Response to Referee #3 – "A comparison of carbon monoxide retrievals between the MOPITT satellite and Canadian High-Arctic ground-based NDACC and TCCON FTIR measurements" by Ali Jalali et al.

We would like to thank Referee #3 for their helpful comments. Here we address their review, with their comments in green and our responses indented in black.

General Comments

In this new study, Jalali et al. discuss the validation of MOPITT v8 satellite measurements of carbon monoxide with high latitude ground-based FTIR measurements in the Canadian Arctic. Following a concise introduction and description of the MOPITT and FTIR ground-based measurements, the vertical sensitivity of the measurements of the different instruments in terms of averaging kernels and degrees of freedom for signal are discussed. The methodology section clearly outlines the comparison approach and properly introduces the Taylor diagram as a tool to summarize the intercomparisons of the various MOPITT data subsets with the NDACC and TCCON measurements. For the actual comparisons with the reference data, the focus is given to multiple aspects, including MOPITT pixel-to-pixel bias, noise, and drifts. Results are compared to earlier validation studies using MOPITT v6 and v7 data, illustrating the benefits of the improved retrieval method of the v8 data. Major results are nicely summarized in the conclusions.

Overall, I got the impression that this is a carefully conducted study with sound results, applying state-of-the-art methodologies (e.g., consideration of the averaging kernels in the comparisons and the Taylor diagrams). The study properly considers the results of earlier work on MOPITT CO retrieval validation. The authors clearly spent time and effort to prepare and submit such a well-written, clear, and concise manuscript. Overall, I have only a short list of clarifications and suggestions and would like to recommend the paper for publication in AMT.

Specific Comments

p1, l9: Suggest replacing "within a 1° radius" with "within 110 km radius" (as stated later in the manuscript).

> This has been done.

p2, l12: At the end of the abstract, perhaps add a sentence about any broader implications and/or an outlook of the study?

> We have added this sentence to the end of the abstract. "Overall, this study aims to provide detailed validation for MOPITT v8 measurements in the Canadian high Arctic."

p2, l13-33: In the introduction, it could be elaborated and referenced that the MOPITT CO measurements are of interest for chemistry-transport and climate model validation as well as studies of tropospheric tracer transport, I think. Model validation and transport studies will benefit from proper error characterization and improved accuracy of the new MOPITT v8 data, as described here.

> At the end of p2, l33, the following sentence has been added. "To predict future warming in the Arctic and simulate air pollution impacts in this region, well-validated atmospheric chemistry models are required and these must be evaluated using high-latitude measurements (e.g., Monks et al., 2015; Whaley et al., 2022)."

> References:

> Monks, S. A., et al.: Multi-model study of chemical and physical controls on transport of anthropogenic and biomass burning pollution to the Arctic, Atmos. Chem. Phys., 15, 3575–3603, https://doi.org/10.5194/acp-15-3575-2015, 2015.

Whaley, C. H., et al. Model evaluation of short-lived climate forcers for the Arctic Monitoring and Assessment Programme: a multi-species, multi-model study, Atmos. Chem. Phys., 22, 5775–5828, https://doi.org/10.5194/acp-22-5775-2022, 2022.

p3, l16-27: Did the earlier studies provide any reasons for biases between the NDACC and TCCON measurements?

These earlier studies investigated these differences in detail and found that a number of factors can contribute to these biases. These include the air-mass-independent correction factor used by TCCON, use of different a priori VMR profiles, choices of spectroscopic line lists used, and the impact of smoothing errors.

p4, 24: What are the actual pressure levels of the MOPITT retrievals (or maybe, what is the vertical range with meaningful retrieval results)?

This has been added to the sentence on p4,24 as follows.

Changed from: "…profiles are provided on a 10-level fixed-pressure grid as the average VMR within each layer, …"

To: " … profiles are provided on an equal spaced 10-level fixed-pressure grid (surface, 900 hPa, 800 hPa, ..., 100 hPa) as the average VMR within each layer, …"

p33, l10-13: At the end of the conclusions, perhaps add 1-2 sentences on the broader implications of the study and future work (similar to the abstract).

We have added the following sentences to the end of the conclusions. "Together, these filtering and pixel usage recommendations and comparison results provide guidance for using MOPITT v8 measurements for studies in the Canadian high Arctic. The improvements seen in this latest data version for MOPITT are encouraging for studies using this dataset in the high northern latitudes."

Technical Corrections

p2, l23: remove "140pp"?

This has been done.

p4, l6-7: Would like to suggest not using "Buchholz2017" and "Hedelius2019" and simply keep the references in their original formatting. It does not look like this makes the paper any shorter.

In writing the paper, we chose to use these short forms to make it easier to follow for the reader and because these references are used in the paper 18 and 16 times, respectively.

p4, l9: NASA'_s_

Changed.

p4, l12: 22 x 22 km_^2_

This has been changed to 22 km x 22 km.

p5, l18: _the_ water vapor (?)

The word "that" in this sentence has been changed to "the" as follows: "The new parameterization includes the date and geographical location of the MOPITT observation and the water vapour total column at the observation time."

p9, Table 1: use Copernicus table layout

This has been done.