

Interactive
Comment

Interactive comment on “CO₂ column-averaged volume mixing ratio derived over Tsukuba from measurements by commercial airlines” by M. Araki et al.

Anonymous Referee #2

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General comments

The paper "CO₂ column-averaged volume mixing ratio derived over Tsukuba from measurements by commercial airlines" by Araki et al., is a generally well-written paper. The authors describe a method of using CONTRAIL CO₂ profiles over the Narita airport to generate column-averaged dry-air mole fractions (X_{CO_2}). They show that there is a small (1 ppm) sensitivity of the X_{CO_2} value to the number density profile used (they compare a measured and a modeled profile). Because the bias is small, they conclude that the modeled number density profiles could be used to integrate CONTRAIL profiles over airports for which there are no measured number densities.

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I have two general comments and several specific comments. If these are addressed satisfactorily, the paper may be suitable for publication.

1. The major weakness of this paper is that the X_{CO_2} calculated by the authors from the CONTRAIL measurements are not compared with or validated by any independent measurement. There are multiple references to the Tsukuba FTS which measures X_{CO_2} , and the authors even explain that ground-based FTS measurements of X_{CO_2} are important. However, we do not see any direct comparisons between the columns derived from the aircraft profiles and those from the FTS. A careful comparison of coincident FTS and CONTRAIL measurements under a variety of atmospheric conditions (T/P/H₂O) would be invaluable for determining the accuracy and precision of the authors' method of calculating X_{CO_2} from CONTRAIL, and would significantly strengthen the paper.

2. There are no references to the atmospheric water profile. According to Machida et al., the CONTRAIL CME profiles give a dry-air mole fraction of CO₂ as a function of altitude. To compute a column-averaged dry-air mole fraction (i.e. X_{CO_2}), the total column of dry air needs to be computed. The authors obtain a number density of air from the rawinsondes or the CIRA-86 dataset, but do not mention whether these are dry-air densities or total densities. If they are total densities, they ought to be corrected for the water number density at each altitude. Do the CONTRAIL aircraft measure atmospheric pressure? This is another way of determining the total column of air without rawinsondes. In either case, NCEP or ECMWF global H₂O profiles could be used to correct the pressure or number density, if the met data from Tsukuba do not include a water profile.

Specific comments

Page 3403, Lines 4-7. There is a reference to "ground stations." Do you mean the in situ flask measurements?

A short section on the data and models (grid size, time step, etc.) used in this work

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would be helpful and would make section 2 more readable.

Page 3408, Lines 15-20. Why screen for clear sky profiles for an in situ measurement? If the FTS in Tsukuba can give you criteria for clear skies, why not use the X_{CO_2} measurements from the FTS to compare the total columns?

Page 3408, Line 20. Why do you include the X'_{CO_2} measurements? This extra complexity is justified later in the paper, but a one-sentence justification here seems appropriate.

Page 3411, Equation 4. Matsueda et al. have a 9-parameter equation. You only keep 7 parameters. Could you comment on this? What is the physical meaning of each parameter? Why is your a_5 the opposite sign to Matsueda et al.'s? Is that significant?

Page 3412, Lines 4 and 7. A seasonal amplitude of 4.63 ppm from the aircraft profiles and 8 ppm for the FTS X_{CO_2} values is a big difference! What causes this difference? Can you plot the Tsukuba FTS columns in Figure 2 for comparison? Also, do you really believe you know the seasonal amplitude to two decimal places?

In most places, errors are quoted for each CO_2 value. The exceptions are for the seasonal amplitude values in the abstract and section 3.5. What are the errors on those values?

It would be useful to see a figure comparing of the rawinsonde number densities and the CIRA-86 number densities.

Technical corrections

Page 3403, Line 11 and 14. Change "observation" to "observations".

Page 3403, Line 19. Change the sentence "By using the Fourier Transform Spectrometer (FTS) of the ..." to something like: "Global X_{CO_2} and X_{CH_4} products are obtained from the TANSO-FTS on board GOSAT."

Page 3404, Line 9. Suggest changing the first sentence to something like: "... over

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43 airports in the world since YYYY. Five JAL airliners are instrumented and all flights originate from Narita International Airport (hereafter Narita)."

Page 3404, Line 21. Delete the comma.

Page 3407, Line 14-15. Suggest: "CIRA-86 data were linearly interpolated from a 5° latitude grid to the latitude of Narita."

Page 3410, Lines 13-14. Suggest: "We focused on a set of profiles in a 6-hour window centered on the GOSAT overpass time (13h00 LT)."

Page 3412, Line 21. Remove "than those of these other two sets of measurements".

Page 3413, Line 5. The word "subservient" is incorrect in this context. Remove.

Table I. Suggest adding "in situ CO₂ tower measurements" after "MRI".

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

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