

Atmos. Chem. Phys. Discuss., author comment AC2
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Reply on RC2

Jay Herman et al.

Author comment on "Measurement Report: Observed Increase in Southern Hemisphere Reflected Energy from Clouds During December 2020 and 2021" by Jay Herman et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2022-481-AC2>, 2023

- Make the scientific questions clear. The goals of the study that are stated in the introduction are not related with the final conclusions. An apparent increased in back reflection observed by EPIC was anticipated in 2020 and 2021 as it is stated in the introduction and a correction for the changing orbit in 2020-2021 has been applied as it is stated in the last sentence of the introduction and in section 2. So, the performance of the correction is tested compare to previous years? And the changes of the corrected values of 2020-2021 compared to previous years are explained by changes in cloud cover?

As now more clearly stated in the paper, the differences in cloud reflected energy still appear after the correction for changing observing area is 2020 and 2021 compared to previous years. The change is associated with small SEV angles.

- Try to clarify and put the scientific questions and the related conclusions into perspective and discuss the importance of the results for the community. Studies dealing with changes in cloudiness are of great importance for climate and for the solar energy sector too.

The key here is that the annual integral of cloud reflected energy at 388 nm was almost constant as stated in the paper even though there was a summer increase at Southern latitudes.

- From my point of view, the main dataset was EPIC measurements, and the OMPS-NM were used additionally for supporting the EPIC results and only for SH. So, make also clear the scientific question being addressed using the OMPS-NM data.

I have further addressed this problem

4) The manuscript is hard to follow and essential parts of the analysis are unclear due to

this. I suggest the following changes:

- use different sections for data and methods.

Hopefully, the new version has fixed this

- in methods, it was hard to follow the equations presented. I suggest to explain step by step the equations, by explaining every symbol (not all symbols were explained e.g. L_{ER} or G_i) when they first appear. A figure illustrating the problem geometry it would be also helpful.

The figure for this is pretty standard, namely the area of a spherical cap. I just took the difference between two spherical caps, which gives the area of a latitude band.

2) Specific comments

Lines 24: My opinion is that it is missing from the abstract a link explain why enhanced backscatter effects are anticipated for backscatter angles $\sim 178^\circ$ for 2020 and 2021 and this "problem" first appears in line 31. The relevant discussion is provided by the authors in the introduction (lines 45-51), but I think that it would be helpful to better understand the concluded remarks if a relevant sentence included in the abstract too.

I have added text to the abstract. "The non-repeating tilted Lissajous orbit about L_1 has time varying backscatter angles B_A in the Earth's atmosphere that varied between 176° to 174° during 2015 to 2019 and increased to B_A near 178° in 2020 and 2021. Previous studies have shown that backscattering from the Earth's surface in the visible and near infrared wavelengths increases at high backscatter angles."

Lines 52-59: If I understand correctly the goal of the study wasn't to compare (line 55) EPIC and OMPS-NM data, but to use OMPS-NM data to support EPIC results. Please clarify better and also in this paragraph only 388nm are given, while OMPS data correspond to different wavelengths.

Reference to the different wavelength for OMPS-NM has been added and a sentence added, "This paper uses the 380 ± 0.55 nm L_{ER} data from the downward looking spatial mapper OMPS-NM to validate the observations from EPIC."

Lines 82-83: In previous paragraph (lines 78-80) it is stated that the observed UV reflectivity comes mostly from clouds. Please, try not to repeat and be consistent with previous statements.

Fixed

Lines 115-116: I strongly recommend here to explain in more detail the correction applied and move equation given in lines 167-168 and 174 here. **Fixed**

Lines 117-119: I miss here the connection to the EPIC measurements. The EPIC measured backscatter UV radiances at 388nm are converted to L_{ER} as mentioned in the abstract, but nowhere up to now in the main text this description is given and for the first time appeared in eq (5) with a different symbol L_{ER} without explanation.

Typo: It should all be L_{ER}

The following has been added in the introduction: "Measured backscattered UV radiances at 388 ± 1.5 nm are converted to Lambert Equivalent Reflectivity (L_{ER}) as a function of latitude, longitude, and time (Herman et al. 2018a)."

