Hygroscopic properties of atmospheric particles during winter biomass burning episodes in Athens

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Atmospheric aerosols affect the global radiation budget by scattering and absorbing solar radiation and thus have a direct effect on climate. In addition, depending on their physical and chemical properties, they can serve as CCN becoming cloud droplets, thereby indirectly affecting climate by modifying the cloud reflectivity and lifetime. The indirect effect of atmospheric particles on climate depends among others on their size and hygroscopic properties (Fors et al., 2010).

Biomass burning leads to the emission of a major fraction of atmospheric particles in the atmosphere. These can be directly emitted or formed by the oxidation of gaseous organic species and the subsequent condensation of the corresponding products forming secondary aerosol. Particles emitted by biomass burning consist mainly of organic compounds, a significant amount of black carbon and lower concentrations of inorganic species. While primary particles emitted by combustion sources are in general hydrophobic, biomass burning organic aerosol (BBOA) is relatively hygroscopic and can serve as CCN (Semeniuk et al., 2007).

In this work, we investigate the hygroscopic properties of particle in an urban environment, in the center of Athens, during the winter of 2013, when wood burning in fireplaces for domestic heating was a dominant source of aerosols. A High-Resolution Aerosol Mass Spectrometer (HR-AMS) was employed to monitor the chemical composition and size distribution of PM_1 particles, while a Multi Angle Absorption Photometer (MAAP) provided black carbon (BC) concentration measurements. A Cloud Condensation Nuclei (CCN) counter was measuring size-resolved particles (from 10 to 490 nm in diameter) after they exited a Differential Mobility Analyzer (DMA) in order to estimate particle activation efficiency. The total number of the particles was measured by a Condensation Particle Counter (CPC).

Organic compounds dominated the PM_1 chemical composition with a contribution of 58% to the total mass, followed by BC (20.4%). Sulfate ions contributed 10%, nitrates 5.1%, ammonium 4.2% and K^+ and Cl^- each 1.1%. The average organic fraction during the intensive campaign increased significantly after 18:00, reaching its maximum of 80% at 22:00 and dominated the PM_1 mass concentration until midnight (Figure 1). Positive Matrix Factorization showed that BBOA was the dominant PM_1 source during this period.

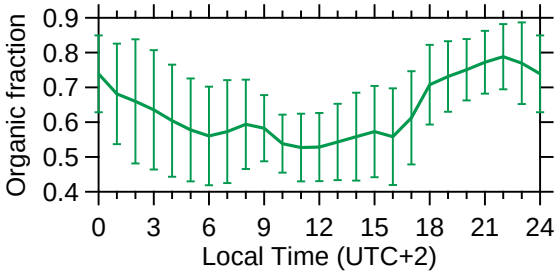

Figure 1: Average mass fraction of organic aerosol in PM_1 particles.

The average hygroscopicity parameter κ of particles 80 to 100 nm during the high BBOA period was constant with a value of 0.15 (Figure 2). The corresponding hygroscopicity parameter for the organic aerosol during the day ranged from 0.06 to 0.21 with an average κ_{org} during the night when BBOA was dominant around 0.1.

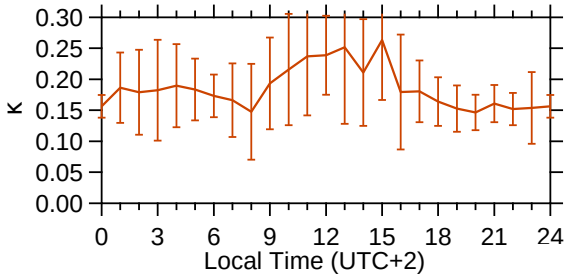

Figure 2: Diurnal profile of the average hygroscopicity parameter κ of 80-100 nm particles.

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Fors et al. (2010) *Atmos. Chem. Phys.* **10**, 5625-5639.
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