

Manuscript for AMT:

Aerosol optical depth determination in the UV using a four-channel precision filter radiometer

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Responses to Anonymous Referee #3

(Reviewer comments in *italic.*)

General comments

1. *Please make sure that you explain all the acronyms/abbreviations the first time they are used in the text.*
Manuscript has been corrected so that acronyms and abbreviations are explained at their first appearance.
2. *Some of the equations could do with a bit more explanation on the used terms.*
Explanations of terms in equations have been improved.

Scientific comments

Page 1-2, Introduction: The terms UV and UVB are not always used consistently in the introduction. I would also specify the wavelength range of UVA and UVB somewhere in the text.

UVA and UVB have been specified in the Introduction. Introduction has partly been rewritten.

Page 1, line 28: You write in line 28 that the 'absorption' of surface UV by aerosols has become of major interest because of the harmful effects on UV on humans and the biosphere. I would suggest to write 'extinction' as aerosols can also scatter UV radiation hence increasing UV levels which also has implications for human health.

Suggested correction has been taken into account in the revision of the Introduction.

Page 5, Eq. 2 and 3: please specify the meaning of the different terms in these equations. Also, R is said to be the actual Sun-Earth distance, but R is also used as a subscript referring to Rayleigh airmass and optical depth. Maybe you could use 'r' for Rayleigh instead of 'R'?

Explanation of terms in the equations has been improved. Rayleigh scattering terms are indicated by 'r' in revised manuscript.

Page 6, line 28: Where do the values for the Angstrom parameters come from?

Justification for the used Ångström parameters has been added.

Page 8, Eq. (5): (In revised manuscript Eq. 7.) should it not be $\ln(V(\lambda)R^2)$ instead of $\ln(V(\lambda))$ and $\ln(V(0, \lambda))$ instead of $\ln(R^2V(0, \lambda))$?

Suggested correction has been applied. Thanks!

Page 8, Eq. (6): (In revised manuscript Eq. 8.) p/p_0 enters the Rayleigh scattering part. But then $\delta(R, \lambda)$ represents the Rayleigh scattering coefficient and not the Rayleigh optical depth.

Good point. p/p_0 has been removed from the equation, and text has been adjusted.

Page 9, line 7: Should this not be equation 6 instead of 5?

Yes. Error corrected. (It is Eq. 8 in revised manuscript.)

Page 9, Eq. (8): why is there no term for the NO₂ and SO₂ airmasses m_N and m_S ? (for ozone, Rayleigh and aerosol, you specify an uncertainty for both the optical depth and the airmasses separately.) Is it because they are assumed to be very small in comparison to the other terms?

Uncertainty terms for the NO₂ and SO₂ air masses have been added to Eq. 10 (former Eq. 8). As indicated by the Referee they are however considered small enough to be neglected. Text justifying this has been added in the solar position and air mass uncertainty section (3.4.6.).

Page 10-11, section 4.2: (Section 3.4.2 in the revised manuscript.) For me it is not always clear how you obtain the actual values of the uncertainties of the contributing factors. For instance, for the first factor (the spread in the Langley Plots), you explain that you assume a triangular distribution for the V₀s and take values close to the max and min of the individual V₀s as limits and then determine the uncertainty which is $[2.2 \ 1.3 \ 1.7 \ 1.1]/6^{1/2}$ %. How do you determine/chose the values used as 'close to the max and min'? Also, if possible, it would be nice if you could clarify this with a figure. Could you maybe clarify the entire paragraph a bit more to make it more understandable for readers who are not so familiar with uncertainty analysis calculations and the statistics behind it?

A figure of V₀ distribution has been added. Attempt has been made to clarify the text regarding the estimation of V₀ uncertainty (old Sect 4.2, new Sect 3.4.2).

Page 11, section 4.3: The suggestion to include a formula for the calculation of Rayleigh optical depth uncertainty has been adopted.

Page 13, for ozone airmass, you take into account the contribution of assuming an incorrect effective ozone altitude. If I understand correctly, you did not take this (an incorrect altitude for Rayleigh) into account for the uncertainty calculation of Rayleigh airmass. Why not? Is it included in the uncertainty due to algorithm uncertainty?

