The NICAM–SPRINTARS simulations of the transport and wetdeposition of the black carbon emitted from a Siberian forest fire in September 2016

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The black carbon (BC) affects absorption/scattering of solar radiation, precipitation, and snow/ice cover. In areas of low human activity such as the Arctic and oceans, even a small inflow of natural or anthropogenic aerosols can directly and indirectly influence solar radiation, clouds, and precipitation, making it important to better understand aerosol transport to such areas. However, the limited number of spatial and temporal observations is available in such areas, and it is useful to use a global chemistry transport model aimed at estimating the transport to such areas and projecting its influence on the climate.

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 timescales and has fine horizontal resolution with 56 km, which is capable of simulating fine scales transport processes of aerosols such as the accumulation of BC behind the cold front, and the wetdeposition process around the low-pressure system.

A large and continuous forest fire was burning near Lake Baikal, Russia in September 2016. At the same time that the observation of BC was performed by observational cruise of R/V Mirai (MR16-06) possessed by Japan Agency for Marine-Earth Science and Technology (JAMSTEC), and the R/V Mirai observed BC peaks near the Aleutians in 25th–26th September. For evaluating the capability of simulating the long-range transport to the low human activity area, we used NICAM–SPRINTARS to simulate the transport pathways, deposition process, and their resolution dependency of observed major forest fire event using the recent fine horizontal resolution (56 km) comparing to low horizontal resolution (220 km), which is still used in recent climate simulations.

The experiments with Siberian forest fire emissions showed that the column BC amount around Siberia is exponentially deposited from Siberia to the Aleutians. These BC was deposited by precipitation associated with a low-pressure system, exponentially decreasing along the transport pathway from Siberia to Kamchatka. The wetdeposition flux in 220 km model along the transport pathway is large in magnitude than that in 56 km model due to the patchy peak areas of deposition, causing the relatively larger maximum of BC in 56 km mode along with the R/V Mirai path.

Some additional deposition in Arctic for the 56 km experiment is much larger than that for 220 km experiment in the 27th–28th September. We found that in the 56 km experiments, the BC emitted from the Siberian forest fire was transported as far as the Arctic with a filamental structure of high-BC area around the Bering and Chukchi Seas from the 27th–28th with the ascending motion around the developed low-pressure system. In contrast, the 220 km experiments produced the widespread high-BC area with

relatively smaller amount of maximum concentration, especially around 8 km, associated with the weak ascending motion around the low-pressure system.

These results suggest that the 56 km resolution was required to reproduce the inflow of BC to the Arctic due to the high-resolution transport process of developed low-pressure system around the Bering and Chukchi Seas as well as the high-resolution wetdeposition process near Siberia. Thus, the future climate simulations and the transport and budget analysis need to be performed with fine horizontal resolution (~56 km) using the global chemistry transport models.

Keywords: black carbon, aerosol transport model, wetdeposition

