In-situ observations of ice crystal habits, their complexity and angular light scattering properties during ACRIDICON-CHUVA

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Cirrus clouds are ubiquitous throughout the upper troposphere and are known to have a significant impact on Earth's climate (Baker, 1997; Liou, 1986; Lynch et al. 2012). Tropical cirrus clouds are among the most frequent high level clouds, as up to 70% of tropics are covered with cirrus cloud systems (e.g. Nazaryan et al., 2008; Guignard et al., 2012). Convection plays an important role in the formation of ice crystals and their transportation to upper troposphere. To study the microphysics of these convective outflow systems in-situ, the German-Brazilian cooperative aircraft campaign ACRIDICON-CHUVA on the German research aircraft HALO was conducted over the Amazonas in September/October 2014.

During the campaign, we operated the novel Particle Habit Imaging and Scattering Probe (PHIPS-HALO), which simultaneously takes stereoscopic images of individual ice crystals and measures their scattering phase function. The stereoscopic images were used to identify the ice crystals habits in convective outflows and in-situ cirrus. Additionally, the crystal complexity of small (<50 μm) ice crystals were determined from SID3 diffraction patterns.

We found a clear separation of the ice particle habits in convective anvils and in-situ cirrus. The dominant ice particle habit in anvils were plates and aggregates of plates, indicating the growth of the ice particles had taken place in the convective cells at temperatures around -20°C. In-situ cirrus ice particle habits were found to be mainly vapor grown columns and bullet. We frequently found high aerosol concentrations (>1000 cm^{-3}) at the boundary layer below the convective cells. The high aerosol number concentrations correlated with a high fraction of plate-like ice particles. Generally, little or almost no indications of homogeneous freezing in the form of frozen droplets were found. Surprisingly, the scattering properties of the measured in-situ and outflow cirrus did not significantly differ from each other, despite the clear separation of the particle habits. We measured a smooth and featureless scattering phase function with high fraction of backward scattering (low asymmetry parameter). The similarity of the scattering phase function is argued to be due to high degree crystal complexity observed during the campaign.