Comparison of Backscatter Coefficients for Airborne Cloud Probes

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A major aviation hazard is power loss caused by ice particle accumulation within jet engines. High-altitude cirrus clouds are especially dangerous since pilots are often unaware when the aircraft is flying in high ice particle conditions. The commercial aerospace industry is currently investigating several approaches to mitigate the risks posed by high-concentration ice crystal conditions. One such approach uses specially-designed airborne lidar systems to quantify high concentrations of ice crystals, which enables pilots, or engine control systems, to enact appropriate counter-measures. A key component in developing a high ice crystal concentration mitigation system is reference measurements of ice crystal size distributions taken by reliable cloud probes.

Research aircraft flights in Florida anvil cirrus clouds on 31 July 2015, 1 August 2015, and 2 August 2015 have segments with different temperatures, habits, and particle size distributions. Measurements with wing-mounted probes (Cloud Droplet Probe (CDP), Two-Dimensional Stereographic (2D-S) probe, and High-Volume Precipitation Spectrometer Version Three (HVPS3)) are processed to obtain particle size distributions with a corresponding measurement uncertainty. The backscatter coefficient is calculated from *in-situ* measured particle size distribution using the backscatter efficiency determined using Mie theory for small particles and a backscatter efficiency equal to one for large particles. The comparison of the 1 Hz derived backscatter coefficient to the measured backscatter coefficient from an on-board lidar system known as the Optical Ice Detector (OID) shows varying degrees of agreement for the ice cases; however, there is a clear negative bias for the liquid water cases. Total water content measurements are correlated with changes in the OID Lidar measurements. The agreement between the OID and cloud probe observations indicate that the OID could be used successfully to mitigate the ice particle risk for jet engines.