



Sampling errors in daily average temperatures from Greenland climate records

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Over the last years destructive climate events like heat-waves and floods have been attributed to global warming. The warming trend is higher in the Arctic than the global average, therefore its contribution to the global warming is relatively larger than other areas. In addition, the temperature increase in Greenland is an important driver of the melting of the Greenland Ice-Sheet, which leads to sea level rise. It is crucial to have temperature records of high quality in this area to properly assess the climatic changes. This will improve understanding of the involved physical mechanisms, past changes and improve predictions for the future temperature development in the Arctic. This study investigates daily averages of the sub-daily 2m air temperature measurements from the DMI Greenland station network spanning 1958-present day. The data from before 1958 has only been digitized as monthly averages, where parts of the data has been homogenized. The data from after 1958 has not been homogenized. The data is currently used for assessment and predictions of the surface mass balance of the Greenland Ice Sheet, temperature/climate reanalyses, global temperature products, validation of proxy data, etc.

This study assesses the errors due to uneven sampling times, and presents a method to improve the calculation of daily average temperatures. The current practice is to average the available measurements without considering what time of day they are from and how the measurements are distributed. In addition to missing values, the weather station network has periods of different measurement practices for different stations. Before automatic weather stations were introduced several weather stations have periods with measurements only from the daytime, when the temperatures are generally higher. This can lead to a warm bias in the daily averages compared to more recent data where there are generally observations for every hour of the day. This can affect temperature trends, as the positive bias is generally found in earlier periods of the dataset. As the diurnal cycle varies over the year, the magnitude of the bias also varies seasonally. The correction method used to reduce these biases is a moving average over the years with evenly distributed data covering the whole day, taking into consideration hours of observation present and time of year of the station in question. The biases before and after correction are assessed. The largest average simulated bias before correction over several years of data is 1.25 °C. The largest average simulated bias after correction is reduced to 0.45 °C. These corrections will improve the monthly and annual average temperatures for the DMI Greenland station network, as they are calculated

from the daily average temperatures. This study is limited to the weather station network in Greenland managed by DMI, but the findings are relevant for other networks in other areas, as long as there are uneven sampling times and a diurnal temperature cycle. This problem might affect decision making on a high level, like assessing a breach of the Paris agreement.