Atmos. Meas. Tech. Discuss., 3, C466–C470, 2010
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Atmospheric Measurement Techniques Discussions

Interactive comment on "Carbon monoxide mixing ratios over Oklahoma between 2002 and 2009 retrieved from Atmospheric Emitted Radiance Interferometer spectra" *by* L. Yurganov et al.

Anonymous Referee #1

Received and published: 20 May 2010

General comments: This discussion paper presents CO values retrieved from AERI-SGP measurements between 2002 and 2009. The authors present improvements to an existing algorithm for retrieving the CO mixing ratio from AERI measurements and validation by comparison to simultaneous, independently measured CO profiles for 98 case studies. Presentation and validation of the time series of CO measurements is an important contribution, making the paper worthy of publication.

The two main weaknesses of the paper are the error analysis and the solar radiation correction.

Error analysis. The accuracy in the retrieval technique is stated as better than 10%,

but inadequate detail is given as to how this value is determined, or how this retrieval method compares (quantitatively) to other retrieval techniques. A citation to He et al. is made, but I could not find a reference to "better than 10%" in that paper in connection with retrieval accuracy. Does this accuracy include effects of water vapor and temperature errors? Similarly, the authors should state the accuracy of the water vapor and temperature profiles used in the retrieval algorithm and propagate them into errors in their retrieved CO, with a brief explanation. In the case of water vapor, providing error estimates for the AERI-derived PWV and the MWR PWV would show that the MWR PWV is more accurate and provide motivation for scaling to match the MWR PWV. An additional source of error in retrieved CO is due to errors in the AERI spectral calibration; this needs to be included in the error budget. Finally, they should explain clearly how the errors were incorporated to get the error bars shown in Fig. 8.

Solar radiation correction. The authors speculate that a source of error is due to scattering of solar radiation by clouds and aerosols. But is speculation necessary? It would be helpful if the authors would explain why aerosol-specific instrumentation at the SGP site were not used to document the existence or amount of aerosol present. The authors attempt to correct for the solar radiation after showing that a positive bias exists in the RD in microwindows (transparent regions between strong emission lines) near the strong CO lines. I find this correction unnecessary and also unconvincing. The correction does not seem to make much difference except near noon, and near noon, the correction does not remove all of the correlation between retrieved CO and the diurnal cycle of solar radiation in Fig. 11. The decision to set S=-40 seems arbitrary. Therefore, there doesn't seem to be adequate rationale for examining the remaining 7 ppb diurnal cycle to see if it might be real. Instead of correcting for the bias, the authors might use the magnitude of the RD seen in the microwindows to estimate the sizes of errors in the retrieved CO. These error bars are needed in Figs. 9-11 to show whether the AERI CO is different than the tower CO to within the uncertainty in the AERI-CO.

Finally, this article requires considerable editing for grammatical mistakes and problems

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with organization, consistency, and clarity, some of which are described following the specific comments on the scientific conten.

Specific Comments:

Page 1265, lines 22-28. The text is too similar to text on the ARM website at http://newdesign.arm.gov/about/. The authors should put quotes around text that is identical and reference the web site.

Page 1266 lines 19-23 The text is too similar to the text on the SGP web site at http://newdesign.arm.gov/sites/sgp.stm, and needs to be rephrased or quotes should be inserted.

Abstract: In the abstract, the word "significantly" should be removed on line 7 of page 1264 unless the authors show that the changes are significant overall. The abstract needs to be rewritten to be more clear and concise.

Page 1267, line 4. Insert the word "The" before AERI so that you are describing this specific AERI, since different AERIs have different spectral ranges.

Page 1267, lines 25 - page 1268 line 4. More explanation is needed here. Why doesn't a nonlinear least squares iterative approach work here? How will a fast forward model help? Please link the McMillan et al. one-parameter retrieval model to the He et al. model you term v. 1 in the introduction, perhaps on line 28.

Page 1268, line 3: The authors mention "until we develop a fast spectra computation routine..." What is the expected improvement in speed and/or retrieval accuracy with the new routine?

Page 1268, line 21: Again, it would be helpful to mention v.1 here.

Page 1269, line 8: How does the retrieval accuracy compare to other methods? The authors should mention briefly how the retrieval accuracy is determined. For example, is this in the absence of instrumental and other errors?

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Page 1269, line 10: Since the authors focus on improving the water vapor profiles, more details are needed about how they were retrieved from the same AERI spectra. For example, are any ancillary data, like radiosoundings, used in the retrievals? Can the authors include a statement of the accuracy of the AERI-derived water vapor and temperature they actually use?

Page 1270, lines 14-15: Change “disagreement . . . was well below,” to “agreement . . . was well within,” to avoid confusion.

Page 1279, line 19: Since it is not true that water vapor profiles must be scaled, rephrase this sentence and the following sentence to include a statement of the improvement in accuracy gained by scaling the water vapor profiles, e.g. that scaling by the PWV MWR improves accuracy by $\sim$x% for cases with PWV>3, and that this results in an improvement of y% in the retrieved CO.

Page 1269, line 20: A few other possible sources of error are errors in the AERI itself (i.e. the calibration accuracy and/or a possible bias in the AERI instrument) and errors in the PWV, which would cause errors in the water vapor continuum radiance.

Technical corrections:

Numerous grammatical and spelling errors and organizational issues need to be addressed in this article. In addition, figure captions, labels, and legends need to be standardized. Following are a few specifics (not exhaustive).

- Please define all acronyms, including in figures.

- Please use superscripts and subscripts where necessary.

- Section 2 contains a lot of topics. Perhaps reorganize, or start with a small introductory paragraph.

- A discussion of ongoing research might be more appropriate in the discussions or conclusions than at the end of section 2.

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- Page 1264, line 176, Restate the section beginning, "An aircraft supplied," to start with something like "These tropospheric profiles extend from the surface to 5 km and were derived from..."

- It would be helpful if the discussion of the various algorithms for CO retrieval along with their accuracies were together in one section, so the reader can put the accuracy of this retrieval algorithm into context.

- Page 1266, Lines 1-9: This paragraph needs to be reorganized. As an example, the authors could start a new paragraph beginning with "In the present paper." Briefly list the improvements in the next sentence, and remove the word "Here" from the following sentence (currently line 4). Remove the sentence on lines 5-6: "The laborious ... documented."

- Page 1268, lines 6-20. There are too many topics in this paragraph.

- Page 1271, line 26, “Obviously” is spelled incorrectly.

- Page 1280, lines 1-3: Rephrase to make this clearer.

- Page 1283, line 14, “radiance” is spelled incorrectly.

- Page 1296, Fig. 7 caption, Rephrase the following, “. . .corrected for the scattered light using for different slopes, S, of the correlation between CO and RD.”

- Page 1268, line 13. Is the Turner et al. paper from 1999 or 2000?

- Figure 8, “convolved” is misspelled.

Interactive comment on Atmos. Meas. Tech. Discuss., 3, 1263, 2010.