Atmos. Meas. Tech. Discuss.,
doi:10.5194/amt-2020-63-RC2, 2020

Atmospheric Measurement Techniques Discussions

AMTD

Interactive comment

Interactive comment on "1.5 years of TROPOMI CO measurements: Comparisons to MOPITT and ATom" *by* Sara Martínez-Alonso et al.

Anonymous Referee #2

Received and published: 6 April 2020

This manuscript compares TROPOMI carbon monoxide retrievals to data from the MOPITT satellite and in situ airborne profiles (ATom-4). The manuscript is well written and falls into the scope of AMT. I recommend publication after the following comments have been addressed.

General Comments

My main concern is that the significantly different vertical sensitivities of the instruments and the different apriori profiles used in the algorithms are not taken into account in the comparison of the TROPOMI and MOPITT data. It is alleged that the corresponding

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comparison methodology is not applicable to profile scaling retrievals. However, I do not agree with this view as TROPOMI's averaging kernels (AKs) take into account that it is a profile scaling retrieval. The AK value of the i-th layer quantifies as usual the sensitivity of the total column to a change of CO in the i-th layer. It is also not a question of constraining the results with the apriori or not. If the AKs are not a direct output of the retrieval, you can simply compute them for every kind of algorithm by confronting the retrieval with simulated measurements and doing the following for each layer i: 1) change the abundance in the i-th layer, 2) perform the retrieval, 3) compare the retrieved column to the "true" column. For a meaningful comparison, at least the individual apriori profiles of both retrievals should be replaced by a common prior by using the AKs (see e.g. Section 4 of Rodgers and Connor (2003) or Appendix A of Wunch et al. (2011)). The common prior can be the TROPOMI prior, the MOPITT prior, or a different third prior. Please improve the comparison method by taking these aspects into account or give a justification why the consideration of the AKs is negligible in this analysis and prove by example that the figures of merit like the global bias between the two data sets do not critically depend on whether the individual apriori profiles are replaced by a common prior.

Specific Comments

Page 1, Lines 4-5: TANSO-FTS-2 on the GOSAT-2 satellite (launched in 2018) is also deriving CO from solar reflected radiances in the $2.3\,\mu$m spectral region.

Page 1, Lines 16-17: see general comments

Page 3, Lines 49-50: TANSO-FTS-2 on the GOSAT-2 satellite is also deriving CO from solar reflected radiances in the $2.3\,\mu$m spectral region.

Page 7, Lines 157-160: see general comments

Page 8, Line 195: The units in Eq. (1) do not match.

Page 9, Lines 223-225: Why not use the actual TROPOMI averaging kernels here instead of a binary step function?

Page 10, Lines 242-243: Why not use the actual TROPOMI averaging kernels?

Page 13, Lines 342-343: The negative bias could simply be a consequence of the different sensitivities and apriori profiles used in the estimation of the true atmospheric state for the two individual instruments. Thus, consideration of the averaging kernels is important. Please note for example the change in sign for the biases in Figure 6 due to the AKs.

Page 14, Lines 378-380: How do these error estimates change when considering the averaging kernels and apriori profiles?

Page 14, Lines 384-386: In addition to the global accuracy and precision, it would also be interesting to quantify the regional relative accuracy quantifying region-to-region biases, e.g. the standard deviation of the individual biases for the regions of Figures 2-5. The precision requirement of 10 % is not satisfied.

Page 14, Line 390: To validate TROPOMI retrievals over land, ground-based measurements from the Total Carbon Column Observing Network (TCCON), which are calibrated using aircraft profiles, can also be used. In contrast to aircraft data this would also allow the validation of seasonal variability at a fixed location.

Page 14, Line 392-393: I would call a comparison to other satellite data sets verification instead of validation. Has the seasonal variability of MOPITT also been validated, e.g. by using TCCON or NDACC ground-based measurements?

Page 14, Line 395-396: TANSO-FTS-2 on the GOSAT-2 satellite is also deriving CO from solar reflected radiances in the $2.3\,\mu$m spectral region.

Page 14, Line 399: Please replace “do not fully account for” by “do not account for”.

Page 15, Line 408: What about transport of CO from major sources in coastal regions to the ocean?

Page 15, Line 411-412: or validation with ground-based measurements (TCCON or NDACC)

Figures 3-5: Please add regional mean bias and standard deviation of the differences to all individual subplots.

Figures 13-14: Please add the standard deviation of the individual regional biases as a measure of the region-to-region bias to the plots (for TIR, NIR, and TIR+NIR).

Table 1: Please add region-to-region biases in case "all ROIs".

Technical Corrections

Page 3, Line 50: Please rephrase "is key."

Page 8, Line 195: Please replace $\Sigma_{i=1}^{i=n}$ by $\Sigma_{i=1}^{n}$ in Eq.(1).

Page 13, Line 340: Please add the unit % for the relative biases.

References

Rodgers, C. D. and Connor, B. J.: Intercomparison of remote sounding instruments, J. Geophys. Res., 108, D3, 4116, https://doi.org/10.1029/2002JD002299, 2003.

Wunch, D., Wennberg, P. O., Toon, G. C., Connor, B. J., Fisher, B., Osterman, G. B., Frankenberg, C., Mandrake, L., O'Dell, C., Ahonen, P., Biraud, S. C., Castano, R., Cressie, N., Crisp, D., Deutscher, N. M., Eldering, A., Fisher, M. L., Griffith, D. W. T., Gunson, M., Heikkinen, P., Keppel-Aleks, G., Kyro, E., Lindenmaier, R., Macatangay,

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R., Mendonca, J., Messerschmidt, J., Miller, C. E., Morino, I., Notholt, J., Oyafuso, F. A., Rettinger, M., Robinson, J., Roehl, C. M., Salawitch, R. J., Sherlock, V., Strong, K., Sussmann, R., Tanaka, T., Thompson, D. R., Uchino, O., Warneke, T., and Wofsy, S. C.: A method for evaluating bias in global measurements of CO_2 total columns from space, Atmos. Chem. Phys., 11, 12317-12337, https://doi.org/10.5194/acp-11-12317-2011, 2011.

Interactive comment on Atmos. Meas. Tech. Discuss., doi:10.5194/amt-2020-63, 2020.