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Discussions

Interactive comment on "Reduction in Earth Reflected Radiance during the Eclipse of 21 August 2017" *by* Jay Herman et al.

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The authors use DSCOVR/EPIC observations from 21st August 2017, which were taken in the Lagrange-1 point, to estimate the reduction of Earth reflected solar radiance during the solar eclipse. They compare images from the day before and the day after the eclipse and find a reduction of about 9.7% for a particular location (Casper, Wyoming). They find similar results for absorbing and non-absorbing channels, thus they conclude that the reflected energy is dominated by radiation reflected by clouds with a significant contribution of Rayleigh scattering at the shorter wavelengths. Further, for two locations, they have calculated the reduction of reflected radiance in the totality region and they found, that it highly depends on the cloud cover. When clouds are present, the reduction is much less than without clouds.

Since this is to my knowledge the first estimate of the reduction of the reflected radiance

from space, the result is interesting and it should be published.

However, before publication in AMT, the paper needs to be revised and some figures could be improved (see below).

General comments:

1. In the abstract and also later in the text (l. 237 ff, l. 366 ff), the observations are compared to modelling results by Emde and Mayer, 2007: "A previously published clear-sky model (Emde and Mayer, 2007) shows results for a nearly overhead eclipse had R_{EN} (340nm)=1.7×10^4 compared to the maximum measured non-averaged R_{EN} (340) at Casper of 515 ± 27 with optically thin clouds under similar geometrical conditions." Such a quantitative comparison is not possible, because the modelling result refers to the reduction of global irradiance (measured from the surface) in the center of the umbral shadow. This is a different quantity and the observation geometry is completely different, thus it is not surprising that the results do not agree to the DISCOVR observations. For a quantitative comparison, the 3D radiative transfer model needs a completely different setup, one has to model the reflected radiance for the specific observation geometry of DISCOVR (with a phase angle of about 172°). This should be possible using a Monte Carlo code like MYSTIC used by Emde and Mayer, 2007, but as said before, it requires a completely different setup. It can be mentioned in the text, that it would be interesting to model the observations with 3D RT models, but quantitative comparisons should be removed from abstract, text and summary.

2. Why is the global reduction of the reflectance (Section 3.2) only calculated for Casper and not for Columbia. It would be interesting to see, how much the reduction of global reflectance depends on the location of the clouds. Please include results for Columbia in Section 3.2.

3. Could the DISCOVR data, which is used for the study, added as supplementary data to the paper in addition to the provided links?

Specific comments:

l.1 "Sunlit" -> "sunlit"

l. 16: "A reduction of 9.7±1.7% in the radiance (387 to 781 nm) reflected from the Earth towards L1 was obtained..." -> Please clarify that this is the spectrally integrated global reflectance.

l. 25ff:"A previously published ..." -> remove this sentence from abstract (see above).

l.45 "earth" -> "Earth"

l. 55: "The totality region (umbra) is about 250 to 267 km in diameter, ..." -> in line 151 it is said that the totality shadow is 116 km wide over Caspar. How do these numbers match? In l. 151ff both axes of the umbral shadow should be provided for both locations (Caspar and Columbia). On which parameters does the size of the shadow depend apart from solar zenith angle? The distances Sun-Earth, Moon-Earth also determine the extent of the shadow.

l. 60ff: The overview paper of Gerasopoulos et al., 2008 is cited and it is said that it would include MODIS observations of the eclipse from 2006 over Europe. This is not correct, the paper includes a MODIS image from the same day (taken before eclipse) to show the cloud formation over Greece.

l.66ff: "A 3D Monte Carlo radiative transfer study (Emde and Mayer, 2007) was applied to the geometry for the nearly overhead total eclipse of 29 March 2006 (13:20 local time in Turkey), but without the effect of clouds included in the calculation. Successful modelling of an eclipse under realistic conditions is the first step to improved modelling ..." -> The modelling was realistic for the given observation over Greece, because the region was cloud-free. A comparison to observations showed an excellent agreement (see Kadzantzidis et al. 2007, https://www.atmos-chem-phys.net/7/5959/2007/). Of course, clouds need to be included when present. Please clarify this sentence.

l. 71ff: "The observations from the DSCOVR satellite are part of a larger project that

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combines simultaneously obtained satellite and ground-based measurements using a pyranometer (Ji and Tsay, 2000) and the Pandora Spectrometer Instrument (Herman et al., 2009) at both sites." -> Is this data available?

l. 75: "This study presents the only synoptic satellite data of the sunlit Earth ever obtained during an eclipse ..." -> What about images from geostationary satellites? I remember movies of MSG images of the eclipse from March 2006.

l.119: "To reduce the volume of data, all measurements, except those from the 443 nm channel, were averaged onboard DSCOVR to 1024 x 1024 pixels." -> Why is the 443nm channel treated differently?

l. 167: "340 nm, with strong Rayleigh scattering effects (haze)" -> haze (aerosol) scattering is not the same as Rayleigh (molecular) scattering.

Fig.3: These images are very nice. I would prefer north up as usual, even if inconsistent with Fig. 7.

l. 173 "3.1 Comparison of Eclipse and Non-Eclipse Days for Caspar, WY and Columbia, MO "-> Use a more specific title, what is compared?

Fig. 5: "Middle"-> "Bottom"

Fig. 6a,b: These figures all look quite similar. Why are all channels shown for Caspar, WY and only one for Columbia (as lower left plot in Fig 6a). This arrangement is confusing. Suggestion: Use 3 representative channels and show the results for Caspar, WY on the left and the corresponding results for Columbia on the right. Maximum values for all channels and for both locations should be included in Table 2.

Table 2: Please include also the <R_EN> values for Columbia in the table.

l. 234ff: "A detailed radiative transfer study for realistic conditions is made feasible by using EPIC's simultaneous estimates of cloud reflectivity and transmission, cloud height, aerosol amounts, and ozone amounts." -> It there a data product including

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these estimates. If yes, please provide reference.

l. 237ff: see "general comment 1"

Fig.8 a,b,c, A2: I think that not all of these figures are needed. Fig. 3 nicely shows, how the shadow and the Earth looks in various channels and Fig. 4 shows the synoptical conditions during the eclipse and the day before and after the eclipse. I suggest to put most of these figures in the appendix. l. 285: "While the figures are similar from wavelength to wavelength, there are differences in the depth of the eclipse totality and the reflectivities of the surrounding clouds." With the chosen grey-scale colormaps these difference are not visible. I suggest to use a colormap similar to the one in Fig.7 to visualize the differences in the depth of the eclipse totality.

Table 3: Please include this table also for Columbia.

l. 325: "This means that EPiC is observing close to "hotspot" conditions where the backscatter amount increases with increasing wavelength (Maignan et al., 2004). At 551 and 680 nm the hotspot effect is smaller than at 780 nm." -> This is not obvious from Table 3, integrated counts are much larger for 551nm than for 780nm. Please explain.

l. 330: "The solar spectrum used is a combination of data named atlas_plus_modtran (Mayer and Kylling, 2005)." -> Mayer and Kylling is the reference for the libRadtran software package, from which the solar irradiance data is taken. Please rewrite sentence more clearly.

l. 363: "A previously published clear-sky model result for a nearly overhead eclipse ratios and an ocean surface albedo of 0.06 (Emde and Mayer, 2007) had R_EN (340nm)=1.7x10ˆ4 compared to the measured non-averaged R_EN (340) at Casper of 515±27 with optically thin clouds under similar geometrical conditions." -> these results can not be compared (see general comments). Not R_EN has been modelled by Emde and Mayer, the value refers to global irradiance at the surface!

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