Characteristics of light-absorbing aerosol depositions over Greenland ice sheet derived from the NASA's MERRAero aerosol reanalysis data

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Significant melting over a large area of Greenland ice sheet (GrIS) was reported in July 2012 (e.g., Nghiem et al., 2012; Bennartz et al., 2013; Niwano et al., 2015), and the development of low level clouds were attributed to the main reason for the melting (Bennartz et al., 2013; Niwano et al., 2015). Examining many possible factors to this significant melting over GrIS would have benefits to prepare for future changes on GrIS and climate change. To discuss another possible contributions to the snow melting (i.e., snow darkening), we mainly examine the climatological characteristics of horizontal deposition patterns of light-absorbing aerosols (LAA; i.e., dust, BC, and OC) over GrIS during July 2012. We use the MERRAero aerosol reanalysis data (e.g., Kessner et al., 2013; Colarco et al., 2014), which was recently produced with NASA's Goddard Earth Observing System Model, version 5 (GEOS-5; e.g., Rienecker et al., 2008; Molod et al., 2012) by the NASA's Global Modeling and Assimilation Office (GMAO: http://gmao.gsfc.nasa.gov/). The MERRAero uses the MERRA reanalysis data (Rienecker et al., 2011) for its atmospheric fields and further implements the aerosol data assimilation using the Aerosol Optical Depth (AOD)from MODIS instrument (e.g., Kessner et al., 2013; Colarco et al., 2014). However, the version of GEOS-5 for MERRAero did not consider the snow darkening effect (Yasunari et al., 2015b) and the other GEOS-5 version with the snow darkening module, GOddard SnoW Impurity Module (GOSWIM; Yasunari et al., 2014; 2015a) had only considered SDE over seasonal snowpack. Therefore, we currently cannot examine SDE over GrIS in detail with the MERRAero data alone. So, we, first of all, will focus on the depositions of LAA over GrIS to study a potential effect of SDE on melting of GrIS..

We focus here on the LAA depositions over GrIS with the MERRAero data. The climatologies for 2003-2014 were used to compute year-to-year variations. Over the southern and western part of GrIS, higher dust deposition is observed in July 2012, suggesting a potential impact of dust SDE and/or radiative forcing on snow melting in the area (Figure 1). However, BC and OC had no changes, implying negligible snow darkening effect caused by these aerosol depositions (Figure 1). It appears that the anomaly pattern of the dust deposition was mostly explained by the wet deposition pattern over GrIS, indicating that this dust deposition feature was driven by precipitation. The anomaly increases of low-level cloud fraction and precipitation were also seen over the western and southern parts of GrIS from the MERRAero data. This increased precipitation characteristic is consistent with the discussions from the *in-situ* observations at the northwestern site over GrIS (Niwano et al., 2015). The increased precipitation from the low-level cloud was likely to increase the dust wet deposition over the western and southern areas of GrIS in July 2012 too.

LAA deposition patterns over GrIS in different years will be also discussed.

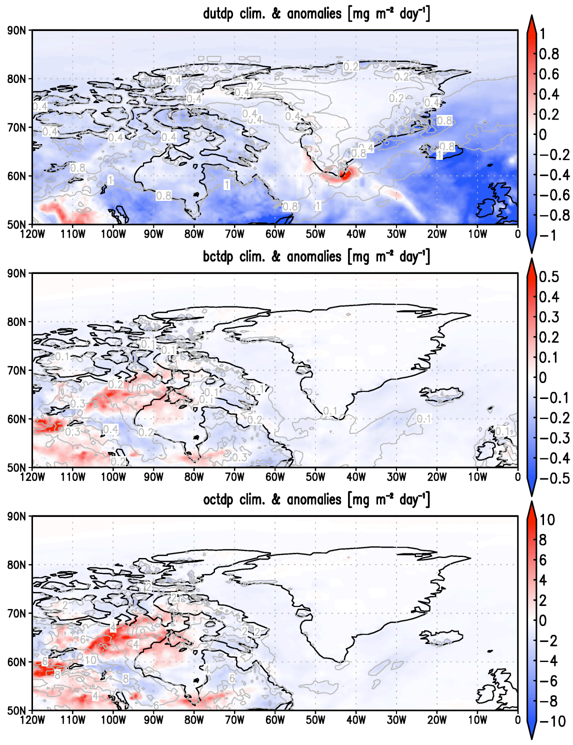

Figure 1. Climatological LAA deposition patterns for 2003-2014 and their anomalies in July 2012. Contours in gray and shaded colors denote climatologies and anomalies, respectively. (top) dust deposition flux; (middle) BC deposition flux; (bottom) OC deposition flux.

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