Analysis of Atmospheric Aerosol (PM2,5) in Rio de Janeiro City

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1. Introduction

Several studies indicate that mortality and morbidity could be well correlated to the concentrations of fine fraction of the atmospheric aerosol (PM2.5).

This experiment analyzed the PM2.5 in Rio de Janeiro city, being part of a main study of air pollution impact on human health in six Brazilian metropolitan areas.

Figure 1 - wind direction frequency in the days of sampling campaign

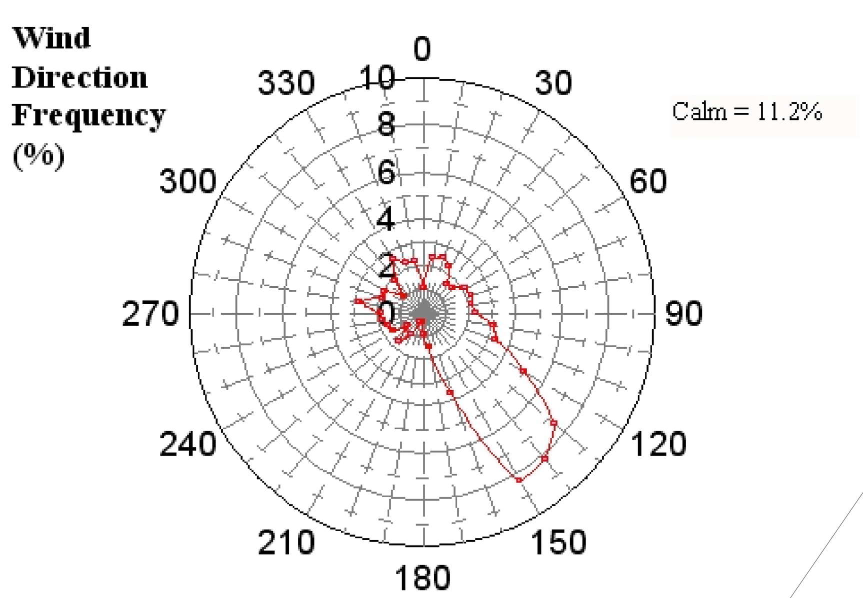

Figure 2 –Oil Refinery - Reduc

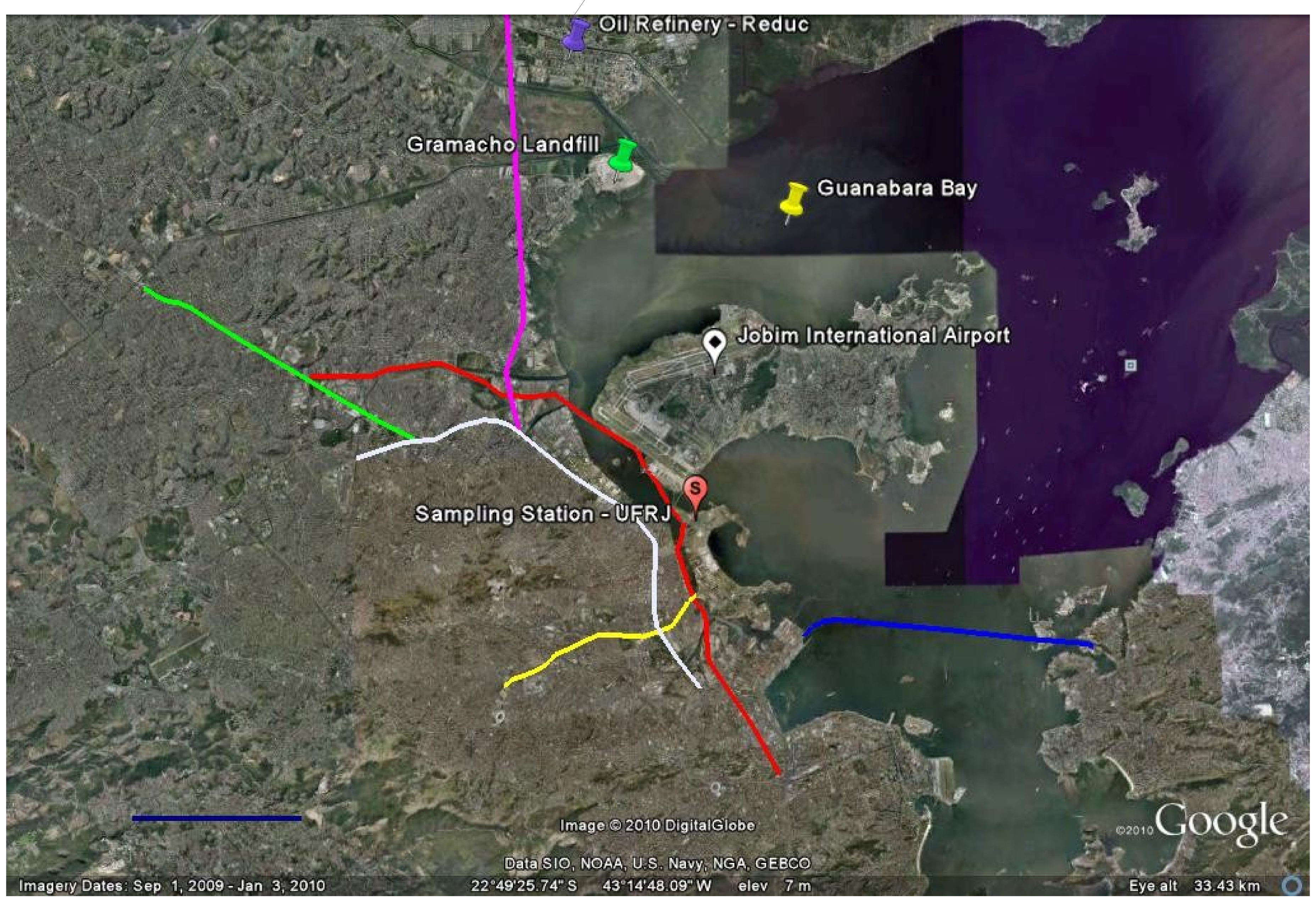

Figure 2 – Satellite image of the sampling area at Rio de Janeiro city. Sampling Point at 22º 50'28'' S and 43º 14'10'' W Noticeable source or sites are signed in.

The Principal Components Analysis obtained in the present work are quite compatible with the values observed in other recent study (Godoy, 2009). There were found four components with varience explaneid of 80.7%. We found one more, five components, with 81.9%.

Table 3 – Aerosol mass and Black Carbon concentration with Seasonal Analyses

average (mg/m3)	winter	summer	annual
MP2,5 mass concentration	19,60 (12,23)	13,25 (5,51)	16,43 (9,99)
Black Carbon	3,86 (2,60)	2,32 (1,19)	3,09 (2,16)

