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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Technical Note: REFIR-PAD level 1 data analysis and performance characterization" *by* G. Bianchini and L. Palchetti

Anonymous Referee #1

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General comments:

This paper presents the level 1 processing for the REFIR-PAD instrument and states the performance of the instrument and the calibration. In general, the paper is clearly written, the relevant principles of an FTS measuring in the FIR region are well described, and the calibration procedure as well as the characterisation of the performance are comprehensible for the reader. Nevertheless, I think that some more explanations or clarifications would be helpful (see specific comments). This paper is useful for people working with FTS instruments and dealing with instrument characterisation and calibration.

Specific comments:

Page 369, line 15: What is the maximum optical path difference corresponding to the resolution of 0.5 cm-1? Since "resolution" is not unambiguously defined, the maximum optical path difference should also be mentioned here.

Page 372, line 11: Could it be that you mean "higher" instead of "lower"?

Page 373, line 9: It would be interesting to know the sampling frequency of the infrared signal in the time domain. This could either be stated here or on page 369, paragraph beginning line 13.

Page 373, line 11: Since the interferogram can only be cut at an integer number of points, the desired resolution must correspond to an interferogram length being an integer multiple of the laser wavenumber. Does this mean that the desired resolution is maybe not reached exactly?

Page 373, line 24: What else but noise is included in the high resolution component of the phase spectrum? I would expect that all phase features have low resolution and thus the high resolution component of the phase only contains noise. If the phase spectrum contained other features than noise, it would be necessary to take them into account within the phase correction.

Page 373, same paragraph: I would mention already here that the beam splitter emission needs not to be considered (as stated on page 375, line 11). What degree of isothermy is required for neglecting the beam splitter emission?

Page 374, last paragraph: In this paragraph, only the precision of the blackbody temperatures is stated. However, for a good calibration, a high accuracy is also required. What is the accuracy of the temperature measurements?

Page 375, line 2: "calibrated housekeepings": In which way are the housekeepings calibrated? Or do you mean something like "housekeepings used for calibration"?

Page 375, lines 6/7: How is the laser frequency calibrated? What kind of single measurement is used for the frequency calibration? Could a misalignment between laser

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and infrared beam (leading to slightly different OPDs) affect the quality of the frequency calibration?

Page 375, line 17: "Complex spectra are used ..." : What kind of residual phase error do you expect? Why should these phase errors not be corrected during the phase correction you describe on page 373? If the residual phase errors are not the same in all spectra (atmosphere and blackbodies), the complex calibration will not eliminate these errors. Since you do a complex calibration anyhow, why do you perform an extra phase correction before? I have the feeling that by this way of data processing two phase correction methods are mixed up which maybe does not really improve the result.

Page 376, calibration formulas: I am missing the offset (i.e. the instrument self emission) in the calibration formulas. Can this contribution be neglected? This should be addressed in the text. I suppose that all the calibration formulas have to be applied for each of the two output channels separately and that the two channels (if available) are combined after calibration. This should be stated clearly at this point.

Page 376, line 23f: What has the pressure level to do with the size of the imaginary part? What do you mean with "the imaginary part is smaller"? Smaller than what? And what does the imaginary part of the spectrum prove about the symmetry of the acquired interferogram? I would expect that after phase correction, the imaginary part should generally contain nothing but noise, no matter how symmetric the acquired interferogram originally was.

Page 377, line 2: From Fig. 8 I cannot see any deviation from noise in the imaginary part. What is meant by the "small effect"?

Page 377, line 9: The imaginary part of the calibrated spectrum also contains some interesting information: Does it show only noise as one would expect after correct data processing? Has the "small effect" mentioned in line 2 disappeared in the imaginary part of the calibrated spectrum?

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Page 377, line 15: Here you talk about the measurement accuracy of the blackbody temperatures, while on page 374, you only discussed the precision.

Page 378, line 9/10: When you measure n calibration sequences, this leads to 2n single spectra. In order to make this clear, I suggest to write "... an average of n single spectra, respectively (i.e. ..."

Page 379, line 10: Again, only the precision of the blackbody temperature is considered, while the estimation of the systematic calibration error requires the accuracy.

Page 379, section 4.2: General comment on the systematic error: What about the water vapour inside the instrument wich is clearly seen in the calibration functions? I would assume that these spectral features could also affect the radiometric accuracy.

Page 380, line 20f: Just a comment: The self validation gives a much better result than one would expect from the systematic calibration error shown in Fig. 11. This suggests that the error estimation for the calibration blackbodies is maybe too careful.

Page 381, line 15: Why don't you use the standard deviation of the imaginary parts of the calibrated spectra in order to determine the NESR? The imaginary part should be insensitive to the atmospheric variability.

Page 388, Fig. 4: The two curves in Figs. b,c, and d are very close, therefore a residual plot would be more informative.

Technical corrections:

Page 368, line 16: have become -> has become

Page 368, line 18: are -> is (or change the sentence to: ... are some of the ...)

Page 369, line 3: the Acronym IFAC-CNR is not explained

Page 371, line 7: then -> than

Page 372, line 23: interferogram transformation -> Fourier transformation (?)

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Page 374, line 13: Do you mean "related" instead of "relative"? Otherwise I do not understand the sentence.

Page 374, line 22: a PT100 sensor -> one PT100 sensor

Page 375, line 12: Brasunas et al. -> Brasunas

Page 377, line 7: no comma after "procedure"

Page 377, line 11: uncertainty on -> uncertainty of

Page 378, line 12/13: change the sentence to: " ...where S, Sh, Sc are the averages of the measured radiance, the HBB radiance and the CBB radiance, respectively, and (Delta)S is the 1(sigma) uncertainty on the single uncalibrated spectra."

Page 378, line 17: varying -> by varying

Page 395, Fig. 11 Figure caption: reference blackbody -> reference blackbodies (in order to make clear that the errors of all blackbodies are taken into account).

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Interactive Comment