

Interactive comment on “Effects of total solar eclipse of 29 March 2006 on surface radiation” by S. Kazadzis et al.

Anonymous Referee #2

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GENERAL

The paper “Effects of total solar eclipse of 29 March 2006 on surface radiation” by S. Kazadzis et al. presents the solar eclipse as seen by a broad range of different radiation measurements taken at the Greek island of Kastelorizo during a two day campaign. The measurements were only to a minor extent disturbed by clouds appearing mostly after totality. The paper presents interesting features in the measured radiation quantities, and also includes analysis on the changes in the extraterrestrial spectrum during the eclipse. Thus, the paper is of general scientific interest and could be published in ACP. However, the paper suffers to a certain extent of being disconnected. It could be improved by making the structure more logical, by emphasizing more the connection between the different results shown, and by including more background/physics in the

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discussion.

Here are the three main areas that need improvement:

(1) It would be useful to explain more the physics behind the phenomena seen in the measurements, and also to more enlighten the background and the motivation for the analyses presented. The structure of the paper as a whole could also be made more logical. This would all make it easier to follow the text and the results in general. At some points, the results should also be compared more in detail to earlier studies, or at least the results of the earlier studies could be explained more in detail. The order of appearance of the different sections could perhaps be changed. Now the first results presented concern the measured total ozone column. However, the total ozone column is only a product derived from the measured irradiances, thus it would be more logical to treat the ozone column after the radiation measurements. In addition, I would personally prefer to start the results by the extraterrestrial spectrum, because the effect of the eclipse on the extraterrestrial spectrum is reflected in all measurements of surface radiation, and finally also in the measured total ozone column.

(2) Precision of language, and to some extent also the accuracy in describing the experiments, could be improved. For instance, it is important to keep it perfectly clear in the text that the solar eclipse affects the total ozone *derived* from the Brewer measurements, not the ozone column itself (at least to any great extent if I understand correctly). In the current version of the manuscript, this difference is sometimes unclear (e.g. “During the course of the eclipse, one can see a gradual decrease in total ozone” sounds as if the decrease were real, not an artefact). In general, the authors should also be more specific when describing the data presented in the figures (especially which instruments have been used).

(3) Consistency in writing. Dates should always be presented according to the same style (does ACP have recommendations for this?). The citation style should be the same for all references (Köpke et al. / Köpke *et al.*). Spelling of, for instance, mod-

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eling/modelling. Finally, all abbreviations should be properly defined before first use (here, ET is not defined).

SPECIFIC

1 Introduction

-the references suggested by Claudia Emde in her interactive discussion should be added, also the paper by Emde and Mayer

-"possible effects of a solar eclipse on the ozone column" / see comment (2) above, it would also be useful to elaborate more what are the expected reasons behind the effects seen

-"Other studies, however, in which other instruments were used for the determination of total ozone, have shown different results as to the sign and the magnitude of total ozone change" / this is quite a strong statement considering that no details are given, are there any references to these studies?

2.2 Instrumentation

-it would be useful to provide the home institutes of the Brewer and Bentham instruments, so that they can be connected to the discussion in Bais et al., Kylling et al. and Webb et al.

-what corrections were applied to the Brewer and Bentham data? brief description should be enough

-"record spectral measurements of GI, DI and AF" / later it is mentioned that also zenith radiance was measured, this could be mentioned here

2.3 Modelling of the extraterrestrial...

-it would be useful to explain more background, to make the reader understand why this section is included here. What is the modeled ET needed for in this study? (see also general comment 1) And what kind of features are expected in the ET during the eclipse?

3 Total ozone column

-for understanding what is seen in the measured total ozone column, the wavelengths used in the Brewer algorithm need to be mentioned

-a bit more on the background/physics could be explained. How come that the changes in the ET yield an underestimation in the total ozone column? Or is it actually the other way around?

-"Therefore the most likely reason for the apparent reduction in total ozone values during the eclipse is "contamination" of DI measurements by the diffuse radiation" / this is one of the most interesting parts of this paper and should be elaborated more. Would it be possible to make at least a rough quantitative analysis based on results in Emde and Mayer (2007), or perhaps Arola and Koskela (2004; they calculated error in AOD due to diffuse radiation measured as direct)?

-Figure 1 / it seems there are some points also outside the 70% coverage that already show some signal of the eclipse effect in the measured total ozone column

4 Spectral measurements of solar irradiance during the eclipse

-title of section / the section includes measurements of irradiances, but also of actinic flux, thus the term radiation would be more appropriate than irradiance in the title

-Figure 2 / it is peculiar that this figure is presented under the main section 4, instead of within a subsection. Units should be included in y-labels of the figure, also the instrument(s) used to obtain the data.

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-”With the use of DI spectroradiometric data the spectral aerosol optical depth could be derived” / which instrument, algorithm?

4.1 Global irradiance flux

- description of normalization starting with ”First, the data were corrected for the effect of the changing solar zenith angle”, including also the following sentences / it is difficult to follow from the text exactly how the normalization was performed, please consider rephrasing

-”The change in irradiance at 312, 320 and 340 nm relative to the irradiance at 380 nm, is respectively about 20%, 15% and 10% for 99% sun coverage” / here it would be interesting to have more information about the physics behind, why does the observed feature occur? It is also difficult to understand exactly what quantity the percentage numbers are describing

-”mainly after 11:15” / it seems the change in the ozone column has a clear influence already earlier, e.g. at 11:00

-”A possible reason might be the faster decrease in the direct irradiance compared to the diffuse irradiance during the eclipse which will have a more pronounced effect on GI than on AF” / this subject was discussed in quite detail by Köpke et al. (2001), and their work should be referred to, compared to, here

-”RTM calculations for the specific solar zenith angles, using the measured aerosol optical depth” / are the RTM calculations described in more detail somewhere else? If not, they should be

-Figure 5 and the text connected to it / the motivation for showing the photolysis rates should be explained in the paper, otherwise this part is somewhat surprising to the reader and not connecting to the rest of the paper. Furthermore, the background and physics of the phenomenon could be explained.

