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Discussions

Interactive comment on "Characterization of the instrument temperature dependence of Brewer total ozone column measurements" *by* Alberto Berjón et al.

Alberto Berjón et al.

alberto@goa.uva.es

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We would like to thank Dr. Vladimir Savastiouk for all his constructive suggestions and comments. They have been quite useful to improve the paper. We include as additional information the .pdf file of the discussion paper with all changes highlighted.

General comments:

GC#1: While the paper implies that the results can be generalized to all Brewers

C1

it doesn't discuss how the presence of the NiSo4+UG11 filter can affect (or not) the results.

Brewer MKIII model have been used in the experiments carried out in the present study, both in the PTB and in K&Z. In addition, section 4 shows a study about the Brewer Operating temperature in the EUBREWENET stations, which include Brewer models MKII & MKIV. This section is complemented with a stadistic of temperature sensitivity of the different Brewer models (Fig. 3), which show a different behavior between the MKIII model and the MKII & MKIV models. Therefore the conclusions of this work can not be extended to the MKII & MKIV models.

To clarify this point we have modified the following sentence of the conclusions:

... of the temperature dependence of the Brewer measurements used to retrieve atmospheric TOC.

By

... of the temperature dependence of Brewer MKIII measurements used to retrieve atmospheric TOC.

And included the following sentence:

The analysis of the EUBREWNET data shows some temperature sensitivity differences between Brewer MKIII model and the MKII and MKIV models, may be related with $NiSO_4$ filter. Therefore the conclusions of this work can not be extended to the MKII and MKIV models.

GC#2: It is extremely important in my opinion to clearly distinguish and address separately the two very different effects that temperature has on the Brewer spectrophotometer measurements: 1) a spectrum shift due to difference in temperature coefficient of expansion between glass and metal and 2) changes in the

C2

PMT+order filter combination (if one is present) sensitivity/transmission (potentially wavelengths dependent).

We agree with the referee in the importance of this point. However it is out of the scope of this work and it should be addressed in future works, designing an experiment which focus on this objective.

GC#3: A more important comment is about the terminology for the experiments that are described in the paper. The experiments are referred to by the location where they took place, ptb and K&Z, but these two locations/methods were only used for one Brewer each and not for both Brewers mentioned in the paper. This is important when comparing the results: the differences may be due to location/equipment or the Brewer instrument or both.

The used nomenclature is intended to emphasize that the two experiments are different indeed.

We consider also important the possible influence of using two different instruments in both experiments. But using the same instrument is not a guarantee either that the results will not be conditioned by the state of the instrument, as shown by the repetitions PTB1 and PTB2.

GC#4: Also, PTB1 was by all accounts a failed experiment due to poor SL bulb and I do not see any advantage in presenting these results other than mentioning that a stable and reliable SL bulb is needed for TC calculations.

We have decided to include the PTB1 measurements due to existence of unexpected hysteresis cycles in the absolute measurements that are ratified in PTB2. We believe it is important to show the two repetitions to clarify that these cycles are not due to problems in the experiment.

GC#5: Many scatter plots of R6 vs T show variability for a given temperature greater (often significantly greater) than the difference in R6 at the extremes of the temperature range when using mean values for each temperature. Calculating TC from such data is very questionable as depending on the number of points at each temperature the mean can change if you wait long enough. In other words, TC=0 is all you can say in such situations.

The trends observed in the mean R6 vs T are in general also observed in the non averaged R6.

We have used the R6 average for each temperature because the number of measurements for certain temperatures is much higher than for others, which can lead to an overweighting of certain temperatures. Averaging also reduce the outliers effect in the regressions. In general, the differences between the coefficients obtained after averaging and no averaging is less than the error shown in Table 1.

Line-by-line comments:

P2 L4 Strictly speaking, positioning of the grating at the operating wavelength is not part of the HG test,this is done after the test. If you want to be more precise try re-writing this sentence.

We have corrected the sentence:

The HG test uses a mercury discharge lamp to precisely locate the 302.15/296.73 nm mercury line.

By

The HG test uses a mercury discharge lamp (line 302.15nm or 296.73 nm) to check

the stability of the wavelength calibration during Brewer operations.

P2 L6 "may not be perfect" seems out of place as this is precisely the reason HG test is done. Maybe this sentence was intended to be earlier in the text?

The sentence is relocated in the previous text:

To avoid this effect, the material of the push rod that controls the movement of the diffraction grating is selected so that its contraction and expansion causes the opposite effect on the spectrum, thus minimizing the effect of the temperature on the measurements. Nevertheless mechanical tolerances in the manufacturing may cause imperfections in this temperature compensation, thus the Brewer operational procedure recommends...

