Effect of Humidity on Filter-Based Measurements of Aerosol Light Absorption

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The absorption coefficient σ_{ap} is an important parameter characterizing the optical properties of aerosol particles. Together with the scattering coefficient σ_{as} it determines the single scattering albedo, which is a key parameter governing aerosol radiative forcing. Very often σ_{ap} is measured by a filter-based method, where absorption is derived from the change in light attenuation (ATN) through a filter on which the particles have been collected. For the two most common commercially available instruments of this type, the Particle Soot Absorption Photometer (PSAP) and the Aethalometer, empirical correction schemes were developed to provide a calibration of the measurement and to reduce artifacts present in any filter-based absorption measurement. However, none of these corrections takes into account artifacts related to enhanced or changing relative humidity (RH). Such artifacts have been reported, but have not been thoroughly studied so far. We present the first results of our respective investigations.

Panel (a) of Figure 1 shows the effect of sudden RH changes on σ_{ap} as measured with an Aethalometer. It can be seen that rapid RH increases cause large positive σ_{ap} spikes, whereas rapid RH decreases lead to large negative σ_{ap} spikes. The larger the RH step, the larger the σ_{ap} spike. The reason for these spikes is the increase of the ATN with increasing RH, cf. panel (b). We believe that it is due to water entering the filter which may cause the filter fibers to swell and/or increase light scattering. The RH effect on the ATN shows almost no wavelength dependence. It is reversible and repeatable. Furthermore, the effect does not depend on the amount of soot loaded on the filter, indicating that it is a pure filter artifact. The situation is similar for the PSAP. RH jumps lead to spikes in the σ_{ap} data due to changes in the ATN. Up to RH ≈ 60 the effect is less pronounced than for the Aethalometer, cf. panel (b). However, for higher RH there is no clear relationship between RH and ATN. This distinct different behavior is attributed to the different filter materials used in the two instruments. For unloaded filters and filters containing only soot, enhanced but constant RH slightly increases the noise levels but does not affect the performance of the two instruments otherwise. This may not be true if a lot of hygroscopic material is present in the filters.

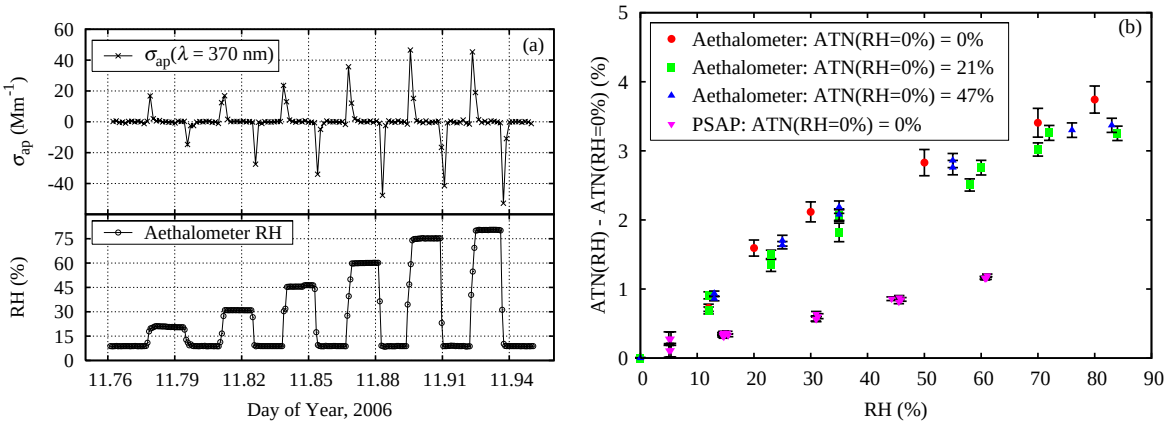

Figure 1. Effect of humidity on Aethalometer and PSAP measurements. (a) Aethalometer aerosol light absorption coefficient of filtered (i.e., particle-free) air and RH in the instrument as a function of time. Measurements were made with an unloaded filter. (b) ATN(RH) – ATH(RH=0%) as a function of RH for sampling particle-free air with an Aethalometer on filters previously loaded with different amounts of Palas soot and for sampling particle-free air with a PSAP on an unloaded filter. In case of the Aethalometer the data represent averages over all wavelengths.