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## AEROSOLS OBSERVATIONS BY AN ELASTIC LIDAR SYSTEM OVER THE CITY OF SÃO PAULO, BRAZIL

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### INTRODUCTION

São Paulo (23°33'S, 46°44'W, 780 m ASL) is one of the most polluted cities in the world, regarding atmospheric air quality, (CO, suspended aerosol particles). In this paper, we present the first aerosols observations performed by an elastic backscatter lidar system, over the city of São Paulo. The lidar measurements concerned the retrieval of the vertical profile of the aerosol backscatter coefficient at 532 nm, using the Klett inversion technique, in the Planetary Boundary Layer (PBL) and the adjacent lower free troposphere. Systematic aerosols observations to be performed during the year 2001, will enable the characterization of the various tropospheric layers, and help to design an efficient air pollution abatement strategy in the city of São Paulo.

### METHODS

The use of the laser remote sensing technique (LIDAR), in conjunction with other remote sensing (DOAS systems, wind profilers) or *in-situ* techniques (air pollution monitors, meteorological instrumentation etc.) gives extended possibilities to study the structure and chemical composition of the lower troposphere, enhancing the effectiveness of numerical air pollution models, thus leading to an efficient design of air pollution abatement strategies.

Following these goals, a compact elastic backscatter lidar system was recently developed to monitor the aerosol vertical distribution in the São Paulo urban area. A brief presentation of the lidar system is given below, while the following paragraph presents the methodology applied to retrieve the vertical distribution of the aerosol backscatter coefficient  $\hat{\alpha}_{\text{aer}}$  at 532 nm. The elastic backscatter lidar system was designed to perform atmospheric aerosol measurements with the following features (Landulfo *et al.*, 2000): measurement range: 0.3 to 25 km, vertical resolution: 10 to 100 m, temporal resolution: 13 minutes, measurement period: day and night-time.

In the present state, the retrieval of the aerosol backscatter coefficient  $\hat{\alpha}_{\text{aer}}$  at 532 nm is based on the Klett's inversion technique (Klett, 1985). However, as it is very well known, the retrieval of the aerosol backscatter ( $\hat{\alpha}_{\text{aer}}$ ) and extinction ( $\hat{\beta}_{\text{aer}}$ ) coefficients is an ill-posed problem in the mathematical sense, leading to possibly large errors (>30%) when the lidar equation is inverted. In our case we will be limited

to the retrieval of only the aerosol backscatter coefficient  $\hat{a}_{532}$  at 532 nm. In order to improve the accuracy of the retrieved profiles of  $\hat{a}_{532}$ , we will use as input to our inversion algorithm the vertical profile of the lidar ratio S ( $S = \hat{a}_{532} / \hat{\sigma}_{532}$ ), which will be calculated using locally derived radiosonde data of the relative humidity (RH) and assuming the relationship between S and RH, as given by Ackermann *et al.*, 1998. This inversion procedure was applied to a series of lidar signals obtained on January 16, 2001, over the city of São Paulo, from 10:30 LT to 11:30 LT. The derived profiles of the  $\hat{a}_{532}$  at 532 nm, presented in Fig. 1, as a function of altitude ASL, show increased values of  $\hat{a}_{532}$ , which are due to the large emissions of aerosol particles by buses and trucks circulation inside the city of São Paulo, and the high values (~75%) of RH in the lower part of the PBL. The peaks observed around 1.8 km and 2.3 km are due to clouds. Local radiosonde data taken at 12:00 UT showed an unstable layer between surface and 500 m ASL, while the wind, which was from north, had a velocity of 5 m/s between 770 m and 2 km ASL.

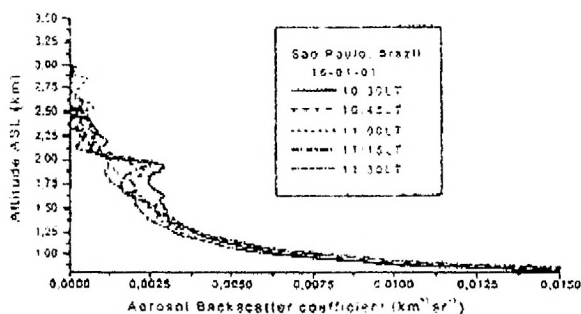


Figure 1. Vertical profiles of the aerosol backscatter coefficient ( $\text{km}^{-1}\text{sr}^{-1}$ ) at 532 nm, (the altitude is expressed in km ASL), obtained every 15 min. over the city of São Paulo, Brazil on January 16, 2001 (10:30 LT to 11:30LT).

CONCLUSIONS

We presented the first lidar measurements of the vertical profile of the aerosol backscatter coefficient at 532 nm, over the city of São Paulo, Brazil. The values retrieved for  $\hat{a}_{532}$  (532 nm) were typical of polluted air masses in an urban site. In order to retrieve quantitative lidar data, with improved accuracy, we plan to upgrade our lidar system, by integrating a Raman channel, based on the 355 nm laser radiation shifted by the atmospheric nitrogen, at 387 nm. This will permit us to retrieve the vertical profile of  $\hat{a}_{532}$  and  $\hat{\sigma}_{532}$ , independently (Ansmann *et al.*, 1990).

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