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Atmospheric Chemistry and Physics Discussions

Interactive comment on "CO_2 column-averaged volume mixing ratio derived over Tsukuba from measurements by commercial airlines" *by* M. Araki et al.

Anonymous Referee #1

Received and published: 17 March 2010

Review of Araki et al. ACPD 10 pp3401-3421

This paper presents an important dataset that could be extremely useful, particularly for validation of other measurements. In this respect, the dataset and potential application are valuable. There is no doubt that the CONTRAIL project enhances the collection of airborne measurements of CO2 and being able to use the profiles obtained via these aircraft measurements to derive column-average dry-air mole fractions of CO2 that can be used for satellite validation (and potentially for FTS calibration?) is a very worthwhile advance in the measurements obtained via that programme.

The manuscript touches on some of the sensitivities in deriving this XCO2 product from

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these data and how these may influence GOSAT validation, but to apply this method on a wider scale and for future satellites with higher precision and accuracy, further error and uncertainty analysis is required.

In general, the manuscript is well-written and is suitable for publication in ACP, but a number of points require clarification.

Some general thoughts:

Need to explain why you want the CO2 over Tsukuba rather than Narita. At present, it seems like there is no need for the CO2 columns to be over Tsukuba, and you could equally simply just use Narita as the location of choice.

Type I/II analysis naming causes confusion – consider replacing with xCO2_obs and xCO2_met. If you do insist on referring to them as Type I/II analyses, then make an explicit definition of each of the different xCO2s, possibly in a table, so that it is easy to see what the differences are.

The manuscript keeps alluding to use for GOSAT validation without ever explicitly addressing this. I suggest reworking section 3.3 to be more explicit about addressing whether these data can be used for GOSAT validation – e.g. titling the section "3.3 Suitability for GOSAT validation". May also want to mention the relative uncertainties c.f. the goal for GOSAT precision.

The comparison to FTS screams out for a figure including both datasets.

The manuscript would benefit from an explanation of: (i) the integration of in situ/aircraft to column-averaged, or reference somewhere that does. (ii) the derivation of uncertainties & assumptions leading to them.

Specific comments:

L18: to me a figure of 0.922ppm does not seem like a small uncertainty. Relative to the desired GOSAT precisions it is, but in absolute terms it is not.

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L2-3: What makes the ground-based FTS a powerful tool for satellite validation?

L16-19: It is fair enough that you wish to use Tsukuba meteorological data in conjunction with the Narita CONTRAIL data, but if the idea is to validate over airports, why not 'shift' the meteorological data to Narita rather than the CO2 data to Tsukuba? And why is the ancillary meteorological data necessary? This isn't clear without a description of the integration of the profiles to yield XCO2.

Page 3405:

L10-13: I find the nomenclature associated with the two types of analysis confusing (see general comment). I'd prefer something like "XCO2 was calculated based on two different sources of ancillary meteorological data: (i) Tsukuba observational data (hereafter denoted XCO2,obs) and (ii) global meteorological data (denoted XCO2,met)."

Page 3408:

L20: The X'CO2 concept comes out of nowhere. Also, Figure 2 does not show a calculation, it shows the result of a calculation – reword to ". . .were calculated and are shown in Fig. 2"

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L4-10: I don't entirely follow this paragraph, especially when XCO2(I') based on XCO2(I) is referred to. If XCO2(I) is being used as 'truth', then the reference to bias is fine, but it is not clear how the uncertainties are derived.

L19- : It is not clear how the uncertainties are derived. Also, in Table 2, listing uncertainties of 0.0 is unrealistic. Again, the calculation of biases and uncertainties for one type of analysis 'based' on another is confusing. It is not clear what is actually being done here, or why? This would benefit from an explanation of how and why this is done.

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L10/Section 3.3: It seems like this is approached with reverse logic. It would be better to state up front that you wish to assess the integrated profiles for their suitability for GOSAT validation. In fact, I think this section would be better titled “Suitability of CONTRAIL-derived XCO2 data for GOSAT validation”, and look at the time window, and also refer to the profile-derived XCO2 uncertainties relative to what is necessary to adequately validate GOSAT.

Page 3411

First paragraph: I’m not sure that it is necessary to define northern and southern as case N and case S.

How are “high concentrations of CO2” defined?

