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Interactive comment on "Piecewise log-normal approximation of size distributionsfor aerosol modelling" *by* K. von Salzen

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I agree with the referee that comparing the PLA method to the single-moment sectional scheme cannot produce a comprehensive evaluation of the method. However, as also indicated in my reply to Steve Ghan, who had similar concerns, I think that this comparison is an important first step because of the simple and well understood features of the scheme and its widespread use in aerosol modelling. Given the relatively large number of conceptually different approaches that are used in models, it is less obvious which other schemes should be considered. The paper will be modified to emphasize this point.

On the other hand, it appears that the method proposed by Tzivion et al. (1987) is an interesting method to compare with since it is also based on the assumption that

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aerosol number and mass concentrations can be used to constrain the size distribution within sections of the size distribution. I have used Tzivion et al.'s approach for comparisons with the observed size distributions (as in Figs. 3 and 4). I have also done additional simulations based on Tzivion et al.'s approach using the single column model (as in Figs. 7 and 8). Interestingly, according to these results, their method produces even larger rms errors than the simple single-moment sectional approach! I will explain the reason for this in the paper in detail and possibly in an additional discussion, if requested. However, a rather minor modification of Tzivion et al.'s approach leads to considerably improved results for this method. Generally, the improved version of Tzivion et al.'s method produces rms errors in Figs. 4 and 8 that are somewhere between the results of the PLA and the single-moment approaches. Results of Tzivion et al.'s and the improved method will be included in the paper.

Since it can still be argued that additional comparisons should be performed for the PLA method, I have also tested an approach that uses a representation of the aerosol size distribution in terms of second-order polynomials. For example, von Salzen and Schlünzen (1999) have used second-order polynomials to represent aerosol mass size distributions based on the approach that was proposed by Bott (1989). It turns out that this approach gives very good results when applied to the observed size distributions for 10 or more sections. However, the rms errors are considerable for the number size distribution at smaller number of sections if the method is applied to the mass size distribution (and vice versa). A more substantial problem with this approach is that it can produce negative values of the size distribution. Although there are techniques that can be used to prevent negative results in applications of the method to tracer advection (Bott, 1989) and coagulation (Bott, 1998), it does not seem straightforward to come up with a correction that is general enough for applications of this approach to all relevant processes (e.g., including gravitational settling).

I seems that an application of the PLA method to the development of a parameterization of coagulation would be a useful and important step, as proposed by the reviewer.

In fact, I am planning to start working on such a parameterization shortly. However, the purpose of the paper is not to proof the efficiency of the PLA method for a number of different parameterizations. Instead, my intention is to demonstrate the usefulness of the approach for a limited number of important examples. While coagulation undoubtedly is an important process for the aerosol number concentration, similar arguments can probably be made for other processes such as in-cloud production of aerosols, activation, etc. with respect to other moments of the aerosol size distribution. Additionally, tests of individual parameterization are often for isolated and very specific cases in the literature. There is no agreed protocol that would allow to put results of these studies into the context of general situations that occur in the atmosphere. Consequently, I don't think it would be feasible to add descriptions of additional parameterizations and corresponding tests without considerably adding to the discussions in the paper. Despite this limitation, I am convinced that the tests presented in the paper are meaningful. For example, nucleation and condensation represent important sources of secondary aerosol in the atmosphere. The application of a numerical approach to these processes constitutes a tough test of the approach owing to the considerable degree of non-linearity that arises from the competing effects of nucleation and condensation for the gas-to-particle transfer of mass. Among others, the accuracy of solutions for these processes depends strongly on the ability of the algorithm to faithfully represent the condensation driven transport of particle properties over a wide range of sizes in the particle spectrum.

Thanks to the reviewer for his helpful comments!

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