

Interactive comment on “Metrology of the Solar Spectral Irradiance at the Top Of Atmosphere in the Near Infrared Measured at Mauna Loa Observatory: The PYR-ILIOS campaign” by Nuno Pereira et al.

Anonymous Referee #1

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The manuscript describes measurements of the near infrared solar irradiance from the surface and its extrapolation to top-of-the-atmosphere (TOA) solar irradiance using the Langley-plot technique. The experiment was performed at the high-altitude Observatory in Mauna-Loa, Hawaii and is a follow-up experiment to a similar one performed at Izaña, Tenerife, Canary Islands. The resulting TOA irradiances are compared to space-based measurements of solar irradiance, and a rudimentary uncertainty analysis is provided. The paper provides an important dataset to try to resolve observed discrepancies in space-based solar irradiances in the near infrared range. The advan-

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tage of ground-based measurements is the possibility of characterising and calibrating the instrument before, during, and after the measurements in order to validate the measurements.

However the paper needs some modifications before it is ready to be published, as described below.

Minor comments:

- As implied in the title, the paper would like to provide a validated dataset with well defined uncertainties to serve as reference for solar irradiance in the NIR. For that to be accepted, a comprehensive uncertainty budget would be desired, following the traditional terminology used in the metrological community. For example signal to noise is not the most important source of uncertainty, it is in fact quite straightforward, and can be reduced by increasing the sampling, a fact the authors fail to mention (Type a uncertainty). What about the nonlinearity, which could affect the measurements from the differences in intensity between the lamp sources used for the calibration and the solar irradiance? Temperature stability, flat field of the entrance optics, detector stability on diurnal time scales, all could affect the measurements. To be more convincing, the authors might want to be more thorough, since as they claim the measurements performed with the same instrumentation in Izaña and Maunaloa differ by more than their estimated uncertainties, indicating that possibly some systematic source of uncertainty was not taken into account. At the end of Section 3.4 I suggest to include an uncertainty table listing the uncertainty components, the type of uncertainty, coverage probability, degree of freedom, if it is simple or expanded uncertainties.

- The airmass calculation used in the paper (see page 6, Figure 1 and later) is based on the Kasten and Young Formula, which assumes a standard US atmosphere. At large airmasses, the profiles of relevant atmospheric species such as water vapour become relevant, and especially at airmass 8 the difference between the profiles of the standard US atmosphere and the one at MaunaLoa could add a discrepancy affecting

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the langley-plot retrieval. Could the authors discuss this possible source of uncertainty?

- The paper is missing a conclusion. For example, as a reader I would expect to know if the original problem, namely the observed discrepancies between spectra, is now resolved with this ground-based measurement, what else is needed, and a final outlook.

- The authors might have not been aware of it, but recently a paper has been published in ACPD which compares the quality of langley-plot retrieved solar irradiances between MaunaLoa and Izana. I think the authors should refer to this paper in their introduction and when discussing the Langley-plot technique. (Toledano et al., ACP-2018-430)

technical comments and corrections:

P1, line 16, a reference is missing (?)

P1, line 17 evolved

P2, l 16 : Mention the paper of Toledano et al., here for example

P3, l 15 and where it is used : entrance slit is the correct term

P3, eq. 1: As it is the equation is not correct: the TOA irradiance cannot be divided by the square of the Sun-Earth Distance. It probably should be the squared ratio between the standard Earth-Sun distance and the actual distance at the time of measurement.

P3, l29. change l to l0 for the symbol of top of atmosphere

P4, lines 5-8. The argument needs to be modified: The problem is not gas absorption per se, but the saturation of individual absorption bands, in combination with the resolution of the instrument. For example, in the visible region, the ozone absorption from the Chappuis band does not affect the Langley-retrieval as long as the ozone is stable during the measurements.

P4, l 24, change T to TBB

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P4, l 26. Please add a reference for the quoted uncertainties of the emissivity, aperture and distance. The distance uncertainty might be relevant to the calibration performed at PTB with their system, but I doubt that the distance between the entrance optic of the solar spectroradiometer and the Blackbody aperture can be determined to this uncertainty, considering that it is not only a geometrical measurement that is relevant, but the distance between the optical reference planes of both elements (entrance optic and aperture of BB).

P5, l 22-24. The Aeronet network is repeated twice, please remove one instance of the two.

P6, l 7 the the

P 7, Figure 2. Could the combined uncertainty be added to this plot?

P7, Section 3. See earlier comments on the uncertainty treatment.

P8, l 16-17. The uncertainties of the Lamps are not uncorrelated (for example the blackbody is always the same) and can therefore not be combined and divided by $\sqrt{N-1}$.

P8, Section 3.3 Here, the atmospheric profiles need to be considered for the AMF calculation and the resulting uncertainty when using a US standard atmosphere. Furthermore, the refraction becomes critical at these large solar zenith angles, and will also add to the uncertainty.

P9, l 23 change "error bars" to "uncertainty"

P9, lines 21-28. I find the discussion partly confusing because some of the spectra are compared with the PYR-ILIOS, but others are compared between each other, and it is not clear what is the result of this paper and what could be moved into the introduction. Could it be rewritten?

P10, Figure 3: What do the shaded areas represent?

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P10, l 2, change "error bar" to "uncertainty"

P10, l. 8; I would rephrase this part. It was not "impossible to be monitored", but at the time you did not consider this as a potential source of uncertainty.

P15, Figure A1. It is not clear how this figure supports the paper, and specifically the uncertainty estimation? If it is random noise, then additional sampling would improve the uncertainty (Type-A uncertainty). The x-axis is in volt, but it should be solar irradiance or wavelength to understand the relationship with Figure 2.

P16, caption (and possibly at other places in the manuscript: Please be careful to use the terms shorter or longer wavelengths, instead of upper and lower.

P17, Table A1. I assume AM refers to the morning? Could it be removed from the first column and placed in the caption?

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