Determination of the mean aspect ratio of aerosol particles from optical data

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Airborne aerosol particles coexist in complex systems with variable size distributions, shape distributions, and orientation distributions as well (Mishchenko et al., 1997). Shape of the particles can vary from nearly spherical (like water droplets or water soluble aerosols; Buseck and Pósfai, 1999) to highly irregular (e.g. desert dust; Volten et al., 2001). Solid particles made up of deliquescent materials become solution droplets at high humidity. Under low relative humidity conditions the solid materials can in preference form the morphology of the aerosols. Basically, it is impossible to describe the realistic shapes and shape distributions of ambient aerosols (but in some cases the exact modelling of aerosol morphologies is required e.g. for correct interpretation of measured data or for accurate modelling of the optical properties of irregularly shaped particles; Hellmers and Wriedt, 2004). Instead, it is more convenient to characterize the prevailing morphology of aerosols by means of aspect ratio, which relates the largest and smallest characteristic sizes of arbitrarily shaped particle. Except rare extreme cases, the tropospheric aerosols have predominately moderate aspect ratios with typical values between 1 and 2.3 (Mishchenko et al., 1995).

The shape of aerosol particles is one of key factors influencing the optical properties of atmospheric environment. Therefore it is rather evident, that optical measurements of scattered and attenuated light can provide valuable information on microphysical properties of aerosol polydispersions (Quirantes and Delgado, 1998). Retrieval of the aspect ratio from optical data is an ill-posed problem which requires an existence of subsidiary a-priori information (e.g. on particle chemistry). Assuming the mean refractive index of the particles is known, the solution of the inverse problem is possible.

During field campaigns we measured the phase function and aerosol optical thickness in Bratislava (capital of Slovakia) and interpreted the results in terms of surface distribution function and mean effective aspect ratio of aerosol particles. In general, the aspect ratio of aerosol particles is still scarcely evaluated quantity and it was never recovered in Bratislava by means of optical methods. Obtained behaviour of aspect ratio in Bratislava was compared with that obtained in Vienna. In context of a general picture it is of high interest to compare a city with long experience in fighting pollution (i.e. Vienna) with a city at the beginning of cleaning process (i.e. Bratislava). Comparing the aerosol properties in both cities we found that particles in Bratislava are larger whenever, and non-deliquescent to a great extent. While aspect ratio of Viennese aerosols is typically small (quite frequently it is less than 1.2), the aerosol particles in atmosphere of Bratislava are more non-spherical (the aspect ratio may reach the value about 1.4).

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