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Atmospheric Measurement Techniques Discussions

Interactive comment on "The world Brewer reference triad – updated performance assessment and new double triad" *by* Xiaoyi Zhao et al.

Anonymous Referee #2

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This is a good update of the work of Fioletov et al. [2005] addressing the precision on the WCC triad, with interesting model comparison introducing external instruments in the assessment. However, three important topics are not addressed in this work,

1. How absolute calibration is done. 2. How the calibration are maintained between absolute calibrations. 3. How the calibration is transferred to the traveling instrument and then to the Brewer network.

Simultaneous observations are required for the calibration transfer of the Brewer, so it seems feasible to have enough simultaneous measurements over a month to derive the calibration constants of the Brewer triads, using every Brewer as a reference to

calibrate the others. This will produce a monthly series of the calibrations constants (Fo, α) to compare with model results.

There is no mention of the number of observations in the study. In contrast with other studies there is no plot of the simultaneous measurements (see for example Figure 3 of [Stübi et al., 2017]). Observing at the hourly data set used for the comparison with the reanalysis, we can almost get a view of the differences without using any average.

In general, the figures are difficult to see , especially if they are printed, because the several curves in the figure are not easily to distinguished. I suggest extending both axis for a clearer view, and using consistent symbols for BrT and BrD representation. In addition, I also suggest indicating the dates of the calibrations on the graphs.

General Comments:

1. The independent calibration of the instruments is not described. As the authors say, (line 80) The absolute calibration is "critical to review and assess the ... instrument performance", but there is no description of the methodology used, the results of the calibration and the level of agreement with the results of this work.

2.Thenumberofcalibrationsoftheinstrumentsislow,intheperiodof20yearsanalyzedBrTinstrume were calibrated four times, on average every 5 years. While brewer instruments of the Network for detection of the Atmospheric Climate Change are requested to be calibrated every year and WMO recommends a two-year cycle calibration. It is crucial to know how the calibrations are maintained between absolute calibrations.

3. The transfer method from the triad to the travelling reference need to be clarified. Which of the instruments are used for transfer ?. What ozone data do you use for the transfer? That from the BrT or the straylight-free data ? The observations from the BrT, BrT-D or an average of all six instruments? Which period of time is used for the calibration of the traveling reference.

4. Different updated versions of the model Fioletov et al. [2005] have been used to

establish the perfor- mance of the Brewer instrument, but this method is not used for the satellite and reanalysis comparison. For validation of this model a comparison of the triads using hourly observations (as reanalysis) may be of interest.

5. The Methods 2 and 3 also evaluate the error in the Extraterrestrial constant and absorption coefficient. These parameters are also obtained during the calibration, but no comparison is made between the model-derived parameters and those obtained when the instrument is calibrated.

6. The Stray light effect on the ozone is the power law of the ozone slant column Karppinen et al. [2015] Moeini et al. [2019], although the observations are limited by air mass (3.5) and not by ozone slant column. A Brt to BrtD comparison against the ozone slant column may give us the correct limitation of the ozone slant column for the analysis.

7. The use of different timescales, monthly, three monthly or six monthly make the comparison of the different models difficult. Please unify the results.

8. Results of the regular standard lamp tests of the Brewers, normally a good indicator of the stability of the instrumental calibration. A comparison of these measured SL-test records with the presented statistical parameters should be included and hopefully show the same good stability.

Specific Comments

3.1. Page 1 Line 27 Reference to the WMO requirements document is missing.

3.2. Page 1 Line 27 Reference to the uncertainty analysis is missing.

3.3. Page 2 Line 49 random uncertainty ? Please use standard meteorologic terminology

3.4. Page 2 Line 53 Please update Stray Light correction references, [Karppinen et al., 2015], [Rimmer et al., 2018]

3.5. Page 3 Line 63 The Arosa triad is now in Davos at PMOD World Radiation Center ([Stübi et al., 2017])

3.6. Page 3 Line 65 Reference comparisons are described in [Redondas et al., 2018]

3.7. Page 3,Line 80 The instrument calibration every 2-6 years ?, the range looks 3-8 years.

3.8. Page 5,Line 116 Please detail the configuration of the BPS. Was this software also used for the previous Fioletov et al. [2005] analysis? Which are the main differences?

3.9. Page 5,Line 113 Please associate the references with the corresponding product

3.10. Page 6,Line 140 What is an independent calibration technique? Please clarify.

3.11. Page 7,Line 180 Please indicate the Pandora calibration.

3.12. Page 8,Line 165 Are Serdyuchenko cross sections used in this work? Please clarify.

3.13. Page 8,Line 170 Can you please summarize the differences between the official Pandora observations at Downsview that can be obtained from the Pandonia Global Network, and the ones used in this work? Are the observations used here also publicly available?

3.14. Page 8,Line 170 StrayLight (ozone slant column dependence) , see general note 9.

3.15. Page 10,Line 220 Can you quantify the good quality of MERRA total ozone , for example, the BIAS and standard deviation with ground base?.

3.16. Page 10,Line 245 "the baseline is only needed to adjust for the time difference in ozone measurements by individual Brewers" How large is the time difference between the measurements of the Brewers of the Triads? Couldn't they run in sync? If all the Brewers were in sync, would the baseline calculation (Ai coefficients) still be needed?

3.17. Page 12,Line 307 As the triads receive its ETC independently , can be used as ozone for the model 3.

3.18. Page 13,Line 325 The total ozone above 400 DU are usual in Toronto and with 3.5 airmass limit means 1400 ozone slant column, so this observations are seriously affected by stray ligth. Why the double brewer are also limited in airmass?.

