impact , in terms of NO_2 and PM10, of a Waste Incinerator to be built in the neighbourhood of the town of Turin (Italy).

The investigated area includes the town of Turin, a few smaller towns in its neighbourhood, a hill chain and part of the Western Alps and is characterised by non stationary meteorological conditions, i.e. breezes, low winds, inversions, foehn episodes, etc.

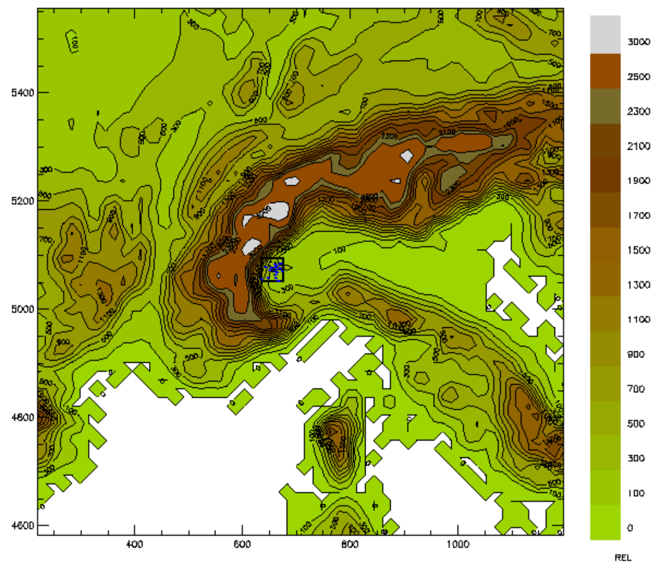

Figure 1– Outermost and innermost computational domains employed for the RMS modelling system.

The general aim of this work was not to compute the mean annual g.l.c. distribution but, due to the peculiar orographic and dispersion conditions, we were asked to study the g.l.c. distribution during particularly adverse dispersion conditions possibly causing severe pollution episodes with a three-dimensional (3-D) modelling system (this last is essential to get reliable simulations in highly 3-D complex conditions). The rationale of this choice is the following: if the influence on g.l.c. of the Incinerator in the worst dispersion conditions stays within the Law Limits imposed on short term concentrations for the considered pollutants, its construction could be proposed without causing or worsening pollution episodes.

Modelling system
Dispersion simulations were carried out in a 40 x 40 km^2 domain, centred on the Incinerator location, with the RMS modelling system (Ferrero et al., 2003; Trini Castelli et al., 2003). RMS (acronym for RAMS-MIRS-SPRAY), includes the mesoscale model RAMS, giving the flow field and surface layer parameters, the Lagrangian dispersion model SPRAY, computing the 3-D diffusion and the interface code MIRS, connecting the outputs of RAMS to the input of SPRAY and performing the parameterisation of the atmospheric boundary layer variables and of the turbulence fields not directly given by RAMS. Three nested grids were used in RAMS, downscaling from 16 km to 1 km of resolution. The map corresponding to the coarsest domain is plotted in Figure 1; the black square identifies the 40 x 40 km^2 smallest domain, where SPRAY simulations were performed.

On each episodes, hourly and daily ground level concentration maxima and averages were computed both at the Turin Province network stations and over all the domain using high resolution concentration cells (250 x 250 x 15 m^3). The contribution of the incinerator to exceedances, if any, of the EU and national standards were also estimated.

PERIOD SELECTIONS
Three episodes (scenarios), lasting 4-5 days each, were selected looking for meteorological conditions particularly critical from the pollutant dispersion viewpoint. The selection was based on the analysis of: meteorological and air quality data of the Turin Province network, synoptic data, Milano-Linate radiosoundings and satellite images. The annual frequency of occurrence of the selected periods was estimated through a method of classification of the typical circulation patterns over Northern Italy (Finardi and Pellegrini, 2004; Louka et al., 2003).

