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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Restoring the top-of-atmosphere reflectance during solar eclipses: a proof of concept with the UV Absorbing Aerosol Index measured by TROPOMI" *by* Victor Trees et al.

Anonymous Referee #2

Received and published: 29 December 2020

The paper describes a method to correct TROPOMI/S5P observations during solar eclipses. The shadow of the moon reduces the incident irradiance. In the derivation of reflectances from this observations the irradiance of non-eclipse conditions is used, therefore these reflectances are wrong and retrieval algorithms using these reflectances yield wrong results. Therefore observations during eclipses are currently not used for further analysis. The observations can be corrected quite easily by using the reduced incident irradiance to derive the reflectance. Consistently with other studies, it is shown that in order to compute the reduced irradiance it is important to take

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into account the solar limb darkening. The authors derived such a correction method and apply it to the derivation of the aerosol absorption index. Using the corrected reflectances they obtain reasonable results also during the eclipse which are consisted with observations derived in non-eclipse conditions. Satellite based aerosol and trace gas measurements my reveal interesting effects of the solar eclipse on the composition of the atmosphere, however this is not investigated in the study. The paper is generally well written in good English and the number of figures is appropriate. I recommend publication in ACP after some revisions as suggested in my comments below.

General comments:

- In the paper the method to correct observations during solar eclipses is described. It is mentioned in the introduction that corrected observations can be used to study effects of the solar eclipse on atmospheric composition. I suggest to include such a study, this would increase the scientific relevance of the paper significantly.

- Motivate, why it is interesting to study solar eclipses and their effects on atmospheric composition. In the abstract it is written that it is "may be of particular interest", this sounds as if the authors do not know themselves whether it is really interesting ...

- How important is this correction method? How frequently are the observations disturbed by solar eclipses?

Specific comments:

l.1 "Solar eclipses reduce the measured top-of-atmosphere (TOA) reflectances as derived by Earth observation satellites, because the solar irradiance that is used to compute these reflectances is commonly measured before the start of the eclipse." -> This sentence in the beginning is a little confusing, rephrase? First mention that solar irradiance is reduced in moon shadow. Then mention, that normalized quantity "reflectance" should not be affected when reduced irradiance is used for normalization and write that this is not yet done in the operational processing of the data ...

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l.12 "in a maximum Moon shadow signature in the AAI of 6.7 points increase" -> what is a "point"?

l.206: "We provide the recipe for the computation of X ... "-> Have you compared your derivation to that presented in Ockenfuss et al. 2020?

l.287: "The maximum underestimation of f0 at 380 nm, when using $\Gamma = 1$, was 0.06 at 6.04°N latitude and 107.19°E longitude." -> What is the maximum underestimation when limb darkening is taken into account ...

l.318: "The negative mean AAI are partly caused by the scattering of cloud droplets, but also due to a radiometric calibration offset and degradation in the TROPOMI irradiance data ..." -> Please explain: 1. Why is AII negative for cloud scattering, 2. Why is there a radiometric calibration offset, 3. Why is there a degradation in the TROPOMI irradiance data

Fig.16: I have a general question about the interpretation AII. It seems that in the figure most higher values of AII are not due to aerosols but due to clouds and sunglint? Also values seem to be higher towards the edges of the orbit, are these AII values correct? Can you indicate an area in the figure which clearly shows an increased AII due to the presence of aerosol?

l.385: "at 36°-42°N latitude and 78°-86°E longitude" -> could you mark this region in Fig.20?

l.440: "Hence, the solar irradiance correction of this paper could be used to potentially prove that the yellow and orange colors in satellite images are indeed caused by solar limb darkening." -> Can you try this and include a corrected image? This should not be much work?

Technical corrections:

l.17: "can be used to detect real AAI rising phenomena ... " -> "can be used to detect real AAI rising phenomena during a solar eclipse ... "

l.90: "and on phi-phi0" -> mention that if 3D effects matter the absolute azimuth angles need to be taken into account

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