

COMPARATIVE STUDY OF THE ATMOSPHERIC DISPERSION MODELS – CALPUFF AND AERMOD – THROUGH THE ANALYSIS OF AIR QUALITY IN THE METROPOLITAN REGION OF GRANDE VITÓRIA

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INTRODUCTION

The protection and preservation of the environment and its natural resources is a current topic with strong growth trends. Within the environment, the atmospheric resources have been studied due to its major influence on the quality of life and public health. Because of this influence, it is important to estimate the pollution caused by new projects in order to meet regulatory levels and maintain air quality.

The United States Environmental Protection Agency develops and provides atmospheric dispersion models for regulatory applications, being the AERMOD and CALPUFF two of the most important models. The objective of this paper is to compare those two regulatory atmospheric dispersion models in order to determine which one is more appropriate to estimate concentrations of particulate matter in the Metropolitan Region of Grande Vitoria.

The pollutant used for the comparison was the particulate matter, since complaints from the residents in the area are common.

METHODOLY

The atmospheric pollution sources data used in the paper were taken from an inventory developed for the region in 2010. The inventory contemplates the

main industrial sources, harbors and airports, the main traffic lanes and landfills of the region. Smaller pollutant sources like residences and commercial buildings as well as secondary traffic lanes were presented as large area pollutant sources.

Volume sources and area sources were used normally by the models while the line sources were approximated by area sources of small widths. For the mobile sources, only the diary variation was taken in account.

The concentration data extracted from the models were compared with the concentration data extracted from eight monitoring stations in the area during the year of 2010.

The statistical parameters used to compare the models were the correlation coefficient, the fraction bias, the normalized root mean squared error, the bias, the ratio between Robust High Concentrations (RHC) and quantum x quantum graphics.

RESULTS AND DISCUSSION

All of the statistical parameters have ideal values which would be obtained if the concentration data was completely equal. Those values are presented in the table below.

Table 1 - Theoretical ideal value for the statistical parameters.

Statistical parameter	Theoretical ideal value
Correlation coefficient	1
Bias	0
Normalized root mean squared error	0
Fraction bias	0
Ratio between RHC	1

