

Atmos. Chem. Phys. Discuss., referee comment RC2
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Comment on acp-2022-657

Anonymous Referee #2

Referee comment on "Global sensitivities of reactive N and S gas and particle concentrations and deposition to precursor emissions reductions" by Yao Ge et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2022-657-RC2>, 2022

The manuscript presented a suite of model sensitivity simulations, which investigated the global responses of atmospheric reactive nitrogen and sulfur levels and their deposition fluxes to their emission reductions. Global 20% and 40% emission reductions for NH₃, NO_x, and SO₂ (individually and jointly) were simulated to analyze the resulting changes in global nitrogen and sulfur concentrations and deposition, as well as annual mean PM_{2.5} concentrations. The results show that the individual emissions reduction (NH₃, NO_x, or SO₂) has multiple co-benefits and small disbenefits on different species. Such changes reflect geographically-varying non-linear chemical responses of nitrogen, sulfur, and PM_{2.5} to emissions reductions

I think the manuscript, by comprehensively analyzing the response of multiple indicators (air pollutants levels and deposition fluxes), includes important findings to understand the underlying drivers or mechanisms in response to emission reductions regionally and globally. This study is thus well-suitable for the scope of ACP, and I would like to see its publication. Before that, some moderate comments shall be addressed.

Specific comments:

1) Model set-up

Global 20% and 40% emission reductions were applied in this study. Some sentences are needed to justify the selection of 20% and 40%. Why a greater emission reduction (i.e., 60%) was not considered?

2) Section 3.1.2, Line 260

What are the sources of fine and coarse nitrate aerosol? Can you explain why coarse nitrate would increase associated with NH₃ emission reduction? Please clarify.

3) Page 18, Figure 8

Figure 8 showed the spatial sensitivity regimes based on 40% emission reductions and

annual mean PM2.5 concentrations. Such sensitivity regimes shall have large seasonal variations. Do you have the model datasets to generally the seasonal maps? That shall provide valuable information to understand the SIA formation regimes.

4) For the green/red circles and stars in Figures 2, 4, 6, 9, and 11, in the main text, the symbols that are discussed as the maximum reductions (e.g., Page 11, Line 330-335) were denoted as "Min" in these figures. Please be consistent.

5) Page 25, Line 708-710

It is not clear what "non-linearity" mean here in the text. We can see from Figures 3, 5, 7, and 10, the responses with respect to 20% vs. 40% emission reductions are rather linear. They deviate from the 1:1 line, however, the responses are linear. Please clarify.

6) The writing of the manuscript is rather intensive. Many results are described in parallel, which makes the manuscript less focused. I understand that many results can be derived from the set of sensitivity simulations, still, the key findings of the study shall be better emphasized in the abstract and conclusions.