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How reduction policies on emission scenarios can affect air quality in the Tuscany region

C. Grassi[1], S. Verrilli[2], L. Tognotti[2]

[1]Department of Mechanical, Nuclear and Production Engineering, University of Pisa, 56100, Pisa, Italy
[2]Department of Chemical Engineering, University of Pisa, 56100, Pisa, Italy

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The need to determine the more suitable policies to obtain significant reduction of the air quality pollutants concentration suggest to configure and test an advance modeling system for the Tuscany region to verify and understand the relative contribution of the long range transport of pollutants, emissions, physical and chemical atmospheric processes.

The CAMx multi-scale three dimensional photochemical grid model [Environ2004] was configured to the Tuscany region scenario: regional domain of center Italy comprising the Tuscany region with an horizontal master grid of 46 x 44 cells (6km x 6km) and 17 vertical levels of variable thickness form 20m up to 3600m agl. Regional emission inventory data were elaborated for pollutants emission and detailed VOC and $PM_{2.5}$ speciation was applied [Passant, 2002, SCC2004]. In addition three different emission scenarios were prepared, based on regional inventory and IIASA projections, to assess the impact of the possible environmental policies on air quality. The meteorological input fields were elaborated from MM5 prognostic meteorological model data [Cetemps]. The IC and BC concentrations were provided by chemistry transport model CHIMERE [Cetemps].

The simulations were performed to reconstruct the air quality pollution in the Tuscany region during the months of October and May 2005.

Table 1. Measured and predicted ozone an PM_{10} concentrations [$\mu g/m^3$], Tuscany air quality network.

			PISA	FIRENZE	AREZZO	LIVORNO	LUCCA
			Sub.Back.	Urb.Back.	Urb.Back.	Sub.Back.	Sub.Back.
PM10	MAY	PREDICT	25.9	30.4	31.7	18.9	28.3
		OSSERVED	27.5	22.1	20.1	17.8	22.1
		RMSE	***4.2***	***10.4***	***11.7***	***5.1***	***7.6***
	OCT	PREDICT	24.4	27.3	34.6	28.6	23.2
		OSSERVED	30.6	23.0	30.6	15.3	25.9
		RMSE	***8.6***	***11.5***	***10.9***	***10.4***	***11.6***
O3	MAY	PREDICT	93.8	102.6	105.9	105.3	104.5
		OSSERVED	97.8	107.4	100.8	104.6	85.1
		RMSE	***11.7***	***21.9***	***10.3***	***7.0***	***24.0***
	OCT	PREDICT	79.6	58.2	67.1	77.0	88.1
		OSSERVED	45.9	28.8	35.9	70.0	49.8
		RMSE	***40.4***	***32.3***	***36.0***	***35.3***	***44.7***

The predicted time series of hourly ozone and daily PM concentration were found to be in good agreement to observed ones; the root mean square error between observed and predicted concentration were shown in table 1 together with the averaged concentration values.

The daily time series showed significant differences between costal and continental or northern and southern sites, confirming the spatial and temporal observed PM_{10} levels. Important results are related to the $PM_{2.5}$ and PM_{10} concentration ratio that showed variable values from 60% for rural locations to 86% in urban or industrial sites. Significant difference were shown also between the two periods, in fact the 76% in October and 53% during may, indicating a major contribution of crustal component to the coarse fraction of the PM_{10}.

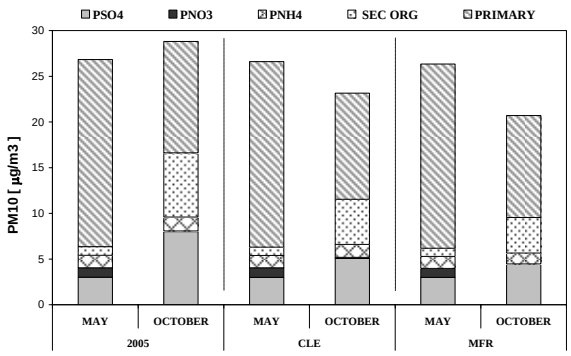

Figure 1. Average PM composition calculated by the models for the three emission scenarios.

The results related to the application of emission reduction as calculated by IIASA for CLE2010 (Current LEgislation) and MFR2010 (Most Feasible Reduction) to the regional emission inventory are shown in figure 1. The main difference in the effects of emission reduction occurred in the month of October when the secondary organic and ammonium sulphate concurred to the 50% of PM predicted mass concentration. The same reduction applied on the emission of primary particles and gaseous precursors have basically no effects in May related to the contribution of primary crustal particles that concurred up to 70% of the PM concentrations.

CETEMPS Center of Excellence 2005 - Experimental Chemical Weather Forecast over Italy, University of L'Aquila.

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