

Geosci. Model Dev. Discuss., referee comment RC1
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Comment on gmd-2021-166

Anonymous Referee #1

Referee comment on "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" by Yao Ge et al., Geosci. Model Dev. Discuss., <https://doi.org/10.5194/gmd-2021-166-RC1>, 2021

Atmospheric chemistry and transport models (ACTMs) are crucial to understanding sources and impacts of reactive nitrogen (Nr) 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 Nr 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. NH₃) are sensitive to the choice of different inventories of primary emissions (e.g. China), but much less so for secondary components (e.g. NH₄⁺). 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 NH₃ concentrations in spring and summer, and lower concentrations in winter. The authors also reported high correlations between measured and modelled NH₄⁺ precipitation concentrations in all regions except East Asia (receiving greater anthropogenic activities). They evaluated model-measurement bias for various atmospheric Nr 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 Nr and SIA. The authors' work provides strong implications of modeling the atmospheric processes regionally and globally but the key point is the (relatively) accurate emission inventory of Nr species. The manuscript fits well the scope of this journal and merits to be published after minor revisions as follows.

L80: wet deposition of Nr

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

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 $0.1 \times 0.1^\circ$ and $0.5 \times 0.5^\circ$)? I have the same concern on uncertainties for the re-assigned 11 selected nomenclature for sources of air pollution sectors in all inventory emission sector-layers.

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