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Melting of hailstones – an experimental study in the Mainz vertical wind tunnel

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The microphysics of melting hailstones is one of the major sources of uncertainty in cloud models and in radar meteorology. Therefore, an accurate characterization of the melting behavior of hailstones is crucial for improving the now- and forecasting of precipitation. Besides the temporal evolution of the particle shape and fall speed, the meltwater content, and the total melting time as functions of relative humidity and hail size are of great importance. In contrast to in situ observations, experiments at the Mainz vertical wind tunnel (M-WT) provide detailed characterization of the complete history of these quantities from the fully glaciated to the entirely molten state of hailstones.

In the melting experiments reported here, ice spheres from 5 to 20 mm in diameter were positioned in the center of the M-WT by means of a specially designed tube bearing with very low friction, and floated at their terminal velocity without wall contact. In this way the heat transfer, and thus, the melting rates typical in the real atmosphere were simulated. The first set of experiments were carried out at a constant ambient air temperature of 23°C. In a second series of experiments the wind tunnel air temperature was continuously increased from 0°C to +15°C using either the dry (+1 °C/100 m) or the moist adiabatic lapse rate (+0.6°C/100m). To examine the effect of the humidity on the melting process, both sets of experiments were carried out at 40% and 80% relative humidity.

We present here preliminary experimental data on the time evolution of molten fraction, surface temperature and terminal fall velocity of melting hail, and provide possible parameterizations for these microphysical properties.