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Aerosol load characterization over South–East Italy for one year of AERONET sun-photometer measurements

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Abstract

Daily averaged retrievals of AERONET sun photometer measurements from March 2003 to March 2004 are used to provide preliminary results on the characterization of aerosol properties and changes over south–east Italy (40°20′N, 18°6′E). It is shown that aerosol optical and microphysical properties and the dominating aerosol types depend on seasons. Aerosol-parameter frequency distributions reveal the presence of individual modes that lead to the assumption that moderately absorbing urban–industrial and marine-polluted aerosols dominate in spring–summer and autumn–winter, respectively. It is shown that aerosol optical depths (AODs), single scattering albedos (SSAs), and Angstrom coefficients (Å) of urban–industrial (spring–summer) aerosols are characterized by lognormal distributions with peak values of 0.20 ± 0.03, 0.94 ± 0.01, and 1.58 ± 0.03, respectively. On the contrary AOD, SSA and Å values of maritime-polluted (autumn–winter) aerosols are characterized by lognormal distributions with peak values of 0.049 ± 0.008, 0.974 ± 0.003, and 0.7 ± 0.1, respectively. It is also shown that the frequency distribution of real n and imaginary k refractive indices permits inference of the dominant aerosol constituents: sea-salt, water soluble, soot, and mineral particles.

Finally, it is shown that dust outbreaks do not significantly affect the seasonal evolution of aerosol parameters, and that sunphotometry retrievals along dust events are in satisfactory accord with experimental findings indicating that moderately-absorbing ($0.005\leq k\leq0.05$) dust particles with a high content of illite are mainly advected over the Mediterranean basin during Sahara dust storms.

Keywords: Sun photometer; Aerosols; Aerosol optical and microphysical properties

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1. Introduction

Radiative forcing by natural and anthropogenic aerosols presently represents one of the most uncertain aspect of climate models (e.g. Hansen et al., 1997; Penner et al., 2002), since aerosol is a highly inhomogeneous and variable atmospheric component that is difficult to model. The last generation of satellites carrying instruments such as the moderate resolution imaging spectroradiometer (MODIS), the multiangle imaging spectroradiometer (MISR), and the wide field of view imagining radiometer POLDER (POLarization and Directionality of the Earth's Reflectances) reveal the big interest of the scientific community in getting worldwide aerosol characterizations. Several experimental studies on aerosols have focused in the last years on the Mediterranean area (e.g. Formenti et al., 2001a; Lelieveld et al., 2002; Gerasopoulos et al., 2003): a net direct radiative forcing by sulphate aerosols (anthropogenic) is predicted to occur in the eastern Mediterranean between Greece and Israel by various models (e.g. Kiehl and Rodhe, 1995; Boucher and Anderson, 1995). The east Mediterranean basin is a crossroad where aerosols from different sources converge: urban/industrial aerosols and seasonal biomass burning from Central and Eastern Europe (e.g. Zerefos et al., 2000; Lelieveld et al., 2002), maritime and long-range transported polluted air masses from the Atlantic Ocean (e.g. De Tomasi and Perrone, 2003), mineral dust from North Africa (e.g. De Tomasi et al., 2003), and sea spray from the Mediterranean sea itself. Moreover, aerosols of different origin and type can superimpose and combine in summer, when wet removal is practically absent and photochemical reactions are favoured by the large amount of solar radiation reaching the earth's surface.

3. Summary and conclusion

Temporal plots and frequency of occurrence distributions of daily-averaged retrievals of AERONET sun photometer measurements performed at Lecce from March 18, 2003 to March 27, 2004 are used to get preliminary results on the characterization of aerosol load and dominant aerosol types over south–east Italy. 4-day-analytical backtrajectories are used to show the impact of continental pollution from Central and Eastern Europe, of maritime and long-range transported polluted air masses from the Atlantic Ocean, of mineral dust from North Africa, and of sea spray from the Mediterranean Sea itself. Temporal plots of the main aerosol parameters at 441 nm reveal a significant seasonal variability of aerosol load, particle size distribution and chemical composition. It is shown that AODs and SSAs take 15-day-averaged values spanning the 0.2–0.4 and 0.93–0.95 range in spring–summer, respectively. AOD and SSA 15-day-averaged values vary in the 0.1–0.2 and 0.97–0.98 range respectively in autumn–winter. As a consequence, the AOD frequency distribution shows two dominant modes peaked at 0.049 ± 0.008 and 0.20 ± 0.03 that characterize the AOD distribution in autumn–winter and spring–summer, respectively. The SSA frequency of occurrence plot also allows the fitting by a bimodal lognormal distribution with the larger amplitude mode peaked at 0.974 ± 0.003 and the lower amplitude mode at 0.94 ± 0.01. It is shown that the mode peaked at 0.94 ± 0.01 that spans the 0.86–0.99 range is mainly representative of spring–summer SSAs. Then, the comparison with literature data of Lecce's spring–summer AODs and SSAs has led to the assumption that moderately-absorbing urban–industrial aerosols dominate in spring–summer at Lecce. Urban aerosols span the 0.94–0.98 SSA range, according to d'Almeida et al. (1991), and dry-internally-mixed urban aerosols are characterized by SSA=0.91 (Levoni et al., 1997). Moreover, it has been shown that measurements performed in summer regimes at GSFC and Creteil-Paris, to characterize urban–industrial aerosols (Dubovik et al., 2002a), are in satisfactory accordance with the results of this paper.