Temporal variations of concentrations, size distributions, and seasonal variations of anthropogenic and natural black carbon in Greenland

*Kumiko Goto-Azuma[1,2], Yoshimi Ogawa-Tsukagawa[1], Yutaka Kondo[1], Remi Dallmayr[1,10], Motohiro Hirabayashi[1], Jun Ogata[1], Kyotaro Kitamura[1], Kenji Kawamura[1,2], Hideaki Motoyama[1,2], Sumito Matoba[3], Teruo Aoki[4], Nobuhiro Moteki[5], Sho Ohata[5], Tatsuhiro Mori[6], Makoto Koike[5], Yuki Komuro[7], Akane Tsushima[8,9], Naoko Nagatsuka[1], Wataru Shigeyama[1,2], Koji Fujita[9]

1. National Institute of Polar Research, 2. SOKENDAI, 3. Hokkaido University, 4. Okayama University, 5. University of Tokyo, 6. University of Science, 7. Yamagata University, 8. Research Institute for Humanity and Nature, 9. Nagoya University, 10. AWI

An ice core retrieved at the SIGMA-D site, Northwest Greenland, in 2014 was analyzed down to the depth of 113 m. Between 6 and 113 m depths, we used a Continuous Flow Analysis (CFA) system developed at the National Institute of Polar Research. The CFA system enabled us to obtain high resolution data of black carbon (BC), stable isotopes of water, microparticles and six elements (Na, K, Mg, Ca, Fe, and Al). The top 6 m of the core was cut at a ca 5 cm interval, melted and analyzed. For BC analysis, we used a recently developed Wide-range SP2 (Single Particle Soot Photometer). We dated the core by annual layer counting using mainly Na and water stable isotopes, with occasional use of other impurities. We divided a year into 12 months and calculated monthly averaged BC concentrations and size distributions.
Here we report the variability of monthly resolved BC concentrations and size distributions over the past 350 years. BC number and mass concentrations started to increase in the 1870s, reached its maximum in the 1920s - 1930s, and decreased again since then. The increases are likely due to anthropogenic input. The increases are most significant in fall and winter months. We find anthropogenic changes in seasonality of BC concentration: annual concentration peak shifted from summer to winter. We also find anthropogenic changes in size distribution of BC: the mode diameter of mass concentration and average mass of BC particles became larger. This suggests that anthropogenic BC particles are larger than natural ones in the snow deposited in Greenland. Apart from anthropogenic BC, BC concentration occasionally showed large spikes in summer. They are likely originated from biomass burnings. We will compare the results from the SIGMA-D core with those from other ice cores drilled in Greenland and discuss spatial variations of BC.

Keywords: Black carbon, Greenland, Ice core

