Response to the comments of Editor (egusphere-2024-2372)

I advise the authors to provide an extended discussion considering all referees comments, especially considering one of the referee's criticism of novelty associated to BC ageing being previously modeled with similar methods.

Response: We sincerely appreciate the editor's thoughtful reminder. We have addressed all the reviewers' comments, including the critique related to the novelty of modeling BC aging with similar methods. Ambiguity in our original manuscript might have led to misunderstandings of the reviewer. Through collaboration with the CMAQ development team at the Office of Research and Development (ORD), US EPA, this is the first time the BC aging process has been considered and tracked within the framework of CMAQ model and WRF-CMAQ two-way coupled model. Even though CMAQ model is a modal model, our approach of incorporating BC aging process in the model is different from other existing modal models, such as CAM5-MAM3 and CAM5-MAM7 models (Liu et al., 2012; 2016). Unlike these models, which introduce an additional mode to represent externally mixed BC, our approach takes a different strategy for representing BC mixing state and aging dynamics.

The CMAQ model, as a well-established air quality model, includes over a hundred aerosol species and hundreds of chemical reactions, representing a robust set of physical-chemical processes. Within the WRF-CMAQ model framework, our focus, we introduced two new species (Bare BC and Coated BC) to represent different BC aging states and we believe this is a more suitable method to incorporate the effects of BC aging. Secondly, we represented the aging process through a virtual chemical reaction and modified key processes influenced by different BC aging states, including wet deposition and aerosol optics. The aerosol optics algorithm, which is highly sensitive to particle size, was updated with recalculating size information accordingly. This method minimizes computational complexity while incorporating BC aging into the CMAQ model and WRF-CMAQ coupled model. Without compromising the accuracy of commonly simulated variables in the original model, this method introduces the capability to simulate BC mixing states, this method introduces the ability to simulate BC mixing states, the wet deposition of internal and external BC, and improves the accuracy of BC mass concentration and aerosol optics. Therefore, our approach offers a novel perspective on incorporating BC aging within a modeling framework. We have revised the manuscript to articulate clearly the novelty of our method (details can be found in the response AC2).

References

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