The selected periods concerned: 1) winter anticyclonic weak wind conditions (3-7 January 2000), 2) intense wind - westerly foehn (8-11 February 2000) and 3) summer anticyclonic conditions (9-13 September 1999). Case 1 is usually associated to the most intense air pollution episodes in the area, case 2 is likely to cause adverse pollution conditions on the orographic ranges surrounding Turin and case 3 is connected to the fumigation of elevated plumes.

Figure 2 plots, as an example, the trends of wind speed and direction observed at a station in the Turin downtown during January and February 2000 and September 1999. Looking, in particular, at the values occurring in correspondence of the three chosen episodes, it can be easily noticed that in the first and third episode wind speed was around 1 $m\,s^{-1}$, while during the second episode it was included within 4 and 6 $m\,s^{-1}$.

Results
The left part of Figure 3 shows an example of the comparison between simulated (by RAMS) and observed wind speed and direction in Turin downtown, whereas the right part of Figure 3 plots the observed NO_2 concentration (present status), the simulated contribution of the Incinerator and the sum of the two. The 200 $\mu g/m^3$ line indicates the limit value that, according to the EU and Italian legislation, must not be overcome for more than 18 times per year. It can be seen that for this station and this episode, there are no cases in which the Incinerator contributes to increase the number of exceedances.

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Figures 4 refer to the estimate of the global Incinerator contribution to the g.l.c. distribution in the three episodes. It shows the top-ten g.l.c. i.e. the average of the ten concentration grid boxes, included in the entire computation domain (40 km × 40 km), experiencing the maximum NO_2 daily average values. As it can be seen, these values are low with respect to both the hourly average (200 $\mu g/m^3$) and the yearly average (40 $\mu g/m^3$) concentration limits.

Figures 5 show the NO_2 g.l.c. isolines distribution for the maximum of hourly concentrations for each episode, according to the Incinerator dispersion simulation. Figure 5a, relative to episode 1 (winter anticyclonic weak wind conditions) shows, as expected, that the highest concentrations occur close to the incinerator (1- 3 km) during the daytime hours (fumigation).

