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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Inverse modeling of SO_2 and NO_x emissions over China using multi-sensor satellite data: 2. Downscaling techniques for air quality analysis and forecasts" *by* Yi Wang et al.

Anonymous Referee #2

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This manuscript presents down-scaling results of SO2 and NOx emissions and concentrations based on the coarse-resolution joint emission inversion results from Part 1. The downscaling approaches used information from TROPOMI NO2 observations, MIX inventories, and VIIRS nighttime light observations. The downscaling results were compared against surface in-situ observations. The impact on regional air quality forecasting is also addressed. The prosed approaches are unique and could contribute to improving regional air quality modeling. I would, however, advise the authors to revise the manuscript. These revisions should be made before the manuscript can be considered for publication.

[Major comments]

As I suggested for Part 1, all the results need to be revised using higher resolution (at 0.5°x0.667° degree resolution) joint inversion results for this type of regional study. The 2°x2.5° resolution inversion could lead to large systematic biases in both local and regional emissions and concentrations in the downscaling analysis, associated with the non-linear chemistry. Ideally, inversion calculations should be done at 0.25° or 0.05° degree resolution to provide reference information for the downscaling results, but this could be difficult.

It is more straightforward to conduct high-resolution inversions using regional models. There are already several high resolution regional inversion frameworks, for instance, using WRF-Chem. The benefit of using the current coarse resolution global joint inversion framework (rather than regional high resolution inversion systems) to improve regional NOx and SO2 emissions and air quality forecast for China needs to be discussed.

The current manuscript is technical and does not seem provide sufficient scientific implications for ACP (not for GMD). It is required to provide scientific implications based on the proposed approaches. For instance, more detailed information on differences in the spatial patterns between VIIRS nighttime lights and MIX inventories and possible biases in the MIX emission inventories for each emission category would be interesting. Such information will be essential to determine the best downscaling approach for right reason.

The evaluations of forecasts in Section 4.6 are not informative in the current form. Because the purpose of this study is to improve regional air quality forecasts, evaluations of simulated ozone (one of the most important air pollutants) using in-situ observations would add important information.

The use of GCv12.0.0 model instead of GC adjoint v35m could provide some insights into the model dependent posterior emission inventory. Nevertheless, the usefulness

of the proposed downscaling approach should first be evaluated in a consistent framework (GC v35m) to avoid too much complications. Otherwise, it is required to demonstrate the model performance difference in detail.

More specific comments:

3.2.2 I'm wondering if this approach can be applied to SO2. If not, please explain the reason.

L350 "Thus, for SO2. . ." This suggests that the overall spatial pattern was degraded, while capturing hot spots. What emission sources were actually degraded? This would provide important implications into the emission inventories.

L360 "The MIX-DDC-POS. . .". It is not clear to me that the POS is better and the CGS effect still exists (how did you know?).

L365 "Thus MIX-DDC-POS".. Why did the MIX-DDC approach show good spatial pattern for NO2 and not for SO2? The MIX SO2 and NO2 spatial pattern should look similar.

L378 Why are there large positive biases?

L400 The correlation is very low. Please discuss it.

L416 I'm not sure if this is really caused by the CGS effect only. For instance, what happens when posterior emissions are biased?

L417 "which may be attributed. . ." I don't understand the sentence.

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