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Atmospheric Measurement Techniques Discussions

Interactive comment on "Use of the CALIOP vertical feature mask for evaluating global aerosol models" *by* E. P. Nowottnick et al.

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Anonymous Referee #2 Received and published: 4 March 2015 General comments This paper is really interesting and dealing with a relevant issue for aerosol global studies: the aerosol typing and how this is captured by the models (and by the satellite). As general comment, I suggest to the author to explicitly report that CALIPSO typing algorithm has of course some limits and some are already known. Report about this, some references. Moreover as I reported also in the quick comment, I suggest to modify the nomenclature of VFM as obtained by MERRAero. There are CALIPSO Level2 and Level3 data as well, and actually the VFM is a CALIPSO Level2 product. Using Level 2 and Level3 nomenclature for the MERRAero, even with a different mean-

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ing respect to CALIPSO one, could be misleading and could confuse the reader. Apart from this general comment, there are minor points to be addressed, which I report in the Specific comments below.

We thank reviewer #2 for providing comments/suggestions on how to improve our manuscript. To avoid confusion, we have renamed the MERRAero Level 2 and Level 3 VFMs "MERRAero-CALIOP" and "MERRAero-Extinction", respectively.

Specific comments: Page 1402 lines 10-13: here is not clear the difference between lev2 and lev3. The authors describe it better in the text. I consider important the abstract reports in the clearest way this relevant difference.

We agree that the description of our MERRAero-CALIOP and MERRAero-Extinction previously (Level 2 and Level 3) methodologies was not clear here. We have modified the text as follows: For comparison to the CALIOP VFM we construct two synthetic VFMs using the MERRAero aerosol distributions: a CALIOP-like VFM in which simulated the MERRAero calculated total attenuated backscatter and estimated particulate depolarization ratios are used to mimic the CALIOP VFM typing algorithm, and an extinction based VFM in which we use MERRAero extinction to map MERRAero aerosols to the CALIOP VFM types.

Page 1404 lines 23-26: for ground based/airborne lidars, your references are just some examples, so use e.g. and probably it would be more correct to provide few references but for different regions of the globe.

We have added e.g. before our reference list and have added references to additional studies from around the globe. "...ground-based (e.g. Huang et al., 2010; Johnson et al., 2008; Papayannis et al., 2005; Matthias et al., 2004; Reid et al., 2003; Campbell et al., 2002; Welton et al., 2001; Welton et al., 2000) and airborne (e.g. Rogers et al., 2009; Esselborn et al., 2008; Reid et al., 2003; McGill et al., 2002; Browell et al., 1997; Browell et al., 1983) lidar systems..."

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Page 1407, line 19: decreases

Changed.

Page 1413, lines 5-18: authors state that using their look up tables and computing particulate depolarization ratios, they found values different from measured ones, so they increased of 30% the depol values for dust particles. A fair explanation of this problem is reported about the inability of the model to represent the actual non-sphericity of dust particles. My point here is: does this inability affect not only particulate depolarization ratio but also other parameters as extinction and backscatter?

This is a question. We have used observation-based refractive indices for dust that have been shown to compare well with MODIS, AERONET, and CALIOP observations (Colarco et al., 2014a). Our use of non-spherical particles yields a realistic lidar ratio (40 Sr) despite the need to adjust our depolarization ratio. If we had used a spherical model for dust, we would have less backscatter and subsequently a lower lidar ratio ($\sim$20 Sr) and would have to assume a depolarization ratio for dust. So, while it is unfortunate that we cannot directly simulate observed dust depolarization ratios using our non-spherical dust model, our dust optical model produces realistic extinction to backscatter ratios.

Page 1416, line 7: fig. 2a

The AERONET station locations are plotted on Figure 1a. I have clarified this in the text (station locations on Figure 1a).

Page 1416, line 19-20: though. . .MERRAero. Not clear, please rephrase.

We were referring to the lack of observations of high AOT events by AERONET at Capo Verde. We have reworded the sentence: “At Capo Verde, an island site off the west African coast and under the main dust pathway, MERRAero captures the timing and observed magnitude of AOT during July with a modest correlation coefficient (r2 = 0.437) and unfortunately there are not quality assured AERONET observations of the

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high AOT events simulated in MERRAero."

