Aerosol particle size has important influence on its optical properties as well as radiative and climatic effects. To develop a more computationally efficient aerosol particle size parameterization in a global model is of great importance for modelling and remote sensing. The development of the R_{eff} parameterization for OM and SNA combining observations and GEOS-Chem-TOMAS simulation in this study is of good innovative and utility, though there are some inadequacies in the development of the parameterization as well as in its validation. I recommend it can be accepted after the following major revisions.

Major issues:

1. The main demonstration focuses on the time and area dominated by SNA and OM and does not provide sufficient proof of the simulation ability of the new parameterization. In addition, the parameterization is still very deficient for the extinction simulations at upper levels and low aerosol concentrations (as shown on the right side of Fig. 2, many upper level simulated extinction is only about 1/3 of the measured)

2. Some of the statements have inconsistencies between the figures and the text (some of which are pointed out in minor comments), and it is advisable to provide visual illustrations or relevant references when explaining the physics behind the issues in the pictures (e.g., Lines 298-302).

Minor comments:

1. Lines 41-42. Please explain the "strong size dependence" of the number of CCN.

2. Lines 61-62. Only 3 of the 10 models contain online size-resolved aerosol microphysics does not visually illustrate its computational cost, and it may be more convincing to provide comparative results of computational speed or other references.

3. Lines 85-86. Provide references to the dominance of OM and SNA in fine aerosol composition in populated areas.

4. Line 206. Compared to DISCOVER-AQ, M_{SNAOM} in KORUS-AQ results is not significantly sensitive to aerosol size, better to quantify the correlation and provide an explanation.

5. Top of Figure 3. The use of such a low differentiation color for two types of data in a graph makes it difficult for the reader to access the information, and it might be better to use a different marker or a more differentiated color.

6. Line 257. The tendency of M_{SNAOM} and R_{eff} do not look consistent from the graph, and it would be better to provide some quantitative illustration

7. Lines 265-267. The demonstration of OM mass fractions as a driving factor is not rigorous enough, for example, in the area of high OM mass fractions in Central Africa, M_{SNAOM} and Reff have similar distribution in general rather than "high R_{eff} despite the low M_{SNAOM}" as stated in the paper.

8. Line 273. Is it R_{eff} for OM and SNA or for all aerosols?

9. Top of Figure 5. Same as Figure 3

10. Lines 315-316. R_{eff} magnitude and distribution are not as "well represented" as stated in the paper. The bulk underestimates the hotspot values of TOMAS and their distributions in North America and Europe show significant differences (top of Figure 3 and Figure 5), which need to be further elucidated or improved to eliminate this difference.

11. Lines 316-317. R_{eff} decreases with height, and it is not reasonable to use the R_{eff} value to illustrate the diminished difference at different R_{eff} levels. It is more appropriate to use parameters such as percentage change to express it.

12. Lines 318-327. It is better to combine the satellite-retrieved AOD rather than only using simulated data to illustrate the changes in the updated compared to the base.

13. Lines 335-336. Who does "as a function of the parameterized surface R_{eff} for SNA and OM" refer to specifically?

14. Figure B4. The figure only shows the difference between AERONET and the default GEOS-Chem simulation and the difference between the new parameterization and the default simulation, which does not capture the impact of the new parameterization, so why not directly show the difference between AERONET or other observations with the new parameterization and the default simulation?