

Review of the manuscript

Air quality modeling intercomparison and multi-scale ensemble chain for Latin America

Pachon et al., 2024

The submitted manuscript describes an intercomparison of global and regional air quality models operating over Latin America, focusing on the model performance over 4 selected cities. The model results are evaluated against surface measurements of the main air pollutants (NO₂, O₃, SO₂, CO, PM), for each individual model as well as for a model ensemble. The paper in detail describes performance of each model and of the ensemble median by providing the statistical scores for selected pollutants, cities (of different sizes) and seasons (January and July). The study raised up number of interesting points, such as the need for higher model resolution over smaller cities, importance of emission inventories including the local knowledge, the role of wildfires, etc. It also addressed the capabilities and limitations of each of the model and its setup.

As the authors state, this is the first study focusing on the intercomparison and evaluation of the air quality models in this region, and I find this coordinated effort a unique and valuable step forward for the air quality modeling over Latin America.

I recommend the manuscript to be accepted for publication after addressing the following minor comments:

1. Since the paper compares results of different models and their set-ups, I find the Section 2.1 (*Description of the models and modeling set-up*) to be the core part of the manuscript. However, it seems a bit inaccurate or lacking important details. Could the authors please be more specific and include in the paragraph describing each model information on the meteorology driving the model, anthropogenic, biomass burning and biogenic emission inventories, stating the exact name of the emission datasets?

E.g. for SILAM the authors say “the anthropogenic emissions were adopted from the CAMS global emission inventory” (L 74). However, there exist different CAMS inventories and different versions. Also, when the authors say “The biogenic emissions were simulated off-line by the MEGANv2.1 model” (L68, L76, L83), does it mean the MEGAN model runs were performed specifically for this study or did the model use an offline emission inventory calculated by the MEGAN model? Please make clear and if the latter, please specify which biogenic emission datasets were used.

The paragraph describing the WRF-Chem set ups (both for MPIM and USP) is rather brief (L97 – 100). Could the authors be more specific and provide more detail on the emission data used and the difference between MPIM and USP set ups?

The above mentioned applies also to the summary Table 1. The descriptions seem inaccurate or incomplete.

- The table is missing vertical resolution for MPIM WRF-Chem and projection for ECMWF-CAMS – please add and if not possible to define, indicate so in the table

- Please define IC-BC abbreviations in the text or in the table footnote
 - Please be more specific in description of the emission datasets used and state the name of the emission dataset (including version). E.g. for SILAM the Table states CAMS-REG-AP v3.1 and TNO-MACC which are both regional European inventories. But it is not clear which global anthropogenic dataset was used. Similar for biogenic dataset.
2. South America, esp. the Amazon, is one of the major sources of biogenic VOC emissions globally. I would expect the biogenic VOCs could impact O₃ and CO concentrations, esp. in Bogota and Sao Paulo. The paper discusses effect of NO₂ on O₃, mentions effect of wildfires or excessive OH concentration on CO. But does not mention the possible role of BVOCs. Could the authors please comment on this and where appropriate, include the effect of BVOCs in the discussion? E.g. could the model underestimation of CO be partly explained by possible underestimation of BVOC emissions? The CO January maxima “north of Argentina, south Bolivia, Paraguay and south of Brazil” (L433, Fig. 7) coincide with locations with high isoprene emissions.

Technical comments:

I'd suggest adding a short paragraph at the end of the Introduction section, overviewing the following sections of the manuscript.

L90: please remove *scales* (repetition)

L91: please replace *FINN module* by *FINN dataset*

L115: please replace *Suplhur* by *suplhur*

L116: please add PM10 as well

L133: Please replace *simulate* by *simulated*.

L242: The sentence beginning ‘On the other hand’ seems incomplete.

L395: Please check the MNBIAS and FGE values in the text. According to the Table A4 these should be 3.6% and 0.1.

L415: Please replace ‘hot pollution spots’ by ‘pollution hot spots’