

Interactive comment on “Aerosol pH and chemical regimes of sulfate formation in aerosol water during winter haze in the North China Plain” by Wei Tao et al.

Anonymous Referee #2

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General Comments:

This study implemented a new aerosol water chemistry module (AWAC) in the WRF-Chem model, and aimed to understand the mechanisms of haze formation over China, in particular, to examine the relative roles of multiphase chemical reactions in aerosol water on particulate sulfate production, which is mainly related to the questions about aerosol pH. They investigated the spatial and temporal distributions of pH around Beijing with the model, and found that the rapid production of sulfate in the NCP can be maintained with the pH range of 4.2-5.7. This is a very interesting and important work. Scientifically, it is still under debate. The analysis of modeling results provided some

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evidence. However, I still have some questions about the uncertainty of results and the robustness of conclusion. More analysis and clarifications are needed before publication.

Specific Comments:

1. As the authors also agreed, the pH may be one of the key factors controlling the AWAC processes. However, unfortunately, there is no direct measurement of pH for evaluation. Currently, most studies used the model to calculate the pH, which makes the pH estimation dependent on modules. It is good to couple ISORROPIA II into WRF-Chem, but we still cannot rule out the dependence of pH calculation on this module. In WRF-Chem, the existing module for pH calculation is MOSAIC. Did the authors estimate the pH with MOSAIC and compare the values with ISORROPIA? Are they consistent?

2. For evaluation, since NH_3 and NH_4^- are so important in this AWAC system, could authors evaluate both of them? In Fig. 1, I didn't find the evaluation of NH_4^- and NH_3 . In Fig. 2, for PM_{25_OCAT} , why not evaluate the absolute values of each components such as K, MG, CA? The emission factor of OCAT is multiplied by 4.5 to match observation. How is this applied? Do you apply it to the total dust emission? This is a huge factor. Did you evaluate the dust mass/AOD over the dust source region to confirm this?

3. In Fig. 1 and 2, although the added AWAC significantly increased sulfate production and the mean is closer to the observation, however, it is evident that the model still missed many events. This reflects that there are still some other important processes/mechanisms are missed in the model. Therefore, is it reasonable to use the observation to constrain the model AWAC process? i.e., there may be other processes contributing to the sulfate mass concentration more than AWAC? Please add some explanation and discussion. Related question, any evidence of significant contribution of AWAC on sulfate production in other events in recent year (2017, 2018, 2019)?

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4. Line 21 of page 3, “except for” to “besides”?

5. Table 2, the description of scenarios includes “halved”. It seems to me that there are only two cases: zero and doubled.

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