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Atmospheric Measurement Techniques Discussions

Interactive comment on "Impacts of updated spectroscopy on thermal infrared retrievals of methane evaluated with HIPPO data" *by* M. J. Alvarado et al.

Anonymous Referee #2

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This article evaluates differences in a new processing version of TES CH4 retrievals that employ an updated set of spectroscopic parameters for the molecule. It uses a reliable external reference data set (in situ aircraft measurements from HIPPO) that provides a good, independent measure of whether the new spectroscopic parameters improved results or made things worse.

The paper is well organized, and the English/grammar usage is excellent. The study is relatively thorough, and the conclusions are sound. I would recommend publication, subject to the following two technical corrections:

Page 10060, line 16: the acronym DOFS is used without definition

Page 10065, line 9: the retrieval grid vector, z, is defined in Eq. 2, not Eq. 1

My one area of concern with this work (for which I wouldn't necessarily suggest changes in the article) is the N2O correction. The authors do address the accuracy of their assumptions used as the basis of their correction (the N2O a priori). For measurements with at least 1.6 DOFS, the difference between the assumed TES N2O a priori and the HIPPO N2O measurements was on average <0.5 ppb, with a maximum of 5 ppb. For measurements with DOFS < 1.6 DOFS, the average discrepancy is about 1.5 ppb. They do not mention the maximum discrepancy in this data set. Deficiencies in the N2O a priori should not introduce significant error in the averaged results.

However, it seems to me that the N2O-based correction appears to work because the spectroscopic parameters employed for N2O (from HITRAN 2000) are "bad in a similar way" to the CH4 spectroscopic parameters. When they switch to updated parameters for N2O, the retrieved N2O results are closer to expectations and the N2O-based correction no longer works properly. This is not an ideal situation for applying a correction. Ideally, deviations in retrieved N2O from expectations would be mostly from some inherent limitation in the retrieval process that would yield similar systematic errors in the CH4 retrievals. Relying (at least partially) on the nature of deficiencies in the N2O spectroscopic parameters to correct CH4 retrievals is a bit of a dangerous game, but it appears to improve the results and so would seem to be defensible.

It would suggest to me that there likely remain errors in the CH4 spectroscopic parameters. With the new CH4 spectroscopic parameters, the agreement with HIPPO results improves, even in the absence of the N2O-based correction. I agree with the authors' assessment that the new set of CH4 parameters represents an improvement. However, I suspect that further improvements are required in the parameters. There is a newer line list than was considered here (HITRAN 2012). It would be beyond the scope of this paper but is probably worth looking at. Based on my experiences with

CH4 in HITRAN 2012, I am not convinced it holds the answer, but I have not looked in detail at the frequency region employed in the CH4 retrievals for this study.

Interestingly, the changes in spectroscopic parameters for N2O between HITRAN 2000 and HITRAN 2008 may hold some clue as to the sort of refinements necessary for CH4, if the HITRAN 2000 N2O parameters are “bad in a similar way” to the CH4 spectroscopic parameters.

The residuals near 1310 cm-1 suggest there might be something missing in the calculated spectrum. There is HNO3 in that region, but this is not mentioned in the text. Does it not contribute significantly in your measurements? Also, N2O5 has an absorption feature near 1250 cm-1. Measuring in emission, TES can collect measurements at night when N2O5 levels could be quite high. It doesn’t contribute significantly in the TES measurements?

Possible additional references:

Page 10060, line 23: Gives CH4 concentrations in 1750 and 2011 without a reference. I understand the reasoning but don’t like seeing quantitative values quoted without a reference.

Page 10061, line 20: In recent years... Presumably this is referring to studies with GOSAT data, and it might be appropriate to provide an example reference.

Interactive comment on Atmos. Meas. Tech. Discuss., 7, 10059, 2014.