Seasonal variation of the concentration of black carbon and the size distribution of the surface snow sampled in the Syowa station in the Antarctica

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Black carbon (BC) strongly absorbs the radiation, leading to large climate effects. BC deposited on the snow/ice packs also leads to positive radiative forcing, reduces the snow/ice albedo. The snow albedo is estimated considering snow grain size and impurities, to clarify the size distribution of BC particles in snow is important. But the technique for measurement of the size distribution of BC in snow is developed in recent, the size distribution of BC is not understood sufficiently, especially Antarctica.
In this study, 29 snow samples were obtained at Antarctica, Syowa station, with the Japanese Antarctic Research Expedition 52 (JARE52, 2010-2012), measured for the BC concentration and its size distribution in snow and discussed. The BC concentration and its size distribution are measured by the Single Particle Soot Photometer (SP2) with an improved technique for measuring the size distribution wider (Mori et al., 2016), and ions and pH are measured at the each samples. The atmospheric BC concentration was measured by an Aethalometer during sampling period.
Snow samples were scooped from the surface of the snow to 250cc glass bottles directly, had been kept below -20 °C until the measurement. October 2011, relatively continent snows were sampled on the traverse route for the Mizuho station by JARE52. Based on reports of Kinase et al. (JpGU2015) and Kinase et al. (2016), snow samples were distributed to 3 of 20 cc glass bottles using a ceramic knife, melted in refrigerator, sonicated 15 minutes, and mixed to an 1 bottle. 30cc LDPE bottles were obtained for measurements of ions and the pH.
From results, the averaged BC concentration in snow samples were 591.6 ±714.1 (ng L^{-1}), and we found the seasonal variation, low in winter (May to September) and high in other seasons. Mizuho route samples were higher than Syowa. These results were little higher than previous studies which were obtained in other period, other locations and other method, but agreed on an order. Also we could find the seasonal variation of the size distribution, small particles were mainly in winter, but large particles were found in summer. But this measurement had not done in previous, we could not compare with other studies. Concentrations of ions and pH had no same variations.
For the atmospheric BC concentration, the sample air was heated to 300 ºC for decreasing effects by the volatile particles, but the effect of non-volatile particles remained. Hence, the measurement of the atmospheric BC had a large uncertain, it was high during winter and low during summer. Hara et al. (2008) showed that there are two processes of transporting atmospheric BC around Syowa, by the blizzard during winter and by the katabatic wind during summer. This result indicates that the dominant transporting/deposition process of atmospheric BC would change in each season.
Therefore, the atmospheric BC had the opposite trend to BC in snow, the atmospheric BC concentration would not effect to the BC in snow directly. The seasonal variation of BC in snow would depend on other process, such as the deposition process and others.

Moreover, the radiation had the same trend to the concentration and the size distribution of BC in snow, the radiation would effect for the seasonal variation of BC in snow. Heating and melt/refreeze cycle would change the size distribution (Kinase et al., (JpGU2015) ; Kinase et al., (2016)). The radiation would lead the heating of ice nuclei and surface snow, this indicates the seasonal variation of the concentration and the size distribution of BC would be related to the seasonal variation of the radiation. More studies of BC in snow are needed in the future, such as a long-term monitoring, the variation of the water cycle and deposition efficiency of BC to the snow, and the heating effect for the snow and ice nuclei.

Keywords: Antarctica, Syowa station, snow, Black carbon, size distribution, seasonal variation