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Aerosol characterization in Northern Africa, Northeastern Atlantic, Mediterranean Basin and Middle East from direct-sun AERONET observations

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Abstract. We provide an atmospheric aerosol characterization for North Africa, Northeastern Atlantic, Mediterranean and Middle East based on the analysis of quality-assured direct-sun observations of 39 stations of the AEROSOL ROBOTIC NETWORK (AERONET) which include at least an annual cycle within the 1994–2007 period. We extensively test and apply the recently introduced graphical method of Gobbi and co-authors to track and discriminate different aerosol types and quantify the contribution of mineral dust. The method relies on the combined analysis of the Ångström exponent (α) and its spectral curvature $\delta\alpha$. Plotting data in these coordinates allows to infer aerosol fine mode radius (R_p) and fractional contribution (η) to total Aerosol Optical Depth (AOD) and separate AOD growth due to fine-mode aerosol humidification and/or coagulation from AOD growth due to the increase in coarse particles or cloud contamination. Our results confirm the robustness of this graphical method. Large mineral dust is found to be the most important constituent in Northern Africa and Middle East. Under specific meteorological conditions, its transport to Southern Europe is observed from spring to autumn and decreasing with latitude. We observe "pure Saharan dust" conditions to show $\text{AOD} > 0.7$ (ranging up to 5), $\alpha < 0.3$ and $\delta\alpha < 0$ corresponding to $\eta < 40\%$ and $R_p \sim 0.13 \mu\text{m}$. Small pollution particles are abundant in sites close to urban and industrial areas of Continental and Eastern Europe and Middle East, as well as, important contributions of biomass burning are observed in the sub-Sahel region in winter. These small aerosols are associated to $\text{AOD} < 1$, $\alpha > 1.5$ and $\delta\alpha \sim -0.2$ corresponding to $\eta > 70\%$ and $R_p \sim 0.13 \mu\text{m}$. Here, dust mixed with fine pollution aerosols shifts the observations to the region $\alpha < 0.75$, in which the fine mode contribution is less than 40%.

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