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Microphysical Ice Crystal Properties in Mid-Latitude Frontal Cirrus

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Cirrus clouds modulate the climate by reflection of shortwave solar radiation and trapping of longwave terrestrial radiation. Their net radiative effect can be positive or negative depending on atmospheric and cloud parameters including ice crystal number density, size and shape. Latter microphysical ice crystal properties have been measured during the mid-latitude cirrus mission ML-CIRRUS with a set of cloud instruments on the new research aircraft HALO. The mission took place in March/April 2014 with 16 flights in cirrus formed above Europe and the Atlantic. The ice clouds were encountered at altitudes from 7 to 14 km in the typical mid-latitude temperature range. A focus of the mission was the detection of frontal cirrus linked to warm conveyor belts (WCBs). Within WCBs, water vapor is transported in the warm sector of an extra-tropical cyclone from the humid boundary layer to the upper troposphere. Cirrus cloud formation can be triggered in the WCB outflow region at moderate updraft velocities and additionally at low updrafts within the high pressure system linked to the WCB. Due to their frequent occurrence, WCBs represent a major source for regions of ice supersaturation and cirrus formation in the mid-latitudes.

Here, we use data from the Cloud and Aerosol Spectrometer with detection for POLarization (CAS-POL) and the Cloud Combination Probe (CCP), combining a Cloud Droplet Probe (CDP) and a greyscale Cloud Imaging Probe (CIPgs) to investigate the ice crystal distribution in the size range from 0.5 μm to 1 mm. We derive microphysical cirrus properties in mid-latitude warm front cirrus. Further, we investigate their variability and their dependence on temperature and relative humidity. Finally, we compare the microphysical properties of these frontal cirrus to cirrus clouds that formed at low updrafts within high pressure systems or at high updraft velocities in lee waves. We quantify statistically significant differences in cirrus properties formed in these various meteorological regimes. Our studies of mid-latitude cirrus clouds help to better understand their radiative properties in order to assess their impact on climate.