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Assessment of global ice crystal number concentration estimates from lidar-radar satellite remote-sensing

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The number concentration of cloud particles is a central quantity for understanding aerosol-cloud interactions and describing clouds in climate and numerical weather prediction models. In contrast with recent advances for liquid clouds, few observational constraints exist on the ice crystal number concentration (N_i).

This work presents results based on a newly developed retrieval of N_i, derived from combined lidar-radar measurements. The operational liDAR-raDAR (DARDAR) product serves as an existing base for this method, which focuses at the moment on ice clouds with temperatures T_c < -30°C.

We first show that this new N_i product compares reasonably well against in situ measurements from mid-latitude and tropical airborne field campaigns. Current limitations are nevertheless discussed. Following this evaluation, this new product is analyzed in the context of a case study representative of a frontal system. Regional reanalyses are jointly used to assess the physical consistently of N_i spatial distributions. Finally, this consistency is discussed based on 10 years global climatologies. Notably, increases in N_i are found towards cold temperatures and, more significantly, in the presence of strong updrafts, such as those related to convective or orographic uplifts.

Further evaluation and improvements of this method are needed but these results already constitute a first encouraging step towards large-scale observational constraints for N_i.