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***Interactive comment on* “Influence of observed diurnal cycles of aerosol optical depth on aerosol direct radiative effect” by A. Arola et al.**

Anonymous Referee #2

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General comments

The present paper assesses the influence of diurnal variability of aerosol optical depth (AOD) on aerosol direct radiative effect (ADRE) at the top of atmosphere (TOA). To my knowledge it is the first time the specific problem is addressed in literature contrary to the diurnal variability of AOD which has been examined in a number of previous studies. In this aspect, the paper deserves to be published and concerns a great number of scientists interested on aerosol radiative and climatic effects. The authors make use of the libRadtran package together with hourly resolved AERONET data to estimate hourly ADREs and then to yield daily mean values which are then compared to ADREs computed using mean daily AOD. They also attempt a similar comparison and estimation of dADREs but using MODIS Terra and Aqua AOD values obtained at

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their overpass times. Both RTM and input data are adequate to perform such a study and to fulfil the defined objectives. Also, the paper is in general well organized and written in a concise way. Nevertheless, there are a number of issues mainly related to the presentation and discussion of the obtained results, as described below (Main and other comments).

Main Comments

1. Are the used AERONET AOD data cloud screened? It seems so, since Level 2 data are used. This may be an important issue in terms of the impact that can have on the appropriate estimation of the average daily cycle of AOD for each site using multiyear seasonal values. Can the authors comment on this?

2. In calculations, some smoothing has been applied, for example by: (i) estimating an averaged diurnal cycle of AOD based on more than 30 multiyear (hourly) data from each season, instead of working on an individual daily-hourly basis, e.g. case by case, (ii) in terms of insolation, the hourly solar radiation of the 15th day of each month was used instead of hourly solar data for each day of each month. This smoothing has potentially dumped the effect of daily AOD variability on ADRE values. Can the authors at least comment on these issues, since specific sensitivity studies can be performed to assess the magnitude of induced uncertainties?

3. Relative percent (%) values of dAODs and dADREs should be shown apart from absolute ones, in order to better assess the magnitude of differences. This is only done on Table 1 but can be further done on Figures.

4. The paper lacks an essential discussion of much of the presented results, e.g. those of Table 1 or the diurnal variability of AODs, while assessments of potential explanations and causes of features of the results are not sufficient.

5. It would be informative to provide a map with the location of AERONET stations that are considered in the study.

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6. Explain why are ADRE values computed only at TOA and not at other levels, for example at surface.

Others

1. Abstract, last line: also give relative percent values apart from absolute ones.
2. Section 1, Introduction, second paragraph: reference Christopher et al. (2003) is not consistent with the list of references (2006).
3. Sub-section 2.1, AERONET data: state how many stations are used and what aerosol regimes are covered. Also, provide a relevant global map indicating the stations.
4. Sub-section 2.2, Calculation of the radiative effect: only a single line is devoted to the radiative transfer model used. Although it is a well know tool, this is not enough and a few more information is necessary. Also explain why computations are only performed at TOA and not at other levels, e.g. surface or in the atmosphere.
5. Sub-section 2.2, Calculation of the radiative effect: referring to linear extrapolations applied to derive surface albedo at longer than 1020 nm wavelengths, how realistic is doing this so to have the albedo decreased at 0.01 at 5000 nm?
6. Sub-section 2.2, Calculation of the radiative effect: similarly to previous comment, but referring to interpolation/extrapolation applied to four wavelengths in order to cover the full solar spectrum range, how realistic is this? Also provide the values of the four wavelengths.
7. Sub-section 2.2, Calculation of the radiative effect, last paragraph: a reference to the relative role of changing AOD, SSA (single scattering albedo) and AP (asymmetry parameter) for ADRE values should be made, based on existing literature (e.g. Hatzianastassiou et al., 2004, Tellus-B).
8. Sub-section 2.2, Calculation of the radiative effect: a reference should be made to

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the rest of radiative transfer model input data.

9. Sub-section 3, Results, 1st paragraph: here a reference to the aerosol regime of the considered sites can be informative. Also, a short discussion on the diurnal AOD variability can be added. For example, features and causes of the hour to hour, and especially morning to afternoon, changes can be reported.

10. Sub-section 3, Results, 2nd paragraph: state what are the values (absolute terms) of ADREs and comment on their sign and nature of DREs (cooling, warming).

11. Sub-section 3, Results, 3rd paragraph, 5th line: here reference is made only to the role of changing sign of ADREs due to changing solar zenith angle (SZA). However, no comment is made on the role of changing magnitude of ADREs due to changing solar radiation (taking maximum values at around solar noon for clear skies).

12. Sub-section 3, Results, 4th paragraph: explain/discuss in more detail the results of Table 1.

13. Sub-section 3, Results, last paragraph, last sentence: do you have any idea for explaining this behavior?

14. Section 4, Conclusions, last paragraph: delete “As Figure 4 suggests”.

15. Table 1: compute overall results per season and station. Also compute annual results for each station.

16. Table 1: why there are largest differences for Mexico (dADREs) for MODIS (Terra and Aqua, 5th and 6th columns)?

17. Table 1: why there are largest differences for Hamim (dADREs, 4th column)?

18. Table 1: how can be explained the differences between MODIS Terra and Aqua (for example, smaller dADREs for Terra than Aqua for all seasons except for winter)?

19. Figure 2: it is important to show relative percent values of dADREs as well, apart

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from absolute ones in order to assess their magnitude.

20. Figure 2: I suggest to show the evolution of absolute values of AOD and dADREs as well. This will make easier to follow the discussion often referring to positive/negative ADREs.

21. Figure 4: report the mean dADRE values on each (seasonal) plot.

22. Figure 4: specify y-axes on plots.

23. Figure 4: produce similar graphs with percent dADRE values in x-axes.

Interactive comment on Atmos. Chem. Phys. Discuss., 13, 10327, 2013.

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