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Seasonal variations of Asian black carbon outflow to the Pacific using a tagged three-dimensional model

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The Community Multiscale Air Quality model with a source and process tagged method (CMAQ/PASCAL) was used to understand source regions and types (anthropogenic (AN) and biomass burning (BB)) of Asian black carbon (BC) outflow to the Pacific during 2008 - 2010. The model calculations generally reproduced absolute concentrations and temporal (seasonal, monthly, and day-to-day) variations of BC mass concentrations observed by both surface and aircraft measurements in outflow regions in East Asia. These model calculations show that both the total eastward flux and transport efficiency (fractions transported from sources) of BC are the highest during spring (26 kg s-1 and 33% at 150E) and the lowest during summer (8 kg s-1 and 20% at 150E). These seasonal variations of Asian BC outflow are generally controlled by transport patterns (monsoons, frontal passages, and convection) and emissions from the following three sources: (1) AN emissions from China (China AN), (2) BB emissions from Southeast Asia and South China (SEA BB) during February - April, and (3) BB emissions from Siberia and Kazakhstan (Siberia BB) during April - July. In our calculations, China AN dominates the total eastward BC flux on period average (61%, 17%, and 6% from China AN, Siberia BB, and SEA BB, respectively, at 150E). On the other hand, SEA and Siberia BB account for 30 - 50% of the total eastward BC flux (150E and 175E) during spring and summer, and they intensify seasonal contrast of Asian BC outflow flux. BC from Siberia BB is also found to be transported to the Pacific more efficiently than that from other sources. Although the amounts of BB emissions are currently highly uncertain, our results suggest that the control of Siberia BB will be important in terms of the trans-boundary transport of BC to the Pacific, North America, and the Arctic.

Keywords: black carbon, regional three-dimensional model, tag model, East Asia, source contribution, biomass burning