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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Evaluating High-Resolution Forecasts of Atmospheric CO and CO_2 from a Global Prediction System during KORUS-AQ Field Campaign" *by* Wenfu Tang et al.

Anonymous Referee #1

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The authors have presented an evaluation of the CAMS prediction system, focusing on CO and CO2, during the KORUS-AQ campaign. They evaluated three different CO and CO2 forecast and analysis products: 16-km CO and CO2 forecasts, 9-km CO and CO2 forecasts, and analyses of CO and CO2 at 80 km and 40 km, respectively. The CAMS products were compared to the KORUS-AQ aircraft data as well as to ground-based and satellite measurements of CO and CO2. They found that CAM overestimated CO2, suggesting a positive bias in background CO2, whereas it underestimated CO, with the underestimate confined mainly to the lower troposphere. The authors also found that CAMS underestimates the outflow of pollution from China, possibly due to an underestimate of Chinese emissions. The study is a nice evaluation of CAMS CO

and CO2 under unique conditions. I have no major concerns about the analysis. My main concern is about the appropriateness of the manuscript for ACP. As a model evaluation study, I think it is better suited for GMD than ACP. My comments below are relatively minor, but must be address before the manuscript can be accepted for publication, if the Editor decides it is suitable for ACP.

Comments

1. There is no mention of the CAMS OH field, which is critical for the simulation of CO. What is the global mean OH from the analyses and forecasts? On page 5, lines 28, it is mentioned that the 16-km CO forecasts use a linear chemistry scheme. A brief description of the scheme, either in the manuscript or in the supplement, would be helpful.

2. It is stated that the overestimate in CO2 is associated with the bias correction in the biogenic source of CO2, but there is no discussion of this "bias correction". Furthermore, in Agusti-Panareda et al. (2016) CAMS CO2 was underestimating CO2 observations from the surface in situ network and from TCCON, which the "bias correction" (the biospheric flux adjustment) reduced. Why is CAMS overestimating CO2 here? A discussion is needed about the treatment of the biospheric fluxes in CAMS and its possible impact on the modeled CO2 over Korea.

3. On page 11 it was shown that the model produced steeper vertical gradients in CO and CO2 than observed over Seoul, which the authors suggested may be due to weak boundary layer mixing. Since CAMS seems to perform better over Taehwa, it would be interesting to compare the vertical gradients over Seoul and Taehwa in CAMS and in the observations to see if the issue is mainly an inability of CAMS to capture the PBL heights over the Seoul urban environment.

4. I am surprised that the analyses are not much better than the forecasts. Indeed, it seems as though the 9-km forecast is better than the analyses in some cases. I think it would be helpful for the reader if the authors expanded the description of the analyses

to give the reader more information about the configure and quality of the analyses. Figure S1 and the brief text on page 5 are not enough.

5. The discussion of enhancement ratios is confusing. It is unclear if the authors are using the slope of the CO/CO2 relationship or the slope of delta CO/delta CO2 relationship. The two approaches are different. The description in the text suggests that they are using the RMA regression of CO/CO2 to assess the combustion sources, but throughout the text there is use of the delta CO/delta CO2 notation. If they are indeed calculating an enhancement ratio (delta CO/delta CO2) above the background, how is the background being calculated? How sensitive is the analysis to the definition of the background?

6. The authors found that CAMS underestimated CO during China outflow events, but overestimated it under normal conditions. What are the different source regions for air reach the West Sea during "outflow" and "normal" conditions? To what degree is the model bias due to CAMS not capturing this difference in transport as compared to it not have the correct balance of emissions in China?

Technical Comments

1. Page 4, line 26: add a comma between "forecast" and "CO2".

2. Page 4, line 28: add "the" between "on" and "free-running".

3. Page 5, line 1: Is Figure 1 really necessary? I don't think it adds much to the manuscript. Since there are already 11 figures, I would suggest removing Figure 1.

4. Page 6, lines 1 and 2; add "the" before "South Korean peninsula".

5. Page 6, line 7: remove "including" before the list of the three questions.

6. Page 6, line 8: The wording for question (3) needs improving. The English is not quite correct.

7. Page 8, lines 22 and 23: The revisit and overpass times seem to be used inter-

changeably here. The revisit time of OCO-2, for example, is 16 days since it is in the A-Train orbit. However, the local overpass time is around 1:30 pm. For GOSAT the revisit time is 3 days.

8. Page 8, line 26: Change 0.09e18 from e-notation to standard SI notation.

9. Page 9, line 5: Please add "is" between "CO2" and "associated".

10. Page 10, line 1: The variance in CO in the May 3rd data does not seem larger than average to me. In fact, it seems to be smaller than average.

11. Page 10, lines 12 and 14: Please change "tale" to "tail".

12. Page 12, line 4: It is unclear what is meant by the statement that "the wind speeds dominate the transport flux variations in CO2." It the argument here that the meteorological uncertainty is the dominant contribution to the uncertainty in the forecast and analysis fields? If so, how does one come to that conclusion from Figure 7?

13. Page 15, line 23: Section 4.2 only discusses the comparison to ship data of CO, not CO and CO2.

14. Page 15, line 23: change "shop tracks" to "ship tracks".

15. Page 17, line 7: Change "size of CO data" to "amount of CO data".

16. Page 40, Table 3: The title for the table is wrong. This is the same title as for Table 4.

17. Figure S1: Should the labels "FX9s" and "FX16s" in the figure be "FC9s" and "FC16s"?

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