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Interactive comment on "Methane cross-validation between three Fourier Transform Spectrometers: SCISAT ACE-FTS, GOSAT TANSO-FTS, and ground-based FTS measurements in the Canadian high Arctic" *by* G. Holl et al.

Anonymous Referee #1

Received and published: 13 January 2016

Holl et al. provide a comprehensive account of measurement intercomparison between three remote sensing Fourier transform infrared spectrometers. Measurements of atmospheric methane from two satellite-based instruments and one ground-based instrument are cross-validated at one location in the Arctic. The authors investigate differences for profiles as well as for partial columns, taking into account the information content measured by each instrument.

The paper meticulously describes the methodology, drawing on previous work in the field. Writing style is clear and concise, and includes rigorous analysis and sound

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statistical interpretation. The subject matter is relevant to the scope of AMT. Subsequent to addressing or responding to the minor comments below, I recommend that the manuscript be accepted for publication in AMT.

Specific Comments:

Page 13202, Line 21: While it was the aim that MOPITT measure methane, there is no operational methane product, due to several radiance-based issues, some of which are described in Pfister et al. (2005).

Page 13203, Lines 23-26: I would like to see a bit more detail describing the coming sections rather than just "Results, Discussion, Conclusions". Particularly, I think more specific details are needed about Sections 3, 4 and 5.

Page 13204, Line 21: Discuss what pressure range is covered by the 47 levels. This will help prime the reader for the following sentences where selection of the pressure and temperature profiles is explained.

Page 13205, Lines 12-20: The vertical resolution of ACE is first described as 4km, but then later described as being retrieved on a 1 km altitude grid. How do these reconcile?

Page 13208, Lines 22-24: It is unclear why a different spatial extent is used to compare ACE-FTS and TANSO-FTS instead of using the same radius around the PEARL-FTS station.

Page 13209, Line 11, and Line 18: Averaging kernels (AK) and a priori do not need to be interpolated because you smooth the interpolated higher resolution measurement with the lower resolution AK and a priori. This only requires interpolation of the higher resolution profile onto the lower resolution grid.

Page 13211, Line 7: I would argue that the coincidence error could still be important, but the error cannot be reduced by taking into account collocation distance.

Section 2.7: It would be useful to mention within the partial column calculation methodology section at what point averaging kernels are applied. It seems as though some-

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times they are smoothed (section 3.5) and other times not (e.g. Figure 5).

Page 13213, Line 14: Mention typical choices for f and c. Also mention that criteria for choosing f and c are shown later in section 3.2 and vary between instruments.

Page 13215, Lines 5 to 17: This methodology is not really about "choosing a closest profile". Rather, it is calculating a representative covariance matrix for several sets of retrievals, defined as likely to have an equivalent error covariance.

Page 13224, Paragraph on lines 6-21: Can the comparison of V2.2 and V3.0 in Waymark et al. (2013) be used to lend any insight on whether the differences found relative to De Mazière et al. (2008) are expected?

Table 2, Figure 17 cation, Page 13222, Line 15 and elsewhere: The altitude range for the comparison of PEARL-FTS and TANSO-FTS partial columns is defined at the lower boundary by TANSO to be 5.2 km according to page 13218 line 18. However, elsewhere in the discussion this lower boundary is 5.3 km.

Figure 1 Caption: Collocation is shown as 12 h of PEARL, but in the text on page 13208, line 8, the text says collocations are within 24 h.

Figure 8: What causes the horizontal lines in the lower 10 km of the PEARL-FTS sPV plot?

Figure 17 and discussion on page 1322, Lines 15-17: There are 4 points which look to be outliers on this plot. Outliers can greatly influence linear regression. Was linear regression without the outliers performed to make sure these points do not have a major effect on the result?

Technical Corrections: The paper is well written and there are only minor technical corrections. Below are some suggested grammatical changes and areas to include additional information.

Page 13200, Line 16: An additional **collocation** criterion

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Page 13201, Line 6: The phrase "expressed in absolute or relative terms" is indicated in the brackets, but I cannot see where any absolute terms are recorded within the bracketed values (e.g. -1.6 is not an absolute value)

Page 13201, Line 15: third **largest** contributing

Page 13202, Line 7: process **of verifying** that

Page 13203, Lines 11: A more appropriate term to use instead of "A special case of" may be "A sub-category of" or "One type of". Th subsequent sentences do not go into how occultation measurements are "special" compared to other types of limb measurements.

Page 13204, Line 16: The **retrieval** strategy

Page 13204, Lines 21 and 24: I would clarify that "below 10 Pa" and "Above 10 Pa" means at **altitudes** above and below 10 Pa, because 100 Pa > 10 Pa can also be interpreted as an "above" relationship.

Page 13207, Line 7: Are the pressure level ranges of "94 to 56 Pa" meant to be pressure level width ranges?

Page 13210, Line 20: I would avoid using "He proposes" and instead use "They propose".

Page 13211, Line 14: Explicitly state at which level sPV is investigated.

Page 13216, Line 7: above in **Section 2**.

Page 13219, Line 18: and **implies** that showing

Page 13221, Line 6: It would be useful to make a reference to Figure 2, that shows TANSO-FTS contains almost no information above 15 km.

Page 13221, Line 7: FTS tends to **be very similar** to TANSO-FTS

Page 13221, Line 22: Change "0" to "zero"

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Page 13223: Some of the information in the sentence lines 3-5 is repeated on lines 6-8. I suggest consolidating these two sentences.

Table 1 Caption, 4th sentence: There are two row headings including "primary" so indicate the "No. primary" row.

Figure 6 and 7: The x-axis tickmarks and labels would be better in the middle of the bar-chart columns.

Figures 9, 11 and 13: Consider making the units of the x-axis ppbv to be consistent with Figures 10, 12 and 14

Interactive comment on Atmos. Meas. Tech. Discuss., 8, 13199, 2015.