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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Numerical analysis of the impact of agricultural emissions on $PM_{2.5}$ in China using a high-resolution ammonia emissions inventory" *by* Xiao Han et al.

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The NH3 emissions from agricultural activities in China, which is one of the largest agricultural countries in the world, significantly affect regional air quality and horizontal visibility. In this study, the contributions of NH3 from multiple agricultural emissions to aerosols were calculated using the RAMS-CMAQ-ISAM system; it allowed to trace the transport and chemical reactions of NH3 from fertilizer and husbandry emissions sectors to quantitatively estimate the contribution of agricultural NH3 emissions to the PM2.5 mass concentration in China. As input was used the high-resolution PKUNH3 emissions inventory, which was complemented with MIX Asian, REAS and GFED data;

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Discussion paper

different meteorological factors were used to capture the formation processes and transport of secondary aerosols. For model evaluation, several observation data were compared with the simulation results for both meteorological parameters and SO2, NO2, and PM2.5. Major points. Suggestion: the "Results and discussions" section should be extended by providing explanations on different aspects.

1) How the emissions input influences the changes in concentrations patterns? Please discuss the seasonal variation in emissions for the months of January, April, July and October.

R: Thanks for this comment. The horizontal distribution, budget, and seasonal variations of PKU-NH3 emission inventory have been shown in the papers published by Pro. Song's research team (Kang et al., ACP, 2016; Liu et al, PNAS, 2019). Therefore, this information will not be displayed here again. However, we try to extract the data from PKU-NH3 emission inventory, and added Figure A5 which provided the regional average emission flux of each sectors (g/s/grid) over several major regions in January, April, July and October. It can be seen that the emission flux was higher in summer and lower in winter. The strongest emission flux mainly appeared in BTH, SDP and CNC, and the values in YRD, SCB and NEC was higher, too. These features generally followed the distribution pattern of NH3 mass concentration as shown in Figure 3. We have added the statement in Appendix A. Please check if it is appropriate.

2) Identify, which of the agricultural sub-sectors, i.e., fertiliser, husbandry, farmland ecosystems, livestock waste, crop residue burning, and excrement waste from rural populations, are contributing most to the seasonal changes.

R: Thanks for this comment. Furthermore, the contribution percent of each sector emission fluxes were calculated and shown in Figure A6. It can be seen that the highest proportion was contributed by husbandry, followed by the contribution of fertilizer. The total percent of husbandry and fertilizer was relatively higher in spring and summer, but lower in winter (brodly higher than 60% at least). In general, the emission from husbandry and fertilizer should be the major contributor to NH3. In addition, the contribution of other sector, including industry, residential and transport, was also obvious. The discussion has been added to the paper (Appendix A). Please check if it is appropriate.

3) Emphasis the influence of meteorological conditions.

R: Thanks for this comment. We added the monthly horizontal distribution of the surface wind field in Figure 4, and modified related discussion (Line 225-227). Please check if it is suitable.

4) How this tool could support policy makers in designing the PM2.5 emissions mitigation strategy in China.

R: Thanks for this comment. The model system can be used to capture the source contribution features over the regions we concerned. The emission sectors and transport features can be obtained quantitatively based on the simulation results. Then, we can determine whether the control strategy is needed, and how much emission flux should be reduced. This is a useful tool for PM2.5 because most of the PM2.5 components are secondary species, which is hard to capture the source contribution features due to the strong nonlinear effect. Therefore, the model system should be helpful to make the PM2.5 emission control policy in China. However, the specific policies depends on more detail information in different regions (such as natural background, economic conditions, industrial structure, etc.), not only depends on the model simulation results.

5) Explain why “the influence of NH3 would enhance with the decreasing of ambient NH3 mass concentration”; provide directions for further research on this topic.

R: Thanks for this comment. This feature was deeply discussed by Wang et al. (2011; Impact Assessment of Ammonia Emissions on Inorganic Aerosols in East China Using Response Surface Modeling Technique). The results of RSM (Response Surface Modeling) in their study shows that the change of NO3- mass concentration is very sensitive to the emission level of NH4+ and performs as nonlinear relationship. The reduction of NH3 emissions can play a very significant role in reducing the mass concentration of NO3- under NH3-poor condition. However, there will be excess NH3 in the atmosphere under NH3-rich condition, and these excess NH3 could neutralizes more nitric acid even in the case of emission reduction. Thus, the emission reduction effect is not significant under NH3-rich condition. In addition, the SO2 will compete for NH3 and prevent the generation of NH4NO3 under NH3-poor condition because the reaction between H2SO4 and NH3 takes precedence over the one between HNO3 and NH3. Oppositely, SO2 should be benefit for the formation of NO3- (especially in summer) under NH3-rich condition according to the calculation of Wang et al. (2011). This should be a reason why the effect of NH3 emission control is not obvious in the case of NH3-rich condition as well.

Minor points. For the regions in China for which the findings are discussed – spell them out (e.g. “NEC”). Figure 6 – add to the caption “April and October”. What is T in Table 2 - “of T contribution”. What is TA, Page 9, line 269 - “10% TA NH3 emission”

R: Thanks for the comments. All error points were modified.

Please also note the supplement to this comment:
https://www.atmos-chem-phys-discuss.net/acp-2019-1128/acp-2019-1128-AC3-supplement.pdf

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