Spatial variation of surface mass balance and seasonal variation of dust deposition at EGRIP, Greenland

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We conducted snow pit studies at EGRIP (East Greenland Ice Core Project) camp to study spatial variation of surface mass balance and to examine seasonal variations of dust concentration and size distribution, which can be affected by changes of atmospheric and ground surface environment. In June-August 2017, we dug three pits with depths of 2.01 m (pits A and B) and 2.22 m (pit C). Pit B was located 650 m away from pit A in the southeast direction. Pit C was 1280 m away from pit B in the southeast direction. Snow sampling and density measurement were carried out at 0.03 m interval in those pits. Snow samples were melted, and stable isotopes of water ($\delta^{18}O$ and δD) and dust concentration and size distribution for diameters between 0.52 and 12 μm were analyzed. $\delta^{18}O$ and δD were measured by a mass spectrometer (Thermo Fisher: Delta V). Dust concentration and size distribution were measured by a Coulter counter (Beckman Coulter: Multisizer 4e) and a laser particle counter (MetOne: Model-211).

In all pits, vertical profiles of $\delta^{18}O$ and δD showed a clear seasonal variation, which allowed to date the pits. Pit A and pit B covered four years from 2013 to 2017 and pit C covered five years from 2012 to 2017. The estimated surface mass balances of pit A, pit B and pit C were 123-159 mm w.e./yr, 133-177 mm w.e./yr and 104-184 mm w.e./yr, respectively. Although annual surface mass balances in 2013-2017 obtained from the three pits exhibited spatial variability, averages for 2013-2017 were very similar, ranging from 135 to 157 mm w.e./yr. This result indicates that the spatial variability was probably because of post depositional redistribution of snow caused by wind-erosion and snow drift. Vertical profiles of dust concentration and size distribution in the three pits showed clear seasonal variations. In the layers from winter to spring, dust concentrations showed annual peaks caused by fine particles (< approximately 4 μm). In layers from summer to autumn, dust concentrations were lower than those in the winter to spring layers, and large particles (> approximately 4 μm) contributed significantly to dust concentrations. This result is attributed to the seasonal change in predominant dust source regions. The significant contribution of large particles in the summer to autumn layers suggests local dust input from area around Greenland where dust source is affected by seasonal snow covers.