Concentrations and Size Distributions of Black Carbon in the Surface Snow of Eastern Antarctica in 2011

T. Kinase[1,2], K. Adachi[1], N. Oshima[1], K. Goto-Azuma[3,4], Y. Ogawa-Tsukagawa[3], Y. Kondo[3], N. Moteki[5], S. Ohata[6], T. Mori[5,7], M. Hayashi[8], K. Hara[8], H. Kawashima[9], and K. Kita[2]

[1]*Meteorological Reserch institute*, [2]*Ibaraki University*, [3]*National Institute of Polar Research*, [4]*SOKENDAI*, [5]*The University of Tokyo*, [6]*Nagoya University*, [7]*Tokyo University of Science*, [8]*Fukuoka University*, [9]*Akita Prefectuaral University*

Aerosol particles are emitted from both natural and anthropogenic sources and travel across the globe. They influence the climate through becoming cloud condensation and ice nuclei and absorbing and scattering solar radiation in air and on snow/ice surfaces. Black carbon (BC) is one of the most important aerosol particle for the climate and absorbs light as an impurity in surface snow/ice. As the result, BC exhibits positive radiative forcing and contributes to global warming. However, the climate effect by BC in snow still has large uncertainties, because the knowledge of BC concentrations and size distributions within surface snow is limited, especially in Antarctica. This study analyzed the concentrations and size distributions of BC and inorganic ions in snow samples collected at the Syowa station in Antarctica from April 2011 to December 2011 and along a traverse route to an inland (Mizuho) station.

We measured BC concentrations, size distributions, and inorganic ion concentrations of snow samples from the Syowa station and from the traverse route to the Mizuho station during the 52nd Japanese Antarctic Research Expedition (JARE52) in Antarctica. The modified single particle soot photometers (SP2) were used for analyses of BC concentrations and size distributions in snow. BC concentrations in snow increased in December. The average mass and number concentrations of BC (C_{MBC} and C_{NBC}) between April and November were 288.2 ng L^{-1} and 101.5 particle μL^{-1}, respectively, and those during December were 2117.3 ng L^{-1} and 812.7 particle μL^{-1}, respectively. The C_{MBC} and C_{NBC} of the traverse route samples were 727.7–1153.2 ng L^{-1} and 249.6–454.6 particle μL^{-1}, respectively and were 1.7–2.7 times higher than those of the Syowa samples. The C_{MBC} values were consistent with those in previous studies observed in other areas, but the average mass of BC particle (m_{BC}) was 2.8 (1.8–5.8) fg particle^{-1} and it was smaller than typical values in the Arctic. The size distributions of BC in snow were bimodal with MMD values of ~140 nm (fine) and ~690 nm (coarse). The MMD values in our study (149–191 nm) were smaller than those in other areas. Inorganic ions in snow in Syowa mainly originated from sea salt and did not correlate with C_{MBC} and C_{NBC}. The Na^+ and Cl^- concentrations in snow largely decreased with increasing distance from the coastal area.

The BC concentrations in the ground-level atmosphere and snow did not change simultaneously, and BC concentrations increased in December when the ambient temperature increased above 0 °C with strong solar irradiance. This result indicates that the BC concentrations in snow are largely influenced by postdeposition processes. The relatively lower inorganic ion concentrations away from the coastal area than those at the Syowa station (coastal area) indicate lower contributions of snow transported from the ocean in inland regions, and the relatively higher BC concentrations away from the coastal area imply contributions from inland, i.e., the upper atmosphere. The smaller BC size distribution in our samples than in other regions with neighboring BC sources suggests that the BC in the Antarctic snow originated through long-range transport, resulting in a decrease in m_{BC} values by the removal of large BC particles during transport. Our results are the first to clarify the BC concentrations and size distributions around Syowa from measurements.

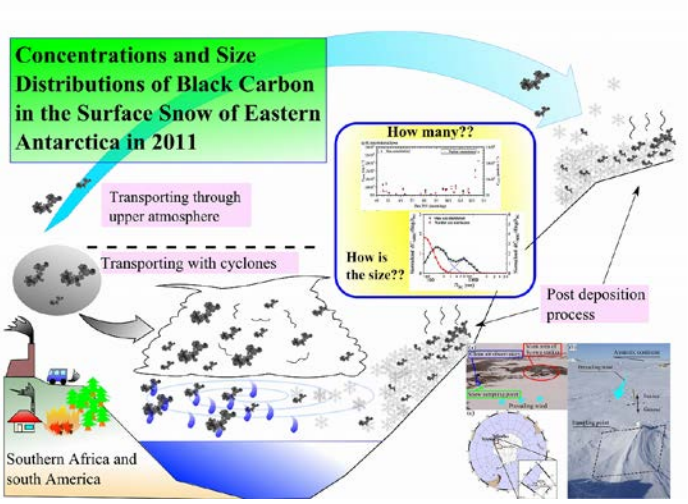

Figure. Graphical abstract of this study.

References

T. Kinase, K. Adachi, N. Oshima, K. Goto-Azuma, Y. Ogawa-Tsukagawa, Y. Kondo, N. Moteki, S. Ohata, T. Mori, M. Hayashi, K. Hara, H. Kawashima, and K. Kita, Concentrations and Size Distributions of Black Carbon in the Surface Snow of Eastern Antarctica in 2011, J. G. R. Atmos., accepted, 2019.