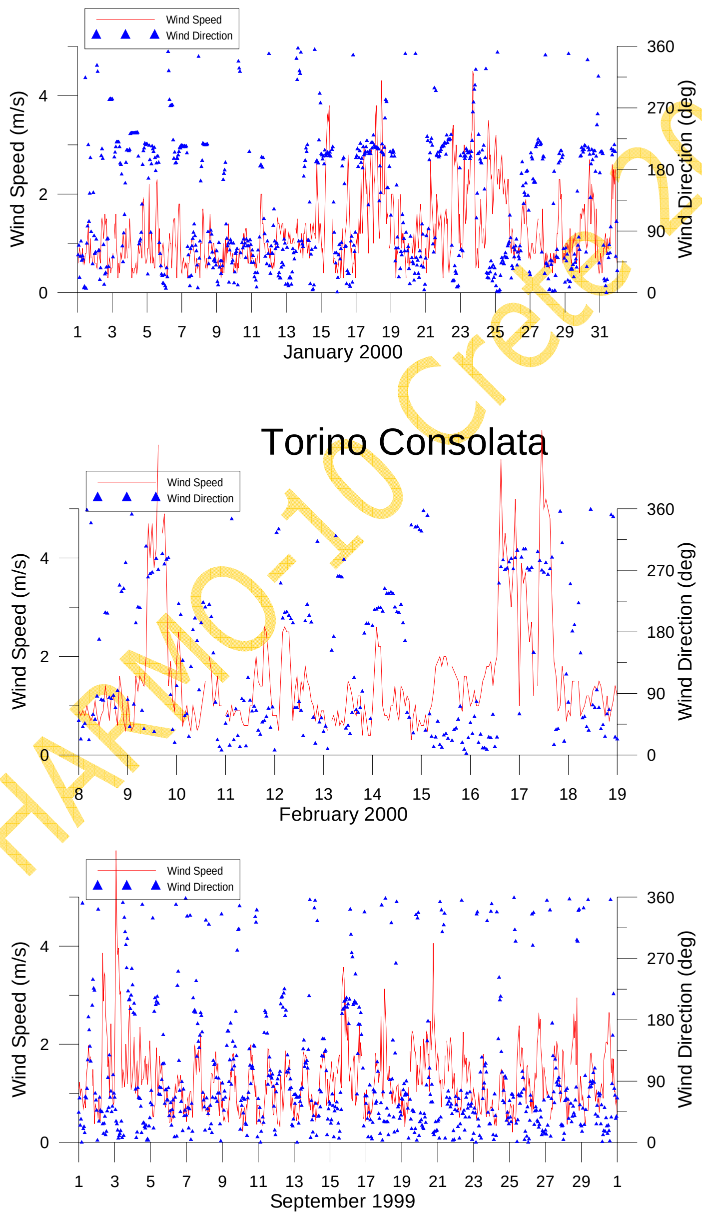

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Figure 2 – Wind speed and direction recorded at a station in the Turin downtown (Torino-Consolata) during January and February 2000 and September 1999

Figure 5b, relative to episode 2 (intense wind - westerly foehn) indicates that, besides the peak close to the emission, a secondary peak appears on the hills surrounding Turin due to the part of the plume that is transported by the more intense wind occurring aloft.

Figure 5c (summer anticyclonic conditions) presents a g.l.c. distribution similar to that of the previous case but with reduced concentration values, due to dispersion conditions characterized by less stable conditions and winds velocities of lower intensity.

The modeling study results concerning PM10 are not presented due to the large ratio between NO_X and particulate Incinerator emissions that caused a largely reduced impact on PM10 g.l.c.

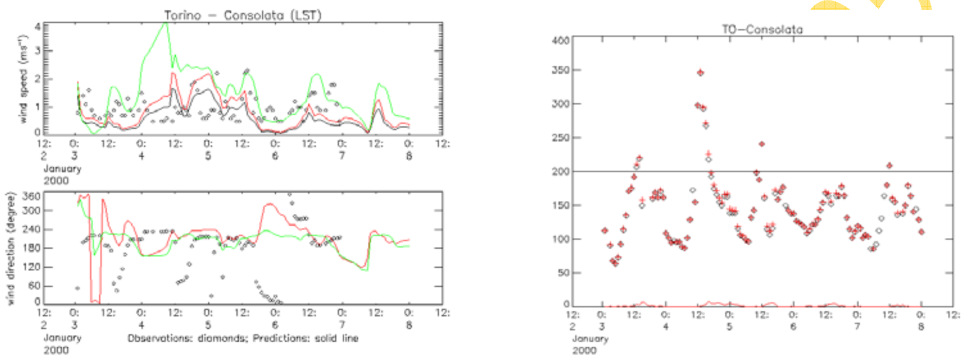

Figure 3 – Simulation results at a station in the Turin downtown, during the first episode. On the left, wind speed (top) and direction (bottom) at the three first levels of RAMS simulation against observed data. On the right, contribution to NO_2 concentration from the Incinerator (solid line), summed up to the observed data (crosses) plotted together with the observed data themselves (rhombus)

