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Atmospheric Measurement Techniques Discussions

Interactive comment on "Reconstruction of high resolution time series from slow-response broadband solar and terrestrial irradiance measurements by deconvolution" *by* A. Ehrlich and M. Wendisch

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The comments of the reviewer have been helpful to improve the manuscript. Especially the remark about the misleading title which still included pyranometer measurements was important to improve the manuscript.

The detailed replies on the reviewers comments are given below.

The reviewers comments are given italicized while our replies are written in roman

letters. Citations from the revised manuscript are given as indented text.

Detailed Replies

title: The work is demonstrating the feasibility for reconstruction of slow-response terrestrial irradiance measurements. A similar behaviour can be expected with solar irradiance by pyranometers (as mentioned in section 1, line 85-88). But lab and field applications are conducted using CGR4 and no further specific work is presented related to pyranos. It should have it to be announced in the title.

This is a very valid remark. The hypothesis, that the method will work similarly for pyranometer was not proven in our study. We therefore changed the focus in the title to the terrestrial pyrgeometer measurements. The new title reads:

> Reconstruction of high resolution time series from slow-response broadband terrestrial irradiance measurements by deconvolution

sec 1, line 104-113: Attitude correction is definitely needed with solar irradiance. However it is mentioned that no correction is applied and moreover no solar irradiation data are subject of interest later in the text. Might be stated less contradictory. What about attitude correction of longwave sensors ??

An attitude correction, as described by Saunders et al. (1992), can only be applied when the direction of the incident radiation is known, such as for direct solar radiation. A correction of longwave terrestrial radiation in similar ways is not possible as the terrestrial radiation is diffuse; distributed over the entire hemisphere.

sec 1, line 125-129: The aspect of a potential temperature equilibrium time lag is discussed with PIR, but laboratory and field measurements were conducted with CGR4. What can be stated about that?

This was a helpful question. Unfortunately, no similar studies on the performance of CGR-4 are available. Most applications of CGR-4 are ground based where changes of the ambient temperature are much slower. The response time of 6 s specified for the CGR-4 preliminary accounts for the thermal equilibrium of sensor, dome and ambient temperature, when only the terrestrial irradiance changes. This covers conditions of flight legs in constant altitude such as analyzed in this study. For ascents and descents the effects are likely larger. Up to now, we did not investigate this problem with help of data collected during ascents and descents within VERDI as our current focus is to resolve small scale variabilities during horizontal flight legs where ambient temperature effects are small. To point this out more clearly, we added the following discussion in the introduction:

> Similar investigation for the CGR-4 are not available. The response time of 6 s specified for the CGR-4 preliminary accounts for the thermal equilibrium of sensor, dome and ambient temperature, when only the terrestrial irradiance changes. This is valid as a first approximation for flights in constant altitude (constant ambient temperature).

However, by the reviewers comment we noticed, that we did not state in the manuscript, that the reconstruction algorithm was applied only to the thermophile output of the pyrgeometer and not to the final irradiance which includes also the sensor temperature measured by an internal thermistor. This approach was chosen due to the different response times of thermophile and sensor temperature. This information is probably required for the reader to reproduce our results. Therefore, we added in the introduction of the laboratory studies and the airborne measurements the following sections:

> As discussed by Albrecht et al. (1974) the pyrgeometer thermophile and the dome temperature exhibit different response times. Therefore, in this section only net irradiance measured by the pyrgeometer thermophile were analyzed

> which excludes additional effects due to the time response of the internal thermistor.

> For the reconstruction of the time series presented in this section, the thermophile output of the CGR-4 and the sensor temperature measured by an internal thermistor were treated separately. The deconvolution was only applied to the thermophile output as the thermistor has a much slower time response and temperature changes in constant flight altitude are negligible.

sec 3.2/sec 3.3.1: Amplitudes written in the text (line 392, 395) provided for boxcar reconstruction obviously do not correspond to what can be observed in figure 3. Moreover it shall be exactly the same as with the periodic oscillating time series (line 456-458) ??

We assume, the reviewer compared the numbers of the amplitudes given in the text with the reconstructed time series. However, the amplitudes F_n given in this locations refer to the noise of the original measured signal (black line) which are much to low to be visible in the plot. It does not describe the noise of the reconstructed time series (red line, with amplitude theoretically similar to F_min). This was certainly not explained with sufficient care in the manuscript. Therefore, we added "measurements" in the text:

> For a sampling frequency of $f_\mathrm{s} = 16$ kHz the noise of the measurements is lowest with an amplitude of $\Delta F_\mathrm{n} = 0.08\,\mathrm{W\,m^{-2}}$ which allows to use a high cut-off frequency of $f_\mathrm{c} = 1.5$ Hz. With a reduced sampling frequency ($f_\mathrm{s} = 8/4$ kHz) the noise amplitude of the measurements increases (0.12/0.25 $\mathrm{W\,m^{-2}}$) and lower cut-off frequencies were feasible ($f_\mathrm{c} = 1.2/1.0$ Hz).

conclusions, line 820-821: As discussed with the title, I do share your point of view

that the setup would work with pyranometers, too. But time constants vary a bit, signal amplitudes differ and no results of investigations using pyranos are presented here. Thus a suggestion would be to use a more careful wording.

The reviewer is right, we should not conclude about the feasibility of using the same method for pyranometer without showing. We changed the wording to:

> The reconstruction method presented here for pyrgeometer can be adapted to pyranometer and other sensors with slow response times such as contact thermometer or capacitive hygrometers.

line 93: can 'be' faster instead of 'by'

We did not find 'can by' in the latest manuscript. This mistake must have been removed already in the typesetting process.

wrong year (2015 instead of 2012) provided at line 636, captions of figures 7 and 8

Of course. We did correct the year.

line 749: 'can be removed efficiently'

Has been corrected in the revised version.

Interactive comment on Atmos. Meas. Tech. Discuss., 8, 5179, 2015.