J4.4 CLIMATE VARIABILITY AND TRENDS ALONG THE WESTERN SLOPE OF THE GREENLAND ICE SHEET DURING 1991-2004

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1. INTRODUCTION

The Greenland ice sheet plays a crucial role in global climate because of its high elevation as a topographic barrier for synoptic scale circulation, and its substantial volume of fresh water stored in the ice mass.

The total ice-covered area on Greenland is 1.756 x 10^6 km^2, with 1.707 x 10^6 km^2 ice sheet area and 0.049 x 10^6 km^2 valley glaciers and ice caps [*Weidick*, 1995]. The ice volume is estimated to be 2.6 x 10^6 km^3, which is an equivalent of 7.2-m sea level rise. The Greenland ice sheet mass balance may exert significant control over sea level rise [*Krabill et al.*, 2000].

Greenland, located partly in the predominant path of low-pressure systems, influences the pattern of general atmospheric circulation over a sizable portion of the Northern Hemisphere. Cyclones approaching northward over the North Atlantic are diverted by the ice sheet either into the Icelandic Low region or into Davis Strait and farther on into Baffin Bay.

The Greenland ice sheet is quite sensitive to external forcing as was shown by a simple climate sensitivity study; a 3 °C warming in spring during the onset of melt would increase the sublimation by as much as ~22 km^3 water equivalent for the entire ice sheet [*Steffen*, 1995]. This equals 4% of today's annual accumulation over all of Greenland. The last four decades have shown some considerable cooling around Greenland [*Box*, 2002] with a large temperature rise in recent years. The annual mean air temperature was found to be 2 ºC warmer for the central part of Greenland for the time period 1995–1999, as compared to the standard decade 1951–1960 [*Steffen and Box*, 2001]. Also, a notable increasing trend of 4.5% per year in melt area has been observed between the years 1979 and 1991, which came to an abrupt halt in 1992 after the eruption of Mount Pinatubo [*Abdalati and Steffen*, 1997]. A similar trend is observed in the temperatures at six coastal stations [*Abdalati and Steffen*, 1997].

2. The Greenland Climate Network (GC-Net)

The first automatic weather station of the Program for Arctic Regional Climate Assessment (PARCA) was installed at the equilibrium line altitude near Jakobshavn (69°34′03″N, 49°19′17″W), at the Swiss Camp in 1991 (Fig. 1)[*Steffen and Box*, 2001]. Currently the network consists of 18 automatic weather stations distributed over the entire Greenland ice sheet The objectives of the Greenland Climate Network (GC-Net) stations are to measure hourly, daily, annual and interannual variability in accumulation rate, surface climatology and surface energy balance parameters at selected locations on the ice sheet, and to monitor near-surface snow density at the AWS locations for the assessment of snow.

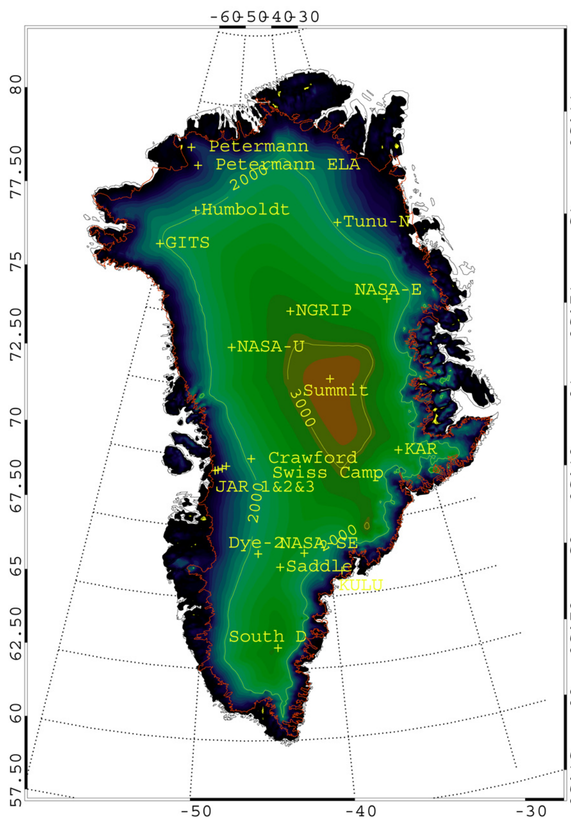

Figure 1: Location map of Greenland Climate Network (GC-Net) automatic weather stations (AWS). The ice sheet extend is shown with a red contour line.

