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Geoscientific Model Development Discussions

Interactive comment on "Revised treatment of wet scavenging processes dramatically improves GEOS-Chem 12.0.0 simulations of nitric acid, nitrate, and ammonium over the United States" *by* Gan Luo et al.

Anonymous Referee #1

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The authors aim to improve wet deposition simulation of nitric acid, nitrate and ammonium over the United States using GEOS-Chem via updating both in cloud stratiform cloud scavenging and below cloud washout. For in cloud scavenging, they adopt the dynamic varied condensed water content provided by MERRA2 meteorological fields, needed in wet scavenging parameterization, instead of the current assumption of a global flat value. For below cloud washout, they derive a new set of empirical washout scavenging coefficient and exponential coefficient for nitric acid based on the size-resolved coefficients summarizing from field measurement and theoretical derivation.

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Discussion paper

This is an interesting and valuable study. The study would have a potential impact on the broad atmospheric composition study via improving tracers' wet scavenging if the authors could validate their work for other aerosols and their precursors. A minor revision is required before the paper is published in GMD.

Major Comments

The authors test the physical-based condensed cloud water for stratiform cloud rainout. Convective cloud removal is important and is necessary to be studied as well. Studying convective rainout is particularly important for using the current generation of NASA GEOS meteorological fields since its partitioning of large scale and convective clouds tilts more towards the latter. The convective cloud fraction and water content can be provided by the GEOS model.

The authors are highly encouraged to evaluate and summarize the impact of their work on other aerosols and their precursors. Once the GEOS-Chem adopts the improvements in wet scavenging parameterization suggested by the authors, all aerosols and their precursors undergoing wet scavenging will be impacted. To have confidence in using their work, they should at least provide a brief description of the model performance for all important aerosol fields in supplementary material. In addition, the authors' work focuses on the United States only. What is the anticipated influence of the improved wet scavenging on other regions?

To be more useful of the proposed work on wet deposition, more words are needed about the broader impact of the study on the whole atmospheric chemistry community. Can other global chemistry models adopt their improvement? Is there anything that other modelers should be cautioned of in adopting their work?

Specific comments

1. Page 3 line 26 equation 1: Should the k in exponential term differ with the k in the denominator of coefficient? For my understanding, the k in exponential term, which is

the first-order rainout rate, is linked to specific tracer species. One the other hand, the k in denominator represents the generic conversion rate of cloud water to precipitation. Please double check this. Please also give units of these fields and parameters in equation 1. 2. Page 7 lines 4-19: How about aerosols? Should the washout scavenging coefficients of aerosols be adjusted accordingly? 3. Page 8 line 7: Please add one more case study. Similar to case study 4 but empirical washout rate of HNO3 is applied only to large scale precipitation. This case, combined with case 4, will give us further information about the relative washout contribution from large scale and convective scale precipitations. 4. Page 8 line 7: Do the authors present the work of empirical washout rates for aerosols? Section 2.2 seems only give discuss for HNO3. What are the new empirical washout rates for aerosols? 5. Page 9 lines 1-2: The change range shown here (from 150% to 24%) includes not only using empirical washout rate, but also changing cloud condensation water.

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