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From airborne cloud remote sensing observations to cloud regime classification

Heike Konow and Felix Ament
Hamburg University, Meteorological Institute, Hamburg, Germany (heike.konow@uni-hamburg.de)

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 such as the cloud remote sensing configuration NARVAL (Next-generation Aircraft Remote-Sensing for Validation Studies) on the German research aircraft HALO (High Altitude Long Range Research Aircraft) offer a more detailed insight due to lower altitude and higher sampling rates than satellite data.

Part of the NARVAL payload on HALO is the HALO Microwave Package (HAMP) which consists a suite of passive microwave radiometers with 26 frequencies in different bands between 22.24 and 183.31 $\pm$ 12.5 GHz and a cloud radar at 36 GHz. This payload was flown on HALO between 2013 and 2016 on several campaigns: NARVAL-I (2013 and 2014), NARVAL-II (2016), NAWDEX (2016, North Atlantic Waveguide and Downstream Impact Experiment).

Cloud regimes can be characterized by cloud macrophysical parameters such as cloud fraction, cloud top height, cloud length, etc. During all campaigns, a range of different cloud regimes were investigated. For example, during NARVAL-I (South) and NARVAL-II, cloud fraction observed by HAMP instruments ranged between 10 % and 40 % over the duration of the individual flights. During NARVAL-I (North) and NAWDEX, cloud fraction was between 50 % and 80 %. This shows the range of cloud parameters in different regimes.

Cloud regime classification can be approached in two different ways: regimes can be deduced by analyzing a priori information such as atmospheric thermodynamic profiles and satellite data and then infer the cloud characteristics in these conditions. The second, inductive, approach is to characterize cloudy scenes by cloud macrophysical parameters. We will present both approaches and show how cloud macrophysical parameters from radar and radiometer observations onboard HALO can be used to characterize different cloud regimes during past aircraft campaigns. This allows for a classification of measurement segments directly from aircraft observations to use in satellite and model evaluations.