Particulate matter concentration forecast over the metropolitan area of São Paulo

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Resumo

Em virtude dos grandes males causados à saúde pela poluição nos grandes centros urbanos, a utilização de modelos meteorológicos acoplados aos modelos químicos, resultando em modelos de previsão da qualidade do ar, tem aumentado significativamente nos últimos anos. Exemplos desse tipo de utilização são os modelos WRF-CHEM, utilizado em vários países do mundo, e SPM-BRAMS, recentemente desenvolvido por pesquisadores da Universidade de São Paulo e do INPE e utilizado operacionalmente no laboratório MASTER do IAG-USP. Embora o modelo seja utilizado para a previsão das concentrações dos principais poluentes monitorados na região, neste trabalho são apresentadas comparações entre as concentrações de material particulado fino ($PM_{2.5}$) previstas e aquelas derivadas das observações na rede da CETESB. O $PM_{2.5}$ está relacionado aos efeitos deletérios à saúde e está sendo estudado o estabelecimento de um padrão de qualidade do ar para esse poluente. Além da questão da relação com impactos negativos à saúde, há também os impactos ao clima, já que as partículas finas estão relacionadas com a formação de precipitação e extinção da radiação.

1. Introduction

In the recent years, following the advances in computers, the development of air quality models has considerably increased, since the air quality is important for human health. The attempt of forecasting critical episodes of pollution goes from the use of neural network models (Perez

and Reyes, 2006) to mesoescale (Berge et al., 2002) or large scale models (Jacobson, 2001).

Following these efforts, an automated forecast system for air quality in the Metropolitan Area of São Paulo (MASP) has been operational since 2004. The forecast system, based on the Brazilian version of the Regional Atmospheric Modeling System (BRAMS) – www.cptec.inpe.br/brams, automatically downloads the required meteorological input data and produces a 48 hours forecast of the main pollutants concentration, and posts the results on a public website (www.master.iag.usp.br/poluentes). Some comparisons of modeled and observed concentrations of $PM_{2.5}$ for a longer forecast period (6 days) are shown in this paper. The period of comparison goes from 14 to 20 of May, 2006.

2. Methodology

The SPM-BRAMS was integrated over a period of 6 days, starting from 00 UTC, May 14th up to 00 UTC, May 20th, 2006. For the initial condition, temperature, relative humidity, geopotential height, and the horizontal wind components (u and v) are taken from the NCEP Aviation (AVN) model, whose data originate at twelve hour intervals and at grid spacing of 1.0 x 1.0 degrees. Simulations were performed using two nested grids: a coarse grid with 16 km x 16 km resolution on a 672 km x 640 km domain (42 x 40 grid points) and an inner grid with 4 km x 4 km resolution on a 216 km x 216 km (54 x 54 grid points).

Hourly mean concentrations are used for the evaluation of the results. Over MASP, there are four stations measuring $PM_{2.5}$ since 2002. Based on these stations, the ratio between $PM_{2.5}$ and PM_{10} varies from 50 to 60%, in the average. Following these results, we used the relation $PM_{2.5} = 0.6 \times PM_{10}$. The emissions of PM2.5 were based on CETESB 2006 inventory built in an annual basis. A comparison between the modeling and measured values was performed for the stations of Centro, Diadema, Parque D. Pedro II and Santo André.

3. Results and discussion

The previous studies of forecasting air quality were performed for the gaseous compounds with good agreement between the simulated and measured data. The gaseous compounds in the Metropolitan Area of São Paulo are mostly related to the vehicular emission according to the official data. However, for the airborne particles, there is a significant contribution from other sources, although the fine fraction is more closely associated to the heavy-duty vehicular emission. The uncertainties in the

simulations are more related to the lack of knowledge about industrial and heavy-duty participation in the particle emissions. In previous works it was shown that the fine particles are composed most by elementary and organic compounds – the secondary organic aerosols. An important feature is the possible production of fine particles by secondary process, as gas to particle conversion. The secondary process is probably responsible for most of the fine particles formation. Table 1 shows the statistical parameters used for the evaluation of the model during the period. Following some common model criteria for skill analysis, one can see that the results for all stations used can be considered to have a good skill. (i.e., sobs » ssim, RMSE < sobs; d is close to 1). This result can be confirmed by the time series presented in Figure 1. As shown in Table 1, model results are quite close to the observed ones for the whole period of forecast.

Table 1. Statistical parameters over the four stations used in the analysis.

Station	σ_{obs}	σ_{sim}	R	RMSE	d
Centro	17.88425	12.32117	0.7472374	11.90486	0.8269058
Diadema	17.15626	13.64201	0.6539786	14.03294	0.7682181
P. D. Pedro	17.88425	12.32117	0.7472374	11.90486	0.8269058
S. Andre	12.72789	11.33563	0.6885654	9.720912	0.8113594

4. Conclusions

Although the system in the operational procedure has been recently implemented, throughout the comparisons with surface measurements over a considerably long period it is possible to verify the applicability of the system for air quality forecast. Limitations of the use of the system lay on emission inventory, which is far from the desired, especially when the industrial emissions are considered.

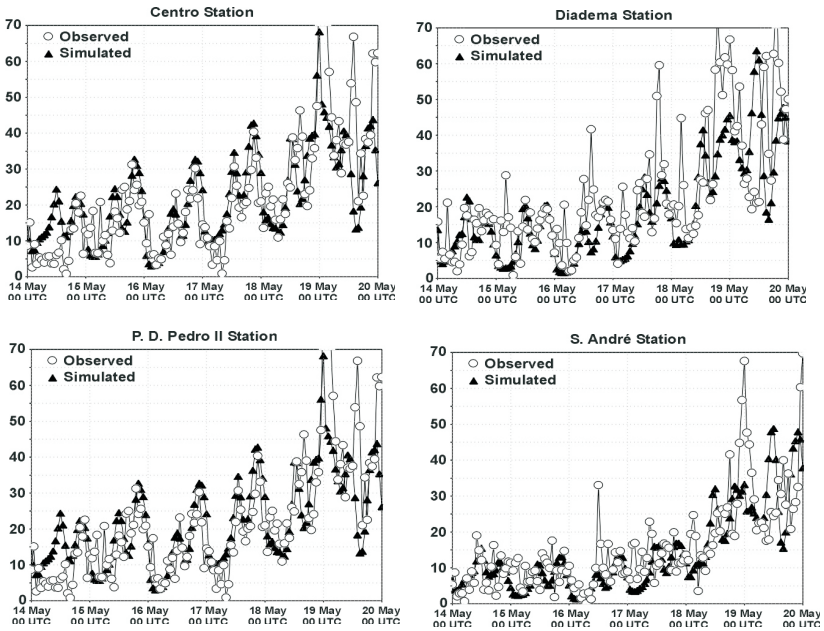

Figure 1. Comparison between surface $PM_{2.5}$ concentration (μ g m^{-3}) during May, 14 - 20, 2006 period.

5. Acknowledgments

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6. References

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