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Comment on acp-2021-307

Anonymous Referee #2

Referee comment on "Twenty years of ground-based NDACC FTIR spectrometry at Izaña Observatory – overview and long-term comparison to other techniques" by Omaira E. García et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2021-307-RC3, 2021

Manuscript by Omaira E. García et al. titled "Twenty years of ground-based NDACC FTIR spectrometry at Izaña Observatory - overview and long-term comparison to other techniques" presents a comprehensive analysis of the long-term FTIR-monitoring which is being carried out at Izaña Observatory. Izaña Observatory whose history dates back to 1916, has a strategic location for the investigation of atmospheric processes and contributes to numerous international programmes and observational networks (GAW-WMO, WDCGG, WOUDC, NDACC, TCCON, AERONET, BSRN, MPLNET, E-GVAP, NOAA/ESRL/GMD CCGG, etc.).

Authors provided a thorough description of the unique FTIR-experiment which was started in 1999. The abstract clearly presents the subject matter and findings of the paper. The scientific basis of the results reported in the paper is the reliable and recognized technique of atmospheric FTIR-spectrometry, and widely used inverse methods for atmospheric sounding (formalism by Rodgers(2000)). Both, the acqusition of MIR spectra of direct solar radiation using FTIR-system installed at Izaña Observatory and the following FTIR-spectra processing are described by authors in detail.

The investigated time series of C2H6, CH4, ClONO2, CO, HCl, HCN, H2CO, HF, HNO3, N2O, NO2, NO, O3, OCS, and three isotopologues of water vapour (H216O, H218O, and HDO) are of fundamental importance to the atmospheric studies including the interactions of atmospheric composition and climate, the investigation of trace gases temporal variations and processes driven these variations, the verification of modern CTMs (chemical transport models) and the validation of satellite obsevations. The manuscript is well-written and structured, contains new results that can be of interest to scientific community. Bibliography, in general, provides a relevant list of references, nevertheless, according to referee's opinion, the number of references could be reduced because the bibliography section occupies about one six of the whole paper volume.

1) Lines 131-134: *"By evaluating spectral signatures of vibrational-rotational transitions contained in the solar absorption spectra measured, the FTIR technique allows total column amounts and low-resolution vertical profiles of different atmospheric trace gases to be retrieved with a high degree of precision."* The "degree of precision" is expected to be different for different trace gases and not necessarily "high" for those retrieved species which have weak absorption signatures in the analyzed FTIR-spectra. If statistical errors/uncertainties can be considered as a measure of "degree of precision", we can see in Table 3 that these errors can reach ~50% for H2CO and ~100% for ClONO2.

2) Section 3.1: Whether FTIR-instruments (an IFS 120M and an IFS 120/5HR) at Izaña Observatory have been operated remotely or by an operator/technician? Could you please specify?

3) Lines 209-211: *"The only quality filter applied on public FTIR products is that observations taken at high solar zenith angles (≥85°) have been excluded to avoid imprecise retrievals (mainly caused by misalignments of the solar tracker or spectroscopic issues). These data represent less than 1% of the total data set."* It is expected that clouds are one of the most important factor leading to the outliers in retrieval results. Are the FTIR-observations at Izaña Observatory free of this effect?

4) Lines 191-193: *"Most relevant changes are those related to CH4, for which the spectral micro-windows are adopted from Sepúlveda et al. (2014), and the spectroscopy parameters correspond to the improved linelist provided by Dubravica et al. (2013)."* What are the principle differences between CH4 retrieval strategies reported in Sepúlveda et al. (2014) and Sussmann et al. (2011)? Does the modified CH4 retrieval strategy by Sepúlveda et al. (2014) provide the homogeneous results with other IRWG-NDACC sites which make retrievals according to Sussmann et al. (2011)? Please, clarify this. Reference: Sussmann, R., Forster, F., Rettinger, M., and Jones, N.: Strategy for high-accuracy-and-precision retrieval of atmospheric methane from the mid-infrared FTIR network, Atmos. Meas. Tech., 4, 1943–1964, https://doi.org/10.5194/amt-4-1943-2011, 2011.

5) Fig.14 (page 37) and Fig.15 (page 41): This is not easy to distinguish between the sizes of dots which correspond to R^2=0.5 and R^2=0.3.

6) Maybe, it is worth adding to manuscript a table summarizing all the long-term trends reported and discussed in the text in Sections 5, 6, and 8. Such a table will simplify reading and navigation through the manuscript.

7) Section 5, Fig.7, and Appendix B: Which methods and/or criteria were implemented for the selection of an optimal set of frequencies used for the construction of multi-regression fit presented in Fig.7? Evaluation of statistical significance, cross-validation, etc.?