Author's response amt-2017-240:

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

(1) Comments from referees/public

1: Section 2: Give some CCD detector characteristics, e.g. how many pixels does it have, does it have an electronic shutter, or give a reference.

2: Section 2: "This detector can be spectral mismatch-corrected ...": does this refer to a comparison of the measured data with the solar Fraunhofer structure as it is mentioned later in the paper? If yes, what does this have to do with the detector? It can always be done.

3: Section 2: Define the expression "BiTec sensor system", describe it and/or give reference.

4: Section 2: What set of optical filters is in the system. Exactly the same ones as described in Shaw et al., 2008?

5: Section 2: Give a reference for the statement that the stray light correction method based on the LSF improves the measurement threshold by 2 orders of magnitude.

6: Section 2: How long does it take to get one spectra with this instrument?

7: Section 3: "After an initial settlement ... ": does "initial settlement refer to temperature stabilization?

8: Section 3: "After an initial settlement ... accuracy was found to be better than 0.1 nm": what does this mean? The dispersion could not be determined better than 0.1 nm?

9: Section 3: " ... the wavelength scale was adapted with high accuracy ...": give a value for the accuracy even if it may be listed in the referenced paper Egli et al., 2014.

10: Section 3: " ... linearity with a deviation smaller than 1% in the full dynamic range ...": this is a very small value. There should be an explanation why this is so good. Is this detector so great or is the "full dynamic range" not starting with very low counts? A figure could be added. Or give a reference.

11: Section 4.1: " ... the entrance optic is kept clean with a constantly heated dry airflow.": describe this more in detail or give a reference. How does the air flow inside the entrance optic tube, with which the instrument was equipped for the measurements at Izana?

12: Section 4.1: Describe the tracker, which was used or give a reference.

13: Section 4.1: Do you mean 0.01° pointing accuracy or precision or resolution (step)? If you mean accuracy, explain why the accuracy is that good or give a reference. Does it have a quadrant detector or similar system included?

14: Section 4.1: What is the difference between the gray and green line in figure 4?

15: Section 4.1: For the (excellent) comparison with Qasume (figure 4): was the radiometric calibration for BTS done in the laboratory and not repeated in the field? In this case the instrument seems to be very robust with respect to transport, which should definitely be mentioned as a strength in the paper.

16: Section 4.2: The ozone algorithm is based on Masserot et al., which is an algorithm for global measurements (not direct sun data). How was the algorithm modified?

17: Section 4.2: What effective ozone temperature is used in the algorithm?

18: Section 4.2: Table 1: the value of 270 DU for OMI seems to be a typo (based on figure 8 it should be around 275 DU).

19: Section 4.2: "A first analysis of the TOC determination uncertainty ...": although a reference is given, the authors should still give a number for the uncertainty determined in Vaskuri et al. at this place, so that the reader does not have to look it up himself.

20: Section 4.2: " ... At air masses larger than 4 ... the signal to noise ratio decreases ... becomes less reliable." Are the data just getting more noisy or are there systematic effects happening?

21: Section 4.2: Figure 8: why are there several gray dots at the same time?

22: Section 4.2: Figure 8: how do the authors explain the decreasing TOC from BTS between 16:00 and 18:00 UT? A residuals stray light effect? An algorithm issue?

23: Section 4.2: It is somewhat surprising to me that the Qasume and BTS spectra are nearly identical (figure 4), but there is a systematic TOC bias. The authors should elaborate on this, which might need more description of the algorithm.

24: It seems that the Ozone algorithm is purely based on lab-calibration. If this is true, the authors should mention this positively in the paper.

(2) Author's response

1: Section 2: Done
2: Section 2: The spectral mismatch correction is implemented for measurements of conventional UV sources and it is not relevant for solar measurements. The sentence is removed.
3: Section 2: Sentence removed, not relevant in this context.
4: Section 2: 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.
5: Section 2: Done
6: Section 2: We agree that this is of interest. However the measurement time depends on the light source, resolution, etc. This is why we stated a typical measurement time.
7: Section 3: Initial settlement is referred to a period of few weeks after the instrument was first used. The sentence was modified to avoid confusion.
8: Section 3: The remaining uncertainty for the overall standard wavelength calibration was 0.1 nm.
9: Section 3: Done
10: Section 3: We totally agree, the sentence had to be modified, as the **remaining** deviation from nonlinearity after correction is smaller than 1%.
11: Section 4.1: This sentence had to be modified as the air flow is not passing the tube and thus is not cleaning the entrance optics.
12: Section 4.1: Done
13: Section 4.1: 0.01° pointing accuracy is achieved by EKO STR-32G trackers. Since we stated the type of sun tracker as a reference it should be clear now.
14: Section 4.1: We modified the sentence to make it clearer.
15: Section 4.1: The radiometric calibration has been carried out in the lab before and after the intercomparison as well as in the field. An additional sentence in section 3 points out the robustness of the instrument as suggested.
16: Section 4.2: A sentence has been added to make it clearer.
17: Section 4.2: A sentence has been added.
18: Section 4.2: Corrected
19: Section 4.2: Done
20: Section 4.2: An explaining sentence has been added.
21: Section 4.2: An explaining sentence has been added.
22: Section 4.2: An explaining sentence has been added (see comment 20).
23: Section 4.2: We agree to the reviewers concern and added a discussion regarding the observed difference between BTS and QASUME TOC.
24: Section 4.2: See comment 15.

