

EGU2020-6459

<https://doi.org/10.5194/egusphere-egu2020-6459>

EGU General Assembly 2020

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Interaction between the Black Carbon Aerosol Warming Effect and East Asian Monsoon

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Black carbon aerosol (BC) has a significant influence on regional climate changes due to its warming effect. Such changes will feedback to BC loadings. Here, the interactions between the BC warming effect and East Asian monsoon (EAM) in both winter (EAWM) and summer (EASM) are investigated using a regional climate model RegCM4, which essentially captures the EAM features and the BC variations in China. The seasonal mean BC optical depth is 0.021 over East Asia during winter, which is 10.5% higher than that during summer. Nevertheless, the BCs direct radiative forcing is 32% stronger during summer (+1.85 W/m²). The BC direct effect would induce lower air to warm by 0.11-0.12 K, which causes a meridional circulation anomaly associated with a cyclone at 20-30 °N and southerly anomalies at 850 hPa over East Asia. Consequently, the EAM circulation is weakened during winter but enhanced during summer. Precipitation is likely increased, especially in south China during summer (by 3.73%). Compared to BC changes due to EAM interannual variations, BC changes due to its warming effect are as important, but weaker. BC surface concentrations are decreased by 1~3% during both winter and summer, by 1~3%, while the columnar BC is increased in south China during winter. During the strongest monsoon years, the BC loadings are higher at lower latitudes than those during the weakest years, resulting in more southerly meridional circulation anomalies and BC feedbacks during both winter and summer. However, the interactions between the BC warming effect and EAWM/EASM are more intense during the weakest monsoon years.