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Phase Doppler Interferometry for Efficient Cloud Drop Size Distribution, Number Density, and LWC Measurements

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Abstract

Threats to aviation safety as a result of super-cooled large drops (SLD) has been addressed by the FAA rules change (14 CFR Part 25) with the additional icing certification requirement. SLD clouds often consist of bi-modal drop size spectra leading to significant problems in simulating and characterizing these conditions in situ and in icing wind tunnels. Legacy instrumentation for measuring drop size distributions and liquid water content are challenged under these conditions. The large size range measurement problem is addressed with the development of the Phase Doppler Interferometer, Flight Probe Dual-Range (PDI FPDR). The method is described in this report along with the measurement capabilities including the dynamic measurement range and overall working size range. The PDI instrument bases drop size measurements on the light wavelength as the measurement length scale. The light wavelength is a much more robust scale, especially as compared to the light scattering intensity. Methods for accurately characterizing the sample volume in situ based on measured drop velocity and transit time are reviewed, given the importance of this parameter for merging results and measuring LWC. Droplet coincidence in the sample volume can be problematic so this condition is treated with an innovative signal parsing approach. Measurement examples acquired in the NASA IRT are provided. Measurements of LWC showed good agreement with the Artium Particle Imaging (PI) instrument but diverged from the tunnel calibration results for larger MVD values.