(3) Author's changes

The green text was added, red deleted:

1: Section 2: The spectrometer uses a back-thinned CCD detector with 2048 pixels and an electronic shutter integrated in a compact optical bench.
2: Section 2: This photodiode ~~detector~~ can be spectral mismatch-corrected (CIE, 2016) during the measurement by the spectrometer measurements with regard to its radiometric value.
3: Section 2: Therefore, this ~~advanced~~ BiTec sensor system (BiTec since two technologies are combined, integral photodiode and spectroradiometer) combines the advantages of two sensor technologies to perform reliable measurements in the UV spectral range.
4: Section 2: In the device one yellow glass filter and four interference filters with different wavelength ranges are integrated.
5: Section 2: (Zong et al., 2006)
6: Section 2: Hence the overall measurement time to get a full spectral measurement is the sum of all integration times of the sub measurements. Typically this measurement time is in the range of a few seconds, depended on the light source to measure.
7: Section 3: ~~After an initial settlement of the instrument, the~~ ~~wavelength accuracy~~ The uncertainty for the wavelength calibration was found to be better than 0.1 nm.
8: Section 3: See 7.

9: Section 3: For measurements of solar irradiance however, the wavelength scale was additionally adapted with ~~high accuracy~~ standard deviations better than 0.02 nm to the solar Fraunhofer lines using the MatShic algorithm (Egli et al., 2014).

10: Section 3: By applying a mathematical correction for nonlinearity, the spectrometer showed linearity with a deviation smaller than 1 % over ~~in~~ the full dynamic range for the characterised measurement mode.

11: Section 4.1: The instrument was integrated in a weather-proof housing which is temperature controlled (ambient temperature range from -25 °C to +50 °C) and water proof., and the entrance optic is kept clean with a constantly heated dry airflow.

12: Section 4.1: Mounted on a solar tracker (EKO STR-32G) with a pointing accuracy of < 0.01°, the instrument measured direct solar irradiance.

13: Section 4.1: See 12.

14: Section 4.1: The ratio (grey line for single data and green line for moving average) of measurements (right axis) shows satisfactory agreement with average deviations of less than 2.5 % between 300 and 420 nm.

15: Section 3: The used standard lamps allow recalibration of the instrument in the laboratory and in the field. During the measurement campaign, described below, the radiometric calibration of the BTS2048-UV-S could be verified with a standard deviation of less than 1% compared to the calibrations in the laboratory before and after the campaign.

16: Section 4.2: In contrast to Masserot et al., direct irradiance instead of global irradiance has been modelled as input for the look-up table to adapt the algorithm to the measurements performed with the BTS.

17: Section 4.2: The temperature and ozone profile of the chosen atmospheric profile lead to an effective ozone temperature of 232.3 K.

18: Section 4.2: Aura Ozone Monitoring (OMI) ~~270~~275 TOC/DU

19: Section 4.2: A first analysis of the TOC determination uncertainty of the BTS-device, which is in the range of 5 DU, has been carried out by Vaskuri et al. (2017) based on a Monte Carlo method.

20: Section 4.2: At air masses larger than 4 during sunrise and sunset, the signal to noise ratio decreases in the shortwave region of the spectrum and, therefore, the TOC estimations become ~~less reliable~~ more noisy. In addition, at lower irradiance levels the detection threshold of the instrument increasingly affects the wavelength band from 305 nm to 310 nm which leads to higher systematic uncertainties for the calculation.

21: Section 4.2: Figure 8 Grey dots symbolize the BTS TOC measurements captured every 8 seconds, the digitization steps result from the 1 DU resolution of the look-up table.

22: Section 4.2: See 20.

23: Section 4.2: The systematic differences between BTS and QASUME TOC values, even if the spectra of both instruments agree well as shown in Figure 4, arise from different model approaches which are used for the TOC determination. In addition, the modelled TOC values of BTS and QASUME are based on slightly different input parameters for the atmospheric conditions. This is the case becauses since we have chosen our parameters without knowledge of the QASUME parameters to ensure an unbiased comparison.

24: Section 4.2: See 15.