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Multicomponent aerosol dynamics model UHMA: model development and validation

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Abstract. A size-segregated aerosol dynamics model UHMA (University of Helsinki Multicomponent Aerosol model) was developed for studies of multicomponent tropospheric aerosol particles. The model includes major aerosol microphysical processes in the atmosphere with a focus on new particle formation and growth; thus it incorporates particle coagulation and multicomponent condensation, applying a revised treatment of condensation flux onto free molecular regime particles and the activation of nanosized clusters by organic vapours (Nano-Köhler theory), as well as recent parameterizations for binary H_2SO_4-H_2O and ternary H_2SO_4-NH_3-H_2O homogeneous nucleation and dry deposition. The representation of particle size distribution can be chosen from three sectional methods: the hybrid method, the moving center method, and the retracking method in which moving sections are retracked to a fixed grid after a certain time interval. All these methods can treat particle emissions and atmospheric transport consistently, and are therefore suitable for use in large scale atmospheric models. In a test simulation against an accurate high resolution solution, all the methods showed reasonable treatment of new particle formation with 20 size sections although the hybrid and the retracking methods suffered from artificial widening of the distribution. The moving center approach, on the other hand, showed extra dents in the particle size distribution and failed to predict the onset of detectable particle formation. In a separate test simulation of an observed nucleation event, the model captured the key qualitative behaviour of the system well. Furthermore, its prediction of the organic volume fraction in newly formed particles, suggesting values as high as 0.5 for 3–4 nm particles and approximately 0.8 for 10 nm particles, agrees with recent indirect composition measurements.

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