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# *Interactive comment on* “Modelled deposition of nitrogen and sulfur in Europe estimated by 14 air quality model-systems: Evaluation, effects of changes in emissions and implications for habitat protection” *by* Marta G. Vivanco et al.

**Marta G. Vivanco et al.**

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First of all we would like to thank the reviewer for comments and suggestions.

The document attached (supplement) includes the complete responses in a colored version.

Comments from the Reviewer are referred to as RFC. Authors’ responses are indicated by AR.

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Discussion paper

Reviewer 1 Comment:

The manuscript is well structured and written. It provides a valuable comparison for modeled deposition of nitrogen and sulfur by fourteen air quality models over Europe. There is a lot of information provided from the evaluation results in the manuscript and the supplementary material. I think the article deserves publication. I have only a few minor comments to be considered by the authors.

RFC.1: In Section 2.1.1 the emissions used are only briefly described. Although there are references provided I would suggest to provide a little more information for Copernicus, HTAP_v2.2 and ECLIPSE_V5 emissions (eg. spatial resolution, temporal resolution).

AR.1: Yes, it's true. We have now added some more information in the text, specifically the spatial and temporal resolution. We have also included this information in Table 2.

RFC.2: In Section 2.2 please describe briefly how the statistical measures for each individual station are implemented in smile plots where we see the entire set of stations.

AR.2: Each point in smile plots corresponds to the statistics calculated using the data from all sites combined. We have modified the sentence to clarify this this in lines 152-153: "For each model simulation and set of sites with observations, the following statistics were calculated (Table 4) for each variable (considering all the values in time and space): "

RFC.3: it is stated that there is a tendency for the models to underestimate WSO4_S and simultaneously overestimate the gaseous pollutant SO2_S on and annual and monthly basis. Please discuss some possible reasons for this. Is there a possibility for less efficient heterogeneous oxidation of SO2?

AR.3: Yes, this happens for some models. We included in the text some allusions to an potential underestimation of the aqueous chemistry (559-561): "The fact that sulfate concentration is also low for several models in Jan and Feb and SO2 somewhat high could be due to an underestimate of the conversion to aerosol (sulfate) via aqueous chemistry, which could be another cause of the excess NH3." The relation of this to wet deposition would be clear if the efficiency of wet scavenging for SO2 (if overestimated) was lower than that for the sulfates, which in fact is the case for the parameterization used in EMEP model parameterization. But although it's out of the scope of this paper to look into detail the parameterization of all the models, due to the complexity of the variables involved, chemical and meteorological, we have included in the conclusion section the potential occurrence of a low heterogeneous SO2 oxidation efficiency, suggested by the results in this study.

RFC.4: In Section 3 it is written that "As can be inferred from AM 2.3, AQ_DK1_HTAP estimate the main contribution from the gas phase,. . .". To my understanding this holds for AQ_F11_HTAP according to AM2.3 while for AQ_DK1_HTAP the highest contribution comes from the particle phase.

AR.4: It's true that this figure in AM 2.3 has not been sufficiently explained, as left (dry deposition from NO2) and middle (dry deposition for HNO3) maps correspond both to gases, and only the one in the right correspond to the particle phase. This could have led to a wrong interpretation, but the statement was correct; for AQ_DK1_HTAP the main contribution to dry deposition comes from the gas phase (in particular from HNO3).This is also valid for AQ_F11_HTAP.We have modified the text slightly to avoid confusion (lines 332-337)

Before: "Significant differences can be found when looking at the gas and particle deposition for the AQMEII3 participants. Two gases, NO2 and HNO3 can contribute to OND. As can be inferred from AM 2.3, AQ_DK1_HTAP estimate the main contribution from the gas phase, whereas in the case of AQ_TR1_MACC, highest contributions to OND come from the particle phase. This highlights the importance of making measurements that can shed more light on these processes, providing modelers with data that can be used to parameterize and evaluate the different processes."

Now: “Significant differences can be found when looking at the gas and particle deposition for the AQMEII3 participants. Two gases, NO2 and HNO3 can contribute to ONDD. As can be inferred from AM 2.3, in the case of AQ_DK1_HTAP and AQ_F11_HTAP the gas components (NO2 and HNO3) contribute more to ONDD than the particle phase, whereas in the case of AQ_TR1_MACC the largest contributions to ONDD come from the particle phase. This highlights the importance of making measurements that can shed more light on these processes, providing modelers with data that can be used to parameterize and evaluate the different processes.”

Final comments: We have updated the maps with sites, as we noticed some missing sites in the original maps.

Please also note the supplement to this comment:
https://www.atmos-chem-phys-discuss.net/acp-2018-104/acp-2018-104-AC1-supplement.pdf

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