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Shape and oscillation measurements of pure and polluted raindrops in the Mainz vertical wind tunnel

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The characterization of falling raindrops is one of the hottest topics of precipitation microphysics. The oscillation behavior and the average form of the drops are key parameters for the precipitation now-casting by weather radars, while the internal circulation plays an important role in the uptake of gases by the raindrops. The Mainz vertical wind tunnel is world-wide a unique piece of equipment for the investigation of different hydrometeors (cloud droplets, raindrops, ice crystals, graupels and snow flakes) while they are freely floating in a vertical upwind. Thereby it allows an appropriate laboratory simulation of hydrometeors falling at their terminal velocities in the free atmosphere.

The characteristics of pure water drops with different sizes from a few hundred microns up to several millimeters were investigated in extensive studies. The form and the average axis ratio – two of the most important microphysical parameters for radar measurements – were found to fit very well to the most relevant model computations.

In clouds raindrops are often formed by the melting of ice crystals and snow flakes which wash out polluting constituents from the atmosphere directly by scavenging or by riming quite efficiently. So real raindrops do not consist of pure water but contain, for instance, surfactants as reported in the literature. The presence of surfactants results in altered surface tension and, thus, the oscillation behavior, the form and internal circulation of the raindrops may differ from that of pure water drops. For this reason the experiments with raindrops in the Mainz vertical wind tunnel have been extended to polluted water drops with well-controlled physical parameters. The results which are presented here show significant deviations in raindrop characteristics from model computations for pure raindrops indicating that some parameters neglected in raindrop models (particularly the effect of the internal circulation) are after all relevant.

The presented experiments will help to further refine the computations used in radar meteorology.