Relationship between the tropospheric aerosol size distribution and cloud droplet effective radius in a rural region of São Paulo State

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The composition of the aerosol in the lower troposphere of the central region of the Brazilian State of São Paulo is governed mainly by the relative intensities of different anthropogenic sources: sugar cane burning, soil dust resuspension, industrial emissions, and road transport.[1,2] The resulting primary and secondary aerosols are present at concentrations that far exceed natural background levels.

Because of these emissions, the regional aerosol is substantially modified in terms of its chemical composition and its hygroscopic characteristics, and this is expected to affect the processes involved in cloud formation and, consequently, precipitation. The solubility of the particles suggests that they should be able to act efficiently as cloud condensation nuclei (CCN). It is therefore important to understand how different categories of aerosol might influence the processes of cloud formation and precipitation, due to the potential impacts on both agriculture and the water supply.

Size distributed number concentrations of ambient aerosols were measured at a rural site in the municipality of Araraquara, located in the interior of São Paulo State within one of Brazil's most important intensive sugar cane producing regions. Other significant economic activities here include citrus production and the industrial processing of the agricultural products.

The number concentrations of the aerosols were measured as a function of particle size using a TSI Model 3080 electrostatic classifier fitted with a Model 3081 differential mobility analyzer, connected to a condensation particle counter (CPC, TSI Model 3775) and operated in the scanning mobility particle sizer (SMPS) configuration. The size interval of the particles measured was 14.6-661.2 nm, and data were collected continuously, every 10 minutes, between August 2011 and November 2012.

In parallel with the ground-level measurements, the cloud droplet effective radius (r_e) corresponding to clouds present above the sampling site was retrieved from the database of the MODIS (Moderate Resolution Imaging Spectroradiometer) instruments carried on board NASA's Terra and Aqua satellites. The area considered for the satellite data was a rectangle (approximately 47 km x 47 km) described by the geographical coordinates: -21.564S, -48.452W (upper left corner); -22.063S, -47.953W (lower right corner). The satellite overpasses occurred during the periods (UTC): 12:30-14:30 (Terra); 16:00-17:30 (Aqua).

The SMPS data used considered an average of five individual measurements, centered on the time of the satellite overpass. The data were grouped according to both the total number concentration and the type of aerosol size distribution observed, considering the presence of an Aitken mode or an accumulation mode (as well as a number of mixed cases). The existence of an Aitken mode, without any obvious accumulation mode, was considered to reflect the presence of fresh particles, including those derived from recent nucleation, while a single accumulation mode was indicative of the presence of particles that had experienced aging within the atmosphere (Fig. 1).

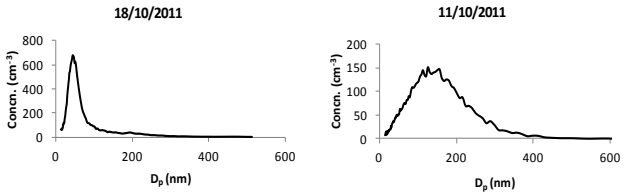

Fig.1. Examples of events characterized by Aitken (left) and accumulation (right) modes in the size distribution.

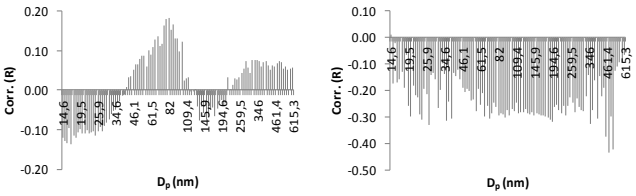

Fig. 2. Correlations obtained between r_e (Aqua data) and the size distributed aerosol number concentration during Aitken mode (left) and accumulation mode (right) events.

During Aitken events, the value of the coefficient (R) for the correlation between r_e and aerosol number concentrations showed a variable relationship as a function of particle size, while during accumulation mode periods, negative values of R were obtained for all size fractions (Fig. 2). The findings suggest that the relationship between tropospheric aerosol loadings and cloud properties in the study region may be more complex than previously thought, since cloud droplet size can show either a positive or a negative relationship with the aerosol number population in the lower troposphere.

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[1]Allen, A.G. *et al*. (2004) *Atmos. Environ*. **38**, 5025-5038.
[2]Da Rocha, G.O. *et al*. (2005) *Environ. Sci. Technol*. **39**, 5293-5301.