*Once again, we wish to this reviewer for such interest and close reading of our paper. It is a little concerning that you state: "*This time there were not responses to my latest comments…*"We regret that you did not see, (receive), our point-by-point response to your previous comments. In fact, most of the changes and subsequent improvements regarding the discussion of the effect of dust particles on our results came from your review. None the less, we see that you have found the changes based on the comments below.*

Review of re-revised paper:

Evaluation of aerosol optical depths and clear-sky radiative fluxes of the CERES Edition 4.1 SYN1deg data product *by D. Fillmore et al.*

Highlights

- \- needed paper as MATCH aerosol data are an important element CERES products
- \- now different larger dust sizes are included (good) ... but not correct SSAs (bad)

Concerns

- \- solar flux validation for aerosol cannot be drawn from AOD data alone – aerosol absorption and aerosol size are also important.
- \- apparent effect of decreasing SSA at increasing coarse dust sizes is ignored → wrong absorption is assumed

General comments

I have now reviewed the paper several times. This time there were no responses to my latest comments ... so I just re-read its content. I am delighted that now larger dust size are considered (great), but unfortunately the associated lower SSA (with larger sizes – for the same RFimag) are ignored. This becomes quite apparent from the supplied simulations in Table 6.
I have provided similar simulations, with the associated stronger AAOD (from lower SSA values) at larger sizes and I could demonstrate that for the particular set-up solar losses to the downward surface fluxes are twice as large with a dust size increase by a factor of 4. Thus, with a stronger mineral dust absorption, it is also likely that the' unresolved' issue for dust regions will disappear.

Thus, please redo your dust simulations and re-evaluate the dust area flux comparisons before publication.

Based on your comments below regarding the dependence of irradiance on particle size, specifically Table 6 in the paper, we have found that one SW number was incorrect. Once the correct number was in place, we find that we do not need to re-evaluate our calculations as they agree with the values provided in your review. While, at the same time we also agree that the SSA in the OPAC tables being used for dust particles likely underestimate SW absorption. See below for discussion.

Specific comments

37/38 Clarify this sentence: both Merra and Match are assimilations and the MODIS AOD input is the same. If not explain. Or has this to do that Merra allows for washout processes?

Line 37/38. We have rewritten the sentence to be more precise to read:

'The difference is largely due to the differing methods of assimilating the MODIS AOD data product and the use of quality flags in our assimilation.'

39-42 I assume that refers to Match AOD. So, the surface-flux comparison indicates solar attenuation is too small (-> AOD underestimates and/or absorption underestimates

Yes, those are the two primary possibilities.

42-45 So the CERES clear-sky reflection needs more reflection of the surface site (-> AOD overestimates and/or absorption underestimates.

... so if we combine the two findings... then the only conclusion is that MATCH aerosol absorption is underestimated (which for dust is likely an underestimation in size)

MATCH optical thicknesses over desert sites for clear- and all-sky conditions are larger (Tables 3 and 4). Computed downward shortwave from North Africa groups is larger than observed downward shortwave irradiance at the surface. As the reviewer suggested, it appears that we underestimate shortwave absorption, if particle size is larger. Here are the single scattering albedos as a function of dust particle size with OPAC refractive index. These single scattering albedos are low compared with those provided by the reviewer.

Single scattering albedo of dust particles with OPAC refractive index

Particle size	*1.9 (2.15)*	*0.78 (2.0)*	*0.39 (2.0)*
546 nm	*6.67931E-01*	*8.00413E-01*	*8.78470E-01*
642 nm	*7.15135E-01*	*8.46123E-01*	*9.11902E-01*
842 nm	*7.63865E-01*	*8.85041E-01*	*9.37848E-01*
1226 nm	*7.84489E-01*	*9.02001E-01*	*9.47219E-01*

We believe that the dust size the reviewer mentioned in his comment on line 174 is too large. But we get similar single scattering albedos with a smaller size using OPAC refractive indices.

46/47 leaving issues unexplained (even in the abstract) is discouraging 167 now several dust sizes are allowed (great !!)

Line 47/49. We have changed the sentence to suggest the error may be due to the choice of dust particle size and distributions.

174 the SSA (and ASY) varies with large dust size (and even spectrally), update Figure 1 and simulations! For mineral dust re of 1.5, 2.5, 4.0, 6.5 and 10um the mid-visible SSA values are 0.962, 0.931, 0.918, .882 and .840 for the same imaginary part (here 0.0011). In addition, since the dust solar spectral Rfimag are larger towards the UV the SSA value at shorter wavelengths are even lower (more absorbing)

Figure 1 shows the values currently in the radiative transfer model and so represent the calculations in the SYN1deg data product. Changing the values is not currently an option for the operational SYN1deg product.

223 just curious... are the land-sea contrast offsets of northern Africa a MODIS or a modeling problem? (I do not see very strong offsets in MODIS statistics.)

Because a large land-ocean contrast over the west coast of north Africa does not appear on the right side of Figure 3, it appears to be a modeling problem.

232 Merra apparently includes other AOD data from other sources (MISR, AERONET), but MODIS data should dominate (in volume) so I would not expect so significant differences as displayed in Figure 3. How can you exclude that model-specific aerosol processing in the base- line model (without assimilations) is not the issue. This could be easily verified ... or?

