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Ice formation in altocumulus clouds over Leipzig: Remote sensing measurements and detailed model simulations

Martin Simmel, Johannes Bühl, Albert Ansmann, and Ina Tegen
Leibniz Institute for Tropospheric Research, Leipzig, Germany (simmel@tropos.de)

Over Leipzig, altocumulus clouds are frequently observed using a suite of remote sensing instruments. These observations cover a wide range of heights, temperatures, and microphysical properties of the clouds ranging from purely liquid to heavily frozen. For the current study, two cases were chosen to test the sensitivity of these clouds with respect to several microphysical and dynamical parameters such as aerosol properties (CCN, IN), ice particle shape as well as turbulence.
The mixed-phase spectral microphysical model SPECS was coupled to a dynamical model of the Asai-Kasahara type resulting in the model system AK-SPECS. The relatively simple dynamics allows for a fine vertical resolution needed for the rather shallow cloud layers observed. Additionally, the proper description of hydrometeor sedimentation is important especially for the fast growing ice crystals to realistically capture their interaction with the vapour and liquid phase (Bergeron-Findeisen process). Since the focus is on the cloud microphysics, the dynamics in terms of vertical velocity profile is prescribed for the model runs and the feedback of the microphysics on dynamics by release or consumption of latent heat due to phase transfer is not taken into account.
The microphysics focuses on (1) ice particle shape allowing hexagonal plates and columns with size-dependant axis ratios and (2) the ice nuclei (IN) budget realized with a prognostic temperature resolved field of potential IN allowing immersion freezing only when active IN and supercooled drops above a certain size threshold are present within a grid cell.
Sensitivity studies show for both cases that ice particle shape seems to have the major influence on ice mass formation under otherwise identical conditions. This is due to the effect (1) on terminal fall velocity of the individual ice particle allowing for longer presence times in conditions supersaturated with respect to ice and (2) on water vapour deposition which is enhanced due to increased capacitance because of deviation from the spherical shape.