Our point-by-point responses are provided below. The referees' comments are italicized.

Response to Referee #2

This is a straightforward and concise analysis of the sensitivity of particle nitrate loadings to winter haze episodes in Northern China. It addresses an important question –how to effectively reduce particle loadings under conditions of very bad air quality. The authors argue that because a significant proportion of Northern China's NH_3 *emissions during the winter come from livestock, and because current agricultural practices lead to high emissions which could be reduced relatively easily (by 60% through adopting practices more common in Europe and the U.S.), that reducing total* NH_3 *emissions by 40% in the winter in achievable. Based on this argument, the paper pursues two complimentary approaches to testing the sensitivity of particle nitrate to reductions of* NH_3*. In the first, they use thermodynamic modelling of a comprehensive observational dataset obtained from measurements at a single site. While the modelling is not perfect, especially in terms of its performance for gas phase species, the authors make the case that the model results are robust for the particle phase and thus reliable for predictions when particle mass loadings are high. By applying a consistent 40% reduction to total ammonia (TA) mass loading, they find a significant reduction in particle nitrate that grows in absolute and relative terms over the course of a 4-day haze event.*

Response: We thank the reviewer for the very helpful comments. Please see our point-by-point reply below.

To take a more holistic approach, the authors also perform WRF-Chem simulations over a domain centred on Northern China, performing a base case run and one in which NH_3 *emissions from livestock were decreased by 60%. The authors make the argument for this more sophisticated approach in part because the non-linear relationship between ammonia and nitrate could change lifetime of nitrate. The authors miss an opportunity to test whether this is true under their conditions. I would encourage them to calculate the change in total nitrate (TN) burden (and/or lifetime) as a result of changing the* NH_3 *emissions.*

Response: Accepted. As you suggested, we calculated the change of TN burden and relevant descriptions were added to Section 3.2.

Revision: (Page 8, Line 296-298) "In addition, TN was reduced by 34.1% (from 31.8 $\mu g/m^3$ to 21.0 $\mu g/m^3$), which was in line with the assumption in Sect 2.3."

They should also calculate the change in TA burden (and/or lifetime) to determine in a reduction in concentration of 40% is the result. Because the WRF-Chem simulations do a relatively poor job in representing TA at the observation site, confidence in the *model predictions is undermined. In part 3.3, the authors use the metric of molar ratio (R) to explain under what conditions particle nitrate is sensitive to reductions in TA vs TN. It would be useful if they could place their model simulation results in the context of this framework. If the model is biased in TA (or TN) but occupies a relatively 'flat' part of the isopleth diagram, then its predictions could still be robust. But if biases in the model lead to changes in R near 1, then the predictions may not be as reliable.*

Response: Accepted. We calculated the change in TA burden and relevant descriptions were added to Section 3.2. Meanwhile, we improved our model performance and added discussions of the simulation biases and their impacts in Section 2.2 and 3.3, respectively. During the simulation case, the average simulated value of R is 1.3, which is equivalent to the observed value (1.3). Since WRF-Chem has a good estimation of the availability of ambient NH_3, its estimation of the efficiency of particulate NO_3^- reductions is reliable.

Revision: (Page 8, Line 298-301) "Correspondingly, TA decreased by 40.7% (from 17.15 μg/m^3 to 10.2 μg/m^3), very close to the reductions of NH_3 emission (40%). This indicates that it is reasonable to use TA reductions to represent NH_3 emission reductions in the ISORROPIA-II simulation."

(Page 5, Line 185-193) "The performance of WRF-Chem is evaluated by comparing measured and simulated NO_3^-, NH_4^+, SO_4^{2-} and TA. Specifically, the observed and simulated values are, respectively: (1) NO_3^-, 39.8 ± 14.7 μg/m^3 versus 39.1 ± 15.6 μg/m^3; (2) NH_4^+, 27.7 ± 8.6 μg/m^3 versus 26.5 ± 11.7 μg/m^3; (3) SO_4^{2-}, 42.4 ± 16.0 μg/m^3 versus 39.7 ± 20.8 μg/m^3 and (4) TA, 34.6 ± 8.5 μg/m^3 versus 32.1 ± 11.0 μg/m^3. The MB of these four species are -0.7, -1.2, -2.7 and -2.5 μg/m^3, respectively. Simulated particulate NO_3^-, NH_4^+, SO_4^{2-} and TA approximately agreed with the measurements (Figure S2). There are still some simulation biases that may affect the simulation of particulate NO_3^- reductions efficiency. This is discussed in detail in Sect 3.3."

(Page 12, Line 365 - 369) "Based on the above analysis, the influence of WRF-Chem simulation biases on particulate NO_3^- reduction efficiency simulation mainly depends on the simulation bias of R. During the simulation case, the average simulated value of R is 1.3, which is equivalent to the observed value (1.3). Since WRF-Chem has a good estimation of the availability of ambient NH_3, its estimation of the efficiency of particulate NO_3^- reductions is reliable."

Specific comments

In the abstract and throughout the text, the authors consistently focus on the reduction in particle nitrate loading that results from reductions in NH_3 emissions, but particle ammonium levels also change. While the absolute change in mass loading of ammonium will be less than nitrate due to its lower molecular weight, it would still be *worth it in a couple of instances to calculate and report the total reduction in $PM_{2.5}$ mass from nitrate AND ammonium.*

Response: In Section 3.2, we have shown the changes of $PM_{2.5}$ simulation values before and after NH_3 emission reductions. As you suggested, we calculated the changes of the sum of particulate NO_3^- and NH_4^+ before and after NH_3 emission reductions in simulations of ISORROPIA-II and WRF-Chem. Relevant descriptions were added in Section 3.2.

Revision: (Page 9, Line 274-275) "The sum of particulate NO_3^- and NH_4^+ decreased from 68.7 to 46.3 μg/m^3 (a 32.6% reduction)."

(Page 9, Line 286-287) "Meanwhile, the particulate NH_4^+ decreased from 16.3 to 11.7 μg/m^3 (a 28.1% reduction). The sum of particulate NO_3^- and NH_4^+ decreased from 46.9 to 30.2 μg/m^3 (a 35.6% reduction)."

Section 2.2 More information should be provided about the inventory. Over what geographic area are the emissions quoted for? 'North China' is referred to several times, but it would be useful to be more specific. Is the region under study the totality of the six provinces shown in Figure 2, or just the area within the blue box in Figure 2? Or the domain in Figure S3? Also, is the inventory used in this work archived and available for public access?

Response: Accepted. In this study, the inventory includes six provinces mentioned in the introduction sector. To make this clearer, we added the relevant description in Section 2.2. In addition, our inventory can be accessed by contacting the corresponding author. Relevant instructions are added to the Acknowledgement.

Revision: (Page 3, Line 108-109) "A comprehensive NH_3 emission inventory of northern China (including the six provinces mentioned above) in December 2015 at a monthly and 1 km × 1 km resolution …"

Figure 2 – I suggest adding a third panel that shows either the absolute difference between the two model runs or the percent decrease. It would be useful to see the spatial pattern of the change in nitrate.

Response: Accepted. The panel as you suggested has been added to Figure 2 and the relevant description has been added in section 3.2.

Revision: (Page 8, Line 291-293) "In some areas with high particulate NO_3^- concentrations, particulate NO_3^- had been effectively reduced by more than 30 μg/m^3 (shown in Figure 2c)."

Figure S3 – Is it kg of N in NH_3 or kg of NH_3 itself?

Response: It is kg of NH_3 itself.