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The July 2016 Study of the water VApour in the polar AtmosPhere (SVAAP) campaign at Thule, Greenland: surface radiation budget and role of clouds

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The Study of the water VApour in the polar AtmosPhere (SVAAP) project, funded by the Italian Programme for Antarctic Research, is aimed at investigating the surface radiation budget (SRB), the variability of atmospheric water vapour, and the long-term variations in stratospheric composition and structure at Thule, Greenland, in the framework of the international Network for Detection of Atmospheric Composition Change (NDACC). Thule High Arctic Atmospheric Observatory (THAAO, 76.5° N, 68.8° W) is devoted to study climate change and has been operational since 1990, with the contribution of different international institutions: DMI, NCAR, ENEA, INGV, Universities of Roma and Firenze (http://www.thuleatmos-it.it). As part of SVAAP an intensive field campaign was held at Thule from 5 to 28 July 2016. The campaign was also aimed at supporting the installation of VESPA-22, a new microwave radiometer for water vapour profiling in the upper atmosphere and integrated water vapour (IWV), and offered the possibility to study the cloud physical and optical properties and their impact on the SRB.

Measurements of downward shortwave (SW) and longwave (LW) irradiance were already available since 2009. Additional observations were added to obtain the SRB and to characterize the atmospheric state: upward SW and LW irradiance, upwelling and downwelling photosynthetically active radiation (PAR), downward irradiance in the 8-14 μm infrared window, temperature and relative humidity tropospheric profiles, IWV, liquid water path (LWP), lidar tropospheric backscattering profiles, sky brightness temperature (BT) in the 9.6-11.5 μm spectral range, visible and infrared sky images, surface meteorological parameters. Moreover, 23 radiosonde were launched during the campaign.

Data from the period 14-28 July are presented in this study. The first part of the campaign was characterized by stable cloud-free conditions, while alternation of cloudy and cloud-free sky occurred after 18 July. The time evolution of SW and LW SRB, surface albedo, and derived cloud parameters, such as cloud optical thickness and effective radius, are presented and discussed. Thickest clouds reached visible optical depths of about 200, and values of LWP of about 0.4 kg/m2. While the SW SRB is always positive during the measurement campaign, the LW SRB is negative under cloud-free conditions (own to -100 W/m2 at noon), becoming positive (up to +50 W/m2) during cloudy periods. The total (SW+LW) SRB is positive and its variability is dominated by the SW irradiance. Clouds induce a reduction of the SRB compared to the cloud-free periods, thanks to the dominant SW effect. The LW component offsets about 20% of the SW at noon in clear sky, and contributes up to 50% of the total SRB in thick cloud conditions.

The availability of the cloud physical and optical properties and the atmospheric vertical profiles allow to study in details the SW and LW cloud radiative effect by means of radiative transfer simulations performed with MODTRAN6.0 model.