How often and how strongly does riming occur in non-convective clouds?

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Riming is one of the major microphysical precipitation processes in clouds. Riming significantly alters the mass flux in clouds and enhances the amount of snowfall accumulated on the ground. In addition, riming is also a critical factor for secondary ice processes and indicates the presence of large, super-cooled droplets which are of high relevancy for aircraft icing warning methods.

Up to now, statistics of the frequency or seasonal dependence of riming are completely missing. This is to some extent surprising as there exists a close relation of the Doppler velocity measured by zenith pointing radars and the degree of riming of the ice particles. The steadily increasing time series of ground-based cloud radar observations at various locations (e.g. within the ARM program or from European sites) bears thus the potential to infer a first climatology of riming for non-convective clouds. Such statistics can be also very valuable for the upcoming EarthCare mission which will deploy for the first time a Doppler radar in space and thus allows to apply similar techniques globally.

In this contribution we will first present the overall concept on how to extract information about the intensity of riming from zenith radar observations. We will present new radar retrievals for riming which have been derived from large in-situ datasets obtained during a recent ARM campaign in Finland. The new relations are then applied to multi-year cloud radar datasets from stations across Europe including a site in the Arctic. The most striking finding is that the frequency of riming seems to be a strong and almost universal function of temperature. This finding could be very valuable for parameterizing riming in weather and climate models as well as for improving warnings of aircraft icing.