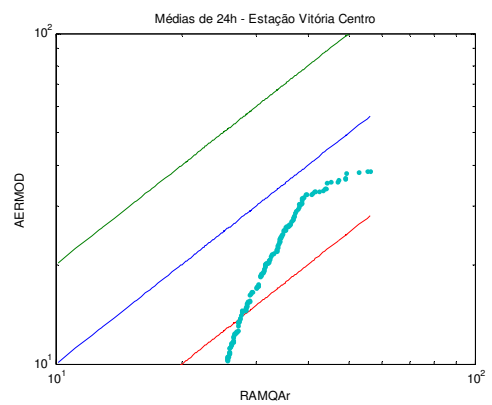
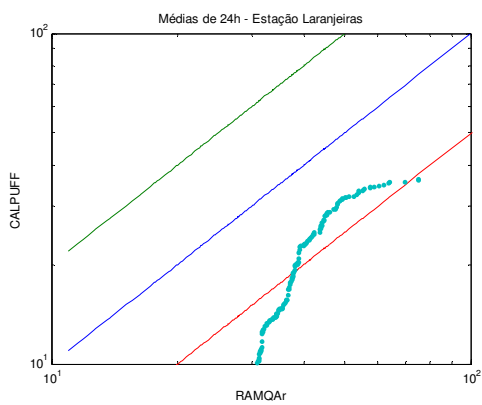
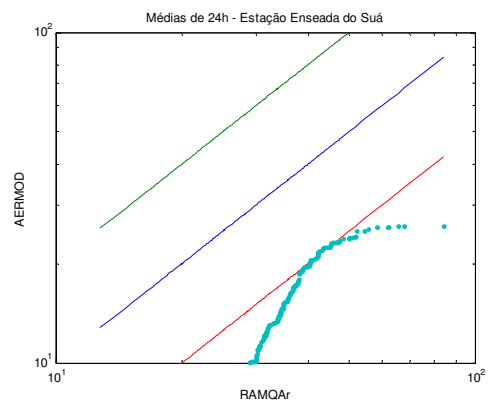
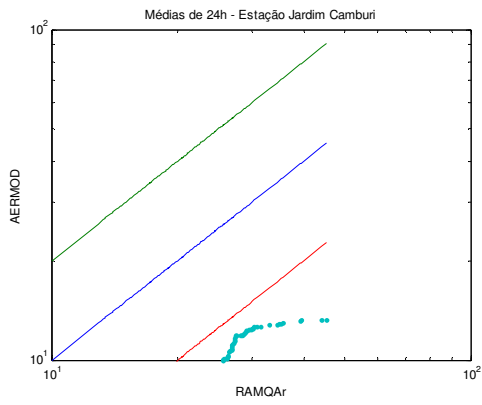
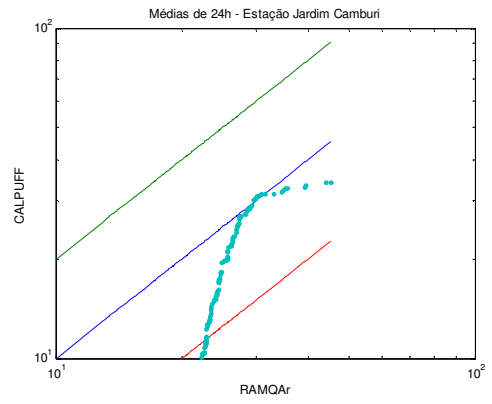
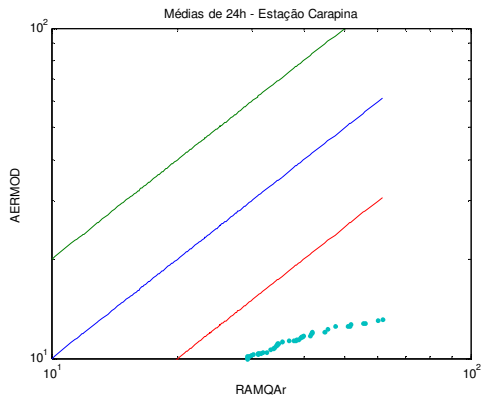
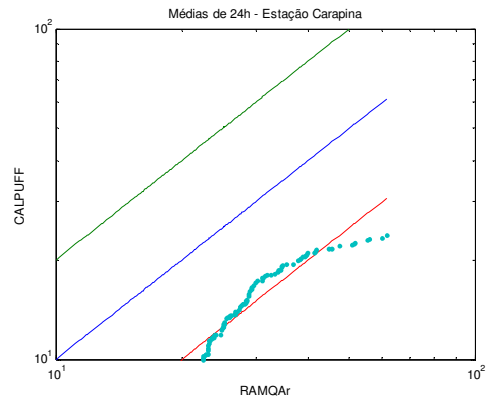
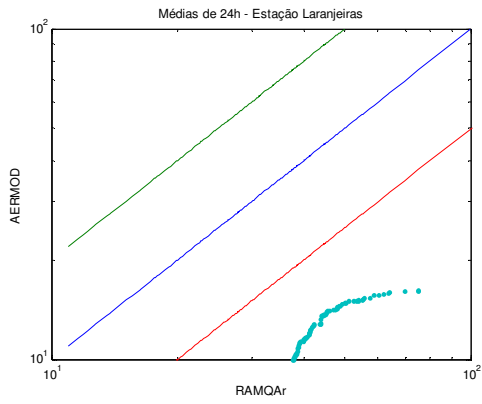
The statistical parameters calculated using diary means are shown in the table below.

Table 2 - Statistical parameters using diary means.

Statistical Parameters	Estação Laranjeiras		Estação Carapina		Estação Jardim Camburi		Estação Enseada do Suá	
	AERMOD	CALPUFF	AERMOD	CALPUFF	AERMOD	CALPUFF	AERMOD	CALPUFF
Correlation coefficient	-0.144	-0.210	0.151	0.244	0.049	-0.069	0.107	0.141
Bias ($\mu\text{g}/\text{m}^3$)	-22.514	-11.483	-13.910	-4.536	-11.772	2.773	-13.559	-0.538
Normalized root mean squared error	2.139	1.076	1.693	0.934	1.480	1.909	0.760	0.707
Fractional bias	-1.022	-0.414	-0.756	-0.195	-0.684	0.111	-0.548	-0.017
Ratio between RHC	3.084	9.831	1.102	3.584	5.153	16.400	9.603	21.318
Statistical Parameters	Estação Vitória Centro		Estação Ibes		Estação Vila Velha		Estação Cariacica	
	AERMOD	CALPUFF	AERMOD	CALPUFF	AERMOD	CALPUFF	AERMOD	CALPUFF
Correlation coefficient	0.232	0.316	0.116	0.246	0.136	0.141	-0.041	0.258
Bias ($\mu\text{g}/\text{m}^3$)	-6.116	-6.632	-9.349	-7.753	-10.817	-2.411	-27.689	-19.328
Normalized root mean squared error	0.753	0.667	0.834	0.713	0.931	0.829	2.946	1.074
Fractional bias	-0.247	-0.268	-0.372	-0.297	-0.547	-0.100	-1.137	-0.669
Ratio between RHC	81.431	269.550	102.436	428.813	2.940	4.772	0.388	1.271

It is possible to note significant differences between the monitoring stations. It is important to note that the conditions of installation of which one of the stations used in this paper are different. Also, the frequency of maintenance of those stations is not known.

