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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Simulations of Sulfate-Nitrate-Ammonium (SNA) aerosols during the extreme haze events over Northern China in October 2014" *by* D. Chen et al.

Anonymous Referee #2

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The manuscript discussed the formation of inorganic aerosols (sulfate, nitrate and ammonium) over the North China Plain (NCP) in October 2014 when several extreme haze events occurred. The authors used the WRF-Chem meteorology-chemistry model to interpret surface measurements of meteorology, air pollutants, and aerosol composition during the period. A suite of sensitivity simulations was conducted to quantify the impacts of heterogeneous reaction rates and precursor emissions to inorganic aerosols. The results show that for the haze events in October 2014 over the NCP high heterogeneous reaction rates and high precursor emissions under high relative humidity are likely important factors for the peak PM2.5 concentrations.

This study fits the scope of ACP by targeting the chemical mechanism of inorganic

aerosol formation in a pollution hotspot. The manuscript is clearly presented. I have several comments below that I think the authors shall address before considering publish.

Specific Comments:

1) Page 4, WRF-Chem description: Do you consider aerosol-meteorology interactions in the model simulations? You mentioned that cloud-aerosol interactions were not taken into account in section 2.4. How about radiative effects? Please clarify.

2) Page 5, Line 7: Please add the emission totals over the NCP. This would help to understand the statement in the next sentence that on the molecular basis NCP is NH3-limited.

3) Page 7, Line 8-10: I do not see where in the text you discussed the simulation with only the SO2 heterogeneous reaction. The simulation is also not listed in Table 3. Please clarify.

4) Page 7, Line 17-20: Please clarify whether the emission perturbations (e.g., 25% decrease in SO2, and 30% increase in NH3) are applied to the whole modeling domain or just over the NCP. After decreasing SO2 emissions and increasing NH3 emissions, is the NCP area still under NH3-limited condition?

5) Page 8, Line 5-7: I suggest add some sentences explaining how you determine those high uptake coefficients, for example, to increase SO2 uptake coefficient by a factor of 10. Would those values be valid in the real atmosphere?

6) Page 8, section 3.1: It appears to me that this section is missing some discussions on how biases in simulated meteorology would impact the aerosol simulation. The model generally underestimates relative humidity, while overestimates surface wind speed. How would it affect the aerosol simulation?

7) Page 10, Line 17: Please quantify how much percentage SO2 is overestimated in the model. Can the model versus measurements differences be explained by the

recent emission trends? Please clarify.

8) Page 11, second paragraph: Some discussions on the use of observed SO2 concentrations to calculate model SOR are needed. Despite the sulfur rich environment, reducing SO2 emissions in the model not only reduces SO2 concentrations, but also aerosol sulfate concentrations. How would SOR respond to SO2 emission changes in the model? This can be evaluated with the simulation with 25% SO2 emission reduction. I suggest add some sentences discussing the uncertainties in the model SOR values.

9) Page 25, Line 25 “We conclude that RH in the 80-100% range is a significant factor contributing to peak PM2.5 values”. The conclusion is only partly true. In the 80-100% range SOR and NOR values are much higher, but as for the peak PM2.5 values, from Figure 8, it appears that there are comparable amounts of high PM2.5 values in the 60-80% range. Please clarify.

Technical Comments:
1) Page 9, Line 2-4 “But correlations for boundary layer height and 10-m wind speed”, missing some words here? What correlations?

2) Page 10, Line 9 “Since there” should be “Since their”?

3) Page 18, Figure 1 The blue symbol and the city labels are too small to read on the Figure. Please make them larger.

4) Page 20, Figure 3 Please describe in the Figure caption what are those meteorological variables, such as T2, RH2, WS10, and WD10.

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