Lines 123-129: I cannot see an obvious increase in P_{SE} in Fig 1. Also, is there any comment for the gap for the last ~6months of 2019?

The increase in the global average is small compared to that in the SH because the NH decrease cancels a portion of the SH increase.

The global percent reflected energy P_{SE} appears to slightly increase during December 2020 ($SEV = 1.95^\circ$) (Table 1) compared to the average from previous years (2015-2019) when the SEV angles are larger (Fig.1). The effect during the summer is larger at southern latitudes and decreased during summer (June) at northern latitudes. Sections 2.1 (SH) and 2.2 (NH) will show which latitude bands contribute to the change in reflected energy during 2020 – 2021 when the SEV angles are smallest.

Yes. Failure of the gyroscopes in June 2019 that were replaced with a star tracker and gas-jet propulsion. Normal operation was resumed in February 2020. The explanation is now in the text.

Lines 125-126: see 3rd specific comment

Lines 151-157: This description is for Fig 4 and not 3

Fixed

Lines 158-164: This paragraph fits better after the description of fig 4

Moved

Line 174: R_A or A_C the correction? And 2019 and not 2018? **R_A . A_C has been removed**

$R_A = \text{Area in 2020} / \langle \text{Area 2015-2019} \rangle,$ (10)
where $\langle \dots \rangle$ denotes average

The correction is R_A the ratio of the area viewed when SEV is small compared to when SEV was larger 4 – 6 degrees.

Line 180: Is Fig4 smoothed like Fig 1B? **Not smoothed to that extent. It is a weekly average as described in the text and now specified in the caption**

Line 234: There is no blue curve at fig 11.

In Fig.5 the monthly averages are June to June starting in June 2015 and ending in June 2019. The blue curve is June 2018 to June 2019. The data then starts again in June 2020 to June 2021. In Figure 11, they are December 2015 to December 2018. The blue curve would have been December 2018 to December 2019 but the period July 2019 to February 2020 is missing data. Fig 11 data starts again in December 2020 through December 2021.

I changed to figure caption to read "Fig. 11 Monthly average of NH annual time series of percent reflected energy at 388 ± 1.5 nm for 4 years, 2015 – 2021. The period 2018-2019 is not shown since the data are missing starting on 28 June 2019 to February 2020."

3) Technical corrections

Line 19: R_{SE} corresponds to reflected energy for different wavelengths, so please change the sentence accordingly. **For this paper, R_{SE} applies only to 388 ± 1.5 nm**

Line 78: TOA acronym is introduced here, please put it inside parenthesis and in general check acronym throughout the manuscript. **(TOA) done**

Line 85: OMPS-NM instead of OMPS **Fixed**

Line 86: B_A first appears in main text, please explain symbol **Done**

Line 99: OMPS-NM instead of NPP-NM **Fixed**

Figure 1: The y-axis doesn't have P_{SE} label **Fixed**

Figure 2: Please correct y-axis, $P(t)$, $\Delta\theta$ **Should be P_{SE} (Percent)**

Figure 3: Remove the second "The ratio" from the beginning of the legend. Additionally, it is 2019 and not 2019? The same for fig 9. **Fixed and now references Eq. 10.**

Figure 4: please replace "energy in the P_{SE} " with energy PSE in the and correct y-axis, the same in fig 8. **Fixed**

Figure 5: Please correct y-axis, red line is for 2016-2017? **Fixed**

Figure 6: Please use the same color for lines and legends, here make Dec 2020 the same color with line. Additionally, is it 2018 or 2019? **Fixed, and it is 2018, since December 2019 is missing**

Figure 7: Please correct y-axis. **Fixed**

Table 2: 2018 or 2019? Also, Latitude in degrees. **<2015 – 2018> degrees fixed**

Line 249: in Fig 10 instead of 11. **Fixed**

Line 259: OMPS-NM instead of OMI-NM **Fixed**

Please also note the supplement to this comment:

<https://acp.copernicus.org/preprints/acp-2022-481/acp-2022-481-AC2-supplement.zip>