Authors' response to the reviewers' comments (by Christodoulakis et al.)

We would like to thank referees for their fruitful reviews that helped us to improve our manuscript. We fully agree with their comments, suggestions etc and therefore we will take into account all of them in the revised version of our paper.
Below we respond to their comments:

Response to Referee #1

1) p. 1989, line 8-10. I do not agree with this statement. The stability of new instruments and satellites is validated against Dobson, but they are not calibrated. This is the reason there are differences in total ozone values measured by satellites and various ground-based systems.

We agree with the reviewer's comment and we replaced the term "calibrated" with "validated".

2) p. 1990, lines 22-27, p. 1991, lines 1-3.Please clarify the difference between listed limitations 1 and 3. The third limitation may be better defined as contribution of the spectral component of the Solar light originating outside of the band-pass of the instrument. Since the out-of-band light is not completely removed by the slits, and thus it is measured by the instrument. The dependence of this contribution on the optical path of the light (solar zenith angle and amount of ozone) creates the non-linear error in the retrieved total ozone that appears as diurnal variability in the total column ozone measurements.

We thank the reviewer for his/her valuable comment that we have incorporated into the text. Therefore, we inserted the following text:
"The first limitation refers to the angular distribution of diffused radiation. In case of sun, it is observed an intensity maximum in the area around it which is explained by the scattering function. According to this function, a maximum is observed in forward direction which leads to this intensity maximization (Kondratyev, 1969). The third limitation refers to the contribution of the spectral component of the solar light originating outside the band-pass of the instrument since the out-of-band light is not completely removed by the slits, and thus it is measured by the instrument. The dependence of this contribution on the optical path of the light (solar zenith angle and amount of ozone) creates the non-linear error in the retrieved total ozone that appears as diurnal variability in the total column ozone measurements."

3) p. 1991, lines 19-21,
Are you discussing the zenith sky measurements or direct sun measurements.

We are discussing about direct sun measurements. In order this to be more clear we inserted the following text next:

"In order to determine stray light error for Dobson No. 118 we collected a series of direct sun AD wavelength pairs measurements."
We also inserted the following text:
"It should be also noticed that stray light affects not only direct sun measurements we present here but also zenith blue measurements (Evans et al., 2009)."

4) Not sure if I understand the definition of the external scattered light.

In order to clarify the meaning of the external scattered light we revised the text at this point as follows:
"It should be stressed that this extra radiation may be due to scattering outside the instrument (external), i.e. during sun light propagation through the atmosphere (sky light error, atmospheric scattered light error) or scattering within the instrument (internal) (see point (3) and (1) in paragraph 3.4 of Scarnato et al., 2012, respectively). The external stray light includes both wavelengths which are normally measured from the instrument (homochromatic stray light) and wavelengths different from the desired ones (heterochromatic stray light) which can not be totally rejected by the instrument. Especially for the case of Dobson spectrophotometer which has a wide field of view, about 8° (Staehelin et al., 2003), this kind of stray light is important."

5) Are you suggesting that beside the direct sun light, the instrument also measures the light that is scattered in the field of view of the instrument (Dobson has relatively wide field of view)? See that this would be considered as homochromatic stray light. But then I do not understand the mechanism of the heterochromatic stray light contribution to the external stray light error. Can you provide an example?

In order to make it more clear we inserted the following text:
"The external stray light includes both wavelengths which are normally measured from the instrument (homochromatic stray light) and wavelengths different from the desired ones (heterochromatic stray light) which can not be totally rejected by the instrument. Especially for the case of Dobson spectrophotometer which has a wide field of view, about 8° (Staehelin et al., 2003), this kind of stray light is important."
In addition, Dobson spectrophotometer measurements are affected by longer wavelengths than the desired ones due to incapability of totally rejecting them. The wide field of view of Dobson is also a factor which contributes to this error. As an example: Let consider two different wavelengths A and B. Wavelength A is the unique radiation which we would like to be measured (desired) by Dobson and B the radiation which should be rejected by the instrument and not measured. Let also suppose that we have A radiation intensity 10 units and B radiation intensity 8 units. Due to scattering in the atmosphere and the wide field of view of Dobson, radiation intensities which finally enter in the instrument will be intensified (suppose that will become 11 units for A and 9 units of B). This means that the desired radiation A becomes 1 unit greater than the "original". This is the external homochromatic stray light effect. Radiation B becomes also 1 unit greater than the "original". This is the external heterochromatic stray light effect. During its "trip" within Dobson, radiation A is amplified due to internal scattering e.g radiation A intensity becomes 11.5 units. This is the internal homochromatic stray light effect. Radiation B is also experiencing a same but greater amplification due to internal scattering resulting in greater B radiation intensity (let say 10 units). This is the internal heterochromatic stray light.

