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Geoscientific
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Discussions

Interactive comment on "Representation of nucleation mode microphysics in global aerosol microphysics models" *by* Y. H. Lee et al.

Anonymous Referee #2

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Review of Lee et al. (2013)

General comments:

In this work the authors investigated the sensitivity of simulated particle number and CCN concentrations to using different lowest size cutoffs and model time steps for aerosol microphysics. They found that using parameterized microphysics results in higher formation rate of CN10 from nucleated particles and shorter coagulation lifetimes of ultrafine mode particles than the model with explicit aerosol dynamics. While the particle number simulation is less sensitive to the choice of the microphysics time step than to the choice of cutoff size.

The manuscript is clear and well structured. The topic is of interest to aerosol mod-

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Interactive Discussion

Discussion Paper

elers and fits the scope of GMD well. On the other hand, I agree with reviewer #1 that more information should be provided regarding the computational cost of each experimental setup. Also, in my opinion, the relationship between the adaptive time step (for each aerosol microphysical process) and the 10min/1h time step (for process coupling) should be mentioned/described in the introduction section, so that the reader can understand the motivation of doing such sensitivity experiments better.

I recommend publication of this manuscript once the authors have addressed the specific comments listed below.

Specific comments:

P893: Results presented in present work are based on simulations with one global model with sectional microphysics. It's better to revise title to something like: "Representation of nucleation mode microphysics in a global aerosol model with sectional microphysics".

P896L27: Previous studies using box model simulations already provided some useful hints on how to solve the production-condensation-nucleation system more accurately. See section 2.3 of Herzog et al. (2004) and section 3 of Kokkola et al. (2009). Are there similar studies that investigated this issue using box model simulations with the sectional method?

Herzog, M., D. K. Weisenstein, and J. E. Penner (2004), A dynamic aerosol module for global chemical transport models: Model description, J. Geophys. Res., 109, D18202, doi:10.1029/2003JD004405.

Kokkola, H., Hommel, R., Kazil, J., Niemeier, U., Partanen, A.-I., Feichter, J., and Timmreck, C.: Aerosol microphysics modules in the framework of the ECHAM5 climate model – intercomparison under stratospheric conditions, Geosci. Model Dev., 2, 97-112, doi:10.5194/gmd-2-97-2009, 2009.

P897L14: It would be nice to let the reader know how high the additional computational

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burden is (i.e. % of the total aerosol microphysics integration time).

P898L1: How do you define "explicit"?

P898L25: What are the "tracer processes"? This expression is confusing.

P898L26: If an interal, adaptive time step is used in TOMAS, what's the point to test the "10-min versus 1-h time step" sensitivity? What's the typical (sub-) time step during a strong nucleation event?

P899L21: The assumption of pseudo-steady state is appropriate when the condensation time scale is very short in comparison with the model time step. So for the time step sensitivity experiments, how will this assumption affect the result?

P899L28: The model description on in-cloud scavenging is confusing to me. How do you calculate the wet scavenging coefficients? How is the "modified Koehler theory" applied to calculate the wet removal rates?

P900L3-4: Which method is used? Reference?

P900L24-P901L2: What's the meaning of TOMAS-"30","36", and "40"? They are shown in Fig 1, but still would be nice to include them in the text.

P901L8-9: How it is related to the "interal, adaptive time step" mentioned earlier?

P901L16-L26: This answers my earlier questions (in introduction and this section) on the relationship between the adaptive time step and the 10min/1h time step. It would be helpful to direct the readers to this paragraph before introducing time step sensitivity tests.

P901L27-P902L4: The reference solution is usually established by performing convergence tests. For example, one can reduce the model time step gradually from 1h to 1min and see whether the model result can converge to the 1min solution. Are you confident about whether the model solution has converged with the 10min time step?

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P902L5-9: Is there any boundary nucleation scheme included in the model?

P902L26: How is CCN calculated in TOMAS?

P902L27 and P917 Fig2: The pressure levels presented are strange. It would be hard to compare this result with those from other models. If possible, please show the nucleation rates on standard pressure levels. Also, since J10 is a very important quantity in the discussion, it would be helpful to provide J10 fields in the figure.

P903L7-8: It's surprising to me that the primary particle emissions can contribute so much to the Aitken mode number concentration (or CN10) near the surface. What's the emission size parameter (mass to number ratio) you use in the model?

P903L25-28: Why is the nucleation rate overestimated for ternary nucleation but underestimated for binary nucleation?

P904L10-12: Why is the ultra-fine mode lifetime in the 3nm simulation even larger than that in the 1nm simulation?

P904L6-7: Do you mean the difference between the 3nm run and the reference simulation is around a few percent to 25%?

P905L14: It would be helpful to include numbers for the reference simulations in table 2, otherwise the reader have to turn back to table 1 for detailed comparison.

P906L11-12: Why is there underestimation of CN10? These regions are over pristine area and J10 may possibly be overestimated.

Interactive comment on Geosci. Model Dev. Discuss., 6, 893, 2013.