5. Conclusions

The observed annual average concentration was 16.4 micro-gram/m³ (19.6 micro-gram/m³ in the winter time and 13.3 in the summer time), 64% higher than the annual WHO guide line; 17,7% of the samples surpassed the 24-hour WHO guide line (25 micro-gram/m³). Further those results will be correlated with health data looking for pollutants and sources responsibility. Principal component analysis (PCA) modeling, gave the following dominant sources: diesel emissions and metals (Zn, Cl, Black Carbon, Br, Mn, PM2.5), re-suspended road dust (Ti, Ca, Fe, Si), oil combustion (P, S, V), automobile emissions and industry (Al, K, Pb,Cu), sea spray (Mg, Na).

2. Sampling Campaign

PERIOD	:between August 2007 and September 2008
NUMBER OF SAMPLES	:130
SAMPLING TIME	:24 h
SAMPLER INLET	:cut point of 2.5 µm; flow rate of 8.0 L/min
FILTER	:policarbonate; diameter of 37 mm; holes of 0.4 µm

3. Material and Methods

The filters were analyzed by X-ray fluorescence (XRF-ED) technique, allowing multi-elemental chemical analysis. The aerosol mass concentration were obtained through gravimetric analysis and light reflectance technique was employed to determine black carbon concentrations. We used principal component analysis (PCA) to evaluate the main sources impacting the area of the sampling point.

