Hygroscopic Properties and Mixing State of Ultrafine Aerosol Particles over the Eastern Mediterranean Background Site of Finokalia

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Quantifying the contribution of aerosol particles on local and regional climate is complex due to the diversity of their sources and the various physicochemical processes they participate during their lifetime (Hallquist et al., 2009). The Eastern Mediterranean for example is affected by anthropogenic and natural aerosol emissions (Mihalopoulos et al., 1997), which in many cases blend resulting in increased particle concentrations (Salisbury et al., 2003). In addition due to their interactions with the intense incident solar radiation of the area, the properties of airborne particles can change drastically with time. Having information about the variation of the physicochemical properties of the aerosol in this region is therefore very important for better understanding the contribution of atmospheric particles on climate.

In this work we report on measurements of the hygroscopicity of the particles observed in the atmosphere over a background site in eastern Mediterranean, and use them to determine their mixing state. The site of Finokalia is located on the north coast of Crete (35° 20'N, 25° 40'E) at 250 m a.s.l. Measurements were conducted from 21 August to 28 November 2012, using a Hygroscopic Tandem Differential Mobility Analyzer (HTDMA; Rader & McMurry, 1986). In brief, sampled air was first dried in a nafion tube humidity exchanger to ca. 40% relative humidity (RH). The voltage on the first DMA was adjusted to select and particles having mobility diameter of 40, 60, 80, 100, and 120 nm. The monodisperse particles downstream of DMA-1 were conditioned at a 86±2% RH and measured by the second DMA and the CPC. A curve-fitting algorithm was used to fit up to three lognormal to the measurements depending on their spread. The number of the fitted distributions to each sample was used to determine the mixing state of the particles.

Figure 1 gives an overview of the measurements throughout the whole period of the campaign. Figure 1a shows the daily average hygroscopic growth factor of particles having mobility diameter of 40 nm when selected by DMA-1, whereas Fig. 1b shows the occurrence of samples with more than one distinct modes that indicate externally mixed particles. Until the end of September almost all the samples exhibited internally mixed particles. From October until the end of the measuring period, however, externally mixed particles were more often observed, reaching up to 40% of the total samples on some days. The daily average hygroscopic growth factors of internally mixed particles were ranging from 1.11 to 1.27 with a median value of 1.23. Externally mixed particles average daily hygroscopic growth factors ranged from 1.01 to 1.27 with a median value of 1.08 and from 1.18 to 1.65 with a median value of 1.28 for the first and the second hygroscopic mode.

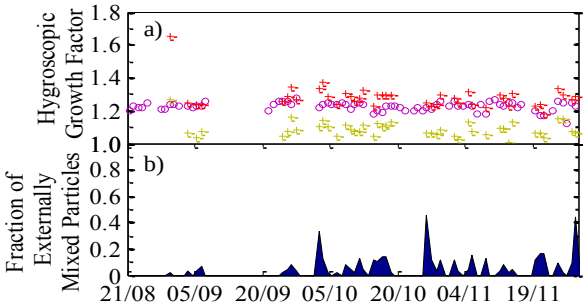

Fig. 1. Daily average hygroscopic growth factors of particles measured at Finokalia (a) and fraction of samples in which externally mixed particles were revealed (b). The hygroscopic growth factors correspond to particles having selected mobility diameter of 40 nm at 40% RH and then exposed to 86±2% RH. Circles indicate internally mixed particles and crosses externally mixed particles (bimodal).

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