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Interactive comment on "Effectiveness of Ammonia Reduction on Control of Fine Particle Nitrate" *by* Hongyu Guo et al.

Anonymous Referee #2

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There is growing interest in controlling ammonia emissions to reduce N deposition and NH4NO3. This study focuses on the non-linearities in the response of particulate matter to changes in ammonia concentration. In particular, they introduce a simple conceptual framework (S-curve) to help explain differences in the sensitivity of PM to NH3 emissions at different locations and for different seasons. Such non-linearities have often been overlooked in previous studies. This study is within the scope of ACP. It is well written and the methods are sound. I only have few comments for the authors to address before I can recommend this study for publication.

Comments

1) The authors introduce a new conceptual framework to explain seasonal and regional differences in the sensitivity of particulate matter to ammonia emissions. This has

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Discussion paper

potential policy implications and it would be useful for the authors to compare with other techniques that have been used previously to highlight potential differences.

In particular, previous studies have used the gas-ratio from Ansari and Pandis to interpret global model results (see for instance Pinder et al. (2007, 20088), Paulot (2016), Pozzer et al., 2017) GR = (TNH4 - 2*TSO4)/TNO3 with 0<GR<1 indicating sensitivity to NHx and GR>1 indicating sensitivity to NH3.

Obviously, this cannot directly address variations associated with seasonality. However, based on the information provided in Table S1, GR∼<1 only for SE US, Virginia, and Pasadena. In other words the weak sensitivity of nitrate to ammonia emissions at the other sites could be inferred simply from concentrations, which is consistent with the findings of the studies mentioned earlier.

In addition, many global models do not use ISORROPIA but simpler (cheaper) aerosol thermodynamic models (see for instance Bellouin et al (2011), Hauglustaine (2014)). Such schemes, which do not explicitly account for aerosol pH, will also simulate a non-linear response of ammonium nitrate to changes in a ammonia emissions (see equation A8 in Bellouin et al (2011)). It would be useful for the authors to show how different the response of nitrate and ammonium to changes in ammonia/NOx emissions (i.e., Fig 5) would be using such approach.

In particular, this would help strength the case for thinking in terms of aerosol pH rather than simply in terms of concentrations.

2)

I am not convinced by the current discussion of the impact of NH3 emissions controls on nitrogen deposition. The authors argue that lowering aerosol pH (via lower NH3 emissions) will modify the ratio of reduced to oxidized nitrogen deposition. However, it is unclear why this is important (no reference is given), especially considering the benefits of lower NHx deposition and the existence of other removal pathways (wet deposition) that may not exhibit the same sensitivity to the NH4/NH3 partitioning. A longer discussion is needed given that this conclusion is highlighted in the abstract.

3) the authors focus on seasonal averages. It would be interesting to discuss whether the sensitivity of particulate matter to NH3 emissions is different depending on the concentration of NO3 and whether this would affect the probability distribution of PM under the different emission reduction scenarios shown in Fig. 5. This may be important for policy makers as some standards are based on 24hr averages (https://www3.epa.gov/ttn/naaqs/standards/pm/s_pm_history.html)

Technical comments

4) p4 line 5 NH3 can also enhance the in-cloud oxidation of SO2 by O3. See for instance Wang (2011) or Paulot (2017)

5) p17 line 15 I believe livestock emissions are likely to dominate ammonia emissions in summer.

6) dash black line Fig. 4 not defined

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