

February 28, 2018

Review of “Characterization of the instrument temperature dependence of Brewer total ozone column measurements” by Alberto Berjón et al.

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The revised text of the paper addressed many of the concerns raised in the initial review and it reads much better now. I did find other areas where the paper can be improved, some of them are very important.

1. The title sounds as if the paper investigates the Brewer ozone calculation temperature dependence in general, but the content is mostly a comparison of 2 different experiments on 2 different Brewers plus a mentioning of variability of temperature coefficient values among the Brewers in EUBREWNET. I am not sure any general statements can be definitively drawn from this. A title similar to “An investigation of TC determination in EUBREWNET Brewers” can be more precise

P1 L20 Push rod doesn't really control the movement of the diffraction grating. Suggest not going into this details and say “materials used in the monochromator are selected to minimize the effect of the internal temperature changes on the spectrum position relative to the exit slits.”

I will repeat my comment in the initial review: the paper does not clearly differentiate between two completely different temperature effects in the Brewer: the positioning of the spectrum and the changes in the spectral sensitivity. Some paragraphs refer to both effects that is extremely confusing. Moreover, the paper doesn't actually investigate anything relating to the spectral shifts and so it is unclear why the authors even go into this area. A simple statement that is in page 1 is more than enough and I feel that no mentioning of this should be anywhere in the paper after that.

P2 L5 “During the test, the diffraction grating is positioned such that the operating wavelengths are dispersed onto the appropriate exit slits” - please rephrase as this sentence doesn't describe much.

P2 L14 TC are calculated for all operating wavelengths, not just those used for ozone

P2 L25 replace “the” with “some” in “quartz window and the neutral density filters”

P3 L7 remove double “an”

P3 L15 it's not really an “alternative”, it's the same

P3 L19 I refuse to accept your explanation that since you've already used this notation for the slit numbering in another paper and this makes it ok to use it again. It is wrong to use unconventional terminology, Many papers before yours used it correctly.

P6 L10-18 Should not be in this paper.

P7 L18 Have you looked at the fact that Brewers have at least three different PMT types and that can contribute to the differences in the TC? If you did, what was the result? If not, why not?

P7 L22,25 The order filter is not just NiSO₄ crystal, but a combination filter with two UG11 glass filters.

P10 L20 *** An important point!!! *** : did you calculate the slopes and their uncertainties using the averages for each temperature? It very much looks like you did and then your uncertainty is incorrect as you forgot that each point (each average) has an uncertainty associated with it already (a very large standard deviation in fact). You should re-calculate those uncertainties using each point or propagate the uncertainties of the averages to that of the slopes. When you do this you will likely find that the uncertainty is larger than 100% for most of your slopes, which brings back my original point from the initial review: if for each temperature you have a spread of R6 so large that is close to the spread between R6 at extreme temperatures you cannot actually correct or improve such data. Whatever you do you will still have that spread. So, the question then is can you even trust such a data for determining TC?

P11 L1 I am not sure I understand why you are saying "in spite of robustness of the TOC calculation algorithm". The algorithm clearly works. It was the instrument (the hardware) that didn't.

P11 L5 You may consider stating clearly that it is imperative to schedule SL tests throughout the day to cover the different temperatures inside the Brewer.

GENERAL COMMENTS

This paper addresses an important issue for the Brewer users and ozone communities, since an accurate assessment of the Brewer temperature dependence is essential to ensure reliable TOC measurements. It is also generally well written. However, some issues should be solved prior to publication.

SPECIFIC COMMENTS

1. The main issue, from my point of view, is the reliability of the measurements in the frame of the experimental setups. For example, the authors state that “The analysis of the internal lamp measurements in PTB1 shows a very marked nonlinear behaviour when using slit 5 and 6 relative to slit 2” (p. 9) and ascribe this behaviour to the internal halogen lamp. However, also the external lamp (slit 5-6) charts in Fig. 7 show some curvature above 40°C, which cannot be ascribed to the halogen lamp. Furthermore, looking at Fig. 6, I cannot understand the inconsistency of the results at PTB2 (internal lamp measurements show hysteresis, while external lamp measurements do not) and K&Z (vice-versa). It would be desirable for the reader to have these issues explained better, in order to trust the results of the experiments (were the external lamps stable? Were temperatures measured reliably? Etc.)

2. I could have missed this information, but was the wavelength alignment (“hg tests”) checked during the chamber experiments? It should be explained whether the final temperature sensitivity takes the wavelength shifts into account;

3. I cannot understand why tau_R6 (linear combination) is much more stable than the relative coefficients. Does this mean that F(306.3) is not a good reference? Or that noise is lower when combining the irradiances at 4 wavelengths compared to only 2 wavelengths?

