

Response to Reviewer #2 comments:

This is an interesting and original manuscript based on scientifically sound investigation. The paper is well written and clearly structured. The paper should be published after the authors have considered the following minor issues.

We thank the reviewer for the enthusiastic response and constructive comments. Below, we include the response to comments and questions raised.

General comments:

Page 4, line 18: The authors state, without any justification, that the dry deposition both ammonia and nitric acid are about 10 times higher than the corresponding particulate forms of these compounds. The authors should shortly explain what this statement is based on? Dry deposition of aerosol particle is strongly dependent on particle size, so do the authors implicitly assume that both ammonium and nitrate are located in the typical accumulation mode size range? As mentioned briefly in section 6, a notable fraction of nitrate can be in the coarse mode at high dust (or sea salt) loading, which would increase the deposition velocity of particulate nitrate.

Answer: The reviewer raises a good point. The deposition velocity indeed changes with size, but for all relevant sizes still differ between the gas and aerosol states up to particles of roughly 10 μm diameter, where it is roughly 1 cm s^{-1} (e.g., Lin et al, 1994). The stated 10-fold velocity difference is indeed an average for submicron aerosol (e.g., Duyzer, JGR, 1994). The whole theory is based on the gas-to-particle velocity ratio k to account for any other factor that makes the deposition velocity differ. This discussion is now reflected in the text.

When investigating and discussing the implication of this study, the authors emphasize air pollution accumulation. This is certainly an important implication. Another theme that the results of this study might have implications are the strength and spatial distribution of nitrogen (also acid) deposition. Could the authors elaborate this issue a bit more than just mentioning "prediction of nitrogen deposition flux" in one place (page 11, line 8)?

Answer: The concentration and spatial distribution of nitrogen species and their relation to acidity and liquid water changes is indeed central to this manuscript. The discussion about deposition patterns is mentioned in other places besides Page 11, as it is discussed in terms of long-range transport and expressed in terms of a conceptual model in the last figure of the paper. We will further elaborate on these points in the revised manuscript.

The caption of Figure 4a is insufficient to understand its contents, especially differences between the filled circles and lines. Figure 4a is first discussed in section 4, but it is not until section 5 where meaning of the lines in Figure 4a are shortly mentioned.

Answer: This is a good point. We will further expand the caption to make it self-explanatory.

What are the 2 different columns under "Beijing" and "Xi'an" in Table 1? They are not explained in Table neither in table caption. The same table has footnotes a and c not explained anywhere.

Answer: We apologize for these oversights. "Beijing" and "Xi'an" refer to data from different locations in China. We will now explain this better in the table and also address the unresolved footnotes.

References

Lin, J.J., Noll, K.E., Holsen, T.M. (1994) Dry Deposition Velocities as a Function of Particle Size in the Ambient Atmosphere, *Aerosol Sci. Tech.*, 20:3, 239-252, doi:10.1080/02786829408959680

Duyzer, J. (1994) Dry deposition of ammonia and ammonium aerosols over heathland, *J. Geophys. Res.*, 99, 18757-18763, D9, doi:10.1029/94JD01210