Atmos. Chem. Phys. Discuss.,
https://doi.org/10.5194/acp-2017-1210-RC2, 2018

Atmospheric Chemistry and Physics Discussions

Interactive comment on "EUBREWNET RBCC-E Huelva 2015 Ozone Brewer Intercomparison" *by* Alberto Redondas et al.

Anonymous Referee #2

Received and published: 5 February 2018

General comments

The paper "EUBREWNET RBCC-E Huelva 2015 Ozone Brewer Intercomparison" by Redondas et al. describes some of the main findings from an international comparison campaign of Brewer spectrophotometers. After an introduction about the Brewer ozone retrieval algorithm and the calibration transfer techniques, particular attention is given to an empirical parametrisation/correction of stray light applied to the single-monochromator instruments. A short discussion about the "standard lamp correction" to track the radiometric stability of the spectrophotometers is also provided.

In my opinion, the paper potentially raises the following important questions:

1. what is the maximum attainable reproducibility by well-calibrated Brewer spectrophotometers?

2. what are the most common sources of error/instability in the Brewer measurements? How can they be identified and solved during an intercomparison?

3. how important is the stray light effect on ozone estimates and what techniques can be used to overcome this issue?

4. how good is the agreement among reference instruments used to calibrate the Brewer network?

Therefore, the manuscript, in principle, addresses relevant scientific questions within the scope of ACP. However, I have two main concerns related to the paper:

1. the stray light and the standard lamp corrections should be discussed more properly (cf. Specific comments);

2. the manuscript resembles more to a technical report than a scientific article (especially considering that the manuscript has been submitted to ACP). The previously listed scientific questions (1-4) deserve a deeper discussion, and should be better enhanced (e.g., they should be presented in the introduction, together with a set of bibliographic references, and answered in the main text through quantitative results). Technical details (e.g., determination of the dead time, dispersion function, etc.) that would be suitable for a report should be omitted in the present paper if not relevant to the scientific discussion. A reorganisation of the paper, keeping theory and results better apart, would improve readability (cf. Technical corrections).

Once these remarks are properly addressed, the paper can be published in ACP.

Specific comments

1. It is rather trivial that the comparison between single- and double-monochromator instruments improves when a stray light empirical correction, obtained from the comparison itself, is applied back to the same set of data. What is not obvious, in my

opinion, is that the correction obtained during the intercomparison can be also used to improve accuracy when the Brewer is moved back to the home institution after the campaign. This would be an important conclusion, but some points should be addressed:

A. it should be proved (or discussed) that the correction only depends on the instrumental characteristics and not on the measurement site;

B. stray light should be characterised, during the intercomparison, for the full range of slant ozone values reached during normal operation. This is particularly important for single-monochromator instruments located at high-latitude stations. Can the authors state that the OSC range during the intercomparison is wide enough?

C. the authors affirm that "These parameters, determined in several campaigns, have been found to be stable" (page 6 l. 8). This is a key point: can they show some quantitative data demonstrating that the correction is stable over time?

2. The section about the SL correction (page 9) is quite inconclusive. It is demonstrated that the SL correction does not improve the accuracy for some Brewers (while it does for others) and that the only way to verify it is an intercomparison against a reference instrument. In that case, how should the Brewer data be reprocessed from one intercomparison to the next? My concern is not to spread the idea that the Brewer data quality is aleatory and that the community does not know how to reprocess the data for improving their quality.

Technical corrections

page 1 l. 4-6: omit the reference to UV and QASUME in the abstract if the UV results are not discussed in the text;

page 1 l. 4: "Twenty-one". It could be useful to mention already in the abstract how many single- and double-monochromator instruments have been studied;

page 1 l. 7: at the first occurrence, use "spectral stray light" instead of only "stray light", to distinguish it from other sources of stray light (e.g., multiple scatter stray light n the

field of view);

page 1 l. 9-10: omit 76% and 50% percentages (16/21 is easy to calculate, and 10/21 is 47%, not 50%);

page 1 l. 10: state the air mass range relative to the 1% and 0.5% thresholds;

page 1 l. 11: enhance the outcomes of the paper, e.g. why / to whom those findings are important?

page 2, Sect. 1: I would expect a more sound introduction, focussing on scientific issues (and related literature, e.g. on the stray light effect, etc.), rather than a summary of the previous campaigns. Also, since the previous technical reports are mentioned, it should be specified what the novelty of the present study is;

page 2 l. 17: "Figure" instead of "Fig." at the beginning of a sentence (https://www.atmospheric-chemistry-and-physics.net/for_authors/manuscript_preparation.html);

page 3 l. 2: table 2 is cited before table 1, please reverse the order of tables;

page 3 l. 3: the measurement site should be better described, since the local characteristics of the measurement site impact of the results of the campaign;

page 3 l. 4-5: since UV radiation is out of the scope of this paper, omit the references to QASUME and WRC-UV;