*We believe it is the MATCH model (and so '*base-line model assimilation'*) that is one of the primary sources of the differences. We state as much in lines 234-235.*

259 the least square fits and rms values (in figure 4) are dominated by the largest AOD, but not by the most frequent AOD, thus possibly also show the scatter plots in log/log scale

The log density plot does show the vast majority of AODs are less than ~0.6. And though the fit line is 'pulled down' somewhat by the larger AODs we feel a log/log plot on top of the log density would not significantly change the results presented. It might bring the fit line a little closer to the 1-1 line, but the point that both MERRA2 and MATCH underestimate AOD relative to MODIS will not change. It is also re-iterated in the statistics below the plots.

459 yes! ... and remember a larger coarse dust size can also increase the aerosol absorption

489 this table is interesting and quite revealing. To demonstrate, I did similar simulations, using a solar zenith angle of 0.95 (not 1, oh well but close), a desert surface albedo, a mid-lat summer atmosphere, and dust with (only) a mid-visible optical depth of 0.2 for mineral dust located between 1 and 3 km altitude. Here different dust sizes with their associated SSA are applied (all dust size-distributions assume the same spectral refractive indices with RFimag at 550nm = 0.0011). The downward shortwave and longwave fluxes of these simulations are

No dust Dust (0.2) Dust (0.2) Dust (0.2) Dust (0.2) Dust (0.2)

reff= 1.5um reff= 2.5um reff= 4.0um reff= 6.5um reff= 10.um

shortwave longwave

998	346
985	354
983	357
980	359
974	359
968	359

These calculations consider the lower SSA at larger size (as they should) and the solar losses at the surface flux losses for factor 4 dust size increase with these calculations are:
-15 W/m2 (between reff 10 and reff 2.5) while the author's simulations - even with larger u0 (=1) - 8 W/m2

(between reff 8 and reff 2). So please redo your calculations with the correct (lower) ssa values at larger sizes ... and you will have an explanation to your dust bias.

And the LW dust impact on downward fluxes depends strongly on the assumed dust vertical distribution as much as on size. Thus, all size (... from AeroNet inversions?), correct RFimag (especially in the stronger absorbing 8-10um region ... from I.Sokolik?) and altitude (...from Calipso?) have to all accurate for useful clear-sky dn LW flux comparisons at the surface.

So when the correct dust sizes/SSAs are applied with the result of a stronger aerosol absorption possibly (with the right dust sizes, and right dust altitudes) correction to AOD and water vapor may not be necessary to bring SW and LW fluxes into agreement.

First. we'd like to point out that there was in fact an error in Table 6. The value for Downward SW irradiance for particle size 2.0μm should have been 1038Wm^{-2}, not 1028Wm^{-2}. This has been corrected in the paper, line 489. This then brings our table values into line with the values presented above by the reviewer. Specifically, he records, for a fourfold increase in particle size, a decrease in DSI from 983Wm^{-2} to 968Wm^{-2} (~16Wm^{-2} or -1.5%). With the correct value in Table 6, a fourfold increase in particle size (2.0μm to 8μm) the DSI in our calculations decreases from 1038Wm^{-2} to 1020Wm^{-2} (~18Wm^{-2} or 1.7%). If we change our cos(SZA) to 0.95 (as the reviewer used) the DSI values at 2.0μm and 8μm are 977Wm^{-2} and 960Wm^{-2}. So again, a similar decrease of ~17Wm^{-2} but the same percentage of 1.7%.

We thank the reviewer for pointing out the discrepancy which was in fact a mistake on our part. We also agree that the discrepancy between the SW down observation and calculations is likely based on the absorption characteristics of the dust particles (based on the SSA's in the table above). We cannot however, at this point in time, change the results in the SYN1deg data product.

*The longwave numbers are correct in Table 6. To comment on the reviewer's statement that '*LW dust impact on downward fluxes depends strongly on the assumed dust vertical distribution as much as on size', *in our offline radiative transfer model we increased the scale height of 1.5km to 5.0km for the same inputs as shown in Table 6. This resulted in DLI values at 0.5μm , 2.0μm and 8.0μm particle sizes of 351Wm^{-2}, 357Wm^{-2} and 359Wm^{-2} respectively. Thus, increasing the scale height of the dust particles did not change the DLI by more than 1%, less than the changes due to particle size. This of course kept the particle size the same throughout the column which does not account for the fact that smaller dust particles are more likely to be lofted higher in the atmosphere.*

577 more clouds→more AOD? ... not for dust, when clouds remove dust

In this case we imply that more clouds indicate more AOD in the MODIS AOD retrieval process as reported in the Varnai et al, 2017 reference.

593 redo your large dust SSA calculations ... and the solar surface vs toa flux difference problem

for mineral dust should be gone.

*At this point in the processing of the MATCH model and its subsequent use in the SYN1deg radiative transfer calculations, we cannot '*redo our large dust SSA calculations'. *What we have done, and at this reviewer's suggestion is try to show, in the paper, potential error due to the constraints we currently have on our dust models in the radiative transfer code (Table 6) and the MATCH model's ability to define large and small dust, Figures 15, 16 and related discussion.*

Below I attach a summary of the top-down (optics → component) approach of the MAC climatology, which lists in Table A1 different dust types, in Figure A3 (column3) seasonal averages of dust size (based on AAODc and AODc-DU), assumed size-distributions and spectral refractive indices in Figure A6 and resulting single scattering properties in Figure A7 (where ‘DU+’ is for larger dust with reff =4um and ‘DU’ is for background dust with reff=1.5um).

We thank the reviewer again for the information and the thorough reviews of the paper. We have added a sentence in the acknowledgements stating how the reviews have improved the paper overall, Lines 610-612.