

Atmos. Chem. Phys. Discuss., referee comment RC2
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Comment on acp-2022-458

Anonymous Referee #2

Referee comment on "Assimilation of S5P/TROPOMI carbon monoxide data with the global CAMS near-real-time system" by Antje Inness et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2022-458-RC2>, 2022

General Comments:

This manuscript presents the assimilation results of NRT CAMS by assimilating TROPOMI CO observations with the following contents: 1) assimilation result of CAMS by assimilating MOPITT and IASI CO; 2) difference between TROPOMI CO and CAMS; 3) difference between CAMS-TROPOMI with control run; 4) validation with respect to independent observations; 5) impact of boreal fires. The experiment results, shown in this manuscript, are helpful for better assimilations of tropospheric CO. I recommend the paper for publication after consideration of the points below.

In general comments, the detail of this manuscript should be improved. There are different experiment configurations with complicated names such as "CY47R3"; The titles of subsections need to be improved, for example, "4.2.1 Difference plots ASSIM minus CTRL experiments"; the fonts of some figures are too small to see; the titles of some figures seem from original experiment records and should be re-designed; the term of "departure" is widely used in figure captions and should be clearly defined: whether they represent model minus observation or observation minus model. While the assimilation result is worthy of publication, the style of the current version is a little different from common research articles.

Specific Comments:

- Page 4, Line 20: What is the purpose of "randomly selecting one observation in each grid cell"? Is it better to use the average of observations within each grid cell to reduce the effect of random errors in satellite observations?
- Page 5, Lines 11-20: I understand there could be some "historical reasons". However, the description here is uncommon in research articles.

- Page 11, Line 29: The direct averaging of satellite data to the model grid may not be a strict "super-observation" because the effect of observation error at each observation point is not considered, for example, Section 2.3.3 in Miyazaki et al. 2012. In addition, I don't think the "super-observation" can reduce random errors. Miyazaki, K., Eskes, H. J., and Sudo, K.: Global NO_x emission estimates derived from an assimilation of OMI tropospheric NO₂ columns, *Atmos. Chem. Phys.*, 12, 2263–2288, <https://doi.org/10.5194/acp-12-2263-2012>, 2012.
- Page 17, Lines 26–27: what is the difference between CTRL and CAMS discussed in the previous section?
- As shown in Figure 11, the improvement by assimilating TROPOMI CO with respect to the original MOPITT+IASI is mainly due to the underestimated CO columns in MOPITT TIR data. However, why the newer multi-spectral TIR+NIR MOPITT data were not considered? In addition, the a priori biases are comparable between MOPITT (0.6) and IASI (1.5), then why the a posteriori bias is much larger in MOPITT (-3.3) than IASI (1.2)?
- Page 25, Figure 18: It is interesting to see the large difference between Europe/North America and China. What could be the possible explanations? A recent study found a similar small influence of MOPITT CO assimilations on surface CO concentrations in China. In addition, what is the meaning of "Marco Polo" in the title of Figure 18c? Tang, Z., Chen, J., and Jiang, Z.: Discrepancy in assimilated atmospheric CO over East Asia in 2015–2020 by assimilating satellite and surface CO measurements, *Atmos. Chem. Phys.*, 22, 7815–7826, <https://doi.org/10.5194/acp-22-7815-2022>, 2022.

Technical Comments:

- Page 1, Line 22: the abbreviation of "NRT" should be defined.
- Page 5, Line 24: change "2021-07-09" to "2019-07-09"
- Page 17, Line 8: change "3 10 18" to "4.3 x10 18"
- Page 21, Figure 12 and Figure 13: the definitions for the abbreviations of "FgDep" and "AnDep" should be provided.
- Page 22, Figure 14: I assume the left and right columns are relative biases for the assimilated and control runs, respectively. But it should be clarified in the figure caption.