Hygroscopic Properties of Fine Aerosol Dust Particles over the Background Site of Ag. Marina in Cyprus

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The island of Cyprus, located in the Eastern Mediterranean, is often affected by dust aerosols transported from the Sahara or from the Middle East desert regions. An intensive monitoring field campaign (part of the BACCHUS project) was setup at the background atmospheric monitoring station of Ag. Marina, Cyprus (35.038° N, 33.058° E, 532 m a.s.l) during March 2015 for probing the properties of dust particles, exploiting the geographical particularity of the island.

In this work we focus on the most severe dust event observed during the campaign with respect to in-situ hygroscopicity measurements. A custom-made Hygroscopic Tandem Differential Mobility Analyzer (HTDMA; Rader and McMurry, 1986) was employed to sample atmospheric particles with dry mobility diameters of 60, 80, 100, 140 and 180 nm and exposing them to a relative humidity (RH) of 87±2% for determining their hygroscopic properties. The TDMAfit algorithm (Stolzenburg and McMurry, 1988) was used to distinguish between modes corresponding to particle populations of different hygroscopic properties. The mass and chemical composition of the non-refractory sub-micrometer particles were obtained from an Aerosol Chemical Speciation Monitor (ACSM; Ng, N. L. et al., 2011) along with the mass of <2.5μm diameter aerosols ($PM_{2.5}$) by a TEOM (Rupprecht and Patashnick, Inc. Model 1400a). Aerosol Optical Depth (AOD) corresponding to the coarse and fine aerosol modes over Nicosia (35.114° N, 33.377° E), which was the closest to the sampling location, were determined by the Spectral Deconvolution Algorithm (SDA; O'Neill et al., 2003) from AERONET observations.

The increased levels of the SDA AOD measured for the coarse mode at 26 March 2015 indicate the arrival of the dust at the site (Fig 1a) but not necessarily at ground level. During this time a closure between $PM_{2.5}$ (measured by TEOM) and submicron mass (measured by ACSM) was observed (Fig. 1b). However, from 29 to 31 March, the $PM_{2.5}$ mass increased significantly, while the submicron mass, reported by the ACSM, was reduced. A possible reason could be either that (a) the dust particles acted as the condensation/coagulation sink for precursor gases and smaller particles due to their increased surface area, thus reducing the mass of the sub-micrometer particle mode or (b) that the $PM_{2.5}$ was dominated by refractory particles. Furthermore, during those days the hygroscopic parameter κ (Petters and Kreidenweiss, 2007) of the 180-nm particles was significantly reduced, suggesting the presence of nearly hydrophobic particles (Fig 1c) in this size range. The hygroscopic parameter estimated from the ACSM measurements (κ_{ACSM}) is also provided in Fig 1c, and shows good agreement with the measurements, except the short period from 29 to 31 March. Note, that κ_{ACSM} was estimated assuming that the organic fraction has an apparent density (ρ_{org}) of 1.4 g/cm^3 and a hygroscopic parameter (κ_{org}) of 0.1.

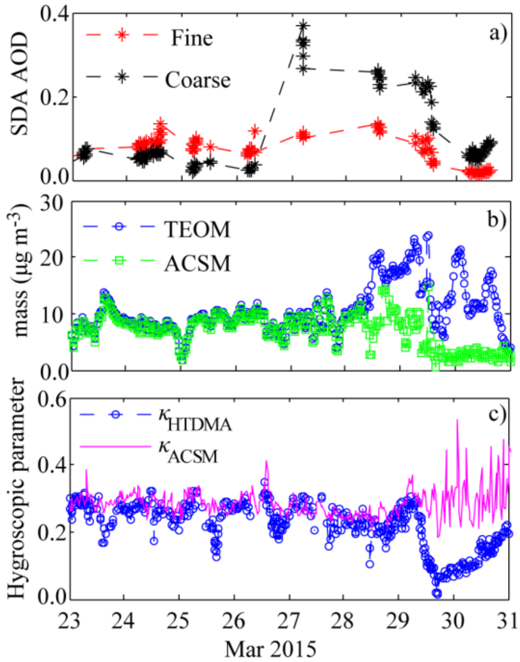

Figure 1. Aerosol optical depth for coarse and fine mode (**a**), aerosol mass obtained from TEOM and ACSM measurements (**b**), and hygroscopic parameter κ values of 180-nm particles obtained from the HTDMA and estimated from particles' chemical composition (**c**), for the period of interest (23-31 March 2015).

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