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Interactive Comment

Interactive comment on "Level 0 to 1 processing of the imaging Fourier transform spectrometer GLORIA: generation of radiometrically and spectrally calibrated spectra" *by* A. Kleinert et al.

A. Kleinert et al.

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We would like to thank the referee for the valuable comments which we answer in the following. Referee comments are inserted *in italics*.

General Comments

This paper gives an introduction to the calibration of GLORIA. Several aspects are explained in good detail and with good reasoning. However, the uninitiated reader (who does not know a lot about FTS instruments) will have difficulties to understand

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Interactive Discussion
Discussion Paper

the paper. In my opinion there are two main reasons for this: 1. Several aspects are not explained to a level that allows the reader to follow the author's reasoning. Ideally, I would expect first a short introduction of the measurement principle, then the basic instrument characteristics and following from this an overview of the calibration that has to be done to convert instrument units to physical units. Some of this is presented in the paper, but in my opinion not in sufficient detail. 2. The structure of the paper makes it difficult to follow the reasoning. Calibration aspects are partially described in sections 3 and 4 (radiometric and spectral) and partially in section 5 (phase, spikes). If more detail is out of scope for this paper, it should at least be re-structured. A concise introductory paragraph that explains all the instrument effects that must be corrected would help the reader to follow the more detailed aspects of the calibration later on. The processing aspects should not be mixed with additional calibration aspects (e.g. phase correction and spike correction).

Some basic knowledge on FTS instruments is required to understand this paper. We feel that an introduction to the measurement principle is out of scope for this paper, but we will add a section with an overview of the required processing and calibration steps after section 2 before explaining the calibration and processing in detail. This should help the reader to follow the detailed descriptions in these sections. Concerning the phase correction and spike correction, we think that it is a matter of opinion if they are considered as calibration or processing aspects. From our point of view these are processing steps which are required to account for a non-perfect behaviour of the instrument rather than calibration issues. The term "phase correction" may be misleading, since we do not correct for all phase effects but only for ZOPD shifts due to imperfect interferogram acquisition. We will reformulate the corresponding section 5.1.5 and use the term "interferogram alignment" instead of "phase correction".

Specific Comments

AMTD

7, C2939–C2944, 2014

Interactive Comment

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2.1 Abstract line 7: "..the detector has a usable range of 128 x 128 pixels" I find the word range in this context confusing, maybe a better term would be "usable area of 128 x 128 pixels"

We will replace "range" by "area".

page 2831,line 20: "the shorter interferograms [...] enable higher horizontal sampling" This statement is unclear to me. I understand that the shorter integration times lead to higher sampling, but why horizontal? The spatial sampling for one image is determined by the detector as I understand it. Is the field-of-view scanned horizontally during one observation, i.e. do you have a measurement at one azimuthal position, then move the field-of-view and then you take another measurement and so on? What is the measurement strategy for one flight?

The horizontal sampling of the measurements is twofold. One image provides a spatial sampling which is determined by the detector pixels, but the horizontal sampling along the flight track is determined by the speed of the aircraft and the duration of one interferogram. For the latter, a shorter interferogram acquisition time leads to a higher horizontal sampling. This is indeed not clear from the text.

We will restructure the whole section and spend more words on the measurement geometry for chemistry and dynamics mode.

page 2832: Suggestion: it might help the reader if you could provide a drawing of a cuboid with axis description

we will add a figure with a schematic drawing of a cuboid.

AMTD
7, C2939–C2944, 2014

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page 2833, line 10ff: A systematic discussion of the contributors to the offset is missing. I would expect that the "typical" contributors are mentioned, such as self emission of the instrument, read-out noise, memory effect (after images) etc. Even if they do not play a role, this should be said.

We will add some information about the physical parameters contributing to gain and offset. The main contribution to the spectrally resolved offset is indeed the self emission of the instrument. The dark current gives an offset to the DC signal of the detector but does not contribute to the modulated signal. Readout noise is a noise source rather than an offset, and we have not observed any memory effect from image to image in our data.

page 2836, line 10ff: The determination of the non-linearity (NL) lacks some essential details: The underlying assumption of the NL determination is that it is independent of the integration time. Was this checked? If there is also a time dependent component (as was seen for similar detectors and readout chains), this would introduce a systematic calibration error, since the calibration sources atmospheric measurements are measured with different integration times.

The quality of the NL correction was checked for different integration times. We will show the reduction of the out-of-band artefacts for an exemplary pixel for two different integration times.

Could you describe in a sentence or two how the linear reference ("virtual detector") was chosen? Did you keep the correction minimal for the typical measured signal level or did you choose the start of the measured curve or something else?

AMTD
7, C2939–C2944, 2014

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The linear reference is chosen such that the correction is minimal for the typical measured signal. In fact, a linear fit was made to three measurement points from the middle region of the detector's dynamical range. We will add this information in the text.

Did you ensure during the NL measurement that intensity variations of the radiance source do not have an impact on your result (by e.g. a measurement sequence short times - long times - short times)

The temperature of the radiance source was stabilised within less than 0.1 K during the characterisation measurements. When going back to short integration times after long times, the signal was reproduced.

Since you check the NL correction quality with "out-of-band artefacts" and even show a figure, I think the basics of the method should be shortly described, a mere reference is not enough in this case.

OK, we will add a paragraph on out-of-band artefacts.

page 2841, line 1: The sentence "In this dataset, the position of a certain spectral line [...]" should be, I assume "In this dataset, the apparent position of a certain spectral line [...]"

Yes, will be changed.

AMTD
7, C2939–C2944, 2014

page 2841, line 4: "The interferogram is zerofilled." What does this mean? Is the grid made artificially more dense? Under what circumstances is this allowed?

Zerofilling means that zero values are added at both sides of the interferogram. This leads to a denser sampling grid in the spectral domain allowing for a better determination of the line maximum. We will change the formulation of this sentence in the text to make this more clear. Zerofilling is generally allowed, but one should keep in mind that the denser grid actually does not contain more information or increases the spectral resolution. Furthermore sharp steps at the end of the interferogram should be avoided because they lead to strong ringing. Especially any DC component has to be subtracted before applying zerofilling.

page 2841, line 9: Why don't you use a harmonic fit to determine the maximum? Is this for computational speed reasons?

A quadratic fit proved to be more stable.

page 2851,line 12: "Cache misses" are not explained

We will modify this sentence and explain cache misses.

Interactive comment on Atmos. Meas. Tech. Discuss., 7, 2827, 2014.

AMTD

7, C2939–C2944, 2014

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