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Interactive comment on “Quantifying lower tropospheric methane concentrations using near-IR and thermal IR satellite measurements: comparison to the GEOS-Chem model” by J. R. Worden et al.

J. R. Worden et al.

john.worden@jpl.nasa.gov

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Response to Reviewers

We would like to thank both reviewers for their time and feedback. Both reviewers suggested that the paper would be greatly strengthened by comparison to in situ data, and we have now included a comparison to in situ data in the revised manuscript. The original reason for not including in situ data was due to a combination of few comprehensive aircraft profile measurements (primarily over NOAA / DOE sites in the Midwest of the

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USA) along with few TES/GOSAT overlaps. Because of the difference in spatial representativeness between aircraft and satellite data and the lack of overall comparisons we found we could obtain a constraint on the bias but not necessarily test the random errors. Consequently we initially decided to wait so that we could more carefully determine how to compare these satellite data against the available in situ data. However, subsequent conversations with Lori Bruhwiler and Ed Dlugokencky suggested that simple comparisons to most surface sites should suffice as they represent background conditions that in turn should be representative of the larger spatial scales (5x4 degrees) that are shown in this paper; these are the comparisons now shown in the paper but with the added component of using the GEOS-Chem model to characterize the relationship between surface methane and lower tropospheric methane. As a result of this comparison we have: 1) Added a new section (Section 3.5) that describes the surface data → GEOS-Chem → GOSAT/TES comparisons as well as a corresponding figure 2) We have revised the abstract to emphasize the comparison to in situ data and de-emphasize the comparison to the GEOS-Chem values (although the text still retains much of the GEOS-Chem comparisons. 3) Comparisons between GOSAT/TES data and GEOS-Chem have been updated to reflect the measured bias in these data.

Response to Specific Comments (Reviewer 1)

Comment: There are no details about the GEOS-Chem model

Response: The GEOS-Chem model and its use for modeling methane is discussed in many previous papers (all cited in this manuscript). To address this comment we have also updated the Appendix with more information. The comparison between surface sites and the GEOS-Chem surface values shown in Figure 10 also addresses this concern.

Comment: Comparing the retrieval to a model is problematic, for example on p. 3859, where the authors describe "...regions where the modeled fluxes are likely in significant disagreement with the true fluxes.

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Response: This comparison shows where the new science lies! Not where the retrieval / model has comparison issues. However, for this paper I use these comparison to demonstrate the sensitivity to the lower-tropospheric concentrations and how typically the most interesting differences are over the source regions.

Comment: Paper lacks a "road map" of its organization

Response: Done

Comment: Change "free-troposphere" to "free troposphere". Similarly for "lower-troposphere". (Done)

Comment: Acronyms not defined: HBL, SWIR, TIR (Fixed)

Response to Specific Comments (Reviewer 2)

P3855, L25: change CO₂ to CH₄? (Fixed) The last term in equation (4) is not the same as the last term in equation (3), it is good to make it consistent (Fixed)

P3858, L18, it is not clear about "the last term"? Do you mean the last term in equation 4 or the third term in equation 3b? Please clarify it. (Fixed)

P3858, L22, change "Sect. 3.1" to "Sect. 3.2" (Fixed)

P3859, L21, it reads as "GEOS-Chem total column minus GOSAT/TES lower- tropospheric methane", which is inconsistent with the figure caption and the context. (Fixed)

Comment: P3859, last paragraph, what about the large negative biases in Center Africa, which is worthy of being mentioned.

Response: I went back and forth on adding a sentence here but could not make it fit easily within the context of the discussion. Certainly though we will look at this in a subsequent manuscript that examines tropical wetland fluxes.

Comment: In Figure 9, it is useful to overplot the mean and corresponding standard deviation (as error bar) or RMS of the difference at each latitude. Also it is good to over

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the mean precision as a function of latitude.

Response: After thinking about this a bit further, we decided to not add error bars representative of the RMS in Figure 9 because the distributions are not typically normal. P3866, L11-12, remove “. IASI” as there are two “IASI” (Fixed)

Interactive comment on Atmos. Meas. Tech. Discuss., 8, 3851, 2015.

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8, C1709–C1713, 2015

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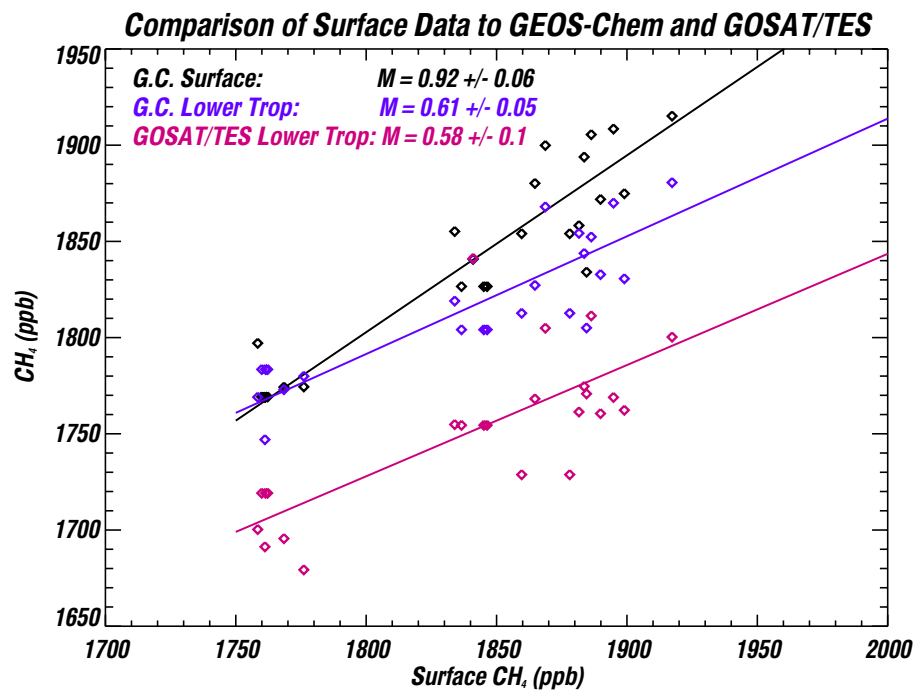
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Fig. 1.

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