# Ion-mediated nucleation in the atmosphere: Key controlling parameters, implications, and look-up table

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**Abstract**. Nucleation is an important source of atmospheric particles and ubiquitous ions in the atmosphere have long been known to promote nucleation. An ion-mediated nucleation (IMN) mechanism based on a kinetic model is supported by recent measurements of the excess charge on freshly nucleated particles and ion cluster evolution during nucleation events. Here we investigate the dependence of steady state IMN rate ($J_{IMN}$) on key controlling parameters. We find that sulfuric acid vapor concentration, temperature, relative humidity, ionization rate, and surface area of pre-existing particles have profound and non-linear impacts on $J_{IMN}$. The sensitivities of $J_{IMN}$ to the changes in these key parameters may imply important physical feedback mechanisms involving climate and emission changes, solar variations, nucleation, aerosol number abundance, and aerosol indirect radiative forcing. We also describe a five-dimensional $J_{IMN}$ look-up table derived from the most recent version of IMN model, with the key parameters covering a wide range of atmospheric conditions. With the look-up table and a multiple-variable interpolation subroutine, $J_{IMN}$ and the properties of critical clusters under given atmospheric conditions can be determined efficiently and accurately. The look-up table reduces the computational costs of the IMN rate calculations significantly (by a factor of around ~ 8000), and can be readily incorporated into multi-dimensional models to study the secondary particle formation via IMN and associated climatic and health effects.