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Atmospheric Measurement Techniques Discussions

Interactive comment on "On instrumental errors and related correction strategies of ozonesondes: possible effect on calculated ozone trends for the nearby sites Uccle and De Bilt" *by* R. Van Malderen et al.

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We thank the reviewer for his/her careful and detailed review of the paper and his/her very constructive feedback. Our response to your questions, comments or suggestions can be found below, with different text formatting for **referee comments** and *author replies*.

General comments

The paper provides a lot of detail on all the different corrections employed, and Uccle employs an interesting yet unconventional method of combining the pump

correction factor and total ozone normalization, but aside from that most other corrections are familiar to other ozonesonde investigators. The detailed discussion of the differences becomes at times difficult to follow and the point of such detailed discussion gets lost at times. This difficulty is compounded by the thin lines in the figures and the difficulty in separating the blue, black, gray, and purple lines. On some figures I just had to give up trying to follow the discussion. The colors were too hard to separate even when the figure is enlarged. The authors should consider attempts to shorten such discussions to the really important points.

We moved the description of some additional corrections in the PRESTO method, usually extrapolations for the early period of BM sondes, to an appendix and the effect of the individual corrections on the average profiles and trends are not longer shown for those additional corrections. So, the attention of the reader will not be longer distracted by these less important correction steps and the figures are generally including less curves, which should enhance their readibility. We also tried to avoid using colors that are hard to distinguish in the same figure.

The main criticism that the authors do not address is what should be made of the trends when the full data records are used? For De Bilt it is tempting to just ignore the 1992-1997 record since it is not that long. This cannot be done for Uccle which extends to 1969. Yet finally when Uccle and De Bilt are really compared, apples to apples, Fig. 10, they show a rather satisfying consistency between stations. What are the trends in the vertical ozone profile which would be inferred from only the Brewer Mast record, 1969-1997? How does that compare to the trends shown 1969-2014 and 1997-2014? This would be much more interesting than comparing 1997-2014 and 1993-2014. The authors may want to consider this comment, enhance the color fidelity in the figures, and the following specific suggestions/questions in preparing the final copy for publication.

We now calculated and described the trends for three different periods: the Uccle entire time series (1969-2014), the Uccle BM time period (1969-1996), and the Uccle/De

Bilt ECC time period (1997-2014). So, we followed the reviewer's advice to replace the 1993-2014 to the 1969-1996 time period. In contrast to the previous version of the manuscript, we did not focus alone on the impact of the correction methods on the vertical trends for different periods, but we also intercompared the different trend estimations for those periods. Moreover, we compared the trends for the different periods with the vertical trends calculated from satellite and ground-based instruments in the Harris et al. 2015 paper.

Specific suggestions/questions

1.5-8. What type of sonde is used at De Bilt? This should be mentioned here.
We changed the first sentence of the abstract into "The ozonesonde stations at Uccle (Belgium) and De Bilt (Netherlands) are separated by only 175 km, but use different ozonesonde types (or different manufacturers for the same Electrochemical Concentration Cell (ECC) type), different operating procedures, and different correction strategies."

1.17. Fix,...whole the vertical...
Done.

2.1 Change to, ...throughout the whole lower atmosphere...
Done.

2.29. I do not believe that this statement is true. Thorough calibration of every ozonesonde prior to flight may be needed, but resources and personnel are seldom available to complete a thorough calibration of each disposable instrument. Rather there are routine checks of the maximum and minimum to see that the range is appropriate. Temper this statement.
We changed this into "Consequently, every ozonesonde needs to be prepared and checked thoroughly prior to launch."

2.24. Since the conversion efficiency is the largest source of error the origin of

the 3.6$\%$ should be stated.
We first mentioned explicitly how the conversion efficiency is defined: "The conversion efficiency is determined by the absorption efficiency α_{O3} of O_3 into the sensing solution and the stoichiometry $S_{O3/I2}$ of the conversion of O_3 into I_2." Then, for the uncertainty of the conversion efficiency, we wrote "Overall, the conversion efficiency is the predominant uncertainty at Uccle ($\approx 3.6\%$ or the square root of the sum of the squares of the relative uncertainties of the absorption efficiency α_{O3} and the stoichiometry $S_{O3/I2}$, which are respectively 0.02 and 0.03, see Smit et al., 2012, and the background current (BGC) has the largest influence on the overall uncertainty at the lowest O_3 concentrations in the upper troposphere."

