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Retrieving fog liquid water content using a new 94 GHz FMCW cloud radar

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The vertical distribution of the liquid water content (LWC) in fog and low stratus is a critical microphysical parameter since it essentially influences the interaction between these low level clouds and the solar and terrestrial radiation.
Despite of this importance there are only few investigations concerning LWC-profiles during fog events, which are mainly restricted to balloon borne measurements and suffer from a low temporal resolution. Therefore, no continuous records covering the whole life cycle of fog events can be provided for climatology studies.
A new ground based frequency modulated continuous wave (FMCW) cloud radar has the po-tential to fill this lack of knowledge. Working at a frequency of 94 GHz (wavelength 3 mm) it is ideal for monitoring low level water clouds. The radar can detect clouds at a minimum height range of ∼30 m and provides a vertical resolution of 4m: This offers the potential to retrieve detailed vertical structures of fog and low stratus.
The reconstruction of the LWC-profile can be accomplished due to the close relationship be-tween the cloud LWC and the detected radar reflectivity. However, this relationship depends strongly on the drop size distribution within the cloud. The strength of the radar reflectivity is related to the sixth power of the drop size distribution and the LWC is related to the latter by the third power.
Former studies yielded the existence of different fog evolutionary stages with characteristical drop size distributions. In order to explore the effect of the different drop size distribution on the relationship between the radar reflectivity and the LWC we conducted radiative transfer calculations with characteristical drop size distributions and LWC-profiles taken from the literature.
For this purpose we adapted the radiative transfer model (RTM) QuickBeam developed for the Cloudsat satellite to our ground based microwave radar. Beside the adaptation to the verti-cal resolution of the ground based cloud radar, the so-called modified gamma distribution, suitable to describe the drop size distribution in fog and low stratus, was implemented into the RTM. By applying representative coefficients for different fog evolutionary stages to the modified gamma distribution together with typical fog LWC-profiles the resulting radar re-flectivity was calculated.
The poster presents the findings of the sensitivity study together with the conception of a new technique to retrieve fog LWC-profiles by means of a novel ground based 94 GHz FMCW cloud radar.