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Investigating the differences of cirrus cloud properties in nucleation, growth and sublimation regions based on airborne water vapor lidar measurements

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Cirrus clouds impose high uncertainties on weather and climate prediction, as knowledge on important processes is still incomplete. For instance it remains unclear how cloud optical, microphysical, and radiative properties change as the cirrus evolves. To gain better understanding of cirrus clouds, their optical and microphysical properties and their changes with cirrus cloud evolution the ML-CIRRUS campaign was conducted in March and April 2014. Measurements with a combined in-situ and remote sensing payload were performed with the German research aircraft HALO based in Oberpfaffenhofen. 16 research flights with altogether 88 flight hours were performed over the North-Atlantic, western and central Europe to probe different cirrus cloud regimes and cirrus clouds at different stages of evolution.

One of the key remotes sensing instruments during ML-CIRRUS was the airborne differential absorption and high spectral lidar system WALES. It measures the 2-dimensional distribution of water vapor inside and outside of cirrus clouds as well as the optical properties of the clouds. Bases on these airborne lidar measurements a novel classification scheme to derive the stage of cirrus cloud evolution was developed. It identifies regions of ice nucleation, particle growth by deposition of water vapor, and ice sublimation. This method is used to investigate differences in the distribution and value of optical properties as well as in the distribution of water vapor and relative humidity depending on the stage of evolution of the cloud. We will present the lidar based classification scheme and its application on a wave driven cirrus cloud case, and we will show first results of the dependence of optical cloud properties and relative humidity distributions on the determined stage of evolution.