

## ***Interactive comment on “Exploring the differences in cloud properties observed by the Terra and Aqua MODIS sensors” by N. Meskhidze et al.***

**N. Meskhidze et al.**

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We would like to thank reviewer for his/her comments. We have done our best to address each of the points as detailed below.

Note: All reviewer comments in italics. All responses by the authors in normal font.

*1. I have one question on terminology. The authors use the terms "semi-direct effect", "indirect effect", "radiative effect"; and "microphysical effect". I believe they refer to only two processes. I suggest the authors use consistent terminology throughout the text (I.e. not two terms for the same thing).*

We have revised the terminology. Now consistent terminology is used throughout the revised paper.

*2. It is well known that aerosol layers may be well above the cloud deck, in particular*

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*off the Coast of Namibia. In such case, the layer at which air warming is expected is not the same as that of the cloud layers. Such cases, that are rather frequent, should cancel the observed correlation. Please comment.*

We have carried out several case studies to examine the vertical distribution of aerosols with respect to clouds. Our studies show that in all three stratocumulus regions aerosols are typically located below the cloud layers. The exception is the region off the coast of South Africa (SAF), where periodic very high AODs are associated with aerosols well above the cloud deck and occasional high aerosol concentrations over stratocumulus clouds decks off the coast of California (CAL) (see auxiliary material Fig. S5). However, during such episodes (particularly over the SAF region) AOD was often  $> 0.8$  and therefore, data points were removed from the analysis by the  $\text{AOD} < 0.8$  threshold filter.

*3. I suggest the authors provide a "back of an envelope" estimate of the atmospheric warming due to absorbing aerosols between the Terra and Aqua overpass as a function of optical depth, using typical values for the aerosol single scattering albedo, layer thickness and solar angle. This would provide an indication of the temperature difference range that results in the observed cloud burn-off.*

We have carried out back of the envelope estimates of heating rates based on the heating rate profiles that were calculated for the Amazon smoke with single scattering albedo (SSA) of 0.91. (Koren et al., 2004). For  $\text{AOD} = 0.5$  we get 1 to 2 degree/day and for  $\text{AOD} = 1.0$  we get 2 to 3 degree/day warming associated to smoke forcing. When representing heating rates of INDOEX (Ackerman et al., 2000) we get 1 degree per day for  $\text{SSA} = 0.9$  and  $\text{AOD} = 0.2$ . While the impact of the smoke layer heating on meteorological conditions depends on the vertical distribution of the smoke (e.g., Yu et al., 2007), such heating can modify atmospheric structure and influence clouds. For stratocumulus clouds we believe the aerosol induced suppression of precipitation and subsequent enhancement of entrainment drying is the potential mechanism leading to the daytime reduction of cloud water (Ackerman et al., 2004; Lu and Seinfeld, 2005;

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Sandu et al., 2008; 2009).

*4. In the discussion about the effect of aerosol on stratocumulus clouds, it is said that the observed diurnal variation is the result of two competing effects, i.e. microphysical and radiative. In my understanding, the radiative processes lead to a diurnal effect, while the microphysical one does not. Then, the microphysical effect has no impact on the Terra-Aqua difference. Please correct or comment. Further in the text, it is concluded that the semi-direct effect dominates the indirect effect. I assume semidirect is the radiative effect, while the indirect is the microphysical. But again, I believe that the microphysical effect has no diurnal signal, so that one cannot conclude on the importance of one process versus the other based on the diurnal signal. This should therefore be corrected or better explained. Note that the claim of the predominance of the semi direct effect is also in the abstract.*

We totally agree with the reviewer and acknowledge somewhat loose usage of terminology. All the concerns were addressed in the revised paper. We also address the effects of large scale dynamical forcing and CCN on regional clouds.

*5. Other comments: Line 98: What is the range of possible time difference between the two satellite paths ? I expect a large range due to observation swath.*

While Terra and Aqua have equatorial crossing times of 10:30 and 1:30 +- 15 min, the difference could be up to 5 hrs over the Southern Hemisphere high latitudes and about 1.5 hours in the Northern Hemisphere high latitudes.

*6. Line 120: For overcast cases, there is no aerosol estimate in the 1° box. The authors use surrounding estimates of AOD. How frequent are these cases and are the results changed if these cases are discarded rather than interpolated?*

If the grid box was completely covered by the clouds and no AOD retrievals were available, we used an average of AOD data from the surrounding 1° resolution boxes. Such procedure was implemented to maximize the number of satellite retrievals. Since from

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the time the manuscript was first put together almost two years of additional satellite data became available, we removed the interpolation and discarded the boxes completely covered by clouds. As can be seen from the new figures, the changes in the results are insignificant.

*7. Line 136-137: Not clear what is meant here. Are pixels "boxes" ? What kind of data are you talking about ?*

Yes we meant boxes. However, in the revised paper we have removed this restriction as well. Again no clear differences between "restricted" and "non-restricted" cases are found.

*8. Figure 1: The limits of the regions are hard to see. Could be shown for all 4 seasons.*

Suggested changes were implemented in a revised manuscript.

*9. Figure 3: I do not think that line plots are appropriate as they assume a linear variations between the points. Bar plots are more appropriate for such figures.*

Suggested changes were implemented in a revised manuscript.

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