Internship AWI

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Contents

1 Introduction

The diurnal temperature range (DTR), the difference between daily minimum temperatures (T_{min}) and daily maximum temperatures (T_{max}), decreases on a global scale and in many regional scales since the 1990s. This decrease is caused by the mean surface minimum temperatures rising faster than the maximum temperatures. The reasons for this dynamic are quantitatively not fully understood yet, but the asymmetry in warming has been linked to factors of external forcing such as greenhouse gases, aerosols, and changes in landscape due to land use, as well as secondary effects such as changes in cloudiness and relative humidity. The extent of change in DTR is of magnitudes smaller than the trends in mean surface temperatures (T_{mean}). The uncertainty in these trends surpasses that of surface mean temperature, and they were only assessed with medium confidence in the fourth and fifth IPCC reports.

In this work, we examine the DTR for the Arctic region. The mean surface temperatures in the Arctic warm more rapidly than in any other region on Earth due to Arctic amplification. At the same time, the Arctic shows great climate variability, which decreases the signal-to-noise ratio (SNR) of the trends in mean surface temperature. As there is no linear coupling between the diurnal temperature range and the mean temperature, the DTR might be less influenced by the high climate variability. In the following, we examine whether the trends in the diurnal temperature range show a better SNR in the Arctic region than the mean surface temperature. This could lead to a more robust parameter to track changes in the polar regions.

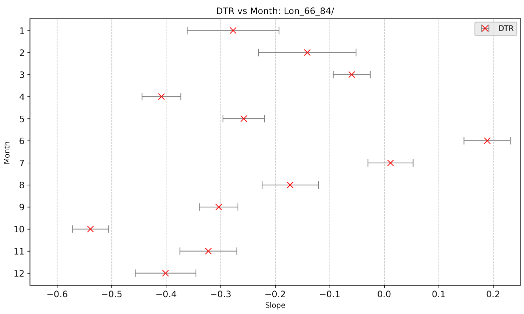
In section (sec1), we investigate factors causing the trends in the Diurnal Temperature Range (DTR) at the AWIPEV meteorological station in Spitsbergen. Since the average temperatures in Antarctica have not changed despite climate change, in section (ref), we address the question of whether there have been shifts in the daily temperature range.

2 Theory

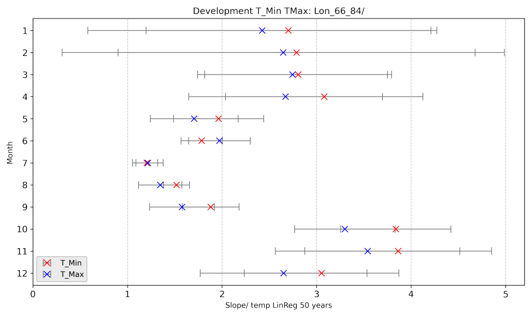
3 Discussion

3.1 Diurnal temperature range

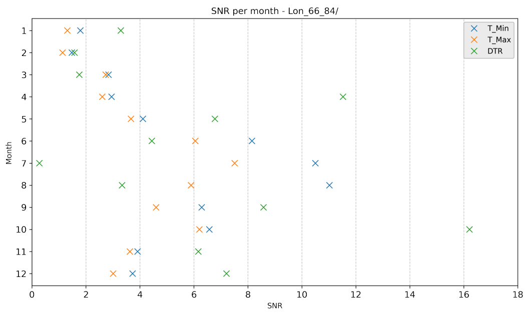
In the following section, the diurnal temperature range (DTR) is investigated. The CRU TS data is analyzed by month and latitude to determine trends.



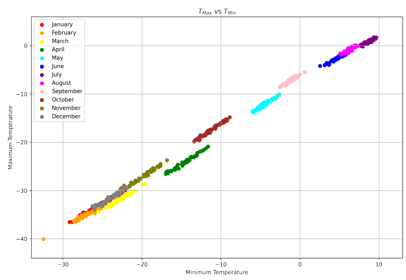
(a) DTR



(b) $T_{\mathrm{min/max}}$



(c) SNR



(d) T_{min} vs T_{max}

Figure 3.1: Diurnal temperature range change **(a)** over 50 years for the entire polar region (66-90°). **(b)** shows, for comparison, the maximum and minimum temperature trends. The variance for these temperatures is much larger compared to **(a)**. **(c)** presents the signal-to-noise ratio for the two previous plots.

