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Thermodynamics of homogeneous nucleation of ice particles in the polar summer mesosphere

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Abstract. We present the hypothesis of homogeneous nucleation of ice nano-particles in the polar summer mesosphere. The nucleation of condensed phase is traced back to the first step on the formation pathway, which is assumed to be the transition of water vapor to amorphous cluster. Amorphous clusters then freeze into water ice, likely metastable cubic ice, when they reach the critical size. The estimates based on the equilibrium thermodynamics give the critical size (radius) of amorphous water clusters as about 1.0 nm. The same estimates for the final transition step, that is the transformation of cubic to hexagonal ice, give the critical size of about 15 nm at typical upper mesospheric conditions during the polar summer (temperature $T=150$ K, water vapor density $\rho_{\text{vapor}}=10^9$ cm⁻³).

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