Study of columnar aerosol size distribution at Mexico City

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Urban air pollution is one of the biggest problems that face Mexico City (MC). This environmental problem in MC has been generated by daily activities of some 21 million people coupled with the vast amount of industry located within the city's metropolitan area. Another contributing factor is the unique geographical setting of the basin encompassing Mexico City.

In order to know more about sources and aerosol formation process many studies have been published. However few studies have examined the optical properties from a climatology approach. In this article we present an aerosol classification by using aerosol optical depth (AOD), size distribution and Angstrom exponent ($\alpha_{440\text{-}870}$) from a 15-year (1999–2014) data set measured by a sun-photometer in Mexico City.

Observations of column aerosol optical properties were conducted with a CIMEL Electronique (CE-318) sun-photometer that is a part of the AERONET global network. These instruments are described in detail by Holben *et al* (1998). Measurements were done during the daytime for the entire study period. The instrument is commonly used to measure direct solar radiation at 8 channels with wavelengths of 1020, 936, 870, 670, 500, 440, 380 and 340 nm.

A graphical framework to classify aerosol properties using direct sun-photometer observations in Mexico City is presented in figure 1a. Aerosol particles have been discriminated by applying the method described by Gobbi *et al* (2007) and Basart *et al* (2009). The method defines the Ångström exponent difference $\delta\alpha = \alpha(440, 675) - \alpha(675, 870)$ as a measure of the Ångström exponent curvature with respect to wavelength, λ: $d\alpha/d\lambda$. The $\delta\alpha$ vs. α (440, 870) space is plotted as the framework for analyzing aerosol properties. In this space, we represent AOD (at 675nm) by a color scale.

The retrieved volume size distributions from AERONET site at MCMA (Level 2) during the study period (1999-2015) presented bimodal modes with volume concentrations usually reached maxima when particle radii ranged between 0.1-0.2 μm for fine and 3.9-5.0 for coarse modes. These bimodal distributions are typical of urban areas and the radii for maxima volumes are almost similar to that found in Los Angles.

Inversion results for the volume distribution showed that the shape of each mode was relatively close to the lognormal distribution. Figure 1b shows the average volume distribution for the three seasons: cool-dry, warm-dry and rainy. A significant seasonal variation is observed, which is mainly influenced by the meteorological conditions. Distributions in Figure 1b show the fine mode with concentrations greater than coarse. This demonstrates that the combustion process is the main source of sub-micron particles at Mexico City. The second peak with particles greater that 2 μm (coarse mode) are mostly composed of soil dust particles.

To summarize, fifteen years of monitoring by sun–sky radiometers at the AERONET site at MC enabled a climatological perspective of the seasonal and annual variation of AOD and $\alpha_{440\text{-}870}$ parameters.

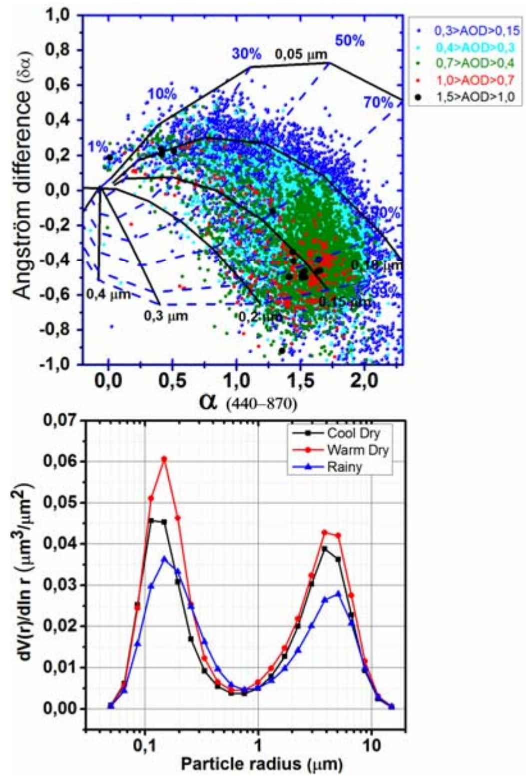

Figure 1. AERONET measurements in Mexico City: (a) the $\delta\alpha$ vs. $\alpha_{(440\text{-}870)}$ is a plot diagram to classify aerosol properties. (b) Average volume distribution for the three seasons: cool-dry, warm-dry and rainy.

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