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Validation of the large-scale Lagrangian cirrus model CLaMS-Ice by in-situ measurements

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Cirrus clouds are an element of uncertainty in the climate system and have received increasing attention since the last IPCC reports. The interaction of varying freezing meachanisms, sedimentation rates, temperature and updraft velocity fluctuations and other factors that lead to the formation of those clouds is still not fully understood. During the ML-Cirrus campaign 2014 (Germany), the new cirrus cloud model CLaMS-Ice (see Rolf et al., EGU 2015) has been used for flight planning to direct the research aircraft HALO into interesting cirrus cloud regions. Now, after the campaign, we use our in-situ aircraft measurements to validate and improve this model – with the long-term goal to enable it to simulate cirrus cloud cover globally, with reasonable computing times and sufficient accuracy.

CLaMS-Ice consists of a two-moment bulk model established by Spichtinger and Gierens (2009a, 2009b), which simulates cirrus clouds along trajectories that the Lagrangian model CLaMS (McKenna et al., 2002 and Konopka et al. 2007) derived from ECMWF data. The model output covers temperature, pressure, relative humidity, ice water content (IWC), and ice crystal numbers (N_{ice}). These parameters were measured on board of HALO by the following instruments: temperature and pressure by BAHAMAS, total and gas phase water by the hygrometers FISH and SHARC (see Meyer et al 2014, submitted to ACP), and N_{ice} as well as ice crystal size distributions by the cloud spectrometer NIXE-CAPS (see also Krämer et al., EGU 2015).

Comparisons of the model results with the measurements yield that cirrus clouds can be successfully simulated by CLaMS-Ice. However, there are sections in which the model's relative humidity and N_{ice} deviate considerably from the measured values. This can be traced back to e.g. the initialization of total water from ECMWF data. The simulations are therefore reinitiated with the total water content measured by FISH. Other possible sources of uncertainties are investigated, as imposed temperature fluctuations, numbers and efficencies of heterogeneous ice nuclei or assumptions concerning the sedimentation rates.

This contribution sums up the results of these investigations and outlines future work on CLaMS-Ice, that will lead to a tool helping to understand the cirrus clouds under the different environmental conditions during ML-Cirrus.