After taking the over all average of the weighted data[1], we investigate the temporal development of DTR monthly average using linear regression. To examine the significance of the trend, the empirical variance in relation to the fit is calculated.

[1] The data are weighted by area. This leads to a stronger emphasis on the "lower" latitudes. The effect of the weighting is decreasingly small at the intervals of 5° chosen later on.

As show in Fig. 3.1, the changes in DTR are significant. But this is also true for the changes in the minimum temperature T_{min} as for the maximum temperature T_{max}. Compared to the changes in mean min./max. temperature he DRT trend does have a bigger SNR, as shown in Fig. 3.1c. This can be explained through the strong correlation between maximum and minimum temperature (see Fig. 3.1d). Due to this higher SNR, the changes in DTR could be an advantageous indicator for climatic changes in regions with high climate variability. Therefore, the robustness of this parameter and trends are investigated in Section 3.2.

3.2 Robustness of the DTR for subgroups of data

The mathematical derivation of uncertainty is to complex for this internship. To gain a sense of how reliable the effect of DTR change is, we compare the results of the left and right hemisphere – the hemisphere from -180 to 0 and 0 to 180 degrees – and further latitude subsets.

As depicted in Figure 3.2, the Diurnal Temperature Range (DTR) exhibits significant variations, particularly at higher latitudes. This variability may be attributed to the data selection process. The dataset encompasses the geographic region illustrated in Figure 3.3. When segregating the data into left and right hemispheres, it becomes apparent that the distribution of landmass is uneven. The left half of the Earth predominantly comprises mainland, whereas the right hemisphere consists mainly of islands. Consequently, temperature variations are influenced by the geographical circumstances, with islands experiencing unique factors such as ice formation, which influence their climate differently.

As shown in Figs. A.1 and A.2, the temperatures and their trends differ significantly for the two areas. The mainland experiences lower temperatures than the island dominated areas, especially for the areas of higher latitude. To check wether the data is robust, we have to compare two equivalent areas. Therefore, Greenland is divided into two halfs and the process is repeated.

