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Effect of humidity on aerosol light absorption and its implications for extinction and single scattering albedo at the Jungfraujoch

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The absorption coefficient σ_{a} is an important parameter characterizing the optical properties of aerosol particles. Together with the scattering coefficient σ_{s} it determines the extinction coefficient σ_{ext} and the single scattering albedo ω.

A common way to measure aerosol light absorption is to use filter based instruments such as the aethalometer or the particle soot absorption photometer (PSAP). These measurements suffer from the inconvenience that they usually have to be performed by inducing the ambient air into a building. This process may change the temperature (T) as well as the relative humidity (RH), causing the measured aerosol properties to differ from the ambient – the climate-relevant – ones.

We modeled the influence of RH on the aerosol absorption coefficient for particles representative of the high-alpine site Jungfraujoch (JFJ, 3580 m asl), which resides predominantly in the free troposphere. Based on a concentric core/coating particle model, RH enhancement factors for absorption, $\chi(\mathrm{RH}) = \sigma_a(\mathrm{RH})/\sigma_a(\mathrm{RH} = 0\%)$, were calculated for ten wavelengths between 370 nm and 950 nm for a summer and a winter case. This wavelength interval corresponds to long-term measurements of dry aerosol absorption coefficients at the JFJ.

Depending on particle size and wavelength, the RH enhancement factors range from 0.94 to 1.78 in summer and from 0.84 to 1.53 in winter at RH between 0% and 99%. However, we demonstrate that, even though the humidity effect on absorption is substantial, its maximum contribution (averaged over all considered size distributions) to the humidity effect on extinction and the single scattering albedo is only 0.2% within

the wavelength range from 450 nm to 700 nm. There are two reasons for this: first, the humidity effect on scattering exceeds the humidity effect on absorption by far, and second, the JFJ aerosol particles scatter much more light than they absorb. According to the location of the JFJ, the presented results are representative of the continental lower free troposphere.