



Investigating dust aerosol effects on mixed-phase cloud glaciation based on an intercomparison of satellite observations

Sarah Brüning¹, Martin Stengel¹, and Daniel Robbins²

¹Deutscher Wetterdienst (DWD), Offenbach, Germany (Sarah.Brueining@dwd.de)

²RAL Space, Rutherford Appleton Laboratory, Harwell, United Kingdom

In the temperature range between 0 °C and –39 °C, clouds may exist in the liquid phase, the ice phase, or as a mixture of both. Cloud glaciation, defined as the transition from liquid to ice, can be driven by multiple processes. On the one hand, enhanced glaciation may result from secondary ice production. On the other hand, atmospheric aerosols can act as ice-nucleating particles (INPs) and initiate ice crystal formation. Previous studies have highlighted the role of mineral dust as the dominant INP source for cloud glaciation at temperatures below –15 °C.

Although recent findings indicate a correlation between aerosol concentration and cloud glaciation, quantifying aerosol–cloud interactions remains challenging. To better characterize and disentangle the natural spatial and temporal variability of relevant observables governing this relationship, this study combines data from multiple satellite instruments (MSG SEVIRI, MODIS, and IASI). In addition, these observations are compared to ICON model outputs and CAMS reanalysis data. The objective is to provide an assessment of the sensitivity of cloud phase to dust aerosol concentration for given temperatures and synoptic conditions across different datasets.

We primarily investigate the influence of the dust aerosol optical depth (DAOD) in the region between the equator and the subtropical dust belt (0–30° N/S). Our findings highlight the relationship between DAOD and cloud glaciation, characterized by a particularly strong increase in glaciation at high DAOD values. The analysis further includes stratification by large-scale synoptic conditions and cloud type, allowing us to narrow down potential differences between convective and stratiform clouds.

Finally, we examine how the integration of vertical profiles from EarthCARE may facilitate the detection of not only horizontally but also vertically collocated cloud and aerosol layers, thereby improving statistical estimates of aerosol–cloud interactions.