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Trends in winter melt periods and surface air temperature lapse rate analysis indicate changes of atmospheric circulation patterns at King George Island, West Antarctica

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The Antarctic Peninsula (AP) is amongst the fastest warming places on Earth and further temperature increase is expected there. As a consequence of the warming, it has suffered considerable environmental changes in the past decades. Exceptional rates of surface air temperature increases (2.5K in 50 years) are concurrent with retreating glacier fronts, an increase in melt areas, ice surface lowering and rapid break-up and disintegration of ice shelves. The South Shetland Islands are located close to the northern tip of the AP and are especially vulnerable to climate change due to their exposure to transient low-pressure systems and their maritime climate. For the King George Island/Isla 25 de Mayo (KGI), the largest of the South Shetland Islands, we have compiled a unique dataset. It comprises long- and short-wave radiation components, temperature profiles, humidity and wind velocities, as well as glacial ice temperatures in profile with a fully equipped automated weather station on the Warszawa Icefield, from November 2010 and ongoing. In combination with two long-term synoptic datasets (40 and 10 years, respectively) and NCEP/NCAR reanalysis data, we have looked at changes in the climatological drivers of the glacial melt processes, and the sensitivity of the inland ice cap with regard to winter melting periods and pressure anomalies. The analysis has showed a positive trend of 5K in minimum air temperatures in winter months along four decades, clearly exceeding the published annual mean statistics, in association with a decline in mean monthly sea level pressure. This concurs with a positive trend in the Southern Annular Mode (SAM) index, which gives a measure for the strength and extension of the Antarctic vortex. We connect this trend with a higher frequency of low-pressure systems hitting the South Shetland Islands during austral winter, bringing warm and moist air masses from lower latitudes. Due to its exposure, the ice cap of KGI is especially vulnerable to changes during winter glacial mass accumulation period. A revision of seasonal changes in air temperature lapse rates and spatial distribution has shown a clear decoupling of atmospheric surface layers between coastal areas and the higher ice cap. Positive air temperature lapse rates have been observed during months of July and August 2011 and 2012, resulting in high standard deviation from the monthly average of $\pm$0.9 K/100m (meaning warm air temperatures at higher elevations). This
paper assesses the impact of large-scale atmospheric and climatic changes on the atmospheric surface layer and glacier mass accumulation of the upper ice cap during winter season for the Warszawa Icefield on KGI.