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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Effects of model resolution and parameterizations on the simulations of clouds, precipitation, and their interactions with aerosols" *by* Seoung Soo Lee et al.

Anonymous Referee #1

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This manuscript is a bit of a mixed bag. I really like the analysis of the difference between the bin and bulk microphysics. The analysis of resolution dependence of the clouds and cloud-aerosol interactions is not so clear, as too little information is provided regarding the representation of deep convection at coarse resolution.

The illustrations are generally helpful, and the writing is mostly quite clear.

Lines 35-38. Is the comparison done at the same scale? We certainly wouldn't expect a coarse resolution simulation to produce the same updraft intensity as a fine resolution

simulation if they aren't compared at the same scale. So I'm withholding judgement on this conclusion until I know more. Perhaps need to clarify this in the text.

Line 68. Not clear what is meant by "scale-aware schemes". Does this refer to microphysics? Please provide citations.

Line 100-102. Not clear what is meant by "RRTMG considers the effects of aerosols on the effective sizes of hydrometeors". RRTMG accounts for radiative effects of both aerosols and hydrometeors, but not the effects of aerosols on hydrometeors. That is handled elsewhere, typically in the microphysics code.

Line 136. Before "less", insert "At pressures".

Line 141. Not clear what is meant by "cloud mass". Is it liquid water content?

Line 192. More description is needed here. The description of the model never discusses how turbulence or convection are represented.

Lines 227-230. Much more description is needed here. Surely more was changed than resolution. The 15 km and 35 km configurations must parameterize convection. How is that done?

Lines 247-248. "substantial decreases in theÂăcloud mass at the 15- and 35-km resolutions compared to the cloud mass in the simulations at the 500-m resolution". Since you refer to decreases, that suggests changes with aerosol, but I'm not sure if that is what you mean. You could mean there is less cloud mass at coarse resolution than at fine resolution. If you mean the latter, replace "are substantial decreases in the" with "is substantially less".

Line 267. As above, change "are decreases in" to "is less".

Line 271. At fine resolution?

Line 280. More discussion is needed here. At coarser resolution the updrafts are not resolved, so aerosol activation is poorly represented. If there is a cumulus parameteri-

zation, it probably lacks aerosol-aware microphysics.

Lines 283-285. If the GFS model lacks aerosol-aware physics then there would be little sensitivity to aerosol. The description of the GFS does not indicate any dependence on aerosol.

Line 291. Need discussion of how convection is represented in ARW at different resolutions. I assume the updraft mass flux in the course simulations is diagnosed from the convection scheme.

Lines 307-310. The difference could be due to poor parameterization of convection in both models. More information is needed.

Lines 311-312. Even if the GFS simulated the updraft mass flux correctly, it would likely still underestimate the sensitivity to the aerosol because it lacks the physics that drives the sensitivity.

Line 313. How do you get updraft speed from updraft mass flux? Cumulus parameterizations produce mass flux, but additional assumptions are needed to diagnose updraft speed. More detail is needed here.

Lines 323-339. Do the convection schemes in the models have any physics that would cause the updrafts to depend on aerosol?

Section 5.2. Excellent work and presentation!

Lines 468-473. Some discussion of the microphysics in the convection schemes used in the coarse resolution simulations would be helpful.

Lines 519-520. It should be noted here that in saturation adjustment schemes the condensed water does not depend on updraft velocity. And the coarse resolution models lack dependence of cumulus microphysics on supersaturation.

Lines 555-570. This is great discussion. Perhaps note that global models designed to represent cloud-aerosol interactions do use a subgrid updraft velocity for activation in

stratiform clouds, so they would exhibit less resolution dependence of clouds than the ARW model. See, e.g, Ghan et al. JGR 1997.

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