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Interactive comment on "Sensitivity of black carbon concentrations and climate impact to aging and scavenging" *by* Marianne T. Lund et al.

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The authors conducted comprehensive model sensitivity simulations to investigate the impact of BC aging and scavenging on BC concentrations and radiative forcing by evaluating model results with observations over the Arctic and remote Pacific oceans. This study could improve our understanding of how some key processes affect global BC simulation and associated radiative forcing. I have three short comments.

1. For BC aging, the authors included the condensation of sulfuric acid and nitric acid as well as coagulation with sulfate in the model. Recently, He et al. (2016a) implemented a microphysics-based BC aging scheme in a global chemical transport model, which accounts for BC aging due to secondary organic aerosol (SOA) condensation and coagulation in addition to the aging processes in the present study. They showed a

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substantial model improvement by comparing with HIPPO observations and that SOA condensation/coagulation also plays an important role in BC aging, particularly over biomass burning source regions. Since the SOA process is not considered here, it would be useful for the authors to add some discussions on this aspect.

Reference:

He, C., Li, Q., Liou, K.-N., Qi, L., Tao, S., and Schwarz, J. P.: Microphysics-based black carbon aging in a global CTM: constraints from HIPPO observations and implications for global black carbon budget, Atmos. Chem. Phys., 16, 3077-3098, doi:10.5194/acp-16-3077-2016, 2016a.

2. For BC simulations over the Arctic, recent study by Qi et al. (2016a) systematically evaluated the effects of model processes such as BC emissions, dry and wet deposition on BC distributions in both the air and the snow surface over the Arctic. They showed that (1) the flaring emissions (natural gas flaring), particularly in North of Russia, has a significant impact on BC concentrations over the Arctic, (2) the low bias in BC dry deposition velocities over snow and ice in current CTMs contributes to model bias in BC simulations, and (3) including the Wegener-Bergeron-Findeisen (WBF) aerosol-cloud process in mixed-phase clouds significantly improves BC simulations both in the Arctic and globally (Qi et al., 2016b). I suggest citing these recent papers and including some discussions on this aspect, since the content is closely related to the analysis and results in the present study.

References:

Qi, L., Li, Q., Li, Y., and He, C.: Factors Controlling Black Carbon Distribution in the Arctic, Atmos. Chem. Phys. Discuss., doi:10.5194/acp-2016-707, in review, 2016a.

Qi, L., Li, Q., He, C., Wang, X., and Huang, J.: Effects of Wegener-Bergeron-Findeisen Process on Global Black Carbon Distribution, Atmos. Chem. Phys. Discuss., doi:10.5194/acp-2016-706, in review, 2016b.

3. For radiative forcing calculation, the authors mentioned that the effects of BC aging on its optical properties is not considered in their model. Recent studies (He et al., 2015, 2016b) showed that BC aging substantially influences its optical properties due to various coating structures and thicknesses, leading to a factor of 2-4 variations in BC absorption and scattering. It would be very helpful if the authors could discuss about this coating effect during aging on BC radiative properties and/or forcing estimates.

References:

He, C., Liou, K.-N., Takano, Y., Zhang, R., Levy Zamora, M., Yang, P., Li, Q., and Leung, L. R.: Variation of the radiative properties during black carbon aging: theoretical and experimental intercomparison, Atmos. Chem. Phys., 15, 11967-11980, doi:10.5194/acp-15-11967-2015, 2015.

He, C., Y. Takano, K. N. Liou, P. Yang, Q. B. Li, and D. W. Mackowski: Intercomparison of the GOS approach, superposition T-matrix method, and laboratory measurements for black carbon optical properties during aging, J. Quant. Spectrosc. Radiat. Transf., 184, 287–296, doi:10.1016/j.jqsrt.2016.08.004, 2016b.

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