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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Assessment of the MODIS Collections C005 and C004 aerosol optical depth products over the Mediterranean basin" *by* C. D. Papadimas et al.

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I. First approach (Comparison between Collection 004 and Collection 005)

1. In the discussion of Figure 4, page 12, lines 11-17, it has been noted that attention should be paid in interpreting the results of Figure 4a. Specifically, it was noted that "care must be taken since the results of Figure 4a and the relevant equation refer to the total number of pixels in the study region. A considerable number of them, however, is labeled by MODIS as "land and ocean" indicating that they include both land and ocean surfaces in their spatial limits. Given that aerosol properties exhibit significant differences above continental and maritime regions, attention should be paid interpretating the results of Figure 4a. Therefore, the analysis was repeated separately

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for land and ocean".

2. A brief description of the major changes that have been applied to the second generation MODIS operational algorithm has been provided in the text, from page 2, line 30 through to page 3, line 6.

The discussion of Figure 1b (showing changes in MODIS AOD from C004 to C005) has been linked to the main changes of the MODIS algorithm. Relevant notes were made in the text, from page 6, line 5 through page 7, line 2, as well as in page 7, lines 5-10.

The discussion of Figure 2a (seasonal differences of AOD between C005 and C004) has been linked to the main improvements in the second generation MODIS retrieval algorithm. Specifically, changes in surface reflectance and aerosol models were identified as responsible for the above differences, with the former evaluated as primarily responsible. The text was modified accordingly, in page 8, lines 1-19.

3. The criterion of availability of at least 50% of total number of daily MODIS data has been used in our analysis in order to ensure the reliability of the findings, especially in terms of temporal variability and tendencies of AOD. This criterion resulted in the omission of data over northern African desert areas. On the other hand, these areas are of special interest to the aerosol community. Thus, as suggested by the Referee, we have reproduced Figure 2b (given below) without applying the criterion of 50% data availability. The equations of linear regression fits for both C004 and C005 collections changed very slightly, i.e. the new slopes are equal to -2.17x10-5 (against -2.15x10-5 using the criterion) for C004 and -2.04x10-5 (against -2.01x10-5 using the criterion) for C005. These very small changes of slopes (0.02x10-5 and 0.03x10-5) have not modified the overall changes of AOD. Therefore, we preferred not to use this new Figure 2b in the revised paper, because it is not providing additional information to that already presented in the ACPD paper and on the other hand it reduces the statistical significance of the plotted data. In conclusion, it appears that the decreasing tendencies

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of MODIS C004 and C005 AOD over the Mediterranean basin are not affected by the omission of the northern African areas due to the applied data availability criterion. A relevant footnote has been made in page 8, line 30.

For the information of the Reviewer, we have also reproduced Figures 1a and 1b (here below) without applying the criterion of data availability. The new Figures (not included in the revised paper) clearly show the northern African areas that were omitted in the original plots (Figure 1). These areas are characterized by AOD values ranging up to 1.15 in C004 and 1.5 in C005 data. Over these areas, the overestimation of AOD by MODIS C004 with respect to C005, ranges from 0.25 to 0.6, i.e. it is very large. Relevant notes were made in the text, page 5, lines 14-17, and lines 30-34.

II. Second approach (Comparison between MODIS and AERONET)

1. In our analysis we have used the Level-3 MODIS C005 and C004 aerosol datasets. The reason is that our first goal is to evaluate the performance of the second generation Collection 005 MODIS operational algorithm for the greater Mediterranean basin with respect to the previous Collection 004. This can be achieved using either Level-2 (resolution of 10 km at nadir) or Level-3 (averaged over 100 km by 100 km pixel areas). Nevertheless, indeed when comparing MODIS AOD data with those from AERONET, Level-3 data may lose detailed spatial and temporal features of aerosols, thus affecting the statistics.