6) p. 1994 – top of the page, end of the paragraph from the previous page – It would be nice to have some statement about the effectiveness of the described alternative measurement method. Was it successful or it had some limitations? I would suggest to add some words here that would explain why the method described in this paper could be a more effective (or reliable) approach for the assessment of the stray light error estimate of the TO column measurements as compared to the other method.

We revised this paragraph adding the following text:
"However, the presented results in that paper concerned stray light effect on the measurements obtained using a special technique for the estimation of ozone profile (Umkehr measurements) and not for the estimation of TOC. Before this method is introduced to Dobson network there are some problems which have to be transcended like the necessary extensive modification of the instrument, the need of experienced operator to implement this along with other specific problems described in details in Evans et al. (2009)."

7) p. 1994, line25-26." In the next step ΔX values from step 2 are added to the total ozone values from step 1. " - this is what I understood from the text. Is it correct?
However, I have difficulty in understanding results in Table 3Following step 3 I need to add TOR (which is Xtrend column from Table 3) and the respective column (i.e. 1.2) from Table 2, then I should get smaller TO value, since values in Table 2 are negative. However, I cannot reproduce Xtrue columns in Table 3.
It appears that in order to obtain value in Table 3, I need to take one single TO value (representative TOC for a day?) and then subtract values from a column in Table 2.

In order to make it more clear we revised the analytical steps and we also added some new steps in the revised version of our paper.

8) p. 1994 line 15 Results of Figure 3 are not sufficiently discussed. – It has a lot of information. Please expand discussion on how the stray light model is fitted to the data. Results seem to differ between 5 days of measurements. What might be the reason?

We have expanded the discussion of how the stray light model is fitted to the data (please see the description of the steps of our methodology in the revised version of our paper).
Regarding the reasons for the observed differences we inserted the following text:
"As can be noted by Fig. 3, the model does not succeed in describing each day's observations for a particular pair of R_0 and α. This behaviour could be interpreted by the fact that the calculated errors "are very dependent" on the model conditions, i.e. the values of the four parameters that model relies on (μ_1, μ_2, R_0 and α), the general operating conditions under which ozone measurements are made along with the lack of knowledge about the propagation of unwanted radiation within the instrument (Basher, 1982)."

9) P 1995, lines 22-23
If I try to calculate correlation between the second column and other columns in Table 3, I am getting difficulty in reproducing results in Table 4. The values in second column become smaller when airmass increases. Values in other columns are

increasing with airmass. The only way to get correlations is to subtract corresponding True ozone value from columns 3 through 7 and obtain residuals. To obtain results in Table 4 I have to correlate negative value of residuals with Xtrend from column 2.
Since there are multiple steps in the process, please take time to describe intermediate steps.

We thank reviewer for this comment. In order to be more clear, we have revised the analytical steps of our methodology accordingly, as mentioned in our previous responses.

10) p. 1996, line 26-27. In order to get score "1" in Table 7 do all three tests have to have "good" results? And the same question for score "0", or rejected condition, is it required to have "rejection" in all three tests or it is sufficient to have one test failed to get final score "0"?

We inserted the following text in order to make it more clear:
"The pairs of R_0 and α which were rejected at least at one of the statistical tests were scored with 0 while the pairs that passed all statistical tests were scored with 1."

11) p. 1997, lines 7-8 I would expect that Final scores in some lines would be 5 (5 days). Since there is no clearly defined parameters for the stray light model – what should be the conclusion? How well can such model explain stray light in the instrument?

We shall discuss it into the revised manuscript.

12) p.1997 lines 17-18. The cause for the offset between satellite and ground-based measurements can depend on various differences in the spectroscopic and other parameters used in satellite and Dobson retrievals, including aerosol interference, interference from other atmospheric absorbers, use of different spectral windows, etc. It is not just stray light that can be responsible for the mean offset.

We revised the text at this point as follows:
"These results among other reasons (different spectral windows, interference from other atmospheric absorbers, differences in the spectroscopic and other parameters used by satellite and Dobson spectrophotometer) may be partially attributed to the plausible underestimation of Dobson measurements due to stray light effect."

