Response to Reviewer (Pekka Kolmonen) Comment #3: Our response is presented in red font.

The manuscript describes work that has been continued to understand and mitigate the existing bias between the two MODIS instruments. Some improvement has been achieved by applying the methods described in the manuscript. In addition, simulated aerosol fields were used to find evidence that the bias is not connected to the diurnal cycle of aerosol conditions. While the scientific significance of the presented work is not at the highest level, the publication of the manuscript is very important for the vast community exploiting the MODIS aerosol data for further research.

The manuscript follows good scientific practice and is written in fluent and easily understandable English.

Thank you Dr. Kolmonen for the review. We will not disagree about the scientific significance in terms of learning about the atmosphere, however, we believe the importance of the work is to let researchers know about pitfalls of using data. The easiest explanation (differences in AM/PM observations implying diurnal cycle) may not be the correct explanation.

Minor comments:

Has the impact of the measurement geometry (before noon - afternoon) been studied? If so, could the authors, please, provide short description in the manuscript and/or a reference.

As far as we know, there has not been a detailed study on this. We do know of some assimilation-based studies (e.g. Hyer et al., 2011) that have looked at the angle-dependence of the biases in AOD retrievals (MODIS Collection 5).

We have created some plots regarding the differences in Local Time observed by the two MODIS sensors (As new Figures within the paper), as well as plots showing relative differences of geometry (shown here only). For the geometry, when looking at 2008 only, there is on average a 0.8° difference in solar zenith angle (Terra < Aqua), and associated difference of 0.3° in scattering angle (Terra > Aqua). Note, however that while the solar geometry is symmetric over the long-term, geometry is less symmetric on shorter time scales.

Satellite Overpass: Local Solar Time



NEW Figure 1: Gridded average MODIS local observation time (local solar time) for Aqua (A), Terra (B) and the difference between the two (C).



Extra Figure (not in paper): Gridded average solar zenith (A) and scattering angles (B) for 2008. Each panel represents the difference between averaged MOD04 and averaged MYD04 (Terra-Aqua).

Could the authors explain the difference in the number of collocations between the instruments in table 1.

Generally, Terra should have more collocations over land, due to Terra observing lower cloud fraction than Aqua over land (see King et al. 2013). We do not know whether a >10% difference in collocations is consistent with cloud fraction difference. It is somewhat puzzling why also more Terra ocean collocations considering higher cloud fraction observed by Terra over ocean, however this might be because the collocated AERONETs are near shorelines. Clearly, this question requires further study.

Errors/typos:

Page 15, line 20: There is an extra "has" word or the word order is wrong.

Removed the extra "has"

Figure 3, caption: Is the "fractional difference" meant to be "relative difference"?

Yes. Thank you.

Hyer, E. J., J. S. Reid, and J. Zhang (2011), An over-land aerosol optical depth data set for data assimilation by filtering, correction, and aggregation of MODIS Collection 5 optical depth retrievals, *Atmospheric Measurement Techniques*, *4*(3), 379-408, doi:10.5194/amt-4-379-2011.