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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Effects of Wegener-Bergeron-Findeisen Process on Global Black Carbon Distribution" *by* Ling Qi et al.

Anonymous Referee #2

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The authors present straightforward study of the impact of the WBF process on black carbon (BC) scavenging in a global chemical transport model (GEOS-Chem). The results are very interesting and important, and the authors are overall, quite thorough in their approach. I have only a few concerns regarding the parmaterizations implemented in the simulations, which require further clarification.

Major comments:

* The experimental and model set-ups are not clearly described. Does the default GEOS-Chem model have a parameterization of the WBF process? Please describe this in Section 3.1. It is ambiguous what is meant by which process (WBF or riming) "dominates". Please describe this in more detail (in Section 3.2). Also, how is the scavenging efficiency parameterized for riming?

* Solely relying on a temperature criterion for generalizing whether WBF or riming "dominates" seems oversimplified. It is also not clear from the description of the method whether the temperature ranges are applied globally. The authors should also note in the text that the WBF process depends on local updraft velocities, saturation vapour pressures over ice and liquid, and ice nuclei present in the region, and models have already started including these factors in their parameterizations as they are all important. How would neglecting these effects on the WBF process influence their results?

References: 1. T. Storelvmo., J. E. Kristjánsson, U. Lohmann, T. Iversen, A. Kirkevåg and Ø. Seland. Modeling of the Wegener–Bergeron–Findeisen process — implications for aerosol indirect effects (2008). Environmental Research Letters, 3(4), 045001. 2. A. V. Korolev and I. P. Mazin. Supersaturation of water vapor in clouds (2008) Journal of the Atmospheric Sciences, 60.24: 2957-2974.

* Sections 2.2, 2.3, 2.4: The errors in the observations appear to be quite large (< 60% for BC_snow and ∼20% for BC_air). What exactly are these uncertainties related to and how are they quantified? How was the accuracy of the measurements in Mori et al. (2014) quantified?

Technical/typographical corrections and minor comments:

* Please mention upfront in Section 2 instead of the Results (page 15-18) that the results of Fukata et al. (1999) are based on a lab experiment.

* Introduction, lines 17-26: Please discuss the impact of the WBF in a broader context. For example, it has recently been shown that it plays an important role in determining the liquid and ice partitioning in mixed-phase clouds, and this could affect cloud feedbacks and climate sensitivity.

References: 1. I. Tan and T. Storelvmo. Sensitivity study on the influence of cloud microphysical parameters on mixed-phase cloud thermodynamic phase partitioning in CAM5 (2016). Journal of the Atmospheric Sciences 73.2: 709-728. 2. I. Tan, T.

Storelvmo and M. D. Zelinka. Observational constraints on mixed-phase clouds imply higher climate sensitivity (2016). Science 352.6282: 224-227. 3. P. Ceppi, D. L. Hartmann and M. J. Webb. Mechanisms of the negative shortwave cloud feedback in middle to high latitudes (2016). Journal of Climate 29: 139-157. 4. G. Cesana and D. E. Waliser and X. Jiang and J.-L. Li. Multimodel evaluation of cloud phase transition using satellite and reanalysis data (2015). Journal of Geophysical Research: Atmospheres 120.15: 7871-7892.

* Page 1, line 17 & page 14, line 28: rimming → riming

* Page 2, lines 2-3: This sentence is confusing. Please rephrase.

* Page 2, line 19: mixed-phased → mixed –phase

* Page 6, line 21: impator → impactor

* Page 11, Line 18: was → were

* Page 12, lines 29-31: this information was already provided earlier.

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