13) The stray light error has seasonal dependence (due to seasonal variation of TOC and thus attenuation of short wavelengths spectrum). It would benefit the paper if you add analysis of seasonal pattern in differences between Dobson #118 and individual satellites.

We revised figure 4 presenting pattern in differences between Dobson No. 118 and individual satellites. We also added a relevant discussion.

14) p.1997, lines 20-22. I am not sure what you mean by "does not suffer". Do you mean that for airmass between 1 and 2.5 instrument has small (define how much)

error on the Dobson retrieved ozone due to stray light. The stray light still is evident in the measurements when airmass is extended to larger than 2.5. However, during Dobson regular operations I assume that measurements are not taken at airmasses larger than 2.5, correct?

We revised the text as follows:
"The main conclusion drawn from the above mentioned analysis is that the Dobson spectrophotometer No. 118 has small error on the retrieved ozone due to stray light. More specifically, for the case of Athens Dobson Station which regular measurements are made for airmass values up to 2.5, a mean underestimation of 3.5 DU, or about 1% of Station's mean TOC value, is obtained."

Technical corrections:
15) p. 1988 line 21-24. Here is suggestion on re-writing the sentence "Since the first instrument was constructed, a number of instruments were placed around the world in at selected stations and that began to be used to measurements of total ozone content (TOC) on a daily basis.

We thank the reviewer for this suggestion. We made this change in the revised version of our paper.

16) p.1989, line 1 "instruments were since created, i.e. Brewers spectrophotometer, "

Done. We made this change in the revised version of our paper.

17) p. 1989, line 6, "Dobson spectrophotometer it makes"

We made the proposed change.

18) p. 1989, line 11. "all sources of errors in Dobson instrument operations"

We also made the proposed change.

19) p. 1990, line 10. Suggested change " Currently there are about 50 Dobson instruments that represent the global Dobson network. It is 100 less instruments that used to monitor total column ozone "

We made the proposed change in the revised version of our paper.

20) p. 1990, line 17-18. Suggested change "Beside these campaigns each station performs regular tests that are designed to determine whether the instrument is operating within the required limits for the accuracy and stability."

We also made this change.

21) p. 1990, line 20. "Instrumental malfunction" ... " limitations in the optical design of the instrument"

We made the proposed change in the revised version of our paper.

22) p.1992, lines 6-10. Correction of the Athen's Dobson record for the previously and newly determined stray light errors can help to adjust the long-term time series and to allow for re-calculations of trends. Is it what you were trying to say there?

Yes, this is what we are trying to say. Therefore, we revised this sentence as follows: "The combination of the new levels of stray light with the previously detected ones will enable a re-calculation of the long-term time series and the reduction of the inaccuracies of the Athens Dobson Station TOC measurements, which according to the literature (e.g Chandra et al., 1996) tracks the seasonal trends of TOC as they are estimated using averaged data of different latitudinal zones of the mid-latitudes of the Northern hemisphere."

23) p.1992, lines 9-10 comparisons to the "zonally averaged data" – is it from the model? Not clear, please add details.

No it is not from the model. We are referring here to the original measurements. In order to make it more clear we revised the text at this point. Please see our previous response.

24) p. 1993, line 21 suggested change to the text "Yet another method can be used to assess stray light contribution to Dobson measurements as described in paper by Evans et al. (2009)."

The following sentence was added in the manuscript.
"Yet another method is under development to assess stray light contribution to Dobson measurements as described in paper by Evans et al. (2009)."

25) p. 1993, line 23, please explain what you mean by "current". May be it should say " current output from photomultiplier tube"? It is also customary to use quotes when inserting text from another publication.

This text was revised as follows:
"The main idea behind this study was presented by Dobson who suggested that if the component of the electrical signal generated from photomultiplier tube due to unwanted radiation (stray light) can be measured, then the obtained measurements can be corrected using an appropriate formula (Dobson, 1968b)."

26) p.1994, line 5 replace "obtained" with "collected"? For example "In order to determine stray light error for Dobson # 118 we collected a series of the AD wavelength pair measurements. The data were collected over a large range of solar zenith angles during 5 clear-sky days in September-October of 2012. For further details see Table 1."

We thank the reviewer for this comment. We revised the text as follows:

"In order to determine stray light error for Dobson No. 118 we collected a series of direct sun AD wavelength pairs measurements. Measurements were collected over a large range of solar zenith angles during 5 clear-sky days in September-October of 2012. For further details see Table 1."

