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Geoscientific Model Development Discussions
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Interactive comment on "Speeding up a Lagrangian ice microphysics code" *by* S. Unterstrasser and I. Sölch

Anonymous Referee #2

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General comments:

This paper presents numerical techniques to optimize the computational efficiency of a Lagrangian particle tracking model EULAG-LCM. It is shown that in certain test cases, for the deposition/sublimation/sedimentation processes, the model solution already converges with a moderate number of SIPs, while a much larger number of SIPs are needed to represent the ice nucleation process. The authors also employ SIP merging/splitting to reduce the SIP number and introduce a stochastic component in the ice nucleation implementation that can reduce the numerical sensitivities to the minimum ice number represented by a SIP (nmin).

Overall the manuscript is well written and the presented techniques are potentially useful for other modelers. I recommend publication of this manuscript once the authors

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Interactive Discussion

Discussion Paper

have addressed my comments below.

Major comments:

1. As the first reviewer already pointed out, the present manuscript lacks a sufficient review of the existing techniques employed in other Lagrangian particle tracking models. Are there similar methods already being used by other Lagrangian particle tracking models?

2. All the sensitivity tests shown in figure 2 are based on the same model setup described in section 3.1. In my opinion, the results will be likely dependent on the assumptions made in this part. For example, the relative humidity (RHi) is set to a constant value. If I understood it correctly, the deposition/sublimation and ice nucleation would not be limited by available water vapor as in reality. It is totally fine for an idealized experiment, but if another RHi profile were selected or if the profile were varying, how would it affect the total SIP number, mean NGB and the overall speed-up? More discussions are suggested in this regard.

3. How is the numerical coupling between ice nucleation and other processes (e.g., deposition/sublimation, vertical diffusion, and sedimentation, etc.) handled in EULAG-LCM? The coupling method will affect the numerical convergence (in time) of the model (e.g., modeled ice number). Since different models apply different numerical coupling between processes, such information will be helpful for other modelers to understand the results.

4. I would suggest the authors to move the SIP initialization (Appendix A) part into the main text, because the information therein is essential for understanding the whole paper.

Minor comments:

P3790 L1: statistical converge -> statistical convergence

P3795 L10: How does RHi evolve in the two cases?

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P3797 L19-20: If the total simulation time is 6 hours, the SIP splitting will only be called around 11 times. Will a higher call frequency improve the speed-up?

P3799 L7: If ensemble experiments were performed, will the random positions of new SIPs increase the spread of results from individual ensemble members?

P3800 L5-7: How is the nucleation rate defined? What is the concentration of ice nucleating aerosols (homogenous solution droplets and heterogeneous ice nuclei)?

P3802 Conclusion: The current results are obtained from some specific model setup/simulations. Please discuss whether the conclusion can be applied to other cases, such as a case with a lot of pre-existing particles, or with strong wind shear, or with a strong perturbation of supersaturation.

P3807 Table 1: Please check Nint values in Run A4 & A5. The current values seem wrong to me.

P3810 Fig1: Please define x and y axes

P3811 Fig2: I would suggest to add the legend in the figure.

P3812 Fig3: Same comment as on Fig 2.

P3814 Fig5: Better use colored lines.

Interactive comment on Geosci. Model Dev. Discuss., 6, 3787, 2013.