Page 1416, lines 22-26: the absence of correlation is not simply related to a potential bias in the values: if they would be just biased the correlation would be however high. The low r could be related to the inability to well reconstruct the angstrom for same particles (eg dust) but not for others. In this way, you would loss correlation.

We allude to this possibility as a cause of the low AE correlation in the text: Comparatively, MERRAero AE values are less than 1 and not well correlated (r2=0.209) when compared to those observed by AERONET, indicating that we are simulating aerosols that are too small due to an incorrect representation of the dust particle size distribution or too large of a contribution from anthropogenic aerosols, such as biomass burning at this location.

Page 1418, lines6-15: I support the hypothesis of marine particles identified by CALIPSO as dust ones. Dust particles flowing at very low altitudes for thousands of km seems to me unrealistic. On the other side, if those layers are marine particle layers instead of dust; this would mean that a lidar ratio around 20 sr instead of 40sr should be used reducing the extinction from CALIPSO (fig 3 top panel) and obtaining a better agreement with MERRAero extinction profiles.

We have added additional text: "Applying the marine lidar ratio (20 sr) instead of dust (40 sr) would reduce the CALIOP extinction by 50% for these layers, resulting in extinction values that are comparable to MERRAero."

Page 1421, lines 4-10: which is this feature with low aerosol load and high depolarization? Which is its source? Explain it, please.

This feature is related to low loading of dust (which still has high depolarization ratios) that is transported to altitudes higher than seen in CALIOP. In the text, we have added further explanation: Comparing MERRAero extinction to the estimated depolarization ratio, we see that this bias occurs in regions with low dust loadings, yet are above the

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minimum extinction (0.003 km-1 from Winker et al., 2013) detection limits of CALIOP, indicating that MERRAero is transporting dust to higher altitudes when compared to CALIOP for this case.

Section 4.4: a general comment. If v2 and v3 agrees you could state that the VFM algorithm works well, great. But if you have a type in your model (lev3), the algorithm identifies another type (lev 2) and CALIPSO another one this could indicate that the optical properties used within the model could be not so reliable. Did you investigate this point? You should at least mention in the paper that the optical properties for some aerosol types could be affect by a certain (please quantify) uncertainty within the model.

Unfortunately, we haven't investigated this point for each individual aerosol species and are not certain how to quantify this uncertainty. However, we did explore the impacts of dust shape and refractive index on our results and found little sensitivity of our desert/polluted dust typing for July 2009.

Page 1426, lines 24-26: this should be an error in the VFM, yes, because marine layer can be detected only over Sea surface.

We have found the file containing this error and have removed it from the analysis.

Figure 6-8 could this be merged? A big figure with 6 rows (0-1 km at bottom and 5-6km at the top) and 3 columns (calipso, MERAAero 2, MERAAero3) would be easier to read

We have merged Figures 6-8 into one.

Page 1429, lines 17-20: is not possible that the model simulates too much particles? This should be also considered and discussed here.

This is a valid point, however, if the model simulated too many particles our MERRAero-Extinction VFM would reflect this. The difference between our synthetic VFMs in this region highlights differences between our MERRAero-CALIOP and MERRAero-Extinction typing. Using depolarization ratio alone, as in the MERRAero-CALIOP more

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dust is flagged downwind of the source region when compared to the MERRAero-Extinction, which is sensitive to the aerosol loading. We discuss this further in our conclusions.

Page 1431, lines 14-17: not clear from figures. Maybe you mean dust-free in CALIPSO VFM?

Just downwind of the Saharan source region, the MERRAero-CALIOP and MERRAero-Extinction VFMs are similar, but over the Caribbean the MERRAero-CALIOP VFM has a greater occurrence of dusty pixels when compared to the MERRAero-Extinction. VFM. I have clarified this in the text.

Page 1432, line 21: through

Changed to through.

Interactive comment on Atmos. Meas. Tech. Discuss., 8, 1401, 2015.