**Atmospheric
Chemistry
and Physics
Discussions**

Interactive comment on "Regional and global modelling of aerosol optical properties with a size, composition, and mixing state resolved particle microphysics model" *by* F. Yu et al.

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The authors thank the referee for his/her great effort in reviewing the manuscript. The detailed comments are very constructive and helpful to improve the paper.

We appreciate the referee's positive comments about the importance of the work and suggestions. We have re-worked on section 2 and addressed all the specific comments, as detailed below.

1. Revised as suggested.

2. Add "mostly" as suggested. Because of missing data and limited duration of the

AERONET measurements at each site, it is difficult to derive reliable statistical information. In our future research, we will further analyze the AERONET data to identify relatively long periods (a couple of months, with minimum missing data) for WRF-Chem-APM simulations and carry out comprehensive statistical assessments of the model performance.

3. Done as suggested.

4. Sentence deleted.

5. Modified as suggested.

6. Changed as suggested.

7. We have substantially shortened the paragraph and combined it with the last one. At this point, we were not able to come up with a suitable reference for the importance of resolving water online. If the referee could suggest some for us, we would be happy to include them here.

8. Sentence deleted as suggested.

9. Done.

10. We have clarified "similar approximations" by replacing "similar approximations for particles containing absorbing cores should be avoided" with "the treatment of particles containing absorbing cores as internally well mixed should be avoided".

11. Done.

12. Thanks for the suggestion. We have added the sentence.

13. Actually, this sentence is a general statement and here k_r and k_i refer to both shell and core (dust or BC). This is clarified in the text.

14. These two paragraphs serve as the description of the Tables. To address the referee's concern, we have deleted the information that has already in the tables. How-

ever, we keep some discussions that should be helpful to better understand the tables. We feel that it is clearer to keep Table 1 and Table 2 separated as one is for shortwave and for particles of different types while the other is for longwave and for dust particles only.

15. For a global aerosol model, the wavelengths of interest are pre-decided and don't change during the simulation. For example, we know the exact wavelengths to be calculated in the model for comparison with certain observations (such as AERONET, etc). As we have pointed out in the previous paragraph, "the values of wavelength are selected based on the wavelengths of AERONET, MODIS, MISR, and wavelength bands of a radiative transfer code used for DRF calculation", and thus "no interpolation with regard to wavelength is needed to obtain the optical properties for comparison with corresponding observations from AERONET, MODIS and MISR, and for input to a radiative transfer code". We have modified the sentence to make it clearer.

16. Revised as suggested.

17. One of objectives of this paper is to present a computationally efficient scheme (using lookup tables) for online calculation of the aerosol optical properties from detailed particle property information predicted by APM. While the designed scheme is computationally efficient, its accuracy is also important. The thick dashed cyan lines in Figure 2 are shown for the comparison purpose, which we feel to be necessary. All the details can be clearly seen when the figure is zoomed in.

18. Revised as suggested.

19. The main purpose of this figure is to illustrate (1) the dependence of Qext and Qabs on key controlling parameters and (2) the accuracy of Qext and Qabs interpolated via the computationally efficient lookup table scheme. The dependence information is used in optimizing the lookup tables (i.e., total # of points and values at each point for all dependent variables). For each curve shown in the Figure, only one parameter (shown as x-axis) is changing (i.e., we don't combine size effects and mixing effects).

We have improved the paragraph for clarity.

20. This ki value (0.27) refers to the brown carbon only. The present model doesn't consider the formation of brown carbon (a part of shell if considered) but the look up table is designed to cover such possible values for future usage. The sentence is clarified. Alexander et al (2008) has been added to References.

21. Done.

22. Shortened the text and added references as suggested.

23. Yes, we treat BC and POC as externally mixed. A sentence has been added to discuss the limitations.

24. The treatment of BC and POC in the present study is the same as the one described in Yu and Luo (2009). While in section 2.3.2.3 of Yu and Luo (2009) we abbreviated BC and POC as BCOC, BC and POC are actually treated separately (i.e., externally mixed), as discussed in detail in the second paragraph of that section.

25. Yes, condensation to all the particles types considered. Details of how we treat SOA are described in Yu (2011). We have reworded the sentences and cited the reference.

26. Deleted as suggested.

27. Done.

28. Done.

29. Done.

30. Done.

31. Done.

32. Moved as suggested.

33. Revised as suggested.

34. We have added several sentences to address the referee's concerns.

35. Done.

36. We have deleted the word "properly" and modified the sentence as suggested.

37. Done.

38. Done.

39. Done.

40. Done.

41. Done.

42. Done.

43. Revised as suggested.

44. Done.

45. Revised as suggested.

46. Modified.

47. Typo corrected. Please see our reply to comment #2 about the statistical analysis.

48. Done.

49. Sentence deleted.

50. Done.

51. Revised as suggested.

52. Revised as suggested.

53. Station 7 is close to Washington DC and Baltimore MD and thus is subject to the

influence of local plumes. The potential causes include uncertainty in the predicted meteorology and local emissions. We have pointed this out in the revised text.

54. The nucleation rates have large spatiotemporal variations. The higher nucleation rates over certain regions on that particular day are mainly associated with high sulfuric acid vapor concentrations. This has been discussed in the revised manuscript.

55. Done.

56. (1) We feel that it is clearer to keep Table 1 and Table 2 separated as one is for shortwave and for particles of different types while the other is for longwave and for dust particles only. (2) We can't remove the "Values at each point" as some values are neither geometric nor arithmetic. (3) Yes, d-shell for BC-core and dust-core is $0 - 1$ μm. We double checked the "values at each point" column to make sure that it gives the same range (typo: "k" should be "l"). (4) The numbers of points are chosen based on the range, sensitivity of optical properties to the parameter, and size of lookup table. (5) Yes, we don't consider the dependency of d-shell on d-core here. (6) Typo corrected $(0.02 -> 0.05)$.

57. Done.

58. Typo corrected. One of objectives of this paper is to present a computationally efficient scheme (using lookup tables) for online calculation of the aerosol optical properties from detailed particle property information predicted by APM. While the designed scheme is computationally efficient, its accuracy is also important. The thick dashed cyan lines in Figure 2 are shown for the comparison purpose, which we feel to be necessary.

59. We tried to make the circle bigger and white line thicker but the overall effect is not that good (overlap of symbols and cover of modeled values by symbols). We find that one can easily pick out the sites when the electronic version of the figure is zoomed in (to 200% or larger).

60. We have added labels. Stations numbers are already in both black (smaller font) and white (larger font) so that they can stand out under both deep and light background colors.