Hygroscopic properties of the anthropogenic aerosol in the Po-Valley, Italy

I. Pap[1], J.Größ[1], A. Hamed[1, 2], W. Birmili[1] and A. Wiedensohler[1]

[1]Department of Physics, Leibniz Institute for Tropospheric Research, Leipzig, 04318, Germany
[2]Department of Applied Physics, University of Eastern Finland, Kuopio, P. O. Box 70211, Finland

Keywords: hygroscopic growth, hydrophobic, hydrophilic, hygroscopicity parameter

Presenting author email: pap@tropos.de

The High Humidity Tandem Differential Mobility Analyzer (HH-TDMA) is designed to measure the hygroscopic growth factors (HGF) at sub-saturated conditions (up to 99 % RH) under highly temperature stabilized conditions. The HH-TDMA was employed to measure the water uptake of aerosol particles in the Po Valley region, which give us a good opportunity to measure the hygroscopic behaviour of these particles during the summer time. The campaign was performed in frame of the EU-PEGASOS project. The measurements were taken in the period at the station San Pietro Capofiume (SPC) in the time period from June 9 to July 10, 2012. HGF probability functions were calculated for four particle sizes (75, 100, 200 and 300 nm). These particles were measured at different RH: 90, 93 and 95.5 %. The HGF probability functions contain a hydrophobic and a hydrophilic mode, leading to a bimodal character in 62 % of the cases, during the whole measured period.

In order to describe the hygroscopic properties of particles, the hygroscopicity parameter κ was calculated using the Köhler theory. This was achieved by using the equation given by Petters and Kreidenweis, 2007. The hygroscopicity parameter κ was applied to all measured HGF probability functions.

The value of parameter κ classifies a certain aerosol fraction as hydrophobic or hydrophilic, similarly to the classification according to HGF. In general, a value close to 0 indicates that the aerosol fraction is hydrophobic. The aerosol fraction for 100 nm particles at 90 % is hydrophilic for a κ value higher than 0.2 (Liu, 2011).

The averaged HGF probability functions and the averaged κ probability functions over the measured period are shown in Figure 1. The distribution is shown for three different RHs for 200 nm particles. The distribution of κ is similar to the HGF distribution. Both, a hydrophilic and smaller, hydrophobic mode can be seen here. The difference between the HGF and the κ distribution is that, in the GF distribution, the hydrophilic peak is shifted with the change of RH, while this shift is negligible in the κ distribution. Due to these results, it can be concluded that κ is relatively constant with relative humidity, meaning no further material gets in solution with increasing RH.

The time series, shown in Figure 2, indicate that the number fraction of hydrophobic and hydrophilic particles varies greatly during the day and the external mixture of 100 nm particles changes drastically. More analysis on hygroscopicity at the SPC station related to the black carbon mass concentration will be presented in our studies.

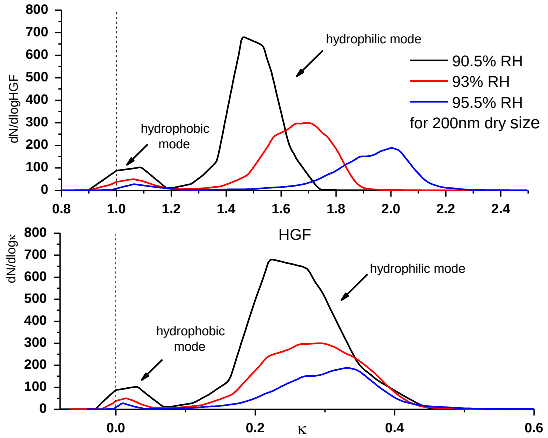

Figure 1: The averaged κ and HGF distribution for 200 nm at different RH. The black, red and blue line represents the particle number concentration density at 90.5, 93 and 95.5 % RH. The dashed line represents the original dry particle state.

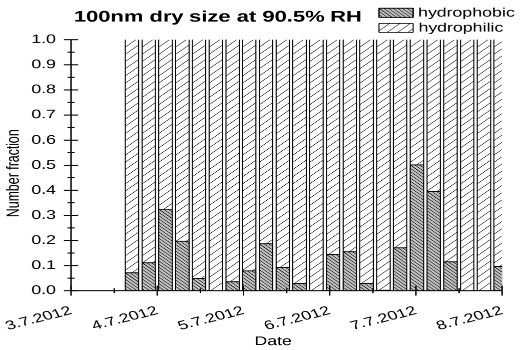

Figure 2: The number fractions of hydrophobic and hydrophilic particles of 100 nm particles at 90.5 % RH. Gray and brighter boxes represent the hydrophobic and hydrophilic number fraction

References

Liu et al. (2011), Atmos. Chem. Phys. ,11, 3479-3494
Petters and Kreidenweiss (2007), Atmos. Chem. Phys., 7, 1961-1971