P2 L25 ground quartz filter is used in both DS and SL measurements

The sentence:

In addition, there are different elements involved in the direct sun measurements but not in the measurement of the internal lamp, such as the quartz window, the ground-quartz diffuser and the neutral density filters,

Is replaced by:

In addition, there are different elements involved in the direct sun measurements but not in the measurement of the internal lamp, such as the quartz window and the neutral density filters,

P3 L10 maybe it is worth mentioning that the movement of the slit mask is "rapid" to indicate that all wavelengths are measured almost simultaneously.

The sentence:

To select the different wavelengths used in the calculation, the Brewer spectrophotometer maintains a fixed position of the diffraction grating and uses a rotating slit mask to select successively each wavelength.

Is replaced by:

To select the different wavelengths used in the calculation, the Brewer spectrophotometer maintains a fixed position of the diffraction grating and uses a rotating slit mask to select successively each wavelength. The rapid movement of the slit mask assure that all wavelengths are measured almost simultaneously.

P3 L18 it is common practice to number slits 0 to 5 with dark count having no slit number (it is not a slit)and numbering slit mask motor positions 0 to 7 with position 1 corresponding to dark count

In the present work we have follow the same slit number nomenclature than in previously published works (Redondas et al., 2014). Furthermore, in order to avoid confusion the wavelengths along with the slit number have always been included in the graphs.

P3 L19 Rayleigh is also explicitly corrected for

To facilitate the understanding of the formulation, Rayleigh correction has been written separately from instrumental corrections in Eq. 1, as in other previously published works (Redondas et al., 2014). In any case, the temperature correction is always made before the Rayleigh correction, so results are equivalent.

P4 L20 I couldn't quite figure out what the advantage is in having tau/I vs tau, I just hope readers are smarter than me.

As detailed in the manuscript, τ_0 is dependent of the measured Intensity. Thus to

perform a temperature correction we need not only τ_0 but also I_c, or more briefly $\tau = \tau_0 / I_c$.

P5 EQ16 and all that leads to it - seems like a very complicated way to show that an addition of a constant doesn't change the convolution with weighting coefficients that add to zero by themselves

The intermediate steps of the equation have been deleted.

P6 L5 the requirement is same as my previous comment - constant in log space - seems like a more precise definition than "the change of the light source is proportional at all wavelengths". Please re-phrase.

Both Irradiance and Log spaces are equivalent. However, for the non-specialist readers, the log space can be confusing. Therefore, to simplify the reading, we consider it appropriate to keep the sentence.

P7 L32 I happen to know that #233 is now installed in Malaysia and cannot possibly be K&Z reference. Please verify this information or say "it used to be" reference.

We correct this error. #233 is not a reference but a research instrument of K&Z. Thus we change the sentence to:

... *and a research instrument of Kipp & Zonen, respectively.*

P8 Please make clear that 185 was only in PTB and 233 was only at K&Z

We add the following sentence in Section 5:

Since different instruments have been used in each experiment (#185 at PTB and

C7

#233 at K&Z) the differences in results may be due not only to the differences of the experiment setup, but also to the different Brewer instrument.

P8 L10 There seems to be no results or consequences of having photodiodes. Why mentioning them?

We correct the misunderstanding by adding the sentence:
The drift of the Xe source irradiance at the Brewer entrance port was corrected by using the calculated mean of the normalized integrated spectral data from the monitor spectroradiometer and the temperature-corrected SiC detector readings.

P10 L4 PMT's dark count is theoretically proportional to the exponent of temperature. This is clearly the case with #233, but not with #185. Is it possible that there was something wrong in the setup of #185?

The possible causes of the effect observed in the dark current are under study at the moment. But it is likely to be related to some parameter in the instrument setup. It is worth noting that after this work this check has been included in the routine RBCC-E control to assure the correct operation of the instrumentation.

P11 L16 Maybe it is worth explaining that having reference temperature close to median operational temperature means little to know correction due to temperature is needed most of the time and thus there is slightly more room for TC inaccuracies.

We modify the sentence:

Finally, it is worth to note that temperature correction is usually applied to measurement data using a reference temperature close to the most frequent operation temperature. However, ... will reduce the uncertainty associated with the uncertainty of the temper-

C8

ature correction.

By:

Finally, it is worth to note that temperature correction is usually applied to measurement data using a reference temperature close to the most frequent operation temperature. A reference temperature close to the mean operational temperature means that the applied temperature correction is most of the time small and thus a low accurate estimation of the temperature sensitivity will not have a high effect over the TOC retrieval. However, ... will reduce the TOC uncertainty associated with the uncertainty of the temperature correction.

Please also note the supplement to this comment:
https://www.atmos-meas-tech-discuss.net/amt-2017-406/amt-2017-406-AC2-supplement.pdf

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