It is a good point that a discussion about the effect of different atmospheric conditions on m_r (relative optical air mass for Rayleigh scattering) was missing. It was already included in $u(m_r)$. Now also explaining text has been added.

Page 14, line 24: Justification for the use of the chosen values on α and β have been added to the text.

Table 2: are the values between brackets not the standard error of the mean V₀ (instead of the standard deviation)?

The notation recommended by the GUM (2008) is followed here.

<http://www.bipm.org/en/publications/guides/gum.html>

In annex B, section B.2.17 "experimental standard deviation" and "experimental standard deviation of the mean" are defined. In Note 3, the notation "standard error of the mean" is stated to be incorrect. As far as we have understood, we are referring to the "experimental standard deviation of the mean", as noted in Sect. 2.2 (Sect. 3.1 in the revised manuscript).

Technical corrections

Page 1, line 11: "UVPFR" explanation added.

Page 1, line 14: Suggested correction applied.

Page 1, line 22: Suggested correction applied.

Page 1, line 28: The term UV is already used in the abstract, I would move the explanation 'ultraviolet (UV)' to the abstract.

Explanation of "UV" moved to abstract.

Page 2, line 6: The first paragraphs of the Introduction have been rewritten and the comment does not apply anymore.

Page 2, line 8-10: Suggested correction applied.

Page 2, line 11: Suggested correction applied.

Page 2, line 14: Suggested correction applied.

Page 2, line 17: Suggested correction applied.

Page 2, line 17 (2): Suggested correction applied.

Page 2, line 19: Suggested correction applied.

Page 2, line 24: Suggested correction applied.

Page 2, line 26: Suggested correction applied.

Page 2, line 26(2): Suggested correction applied.

Page 2, line 27: Suggested correction applied.

Page 2, line 27(2): Suggested correction applied.

Page 3, line 4: Explanation of "PMOD/WRC" has been moved to where it is first used.

Page 3, lines 12-13: Suggested correction applied.

Page 3, line 17: Suggested correction applied.

Page 4, lines 2-5: Suggested corrections applied.

Page 4, line 11: Abbreviation explained.

Page 4, line 15: Suggested correction applied.

Page 4, line 20: Suggested correction applied (combined with suggestion from Referee #2)

Page 5, line 1: Suggested correction applied.

Page 5, line 1(2): Sentence rewritten, only in a slightly different way than suggested.

Page 5, line 2: Suggested correction applied.

Page 5, line 10: Suggested correction applied.

Page 5, line 16: Suggested correction applied.

Page 6, line 5: the percentage for the longest wavelength (0.44%) is not in agreement with the value in table 2 (0.42%).

0.44 % is the correct value, Table 2 has been corrected.

Page 6, line 10: Suggested correction applied.

Page 6, line 17: "VIS" and "NIR" are now specified in the Introduction.

Page 6, line 17(2): Suggested correction applied.

Page 7, line 3: Suggested correction applied.

Page 7, line 4: Suggested correction applied.

Page 8, lines 4-6: Suggested correction applied.

Page 8, line 28: Suggested correction applied.

Page 9, line 6: Suggested correction applied.

Page 10, line 27: Suggested correction applied.

Page 10, lines 28-30: Suggested correction applied.

Page 11, line 11: Should there be '%' after the values?

Yes, "%" is added.

Page 12, line 7: Suggested correction applied.

Page 13, line 4: Reference Zerefos et al. 2016 is not yet in your list of references. And I guess you referred to the discussion paper? You can change this to Zerefos et al. 2017 as the paper is now officially published in ACP.

Zerefos et al. 2017 is now referred to in the text and is now listed in the References.

Page 13, lines 10-11: Suggested correction partly applied.

Page 15, line 5: Suggested correction applied.

Page 15, lines 26-27: Suggested correction applied.

Page 16, line 4: Phrasing changed to "To be more specific, ...".

Page 16, lines 13-15: Suggested correction applied.

Page 17, line 2: Suggested correction applied.

Page 17, line 3: Suggested correction applied.

Page 17, line 12-14: Suggested correction applied.

Page 17, line 14: Suggested correction applied.

Page 17, line 24: Suggested correction applied.

Page 18, line 3: Suggested correction applied.

Table 1 – Caption: Suggested correction applied.

Figure 1 – Caption: Suggested correction applied.

Figure 3 – Caption: Suggested correction applied.