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Ice microphysics retrievals using polarimetric and dual-wavelength radar data – a sensitivity study regarding the assumed ice particle model

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The importance of robust ice microphysics retrievals has been highlighted in the past by several studies. The accurate representation of ice microphysical processes can reduce the uncertainty in numerical weather models which have to deal with the complex nature – various habits, densities, sizes – of ice hydrometeors. To constrain microphysics information, we developed an ice microphysics retrieval algorithm combining measurements from two spatially separated radar instruments. The radar measurements comprise a novel combination of dual-wavelength and polarimetric perspective (i.e., differential radar reflectivity, Z_{DR}) on ice hydrometeors. Exploiting the different scattering behavior (Rayleigh or Mie region) in different radar bands, the dual-wavelength dataset provides information about the ice hydrometeor size within clouds. In addition, Z_{DR} from one of the radar instruments was also used to constrain the shape of ice particles. The measurements were performed with the C-band POLDIRAD (German Aerospace Center, Oberpfaffenhofen) and the Ka-band MIRA-35 (Ludwig-Maximilians-Universität, Munich) using coordinated range-height-indicator (RHI) scans to capture precipitation formation within the 23 km long cross-section between both instruments. To infer microphysical properties, T-matrix scattering simulations were performed in combination with necessary a-priori assumptions about the ice hydrometeors. Due to its versatility, we used the soft spheroid approximation to represent the prevalent ice particles. This approach along with a pre-defined relation between mass and particles dimension (mass-size relation) can help to constrain the prevalent ice particle density, a parameter which is known to be hardly constrained in numerical weather and climate models. In this work, we conducted several sensitivity studies to investigate which assumptions on mass-size relation, particle size distribution and shape (oblate or horizontally aligned prolate) can reproduce our radar observations for the soft spheroid ice model. We also investigated how these assumptions can influence the retrieved median size, the apparent shape and the ice water content of ice particles populations. Our hypotheses were tested for a stratiform precipitation case from a snowfall event over Munich in January 2019.