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Atmospheric Measurement Techniques Discussions

Interactive comment on "Calibration of the total carbon column observing network using aircraft profile data" *by* D. Wunch et al.

Anonymous Referee #1

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General comments:

The paper by Wunch et al. expands upon the earlier work of Washenfelder et al. (2006) and Deutscher et al. (2010) using airborne measurements referenced to the WMO-scale to calibrate TCCON data. Three additional TCCON sites are included in this analysis and a single, global calibration factor is presented for each of the trace gases (CO2, CO, N2O, CH4, and H2O) observed by the ground-based FTS network through the comparison of integrated in-situ aircraft profiles and TCCON column abundances. The calibration factor(s) established is (are) applicable to all the TCCON sites and affords a combined analyses of TCCON and in situ observations for atmospheric inversion modeling studies, as well as a transfer standard between surface monitoring

networks and space-borne sensors (e.g. SCIAMACHY, GOSAT, and the planned OCO refly). This study contributes very meaningful information to the wider scientific community, and the manuscript is recommended for publication pending minor revisions.

Specific comments:

Sections 3.1, 3.2, 3.3 please provide demonstrated precision and accuracy of aircraft instrumentation or include in Table 2.

p2612, L7 is it intended here that the lowest measured aircraft value was assumed to be the surface value?

p2612, L11-13 in order to determine the entire integrated column, it was necessary to extrapolate the aircraft in-situ profile to the lowermost part of the planetary boundary layer and to the uppermost part of the troposphere and the stratosphere. What percentage of the profile does this typically constitute? How much does this contribute to the error assigned to the integrated aircraft column?

Has the the Network for the Detection of Stratospheric Change (NDSC)or Network for Detection of Atmospheric Composition Change (NDACC) been investigated as a supplementary source to fill in UT/LS data gaps since the assumed profile above the aircraft ceiling contributes the greatest uncertainty to the integration e.g. Raman Lidar for water vapor at Lauder?

Find discussion on pages 2612-2613 somewhat disjointed. Starts out discussing CO2, moves briefly to CH4 and N2O, back to CO2, then GFIT of HF is introduced. Suggest leading off with the statement on p2612, L11 "In general, etc.; then discussing CO2; beginning the N2O and CH4 discussion with L9-11 on p2612 followed by why it is necessary to invoke HF for N2O and CH4; then discussing GFIT, Fig 3., etc.

There is mention of an air mass dependent artifact for CO2 at noon vs sunrise/sunset common to all the TCCON sites that is attributable to spectroscopic inadequacies. Is work on-going beyond Rothman et al. (2009) and Toth et al. (2008) to reduce this

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systematic error or is the 1% absolute accuracy in XCO2 considered the best that can be achieved for CO2?

As the O2 dry-air mole fraction continues to decrease in the atmosphere due to the combustion of fossil fuels, will this lead to a larger error in XCO2 with this technique/approach?

Recognize aircraft profiles are from flights of opportunity. Any plan for future profiles during different seasons to explore varing solar zenith angles and air mass values at each of the TCCON sites included in this analysis e.g. to calibrate Park Falls at higher air mass values?

Presuming this analysis uses an average CO2 from the two bands (6228, 6348 cm-1). It would be helpful to state this.

Fig 2 plot corresponding CO2, CO, CH4, and N2O SGP surface/tower data if available from NOAA ESRL or LBNL.

Figures 4-8. Are INTEX-NA CO, CH4, N2O, H2O data available for inclusion in this study?

Technical comments:

Fig 1 unable to see *, + symbols

Table 2 Mentions NCAR Airborne Oxygen (AO2) Li-840 yet lists CO2 as the measurement...does this instrument also provide an in-situ O2 measurement?

provide lat, lon of TCCON sites used in this study

3.1 please provide seasons (months) in which START-08 and HIPPO-1 data were acquired to be consistent with sections 3.2 and 3.3; also clear up same inconsistency in Intro by either eliminating seasonal (monthly) mention or being fully inclusive. alternatively, refer the reader to Table 3 for mission dates.

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Interactive Comment