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Geoscientific Model Development Discussions

Interactive comment on "The impacts of uncertainties in emissions on aerosol data assimilation and short-term $PM_{2.5}$ predictions in CMAQ v5.2.1 over East Asia" *by* Sojin Lee et al.

Anonymous Referee #2

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General summary This paper assesses the impacts of anthropogenic emission uncertainties on aerosol data assimilation and short-term PM2.5 predictions in East Asia. Two different anthropogenic emission inventories are used to calculate background error covariance statistical parameters. This is an interesting topic and such studies are welcome in light of the emerging needs of air quality forecasting systems especially in the developing countries. However, I have three major concerns listed below.

First, it is not clear how the authors created the New NMC background error statistical parameters. The NMC method can use only two forecasts but at line 189, the authors said they used four different forecasts to calculate the background error statistical

parameters. Please explain in detail how you did that?

Second, it is not clear how the 24 h forecasts have been performed. Are they launched everyday after assimilation at 00, 06, 12 and 18 UTC? It is difficult to follow the discussion without answering this question. I was also surprised to see that the benefits of assimilation are diminishing so rapidly. IOA, R, and RMSE go back to the CNTL experiment level in less than 12 hours. Another surprising feature is that MB in the new NMC method is larger up to 6 hours of forecast and decreases with lead time. This is unexpected because one would expect the assimilation to bring the model close to the observations at the initial time and errors would start to grow with lead time as model deficiencies start to take over. Could you please explain this?

Third, I did not find details of the independent observations used for evaluation. From the discussion, it appears that all sites were used for assimilation as well as evaluation in Figures 6 and 7. If that is the case, the results will be artificially good for the assimilation experiments.

Below please find additional specific and minor comments.

Other Specific and Minor Comments

Line 19: spell out PM. Since you are just focusing on PM2.5, you should use PM2.5 here rather than PM.

Line 28: Do you mean 44% stations showed smaller negative bias.

Line 37: Remove "a" before significant.

Line 38: I guess you meant to say "high PM levels affect the radiation budget in Asia."

Line 45: You should also highlight that inaccuracy also results from errors in initial conditions because that's what you improve with chemical data assimilation.

Line 51: Remove "the results of"

Line 126: Change “fewer” to “smaller”

Line 145: Does not GSI optimizes the background fields and creates analysis fields rather than optimizing analysis fields.

Line 148: R is

Line 150: Change “status” to “space”.

Line 158: I guess you meant to say that a small tail of coarse mode distribution represents aerosols with diameter smaller than PM2.5.

Line 189: NMC method can use only two forecasts. Can you explain how you run NMC with 4 forecasts? Did you use the ensemble method of GEN_BE?

Line 194: Add “generate” before the.

Figure 4: Why are there multiple arrows pointing from CMAQ2GENBE to green, red, and blue outlined boxes?

Line 195: The authors state that they extracted background fields from the first simulation (Met. 1 + CREATE emissions) at assimilation times 00, 06, 12, and 18 UTC daily and used the “BKOBS2GSI” module to convert the background file. This is in contrast to the information shown in Figure 3 which shows that 06 hours prediction after assimilation at 00 UTC serves as initial condition for the assimilation and forecast starting at 06 UTC. This statement gives an impression that benefits of assimilation are not accumulated over time as suggested in Figure 3.

Figure 5 and Line 227: Do you use the same background error statistics at 00, 06, 12, and 18 UTC? Are the profiles shown in Figure 5 averaged over all latitude bins? What was the latitude bin in your set-up?

Line 243-244: It is also reflecting that perturbations used for NMC calculations do not account for uncertainties in vertical transport.

Line 246-247: I guess the unit of horizontal length scale is km here.

Figures 6 and 7: Looks like the color bar for RMSE is not correct. RMSE values can’t be too low for the MB values shown in the middle panel. Maybe, you just copied the correlation coefficient color bar to RMSE.

Table 2: Statistical metrics in New NMC are only slightly better compared to conventional NMC. Mean Bias in New NMC is even slightly worse than conventional NMC. This indicates that emission perturbations did not have a very large impact on the analysis fields. This is somewhat unexpected considering large differences between the standard deviation between NMC and New NMC. Could you explain the reason behind this?

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