Interannual trend of satellite-derived snow grain size over the Greenland Ice Sheet

*Teruo Aoki[1,2], Rigen Shimada[3], Masahiro Hori[3], Masashi Niwano[2], Tomonori Tanikawa[2], Sumito Matoba[4], Iizuka Yoshinori[4], Koji Fujita[5]

1. Arctic Environment Research Center, National Institute of Polar Research, 2. Meteorological Research Institute, Japan Meteorological Agency, 3. Earth Observation Research Center, Japan Aerospace Exploration Agency, 4. Institute of Low temperature Science, Hokkaido University, 5. Graduate School of Environmental Studies, Nagoya University

Surface mass loss of the Greenland Ice Sheet (GrIS) is ongoing after the middle of the 1990s. More recently, darkening (albedo reduction) of GrIS is observed from satellite remote sensing (Box et a., 2012). The surface albedo of snow depends on snow grain size and light-absorbing impurity (LAI) concentration in the snowpack (Wiscombe and Warren, 1980; Warren and Wiscombe, 1980). The possible cause of albedo reduction in accumulation area is snow grain growth due to temperature rise because the LAI concentration is low in GrIS (e. g., Mori et al., 2019). In the ablation area, an expansion of bare ice and dark ice extent is a major cause of albedo reduction (Shimada et al., 2016). To investigate the effects of global warming and internal variation of the atmosphere on the surface condition of GrIS, we retrieved an optically-equivalent snow grain radius (R_{s1}) at the topmost snow layer for accumulation area from Moderate Resolution Imaging Spectroradiometer (MODIS) data from 2000 to 2019. The interannual trend of the monthly mean value of R_{s1} was +12 μm/decade in July, whereas the statistical significance of this increasing trend is low ($p = 0.40$) due to the large up and down variation. The large variation of R_{s1} synchronized well with North Atlantic Oscillation (NAO) and not with Arctic Oscillation (AO). The correlation is high with NAO index ($R = 0.71$, $p<0.01$) and low with AO index ($R = 0.36$, $p>0.1$). These results suggest that snow grain size on GrIS is affected by NAO stronger than by global warming during the period from 2000 to 2019.

Keywords: snow grain size, Greenland Ice Sheet, albedo, light absorbing impurity, North Atlantic Oscillation

