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Measuring microphysical inhomogeneities in boundary layer clouds using a holographic imager on a tethered kytoon system

Fabiola Ramelli, Alexander Beck, Jan Henneberger, and Ulrike Lohmann
ETH Zürich, Institute for Atmospheric and Climate Science, Zürich, Switzerland (jan.henneberger@env.ethz.ch)

There is a gap in observations within the planetary boundary layer (PBL) between ground-based tower measurements, which are limited in height, and manned airplanes, which have minimum altitude constrains, in particular in hilly, densely-populated regions. Yet, information about the vertical structure of microphysical cloud properties in the PBL is crucial to improve the forecast of fog.

We developed a measurement platform with a holographic imager on a tethered kytoon system called HoloBalloon. A kytoon, which is a combination of a kite with a helium-filled balloon, has enough payload to lift a single-particle cloud-imager up to 1 km above ground. The one order lower aspiration speed, in comparison to aircrafts, allows probing the fog properties with higher spatial resolution, but have the drawback that the direction and the speed of the air flow towards the instrument is fluctuating. Commonly used cloud imager (e.g. OAPs, CPI), have a sample volume that depends on the aspiration velocity, which necessitates an inlet design to balance the fluctuating aspiration speeds. Holographic cloud imager have sample volume that is completely independent of the aspiration speed, which makes them the most suited measurement technique for tethered kytoon systems.

Observations of a supercooled low stratus event (high fog event) over the Swiss Plateau in February 2018 showed inhomogeneities on different scales. The cloud droplet number concentrations varied between multiple profiles by a factor of two within an hour. On a 10-meter scale, pockets without large droplets where found in single profiles. Boundary layer clouds or turbulences due to cloud-top cooling could have caused these inhomogeneities. These measurements demonstrate the capability of the HoloBalloon platform to measure the microphysical properties of boundary layer clouds on multiple scales.