

PERFORMANCE EVALUATION OF A MODELLING SYSTEM FOR AIR QUALITY FORECASTING AND AIR POLLUTION WARNING DURING PARTICULAR WINDY DAYS, IN A HIGHLY INDUSTRIALIZED AREA

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This study evaluates the performance of a forecast modelling system of particular pollution events, named "windy days", due to the the aeolian resuspensions of particulate matter from the mineral stockyards of one of the largest steel plants in Europe located in Taranto (Southern Italy) industrial area. The modelling system is based on the meteorological prognostic model WRF and two dispersion models: the Eulerian photochemical model FARM and the Lagrangian particle model SPRAY. The system performs 72 hour air quality forecasts every day and produces concentration fields of main pollutants. SPRAY supplies the PM10 fields representing the contribution from the mineral stockyards, which are added to the background fields computed by FARM. The fugitive dust emission from the storage piles in the steelworks plant is dynamically modulated over time, depending on the wind speed, simulating the erosion caused by its action (EPA, 2006).

Figure 1: Diagram of the modelling system

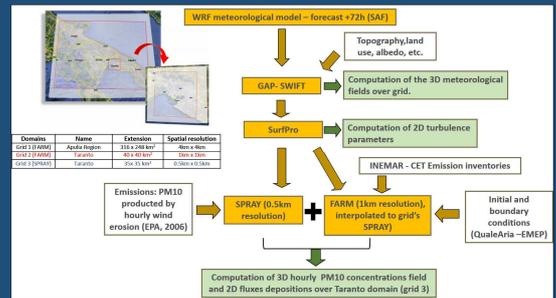
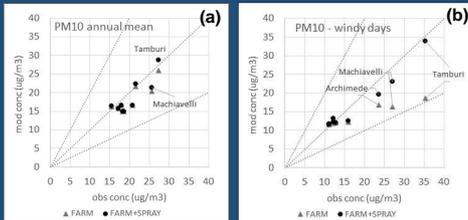


Figure 2: Location of monitoring stations (a) and mineral storage areas (blank areas) simulated by SPRAY (b)



Figure 3: Scatter plot of observed vs modelled PM10 concentrations for FARM (triangle) and FARM plus SPRAY (circles) for annual mean (a) and daily mean of windy days (b).



To evaluate the modelling system performance for the year 2016, the PM10 predictions are compared with the observations, measured in nine air quality monitoring stations located in the Taranto municipality, managed by ARPA Puglia. The locations of the stations are shown in Figure 2(a). Figure 2(b) also shows the locations of the 8 mineral stockyards areas. The total PM10 emissions considered for 2016 and related to the Taranto industrial area are almost 660 tons/year: 185 tons/year are the contribution from the aeolian algorithm and represent the 28% of the total industrial emission.

Figure 5: PM10 concentration maps

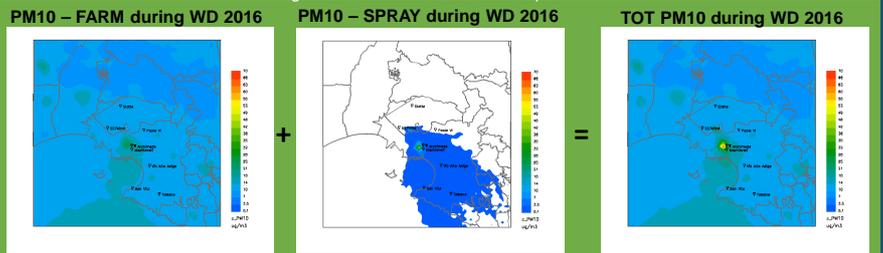


Figure 4: scatter plots of PM10 at 4 stations

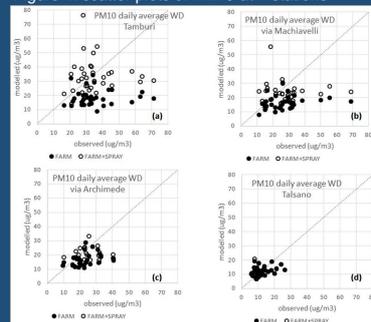


Table 1: PM10 forecast evaluation and skill scores analysis for the FARM model and FARM+SPRAY models considering all the stations in the Taranto area

PARAMETER	RANGE	FARM	FARM+SPRAY
BIAS [µg/m ³]	(-∞, +∞)	-4.2	-1.2
r	[0, +1]	0.50	0.62
RMSE [µg/m ³]	[0, +∞)	10.6	9.2
IA	[0, +1]	0.54	0.76
FAC2	[0, +1]	0.86	0.91
MFB	[-2, +2]	-0.153	-0.003
a		10	40
b		3	12
c		60	30
d		208	199
BIAS SCORE [%]		18.6	74.3
POD [%]		14.3	57.1
FAR [%]		23.1	23.1
ACC [%]		77.6	85.1

The comparisons between observed and modelled PM10 concentrations, considering the annual mean and the windy days mean (Fig. 3a-b), show that the contribution of mineral stockyards emissions is minimal in terms of yearly averages (i.e. very similar levels are estimated by FARM and FARM+SPRAY chains) but is relevant during windy days. The improvement obtained due to the inclusion of mineral stockyards emissions is particularly evident at the stations located near the industrial area (Tamburi, Machiavelli and Archimede), that show better agreement with FARM+SPRAY PM10 levels). (Fig.4)

Figure 5 shows the average concentration maps during the windy days produced by FARM, SPRAY and the sum of both models. Contributions due to the wind action over the stockyards are distributed mainly over the same yards, covering an area of 1 km radius. The assessment of forecast quality is also performed by computing statistical parameters and skill scores (Table 1). The configuration FARM+SPRAY systematically shows better results. The comparison of the skill scores for FARM model and FARM+SPRAY model confirms the better capability of the latter to reproduce the exceedance events during the windy days.