

This study uses the observation-based size-resolved dust concentration, asphericity factor and spectral refractive to improve the simulated dust radiative effect at TOA, surface and in the atmosphere. The adjustment improves the agreement of simulated globally and annually averaged DAOD with the semi-observational based estimate. Several experiments are implemented to investigate the sensitivity of dust radiative effect to dust size, shape, and refractive index. This study finds that a less absorptive SW dust refractive index (RI) and more absorptive LW RI are required for coarse aspherical dust to achieve a better agreement against a semi-observational-based radiative effect efficiency at TOA. The combination of coarse aspherical dust with less absorptive SW refractive index induces a less heating effect in the atmosphere. Overall, this study is interesting and comprehensive, it provides new insights to the research community. I have several minor comments listed below.

1. Line220: In this section, I think it would be helpful to add some equations to show how exactly the emission flux and emitted dust mass fraction are scaled.
2. Line267: Should 'DB17' be 'DB19'? Please correct
3. Line272: Should 'DB19' be 'DB17'? Please correct
4. Line320: In 'The **lower** DAOD550 from E2 to E1', lower should be higher, right?
5. Line376: Please change 'V83 simulation' to 'IMPACT-Sphere-Mineral-V83' to be specific, 'V83 simulation' is confusing, since both E1 and E2 use V83.
6. Section 3.5. Figure 9 shows the comparison between E2 and E1, the difference between E2 and E1 could be divided into 3 aspects: dust size, shape, and RI (SW-RI). Then each aspect is investigated in figure 10. However, I wonder why to choose E4 as a reference case in figure 10? We could see that LW-RI (volz83) is the same for E2 and E1, there is not an experiment (or marker) in figure 10 could directly illustrate the contribution of RI difference (only SW-RI is different in this case) to the radiative effects difference between E1 and E2. Would it be better if change the reference case to be E2? Then set up three experiments to change size, shape, SW-RI respectively?
7. The caption of Figure 4 and Figure 5 is not consistent with the figure, please correct.
8. I think the 'Sphericity' in Figure 10 is the 'Aspherical shape' experiment (E5-E4) in table2. It would be easier to understand if the names are consistent. In addition, in figure10, it would be clearer if add the experiment number (from Table 2) for each marker.