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Simultaneous in-situ and remote sensing measurements of mixed-phased and cirrus clouds – A case study

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Measurements of mixed-phased clouds are important for a better understanding of cloud processes and parameterization for weather and climate models. Especially important properties like number concentration and size distribution of water droplets and ice particles in mixed phased clouds are needed. With balloon-borne in-situ measurements water and ice phase can be distinguished, small particles down to a size of about 10 μm can be measured and the shape of the ice particles can be determined. Because of the slow speed of the instrument, shattering can be neglected. During two weeks in October 2016 a combined measurement campaign of mixed-phased clouds took place at the Richard-Aßmann-Observatory in Lindenberg, Germany. Two types of in-situ particle sondes were flown: the LTU oily-tape imager, and the NCAR type replicator-sonde; radiosondes provided altitude coordinates as well as in-situ profiles of temperature and humidity. In addition ground-based Raman-LIDAR (RAMSES) and Ka-Band cloud Radar instruments were used. As common operating principle, these particle sondes sample cloud particles by collection on a tape covered with a layer of viscous substance. The LTU imager directly makes a photographic recording of the particle; in case of the NCAR type replicator the impression the particle left is photographed afterwards. Data analysis relies on image-processing.

In this paper we present the results from the LTU instrument of three successful flights and compare cloud properties such as particle size and distribution that were derived from the in-situ measurements to those retrieved from the remote-sensing observations. Two of the three measured profiles contain liquid or mixed-phase cloud layers in the lower troposphere. In addition to mixed-phase clouds, we are also interested in thin cirrus clouds that can be detected by lidar but are invisible to the cloud radar. Such a case has been observed during one flight. Our results show that the combined application of in-situ particle sondes and remote sensing techniques is a promising approach to simultaneously investigate micro- and macrophysical cloud properties.