Atmospheric Chemistry and Physics Discussions

Atmos. Chem. Phys. Discuss., referee comment RC2
https://doi.org/10.5194/acp-2021-855-RC2, 2021

Comment on acp-2021-855

Anonymous Referee #2

Referee comment on "Two-way coupled meteorology and air quality models in Asia: a systematic review and meta-analysis of impacts of aerosol feedbacks on meteorology and air quality" by Chao Gao et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2021-855-RC2, 2021

Review of "Two-way coupled meteorology and air quality models in Asia: a systematic review and meta-analysis of impacts of aerosol feedbacks on meteorology and air quality," by Gao et al., submitted to Atmospheric Chemistry and Physics Discussions.

This paper reviews air coupled meteorology-air quality models applied to Asia. It is quite detailed, almost too much in parts of it. It could benefit from more organization, better figure captions, and more specific conclusions. Below are some additional comments.

Introduction. "Online models or coupled models are designed and developed to consider the two-way feedbacks and attempted to accurately simulate both meteorology and air quality." It seems that this would be a good place to identify the origin of such models. According to Zhang (2008), the GATOR-GCMOM model is "the first fully-coupled online model in the history that accounts for all major feedbacks among major atmospheric processes based on first principles (Jacobson, 1994, 1997; Jacobson et al., 1996)."

Introduction. "Currently, there are three representative two-way coupled meteorology and air quality models." What does that mean? There are several more two-way coupled meteorology and air quality models, as cited later in the paragraph.

Introduction. Another coupled air quality-meteorological model used in Asia is GATOR-GCMOM. Its applications have included a study of the local and global fate of radionuclides from Fukushima (Ten Hoeve and Jacobson, 2012), where the model was run in both nested and global mode, and studies of the impact of urbanization in Beijing (Jacobson et al., 2015) and New Delhi (Jacobson et al., 2019) on air quality and meteorology. It seems that these papers meet the criteria listed.

The discussion could be improved by identifying how different models treat aerosol size and composition. Do they use lognormal modes or discrete size sections. How many size distributions in either case are treated? What aerosol physical processes are treated? Coagulation? Condensation/evaporation? Internal-aerosol thermodynamic equilibrium? Hydration?

How are clouds treated in the models? Are they treated with lognormal modes or discrete size distributions or without size information? How do clouds interact with aerosol particles?

Figure 6, caption. "…using two-way coupled models in Asia from literature." Please identify exactly which models are included and where the results are applicable to in the figure caption. Same with other captions.

In the figures, it would be useful to know what the overall mean percent error is in addition to the absolute errors

Figure 9. Please provide details of the models used and the region covered.

Overall, it is difficult to determine what the main scientific takeaways from the paper are. Are the existing models sufficient to provide reliable estimates going forward? What are the main limitations and strengths of the models?

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