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Airborne observations of cloud properties on HALO during NARVAL

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The representation of cloud and precipitation processes is one of the largest sources of uncertainty in climate and weather predictions. To validate model predictions of convective processes over the Atlantic ocean, usually satellite data are used. However, satellite products provide just a coarse view with poor temporal resolution of convective maritime clouds. Aircraft-based observations offer a more detailed insight due to lower altitude and high sampling rates.

The research aircraft HALO (High Altitude Long Range Research Aircraft) is operated by the German Aerospace Center (DLR). With a ceiling of 15 km, and a range of 10,000 km and more than 10 hours it is able to reach remote regions and operate from higher altitudes than most other research aircraft. Thus, it provides the unique opportunity to exploit regions of the atmosphere that cannot be easily accessed otherwise. Measurements conducted on HALO provide more detailed insights than achievable from satellite data. Therefore, this measurement platform bridges the gap between previous airborne measurements and satellites. The payload used for this study consists of, amongst others, a suite of passive microwave radiometers, a cloud radar, and a water vapor DIAL.

To investigate cloud and precipitation properties of convective maritime clouds, the NARVAL (Next-generation Aircraft Remote-Sensing for Validation Studies) campaign was conducted in winter 2013/2014 out of Barbados and Keflavik (Iceland). This campaign was one of the first that took place on the HALO aircraft. During the experiment's two parts 15 research flights were conducted (8 flights during NARVAL-South out of Barbados to investigate trade-wind cumuli and 7 flights out of Keflavik with focus on mid-latitude cyclonic systems). Flight durations were between five and nine hours, amounting to roughly 118 flight hours overall. 121 dropsondes were deployed. In fall 2016 two additional aircraft campaigns with the same payload will take place: The second phase of NARVAL will focus on trade-wind cumuli observations and the NAWDEX (North-Atlantik Waveguide EXperiment) campaign will investigate the warm sector and frontal zones of mid-latitude cyclones.

During the first NARVAL campaign, a broad range of cloud regimes from shallow cumuli to cumulonimbus and cold fronts was observed. Derived cloud covers from different instruments on board HALO varied by as much as 25 % since cloud radar, microwave radiometers, lidar and dropsondes measure different aspects of clouds. A cloud mask combining these observations provides a complimentary view of clouds and allows for identification of joint cloud characteristics (e.g., cloud top of ice or water clouds, cloud depth). We will present benefits gained from this combination of measurements and provide a more comprehensive view on clouds and cloud properties in different cloud regimes. Furthermore, we will give an overview of the plans for future campaigns and demonstrate what new insights we can gain from these airborne observations within the scope of past and future campaigns.