Response to Anonymous Reviewer #2

We would like to thank Reviewer #2 for his/her comments. We have done our best to address each of the points as detailed below.

Note: All reviewer comments are in *italics.* All author responses are in normal format.

#1. *The paper shows that the lidar ratio has considerable spread globally. Because of this, changing the lidar ratio from the CALIOP default to 26 sr, while improving bias in the retrieved CALIOP AOD from SSA, will not drastically improve the error in spatial and seasonal variability. The current paper appears a half-step towards formulation of a lidar ratio that is a function of the wind speed that would significantly improve the CALIOP retrieval relative to the proposed change in global lidar ratio here. Perhaps the step of parameterizing the lidar ratio with wind should be included in this paper? It appears that minimal extra work would be required and the value of this paper to the community would be increased substantially. Unless there are significant reasons for leaving that work to a separate paper I think effort should be made to parameterize the SSA lidar ratio in this study.*

We agree with the reviewer that a parameterization of lidar ratio with wind speed could add value to the paper. However, we note that the lidar ratio is dependent on far more properties than wind speed: mainly atmospheric variables like relative humidity and boundary layer depth and to lesser extent chemical properties. Thus, parameterizing the lidar ratio as a function of ocean surface wind speed may provide an oversimplified expression to the scientific community. Nevertheless, we agree with the reviewer and have included the parameterization as online supplementary Figure S2 with a word of caution. The equation for the least squares linear regression is $S_p = -0.5U_{10} + 28.4$ with an $R^2 = 0.76$.

#2. *Marine organic aerosol may contribute to the spatial and temporal changes in aerosol properties (e.g. O'Dowd et al., 2004). There is limited mention of the impact of marine organic aerosol on the lidar ratio, beyond mention of general chemical composition. Might marine organic be expected to have different optical properties to pure sea salt and affect the retrieval? Might this contribute to the remaining spread and seasonal geographical distribution once wind speed has been accounted for? It may be worth investigating this in future and going into a more detail in this paper how the chemical composition of marine aerosol would be expected to alter the retrieval.*

The reviewer is correct. Organic aerosol is expected to contribute different optical properties than pure sea salt. These differences will indeed propagate through to the lidar ratio retrievals, contributing to the results in this paper. Unfortunately, exactly how we expect these differences to manifest is unclear. A significant amount of laboratory and in-situ evidence has shown that increases in the organic content of inorganic aerosol can influence hygroscopic properties. These changes in aerosol hygroscopicity will probably have an effect on the optical properties for marine aerosol as well. The following was added to the conclusions section of the manuscript: "A large body of experimental data suggests that increases in the organic fraction of marine aerosol can have implications on hygroscopicity (e.g., Saxena et al., 1995; Fuentes et al., 2011; Ovadenevaite et al., 2013) and could potentially influence our results."

#3. *pg221 line 16 - should this be less than (<) 0.01 sr^{-1} based on Omar et al., (2009)?*

We thank the reviewer for catching this inconsistency. The revised manuscript reads: "We start with clean marine aerosol that is identified based on surface type (as determined by the location of the satellite) and either total integrated attenuated backscatter $\gamma' > 0.01$ $km^{-1}sr^{-1}$ or total integrated attenuated backscatter $\gamma' < 0.01$ $km^{-1}sr^{-1}$ and volume depolarization ratio $\delta' < 0.05$ (Omar et al., 2009)."

#4. *Figure 2 - Just a suggestion, but rather than the rainbow color scale it may be informative to use another color scale (e.g. blue-white-red) to highlight the difference relative to the CALIOP assumed values.*

We decided to retain the current figure since in Fig. 1 we show the difference between SODA and CALIOP AOD, which can be a proxy for the difference map suggested by the reviewer.

References:

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Saxena, P., Hildemann, L. M., McMurry, P. H. and Seinfeld, J. H.: Organics alter hygroscopic behavior of atmospheric particles, J. Geophys. Res., 100, 18755-18770, doi:10.1029/95JD01835, 1995.