**Atmospheric
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Discussions**

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Comment

Interactive comment on "GEM-AQ, an on-line global multiscale chemical weather system: model description and evaluation of gas phase chemistry processes" *by* J. W. Kaminski et al.

Anonymous Referee #2

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General comments

This review was submitted on the heels of the thoughtful reviews by Referees 3, 1, and 4. I agree with my colleagues that this manuscript makes a sufficient contribution to be publishable once revisions have been made to address a number of concerns expressed in those three other reviews and in this one. Since many of my concerns with this manuscript have already been mentioned by one or more of the other Referees, I will try to restrict myself to points not already raised.

I very much agree with the other Referees, though, about the apparent arbitrariness and lack of explanation about the choice of comparison periods. For the satellite instru-

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ments, I expect that the start and end dates of their useful observing lifetime might be a contributing factor, but there is no mention of this factor in the text. It also seems like a lost opportunity that a five-year simulation has been performed but only one comparison, the seasonal comparison against the Logan ozonesonde climatology, makes use of this extended simulation period. Referee 3 has suggested that more global diagnostics should be reported. This could include a table showing year-to-year variations in global burdens of selected species. Such a table could both quantify the predicted magnitude of interannual variations in species burden due to predicted meteorology and confirm that there are no secular trends for any species.

Specific comments

Title

Would "GEM-AQ, an on-line global multiscale chemical weather modelling system: model description and evaluation of gas-phase chemistry predictions" be a more accurate title?

Section 2.1.2. Model physics

p. 14899, l. 8-14. How are grid-scale clouds represented?

Section 2.2. Air Quality Modules

p. 14899, l. 24. There are some inconsistencies between the text in this section and the tables. As noted by Referee 1, the text states that GEM-AQ considers 37 advected and 14 non-advected species gas-phase species but Table A1 only lists 49 gas-phase species. Similarly, at the beginning of Section 2.2.1 (p. 14900, l. 10), it is noted that 4 more species have been added to the 47 ADOM-II species, which again comes to 51. Also, it is noted the ADOM-II mechanism has 98 chemical reactions and 22 reactions were added, which gives 120 chemical reactions, but Table A2 only lists 118 chemical reactions. And it is also noted that the ADOM-II mechanism has 16 photolysis reactions, but Table A3 lists 19 photolysis reactions.

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Section 2.2.1. Gas phase chemistry

p. 14900, l. 20. NO_y is not a model variable (Table A1). How is this field used to constrain NO, NO_2, HONO, HNO_3, PAN, and so on?

p. 14900, l. 21. Roughly how many model levels lie between 100 and 10 hPa?

Section 2.2.2. Aerosol package

p. 14901. Just as for Referee 4, it was not clear to me that the aerosol package was activated in the five-year simulation described in this manuscript. Nothing is said in the description of the model configuration at the beginning of Section 3 about the aerosol package being turned off for the simulation, but modelling an extra 60 tracer species clearly has a large computational cost for a five-year simulation. If the aerosol package was turned on, though, then emission values for the aerosol chemical components must be added to Table A4 and some text must be inserted to describe how the chemical speciation and size disaggregation of PM emissions was handled.

Section 2.2.3. Gas-phase removal processes

p. 14901. How many gas-phase species are dry deposited and how many are wet deposited?

Section 2.2.4. Emissions

p. 14902, l. 11. How were the 1∘ by 1∘ anthropogenic emission fluxes interpolated to the 1.5∘ by 1.5∘ model grid? How large were the interpolation errors globally? Locally?

Section 3. Model Simulation and Results

p. 14903, l. 5. Does the sponge *layer* truly only act on the top model *level*?

p. 14903, l. 18. Are there any species in Table A1 that CMAM does not consider, and if so, how were these species initialized?

p. 14903, l. 24. Should sea-surface temperature be included in this list? And following

Referee 3, which if any of these climatological parameters were specified to vary with time and did the time variation depend on the particular year?

