Geoscientific Model Development Discussions

Geosci. Model Dev. Discuss., referee comment RC1
https://doi.org/10.5194/gmd-2020-430-RC1, 2021

Comment on gmd-2020-430

Ying Chen (Referee)

Referee comment on "Investigating the importance of sub-grid particle formation in point source plumes over eastern China using IAP-AACM v1.0 with a sub-grid parameterization" by Ying Wei et al., Geosci. Model Dev. Discuss., https://doi.org/10.5194/gmd-2020-430-RC1, 2021

Oxidation process of SO2 to sulfate is a key factor influence atmospheric aerosol particle chemical composition, size distribution, new formation. This can largely impact the hygroscopicity and available cloud condensation nuclei in the atmosphere and therefore lead to impacts on atmospheric chemical processes and climate. However, this process is usually with a scale much less than regional or climate models' resolution, and the sub-grid oxidation process could be an important source of uncertainty and hamper our better understanding in air pollution and climate. This study took a further step, by including a sub-grid scheme to describe this sub-grid process in a global-regional model to quantify the uncertainty introduced by sub-grid oxidation of SO2 and improve the model performance. I think this is a good piece of work and well fit the scope of GMD, in terms of science. But, I also notice there are many typos and ambiguous statements in the manuscript. I would like to suggest more attention and carefulness on the language and presentation. In general, I believe this work is worth for publishing in GMD after some minor corrections and careful language editing.

Specific comments:

1) end of page-2, coal burning in China contribute 80% SO2 emission. Do you mean 80% of china total emissions or global emissions? And, at nowadays, SO2 emission in China has effectively reduced due to the great success of green energy policy of China. But India surpass the emission of China and tops the SO2 emissions (Li et al., 2017). This point also worth to comment on.

2) line 64-66, please double check the chemical equation. I believe it is OH radical, rather than anion. It would be better to explain that why the concentration NOx and VOCs will affect the oxidation of SO2.

3) lots of typos, here are some examples, but I believe there are many more. Please carefully check the manuscript. Line-71, primary? I think should be 'secondary'?; line 93-94: tens of seconds of kilometers, I do not understand here; 'caocentration'; line 279: 'imparct', etc…

4) please provide the units for all variables in your Eq. 1-6. And you have two equation 5 and 6. What is DSWRF in your Eq. 6? Downward shortwave at TOA or surface?

5) in the P6 scheme, 'x' is calculated as a function of [NOx] depend on high/low-VOC regime. In a very intensive plume, high concentration of fresh emitted NOx would deplete oxidants. Would you please make some comments on this, and discuss how could this effect influence the results.

6) line 300, I do not quite understand there. Why OH is in the range of (1-8)*1e6, but with a peak of 2.7*1e6? Should the peak of 8*1e6? I could be lost in somewhere, please help make it clear.

7) section 2.4. The outer domain of your model is a global domain. But, as I understood, WRF is a regional model. How could a regional model drive a global domain?

8) Would you please comments on that why the performance in Beijing warm season is worse in P6 scheme?

9) line 648-650. ARI contributed to a 7.8% increase in near-surface PM2.5, while API suppressed secondary aerosol formation to a 3% decrease of PM2.5. I do not understand here. First, what is API? Second, why suppress the secondary formation but contribute to a 7.8% increase in PM2.5.

10) figure quality is not good, especially figure 7 and 5.

Reference:

Li, C., McLinden, C., Fioletov, V. *et al.* India Is Overtaking China as the World's Largest Emitter of Anthropogenic Sulfur Dioxide. *Sci Rep* **7,** 14304 (2017). https://doi.org/10.1038/s41598-017-14639-8