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Atmospheric Chemistry and Physics Discussions

Interactive comment on "An evaluation of European nitrogen and sulfur wet deposition and their trends estimated by six chemistry transport models for the period 1990–2010" *by* Mark R. Theobald et al.

Anonymous Referee #2

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The manuscript presents the comparison of the trends of sulphur and nitrogen wet deposition from 4 CTMs to the observations of EMEP Network. The results of the study are of interest because such models are commonly applied to model the impacts of future emission scenarios, creating a need for the knowledge of their reliability at reproducing the trends observed due to past emission changes. The paper is written in good English. The methods are well described and seem sound. However, the major shortcoming of the paper is the tendency to flood the reader with too much minor detail, making the reading tedious. I think the main messages could be delivered better by

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substantially cutting the length of the paper and leaving majority of the specific details about the skill of the individual models in tables instead of the main text, especially as the authors state that providing in depth analysis of the models' performance or inter-model differences it is out of the scope of their study.

Specific comments:

1. Page 2, line 23. Why specifically semi-natural vegetation?

2. The analysis of previously published trends in observational data is currently cut to two parts (before and after the CTM results), making the structure of the introduction confusing and prone to repetition. This text includes too many details and all the specific numbers from all these studies would be far better visible and understandable if presented as a table.

3. The overview of previous model-measurement comparisons could also be substantially shortened, as naming the specific models participating in those studies does not provide extra information, with the possible exception of if these are the same models as used in this study and this information is later used for discussion. I would suggest to try to compress this information into a few sentences per species, giving the general view whether the previous studies have shown any consistent under- or overestimation of its wet deposition. Or, if needed, including a supplementary table with the detailed numbers from these studies.

4. Please provide the reason why the 21-year period was divided to two 11-year sub-periods.

5. Were the NOx and NH3 emissions from wildfires included? How about SO2 from volcanoes?

6. Could the CMAQ results be corrected for sea-salt sulphate (for instance using Na concentration in similar manner to how observations are corrected)?

7. The description of emission changes could be shortened, for instance combining

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what happened to shipping emissions of both NOx and SOx into a single sentence and reducing the listings of specific countries and values.

8. Spatial distributions are compared for 3 years (1990, 2000 and 2010) - are the differences in the patterns between these specific years representative of the overall trends?

9. The paper could be shortened by skipping naming the models which simulated the largest and smallest results in majority of occasions apart from those few where the reason for the outlying model result is given.

10. Page 11, lines 28-31: If the emission data was given at 5-year interval and interpolated between the given years, the models cannot be expected to perfectly reproduce year-to-year variability which might result from instant changes in some emission sources due to closing of some facilities or implementation of emission control measures.

11. Page 19, lines 27 – page 20, line 1 - "the net effect of these uncertainties is not expected to be a large systematic under- or overestimation of wet deposition." Due to the highly soluble nature of the compounds discussed here relatively little precipitation is needed for almost complete removal of them from the below-cloud column, leading to strong non-linearity of the wet deposition process. Thus, errors in modelled rain frequency might be more relevant for modelling the wet deposition than the annual precipitation amount and too frequent light rains instead of a few strong ones can for instance easily lead to positive bias in wet deposition.

Technical corrections:

1. Table 1. The optimal value of the geometric variance should be 1.

2. Figure 4 – Please correct the caption - the three time periods 1990–2000, 2000–2010 and 1990–2010 (left, middle and right columns) seem to be actually 1990–2000, 1990–2010, and 2000–2010

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