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Detecting warm rain from shallow trade wind convection by airborne radar

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One of the sources of uncertainty for climate predictions is the onset of precipitation from shallow convection in the trade wind region. Two aircraft campaigns with the HALO (High Altitude LOng range) aircraft took place in the recent past in the tropical Atlantic upstream of the island of Barbados: NARVAL-South (Next-generation Aircraft Remote-Sensing for VALidation studies) in December 2013, during the dry season, and NARVAL2 in August 2016, during the wet season. During these two campaigns, a wide range of cloud regimes from shallow to deep convection were sampled.

Part of the NARVAL payload on HALO is a 35 GHz cloud radar. Cloud radar measurements are used to analyze clouds and precipitation in shallow convection. It is, however, not straightforward to discriminate between signal of clouds and signal of rain in these radar data. Doppler velocity measurements exist, but aircraft motion and orientation lead to a broadened Doppler spectrum and possibly aliasing. Therefore, these measurements are not helpful for the discrimination. In this presentation, we follow the strategy to determine the cloud base height from other measurements to use as a boundary height between cloud and precipitation in radar data.

This presentation will demonstrate practicability of different methods to estimate cloud base height and thus identify warm rain from airborne cloud radar measurements. The lifting condensation level is calculated from dropsonde profiles and is used as cloud base. We further explore the possibility of using airborne lidar data to identify cloud base heights for optically thin clouds in the vicinity and use the cloud base height determined with this method also for raining clouds. Statistics of the number of precipitating shallow convective clouds from different methods will be analyzed. Results from aircraft measurements during the two campaigns show that about 50 % of shallow convective clouds with about 1 km depth precipitate.