Geoscientific

Model Development

Discussions

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# *Interactive comment on* "Further improvement of wet process treatments in GEOS-Chem v12.6.0: Impact on global distributions of aerosol precursors and aerosols" *by* Gan Luo et al.

**Anonymous Referee #3**

Received and published: 27 March 2020

This paper presented updated treatments of wet processes in GEOS-Chem, including rainout efficiencies for warm, mixed-phase and cold clouds, empirical washout by rain/snow, aqueous phase chemistry and wet removal for SO2 and sulfate, and wet surface uptakes during dry deposition. Model simulated concentrations of aerosols and aerosol precursors were evaluated with various surface observational data sets over the U.S., Europe, Asia, and Arctic as well as aircraft measurements of nitric acid and aerosols during two ATom campaigns. Results showed significant improvement over previous version of the model and better agree with the observations. Although mentioned in various places in the paper, the roles of individual wet processes in the improvements were not systematically quantified. This paper is well organized and

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overall well written, but needs careful proofreading. I recommend publication after the following comments are addressed.

P4, Line 3, eqn 1: Pr is the grid-box large-scale precipitation (rain+snow) formation rate. LCW is liquid phase cloud water content. But the total condensed water content should also include ice cloud water content, which is missing from this equation.

P8, Line 7, eqn 11: same issue as for eqn 1. For T>=258K (warm clouds), this equation assumes zero ice cloud water (ICW), which is probably not true in MERRA-2. Since the model uses temperature ranges to separate scavenging due to warm/mixed-phase/cold clouds, the cloud condensed water (for all T) needs to include ICW. This is expected to have a significant impact on the model results of this paper.

P10-11, Section 2.4: For rainout in cold cloud (T<237K), do you limit it to below the MERRA-2 tropopause?

P16, L17-19, and Fig.5: Please double check. It looks like the L2019 and WETrev lines for HNO3 are switched. What aspect of the "old treatments in GC12" do you mean here?

P19, Code and data availability: the revised GEOS-Chem v12.6.0 code and model output need to be made available at a public data depository. Also it's not clear where the various observational data sets used in this work were downloaded from.

Minor comments:

P4, Line 28: is LW different than LCW in eqn 1.

P5, L1 (and other places): Do you mean "acidity"?

P5, L3: H* can be calculated . . .

P5, L8-9: what are the units for these constants and coefficients?

P6, L19: the comma is misplaced.

P7, L20: LCW not LWC

P13, L3: Emissions are produced by the default setting of HEMCO. Does this mean that emissions are specific to the periods of ATom-1 and ATom-2 campaigns?

P13, L16: Is there a reference for "a large amount of USEPA observations are located at urban regions"?

P14, L20: remove "– ".

P15, L7: low dissolution

P15, L27 & L29: "at Alert during spring" – during winter / early spring?

P16, L1: converted

P16, L10-11: Why are the flight tracks over the land filtered out for comparison?

P18, L18-24: this sentence needs a break.

P19, L3, L12: remove"an"; exist.

Table 1: refer the reader to eqn 16.

Proofread and check for grammatical errors.

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Interactive comment on Geosci. Model Dev. Discuss., https://doi.org/10.5194/gmd-2020-11, 2020.