

Author's response amt-2017-240:

The authors would like to thank the community member for the comments. In the following our response is illustrated.

(1) Comments from community member

1. The units of $\text{mWm}^{-2}\text{nm}^{-1}$ of Figure 4 are incorrect by a factor of 1000. The units should be $\text{Wm}^{-2}\text{nm}^{-1}$, which would mean that the detection limit of the system is about $10^{-4}\text{Wm}^{-2}\text{nm}^{-1}$.
2. State-of-the-art double-monochromator based scanning spectroradiometers such as QASUME have a detection limit of about $10^{-6}\text{Wm}^{-2}\text{nm}^{-1}$ and sometimes better, in particular for direct solar measurements where no cosine diffuser with small cosine error is required. Such diffusers tend to attenuate radiation more than entrance optics for direct measurements.
3. The units of Figure 4 should be corrected and the reasons why the detection limit is about two orders of magnitude worse than that of QASUME should be discussed. Is the difference due to stray light despite the physical stray light suppression of the BTS2048-UV-S system or because of the short integration times of this system and the resulting photon noise? Below 305 nm, the ratio BTS /QASUME shown in Figure 4 is greatly increasing towards shorter wavelength. This is a clear indication of stray light and might be an indication that the stray light suppression of the BTS via the use of interference filters is inferior to that of the double-monochromator based QASUME system. On the other hand, data of the system shown in Figure 5 of the article "Effective stray light suppression with the BTS2048-UV series array spectroradiometer" published in issue 12 of the Thematic Network for Ultraviolet Measurement http://metrology.tkk.fi/uvnet/source/UVNews_12.pdf suggests that the BTS has a detection limit of $10^{-5}\text{Wm}^{-2}\text{nm}^{-1}$ with no obvious sign for stray light, although judging stray light characteristics on a logarithmic scale can be deceptive. While the accuracy of measurements below 305 nm are of little relevance for the ozone retrievals described in the paper, a quantitative assessment of the system's stray light characteristics below this wavelength would be of great interest to gauge the potential suitability of the system and its novel physical stray light suppression method for those solar measurement applications that were up to this date the domain of scanning double monochromator instruments.
4. The anonymous referee had the comment "4: Section 2: What set of optical filters is in the system. Exactly the same ones as described in Shaw et al., 2008?" and the authors replied "We think it is beyond the scope of the paper to provide the technical details of each filter. However, we provide basic information about the filters." I agree with the referee that more information on the filters should be provided and do not feel that enough "basic information about the filters" is included in the manuscript. Currently, the manuscript only provides the following information: P2, L15: "In the device one long-pass filter and four interference filters with different wavelength ranges are integrated." And P5, L13: "Here, several narrow bandpass filters are used in the spectral range between 280 nm and 420 nm." The authors should specify the center wavelength and bandwidth of each narrow bandpass filter (an additional figure with the filters' transmission functions would also be helpful) and describe how the corrected spectrum is obtained from measurements using each of these filters. The novelty of the instrument is its stray light correction scheme and the manuscript should therefore describe how this algorithm works, both in terms of hardware and data processing. I don't consider this "technical details" that are "beyond the scope of the paper".

(2) Author's response

- 1: We corrected the axis label accordingly.
- 2: We agree.
- 3: Due to the design of the adapted BTS entrance optics, the detection limit was not optimized for direct solar measurements. A small diffuser with comparably high attenuation was used. After the campaign, the instrument sensitivity could be improved by a factor of 4.
The comparison of spectral measurements performed with QASUME and BTS is very complex as both instruments have been operated with different bandpass, wavelength stepping, measurement times and intervals and wavelength accuracy. Especially in the spectral region below 300 nm, where the solar irradiance increases rapidly with decreasing wavelength, the data are more uncertain. So, the differences between the two instruments are not only due to stray light suppression. Nevertheless, the potential and the limitation of the instrument for solar measurements could be demonstrated.
Yes, for different configurations, the detection limit of the BTS is different. The article in UVNews 12 showed results that have been taken with longer measurement times and for global solar irradiance

measurements, where the signal is in general higher and therefore more averaging can be performed. The improved BTS for direct solar measurements will have a similar performance. We added statements which emphasize that a measurement interval of 8 seconds was used; hence no averaging or longer integration times were applied.

4. The focus was on the application and characterization of the BTS device to direct solar irradiance measurements and not in focusing on technical engineering details of the meter itself. It has to be mentioned, that for other applications, the measurement device can be equipped with different sets of interference filters and there is no need to use exactly these filters. Nevertheless, more information about the filters is now given in the manuscript: "In the device one longpass filter, a bandpass filter (298 nm to 390 nm) and four interference filters (center wavelength: 254 nm, 285 nm, 300 nm and 400 nm) are integrated."