ELS-XV-2015 Abstracts
ELS-XV-2015-155
Electromagnetic & Light Scattering XV 2015, Leipzig

Characterization of ice crystals and liquid droplets using interferometric out-of-focus imaging for airborne research

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The characterization of droplets and ice crystals in the atmosphere is particularly important. In situ characterizations with airborne instruments is indeed one of the key issues in cloud microphysics. The detection and the characterization of ice crystals is further essential in order to ensure the safety of aircrafts in flight.
We have developed an Airborne Laser Interferometric Droplet Sizer. It is based on the real-time analysis of interferometric out-of-focus images of droplets. In this presentation, we will first briefly describe the instrument realized, and the first airborne images of liquid droplets obtained. We will then demonstrate the possible extension of the technique to the characterization of ice particles. We will discuss the possibility to obtain some informations about the morphology of an irregular rough particle from its speckle-like out-of-focus image. We will show that the size of such particles can be deduced from the size of the speck of light of their speckle-like defocused image. In order to adapt these observations made with salt or sand particles to the case of ice particles, it has been necessary to develop laboratory characterization experiments involving real ice. For this, we have realized a cold chamber. Liquid droplets fall within the chamber and freeze. A second well-calibrated technique (digital in-line holography in our case) has been added to the set-up in order to validate quantitatively the measurements made. We record thus simultaneously the interferometric out-of-focus image and the digital in-line hologram of the frozen droplets. We present the experimental results obtained. We show that the particle's sizes deduced from the size of the speck of light of the speckle-like patterns is corroborated quantitatively by the numerical reconstruction of the hologram recorded simultaneously for the same particle, and that the description proposed to evaluate the size of irregular rough particles is adapted to frozen droplets. We will then present the quasi real-time algorithms that have been developed in order to separate liquid droplets and ice particles, measure their sizes and evaluate the ice water contents and liquid water contents.