

Correlation study between air quality data and the Lidar system in Cubatao, Sao Paulo

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Abstract: We present here the results of two methods with a scanning multiwavelength elastic lidar system and Beta Ray method (CETESB) realized in an industrial area. The objective is a comparison of these two methods to identify fixed sources of aerosol and to monitor plume dispersion. The results of the two aligned techniques indicate that they can provide information on the concentration, spatial and temporal distribution of aerosol.

Keywords: LIDAR, Remote Sensing, Pollutants, Aerosol, PM10.

INTRODUCTION

Cubatão is a city located in the state of São Paulo, Brazil. It is placed on a narrow coastal plain surrounded by mountains on the south, west, east and by the sea to the south. The region holds one of the oldest and largest industrial complexes of Brazil. Because there was no guidance plan for the installation of industrial sites, they have been established in the Serra do Mar State Park. Due to the local topography and proximity of the ocean, wind direction and velocity show daily changes that affect air quality, and frequent events of high pollutant concentration in the industrial area are recorded.

A significant number of events of high levels of pollutants, are recorded by the local authority (CETESB), which operates 2 air quality monitoring stations in the industrial area.

METHODS

It was used for the present work a three wavelength elastic backscatter system operated with a Nd: YAG laser (CFR 450, Quantel SA) at 355 nm, 532 nm and 1064 nm, transmitting pulses of 7 ± 2 ns of duration at a fixed repetition rate of 20 Hz and a divergence less than 0.3 mrad. The system also has a receiver used to collect backscattered laser light, a 150 mm diameter Dall-Kirkham telescope with an effective focal length of 1000 mm.

For the construction of a comparison line, data were also used from the QUALAR - State System of Information on Air Quality of CETESB, through which data on pollutants are available throughout the state territory by manual and automatic networks, these are available in different formats. In the case of this work, among all the pollutants monitored by

CETESB were selected: NO_x, O₃, PM₁₀ to make an analogy with the LIDAR system.

The data extracted from the automatic networks of the QUALAR system are time data of the date of the campaign.

FINDINGS AND ARGUMENT

A campaign was conducted for data collection in August 2016 in the city of Cubatão / SP. The collection site was close to a CETESB station (LAT 23° 51' 08.06s - LON 46° 23' 26.40s) and the purpose was to monitor the spatial and temporal distribution of the aerosols in the region and to correlate these results with pollutant graphs (PM₁₀, NO_x and O₃) obtained by CETESB's QUALAR System from stations located ~ 2km and 4km from where the LIDAR system was installed.

The stations of the CETESB that were used are the stations Centro and Vale do Mogi.

The data demonstrate a considerable amount of particulate matter in the study region. In figure 1A, we have a graphical representation of the backscatter of the particles with a wavelength of 355 nm, we noticed a moderate concentration of aerosols. In Fig. 1B, with a wavelength of 532 nm, it can be considered as a larger grouping of particles, which occurs in the case that the larger the wavelength is larger than its backscatter. In figure 1C we work with the wavelength of 1064 nm, we observe a greater agglomeration of aerosols, which indicates a greater occurrence of aerosols of large particles. The data as an overlay (georeferencing) of the LIDAR graphics on the image of the area in Google Earth (figure 1A, 1B and 1C)



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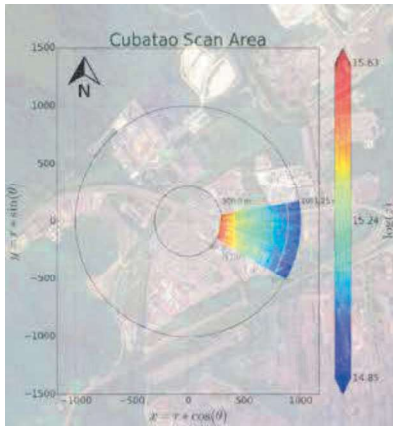


Figure 1A: Plot of 355 nm Google earth V 7.1.8.3036. (January 26, 2017). Cubatao, Brazil. 23°50'57.71"S, 46°23'19.80"W, Eye alt 6.24 km. Digital Globe 2016. <http://www.earth.google.com> [January 17, 2017].

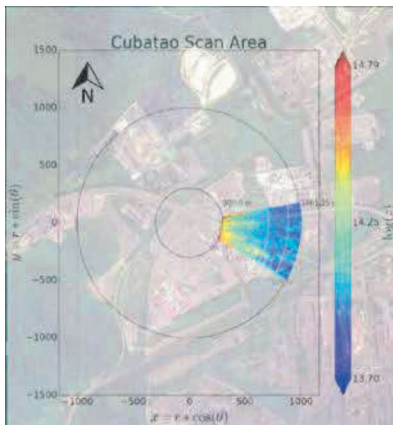


Figure 1B: Plot of 532 nm

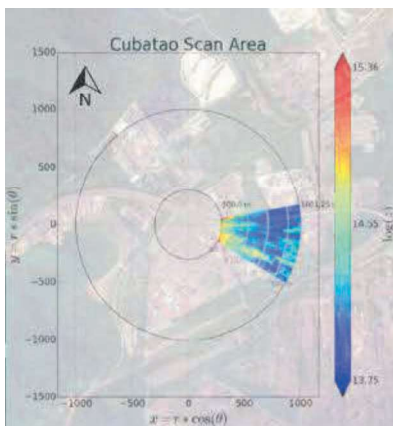


Figure 1A: Plot of 1064 nm

Figures 2A and 2B are taken from QUALAR and show concentrations of NO_x and O₃ (Figure 2A) and MP₁₀ and O₃ (Figure 2B) on the campaign day in Cubatão.

