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SURFACE ENERGY BALANCE AT THE SITE SIGMA-A, NORTHWEST GREENLAND DURING THE RECORD SURFACE MELT EVENT IN THE SUMMER OF 2012

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The snow and ice on the Greenland ice sheet (GrIS) experienced the extreme surface melt around 12 July, 2012. It has been argued that the major cause for the record-breaking event is significant temperature increase over GrIS. However, it is necessary to pay close attention to surface energy balance (SEB) to identify the whole picture of the surface melt. Therefore, in the present study, we investigated SEB at SIGMA (Snow Impurity and Glacial Microbe effects on abrupt warming in the Arctic)-A (78°03'N, 67°38'W, 1,490 m a.s.l.) (Aoki et al., 2014), northwest GrIS during intensive observation period (IOP; 30 June to 14 July, 2012) utilizing newly installed automated weather station (AWS) data, in-situ snow measurements, and numerical snow modeling work with a 1-D multilayered physical snowpack model SMAP (Niwano et al., 2012, 2014). Here energy fluxes are defined to be positive when they are directed into the surface. In the SEB calculation process radiation related components of SEB were directly given from AWS data, while other fluxes were diagnosed with SMAP forced by AWS data. The obtained SEB clearly showed different characteristics between the first half of IOP ("Period-1"; 30 June to 9 July) and the latter half of IOP ("Period-2"; 10 to 14 July). Compared to Period-1, average net longwave radiant flux, sensible heat flux, and latent heat flux increased dramatically by +57.1 W m^{-2}, +11.3 W m^{-2},and +31.0 W m^{-2}, respectively, while average net shortwave radiant flux decreased significantly by -42.3 W m^{-2} during Period-2. As a result, net energy flux at the surface was continuously kept positive after 10 July, while it showed clear diurnal variations (negative in the nighttime and positive in the daytime) until 9 July. The successive positive value of net energy flux during Period-2 explains the dramatic melt event observed at SIGMA-A. The reason for this remarkable transition in SEB characteristics was examined and we concluded that the appearance of low-level cloud (Cumulus, Stratocumulus, and Stratus were manually observed onsite) after 10 July accompanied by significant temperature increase played an important role and induced surface heating through the process known as cloud radiative forcing in the polar region.

References

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