Section 3.1. Ozone

p. 14904, l. 22-23. What was the sampling frequency of the SHADOZ ozonesondes (i.e., how many profiles per season at a station)?

p. 14905, l. 3-6. What is the approximate pixel size for the GOME measurements?

p. 14905, l. 10-12. Were the model values matched in time to the GOME observing times for each pixel (see also Referee 3's inquiry re SCIAMACHY)?

Section 3.2. Carbon Monoxide

p. 14906, l. 22. What is the approximate pixel size for the MOPITT measurements?

p. 14906, l. 22-25. Were the model values matched in time to the MOPITT observing times for each pixel?

Section 3.4. Other Species

p. 14910, l. 6-7. What was the GEM-AQ spatial region used to construct the vertical profiles shown in Figure 10?

Section 4. Discussion and Conclusions

p. 14911, l. 23. How can methyl chloroform be used for a diagnostic metric if it is not a GEM-AQ model species? And how useful is CH_4 for this diagnostic calculation if it is not modelled realistically (see comment below re Table A4)?

Tables

Table A1. A slight expansion of this table would help to tie the model description together. It is noted on p. 14899 that 37 gas-phase species are advected and on p. 14902 that 14 anthropogenic gaseous pollutants and 9 biogenic gaseous pollutants are emitted. Section 2.2.3 notes that some gas-phase species are removed by dry de-

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position and that some are removed by wet deposition. If five columns were added to this table with the headings "Anthropogenic Emission", "Biogenic Emission", "Advection", "Dry Deposition", and "Wet Deposition" and "tick" marks inserted appropriately, a large amount of additional information about the formulation of GEM-AQ would be provided.

Table A4. According to this table, no emissions of CH_4 are considered. If true, does this not significantly affect the simulation of background tropospheric chemistry? It is also very surprising that industrial emissions of higher alkenes (ALKE) are zero. Emissions of HONO are not considered either although they are often treated by regional chemical transport models. And a suggestion: if non-italics were used in this table to indicate emission totals based on the EDGAR inventory and italics were used to indicate emission totals based on the GEIA inventory, it would be possible to provide some additional information about the inventory sources of the emissions that were used by GEM-AQ.

Figures

Figure 1. What is the meaning of the horizontal bars on each profile?

Figure 2. The temperature profile panels are not mentioned in the figure caption.

Technical corrections

p. 14896. For paragraph beginning on line 26, perhaps "In this study GEM-AQ has been exercised ...". And in the last sentence, perhaps "The objectives of this simulation were to ..., to ..., to ..., and to ...".

p. 14897, l. 12. Perhaps "... Cartography) satellite observations (Burrows et al., ...".

p. 14898, l. 25. In previous model formulations of GEM or in other models that used the Arakawa C grid? And for sentence that begins "It is accurate to second order, ...", what does "it" refer to?

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p. 14903, l. 20. Perhaps "... 6 months starting from 1 July 2000"?

p. 14908, l. 24. 220∘ E or W?

p. 14910, l. 13. "Methyl peroxide" here but "methyl hydroperoxide" in Table A1.

p. 14913, l. 22. "chartography"? (cf. p. 14897, l. 12).

p. 14915, l. 7. Is "peraéetique" correct?

p. 14916, l. 31. Perhaps "regulatory applications"?

p. 14917, l. 5. Should be "Fehsenfeld".

p. 14917, l. 25. Can this document be obtained from the web?

Figure 4. Are the ozone time series for hourly ozone measurements? The order of stations in figure and caption does not match the order in which these stations are introduced and discussed in text (p. 14906).

Figure 5. Caption should match Figure 6 caption ("GEM-AQ and MOPITT" and explanation for white pixels). As noted by Referee 4, units in panel titles (ppb) do not match colour-bar units.

Figure 6. Can white pixels also indicate terrain higher than 850 hPa?

Figure 9. The colours used for North America and for South America are similar. Swapping the colours used for South America and Africa, for example, would make it easier to see that five regions have been considered.

Figure 10. As noted by Referee 3, a legend or equivalent is needed.

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