As you only exclude data falling in to the southern airspace and high aircraft CO2 only category, is it really necessary to complicate matters by introducing the cases S and N, and 1, 2 and 3? I think it would be clearer to simply explain why the data from case S1 should be excluded, and then highlight that only one point was removed. In fact, I think that the entire section (Screening criteria) is unnecessary, and the explanation of the removal of that point could be placed in the following section (at line 23).

3.5 Amplitude of seasonal variation

I don’t like the use of the term “fitting curve” – it does not seem right. “Fitted curve” is better, but I think you should consider replacing it by “least-squares fit” when discussing the difference between the measured and fitted values.

Were all individual points used in the fit, or were monthly/weekly averages and standard deviations used?

Were any errors in the fitted co-efficients generated? Do the growth rates, maxima, minima of XCO2 and X’CO2 agree within these uncertainties?

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It would be nice to see a more detailed comparison to the FTS measurements of Ohyama et al.

Also, what is the value/usefulness of your measurements for validating the FTS measurements, or vice versa?

At this point, it would also be nice to have some brief geophysical explanation of what causes the seasonal cycle that is measured.

The use of “global” to describe NCEP/CIRA data is confusing. Could “reanalysis” or “climatological” or some other term be used?

What fraction of the difference between XCO2_obs and XCO2_met is due to the interpolation from lowest aircraft altitude to the ground in XCO2_met?

Technical comments:

Abstract:

L2-5: Presumably the CO2 concentration data were observed by an instrument onboard JAL commercial airliners, not by the airliners themselves.

Introduction:

L26: too many commas!

Page 3403:

L5: suggest replacing “mainly from ground stations” with “, with the majority of measurements being made at ground stations”

L9-10: this first sentence is unnecessary

L21-22: Too many uses of “the satellite” – suggest replacing the first with “of GOSAT”

Page 3404:

L6-7: 11 sites, January 2009 – please update these year-old figures (currently 14 sites

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L11: The CONTRAIL project does not observe 43 airports from Narita, but it might well do so on flights to and from Narita.

L14: “Values” should not be capitalized.

L15-16: “The number of validation sites observed by the CONTRAIL project can be dramatically increased” – how? Is this referring to GOSAT validation? If so, the link to the previous sentence should be clearer. Something like “These CONTRAIL profiles can dramatically increase the number of GOSAT validation sites”

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Analysis:

L9: watch the use of the word “mainly”. I think what you mean is that CME data were used to form the majority of the CO2 profiles used in calculating XCO2.

L15-17: The wording here is a bit awkward. I suggest rephrasing to something like “Additionally, assumptions need to be made about the CO2 profiles above and below the altitudes (. . .) observed by the airliner. These assumptions are outlined below”

L18: The first sentence of this paragraph is a bit cumbersome. I suggest breaking it in to two sentences: “Measurements have shown that the stratospheric CO2 concentration is constant above an altitude of about 20km, and five years older than that of the global mean CO2 concentration in the free troposphere. A free tropospheric average of 381.2 ppm in 2006 with growth rate of 1.9 ppm/yr, for example, yields concentrations of 373.6 and 375.5 ppm for 2007 and 2008, respectively.”

L22,25: Watch the tense – these sentences change tense mid-sentence. Also, linear with respect to what? It might be better to express this as: "CO2 concentrations were linearly interpolated with respect to (altitude?) from either the highest observational point (if above the tropopause) or the tropopause, to 20km."

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L2-3: Why the lowest tropopause, and not the average, for example?

L8: “Within(?) the planetary boundary layer. . .” or "Below the planetary boundary layer height..."

L25-26: I don’t follow this sentence.

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L6-7: This repeats earlier.

L7-9: Why not just say that the temporally closest rawinsonde data were used?

L11-14: “. . .for altitudes over 30km a US standard atmosphere. . .”

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L3: "...Ctower is that observed (or measured, if you like) at the tower."

2nd paragraph: Might be easier to say that a flight was excluded in the minimum altitude was greater than 4km or the maximum altitude less than 5km.

Page 3409:

L14-17: the CO2 profile is uniform ‘in’ or ‘through’ the PBL. Also clarify what the ‘less influence’ is relative to (type I analysis?).

4. Conclusions:

Subservient?

Interactive comment on Atmos. Chem. Phys. Discuss., 10, 3401, 2010.