

Author comment:

Dear Anonymous Referee #2,

Thank you very much for your careful review!

Your comments and suggestions were very helpful to improve it.

In the following we list the applied changes according to your suggested corrections. We have adopted your minor corrections without listing them here.

(0)

I would suggest, but not insist on, a new table at the end which summarises the magnitudes of sources of tracker pointing error, eg pixel size, refraction differences, stepper motor resolution, image analysis etc, all in a common unit (arc s) so that the reader can quickly see, in summary, what are the important and less important factors.

We added the following text and table to section 7 in our manuscript:

“An overview of estimated contributions to the tracker pointing error budget is given in table 1 for our current setup. To estimate the accuracy of the offset between the field stop and the solar disc, we take into account three error sources. First, the theoretical accuracy to determine the center of an ideal circle $\sigma = 0.42/\sqrt{d}$ (Haralick and Shapiro, 1993), where d is the diameter of an observed circular contour in units of pixels, assuming negligible obliquities of the ellipses.

Two other sources limiting the accuracy are the noise generated by the image sensor and the granularity of the solar image. This granularity is due to the scattering properties of the matt finished aperture wheel surface (see figure 5). Other error contributions listed in the table are the atmospheric dispersion (discussed in section 8), the finite angular resolution of the rotary stages, the finite duration of the control loop, and the perspective distortion which results from the fact that the camera records the aperture wheel with an angle of about 14° . This effect can be taken into account in the image analysis, but is not yet included in our software.”

Image reconstruction*	2
Atmospheric dispersion**	up to 3 at 80° SZA
Motor increment	2.6
Finite control loop duration	< 2
Perspective distortion***	2.4

*Finite pixel size, sensor noise + image granularity

**can be removed by proper analysis procedure (see text)

***will be further reduced in future software upgrade

Table 1. CamTracker pointing error contributions in arc sec.

(1)

P4867 I20 This sentence is unclear: : : : one gets a 10% air mass change per degree SZA change at SZA=80 degrees.

We changed the sentence to:

“With a desired tracking range from 0° to 80° solar zenith angle (SZA), one gets up to 10% air mass change per degree SZA change.”

(2)

L24 “: : : an error (in what?) due to the tracking of smaller than 0.05% at SZA-80 is desirable

We changed the sentence to: ... an error in the total gas column due to ...

(3)

P4868 L1 ratioing not rationing This paragraph is not clear – the tracker pointing impact is reduced by ratioing to O2 ONLY if the O2 is also measured from the spectrum taken from the same tracker, not when it is calculated from atmospheric pressure. This point is not clear and the paragraph should be reworded.

We changed the sentence to:

“Although it is possible to reduce the tracker impact in the NIR by ratioing the CO2 retrieved slant column to the O2 retrieved slant column from the same spectrum, an excellent tracking knowledge is nevertheless highly desirable, because this allows to recognize other problems by monitoring the observed O2 column.”

(8)

P4871 L12 The meaning of “binary” is not really clear – would “black/white” be better? Also the use of “contours”, should this be better as “outlines” of the solar disk and field stop images?

We changed the respective sentence to:

“Creating a binary (black/white) picture by applying the threshold, and finding the contours along the obtained areas (solar disk and field stop).”

(13)

P4874 L7 Is the accuracy limited by pixel size? What is the angular size of one pixel in arc s?

Please refer to the newly added section about the tracking error sources.

We added the information concerning the angular pixel size in chapter 4:

“This results in an angular size of about 8 arc sec per pixel.”

(16)

L10 The meaning of this sentence is not clear – is it that the air refractive index difference between tracker camera and IR to be analysed leads to a small offset in the pointing. Please clarify/reword.

We reworded the sentence to:

“The latter is the origin of atmospheric dispersion. In consequence the NIR/MIR solar disc image is slightly shifted versus the VIS/NIR solar disc images which is centered on the field stop by the camera control loop.”