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Relationship between the fraction of backscattered light and the asymmetry parameter

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The fraction of backscattered light 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. On the other hand the asymmetry parameter 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. 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.

The asymmetry parameter is an important input parameter for radiative transfer calculations in order to obtain information of effects of the atmospheric aerosol effects (climate, screening, visibility, and others). Unfortunately measurements of the asymmetry parameter of the atmospheric aerosol 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 figure 1. The majority of the data points suggest an unanimous relation between backscattering and asymmetry parameter. The location where sampling took place and the type of aerosol seems to be of minor importance. The lines in figure 1 show results of calculations for spherical particles having a lognormal monomodal size distribution of various sizes. Several approximations for the relationship *asymmetry vs backscattering* available from the literature are shown as well

Thus it appears that an unanimous relation, fairly independent of location and type of aerosol, has been found between asymmetry parameters and backscattering ratio. The assumption of spherical particles seems to be a good assumption.

Figure 1. Relation between backscattered fraction and asymmetry parameter. The cloud of dots represents about 6500 measurements of the phase function. The lines are results of calculations for aerosols consisting of monomodal spherical particles and approximations