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ATMOSPHERIC DISPERSION OF ASBESTOS PARTICLES FROM RURAL BUILDING ROOFS

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Abstract: Parallel to a census of the asbestos roofs present in Aosta Valley Region (Northern Italy), the regional environmental protection agency (ARPA) elaborated some dispersion simulations of the asbestos particles close to two particular buildings using the MSS (Micro-Swift-Spray) dispersion tool. The aim of the simulation is to analyse the asbestos dispersion very close and around the houses close to the sources. Given that the effective emission values were unknown, an unitary emission proportional to the surface of the roofs was used as a reference input.
The simulation results show a credible and satisfactory reproduction of the particles dispersion around the buildings. The MicroSpray model gives a good performance when associated with such a complex situation and it proves successful in analysing the pollutant dispersion at a microscale very close and around different obstacles.

Key words: *Air quality modelling, urban air pollution, asbestos dispersion.*

INTRODUCTION
The regional environmental protection agency (ARPA) of the Aosta Valley has launched in 2010 a massive census campaign on asbestos roofs which is still present in the region. This study focuses on the dispersion of asbestos particles around two particular buildings located in the Gressan municipality, using a simulation model. The MSS modelling system (Tinarelli et al. 2007), that includes the diagnostic wind reconstruction model MicroSwift and the Lagrangian Particle Dispersion Model MicroSpray was used to perform this analysis, since the computational domain was very small (only 400 x 400 m^2) and some significant obstacles were present at this scale.
The aim of the simulation is to evaluate the impact areas in term of asbestos ground level concentrations emitted by the roofs.

Figure 36. Example of rural roof in asbestos.

METEOROLOGICAL INPUTS
The simulations of dispersion of pollutants must be preceded by a reconstruction of meteorological fields on the domain considered. Due to the large computational demand and the size of files,two particular interesting and significant periods of the year for the dispersion characteristics were chosen for the simulation of the dispersion. The classification procedure operates on daily data and defines a weather type class each day for a single weather station, then checks for the presence of thermal inversion and finally reconstructs a meteorology at the scale of the entire region for the chosen periods.
From the meteorological fields produced using this procedure, the two following different episodes were chosen:

- a mountain breeze, the most frequent scenario in our alpine region,
- a winter thermal inversion, the worst scenario for the pollutant dispersion.

And used as input for the MicroSpray dispersion model.
In the next figures the effect of the buildings present in the domain on the wind speed and direction for the two meteorological scenarios is shown.

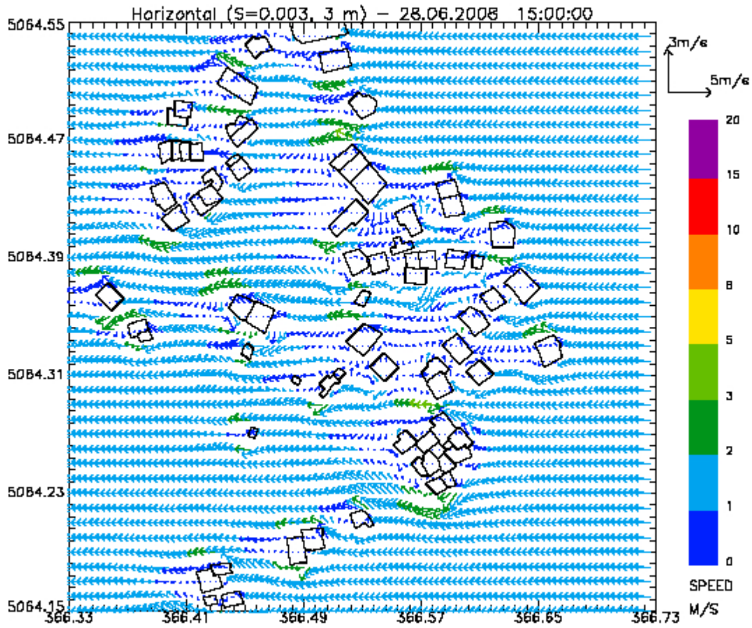

Figure 2. Example of the wind field at 3m during the mountain breeze scenario.

