Geoscientific Model Development Discussions

Geosci. Model Dev. Discuss., referee comment RC2
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Comment on gmd-2021-404

Anonymous Referee #2

Referee comment on "Modeling the high-mercury wet deposition in the southeastern US with WRF-GC-Hg v1.0" by Xiaotian Xu et al., Geosci. Model Dev. Discuss., https://doi.org/10.5194/gmd-2021-404-RC2, 2022

This study presents a representative demonstration of GEOS-CHEM multi-phase, multi-species mercury atmospheric chemical transport algorithms in the WRF-GEOS-Chem model and addresses one extant scientific question through multi-scale regional simulations. This novel tool is a major incremental advance in regional mercury modeling capabilities in scope for GMD and for scientific questions within the scope of EGU. This is also a first demonstration of the ease of transferring GEOS-CHEM algorithms to WRF-GC without the additional model development, porting, and QA/QC efforts usually required, another large incremental advance in regional atmospheric chemical transport modeling beyond the mercury application shown here. Thus, the title reflects the contents of the article as demonstration of model development. The overall presentation well-structured and clearly written, and ready for copy editing for fluency and precision. The original contributions are highlighted, and the number and quality of references are appropriate.

The manuscript nearly meets criteria for initial model demonstration, with a few important omissions. I recommend acceptance following minor revisions to evidence, context, methods and assumptions, and supplemental materials to support reproducibility:

- Comparison of capabilities and performance to prior regional Hg modeling in the domain and elsewhere is a basic expectation, and notably absent. First, the authors must identify the differences and advantages of this model's atmospheric chemical transport mechanisms to other regional models that resolve Hg (e.g., CMAQ, CAMx, WRF-CHEM, STEM-Hg), cite them, and clearly communicate the value and novelty. A table comparing mechanism features would help. Performance comparison to regional scientific and regulatory modeling over the study domain is essential to communicating the applied value of this tool and would best be achieved by comparing to contemporary community model performance benchmarks (e.g., Emery et al., 2017) for the same season. Qualitative and quantitative summaries of the performance advantages of this regional model should appear in the abstract.
- The multi-scale comparison presented requires additional evidence to support the

conclusions and more information on data and assumptions. Fig. 3 must include results from all three scales. The article must describe the spatial and temporal surrogates and processes used to allocate emissions from each sector. The authors are strongly encouraged to present maps of total and sectoral emissions maps at each scale in the supplemental materials. In Fig. 4, panels 2 and 3 appear identical—this should be addressed to provide evidence of different resolutions, spatial patterns, and the differences in magnitude described in the manuscript. The discussion (206-213) should reflect the roles of the emissions inventory and downscaling as limiting factors in resolution for this study rather than an inherent process resolution issue below 50 km.

- The arbitrary filter of 70% data availability for site inclusion should be justified, and other observational data QA/QC steps described.
- The article and the GitHub and zenodo repositories include all files necessary and sufficient for reasonable reproducibility. Addition of a WPS pre-processor file for the domains and scripts for the analysis and figures presented would bring the study close to full reproducibility.

Reference:

Christopher Emery, Zhen Liu, Armistead G. Russell, M. Talat Odman, Greg Yarwood & Naresh Kumar (2017) Recommendations on statistics and benchmarks to assess photochemical model performance, Journal of the Air & Waste Management Association, 67:5, 582-598, DOI: 10.1080/10962247.2016.1265027