The paper presents a numerical study on the optical properties, especially absorption, of black carbon based on different assumptions on the mixing states and regional aerosol models. The AQMEII-3 results are used as the input aerosol properties, and a generalized off-line tool FlexAOD provides a unified method to give the optical properties, which are compared and evaluated by the AERONET results. By connecting the modeled aerosol properties and the observed optical properties, the manuscript presents a unique aspect to understand the absorption of BC aerosols. The paper is well designed and well organized, and I recommend it to publish in ACP after revision. The following lists my comments on the manuscript.

General comments:

1. As mentioned by the authors, the underestimation on total mass is the primary reason for the low AOD obtained, and this can neither be ignored on discussing the absorption properties of BC. This becomes critical because the BC concentration, which is also the primary factor for absorption estimation, may be significantly over- or underestimated. Considering the completely different profile results presented in Figures 2 and 3, the relative performances of the models would definitely influence the absorptions.
2. The modeled results are evaluated by comparing with the observations from AERONET measurements. However, the optical properties of the AERONET are retrieval products based on certain assumptions, and this means the results may differ if different assumptions were made for the retrieval. In other words, how would the uncertainties related to the AERONET observations themselves influence the evaluation of this study?
3. The mean radius of BC is assumed to be 11.8 nm based on Table 3, which is close to the size of monomer in BC aggregates. It is well known that the BC in the atmosphere is in the form of aggregates of those small monomers, and how would the non-spherical geometry influence the results. It would be difficult to account for the aggregation structures in such a work due to the computational burden, but it is worth to discuss the potential influences by considering previous studies. For example, Li et al. (https://doi.org/10.1002/2015JD024718) evaluated the influences of aggregation on BC optical properties especially AAE, and the effects of internal mixing was also studied by the same group (https://doi.org/10.1016/j.jqsrt.2016.10.023).
4. It is noticed that the primary organic aerosol is also absorptive. Is the influence also considered for estimating BC absorption? Its effects should also be removed for estimation on the absorption enhancement.

Specific comments:

1. "Grid Spacing" in Table 2 is listed as either km or degree, and it should be unified for better comparison.

2. The information in Table 4 is not well summarized, and the differences among the six models should be known with only reading the table.
3. In Figure 5, the colormaps for small and large count numbers are close, and clearer colormap is suggested.
4. It seems that Europe and N. America do not show too many differences on the conclusions related to the mixing state and absorption simulations. There are much less data for evaluating the N. America case, which makes the discussion less solid (e.g. Figs 5b and 8b). Why not just focus on Europe, because it will not change the conclusions of the manuscript but makes it much easier for discussion.
5. For Figures 6 and 9, are the values in the y-axis in unit of percentage? For example, does 1.0 mean 100% or 1%?