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Adaptive method of lines for multi-component aerosol condensational growth and CCN activation

[S. Arabas and H. Pawlowska](#) ▾

Received: 29 Jul 2010 – Discussion started: 19 Aug 2010 – Revised: 17 Dec 2010 – Accepted: 03 Jan 2011 – Published: 21 Jan 2011

Abstract. The process of formation of cloud droplets on an ensemble of aerosol particles is modelled by numerous investigators using the method of lines (MOL). The method involves discretisation of the aerosol size spectrum into bins whose positions evolve with time. One of the drawbacks of the method is its poor representation of the aerosol spectrum shape in the region between the unactivated aerosol mode and the activated droplet mode. An adaptive grid refinement procedure is introduced. The procedure splits any overly wide bins into several narrower ones during integration. The number of new bins added is a function of particle concentration in the bin being split. Application of the grid refinement procedure results in suppression of the sensitivity of the computed cloud droplet spectrum characteristics such as droplet number concentration or effective radius to the initial grid choice. A model of droplet formation on multi-component aerosol is formulated for the purpose of the study. Model formulation includes explicit treatment of the droplet temperature evolution. Several examples of the model set-up are used to demonstrate model capabilities. Model results are compared to those without adaptivity. A C++ implementation of the model is available as an electronic supplement of the paper.

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How to cite: Arabas, S. and Pawlowska, H.: Adaptive method of lines for multi-component aerosol condensational growth and CCN activation, *Geosci. Model Dev.*, 4, 15-31, <https://doi.org/10.5194/gmd-4-15-2011>, 2011.