Atmospheric Chemistry and Physics Discussions

Atmos. Chem. Phys. Discuss., referee comment RC2
https://doi.org/10.5194/acp-2021-331-RC2, 2021
© Author(s) 2021. This work is distributed under
the Creative Commons Attribution 4.0 License.

Comment on acp-2021-331

Anonymous Referee #1

Referee comment on "Self-consistent global transport of metallic ions with WACCM-X" by Jianfei Wu et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2021-331-RC2, 2021

General comments:

This is an interesting study on model simulations on Mg, Na and Fe (and their ions) in the mesosphere/thermosphere using an extended version of the WACCM-X model. In my opinion the study is suitable for ACP after some revisions have been made. Two more general aspects that will appear again in the specific comments below are:

(1) the differences between the Mg+ results presented here and the ones based on WACCM-Mg in Langowski et al. should be explicitly discussed and perhaps explained – if possible – by differences in the model set-up.

(2) I agree that there are similarities between the simulations presented here and the SCIAMACHY observations in Langowski et al. (which is very good!), but there are also quite significant differences (e.g., in [Mg+] peak altitude or absolute number densities) which are not mentioned at all. Please discuss the similarities and differences in an objective manner and also include the differences.

Specific comments:

Line 4: “The model with full ion transport significantly improves the simulation of global distribution 5 and seasonal variations of Mg+.”

I don’t think this is entirely correct. The WACCM-Mg simulations shown in Langowski et al. were in better agreement with SCIAMACHY observations in terms of number density than the WACCM-X simulations presented here.

Line 15: “and Friedman et al. (2013) investigated a descending thermospheric K layer up to 155

km at Arecibo“

This statement is a little vague. Did the layer descend from altitudes above 155 km downwards to 155 km? The combination of “descending” and “up to” makes the sentence difficult to understand.

Line 33: “However, no previous studies appear to have examined the full transport of metal ions in a self-consistent global chemical-dynamical model.”

I’m not sure what “self-consistent” really means here. “Self-consistent” is used several times throughout the manuscript and at least in some cases with a different meaning. Can you explain, what it means here?

Line 43: “affects” -> “effects” ?

Line 47: “WACCM-X is developed in the present study”

I suggest replacing “developed” by “extended”, because WACCM-X did already exist before.

Same sentence: “combined with interactive chemistry”

Please mention briefly in what sense the chemistry is interactive. Often the chemistry is not “fully” interactive.

Line 53: “and winds is treated in the same way as most active chemical species”

Which species are treated in a different way? Why?

Perhaps “as most” -> “as for most” ?

Line 56: “including a self-consistent electrodynamics module“

Can you mention briefly, what “self-consistent” means here?

Line 61: “constant F107=124“

I suggest to replace “F107” by “F10.7”. Also: The 10.7 cm flux is not dimensionless. Please add sfu (solar flux units) to the numerical value.

Line 95: “At middle latitudes .. , the peak altitude of Mg+ is 10 km higher in the summer hemisphere,”

Higher compared to which region? The same latitudes in the winter hemisphere? Or the rest of the latitudes? Please specify.

Line 104: “To address this, we also present the simulation results at the same local time (10:00 LT) in Figure 2, and they are in better agreement with SCIAMACHY observations.”

Yes, in some respect these results are in better agreement with the SCIAMACHY observations, but the number densities are even lower and the discrepancy to the number densities observed by SCIAMCHY is even bigger. In addition, the Mg+ peak altitude is still about 10 km lower than in the SCIAMCHY data set. These differences should also be explicitly discussed in my opinion, not only the aspects that fit well.

Line 107: “which is absent in the previous models.”

It is unclear – at least to me - what “previous models” refers to. Previous studies by other groups, WACCM-MG?

Line 110: “the Mg+ column density exhibits relatively high distributions at”

I suggest replacing “high distributions” by “high values”. “High distributions” doesn’t really make sense here.

Section 3.1: Please explain the differences between the extended WACCM-X used in this study and WACCM-Mg used Langowski et al.. The WACMM-Mg results agreed much better with SCIA in terms of [Mg+]. Any idea why? In my opinion these differences are an important aspect that should be addressed in the paper.

Also section 3.1: There are of course similarities between your Mg+ results and the SCIAMACHY observations, but there are also significant differences. The Mg+ peak altitude in your simulations is about 10 km lower than in the SCIAMACHY data. Also, the modelled number densities are about a factor of 2 lower than in the SCIAMACHY data set. These differences should also be explicitly mentioned in the paper and possible reasons discussed. I'm not asking for new simulations, just an objective description of the agreement between model and measurement results.

Fig. 2: Here, the low bias compared to SCIAMACHY is even more pronounced than in Fig. 1. Any idea why?

Fig. 3: Units below colour bar is wrong/incorrect. Please correct.

Also, the MgII VCDs shown here are significantly lower than the ones determined from the SCIAMACHY observations (compare to Fig. 16 (right) in Langowski et al.).

Line 173: "Figure 7 and 8 compares" -> " Figures 7 and 8 compare" ?

Line 186: “In contrast, the reduced densities of the molecular ions (and electrons) at night means that

their increased lifetimes become comparable to transport lifetimes.“

Is the logic behind this sentence entirely correct? Please check.

Fig. 6: The Mg+/Na+ ratios exhibit an interesting interhemispheric difference for solstice conditions. Please comment on it and perhaps provide a qualitative explanation, if possible.

Line 190: “the full life cycle of multiple meteoric”

I’m not sure what this really means: “the full life cycle”. Is the formation of meteoric smoke particles included as well?

Line 195: “(1) A clear seasonal cycle is found in the monthly averaged global distributions of Mg+, in good agreement with the SCIAMACHY measurements”

I agree the seasonal cycle is in good overall agreement with the SCIAMACHY measurements. However, several other aspects show significant differences (e.g. peak altitude, absolute values etc.). The differences should also be mentioned.