7.7-9. If the deficit vanishes rapidly at pressures below 1000 hPa, why is a pressure dependent expression used at pressures below 100 hPa? That doesn't seem rapid. What is the composite of the conversion efficiency? The absorption efficiency has not been previously introduced. Basically these sentences do not tell the reader what was done and that should be changed to be explicit about how the conversion efficiency was adjusted.
*The pressure dependent expression is used at pressures **above** 100 hPa. We wrote more explicitly that "Therefore, for these data, the absorption efficiency α_{O3} (a component of the conversion efficiency η_c) is not longer equal to one and is processed by a pressure-dependent expression for pressures above 100 hPa, so that it equals 0.96 for 1000 hPa and 1.00 for 100 hPa."*

7.12-13. Awkward, change to ... Since at Uccle the recommended ... is only recently available, the value... Replace "former and latter" with what they are to not confuse the reader.
Done.

10.1-2. Why this sentence now, after the earlier discussion about how the background current was dealt with. What is the reader to do with this conflicting information?

This sentence has been removed.

Section 2.2.2. Now I see that this is a description of the operational methods applied at Uccle, but hasn't all of this already been published and will it be used here? I question whether all this detail is necessary for this paper.
The description of the operational methods applied at Uccle has not been published before in a peer-reviewed publication, only in a publication edited by the Royal Meteorological Institute at Uccle. It is however available from the website of the institute's homepage. However, we decided to move the description of some additional corrections in the PRESTO method, usually extrapolations for the early period of BM sondes, to an appendix. As those corrections have a large impact on the average BM ozone profile and trends in the lowermost tropospheric layers, we still want to mention them, without giving all the details on this impact.

13.25-26. It should be stated that the curve showing only the corrections due to Eq. 4 is not shown, since there is no correction shown in the Uccle profile that reaches 4%, otherwise the reader, like me, is confused and wastes way too much time trying to figure it out.
Done.

14.5-15. The percentages quoted here are at times inconsistent with the figure. For example the relative difference at burst altitude is 2% not 4%. The relative differences are not clearly smallest at the ozone maximum, which the reader, since an ozone profile is not shown, has to guess at. Please make the text consistent with the figure shown! The discussion at 16.7-9 provides a more realistic statement of the differences of these profiles.
In this figure (now Figure 7), the comparison between the Uccle and De Bilt average profiles is removed, so that the scale is smaller and the quoted percentages should be more easily read from the figure. When the vertical scale (altitude relative to the tropopause) is used for the first time (Fig 3, presenting the relative uncertainties to ozone), the average Uccle ozone profile is also included, so that the altitude of the

ozone maximum can be derived. In the text discussing this figure, it has also been mentioned that the average tropopause height at Uccle is 11 km. We nevertheless explicitly mentioned in the description of Figure 7 at which altitudes relative to the tropopause the ozone maximum can be found above Uccle or De Bilt: "The relative differences between both corrections are smallest at the surface (around 2%) and at the ozone maximum (around 2% for around 10 km above the tropopause), and largest at the tropopause (about 6%)."

14.23-25. The Uccle ozone profile is not shown in Fig. 6, so the text should not make this claim. What is shown is a difference between the average operationally corrected profiles at Uccle, with, I assume, an average of the operationally corrected profiles between 1993 and 2014 at De Bilt. Insure the text and figures are consistent.
As we decided not to compare anymore the average Uccle and De Bilt ozone profiles for the period 1993-2014, these statements have been removed from the present version of the manuscript.

14.28-30. This statement is correct, but contradicts the statement just above which states that an Uccle ozone profile is shown. Correct these inconsistencies. Why is this statement, as the beginning of this new section, harking back to a figure which has already been discussed? Awkward. What is the operational De Bilt profile? Is this an average?
As we decided not to compare anymore the average Uccle and De Bilt ozone profiles for the period 1993-2014, these statements have been removed from the present version of the manuscript.

15.1 Two different types of ozonesondes where?
The text has been adapted: "Because the Uccle data series has been built up with two different types of ozonesondes (BM and ECC) in 1993−2014 (the time interval of the De Bilt series), we make the comparison with De Bilt for each type separately."

19.28. Than at De Bilt,...
Changed.

Table 1. Why are there two switch dates for sonde type at De Bilt, when there is only one switch between sondes? Compare to the column for Uccle in the same row, and to the row below showing the different radiosonde types.
We added a footnote, explaining that "The SPC ECC 6A is in use in De Bilt since 24 July 1997, but with an interception of more than one year (30 September 1999 – 1 March 2001), when the SPC ECC 5A has been launched again." This statement was also already in the text.

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