To address this problem, and following the suggestion of the Referee, we have used the spatio-temporal window technique (Ichoku et al., 2002), which is adopted and used in similar comparisons between MODIS and AERONET. In our analysis, the MODIS Level-2 AOD products were averaged spatially in a grid box of size 50x50 km centered at the AERONET site. We have performed this comparison for seven (7) important AERONET sites over the Mediterranean basin. The sites were appropriately selected in order to be representative for the different aerosol types that are observed over the Mediterranean basin (e.g. urban, desert, maritime) also ensuring a homogeneous and

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complete spatial coverage. The AERONET stations used are: Nes Ziona, FORTH, Bucarest, Etna, Ispra, Ville Franche and Blida.

Our analysis has shown that the correlation coefficients (R) between MODIS and AERONET did not change drastically using Level-2 instead of Level-3 data. Specifically, the differences in R values did not exceed 0.02 (only for the single case of the Nes Ziona station Level-2 provided a larger increase of R equal to 0.18). It is important that no systematic behaviour was found for the examined stations in terms of performance of Level-2 and Level-3 data against AERONET, i.e. for some (3) stations better comparison was provided by the Level-2 data, against a worse comparison for some (3) other stations. In addition, the computed correlation coefficients between the Level-2 and Level-3 AOD data are quite high with values ranging from 0.84 to 0.99. Finally, the differences between MODIS and AERONET are similar using either Level-2 or Level-3 data. Thus, the differences in AOD range from -0.09 to 0.07 for Level-3 data, and from -0.09 to 0.12 for Level-2. The relative percentage differences, with respect to AERONET AOD values, between using Level-2 and Level-3 AODs are smaller than 5%. Therefore, it appears that the main results and conclusions of the paper remain unaffected using either Level-2 or Level-3 MODIS AOD data. The improved performance of MODIS Collection 005 with respect to Collection 004 in terms of comparison against AERONET, as well as the general decrease of AOD values over the study region (with decreasing values over land and slightly increasing values over ocean) is valid whether using Level-2 or Level-3 data. References to the results of the above analysis have been made in the text (page 10, line 30 through to page 11, line 29, and page 14, lines 16-17).

2. The statement of the Referee sounds reasonable. However, our comparison (Table 1) already shows that this is not happening. Specifically, for 10 urban AERONET stations (Cairo Univ., Bucarest, Rome Tor Vergata, Modena, Venice, Ispra, Marseille, TOULOUSE, Toulouse, Barcelona) MODIS Level-3 data underestimate AOD in only 3 stations (Bucarest, Modena, Marseille) while in the rest of the stations AOD seems to

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be equal or even overestimated. Furthermore, when using Level-2 instead of Level-3 data (see previous comment) we found that the Level-2 AOD value has decreased and not increased, as one might expect based on the Referee's statement. Thus, for Bucarest AOD decreased from 0.25 (Level-3) to 0.24 (Level-2) against the AERONET value of 0.33, while for Ispra AOD decreased from 0.35 (Level-3) to 0.28 (Level-2) against the AERONET value of 0.31. Probably, the reason for this is the dispersion that undergoes the aerosol load, which although it is induced by the urban centers it is transported nearby by meteorological factors (instability, wind). Only in case of very stable atmospheric conditions one could expect significant differences in AOD between urban areas and their surroundings.

3. We agree that the use of daily mean AERONET AOD values for comparison with MODIS AODs induces a degree of uncertainty because of the diurnal variability of AOD, as shown by Smirnov et al. (2002). This has been stated in section 2, from page 4, line 32 though to page 5, line 9, and also in Conclusions (page 14, lines 11-14). Nevertheless, as stated in the text, this uncertainty should be rather small for most sites (except urban/industrial), as can be seen when comparing averages of AOD during the course of the day with those within plus-minus 30 minutes of the MODIS overpass (10:30 a.m.).

The reference of Kazadzis et al. (2007) was removed from the text in the last paragraph of section 1, which reports on studies that have used MODIS C004 AOD products.

"ground-based measurements" was added to TOMS and AVHRR datasets, in page 8, lines 23-24.

References

Smirnov, A., Holben, B. N., Eck, T. F., Slutsker, I., Chatenet, B., and R. T. Pinker, (2002), Diurnal variability of aerosol optical depth observed at AERONET (Aerosol Robotic Network) sites, Geophys. Res. Lett., 29, 2115, doi:10.1029/2002GL016305.

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