27) P, 1994, line 8-10 "Results of the experiment are summarized in Figure 2. The theoretically estimated errors (eq. 2) are plotted as function of airmass. Results vary based on the selected values of R0 and alfa.

We thank the reviewer for this comment. We revised the text as follows:
"Results of the experiment are summarized in Figure 2. The theoretically estimated errors (eq. 2) are plotted as function of airmass. Results vary based on the selected values of R_0 and α."

28) p. 1994 ,lines 10-12 DO you mean that when R0 becomes small, the errors tend to become small, close to zero?

In order to be more clear we revised the text as follows:
"It is obvious from these figures that as R_0 reduces, all the curves (i.e. ΔX error values) tend to zero, even in the case of large α."

29) P, 1994 line 12 – able -> capable

The proposed change was made in the revised version of our paper.

30) P, 1994, line 15 Suggested change "Total column ozone data reduced from AD-pair measurements are plotted as function of airmass, separately for 5 days (Fig 3). Observations are compared with the theoretical stray light model results. Model parameters are provided in each panel legend."

The proposed change was made in the revised version of our paper.

31) p. 1994, line 22-24. …Basher's model (see Eq. 2)…
Suggested text: " Table 2 shows ΔX values as function of airmass (μ) and α. Results are based on the Eq. 2. The best fit to the observations taken on September 5, 2012 is tested by selecting one fixed R0=10-3.5 and by varying α values"

We thank the reviewer for this valuable comment. As mentioned in our previous response we revised the analytical steps of our methodology. We also revised this point (mentioned by the reviewer) accordingly.

32) p. 1995, line 4-5. Suggested change to the text:" The average of the Xtrue is calculated for each column in Table 2. These averages are termed as "true Ozone Value" and are shown at the bottom of the Table 3."

We thank the reviewer for this valuable comment. As mentioned in our previous response we revised the analytical steps of our methodology. We also revised this point (mentioned by the reviewer) accordingly.

33) p. 1995, line 23-25 –suggested change to the text: "Table 4 shows correlation coefficients for all stray-light models that were tested to fit observations on September 5, 2012."

We made this change in the revised version of our paper.

34) p. 1996, line 7 replace "from" by "than"

The proposed change was made.

35) p. 1996, line 8 suggested change: "Table 5 provides all RMSD values calculated for difference between the model and observed data.

We thank the reviewer for this comment. We made the suggested change in the revised version of our paper.

Response to Referee #2

1) Authors need more justification for the statistical approaches used in this study. They narrow down the candidate parameter sets for the smaller root mean square difference (RMSD) and chi square, which assumes the (stray-light-affected) measured TOCs and the "true" TOCs should not have large differences. However, as shown in the Fig. 2 and 3, stray light may cause huge differences depending on the characteristics of instruments, observation geometry and air masses. By this approach, the selection of parameters may be inclined to those cause small effects, no matter what the reality is. Moreover, authors use Pearson's correlation coefficient to assess the quality of the candidate parameter sets, which works only if Xtrend and Xtrue are linear. Again, shown in Fig. 2 and 3., I am not sure if they will be linear. I would like to see more justification for their statistical approach.

We fully agree with the comment of the reviewer. That is why we have employed several statistical tools. Nevertheless, the data intervals used for the comparison appear to have quasi-linear behaviour. More details are going to be discussed in the revised version of manuscript.

2) The "True Ozone Value" in the bottom line are from correction using the final R0 and α values that the authors finally obtained. Although it is in the main text, it would be better to be specified in the figure caption as well.

We changed the caption of figure 3 according to this comment and the revised caption is as follows:

"Figure 3. Comparison of experimental data (black dots) with stray light model applied for two different sets of parameters R_0 and α (solid lines) along with the corresponding True Ozone Values (dashed lines). Empty dots, red and black, represent the corrected measurements using the values R_0=$10^{-3.6}$, α=0.7 and R_0=$10^{-3.8}$, α=0.9, respectively. The presented pairs of R_0, α and the corresponding True Ozone Value have been picked out by the final obtained results. (a) 5 September 2012, (b) 24 September 2012, (c) 29 September 2012, (d) 30 September 2012 and (e) 31 October 2012. Model was executed for values of airmass μ_1=1.0 and μ_2=2.5."

