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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Attenuation of global ultraviolet and visible irradiance over Greece during the total solar eclipse of 29 March 2006" *by* A. Kazantzidis et al.

A. Kazantzidis et al.

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Response to referee 2

We thank the referee for his/her helpful suggestions and constructive remarks. We have accordingly modified the attached version. The introduced changes are explained below.

Comment of the referee: [My main criticism of the paper is that it lacks a Discussion Section where the authors interpret their results and compare them with similar observations that have already been published. For example, why is UV radiation decreasing more rapidly than the visible fraction of the Sun (Page 13483, Line 14)? In addition, reasons explaining the pattern of the irradiance ratios of Figures 4-5 should be pro-

vided.]

The text in the revised manuscript has been modified according to the referee suggestions. The following document has been added in paragraph 4.2:

The relative change of solar irradiance at 380 nm and PAR is shown only at Kastelorizo, Nicosia and Heraklion (Figure 3) and not for the other sites, due to the increased impact of cloudiness in UVA and PAR instrument channels. The solar irradiance at both wavelengths is respectively 33 and 25 times weaker when the sun is visible by about 6%, compared to the irradiance at non-eclipse conditions. The measured decrease on irradiance is 1.5 (at 380nm) and 2 (at PAR) times more than the corresponding value at 305nm. This is explained by the fact that as the eclipse progresses, the diffuse radiation originates from photons that have entered the top of the atmosphere far away from the measurement site. Since photons at shorter wavelengths are more effectively scattered than photons at longer wavelengths, they have a smaller chance of reaching the instrument.

Comment of the referee: [It would be nice if the reason of the inflection of the 305/380 ratio (Figure 5 top) could also be explained, although I understand that an explanation may not be possible at this time. It is puzzling that the 3-D model fails to reproduce the effect (Page 13487, Line 3). It may be pointed out in the conclusions that the interpretation of this observation remains a challenge for future research.]

It is true that the 1-D (shown in figure 5) and the 3-D model (discussed in the relevant text) fail to reproduce the overturned ratio at 305/380. The effect is similar at all three sites, but the interpretation of this observation remains a challenge. Unfortunately, no ozone profile data were available, but strong experimental evidence that there was an oscillation in the total ozone column is provided by Zerefos et al. (Atmos. Chem. Phys., special issue on eclipse of 29 March 2006). According to that study, the cooling of ozone layer in the stratosphere by the supersonic travel of the moon shadow during an eclipse constitutes a source of gravity waves propagating both upwards and

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downwards. It is also evident that our observation should be related with the strange ozone behavior that was also reported in other relevant studies. So, the authors agree that there is still a great challenge for future research. The text in the abstract and the conclusions of the revised manuscript has been modified, in order to point out that this is still an open field. Additionally, the study of Zerefos et. al., is discussed in paragraph 5.2 of the revised manuscript.

Specific comments:

1. The abstract has been modified according to the referee suggestions. All results and more numbers have been included in the abstract.

2. The sentence has been replaced by: The 1-D model reproduced the spectral effect of the eclipse in UVA and PAR wavelength regions within 3% for eclipse percentages up to 50%, but only the half of the observed change was captured as the eclipse progressed.

3. No, the lamp is 1000W!

4. The text in the revised manuscript has been modified according to the referee suggestion. The sentence was rephrased as follows: Under such conditions, the angular response error of the instruments could be considered within 3% for all NILU-UV channels (Kazantzidis et al., 2006).

5. The text in the revised manuscript has been modified according to the referee suggestion. The sentence has been replaced by: The maximum change in the solar zenith angle for the same time between these consecutive days is less than 1.2 degrees and the corresponding model calculated cloud-free difference in channel irradiance is 2.1% at 305nm, 1.4% at 312nm and less than 1% at all other NILU-UV channels.

6. More information about the aerosol conditions in eastern Metiterranean is provided by Kalivitis et al. (Journal of Geophysical Research, vol. 112, D03202, 2007). In figure 4 of this paper the Angstrom exponent is around 1.3 and the aerosol optical depth at

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340nm (derived from the corresponding values at 440nm) is close to 0.4 during springtime. This reference has been added to the relevant text of the revised manuscript (paragraph 3.2).

7. The statement describing the differences between measurements and model calculations has been improved and a more detailed description is given. It seems that model and measurements agree at small and large coverage and not between, but this is an artifact of the logarithmic scale of y axis. The following sentences have been added in the revised document: The agreement between measurements and modeled values at all sites is within 2% for visible parts of the sun of more than 70% and becomes worse as the eclipse progresses. The differences at Heraklion range from 10% to 60% for sun visible parts of 60% and 10% respectively. The differences at Nicosia, for the same visible sun percentages, range from 2% to 30%. At Kastelorizo, the site with the highest eclipse percentage, the agreement between measurements and model estimates is within 8% for visible fraction of sun disk equal to 10%. However, close to the totality the agreement becomes worse (within 60%) as both measurement and model uncertainties become more significant.

8. We agree with that a different pattern in differences between model estimates and measurements should be expected before and after the totality because of the one-minute average values. The sentence has been omitted in the revised manuscript.

9. The paragraph has been excluded from the revised manuscript. In the revised manuscript of Kazadzis et. al.(2007), only the spectral differences between model estimates and measurements are discussed.

10. The text has been modified as to clarify that the model captures only the half of the change observed.

11. The behavior of 305/380 irradiance ratio, described at this part of the text, corresponds to high eclipse percentage conditions. As it can be seen in figure 6, at all sites the measured total ozone was decreased for high eclipse percentages, so the 305/380

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irradiance ratio should be increased. The paragraph was rephrased to clarify this point of discussion.

12. The description of the ozone calculation method has been included in the revised manuscript. The following document was added: “The total ozone values, were determined by comparing a calculated and measured irradiance ratio at two channels with different ozone absorption, according to the methodology proposed by Dahlback (1996). The calculations were performed for cloud-free conditions and a look-up table was created to relate the solar zenith angle and the irradiance ratio to total ozone.” In order to examine the effect of challenging radiative conditions, the measured irradiance ratio was not corrected by the limb darkening effect (it was estimated separately from 1-D model calculations) and the look-up table was not altered.

13. The contents of Zerefos et al., (2001) and Kazadzis et al. (2007) have been already summarized in the Introduction paragraph, where the related studies about the ozone measurements during an eclipse have been discussed.

Technical corrections

All technical corrections suggested by the referee have been included in the revised manuscript. The sentence, on which the comment 7 is referred to, has been excluded in the revised manuscript.

Interactive comment on Atmos. Chem. Phys. Discuss., 7, 13475, 2007.