

gmd-2021-166: Evaluation of global EMEP MSC-W (rv4.34)-WRF (v3.9.1.1) model surface concentrations and wet deposition of reactive N and S with measurements

Ge et al.

Response to Reviewer #1

We thank the reviewer for the time spent reading our manuscript. Below we include all the reviewer comments and provide in blue text our point-by-point responses.

Atmospheric chemistry and transport models (ACTMs) are crucial to understanding sources and impacts of reactive nitrogen (N_r) chemistry and its potential mitigation. In the manuscript, the authors undertook the first evaluation of the global version of the EMEP MSC-W ACTM driven by WRF meteorology ($1^\circ \times 1^\circ$ resolution), with a focus on surface concentrations and wet deposition of N and S species relevant to investigation of atmospheric N_r and secondary inorganic aerosol (SIA). The results of model-measurement comparisons, conducted both spatially and temporally, covering 9 monitoring networks worldwide, showed an overall nice agreement between simulated and observed data. The authors found that simulations of primary pollutants (e.g. NH_3) are sensitive to the choice of different inventories of primary emissions (e.g. China), but much less so for secondary components (e.g. NH_4^+). Furthermore, comparisons of 2010 and 2015 surface concentrations between model and measurement demonstrated that the model captured well the overall spatial and seasonal variations of the major inorganic pollutants, and their wet deposition in different regions worldwide. The model showed better correlations with annual average measurements for networks in Southeast Asia, Europe, and North America than in East Asia (data for 2015), suggesting potential issues with the measurements in the latter network. Temporally, both model and measurement agree on higher NH_3 concentrations in spring and summer, and lower concentrations in winter. The authors also reported high correlations between measured and modelled NH_4^+ precipitation concentrations in all regions except East Asia (receiving greater anthropogenic activities). They evaluated model-measurement bias for various atmospheric N_r species in different networks as well. The greater uniformity in spatial correlations than in biases suggested that the major driver of model-measurement discrepancies were shortcomings in absolute emissions rather than in modelling the atmospheric processes. In summary, this study supported the application of this model framework for global analysis of current and potential future budgets and deposition of N_r and SIA. The authors' work provides strong implications of modelling the atmospheric processes regionally and globally, but the key point is the (relatively) accurate emission inventory of N_r species. The manuscript fits well the scope of this journal and merits to be published after minor revisions as follows.

Response: We thank the reviewer for their support of our work and for their recommendation of publication after attention to some minor revisions.

L80: wet deposition of Nr

Response: Requested change made.

L109-110: use the abbreviation of reference expression by “(Vieno et al., 2010; 2014; 2016)”

Response: Requested change made.

L127-128: As you mentioned here, all inventories were aggregated to $1^\circ \times 1^\circ$ resolution internally in the model. Could you make some comments on the uncertainties due to this aggregation (e.g. from resolutions of 0.1×0.1 and 0.5×0.5)? I have the same concern on uncertainties for the re-assigned 11 selected nomenclatures for sources of air pollution sectors in all inventory emission sector-layers.

Response: The inventory spatial aggregation used the standard EMEP model data conservation aggregation. The re-assignment of emission sectors was achieved by directly summing the emissions from those emission inventory subsectors that are linked to a given SNAP sector to obtain the total emission from this SNAP sector. The uncertainty for this re-assignment process is therefore subject to the propagation rules for uncertainty calculation, which requires information on the uncertainties in all the individual subsector emissions. This information we do not have. We fully appreciate that compiling emission inventories, especially on a global scale, is tremendously complex and challenging, and that we definitely do not have better insight into uncertainties than do the emissions specialists. It is therefore not appropriate for us to attempt our own quantification of sectorial (and total) emissions uncertainties, which would amount only to guesswork.

However, what we can confirm is that our re-assignment of emission sectors does not have any material impact on model output of global total emissions. For instance, the 2010 annual global emission of NH_3 from the ECLIPSE emission inventory is 61.66 Tg yr^{-1} , while the calculated total emission from model output is 61.72 Tg yr^{-1} , a relative difference of $<0.1\%$. Similarly, the 2010 global NH_3 emission from the HTAP emission inventory is 53.46 Tg yr^{-1} , and the same total from model output is 53.51 Tg yr^{-1} , which is also $<0.1\%$ discrepancy.

L966: Delete “14, 16(2014-08-21)” before “14, 8435-8447” and add the “doi” number before “2014”.

Response: Requested change made.