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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Aerosol shortwave daily radiative effect and forcing based on MODIS Level 2 data in the Eastern Mediterranean (Crete)" *by* N. Benas et al.

N. Benas et al.

benas@physics.uoc.gr

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We would like to thank the Referee for the suggestions and corrections. All comments and recommendations have been taken into account. Please find our point-by-point reply below.

GENERAL COMMENT: Based on the comments regarding the validity and reliability of the results, which were evaluated on a mean daily basis using MODIS data acquired at a specific time of the day, we have repeated our calculations for the specific satellite overpass times, instead of the mean daily. All results reported in the revised manuscript are based on these new calculations.

"Page 1-2, Abstract: The inclusion of so many numerical results without any comment on the numbers shown is rather confusing than informative."

The last part of the abstract has been rewritten and the numerical results presented have been reduced.

"Page 2-3. Introduction. Many parts of this section do not belong to an introductory section but mostly belong to the next sections describing the data and the model, and should be moved there. One should expect here from the authors to outline the major objectives of their study. In addition there is a confusion (also later on in the manuscript) with the use DRE and DRF (the latter considered only as the effect of anthropogenic aerosol, but never used again in the manuscript)."

Parts of the introduction describing the methodology of the study have been moved to Section 2 (Model and methodology description). The use of the terms DRE and DRF has been corrected throughout the revised manuscript.

"Page 4. Model description. The authors use actually a two stream model using the delta-Eddington approximation, obviously due to its rapid computation time. However there are nowadays multiple stream solvers that are included in most of the radiative transfer models. The authors should make a comment on the accuracy of their radiative transfer calculations and the expected uncertainty introduced in their estimates due to the simple approximation they use."

Comments on the accuracy and limitations of the radiative transfer calculations have been added in Section 2 (Page 4, lines 17-21).

"Page 5; Lines 1-3. Is there any reference for what the authors mention as standard diffusivity approximation?"

The part describing the diffusivity approximation has been removed from Section 2, based on comments regarding the length of this Section. The diffusivity approximation is described in detail in Vardavas and Taylor (2011), page 75.

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"Page 7: Lines 20-27. This paragraph is very confusing as written. The authors should better provide equations for the various DF's they calculate. In addition the subscripts used are not consistent throughout the manuscript."

The paragraph has been rewritten, focusing on the description of the various ΔFs in terms of the shortwave radiation budget. The subscripts have been corrected to be consistent throughout the manuscript.

"Page 10: Aerosol particles. The correction of winter GADS SSA estimates with the ration of summer ratio of AERONET/GADS seems completely unjustified. At least a range of the values (SSA and ratio) should be given in order to be able to have an idea of the uncertainty included in this assumption."

Re-examining the model output for the months when aerosol single scattering albedo data from GADS were used (namely November, December, January and February), we found that these data were causing biased model outputs, resulting in an overestimation of the aerosol DRE. In order to correct these results, we have replaced GADS data with interpolated values of aerosol single scattering albedo from FORTH-CRETE AERONET station, based on autumn and spring station measurements.

"Page 10. Section 4.1 The validation of MODIS AOT is not necessary. There are already many validation papers (even for Crete) and providing reference to them should be sufficient."

In Section 4.1 of the revised manuscript, MODIS aerosol input data are validated against the FORTH-CRETE AERONET station corresponding data sets, while in Section 4.2 the model sensitivity is examined against variations in these data. The aim of both procedures is to assure the validity and reliability of the model input and output results.

"Page 12. Lines 20-29. This paragraph is rather confusing as written. Actually the authors provide DSR with standard deviation estimates using MODIS optical depths

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which have a certain uncertainty, expressed by the error in the measurement. It should better to show the DSR together with the standard deviations, rather than presenting and discussing them in a different figure. Please consider to revise."

Section 4.2 has been rewritten to include the sensitivity analysis of the model against all input MODIS aerosol data. MODIS AOT uncertainty was used to perform this analysis on the specific data set. We chose to present the results in a different figure, to show their seasonal variability and range, as well as for clarity purposes.

"Page 13. Lines 7-8. The terminology here (NetSurface) is not consistent with the one used in page 7."

The terminology used in page 7 (Page 6 in the revised manuscript) has been corrected.

"Page 13. Section 4.3. There is no information in the text on what calculations is based the daily DSR mean. In addition by checking figure 9 one can detect many outliers which result to large DF's. Have the authors checked these values. Can these be due to AOD contaminated by clouds? Are these consistent with estimates using AOD from AERONET?"

In the revised manuscript all results reported (including the DSR) are based on calculations for the specific satellite overpass time, instead of the daily mean. In Figs. 9 and 10 (Figs. 7 and 8 in the revised manuscript), the majority of the outliers corresponds to days with dust episodes, as detected according to the methodology described in Section 4.3 and verified using back-trajectory analysis.

"Pages 14-15. Section 4.4. The authors do not provide any significance estimate for the trends they calculate."

Statistical significance estimates have been added in Section 4.4 of the revised manuscript (Page 16, lines 10-15).

"Page 15. Lines 10-23. The only criterion for distinguishing anthropogenic particles is the fine mode fraction set to 0.7. Any reference for that? Is this consistent with

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backtrajectory analysis? Do the authors claim that all the fine mode aerosols in the area exlusevily of anthropogenic origin? Please comment."

According to the literature, aerosols of anthropogenic origin are mainly composed of fine mode particles (Dubovik et al., 2002, Kaufman et al., 2002). The technique we use to discriminate aerosols of anthropogenic origin (fine mode fraction greater than 0.7) was first implemented by Barnaba and Gobbi (2004), showing good correspondence to the actual aerosol distribution, evaluated using other methods. Back-trajectory analysis for major anthropogenic events (fine mode fraction greater than 0.9) showed that these particles originate mainly from the Balkan area and secondarily from South Italy and Western Turkey. These results are included in Section 4.5 of the revised manuscript.

"Page 16. Lines 1-5. The seasonality presented here is not consistent with earlier discussion in the same paper. April maximum due to anthropogenic aerosols seems unjustified, as well February maximum due to dust."

The February maximum due to dust was found to be a biased output caused by the use of GADS single scattering albedo for winter months. In the case of anthropogenic aerosols, two maxima are apparent in the new results: a main in August and a secondary in April.

"There is no reference to Figure 15 in the text."

A reference to Fig. 15 (Fig. 13 in the revised manuscript) has been added in Page 17, Line 20.

References

Barnaba, F and Gobbi, G. P.: Aerosol seasonal variability over the Mediterranean region and relative impact of maritime, continental and Saharan dust particles over the basin from MODIS data in the year 2001, Atmos. Chem. Phys., Vol. 4, 2367-2391, 2004.

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D., and Slutsker, I.: Variability of absorption and optical properties of key aerosol types observed in worldwide locations, J. Atmos. Sci., 59, 590–608, 2002.

Kaufman, Y. J., Tanré, D., and Boucher, O.: A satellite view of aerosols in the climate system, Nature, 419, 2002.

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