4. It is stated that “The conclusions of this work cannot be extended to MkII and MkIV models” due to presence of NiSO₄ filter. I agree with the authors that the temperature coefficients may vary between MkIII and other Brewer types, but why the main outcome of the paper (i.e. that the standard lamp can be effectively used to track the Brewer sensitivity to temperature changes) should be compromised?

5. Regarding the very last paragraph, recommending a change of the reference temperature, I am not sure whether this would reduce the uncertainty of the temperature correction. Indeed, since the correction is assessed based on experimental data, small measurement errors at ~22-23°C would result in lower deviations of the angular coefficient if the reference point is farther (0°C) from the reference. Instead, some issues could arise if the temperature dependence is locally linear about ~22-23°C, but globally not linear. In that case, I agree that changing the reference temperature would be a benefit.

6. Finally, according to the data usage rules of EUBREWNET, an acknowledgement to the PI’s providing the data used in the paper (e.g., Fig. 1) should be included. I would suggest the authors to include the statement recommended on the EUBREWNET website: “We thank the European Brewer Network (<http://rbcce.aemet.es/eubrewnet/>) for providing access to the data and the PI investigators and their staff for establishing and maintaining the “#” sites used in this investigation”.

TECHNICAL CORRECTIONS

- check usage of “internal lamp” vs more rigorous “internal halogen lamp” or “standard lamp” throughout the paper. Indeed, two internal lamps are available in the Brewer (mercury and halogen);

- p. 1 line 18, “temperature-compensated” is not clear here, but the concept is explained in the following lines. Simply remove “temperature-compensated”;

- p.2 line 28, “studied by different authors”: please add bibliographic references;

- p. 3 line 20-24: rewrite this paragraph splitting the two points: 1) the weightings are chosen to minimise influence of SO₂, linear effects and constant term; 2) the wavelengths are chosen to maximise sensitivity to ozone and to minimise small shifts in wavelengths (sun scan test);
- p. 4 Eq. 8: it is a common error. To comply with the Lambert-Beer-Bouguer equation, either Eq. 1 should read $ETC - R_0$ or the cross section should be $-\sum(w_i \alpha_i)$. Since the Brewer weightings give a negative differential cross section, it would look better if Eq. 8 had a “minus” sign;
- p. 6 line 1: “it” → “they”;
- p. 6 line 17: define “Cte” (did you mean “constant”?)
- p. 6 line 18, “constant” → “constant over all wavelengths” (not in time);
- p. 7 line 17 and line 28: “Figure” → “Fig.”
- p. 10 line 20: why the diurnal, and not the annual, variation was chosen to provide an idea of the internal temperature changes?

General comments:

The article provides a complete characterization of thermal sensitivity of the Brewer spectrophotometers in total ozone measurements. Although the topic addressed in the paper is very important for Brewer users, the issue of the temperature correction and the experimental procedure to investigate the temperature effect on ozone measurements can be also used for other instruments.

The paper is well-structured, all sections are well interrelated, and the objectives are clearly identified.

Specific comments:

Pag 1 L15: The authors should specify which kind of environmental parameters the instruments are exposed outdoors.

Pag 1 L20: which kind of changes are produced in the measured spectrum?

Pag 2 L4: How the internal temperature is measured should be specified here.

Pag2 L12: typo "approxiamation"

Pag 2 L15: for readers not familiar with TOC measurements with Brewer it needs to specify what is the "routine operation" and what are "the original coefficients".

Pag2 L28: Include some references about that issue.

Pag2 L 30: the acronym "EMRP ENV59" should be explained.

Pag 2 L 34: Specify the places of PTB (Physikalisch-Technische Bundesanstalt) and at Kipp & Zonen facilities

Fig1: specify at least in the legend what is the line inside the box, the top and bottom of each box are the 25th and 75th percentiles of the samples, and which values are set the whiskers.

Pag 7 L17: Typo "EUBRENET", include brackets to "(Figure 3)"

Pag. 7 L 28: why did the authors use only MKIII and not also MKII or MKIV which have shown higher τ_{6} than MKIII?

Pag 9 : typo in "this clearly observed behaviors"

Pag 9: Acknowledgements. As reported in Recommended guidelines for data use and publication of Eubrewnet data, the authors should write : " We thank the European Brewer Network (<http://rbce.aemet.es/eubrewnet/>) for providing access to the data and the PI investigators and their staff for establishing and maintaining the "#" sites used in this investigation."