3. Results

The statistical analysis of the Swiss Camp temperature record reveals large interannual variability in all seasons with increasing temperatures throughout the recording period (Fig. 2). The annual mean temperature increased from -14.7º C (1991) to -10.8º (2003), mean spring temperatures increased from -17.2º C to -13.6º C, and fall temperatures show a similar trend from -13.8º C to

-10.3º C for the 1991 to 2004 record. The largest increase of 6º C was observed for mean winter temperatures, ranging from -25.3º C (1991) to -19.3º C (2003). However, also the largest variability was observed during the winter months. Similar analyses for other climatological parameters such as wind speed, radiation, and firn temperatures will be presented. All these parameters indicate trends from a cooler climate in the early 90's to a warmer climate in the more recent time. Along with the climatological record, glaciological observations such as mass balance, precipitation, and ice flow at the ELA will be discussed in view of the above mentioned variability.

Acknowledgements

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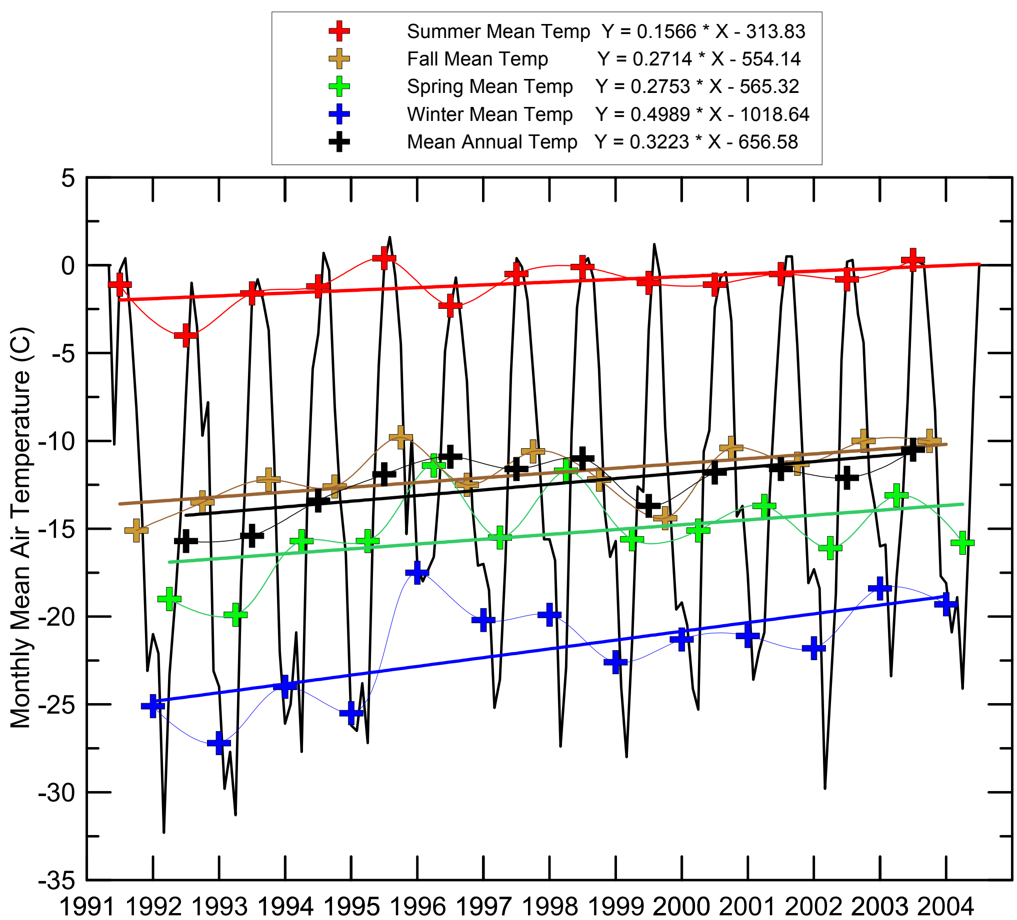

Figure 2: Air temperature time series from the Swiss Camp AWS located on the western slope of the Greenland ice sheet.