

# ***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.**

m.garcia@ciemat.es

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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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Reviewer 2:

The authors compare simulated S and N deposition from 14 models. The paper presents extensive information about the performance of the different models and is definitely worth publishing. However, the paper must be improved in several aspects before it can be published. In particular, some more attempts must be made to explain the reasons for the large differences in simulated deposition among some of the models. Furthermore, parts of the paper are not well organized and hard to read.

RFC.1: Line 100 and Table 2: What is the reason for using such an obsolete version of WRF? Which parameterizations were applied? How does the meteorological input deviate from WRF-Common for those models where a different meteorological input was used and how does this affect the S and N deposition?

AR.1: The meteorological fields were already available from previous studies in the framework of the EuroCordex climate downscaling programme, where WRF 3.3.1 had been used. Then an optimal setup had been identified and used to re-run the model, applying a grid-nudging towards the ERA-Interim reanalysis above the planetary boundary layer. This WRF simulation was used for the ED project; it was interpolated on the 25 km resolution ED grid and used to drive CHIMERE, EMEP and MINNI.

Due to the variability of parameterizations for the different groups using WRF, (groups are indicated in Table 2), and as they have already been published previously (Solazzo et al., 2017 for AQMWII3 community and Colette et al., 2017 for ED community) we think it is more convenient to include references to these publications, that include the parameterizations used in WRF by each group.

The WRF-common was only used by three models of the ED project (ED\_CHIM, ED\_EMEP, ED\_MINNI). The other models in ED community used other meteorological drivers. On the other hand, in the AQMEII3 project, meteorological inputs were selected by each modelling group, so there is a wide variability of meteorological in-

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formation. We focused in this paper on precipitation, since it is a direct driver of wet deposition, by including in the paper statistics for precipitation (annual values in the main text and by month in the AM) for each group, shown as smile plots and tables. We had discussed the performance of models in the original version, saying that they performed well in terms of annual precipitation.

Now we have decided to include a bit more discussion on precipitation, highlighting differences on a temporal basis: including specific ideas such as:

“Smile plots in AM3.5 indicate that some models have larger fractional bias in summer, especially in August, when some models underestimate accumulated precipitation, especially ED\_LOTO, AQ\_DE1\_HTAP, AQ\_UK1\_MACC, AQ\_UK2\_HTAP, and the three models using WRF-Common, that is, ED\_CHIM, ED\_EMEP and ED\_MINNI.”

RFC.3: Lines 102-110: Information (including tables and figures) about the different boundary conditions and emission data should be given in the supplement. Please summarize quantitative differences in the paper briefly.

AR.3: We have included in the text (lines 104-118) and in Table 2 more specific information for emissions and boundary condition (temporal and spatial resolution). Also, we have included a map of differences of emissions of NO<sub>2</sub>, SO<sub>2</sub> and NH<sub>3</sub> in the AM 7A) y AM 7B). Later in the paper, we relate differences in models in dry deposition to these maps.

RFC.4: Line 135: This section does not describe the model evaluation, just the evaluation method.

AR.4: Yes, as this section was included in 2.1, “Methodology”, that’s why this part only describes the model evaluation methodology. But as this could result in confusion we have divided section 2; now section 2 is the old 2.1, so methodology is Section 2 and Results is now Section 3. We agree that it is clearer in this way.

RFC.5: Section 2.2: The ‘Results and discussion’ section includes the evaluation,

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which should be indicated by a separate subsection. Generally, this section should be better organized by adding subsections.

AR.5: We have now divided the manuscript into more Sections/Subsections: - Section 2: 2 Methodology for the evaluation of wet deposition - Section 3: 3. Results and discussion for wet deposition

and we have divided it in 5 subsections:

3.1: Oxidised nitrogen 3.2: Reduced Nitrogen 3.3 Sulfur 3.4 Ensemble 3.5 Joint Discussion

RFC.6: Lines 231 and 232: 'giving the highest/lowest' sounds somewhat odd.

AR.6: We have changed this to: "estimating the highest/lowest"

RFC.7: Line 411: What does 'previously' mean in this context (earlier in this paper, another paper – if so a citation is required)?

AR.7: Yes, it is a bit confusing. We meant earlier in this paper. We have changed the text to: (Section 5.1) "As we have previously mentioned, in the framework of AQMEII3 activities and to give scientific support to the HTAP task force, research activities have included an evaluation of the influence of a reduction of emissions in some parts of the Northern Hemisphere on the air quality other regions."

RFC.8: Section 6: The 'Conclusions' are just a summary and should at least include some critical comments about the deviations of the simulation results from some of the models and future directions.

AR.8: The conclusions section has now more discussion. We have included some parts that were in the old version in previous sections. We agree that now there are more final comments and some directions to continue investigating in deposition processes of models.

RFC.9: Table 2: ED\_LOTO: Does the addition of '(nudged)' mean that no nudging was

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applied for any other model?

AR.9: No, sorry. It's true that this is a bit confusing and unnecessary, as we have not entered in those details for the rest of models. We have removed this "nudged" from the table and we refer to Colette et al. and Solazzo et al. for the WRF specifications.

RFC.10: Table 3, last line: the order of SO<sub>2</sub> and TSO<sub>4</sub> should match the order of the nitrogen compounds.

AR.10: Yes, we have changed that, thank you.

RFC.11: Table 5: The figure caption should be enhanced (add explanations for CL<sup>+</sup> and CL<sup>-</sup> etc.).

AR.11: Done

RFC.12: Figures: The order of the figures should be reconsidered. In some places, the discussion would require a different order of the figure.

AR.12: We have reorganized the paper, by describing first the emission reduction activities and results and after that the effects on vegetation, as graphics on effects included the reduction scenarios. Now we consider that this is much better organized. We moved the figures accordingly.

RFC.13: Figures 5 and 7 seem not to be discussed.

AR.13; Yes, we have now included a reference to them and some discussions (lines 348-356).

RFC.14: Abbreviations: It may increase the readability of the paper if some of the extensively applied abbreviations were replaced by the full text in some places.

AR.14: We have removed some of them from the old Section 3 (now 4).

RFC.15: Please explain why \_N and \_S are sometimes added e.g. to TNO<sub>3</sub> or WSO<sub>4</sub>. To me the additions \_N and \_S seem to be unnecessary.

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AR.15: We found convenient the use of `_N` and `_S` during the treatment of data, due to the diversity of units. To avoid errors in graphics, statistics and therefore in interpretation of results we decided to have very clear variables. We have introduced an explanation to this in Table 1 caption.

RFC.16: Section 3: Why is OND introduced here as a new abbreviation instead of using TNO3 (or TNO3\_N)? Same for RN.

AR.16: Well, these were not the same. In this case OND makes reference to dry deposition (D) of oxidized nitrogen, whereas TNO3 is total air concentration of gas and particle. The idea in this old section was to introduce an abbreviation for dry deposition, with a “D”. As we see this is still resulting in confusion with have called it now ONDD, that seems to bring more the idea of dry deposition. Same for RND, now changed to RNDD.

RFC.17: Lines 373 – 376: The abbreviations, which are explained here are already used in section 4.1 without explanation.

AR.17: Yes, critical load=CL was not introduced since the first use of this abbreviation. We have included it now in the beginning of old Section 4.

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-AC2-supplement.pdf>

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Interactive comment on Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2018-104>, 2018.

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