3) Figure 3 shows theoretical TOCs (true and stray-light-affected) and actual measured (stray-light-affected) TOCs. I suggest the authors to show the "corrected" version of their measurements either in the Figure 3 or in and additional figure, which will give the readers a better idea how much the correction has improved the measurements.

We revised figure 3 adding the "corrected" version of our measurements for the case of R_0 and α values that already presented. We also changed the figure's caption accordingly and we added in Page 1994, line 17 the following sentence:
"In the same figure are also presented the corrected measurements for the case of R_0 and α values already presented."

4) The authors show the inter-comparison between their Dobson measurements and various satellite measurements. Although Dobson and satellite measurements show similar value and trend, it might be very hard for readers to distinguish among the lines. I suggest authors to bin the measurements into some time period bin (possibly a week or a month, or a season) that reduces the noisy behaviors of TOC while still showing seasonal and inter-annual trends well. Plus, showing the comparison of stray-light corrected measurements to the satellite measurements as well as how much the stray light correction has improved the comparison (now it's good place to use Pearson's R) will be a good support of the results of this study.

We replaced the initial figure 4 presenting the daily values of Dobson No.118 and satellite observations with the new figure 4a which presents seasonal mean values of measurements obtained by these instruments. We also added figure 4b which presents the ratios of Dobson raw and corrected seasonal mean values to OMI seasonal mean values for the period 2013-2014 indicatively. By applying Pearson's R the correlation coefficients between the corrected daily TOC values and satellite data are slightly higher (0.91926 and 0.91918 for the case of R_0=$10^{-3.8}$, α=0.9 and R_0=$10^{-3.6}$, α=0.7, respectively) than the one obtained using the raw TOC values (0.91909).

Response to Referee #3

1) In the study you only focus on AD pair observations up to airmass 5 as we can see on figure 3, but the measurement of this pair is not recommended for air masses over 3 then CD pair is used. The CD pair measurement is the recommended measurement for high airmass when the stray light error becomes important as it use longer wavelengths is less affected for the stray light. The comparison of AD and CD

corrected for the known effect of the ozone cross section can give an additional information of the stray-light. (see for example the Figure 9 McPetters et all 2008).

We fully agree with the reviewer's statement that the appropriate pair for observations made for air masses over 3 is CD. However, we can not present a comparison between AD and CD measurements because we perform measurements using only AD pair. Therefore, we will take it into account in our future work on the field.

2) The stay light in Dobson and Brewer are usually shown against the Ozone Slant Column (ozone x airmass) rather than air mass (see for example Evans 2009, Scarnato et all 2012 for example) as the radiation level of short wave-lengths depends heavily of this parameter and they are more affected by the stray light. A plot of the Dobson AD/CD observations during a year averaged on OSC ranges could be illustrative of the stray light effect for AD and CD measurements.

We thank the reviewer for this valuable comment. We present stray light effect against air mass because this parameter (air mass) is involved in Basher's model that we use for this study. In addition, as we mentioned in previous response, we do not perform CD measurements so we can not present the suggested plot. Therefore, we can present such a plot in a future work after we collect a series of CD measurements.

3) For this experiment is clear that the method requires good measurement conditions to get Direct sun measurements along wide range of airmass. But my question is if the method requires and stable ozone?.

According to Basher (1982) is not clear if a stable ozone amount during the experiment is required. However, the diurnal variation of total ozone is about 1% (Sakazaki et al., 2013).

4) I'm also note during the selected days that the ozone goes down with airmass near to 1, do you have an explanation for that ?

We shall give relevant clarification in the revised version of manuscript.

5) On the abstract the authors say that the effect is insignificant but in the last section that the application of the Basher model gives an underestimation of 3.5 DU using the ≈ 1%. The abstract or the last section must to be changed accordingly.

We changed the abstract according to reviewer's instructions. Specifically, the following sentence replaced the initial one in page 1988, line 7.
"The results obtained indicate that Athens Dobson Station instrument, which measurements are made for airmass values up to 2.5, underestimates total ozone content by 3.5DU in average, or about 1% of Station's mean TOC."

6) The attribution to the difference between Dobson and Satellites to the stray-light in the short airmass ranges (up to 2.5) is not justified, as the stray light effect is proportional to the airmass could be illustrative if this differences are plotted against the airmass or to the ozone slant column.

We fully agree with reviewer's comment so we inserted an analysis of seasonal pattern in differences between Dobson No. 118 and individual satellites in figure 4. See also our response to the last comment.