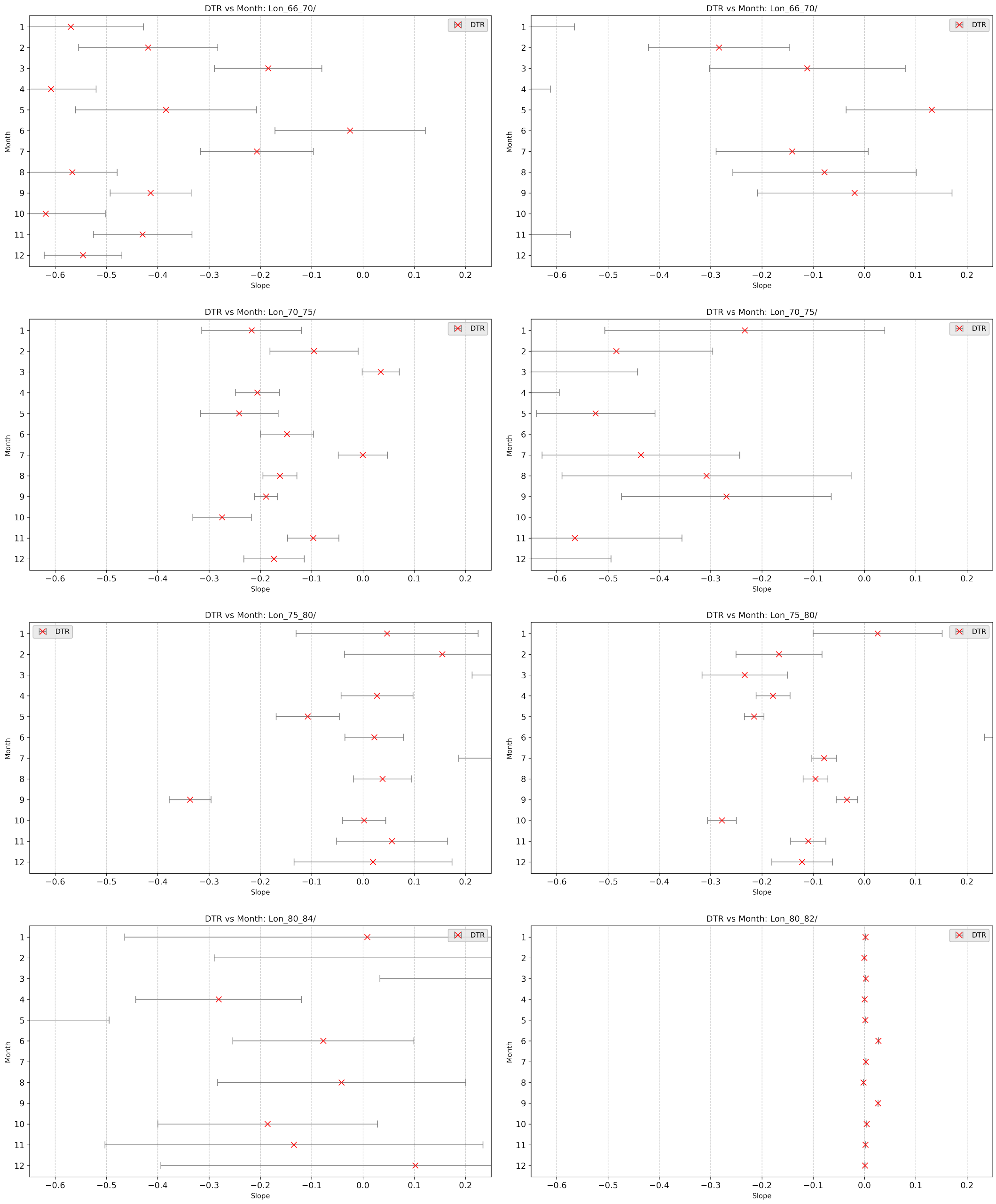


Figure 3.2: Subfigure with Two Columns

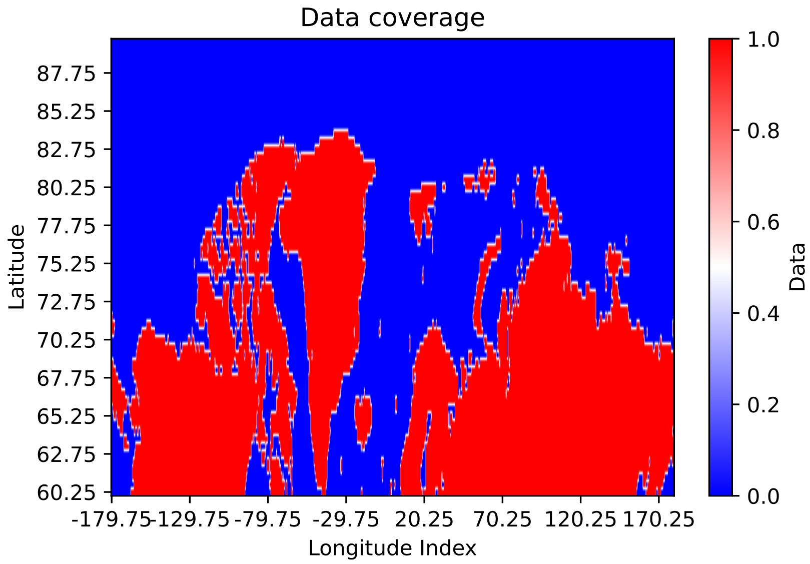
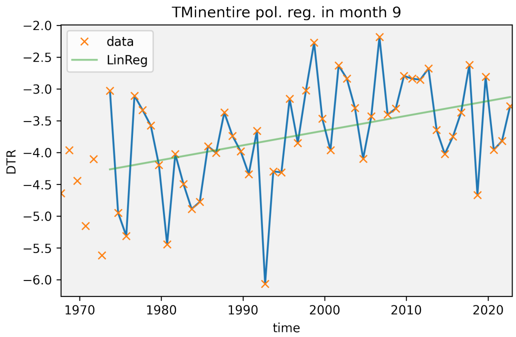


Figure 3.3: Data coverage of the CRU data.

