EGU24-7424, updated on 13 Oct 2024
https://doi.org/10.5194/egusphere-egu24-7424
EGU General Assembly 2024

Characterizing the influence of riming on the spatial variability of ice water content in mixed-phase clouds using airborne data

Nina Maherndl[1], Manuel Moser[2,3], Mario Mech[4], Nils Risse[4], Aaron Bansemer[5], and Maximilian Maahn[1]

[1]Institute for Meteorology, Leipzig University, Leipzig, Germany (nina.maherndl@uni-leipzig.de)
[2]Institute for Physics of the Atmosphere, Johannes GutenbergUniversität, Mainz, Germany
[3]Institute for Physics of the Atmosphere, German Aerospace Center (DLR), Wessling, Germany
[4]Institute for Geophysics and Meteorology, University of Cologne, Cologne, Germany
[5]National Center for Atmospheric Research, Boulder, Colorado, USA

Observations show that ice water content (IWC) is not distributed homogeneously in mixed-phase clouds (MPC). Instead, high IWC tends to occur in clusters. However, it is not sufficiently understood, which ice crystal formation and growth processes play a dominant role in IWC clustering. Additionally, spatial scales of IWC clusters are not well known. This leads to uncertainties of atmospheric models in representing MPC.

Riming, which occurs when liquid water droplets freeze onto ice crystals, is an important ice crystal growth process. It plays a key role in precipitation formation in MPC by efficiently converting liquid cloud water into ice.

In this study, we analyze the influence of riming on IWC variability and compare shallow Arctic MPC to mid-latitude winter storms. We use airborne data collected during the HALO-(AC)^3 field campaign performed in spring 2022 west of Svalbard, and the IMPACTS field campaign, which took place over the eastern USA (winter 2020, 2022 and 2023). In both campaigns, two aircraft were flying in formation collecting closely spatially collocated and almost simultaneous in situ and remote sensing observations.

We quantify the amount of riming using the normalized rime mass M, which we retrieve from a closure of measured radar reflectivity Z_e and measured in situ particle size distributions (PSD). As forward operators in the M retrieval, we use the Passive and Active Microwave radiative TRAnsfer tool (PAMTRA) and empirical relationships of M and particle properties. We calculate IWC from the retrieved M and the measured PSD. In addition, we calculate IWC assuming no riming (M = 0) and perform forward simulations of Z_e for the (theoretical) unrimed case.
Then, we quantify spatial variability of IWC and Z_e with and without riming using autocorrelation, pair correlation, and power spectra. Further, we compare shallow Arctic MPC to mid-latitude winter storms and analyze the role of ice particle number concentration and size.

This will lead to a better understanding of the spatial scale and driver of IWC variability and

thereby help to improve modeling of MPC.