Impact of nucleation rates and diffusional growth on ice nucleation events

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Cirrus clouds in the tropopause region form via two major different pathways, i.e. freezing supercooled cloud droplets (liquid origin) or nucleating ice crystals at humidities below water saturation (in situ formation). The latter case takes place in the low temperature regime (T<235K) and it is assumed that in this regime homogeneous freezing of supercooled solution droplets (short: homogeneous nucleation) is the dominant formation pathway. For homogeneous nucleation, a nucleation rate has been derived from laboratory experiments, based on water activity. The formulation of the nucleation rate is reassessed and simple but robust approximations are presented, which can be used in less complex models without a direct interaction with aerosols. The impact of nucleation rates and the formulation of diffusional growth for idealized nucleation rates is investigated. It can be found that the absolute value of the nucleation rate has almost no impact on the produced ice crystal number concentrations, whereas the steepness of the rate is much more important. Finally, it turns out that the formulation of diffusional growth affects nucleation events crucially in terms of produced ice crystal numbers.