page 3 l. 8-21: those paragraphs have nothing to do with Sect. 1.1, entitled "The X RBCC-E campaign". Omit them and reference the EUBREWNET paper (https://www.atmos-chem-phys-discuss.net/acp-2017-1207/) in your Introduction;

page 4 Eq. 1: if alpha is defined as in Eq. 3, Eq. 1 should read (ETC-F)/(alpha*mu) instead of (F-ETC)/(alpha*mu). Otherwise, if alpha is defined negative (as in the Brewer literature), Eq. 3 should have a minus sign;

page 4 l. 8: define what "double ratios" are, for the unexperienced reader. "corrected for the Rayleigh effects" -> "to which the effect of Rayleigh scattering has been subtracted (Eq. 2)";

page 4 l. 16: "verify" -> "satisfy";

page 4 Eq. 5: Eq. 6 is explained in the following text, please explain Eq. 5 as well;

page 5 l. 1: "calibration" -> do you rather mean "characterization"?

page 5 l. 2: "filter attenuation" -> has any filter already been mentioned in the text?

page 5 l. 3: "The wavelength calibration allows to..." -> "An accurate determination of the operational wavelengths is needed to". "are" -> "is";

page 5 l. 6: "Finally, the ETC transfer is performed by comparison..." -> "Finally, the ETC must be determined by transfer from a reference Brewer (Sect. 2.1) or, in the case of the reference instruments, by the Langley method" (include bibliographic references about the Langley method);

page 5 l. 8-9: "changes ... wavelength calibration will affect the final ETC and changes in the wavelength calibration will affect also the final ETC" -> is there any difference between the two sentences?

page 5 l. 18: "calibration" -> "radiometric";

page 5 l. 20: "for simultaneous measurements BY BOTH INSTRUMENTS";

page 5 Eq. 7: explain that "i" does not refer to wavelength, as in Eqs. 2-6, but to the sample (better: use a different subscript). Correct the sign "-" to "+" according to Eq. 2 (cf. my previous comment);

page 5 l. 27: define the "stray-light free region" from a quantitative point of view;

page 6 Fig. 3: Figs. 3 and 4 are very similar. Consider keeping only one of them. Add units of ozone slant path (cm STP);

page 6 Eq. 8: the "F0" notation of Eq. 4 may be confused with "Fo" of Eq. 8. Consider using a different notation;

page 6 Eq. 8 and 9: as far as I understand, the k(X*mu)ˆ2 term can be attributed to either the F's or to the ETC's, but not to both of them at the same time. In this case, the text should be clearer;

page 6 line 7: "stray-light free OSC region" -> this expression is misleading, since the k(X*mu)ˆs cannot be zero for mu>=1 (or reformulate the correction term to be zero for mu=1). Also, could the ETC be directly retrieved from the fit, together with k and s?

page 7 Eq. 10: since k is negative, if we want the ozone to increase at the next iteraction, there must be a "-" sign, unless alpha is defined negative (Eq. 3). Please, clarify;

page 7 line 5: "2000 DU" -> to what air mass does it correspond, in El Arenosillo? Is the calculation of the air mass reliable at this SZA? Notice that the stray light correction presented in the paper depends on the product X*mu: if X is low during the determination of the correction, mu must be large (but still accurate!) to cover a sufficiently wide range of OSC, since, at high latitudes, the same OSC can be reached at lower mu's;

page 7 "3.1 Reference Calibration" -> or "Agreement between reference instruments"?

page 8 l. 1-6: the comparison of the reference instruments is an interesting topic, and the RBCC campaigns a very unique chance to investigate it. However, the authors should discuss it with more details. E.g., how are the ECCC Toronto Triad and #158 calibrated? The procedure is explained for the IZO triad, but not for other reference instruments;

page 8 l. 5-6: why two different thresholds (900 DU and 600 DU)?

page 8 l.8 to page 9 l. 7: this basically theoretical part should be described in the "Methods" section, not in the "Results";

page 9 l. 13: Brewer #165 does not exist in the list of the instruments;

page 10 l. 3: "Brewer #151 can not be considered an operational instrument" -> what does this sentence mean?

page 10 l. 4: "ago" -> "before";

page 10 l. 12 and 14: "more than 5 units during this period" repeated twice;

page 11 Fig. 9: ordering the x-axis by serial number would improve readability of the chart;

page 12 Fig. 10: both the bias and the spread for Brewers 158 and 228 is large (in the boxplot). Is there any connection between bias and spread (e.g., instability of the lamps...)?

page 12 l. 1-5: move these lines to a "Methods" section;

page 13 l. 4: if the discussed results were representative of the overall Brewer network, this would mean that about 25% of the instruments are "out of spec" after two years. This is a strong statement: could the author elaborate on this?

page 13 l. 7: "celebrated" -> "taking place"?

page 14: can the authors draw more definitive and general conclusions from the study?

page 15 Fig. 13: could the variations over time be explained by the variability of the participating instruments? This should be mentioned in the text. Caption: what does "no operating" mean?

Interactive comment on Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2017-1210, 2018.