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Assessing the size distribution of droplets in a cloud chamber from the time-dependence extinction of a light beam

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The size distribution of droplets is a piece of basic information needed to account for the micro-physical processes taking place in clouds and for estimating the interaction of clouds with the solar radiation quantified by the cloud albedo. The proposed paper introduces and discusses a method for assessing the size distribution of droplets formed in a cloud chamber and allowed to fall in gravitational field. The Stokes friction and the Archimedes force determine a constant fall velocity for each droplet, which is proportional to the droplet radius. This circumstance provides a natural filter which gradually deposits the bigger droplets from the initial distribution. If a laser beam is directed through the chamber towards an opposite sensor, the corresponding signal will therefore increase with time until reaching a stationary limit for the clean air. It is thus expected that this time variation embeds the dependence of the number density of droplets on their radii. More precisely, the volume number density of liquid particles can be extracted from the time variation of the transmitted light intensity. By choosing the light wavelength in the red range, the geometrical optics limit of 2 for the extinction efficiency factor can be used as a good approximation and the optical depth of the laser light in the polydisperse optical medium can be obtained as an integral over the volume number density of liquid particles $n(r)$ multiplied by the corresponding squared radius, r^2. The upper limit of this integral, $r_m(t)$, is time dependent due to the selective fall of droplets and can be correlated to the time-variation of the electric response of the light sensor. After numerical processing of the sensor data, the volume number density of liquid particles can be obtained. The method was applied on a cloud chamber at the Faculty of Physics of the University of Bucharest. The results show generally bi-modal aspect of the droplet size distribution. By assuming that falling droplets do not capture smaller ones in their way, the method obviously has a systematic error which is evaluated and discussed. We speculate that the method can be extended to assessing size distributions of other types of aerosols and to be used also in situ, for low-to-moderate densities of particles.