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Interactive comment on "Intercomparability of X_{CO_2} and X_{CH_4} from the United States TCCON sites" *by* Jacob K. Hedelius et al.

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The paper under consideration investigates the intercomparability of US TCCON sites using the mobile EM27/SUN spectrometer as a travel standard. This is important work in itself as well as in prospect, given the fact that there are TCCON sites located on remote islands or within megacities, where a comparison with in-situ profile measurements collected during aircraft overflights or using aircore balloon technique is difficult or impracticable. In such cases, the mobile spectrometer opens up the opportunity of demonstrating the intercomparability of the remote TCCON site with respect to another TCCON site or a set of TCCON sites used as reference. This work corroborates earlier findings concerning the excellent stability of the mobile spectrometers. The authors perform a sound investigation of the residual differences and of their possible causes. Unfortunately, in my opinion the current version of the manuscript falls short

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Discussion paper

in delivering what could be an exhaustive investigation. The authors could come up with more definite conclusions concerning the underlying instrumental reasons for the remaining discrepancies based on their observations and monitoring capabilities already implemented in TCCON. In my feeling, it is a pity that the authors stop before that point. I rate the paper excellent and recommend publication, but would urge the authors to incorporate appropriate extensions in the final AMT paper (for this reason, I suggest "major revisions" despite of my positive ranking of the paper in all categories). The authors correctly identify the several problems which emerge from the fact that the spectral resolution of the TCCON observation differs from the spectral resolution of the EM27/SUN. The TCCON data product is derived from a high-resolution spectrum, which cannot be achieved with the EM27/SUN, and therefore the two kinds of observation systems are intrinsically different. This fact evokes subtle differences in the derived column-averaged abundances. The associated uncertainties are taken into account by the authors in an appropriate manner. This is how far one can get in verifying the TCCON results with the low-resolution mobile spectrometers and it is the point where the investigation stops. However, it would, in my feeling, be of substantial interest to enlighten a bit further by which instrumental contributing factors the residual discrepancies are generated. For this purpose, the TCCON interferograms could be truncated to the EM27/SUN resolution. This procedure would generate identical observation systems to a degree that a direct intercomparison of derived mole fractions can be performed. Moreover, it would essentially remove the modulation efficiency variations along optical path difference of the high-resolution spectrometer, which in turn impact the TCCON results (whereas other error contributions, e.g. residual nonlinearity, sampling ghosts, etc, are preserved). Based on this additional data set, the participating TCCON sites could be evaluated twice: firstly, based on the TCCON data products in comparison to the EM27/SUN products, secondly, based on the data products derived from resolution-reduced spectra in comparison to the EM27/SUN products. If the biases found between TCCON sites differ, we would assume that this difference is mainly due to ILS differences between sites. TCCON has implemented an instrumental

line shape (ILS) monitoring based on calibrated gas cells: the authors could therefore check whether the empirical statistical findings are in agreement with the expected error propagation of an imperfect ILS - thereby closing the circle. Note that the foreseen capability of handling an imperfect ILS in the analysis is not required for this investigation - estimates of the sensitivity of TCCON data products with respect to modulation efficiency imperfections have been provided by e.g. D. Griffith and other investigators in the past. However, the exercise will provide a preview of the level of intercomparability which can be expected for TCCON when the ILS biases will be incorporated in the standard TCCON workflow (as announced by the authors).

Minor comments: Page 12, line 1 ff: “Of these, only the last three can cause site-to-site bias”. Is this true? If e.g. two TCCON sites are operated in different latitudes, then a comparison between datasets of actual values and TCCON data would reveal a systematic bias between the sites due to spurious air-mass dependence from spectroscopic issues (if we assume that the two sites systematically cover different ranges of solar elevation angles).

Page 12, line 26: The suggestion of using several mobile spectrometers for the intercomparison seems to imply a substantial effort (if the spectrometers are not collocated at the site for performing differential measurements anyway). I would envisage a different recommended standard procedure, especially for remote TCCON sites: the use of a single spectrometer, including a careful demonstration that no instrumental drift occurred (perform an intercomparison with respect to a reference - ideally, a TCCON spectrometer and one or several mobile spectrometers remaining there - before and after the campaign). In this context, I would find it useful to discuss in more detail the level of stability of the participating mobile spectrometers as reaction to transport events. (The LANL spectrometer has been operated site-by-site to the TCCON spectrometer located in Karlsruhe before overseas shipment - it would be interesting to include these observations as well.)

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