

Two years of continuous measurements of surface and columnar atmospheric aerosol properties at Granada, an urban site in Spain.

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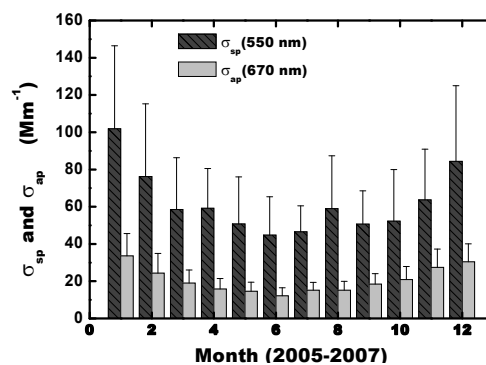
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Aerosol particles affect the Earth's radiative balance, climate and human health. However, despite the significant progress in understanding aerosol effects, these aerosol effects still contain considerable uncertainties due to the poor understanding of aerosol properties and their high spatial and temporal variability (Forster et al., 2007). In this work two years (from December 2005 to November 2007) of continuous measurements of various surface and columnar aerosol properties at Granada (37.18° N, 3.58° W, 680 m a.s.l), Spain, are analyzed.

The scattering coefficient, σ_{sp} , was measured with an integrating nephelometer (TSI, model 3563) in three wavelengths: 450, 550 and 700 nm. Light absorption coefficient at 670 nm, σ_{ap} , was recorded with a Multi-Angle Absorption Photometer (MAAP). Particle size distribution in the diameter range 0.50-20 μm was obtained by an aerodynamic aerosol sizer (APS-3222, TSI). The columnar aerosol optical depth, $\delta_{a\lambda}$, was retrieved using a CIMEL CE-318 Sun photometer.

The daily average values of σ_{sp} at 550 nm range from 12 to 234 Mm^{-1} with an average of $60 \pm 30 \text{Mm}^{-1}$, while the daily average values of σ_{ap} (670 nm) vary from 4 to 57 Mm^{-1} , averaging $21 \pm 10 \text{Mm}^{-1}$. The lowest of σ_{sp} and σ_{ap} values are associated with rain event and the largest values are linked to long range transport from North Africa. Both σ_{sp} and σ_{ap} show a clear seasonal cycle with summer minimum and winter maximum. This seasonal pattern in σ_{sp} and σ_{ap} is opposite to the seasonal cycle showed by $\delta_{a\lambda}$ (Figure 1). The difference in the seasonal features of the surface and column-integrated data is related to seasonal variation in the aerosol vertical distribution, aerosol sources and boundary layer height. The scattering Angström exponent is found to be 1.8 ± 0.2 , 1.6 ± 0.3 , 1.3 ± 0.3 and 1.4 ± 0.3 during winter, spring, summer and autumn, respectively, suggesting a large fraction of submicron particles at the site, especially during winter. These observations are supported by aerosol size distribution measurements made by the APS. Urban aerosols in Granada contain a large fraction of absorbing material as indicated by the average single-scattering albedo of 0.65 ± 0.07 , 0.66 ± 0.06 , 0.70 ± 0.06 and 0.73 ± 0.06 obtained during autumn, winter, spring and summer, respectively.

The aerosol scattering albedo is below the critical value of 0.86 that determines the shift from cooling to warming. A clear diurnal pattern is observed, in all seasons, in σ_{sp} and σ_{ap} with two local maxima occurring in early morning and late evening. This diurnal cycle is mainly attributed to the diurnal evolution of atmospheric boundary layer and local anthropogenic activities. In all seasons, σ_{sp} and σ_{ap} show significant decrease on weekends compared to weekdays, indicating a strong impact of traffic



emissions.

Figure 1. Monthly variations of σ_{sp} (550 nm) and σ_{ap} (670 nm). The error bars are the standard deviations.

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Forster, P., et al.: *Changes in Atmospheric Constituents and in Radiative Forcing*. In: *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K. B. Averyt, M. Tignor and H. L. Miller (eds.)]. *Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 2007*.