The quantil x quantil graphics comparing the data from the models and the data from the stations are shown in the figure below.



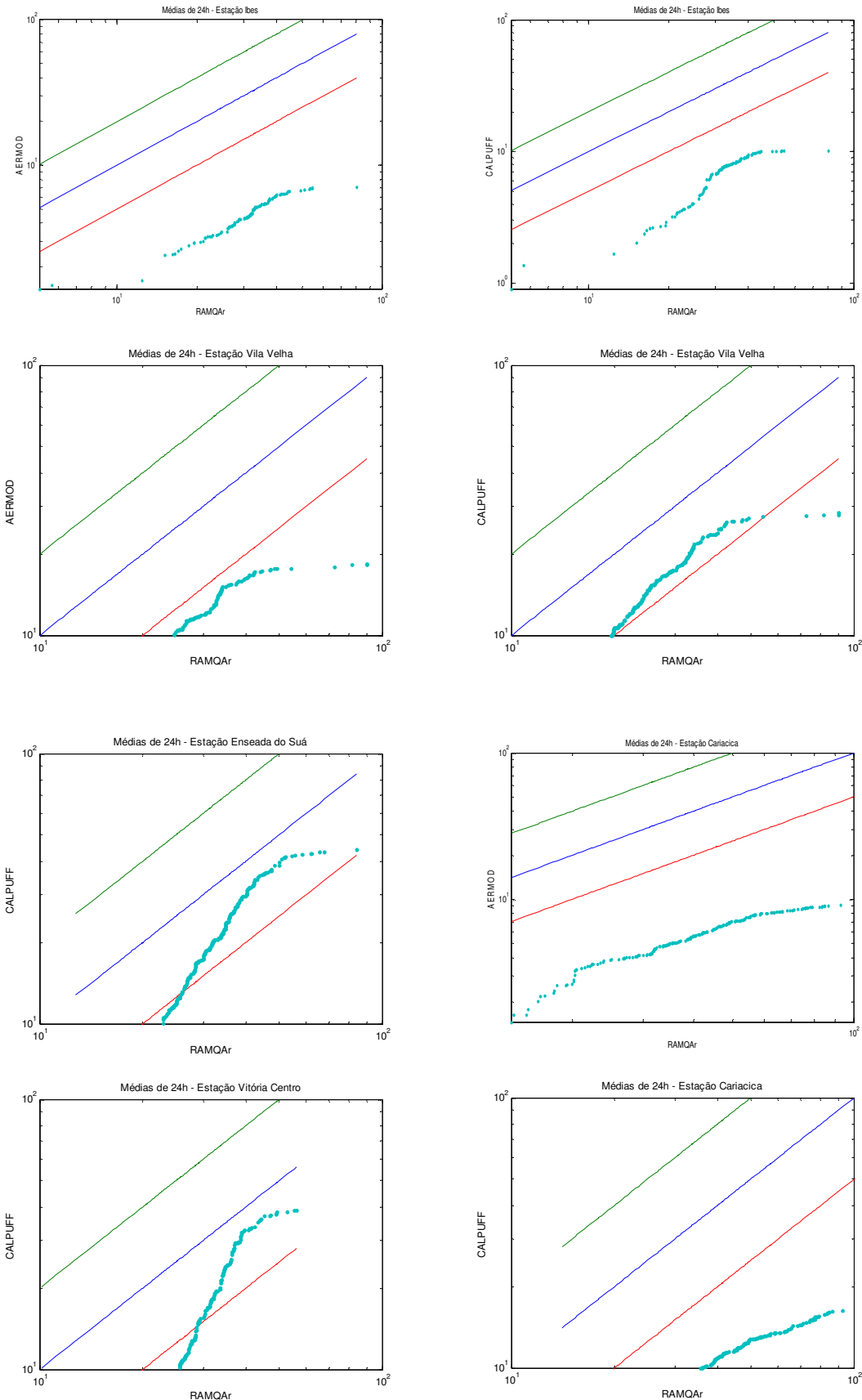


Figure 1 - Quantil x quantil graphics between the data extracted from the models and data from the monitoring stations.

As it can be seen from the graphics, the models underestimate the mean diary concentrations of particulate matter.

CONCLUSIONS

Even though both models showed similar results for the concentrations of particulate matter for the region, CALPUFF allows a better particulate matter concentration prediction for the Metropolitan Region of Grande Vitoria.

Both models underestimated mean particulate matter concentrations, which is not adequate to regulatory applications, although they overestimated the maximum concentrations.

REFERENCES

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