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Distribution of meteoric smoke – sensitivity to microphysical properties and atmospheric conditions

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Abstract. Meteoroids entering the Earth's atmosphere experience strong deceleration and ablate, whereupon the resulting material is believed to re-condense to nanometre-size "smoke particles". These particles are thought to be of great importance for many middle atmosphere phenomena, such as noctilucent clouds, polar mesospheric summer echoes, metal layers, and heterogeneous chemistry. The properties and distribution of meteoric smoke depend on poorly known or highly variable factors such as the amount, composition and velocity of incoming meteoric material, the efficiency of coagulation, and the state and circulation of the atmosphere. This work uses a one-dimensional microphysical model to investigate the sensitivities of meteoric smoke properties to these poorly known or highly variable factors. The resulting uncertainty or variability of meteoric smoke quantities such as number density, mass density, and size distribution are determined. It is found that the two most important factors are the efficiency of the coagulation and background vertical wind. The seasonal variation of the vertical wind in the mesosphere implies strong global and temporal variations in the meteoric smoke distribution. This contrasts the simplistic picture of a homogeneous global meteoric smoke layer, which is currently assumed in many studies of middle atmospheric phenomena. In particular, our results suggest a very low number of nanometre-sized smoke particles at the summer mesopause where they are thought to serve as condensation nuclei for noctilucent clouds.

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