1 Comments

7) p 1990 20
Is not clear the difference between sky light error, and atmospheric scattered error , the causes of the stray

We inserted the following text in the revised version of our paper:
"The first limitation refers to the angular distribution of diffused radiation. In case of sun, it is observed an intensity maximum in the area around it which is explained by the scattering function. According to this function, a maximum is observed in forward direction which leads to this intensity maximization (Kondratyev, 1969). The third limitation refers to the contribution of the spectral component of the solar light originating outside the band-pass of the instrument since the out-of-band light is not completely removed by the slits, and thus it is measured by the instrument. The dependence of this contribution on the optical path of the light (solar zenith angle and amount of ozone) creates the non-linear error in the retrieved total ozone that appears as diurnal variability in the total column ozone measurements."

8) p 1989 10
The Dobson is a reference instrument for TOC but i'm not agree that is "the reference instrument", Brewer spectrometer and DOAS instrument are also used for satellite validation, and not calibration, and both maintains independent scales.

We agree with the reviewer's comment and we made the following changes:
Page 1989, line 6: "the reference instrument" was changed to "a reference instrument"
Page 1989, line 9: "TOC measurements is calibrated" was changed to "TOC measurements is validated"

9) p 1990 10
During the calibration campaigns the instrument are characterized and the calibration is transferred from the reference instrument (primary or secondary standard).

We revised the text in page 1990, line 15 as follows:
"The goals are to evaluate the performance of a particular Dobson instrument against the reference one and to transfer the calibration level of the reference instrument to the examined one"

10) p 1990 l 20-30
Is not clear the difference between sky light error, and atmospheric scattered error , witch are his effects on the ozone measurement and how are related to the stray light.

Regarding the first part of the comment please see our previous response.
Regarding the ozone measurements and the relation with stray light we revised the text as follows:
"The term stray light describes the part of the radiation in a beam, which was not part of it from the beginning, but has contaminated it due to scattering. It should be

stressed that this extra radiation may be due to scattering outside the instrument (external), i.e. during sun light propagation through the atmosphere (sky light error, atmospheric scattered light error) or scattering within the instrument (internal) (see point (3) and (1) in paragraph 3.4 of Scarnato et al., 2012, respectively)."

11) p1991 l 19
Is not clear de descriptions of the internal and external stray light and difficult to compare with other descriptions like Scarnato 2012.

We revised the text at this point in order the meaning of external and internal stray light to be clearer as follows:
"The term stray light describes the part of the radiation in a beam, which was not part of it from the beginning, but has contaminated it due to scattering. It should be stressed that this extra radiation may be due to scattering outside the instrument (external), i.e. during sun light propagation through the atmosphere (sky light error, atmospheric scattered light error) (see point (3) in paragraph 3.4 of Scarnato et al., 2012) or scattering within the instrument (internal) (see point (1) in paragraph 3.4 of Scarnato et al., 2012)."

12) p1997 l 10
The figure 4 will be more illustrative if the ratio is shown of the satellites ozone retrieval with the corrected an uncorrected stray light from Dobson measurements. Will also be interesting to see if the correction will affect to the possible seasonality of the differences.

We replaced the initial figure 4 presenting the daily values of Dobson No.118 and satellite observations with the new figure 4a which presents seasonal mean values of measurements obtained by these instruments. We also added figure 4b which presents the ratios of Dobson raw and corrected seasonal mean values to OMI seasonal mean values for the period 2013-2014 indicatively.

We also inserted the following text:
"the seasonal differences obtained are smaller for the periods March, April, May (MAM), June, July, August (JJA) and September, October, November (SON) and slightly higher for the period December, January, February (DJF)."

We also inserted the following references

McPeters, R., Kroon, M., Labow, G., Brinksma, E., Balis, D., Petropavlovskikh, I., .& Levelt, P. F. (2008). Validation of the AURA Ozone Monitoring Instrument total column ozone product. Journal of Geophysical Research: Atmospheres (19842012), 113(D15).
Scarnato, B., Staehelin, J., Peter, T., Grbner, J., & Stbi, R. (2009). Temperature and slant path e_ects in Dobson and Brewer total ozone measurements. Journal of Geophysical Research: Atmospheres (19842012), 114(D24).
Bernhard, G., Booth, C.R. and McPeters, R.D. (2003). Calculation of total column ozone from global UV spectra at high latitudes. Journal of Geophysical Research 108: doi: 10.1029/2003JD003450. issn: 0148-0227.