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Post-flight analysis of the aerosol impact on size distributions of warm clouds' droplets, as determined in situ by cloud and aerosol spectrometers

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The influence of aerosol on the various aspects of the atmospheric properties as well as on the energetic balance is widely recognised in the scientific community and this issue is currently subject to worldwide intense investigations. Among the multiple ways aerosol particles are impacting the atmospheric environment, their interference with the phase transformations of the atmospheric water is of particular importance. Cloud microphysics, on the other hand, is one of the key components in weather forecast and, therefore, in pursuing daily domestic activities ranging from agriculture to energy harvesting and aviation. The micro-physical processes taking place in clouds are strongly influenced by the spatiotemporal variation of the size distribution of the cloud droplets. In this context, as in situ investigations of clouds seem appropriate, one of the most useful types of instruments is casted into the generic name of Cloud and Aerosol Spectrometer (CAS) that can be mounted on specialized research aircraft. The CAS working principle relies basically on measuring the forward scattering cross section (FWSCS) of light with a certain wavelength on a cloud particle and comparing it to the FWSCS computed for pure water spheres. The eventual matching of these values leads to assigning a certain value for the measured particle's diameter. The light wavelength is usually chosen in a range where pure water has virtually no absorption. However, atmospheric aerosol frequently mixes up with cloud droplets (starting even from the nucleation processes) and alters their optical properties. By increasing absorption and/or refractivity with respect to those of pure water, one can easily show that the FWSCS-diameter diagram changes drastically by becoming smoother and with an overall significant decrease in absolute values. This means that a CAS will systematically count "contaminated" cloud droplets in a lower range of diameters, thus distorting their real size distribution. This effect is inherently degrading the objectivity of CAS measurements and should be more pronounced when levels of sub-micrometer sized aerosol increase at the cloud altitude. The present study aims at pointing out such correlation in order to estimate the reliability of size distributions (and of the ensuing cloud microphysical properties) obtained by CAS.