Avenues/Highways	(%)
Av. Brasil	22.9
Rod. Pres. Dutra	5.5
Linha Vermelha	3.1
Rod. Washington Luis	2.9
Ponte Rio - Niterói	1.9
Linha Amarela	*
Sum	36.6

Table 1 – percentage contribution in the total emissions of PM10 from mobile sources in metropolitan area of Rio de Janeiro (FEEMA, 2004)

4. Results and discussion

Along the lines pink, green and gray there are important industries and intense traffic of heavy and light vehicles. In the south direction there are two important stationary sources: one of the largest landfills in latin american, the Gramacho, and largest refinery complex of Petrobas , the Duque de Caxias refinery (Reduc).

The figure-1 shows that the highest wind direction frequency during the experiment came from southeast, where there is a bridge called Rio -Niterói, also with intense traffic.

The results of gravimetric analysis and reflectance technique are in table 3. The concentrations in winter are higher than summer. The table 2 shows the results of Principal Components Analysis.

Table 2 – Trace elements concentrations and Principal Components in the $PM_{2.5}$. BC - Black Carbon
R1 – Eigenvalues, R2 – Cum. Variance

Concentrations (µg/m³)		Commu-		Rotated Principal Components				
Average	Deviation	nalitie	Element	1	2	3	4	5
0.0389	0.0286	0.81	Ca	0.88100	0.16300	0.05244	0.07233	0.00752
0.0046	0.0030	0.93	Ti	0.87700	0.25500	0.31000	0.04274	0.00935
0.0639	0.0422	0.94	Fe	0.80500	0.47900	0.20500	0.14300	-0.04579
0.0955	0.0963	0.85	Si	0.73700	0.39900	0.37200	0.10200	0.03512
0.0335	0.0410	0.81	***Cl***	0.18700	0.85700	0.16700	0.00476	0.12600
0.0222	0.0161	0.67	***Zn***	0.09757	0.75400	0.09679	0.04012	-0.28700
3.2489	2.0657	0.84	***BC***[1]	0.49100	0.69600	0.16900	0.17900	-0.22000
0.0043	0.0029	0.77	***Mn***	0.49500	0.69600	0.18400	0.02764	0.03982
0.0055	0.0047	0.56	***Br***	0.27000	0.61200	0.12900	0.23300	-0.20300
16.2616	8.7056	0.92	$PM_{2.5}$	0.50600	0.59300	0.28800	0.44700	-0.16100
0.1998	0.3262	0.87	K	0.25200	0.12700	0.88000	0.10100	-0.09190
0.0091	0.0079	0.87	Pb	0.01199	0.45100	0.80900	-0.03489	-0.09360
0.0051	0.0041	0.79	Cu	0.20500	0.28700	0.80600	0.09361	-0.06215
0.0420	0.0387	0.88	Al	0.50600	-0.14900	0.75800	0.16400	0.05541
0.0158	0.0128	0.92	***P***	-0.01743	0.16400	-0.15100	0.92800	-0.06016
0.6914	0.4062	0.90	***S***	0.16100	0.23500	0.20300	0.88100	-0.06527
0.0042	0.0026	0.69	***V***	0.10300	-0.09052	0.15700	0.80100	-0.01090
0.0641	0.0251	0.78	Mg	-0.15200	-0.21300	0.12200	-0.07737	0.83200
0.4348	0.1451	0.76	Na	0.17300	-0.02583	-0.28300	-0.03991	0.80200
			R1	**4.05**	**3.94**	**3.32**	**2.66**	**1.59**
			R2	**21.31**	**42.04**	**59.50**	**73.50**	**81.84**

5. References

FEEMA – Fundação Estadual de Engenharia do Meio Ambiente. Inventário de fontes emissoras de poluentes atmosféricos da região metropolitana do Rio de Janeiro. Governo do Rio de Janeiro, 2004.

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