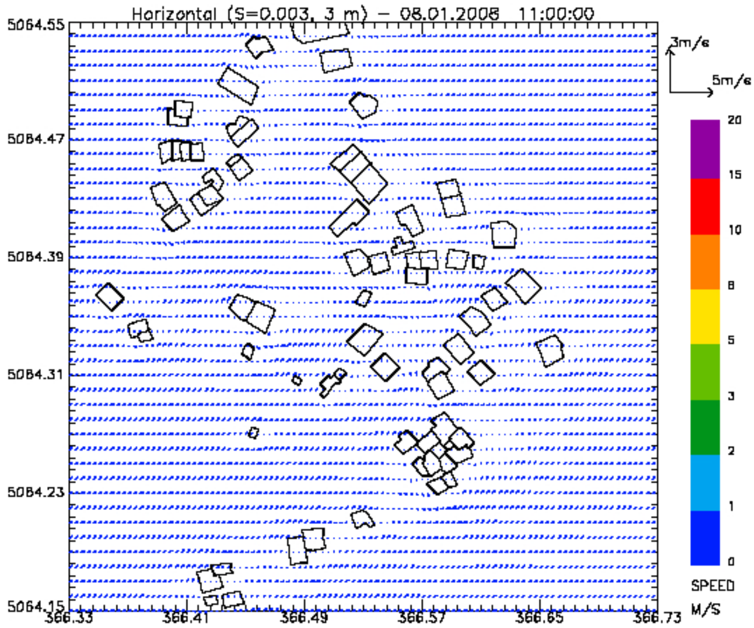

Figure 3 Example of the wind field at 3m during the thermal inversion scenario.

As can be seen from the figures, the two meteorological scenarios give two opposites situations related the wind distribution: in the breeze scenario the wind speed is bigger and it interacts very strongly with the buildings located close to the emissions sources, on the contrary, in the inversion case the wind speed is very low and it doesn't change much in the whole domain. The interaction of the wind with the buildings produces some vortices which rotate around the obstacle.

INPUT EMISSIONS

In the town of Gressan two buildings have roofs with asbestos surrounded by homes at higher heights, our aim was to examine the influence of the nearby obstacles on the dispersion of particles of that pollutant. The situation is highlighted by the following image showing the computational domain, the two roofs in question are marked in red, while green shows the surrounding buildings regarded as "obstacles" in the modelling calculations.

The two roofs in asbestos have the following measures: the larger one is 40 x 64 m^2 wide and 6.5 m high the smaller one is 32 x 24 m^2 and 3.5 m high. These buildings are located near other buildings which are typically more high than those with asbestos roofs. The aim of the simulation is to analyse the asbestos dispersion close and around these houses.

Given that the effective emission values were unknown, an unitary emission proportional to the surface of the roof was used as a reference input (1 μg/m^2·s). The emission values are shown in the next table.

Table 5. Emissions input data

roofs	X (m)	Y (m)	Area (m^2)	Height (m)	Asbestos emissions (μg/h)
Big roof	40	64	2560	6.5	$9.0x10^6$
Small roof	32	24	768	3.5	$2.8x10^6$

Figure 4. Localisation of the two asbestos roofs and the buildings around.

DISPERSION MODEL RESULTS

We performed two simulations, one for every asbestos roof, then we estimated the area most affected by everyone for the two meteorological scenarios.

The parameters of the dispersion simulations elaborated with MicroSpray code are reported in the next table, given that the horizontal linear extension of the domain is less than 1 kilometer and due to the presence of obstacles it was necessary to use this particular version at microscale of the Spray lagrangian dispersion code.

Table 2. Simulations parameters

Parameters	Value
Domain extension	400 x 400 m
Horizontal grid step	2 m
Horizontal Grid cells	201 x 201
Vertical levels	21
Height of the first level	2 m
Maximum height	100 m

In order to depict the behaviour of the dispersion, the following figures show both hourly averaged ground level concentrations at different times (only emission from the bigger roof) and the average values on the entire period of each scenario (separately for both roofs).

Figures 5 and 6 show the hourly concentrations and figure 7 the average of the scenario related to the emissions from the bigger roof. The dispersion is directed towards west – east direction following the mountain breeze, whereas it is located close to the emission source in the thermal inversion case. The concentration values are higher in the thermal inversion case due to pollutant stagnation that characterizes this meteorological phenomenon.

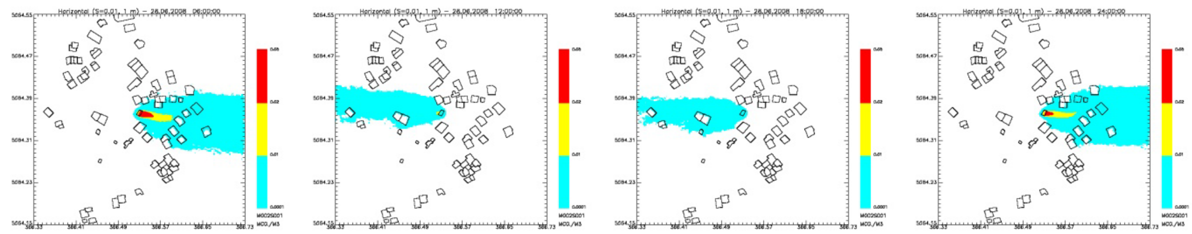

Figure 5. asbestos concentrations distribution from the big roof (breeze case: hours 6.00, 12.00, 18.00 and 24.00).

