

In this study, the authors investigate the effect of changing the (complex) refractive index of black carbon (BC) aerosol on the aerosol absorption optical depth and on the effective radiative forcing from BC-radiation interactions. They isolate the effect of the BC refractive index by running ensembles of simulations in the atmospheric model CanAM5.1-PAM and varying only the BC refractive index among three values commonly used in Earth system models. The authors state that no previous study has isolated the impact of the refractive index of BC in this way, using a single model with other aerosol treatments held constant and the simulations being otherwise identical. If so, then this is an important assessment to have conducted. The manuscript is well written, and the results are important. As such, in my opinion, this manuscript is appropriate for publication in *Atmospheric Chemistry and Physics* pending some clarifications and small corrections, as I list below.

1. It is mentioned in Appendix A, but the authors should also mention in the main part of the text whether the radiative properties of the BC aerosol are affected by humidity.
2. lines 51-31: “For instance, measurements of scattering and absorption by flame-generated particle may be fit to Mie theory (assuming spherical particles) or Rayleigh-Debye-Gans theory (assuming aggregates).” – Rayleigh-Debye-Gans theory is only approximate, and thus the authors should mention other theoretical frameworks that have been used to fit/model scattering and absorption by BC aggregates, e.g., the multiple sphere T-matrix method (MSTM), the discrete dipole approximation (DDA), and the generalized multi-particle Mie method (GMM). (See for example, Liu and Mishchenko, (2005, 2007), Liu et al. (2008), Sorensen et al. (2018), Kahnert and Kanngießer (2020), and Haspel et al. (2023).) Also, “flame-generated particle” should be “flame-generated particles”.
3. lines 99-100: Why is BC set to 1850 levels in the perturbed ensemble? That sounds more like what a control ensemble would be.
4. line 227, lines 266-267: Can the authors explain why the impact on total BC effective radiative forcing is not statistically significant even though impact on the effective radiative forcing from BC-radiation interactions is large?
5. lines 282-291: Even higher values for the complex refractive index of BC have been measured and used in previous studies (e.g., Janzen, 1979; soot G of Fuller et al., 1999; Liu and Mishchenko, 2005, 2007; Liu et al., 2008; Moteki et al., 2010). The authors should mention these and also assess the impact of one of these even higher values.

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