Modifications in hygroscopicity and volatility of wood combustion aerosols after chemical aging

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Combustion of biomass is known to be a major source of gas- and particle- phase air pollution in the atmosphere and to be mainly made of a complex mixture of organics. To date, however, the atmospheric behaviours of these mixtures and their health effects are still largely unknown.

In this study, aging processes of different types of wood burning aerosols (see Table 1) are investigated. The wood burning aerosols are introduced into the IfT LEAK chamber (19 m^3, Iinuma et al. 2004) with and without ozone and /or UV lights simulating day- and night- times. Several online instruments including a Hygroscopic Tandem Differential Mobility Analyzer (H-TDMA), a Volatility Tandem Differential Mobility Analyzer (V-TDMA), a Multi-Angle Absorption Photometer (MAAP), a Scanning Mobility Particle Sizer (SMPS), and an Aerosol Mass Spectrometer (AMS) were used to measure the changes of physical and chemical properties of aerosols. In parallel to the physico-chemical study, modifications of the aerosols toxicity during the aging process were also investigated.

Table 1: Wood species and stoves

Wood	Stove
Spruce	Twinfire stove
Beech	Twinfire stove
Pellet	Pellet oven

In this abstract, the modifications in volatility and hygroscopicity of spruce burning aerosols via photochemical aging are presented as an example. Fig. 1 shows the comparisons of particle number size distributions before and after turning on the UV-lights. Fig. 2 and 3 display the temporal evolution of growth factor and shrink factor for different size particles, respectively. The growth factor is defined as the ratio of the wet particle mobility diameter D at RH=90% to dry diameter D0. The shrink factor is defined as the ratio of the particle diameter at a certain temperature (here, 120 and 300 °C) to the diameter at room temperature (25 °C).
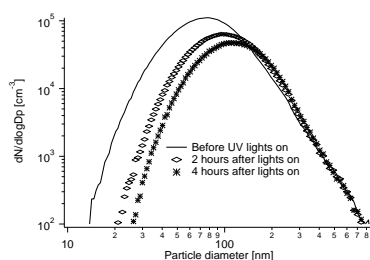

Fig. 1: Particle number size distribution

Before the UV-lights on, the growth factors for 50, 75, and 100 nm particles are within 1.3-1.4, and only

1.1 for 200 nm particles. This indicates that smaller particles are dominated by hydrophilic components, such as inorganic salts, while, larger particles are dominated by hydrophobic fraction, such as soot. After lights on, the growth factors of smaller particles decrease with time consuming. This means that more low hygroscopic organic species produced or condensed on the particles during aging process. But, no any changes in 200 nm particles were observed.
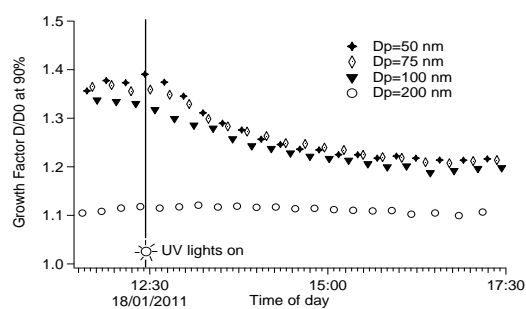

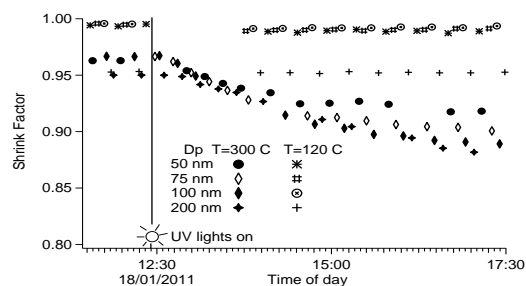Fig. 2: Temporal evolution of hygroscopic growth

Fig. 3: Temporal evolution of volatility

At 120 °C, there is no any difference in shrink factor before and after UV-lights on, indicating that no high-volatile components, such as low carbon-number carboxylic acids, produced during chemical aging. At 300 °C, the particles freshly emitted with diameter of 50, 75, and 100 nm are non-volatile. This confirms that these small particles are dominated by salts. After lights on, the aerosols are more volatile in contrast to primary particles. A detail study on the modifications in hygroscopicity and volatility of wood burning aerosols will be performed by combining the AMS data and filter measurements in the future work.

Reference:
Y. Iinuma, O. Boge, T. Gnauk and H. Herrmann, , Atmospheric Environment 38 (5) (2004), pp. 761–773.