Figure 2A shows that on the day of the data collection CETESB station - Vale do Mogi - recorded its highest peak around 14h (Brasília time), at this time this increase of Ozone maybe due to the greater amount of atoms of free Nitrogen and also by the high influence of the solar rays. Figure 2B shows the concentrations of NO_x and PM₁₀, it is noticeable that there is a symmetry between the data obtained, because when there is an increase of NO_x the concentrations of MP₁₀ are high.

The high concentrations of NO_x, could be related to the fertilizer plant that is in the campaign area, once fertilizer manufacturing processes can generate emission sources of atmospheric effluents such as loading and feeding of raw material; The reactor; The granulation, drying and curing of the products. These sources emit pollutants such as particulate matter (PM), SO_x, NO_x, NH₃ and HF. [2]

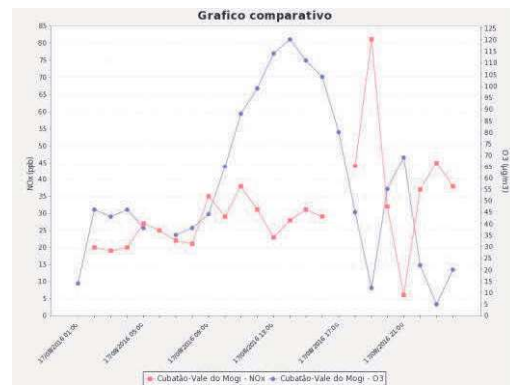


Figure 2A: CETESB station - Vale do Mogi. Comparative chart NO_x and O₃. Hourly data 08-17-2016.

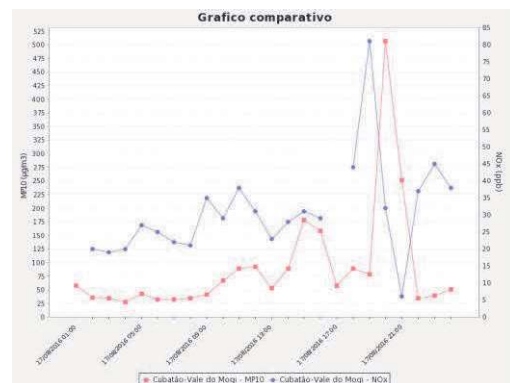


Figure 2B: CETESB station - Vale do Mogi. Comparative chart MP₁₀ and NO_x. Hourly data 08-17-2016.



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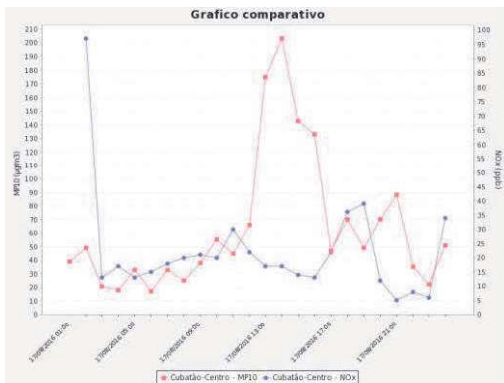


Figure 2C :CETESB station - Centro.Comparative chart PM_{10} and NO_x . Hourly data 08-17-2016.

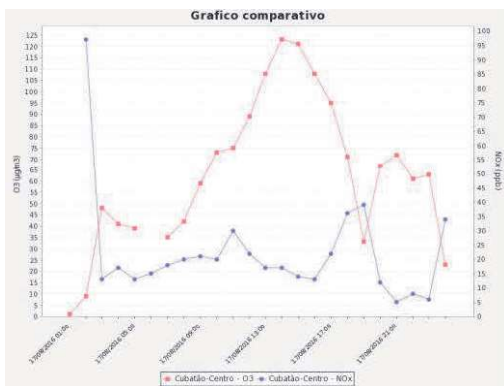


Figure 2D : CETESB station - Centro. Comparative chart O_3 and NO_x . Hourly data 08-17-2016.

Figure 2C shows the relationship between NO_x and PM_{10} , although it follows a similarity to that of the Vale do Mogi, there are some factors that may interfere with the PM_{10} , such as the high circulation of cars. Figure 2D shows a relationship between ozone and NO_x different from that expected, because NO_x is one of the major precursors of tropospheric ozone, if its concentration decreases the ozone should follow the same trend.

CONCLUSIONS

The results obtained by the Lidar system indicate that the region studied has a high concentration of aerosols, as expected, since it is an industrial area with a high flow of vehicles.

Comparing these data with those of CETESB automatic stations, we believe that there is a high probability of the presence of larger particulates, starting at 10 μ m.

The incompatibilities of the data with the theory show that there is a great possibility of transport and confinement of aerosols in the region.

New campaigns will be carried out to optimize the results obtained in the present study.

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