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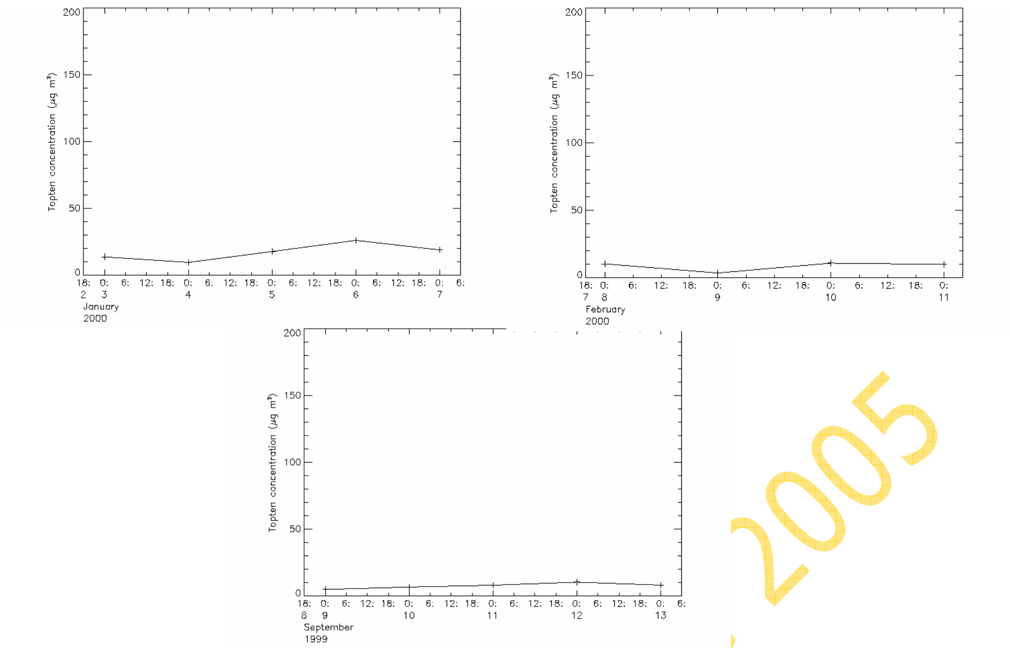

Figure 4 – Daily average of top-ten concentrations for the three episodes

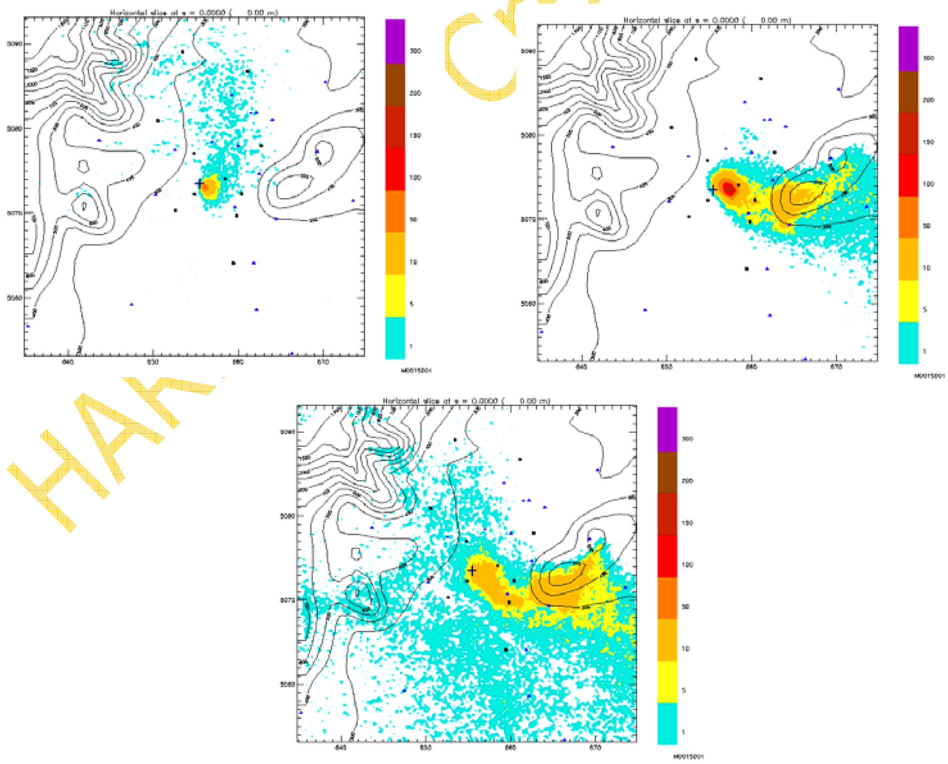

Figure 5 – Isolines of concentration for the case of maximum hourly average value for each episode (concentration scale in µg/m^3 on the right).

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