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

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The referee has raised the question whether the PLA method should also be compared to a single-moment sectional scheme (i.e. bin method) with several hundred sub-bins for each individual bin. I think that the results presented in the paper already contain the answer to this question. Results for applications of the bin method to observation-based size distributions (Fig. 4) and from simulations with a single-column model (Figs. 7 and 8) give evidence that the bin method converges to the exact solution for an increasing number of bins. Note that in the comparison with observation-based size distributions (Fig. 4), the reference size distributions for aerosol number and mass are obtained from a spline fitting procedure and are therefore known exactly. Although there are no known exact reference size distributions for the single column experiment,

it is reasonable to assume that the solution that is obtained in a simulation with 80 bins is pretty close to the exact solution owing to monotonic and consistent convergence of both methods (I am going to also add similar results for a third method and for the number size distribution to the paper to further support this claim - see also the last point in the referee's comments). These results demonstrate that the bin method produces very accurate results at bin numbers on the order of 100 and that very little improvement in the accuracy can be expected at even higher number of bins. Consequently, I don't see any need for adding additional comparisons for the bin method.

I am not sure I understand the second question about the conversion from continuous to discrete size distribution. For the comparison to observed size distributions (Fig. 3 and 4), each one of the methods is used to independently calculate continuous number and mass size distributions within given sections of the size spectrum based only on the number and mass concentration in these sections (which have been obtained from integration over the reference size distribution). For the single column model simulations (Fig. 8), the predicted variables are either particle mass (bin approach) or mass and number (PLA method) in each section. The model treats these variables as prognostic tracers, i.e. they are modified by mixing, physical and chemical sources and sinks in each grid cell of the model and at each time step. For the bin method, the mass in each section is used to diagnostically determine the number concentration in that section (Appendix A.2). For the PLA method, the procedure in Fig. 2 (inside the dashed line) is repeated for each individual time step in order to determine a continuous number size distribution in each section. The continuous number size distribution represents the input to calculations for nucleation, condensation, etc. The conversion in Fig. 2 needs to be repeated each time the number and mass concentrations change in the model, i.e. at least once per model time step. I will improve the model description in the paper accordingly so that this point won't be missed.

The application of sub-bins (as suggested) would require information for the initialization of the sub-bin size distribution at each individual model time step. There does not

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seem to exist a practical way to do this without having to increase the number of tracers in the model.

I will also try to improve the discussions according to the 7 additional comments that the reviewer had. Regarding the last two additional comments: As outlined, this paper includes comparisons to exact and nearly-exact solutions. It would certainly be interesting to compare results of the parameterizations with analytical solutions for individual processes but I don't think that this is feasible nor really necessary within the context of this paper. The approach in this paper avoids to some extends the problem that parameterizations are often tested based on 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. On the other hand, interactions between different processes can be realistically studied in interactive simulations based on atmospheric models such as the one used in this paper. The results in this paper clearly demonstrate that this approach leads to convergence and well constrained results. I will include a brief discussion of this aspect in the paper.

Thanks to the reviewer for his helpful comments!

Interactive comment on Atmos. Chem. Phys. Discuss., 5, 3959, 2005.