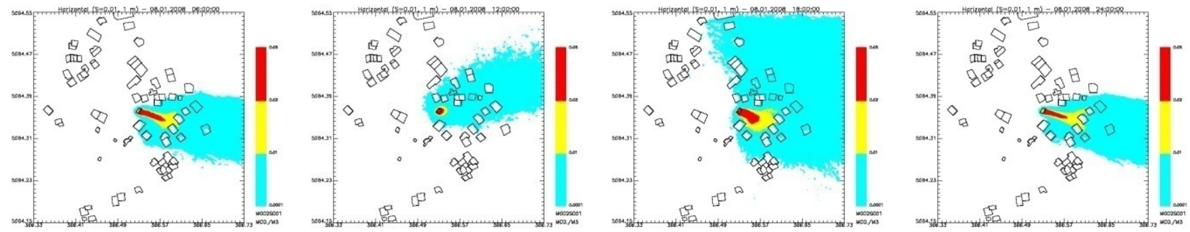

Figure 6. asbestos concentrations distribution from the big roof (inversion case: hours 6.00, 12.00, 18.00 and 24.00).

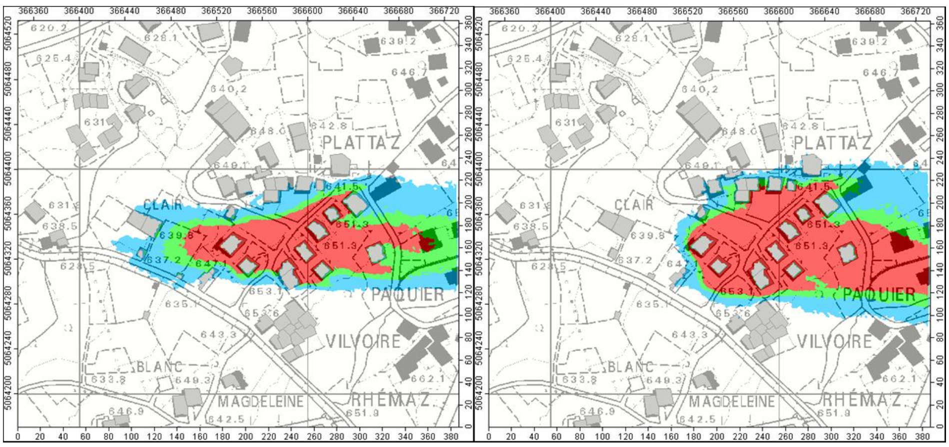

Figure 7. Scenarios average of the asbestos concentrations distribution from the big roof (left: breeze case, right: inversion case).

In figure 8 it's shown the average asbestos concentrations of the two meteorological cases for the second smallest roof. The dispersion trend is similar, the only difference is that the impact area is smaller and it is confined to the closest buildings because of the smaller dimension of the roof.

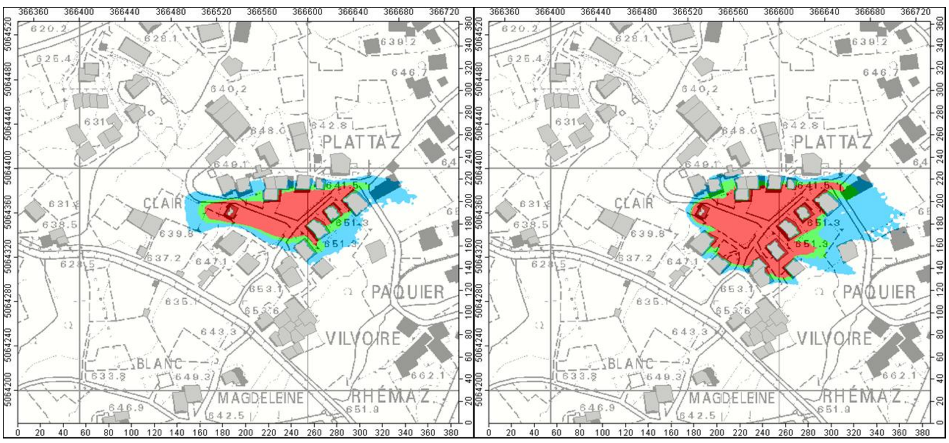

Figure 8. Scenarios average of the asbestos concentrations distribution from the small roof (left: breeze case, right: inversion case).

CONCLUSION

The simulation results show a credible reproduction of the particles dispersion through the buildings. In particular, the concentrations released by the highest roof can bypass more easily the obstacles close to it. The meteorological influence plays a major role: the breeze scenario gives a significant dispersion to the East side because of the wind, whereas the thermal inversion causes a stagnation of concentrations near to the sources.

The MicroSpray model shows a satisfactory performance when associated with this dispersion situation and it proves to be a useful tool in analysing the pollutant dispersion at a microscale, very close and around to different obstacles.

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