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Using airborne lidar and weather radar measurements to characterize the interplay between aerosol and shallow marine trade wind clouds

Florian Ewald, Silke Groß, Martin Wirth, Martin Hagen, and Manuel Gutleben
Deutsches Zentrum für Luft- und Raumfahrt, Institut für Physik der Atmosphäre, Oberpfaffenhofen, Germany
(florian.ewald@dlr.de)

The interaction of aerosol, clouds, and water vapor is still a major source of uncertainty in projections of Earth's future climate. Especially in the trades, the response of shallow marine trade wind convection to external forcings is poorly understood. These low-level clouds have an important cooling effect on surface temperatures, while their amount and height are directly influenced by the radiative cooling by aerosols and water vapor aloft. Furthermore, there is evidence that aerosols can modify the microphysical properties (e.g., by glaciation) and the precipitation formation inside these clouds while water vapor above the trade inversion influences the atmospheric stability in which they form. Due to the small horizontal scale of these clouds, the vertical separation of atmospheric layers, and the temporal evolution of precipitation, the observation of this interplay by geostationary satellites is scarce.

To alleviate this observational data gap over the tropical North-Atlantic region, airborne lidar and cloud radar measurements were performed in the vicinity of Barbados and complemented with dedicated weather radar measurements during the EUREC4A campaign in February 2020. Aerosol properties and the vertical water vapor profile were characterized with simultaneous high spectral resolution and differential absorption measurements using the WALES lidar onboard the German research aircraft HALO. On the same platform, the vertical cloud extent and the presence of precipitation were sampled with the high-power Ka-band cloud radar HAMP MIRA. To capture the temporal evolution of precipitation patterns, these measurements were complemented with measurements of the C-band polarimetric weather radar POLDIRAD which was installed on the windward side of Barbados. During EUREC4A, measurements flights were conducted in high and low aerosol loads to sample its influence on the marine trade wind convection.

This presentation will briefly introduce the instrumentation, data processing, and availability and give an overview of gained insights and ongoing studies. By means of case studies, we will give first impressions of the complementary nature of the collocated, highly resolved airborne measurements and the POLDIRAD measurements which provide the horizontal context and temporal evolution of the precipitation formation. By combining the cross-sectional snapshots with the temporal evolution of the precipitation pattern we will provide a detailed insight into the interplay between the aerosol and water vapor layer and the precipitation formation in the

shallow marine trade wind convection.