First of all, we would like to thank the anonymous referees for their corrections and useful comments. Our responses to individual questions raised by referee #1 are inserted below.

Anonymous Referee #1

Page 7187 Line 8 What is residual here? Is it not just variation?

True, we omitted “residual”.

P 7190 L 26 This is the first introduction of the XCO2 nomenclature, it would be good to define it here.

We inserted the requested definition of XCO2. The sentence now reads: “First, we investigate the impact of an ILS error on column-averaged dry air mole fractions of CO_2 (XCO2) …”

P 7192 L 20 Regarding the wave number ratio: in Figure 1 the ratio of CO2/O2 = 6300/7900 = .80.

We added an additional sentence to the figure caption: The wave number ratio of 0.8 between the CO_2 and O_2 bands applied in the TCCON retrieval produces a shortening of the ME amplitude by the same factor.

P 7193 L 16 "fictive" is strictly correct but "imaginary" or "notional" are more widely used

We changed this, now use "notional".

P 7194 L 3 CaF(subscript 2)

Corrected.

P 7194 L 9 Figure 2 is not very helpful The radiation path is not clear. All the components are not shown. Perhaps an optical diagram could be included.

We modified the figure by outlining the approximate raypath.

P 7195 L 17 Not clear what is meant by 2,....,2.5%

We slightly rephrased: All results indicate a moderate ME amplitude rise along the inner part of the interferogram, rising to values in the 2 to 2.5 % range at 45 cm OPD …

P 7195 L 20 Why is the ME curve not sensitive to information at path lengths greater than 45 cm? Is the max OPD in these tests 45cm or greater (as Fig 4 would imply)?

The recommended max OPD value for recording atmospheric spectra within TCCON is 45 cm. Due to the actual width of the atmospheric spectral lines observed (before convolution with the ILS), very little recordable signal resides in the interferogram beyond this OPD value. Even in case of the spectral scene provided by a low-pressure gas cell, the Fourier contributions are so small that retrieving information on the ME becomes difficult beyond 45 cm. The laboratory cell measurements have been recorded with 64 cm max OPD because the additional time demand is not excessive and no effect on the ME results below 45 cm is expected.

P 7196 L 4 add: ...3.00 mbar C_2H_2, with the addition of an independent measure of the cell pressure.

We have completed the sentence according to your suggestion.

P 7196 L 15 Is this the standard deviation of the difference in the temperature retrieved from C_2H_2 and HCl?

Yes, correct, we state this explicitly in the new text version: “…we do not find a significant bias and a standard deviation of about 0.3 K between the temperature values derived from HCl and C_2H_2, respectively.”

P 7198 L 12 This calibration can identify some misalignment that may influence the ILS of a specific instrument. Does it necessarily eliminate a bias?

The calibration of the various HCl cells used within TCCON versus a common C_2H_2 reference is not expected to remove the overall bias of the network, but should remove the (very critical) station-to-station bias within the network. Before, site A used cell X and site B used cell Y, and the potentially incompatible instrumental line shape (ILS) results derived from these two cells would disturb the consistency of XCO2 time series between sites A and B. After the calibration, effective cell parameters are applied at both sites which ensure that both cells yield compatible modulation efficiency (ME) / ILS results.

Table 1

The number density of HCl in a cell is: n = Ap/RT and the column amount is nl Where A is Avogadro’s number, R is the universal gas constant, p is pressure and T is temperature For cell #1 H35Cl T=296K, p= 473.2 Pa, and l= .1m, so nl = (6.02E23 molecules/mole 473.2 Pa .1 m) / (8.314 Pa m3 / mole K 296 K) = 1.16 E 22 molecules m-2 Which is not the value in the table.

Your statement is correct, these pressure values do not reproduce the cell columns: The cell-specific effective pressure values in the table are solely intended for empirically adjusting the line width of the HCl cell signatures in the ILS retrieval, they replace the physical values (which would be compatible with your consideration) in the input file of the ILS retrieval software. If these effective pressure values are used, different HCl cells should indicate the same ME. In order to summarize each individual step of the calibration procedure and to clarify the meaning of the effective pressure values in the table, we added a paragraph at the end of section 4:

“Collecting all the procedural steps described in this section, the calibration can be summarized in the following step-by-step workflow: (1) A spectrum is recorded with both the reference cell and the HCl cell in the beam path. The 40 cm long and pressure-monitored reference cell is filled with 3 mbar of C_2H_2. (2) A joint fit of ME and gas temperature is retrieved from the C_2H_2 lines, using the spectral window 6560.5 to 6609.5 cm^{-1}. (3) The resulting ME is adopted for the following analysis of the HCl spectrum. (4) The HCl pressure and gas temperature is retrieved using the spectral window 5712.0 to 5782.0 cm^{-1}. While the column amounts and pressure values are fitted individually for $H^{35}Cl$ and $H^{37}Cl$, a common value for the gas temperature is required. The resulting gas temperature is expected to agree with the temperature retrieved from C_2H_2 within a few tenths of a degree. (5) The final product of the calibration process are the effective pressure values at a reference temperature of 296 K and the column amounts for $H^{35}Cl$ and $H^{37}Cl$. (6) These effective pressure values replace the physical pressure values calculated from gas temperature, column amounts, and cell length in subsequent retrievals of ME of other spectrometers. If the gas temperature deviates from 296 K, the effective pressure values are converted to the actual temperature by assuming that the effective pressure is proportional to the absolute temperature.”