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Interactive comment on "Atmospheric composition and thermodynamic retrievals from the ARIES airborne TIR-FTS system – Part 2: Validation and results from aircraft campaigns" *by* G. Allen et al.

Anonymous Referee #2

Overall summary

This paper describes the validation and characterization of results from the AIRES airborne TIR-FTS system, which is designed to augment IASI atmospheric temperature, CO, O3, and CH4 products with finer grid spatial sampling and/or more times per day. The companion paper, Illingsworth et al., 2014 provides the retrieval formalism and motivation for AIRES while this paper focuses on validation with in situ measurements.

General comments

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In the retrieved profile figures, the comparison that is important is ARIES compared to the in situ convolved with the ARIES averaging kernel as compared to all error except smoothing error (as smoothing error is removed when the in situ data is convolved with the ARIES averaging kernel). It is hard to see this comparison on the plots because of the other quantities plotted in figures 7,9,14 and 15. The standard deviation on the a priori is particularly distracting. A comparison of a priori variability versus total error is seen in the (d) panel of the retrieval metrics figures. For temperature, errors on the order of 0.5K and above should be apparent on the plot but the scale does not allow this discrimination. The plot shown for temperature could be replaced by one where zero is the in situ convolved with the ARIES averaging kernel, or an additional plot could be added for this.

MACC is used for the initial guess and a priori. In the methane and ozone sections, comments are made about the MACC biases. The version of MACC used should be specified. I did not see the source of the water and temperature a priori in this paper (The Illingworth companion paper says these were from CAMELOT). A brief paragraph or table should be added to specify the prior for each species in one location. E.g. Table 2 could be augmented to include this information.

The "d" plots of the retrieval metrics are stated as log(error) which is confusing. This is actually regular error plotted on a log scale. The values are hard to parse. For example the text states "The total a posteriori retrieval error for individual retrievals (orange line in Fig. 4d) in this example ranges between 1000 ppm (10%) at the surface and 120 ppm (22 %) at 7 km." This would be much easier to read if it were not plotted with log scale. Also, the exact value of the small errors (e.g. less than 1 ppm) are not important and should not take up half the plot. Percent error for H2O also may be more useful.

For all species with biases, the bias should be compared to the IASI bias. It is important that it is either very carefully characterized, or shown to be consistent with IASI if it will be used to augment IASI results.

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Specific comments

Abstract: specify aircraft height. Line 18: "Partial column mean biases". Partial columns between what elevations? Line 20. Are the "typical a posteriori errors" the total error? For comparisons to in situ with averaging kernel applied, the error should not include smoothing error, see general comments. See also conclusions comments that more information is needed in the paper on the averaged results.

Section 4.3, Temperature. line 16. "The AK peak at each altitude is only slightly dependent on information content from other levels and is typically smoothed over a 1 km length (when using 10 levels at 9 km flight altitude)." In reading this I would assume 10 distinct averaging kernel peaks. However, the full-width-half-max of the temperature averaging kernel is 2 km. Change this to +-1 km length or other such text.

page 3414 line 14 discusses temperature errors or biases on the order of 0.5-1K, however this is impossible to see on Fig 7.

Section 4.4 line 13. Some explanation should be given as to why CH4 sensitivity peaks 2 km below the aircraft. I would assume that this is true only if the aircraft were between certain altitudes?

Section 4.4 line 22. The in situ with the averaging kernel applied should be compared to the sum of all errors except the smoothing error as noted elsewhere.

For CH4, ozone, and CO in situ, refer the reader to Table 1 for the instrument.

Conclusions. The TCCON network is mentioned in the conclusion but nowhere in the paper. TCCON results do not seem relevant to this paper as they are total column results.

"Dataset-averaged a posteriori errors were 0.4%, 9.5%, 5.0%, 21.2%, and 15.0%, respectively." Which datasets are averaged? The numbers listed here do not appear in the text of the paper. A description of how these numbers is calculated should be included.

Figure 4 and similar. The Measurement and Parameter error colors are too similar.

Figure 6b. The noise is obviously too large. The noise should be adjusted to a more realistic value.

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