18th International Conference on Harmonisation within Atmospheric Dispersion Modelling for Regulatory Purposes
9-12 October 2017, Bologna, Italy

PMSS MICRO-SCALE SIMULATIONS OF POLLUTANTS EMITTED BY FIREPLACES LOCATED IN THE URBAN RESIDENTIAL AREA OF TORCHIAROLO (ITALY)

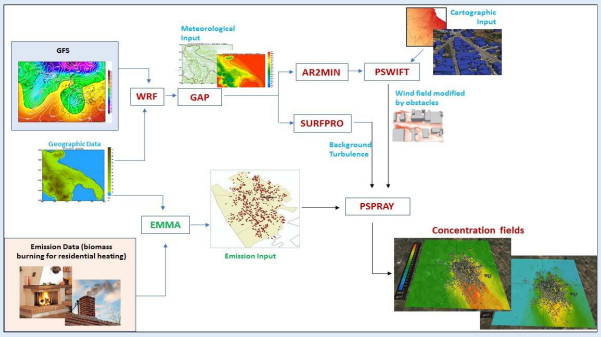
Francesca Intini[1], Angela Morabito[1], Gianni Tinarelli[2], Annalisa Tanzarella[1], Ilenia Schipa[1], Alessio D'Allura[2], Vito La Ghezza[1], Tiziano Pastore[1], Rossella Paolillo[1], Alessandra Nocioni[1], Roberto Giua[1]

[1]Environmental Protection Agency, ARPA Puglia, Bari, Italy
[2]ARIANET Srl, via Gilino 9, Milan, I-20128, Italy

Introduction

Torchiarolo is a small town in the southeast of the Apulia region (Italy), not far (6-7 km) from a large coal energy plant (ENEL Brindisi). The pollution caused by PM_{10} and other species does not seem to arise from the power plant, but it rather shows a more significant contribution from the town itself. PM_{10} concentrations, measured at fixed monitoring stations, show a typical seasonal pattern, with peaks evident in the winter months, and a **high number of exceedances of the limit value set for the protection of human health**. Indeed Torchiarolo is a town with a strong agricultural vocation and habit of using agricultural residues as a fuel for domestic heating.
The atmospheric dispersion of pollutants emitted by fireplaces, located in the urban residential area of Torchiarolo, was simulated at micro-scale in order to reconstruct ground concentrations distribution and, consequently, the impact of PM_{10} and BaP concentrations produced by biomass residential burning emissions.

Figure 1: Diagram of the modelling system



Simulations and input data

The modeling chain used for simulations (Figure 1) is based on **PMSS** (Parallel Micro-Swift-Spray), a modeling suite for primary pollutant transport and dispersion simulations, which is composed of **Pswift**, a diagnostic meteorological preprocessor with null divergence condition, and **Pspray**, a lagrangian particle dispersion model, which can run in parallel mode. Simulations were performed over a 2.4 km x 2.4 km horizontal domain (Figure 2) with 3 m horizontal resolution and were focused over a period of about 13 days during December 2016, when PM10 hourly concentration value of 369 $\mu g/m^3$ has been measured by a local monitoring station (Don Minzoni). Daily forecasts, performed by ARPA Puglia using the WRF model, were used as meteorological input data. Emission input data were taken from a specific statistical survey among citizens, carried out adopting the CATI-CAWI (Computer Assisted Telephone Interviewing-Computer Assisted Web Interviewing) methodology. The total annual emission of PM10 for Torchiarolo resulted of 44.6 tons per year and was equally divided by the number of chimneys detected in the town. High resolution cartographic data, such as localization of 681 fireplaces (identified by photointerpretation of satellite image), 3D reproduction of buildings and high resolution reconstruction of local orography, were used to accurately reconstruct the emission distribution.

Figure 2: Localization of simulations domain and monitoring stations (Don Minzoni, Fanin)

Results and discussion

A comparison between observed and modeled data (Figure 3) was performed as well as a statistical evaluation of model performance (Table 1). The results show the ability of PMSS in in providing reliable simulation of atmospheric dispersion.

Station	Xmean obs ($\mu g/m^3$)	Xmean mod ($\mu g/m^3$)	R	BIAS ($\mu g/m^3$)	RMSE ($\mu g/m^3$)	NMSE	MFB	MFE
Don Minzoni	62,91	50,60	0,72	-12,30	41,93	0,55	-0,24	0,39
Fanin	34,83	31,35	0,54	-3,48	23,29	0,50	-0,06	0,21

Table 1: PM10 forecast evaluation and skill scores analysis for MicroSPRAY model over the entire period considered for simulation (1-13 December 2016)

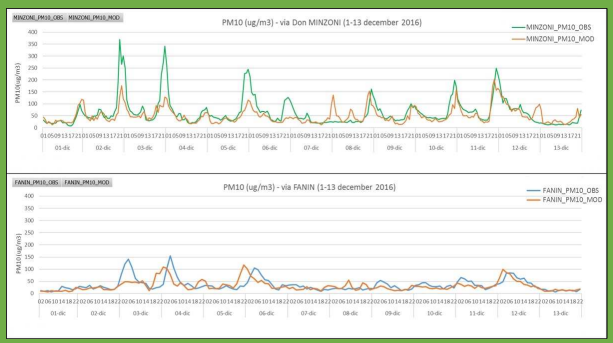


Figure 3: Comparison of the time series of PM10 concentrations measured by the control unit at Don Minzoni (top) and Fanin (bottom) and the time series of the modeled concentrations (included background) extracted at the corresponding points grid, from 1 to 13 December 2016

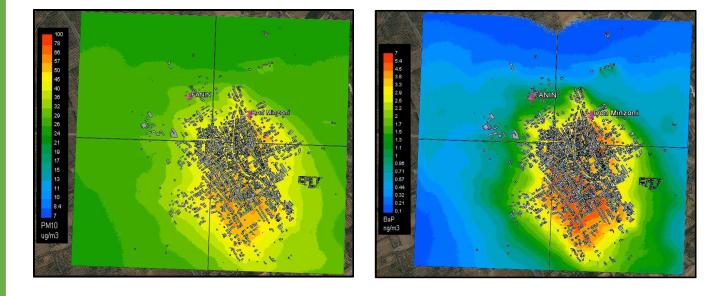


Figure 4: PM10 (on the left) and BaP (on the right) map distribution of average concentrations, modeled on the entire period considered for simulation (1-13 December 2016)

Ground distribution maps of PM10 and BaP average concentrations over the simulated period (Figure 4), show that this period has been characterized by a generalized pollution situation which has widely affected the whole urbanized area of Torchiarolo.

PM10 forecast evaluation and skill scores analysis show that model results are consistent with the observations; a negative bias, that is expected considering that Micro-SPRAY does not take into account secondary pollutants, can be observed (Table 1).
The comparison at the via Don Minzoni sampler shows that the model is able to reproduce quite precisely the peaks of concentration, with some differences in the amount of concentrations (slightly underestimated by the model).

Conclusions

The ground distribution concentrations maps, provided by the PMSS microscale model for the simulated period, show a widespread pollution situation which interests all the urbanized area, and the good reconstruction of PM_{10} concentrations time series leads to the conclusion that the biomass burning for residential heating is the prevailing source of the observed pollution.