Water content and pH of Aerosols over the Eastern Mediterranean

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The recent years, the influence of ambient particulate matter on environmental systems and human health has attracted the scientific interest. Water, inorganic salts, insoluble materials like dust, organic compounds and trace metals are chemical components of airborne particles. The chemical composition of particles can provide critical information about their sources, their atmospheric formation pathways and their toxicity.

The concentration of the hydrogen ion or its negative logarithm, pH, is an important aerosol property that drives many processes related to particle composition and gas-aerosol partitioning. Moreover, pH is the major factor affecting the solubility of trace elements, such as iron and phosphorus that are key nutrients for phytoplankton growth and thus carbon sequestration. Particle pH is calculated by ISORROPIA-II, based on concentrations of chemical inorganic species, temperature and relative humidity for aerosol in thermodynamic equilibrium with water vapour and gas phase precursors (Nenes *et al.*, 1998). Water uptake by atmospheric particles affects their optical (Malm and Day, 2001) and chemical properties and this can influence their interaction with climate. Thus, aerosol water determination by ISORROPIA-II is of particular importance.

Aerosol measurements were conducted at the Finokalia station, an ideal place for background aerosol studies in the Eastern Mediterranean, from June until November 2012. Instrumentation was comprised of a CCN counter, two nephelometers (one dry and one ambient), an Aerosol Chemical Speciation Monitor and concurrent collection of daily filters. Water content was derived by two methods following the methodology of Guo et al. (2014); the first using the measurement of scattering coefficients by the two nephelometers operating in PM1 mode. The second one includes the particle hygroscopicity parameter, κ, which was exported by the CCN measurements and relates the organic contribution to the total water uptake. Inorganic contribution was predicted by ISORROPIA-II using PM1 water soluble ions.

The total water content calculated by the two methods was highly correlated with slope close to 1. Based on this study, the organics contribute 34% of total water, exhibiting a diurnal variability with higher contribution during nighttime, following the general pH trend. With average pH estimated to be 1.3, these highly acidic aerosols will affect many processes such as the solubility and the bioavailability of nutrients. Based on our results, under these acidic conditions, the solubility of P and Fe in aerosols has been found to be 45% and 15%, respectively. The significance of our results for the eastern Mediterranean Sea is thoroughly discussed.

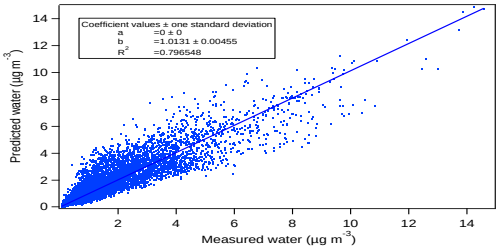

Figure 1. Comparison between total water predicted by ISORROPIA-II and measured water by nephelometers

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Guo, H., Xu, L., Bougiatioti, A.,Cerully, K.M., Capps, S.L., Hite, J. R., Carlton, A., Lee, S., Bergin, M. H., Ng, N. L., Nenes, A. and Weber, R.J. (2014) *Particle water and pH in the southeastern United States, Atmos. Chem. Phys. Discuss.*, **14**, 27143-27193

Malm, W. C. and Day, D. E. (2001) *Estimates of aerosol species scattering characteristics as a function of relative humidity*, *Atmospheric Environment*, **35**, 2845–2860, doi:10.1016/S1352-2310(01)00077-2

Nenes, A., Pandis, S. N., and Pilinis, C. (1998) *ISORROPIA: A new thermodynamic equilibrium model for multiphase multicomponent inorganic aerosols*, *Aquat Geochem*, **4**, 123-152, Doi 10.1023/A:1009604003981