



HAIC/HIWC field campaign – investigating ice microphysics in high ice water content regions of mesoscale convective systems

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Despite existing research programs focusing on tropical convection, high ice water content (IWC) regions in Mesoscale Convective Systems (MCS) - potentially encountered by commercial aircraft and related to reported in-service events - remain poorly documented either because investigation of such high IWC regions was not of highest priority or because utilized instrumentation was not capable of providing accurate cloud microphysical measurements.

To gather quantitative data in high IWC regions, a multi-year international HAIC/HIWC (High Altitude Ice Crystals / High Ice Water Content) field project has been designed including a first field campaign conducted out of Darwin (Australia) in 2014. The French Falcon 20 research aircraft had been equipped among others with a state-of-the-art in situ microphysics package including the IKP (isokinetic evaporator probe which provides a reference measurement of IWC and TWC), the CDP (cloud droplet spectrometer probe measuring particles in the range 2-50 μm), the 2D-S (2D-Stereo, 10-1280 μm) and PIP (precipitation imaging probe, 100-6400 μm) optical array probes. Microphysical data collection has been performed mainly at -40°C and -30°C levels, whereas little data could be sampled at -50°C and at $-15^{\circ}\text{C}/-10^{\circ}\text{C}$.

The study presented here focuses on ice crystal size properties, thereby analyzing in detail the 2D image data from 2D-S and PIP optical array imaging probes. 2D images recorded with 2D-S and PIP were processed in order to extract a large variety of geometrical parameters, such as maximum diameter (D_{max}), 2D surface equivalent diameter (D_{eq}), and the corresponding number particle size distribution (PSD). Using the PSD information from both probes, a composite size distribution was then built, with sizes ranging from few tens of μm to roughly 10 mm. Finally, mass-size relationships for ice crystals in tropical convection were established in terms of power laws in order to compute median mass diameters MMD_{max} and MMD_{eq} .

The preliminary analysis of all HAIC/HIWC flights, performed during the first flight campaign out of Darwin, demonstrate that various flights include high IWC regions mostly produced by high concentrations of small crystals while other flights with similar peak IWCs show high IWC regions nevertheless composed of primarily larger particles. This interesting result indicates that high IWC can be produced and or maintained in various environments, preferentially high concentrations of small crystals, however sometimes by smaller concentrations of larger sized crystal populations. These variations in crystal sizes producing comparable high IWC values are reflected by respective variations in MMD_{max} and MMD_{eq} .

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