The NICAM–SPRINTARS simulation of the long-range transport of black carbon using the K computer

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The Nonhydrostatic Icosahedral Atmospheric Model (NICAM)–SPRINTARS is the global aerosol transport model, which has been developed to calculate global aerosol transport and its influences on radiation and precipitation incorporated with the NICAM. The latest model is developed to include the forest fire emission with daily time-scales and has fine horizontal resolution with 56 km, which is capable of simulating fine scales transport processes of aerosols such as the accumulation of black carbon (BC) behind the cold front, and the wetdeposition process around the low-pressure system.
The large and continuous forest fire emission occurred around Lake Baikal of Siberia in September 2016. The observation of BC was performed from August to October by observational cruise of R/V Mirai (MR16-06) possessed by Japan Agency for Marine-Earth Science and Technology (JAMSTEC), and the maximum BC concentration was detected in 25–26 September around Aleutian Islands. These results imply the long-range transport of BC from Lake Baikal to Aleutian Islands, however, possibility of detection of anthropogenic BC emitted in Asia is not ruled out.
To analyze the origin and transport pathway of observed BC by R/V Mirai observation, we performed the experiments of the NICAM–SPRINTARS with anthropogenic and forest fire emission (Ant+Fire simulation) using the K computer. To estimate anthropogenic BC impact, the simulation without fire emission was performed (Ant simulation). Without fire emission, the BC concentration in 25–26 September is much smaller than observation, indicating small impact of anthropogenic BC on this event. In this event the BC is trapped behind the cold front and beyond the warm front to indicate high concentration peak (about 300 ng/m^3) of surface BC with sharp temporal change. This high concentration event is well simulated by the latest 56-km model, however, the low horizontal resolution experiments about 220-km show relatively low concentration peak (about 100–150 ng/m^3) with roughly temporal change.
We also estimate the BC transport to Arctic. The 56-km model simulation with Siberian forest fire emission (Ant+FireSb simulation) indicates a larger increase in Arctic column BC from 22 to 27 September than the Ant simulation, however, the 220-km model simulations indicate no significant difference of the Arctic column BC level to the Ant simulation.
These results indicate that one noticeable impact of latest model development is achieved by replacing the model’s horizontal resolution being 56-km, which is capable of simulating the fine structure of long-range BC transport to impact on the low human activity area such as Arctic and ocean.

Keywords: black carbon, aerosol transport model, K computer

