Estimation of scattering asymmetry by measurement of backscattering.

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The fraction of backscattered light (*b*) is defined as the ratio of the integral of the volume scattering function over the backward half solid angle divided by the integral of the volume scattering function over the full solid angle. It can be measured with an integrating nephelometer by shading half of the scattering volume. A large number of data are available worldwide. The scattering asymmetry parameter (*g*) is the integral over the full solid angle of the volume scattering function weighted with the cosine of the scattering angle divided by the integral of the volume scattering function. This parameter is an important input for radiative transfer calculations in order to obtain information of effects of the atmospheric aerosol (climate, illumination, visibility, and others). To determine the asymmetry parameter the measurement of the angular dependence of the volume scattering function is needed, which can be obtained e.g. with a polar nephelometer, but data are scarce. It is obvious, that a relation between the asymmetry parameter and the backscattered fraction should exist: the smaller the backscattered fraction, the more asymmetric the scattering, thus the larger the asymmetry parameter.

A large set of 6500 angular scattering data have been obtained at various locations of the world: Vienna (Austria), Kyoto (Japan), Granada (Spain) and Palencia (Spain). The aerosols in these locations were considerably different, ranging from continental, urban, maritime, to desert dust. The volume scattering function has been measured between 5° and 175°, the values for 0° to 5° and 175° to 180° have been obtained by extrapolation of the shape of the curve, thus the whole range of scattering angles was available for calculating the backscattered fraction and the asymmetry parameter of the aerosol.

A summary of all data is shown in Fig 1. Despite the different measurement locations, the majority of the data points is situated in a narrow range. Theoretical considerations for spherical particles of various refractive indices as well as empirical relations agree with the cloud of data points.

A subgroup of data is located in the upper left part of the cloud of data points, which can be characterized by micrometer sized particles, again in agreement with theoretical considerations. Backtrajectories show that the air masses containing the measured particles originate from desert regions, where particles are generated by wind erosion, and thus the majority is in the micrometer size range.

For the majority of the cases an estimation of the asymmetry parameter is possible within ± 0.02, if a rough information is available about the size (e.g. by the wavelength dependence of the scattering coefficient), this is also possible for aerosols dominated by super micrometer sized particles.

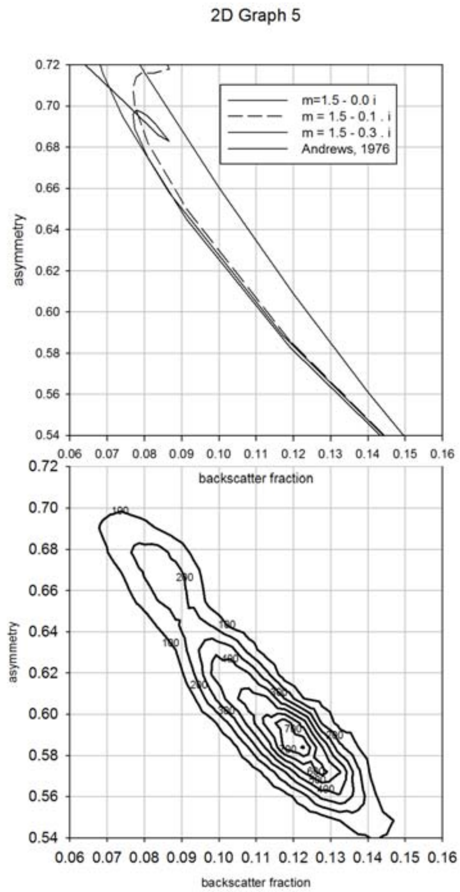

Figure 1. Relation between backscattered fraction and asymmetry parameter. Top: theoretical curves, bottom: Contour plot of number of data points within a range of Δg=0.02 and Δg=0.01.