Atmospheric Chemistry and Physics Discussions

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Comment on acp-2022-82

Anonymous Referee #1

Referee comment on "A new assessment of global and regional budgets, fluxes, and lifetimes of atmospheric reactive N and S gases and aerosols" by Yao Ge et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2022-82-RC2, 2022

General comments:

This paper presents detailed analysis of nitrogen and sulfur fluxes using a global model run from 2015. The results give an updated picture of chemical processing and interregional transport and deposition of these key pollutants, and important recommendations for effective mitigation efforts aimed to improve air quality. The manuscripts is well-written and organized, and I recommend publication following minor revisions discussed below.

Specific comments:

Please include some discussion of model performance and uncertainty. How would the results of the measurement evaluation in the preceding model evaluation paper (Ge et al., 2021, https://doi.org/10.5194/gmd-14-7021-2021) impact the main conclusions in this one? For example, HNO3 concentrations were generally biased low compared to measurements. If this is due to its chemical production being too slow in the model, the resulting deposition estimates would also be biased low; but if the concentration bias is due to deposition being too fast, the resulting deposition may be biased high. Additionally, were there regions where the model performed better/worse than others, and by extension where you have more/less confidence in the regional budgets presented here? Finally, while dry deposition was not evaluated against measurements (given the dearth of those), some caveats about the variability of dry deposition estimates would be appropriate.

ll. 422-425: A 40% decrease in only 5 years seems unrealistic. Are the emission inventories comparable?

ll. 486-511: Given that the aerosol scheme includes equilibrium of ammonium nitrate (R4 in section S1), how do you handle that reaction in the lifetime calculations for HNO3, NH3, NH4+ and NO3-_f?

l. 500: It's surprising that coarse nitrate would have a longer lifetime than fine, given their relative wet scavenging efficiencies. Could you explain? Is it due to the regional differences in where NO3-_f and NO3-_c are dominant?

ll. 563-566: Since Ge et al. (2021) showed that the ECLIPSE 2010 NH3 emissions in east Asia were significantly higher than the HTAP 2010 emissions, some of the RDN flux difference compared to Tan et al. (2018) is due to inconsistent emission budgets rather than an actual increase in emissions.

Table S5: (1) Given the detailed discussion of this table in the main text, consider moving the table to the main paper as well. (2) The lifetimes of RDN and OXN in Rest of World as calculated from sources are highly skewed by inputs from other regions. I would suggest removing these numbers and making a note to that effect.

l. 656: I suggest adding "and deposition" after "RDN concentrations" given the impact of excess N is a driver for this reduction.

ll. 714-715: While models do have these advantages, it's also important to note their limitations and uncertainties.

Technical corrections:

l. 578: typo in "deposition"

l. 650: Remove "The"