

Answers to Referee 3

December 23, 2019

1 Influence of aerosol

1.1 Comment by Referee

[...]But at the same time it is at least equally important to adequately handle (page 8, lines 8-9; page 13, lines 3-6; page 18, lines 5-16) the aerosol presence and loading (measurements used just at 19:00).[...]

1.2 Authors' Response

We agree with Referee #3 that aerosols are another important factor. So far, aerosols were included in the final simulations, but were not discussed in the sensitivity analysis, mainly to keep the study short and because they were already discussed in Emde et al. 2007, however only for wavelengths between 300 nm and 500 nm. Following the Referee's suggestion, we include the following section together with an additional Figure in the manuscript:

1.3 Changes in manuscript

Aerosols

Another factor which influences direct as well as diffuse irradiance is aerosol. During the measurements by Bernhard et al. 2019, used for the comparison in subsection 3.6, several wildfires were burning in the region. Therefore, the authors derived aerosol optical depth (AOD) from measurements of direct spectral irradiance for each channel. At times 16:03 and 19:00, i.e. before the first and after the fourth contact, they fitted Ångström functions of the form $\tau = \beta\lambda^{-\alpha}$ to the data. The coefficients for the first measurement are $\alpha = 1.96$ and $\beta = 0.057$, for the second measurement they got $\alpha = 2.1$ and $\beta = 0.0394$. In our reference simulation, we specify aerosol the same way as they did and similar to Emde et al. 2007. This includes an aerosol model of Shettle 1990. Single scattering albedo was set to 0.95 and asymmetry parameter to 0.7. This profile is scaled to an AOD described by the Ångström function at 19:00. Furthermore, the settings from the sections above are applied: dry grass albedo, MOZART ozone profile and realistic mountain profile. In Figure 1, the blue curve shows the relative change in irradiance during totality if no aerosol would be present. In the

near infrared the effect is strongest, with signal reductions up to 60% despite the generally lower AOD. To get an estimate of the uncertainty of the reference simulation, the orange curve was produced with the Ångström parameters from 16:03. Maximal changes are 10%. To summarize, consideration of aerosol is very important, however the effect of aerosol differences before and after the eclipse were smaller than 10%. Again, we see the red and near infrared wavelength to be more sensitive to the surrounding during totality, which we will explain in the following section.

Abstract:

[...]The influence of the surface reflectance, the ozone profile, mountains surrounding the observer and aerosol is investigated. An increased sensitivity during totality is found for the reflectance, aerosol and topography, compared to non-eclipse conditions.[...]

Introduction:

[..]as well as the surface reflectance, topography and aerosol[..]

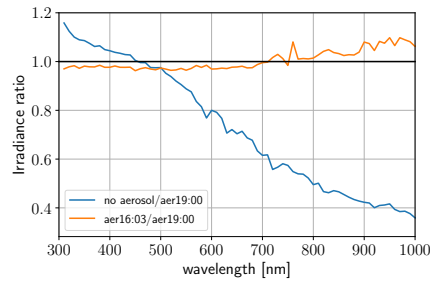


Figure 1: Simulated irradiance during totality (17:20) for different wavelengths, relative to irradiance with the Ångström parameters derived at 19:00. For the blue curve, no aerosol was specified, for the orange curve aerosol was parameterized with the Ångström parameters derived at 16:03.

2 Influence of clouds

2.1 Comment by Referee

I suggest the authors to include some sensitivity analysis taking into account the microphysics and optical characteristics of the existing formations (possibly cirrus)

2.2 Author's Response

Clouds are definitely an interesting factor, especially because they are likely present in most eclipse observations. However, as we already discussed with Referee #2, in our case the visible sky as well as the larger area were nearly

cloud free. Therefore, for modelling the observations, a cloudless setup seemed most reasonable to us. A general sensitivity analysis would be interesting as well, but would require non-trivial changes to our model which does not permit simulations with three-dimensional clouds, spherical geometry, and eclipse condition. These are planned as a future project.