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-“depending on the solar zenith angle” / is really the solar zenith angle the primary factor that determines the wavelength of interest? I would imagine that the intensity of the radiation is.

4.2 Direct irradiance

-“In order to analyze the variation of the ET irradiance during the eclipse, the measured DI was corrected for the changing solar zenith angle according to Beer’s law of extinction” / how does this sentence connect to the text beneath?

-“model calculations” / again, model calculations need to be explained

-“An effect that could explain part of the differences shown in figure 6 is the contribution of the diffuse irradiance (entering in the field of view of the instruments) which increases as the eclipse percentage increase” / this is the same phenomenon as discussed in conjunction with the total ozone measurements, it would be interesting to get a quantitative idea about it (see my previous comment on total ozone)

-sentences starting with “The larger spread...” up to “which show exactly the same behavior” / I cannot follow the thoughts of the authors here, would it be possible to make the text more clear?

5 Extraterrestrial flux...

-“Being a mixture of black body spectra of different temperatures the spectrum at the top of the atmosphere during the different phases of the eclipse can be corresponded to a unique effective temperature. On the contrary if an effective temperature were to be derived from this spectrum, it would have been wavelength dependent” / these sentences contradict each other, first it is said that a unique effective temperature can be inferred from the ET spectrum, then it is said that this effective temperature is wavelength dependent (and not unique)

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-”Using the Atlas 3 ET solar spectrum (Van Hoosier et al, 1997) and the irradiance measurements at the surface” / should be mentioned that it is the direct irradiance that is used

-”The dashed lines represent model calculations” / what model calculations?

-”Without the LD effect the ratios calculated in the upper plot would be equal to one” / why would the ratios be equal to one? If part of the sun is covered by the moon, shouldn't the ET flux be less than during non-eclipse conditions regardless of the LD effect?

-”For 10% sun coverage both instruments and the model calculations show an increase in the calculated ET flux of up to 5% and also a temperature increase (up to 40o)” / I do not understand how this is possible, although the explanation about the temperature of different parts of the sun is provided here beneath. Using common physical sense, it is rather contradictory that the extraterrestrial irradiance would really be increased because the moon blocks part of the sun (I would imagine that the moon should remove part of the incoming radiation). I do understand that the effective temperature can increase, since only the hotter parts of the sun are visible, but I do not understand how the extraterrestrial irradiance can increase. This could be elaborated more in detail. Are there any references where the ET spectrum has been measured outside the Earth's atmosphere during an eclipse? Do they show similar behavior? What about the results obtained by Zerefos et al. (2001)? Their results could be compared to the present ones

-Figure 8 / shows mostly good agreement between model ET and ET inferred from measurements during times not disturbed by clouds. This could be explicitly mentioned in the text.

6 Conclusions

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-“Spectral measurements of the solar irradiance” / as for title of section 4, I suggest using the term radiation

-“changes in the extraterrestrial solar flux predicted by the STAR radiative transfer model” / it is somewhat misleading to say that the ET is predicted by the STAR model, since it is actually predicted according to the technique explained in Köpke et al. (2001)

-“is an artifact in the measured irradiance” / it would be clearer to say that the artifact is in the derived total ozone column

-“Calculations of the ET solar spectrum and the effective sun’s temperature as derived from direct irradiance measurements at the surface, showed an artificial change in both quantities” / the wording artificial is unclear to me - what makes the changes artificial?

-“measured from remote sensing techniques” / it is unclear what is meant by remote sensing techniques here

TECHNICAL

1 Introduction

-“and even fewer measurements exist of solar LD observations” / the wording measurements of observations makes no sense

-“ET” / not defined

2.2 Instrumentation

-“FWHM” / not defined

-“(Bais et al., 2001; Kylling et al., 2005) (Webb et al., 2002)” / too many parentheses

-“simultaneous recording” / should it be instantaneous?

-“broadband and filter radiometers” / also broadband instruments are filter radiometers

3 Total ozone column

-“The 70% coverage corresponds roughly to a reduction in direct irradiance measurements (taken under normal conditions) at airmass factors of more than 3” / I find it difficult to follow this sentence

4.1 Global irradiance flux

-“spectral impact of the LD on the irradiance spectra” / double use of spectra, the latter spectra is redundant

-figure 3 / Figure 3?

-“Similar to the GI, measurements of AF...” / I find it confusing that the sentence starts with ‘Similar to the GI’, could perhaps be left out

-“in the order of 5-8%” / on the order of

-Figure 4 / were both GI and AF measured by the PDA instrument? Data source should be mentioned in the caption.

-photolysis rate or frequency / please choose one

-“J’s” / I suggest using ‘photolysis rates’ instead

4.2 Direct irradiance

-“interested mainly on” / interested in

-Figure 6 / subfigures should have same axis so that they are easy to compare, titles could be added to distinguish them from each other

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5 Extraterrestrial flux...

- "Zerefos et al., 2001" / parentheses missing
- "The analysis shown hereafter is restricted to for the first part" / redundant for
- Figure 8 caption / the figure includes also model data

6 Conclusions

- "Global, direct irradiance" / Global and direct irradiance
- "spectral changes in the ET spectrum" / double use of spectrum

REFERENCES

Arola and Koskela (2004), On the sources of bias in aerosol optical depth retrieval in the UV range, JGR, VOL. 109, D08209, doi:10.1029/2003JD004375.

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