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Identifying sensitivities for global and regional cirrus modelling

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Sensitivities of microphysical characteristics of cirrus clouds strongly alter the dynamical and radiative properties of the atmosphere. Thus in our study, idealized orographic and high-resolution simulations are performed to determine the controlling factors for cirrus formation. For this purpose a two-moment cloud ice scheme is used. This new ice microphysics scheme is an extension of the cloud ice parameterisation operational in the numerical weather prediction models at the German Weather Service (Deutscher Wetterdienst, DWD). As the new cirrus cloud scheme needs to be compatible with both, non-hydrostatic regional and high-resolution global models, numerical stability and physical consistency has to be ensured for a wide range of time steps. Ice nucleation is described using state-of-the-art parameterisations for homogeneous and heterogeneous nucleation. While the latter mainly depends on the existence of ice nuclei, homogeneous freezing of supercooled liquid aerosol occurs in regions with high ice supersaturations and high cooling rates, i.e. in strong vertical updrafts. Further extensions of the operational scheme are made such as particle sedimentation and tracking for activated ice nuclei, which is necessary to avoid an overestimation of heterogeneous nucleation. A relaxation method is applied to achieve a consistent treatment of the depositional growth of the two small-particle ice modes and the larger snowflakes. A systematic sensitivity study shows that the detailed choices in the design of the scheme do matter for the competition of heterogeneous vs. homogeneous nucleation and the representation of ice supersaturation. For validation, the global model GME simulations are compared to CALIPSO lidar data.