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Geoscientific Model Development Discussions

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

Anonymous Referee #1

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Review for Lee et al. GMDD, 2013

In this manuscript the authors assess the errors committed by using different nucleation parameterization in the global aerosol microphysical model GISS-TOMAS. They explore the performance of two different version of GISS-TOMAS, with a cut-off for the particle size at 3nm (TOMAS-36) and 10nm (TOMAS-30), respectively, against a third version of GISS-TOMAS with a cut-off at 1 nm (TOMAS-40). While TOMAS-36 and TOMAS-30 parameterize the growth of the nucleating particles to the respective cut-off with the Kerminen parameterization, TOMAS-40 explicitly simulates the whole size spectrum of particles, 1 nm being the critical diameter for molecular clusters to become stable.

This paper is clear and well written, and well suited for publication in GMD. I think,

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however, that some remarks about the computational burden should be added to the manuscript before publication in GMD.

I have some suggestions that I feel would improve the manuscript.

General Comments

1. The title is pretty generic, and refers to "global aerosol microphysics models". How much do the authors think that their results depend on their particular model? Is it reasonable to assume that 3nm is a good choice of cut-off for other models, too? Have the authors investigated any other parameterization, beside the Kerminen parameterization? If not, I suggest that the authors change their title to refer specifically to GISS-TOMAS

2. As mentioned above, I think that the manuscript should mention the computational burden of the TOMAS-30, TOMAS-36 and TOMAS-40, both for the 10 minutes and 1-hour time-step.

3. Could the authors add a figure or a table showing the vertical resolution of the model? Nine levels are quite few, and I was wondering if TOMAS spans troposphere and stratosphere or only the troposphere, as the pressure Vs. latitude figures seem to suggest.

4. Under which conditions are these results valid? Are they reliable in the stratosphere, too?

5. Have the authors compared TOMAS-30 with any observation? An explicit calculation does not always lead to better results than a parameterization, if many assumptions are made for the calculation and if the parameterization has been well constrained.

6. Has GISS-TOMAS been used with higher vertical and horizontal resolutions, too?

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How does the computational time of TOMAS-36 and TOMAS-40 scale with the resolution?

7. Are sinks like scavenging, deposition and settling included? How does TOMAS distinguish between hydrophobic and hydrophilic particles for the scavenging processes?

8. Is the model also valid at high latitudes?

Specific Comments

1. page 901 L5: What determine the critical diameter? When is it smaller than 1 nm?

2. page 901 L30: Have the authors ever tested TOMAS-30 with a smaller time step? Do the results change?

3. page 901 L16: I am not sure I understand this paragraph correctly. Are the authors describing the operator splitting approach?

4. page 903 L9: Do the authors mean that nucleation rate and CN10 formation rate are not linearly related? Is it correct to say that a higher nucleation rate provides more particles for condensation to happen, and hence, the growth of each particle is slower?

5. page 904 L5: Why is J_{10} over-predicted and J_{nuc} under-predicted? Could it be because of the mechanism of point 4?

6. Fig. 3: Is there a physical reason why Fig.3a and Fig.3b under-predict the CN concentration in the tropics? And why at different altitudes?

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7. Fig. 3c: Why does Fig.3c show such a pattern, with few small areas with under predicted CN10 concentration? What is the difference between those areas and the surrounding areas?

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