3.19. Page 14,Line 341 σâĂš is not defined, is it the mean? In that case, it would be better to use σ ÌĎ

3.20. Page 15,Line 358 It looks like there is a factor 10 missing on the formula.

3.21. Page 15,Line 360 For the uncertainties of ETC, the goal is to have it within $\pm$ 5 R6 ratio units. Please can you clarify which are the typical conditions, and how are these threshold parameters are obtained?

3.22. Page 15,370 The goal of ETC and ozone absorption coefficient should be plotted also as reference.

3.23. Page 16,Figure 2 Could you add the calibration dates to this figure? For Brewer #008, it looks like the error is increasing over the last three years of the period between the 2008 and 2015 calibrations?

3.24. Page 17, Line 395 Figure is difficult to see.

3.25. Page 18, Line 420 Table 4: for comparison, we suggest to include the results of Model 2

3.26. Page 19, Figure 5 It is difficult to see anything, probably it would be better to have one plot for every satellite.

3.27. Page 20, Figure 6 Could you please add a plot with the standard deviation?

3.28. Page 23, Line 515 There is a correction method to account for the filter no linearity Rimmer et al. [2018] why is not applied ?

3.29. Page 24, Line 523 Please clarify, the instrument is not described before and it is not clear how affect to the ozone measurement and when this issue affects to the results.

3.30. Page 24, Line 530 See General comment 8

3.31. Page 24, Line 545 Please explain how Figure 8b is obtained.

3.32. Page 24, Line 575 The determination with the model 2 of the ETC and ozone absorption coefficients cannot be defined as error budget- The results of the Model 2 are quite far from the goal (the axis limits of Figure 2 are +/- 100 R6 ETC units but the goal is +/-5 R6 units).

3.33. Page 26, Line 585 The uncertainty of the Brewer triad is not established on this work, only its long term precision. The highly precise "group scan" is not discussed on this work and shouldn't be in the conclusions.

References

V. E. Fioletov, J. B. Kerr, C. T. McElroy, D. I. Wardle, V. Savastiouk, and T. S. Grajnar. The Brewer reference triad. Geophysical Research Letters, 32(20):L20805, October 2005. ISSN 1944-8007. https://doi.org/10.5194/amt-2020-32410.1029/2005GL024244. URL http://onlinelibrary. wiley.com/doi/10.1029/2005GL024244/abstract.

Tomi Karppinen, Alberto Redondas, Rosa D. García, Kaisa Lakkala, C. T. McElroy, and Esko Kyrö. Compen- sating for the Effects of Stray Light in Single-Monochromator Brewer Spectrophotometer Ozone Retrieval. Atmosphere-Ocean, 53(1):66–73, January 2015. ISSN 0705-5900, 1480-9214. https://doi.org/10.5194/amt- 2020-32410.1080/07055900.2013.871499. URL http://www.tandfonline.com/doi/abs/10.1080/07055900.2013.871499.

Omid Moeini, Zahra Vaziri Zanjani, C. Thomas McElroy, David W. Tarasick, Robert D. Evans, Irina Petropavlovskikh, and Keh-Harng Feng. The effect of instrumen-

tal stray light on Brewer and Dobson total ozone measurements. Atmospheric Measurement Techniques, 12(1):327–343, January 2019. ISSN 5 1867-1381. https://doi.org/10.5194/amt-2020-324https://doi.org/10.5194/amt-12-327-2019. URL https: //amt.copernicus.org/articles/12/327/2019/. Publisher: Copernicus GmbH.

Alberto Redondas, Virgilio Carreño, Sergio F. León-Luis, Bentorey Hernández-Cruz, Javier López-Solano, Juan J. Rodriguez-Franco, José M. Vilaplana, Julian Gröbner, John Rimmer, Alkiviadis F. Bais, Vladimir Savastiouk, Juan R. Moreta, Lamine Boulkelia, Nis Jepsen, Keith M. Wilson, Vadim Shirotov, and Tomi Karppinen. EUBREWNET RBCC-E Huelva 2015 Ozone Brewer Intercomparison. Atmospheric Chemistry and Physics, 18(13):9441–9455, July 2018. ISSN 1680-7316. https://doi.org/10.5194/amt-2020- 324https://doi.org/10.5194/acp-18-9441-2018. URL https://www.atmos-chem-phys.net/18/ 9441/2018/acp-18-9441-2018.html.

John S. Rimmer, Alberto Redondas, and Tomi Karppinen. EuBrewNet â A European Brewer network (COST Action ES1207), an overview. Atmospheric Chemistry and Physics, 18(14):10347–10353, July 2018. ISSN 1680-7316. https://doi.org/10.5194/amt-2020-32410.5194/acp-18-10347-2018.

René Stübi, Herbert Schill, Jörg Klausen, Laurent Vuilleumier, Julian Gröbner, Luca Egli, and Dominique Ruffieux. On the compatibility of Brewer total column ozone measurements in two adjacent valleys (Arosa and Davos) in the Swiss Alps. Atmospheric Measurement Techniques, 10(11):4479–4490, November 2017. ISSN 1867-8548. https://doi.org/10.5194/amt-2020-32410.5194/amt-10-4479-2017. URL https: //amt.copernicus.org/articles/10/4479/2017/.

Please also note the supplement to this comment:
https://amt.copernicus.org/preprints/amt-2020-324/amt-2020-324-RC2-supplement.pdf

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