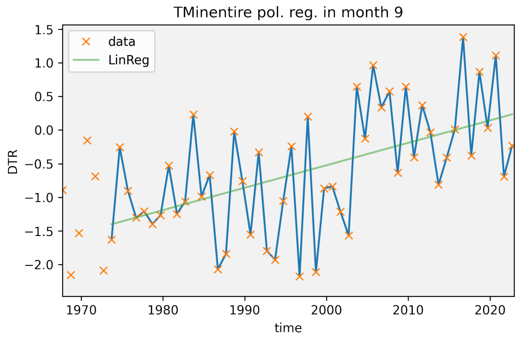
4 Summary

A Append

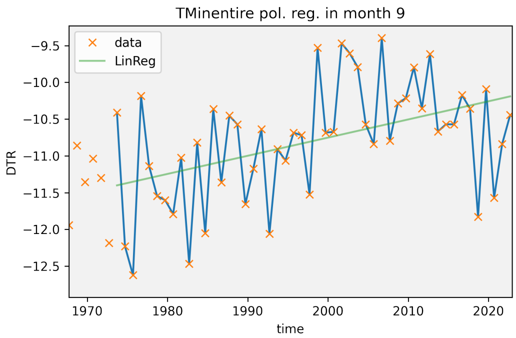
A.1 Robustness



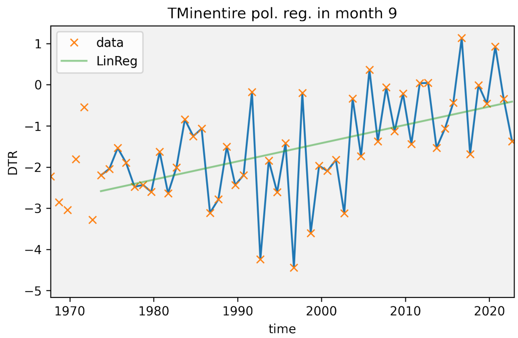
(a) T_{min} for the left hemisphere between 66 and 70°



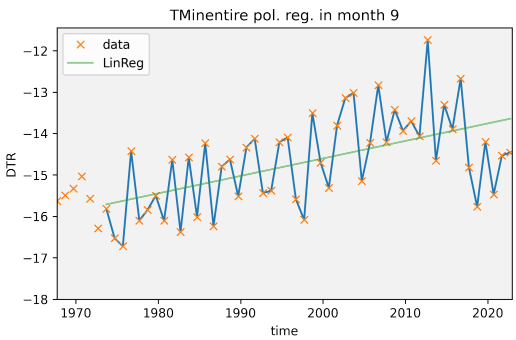
(b) T_{min} for the right hemisphere between 66 and 70°



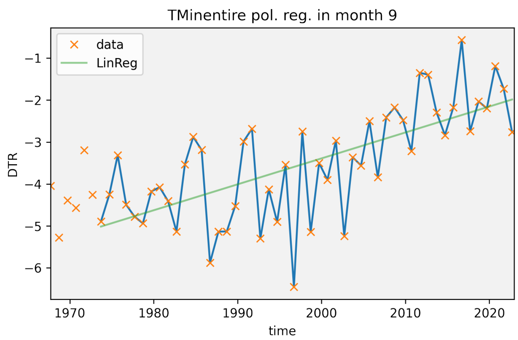
(c) T_{min} between 70 and 75°



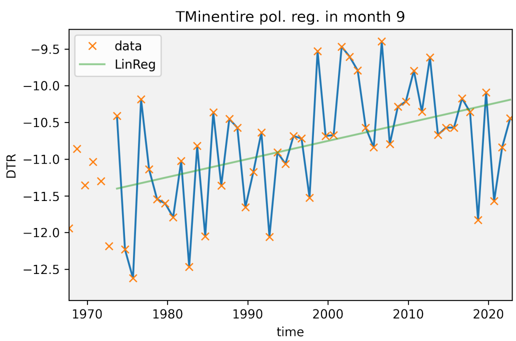
(d) T_{min} between 70 and 75°



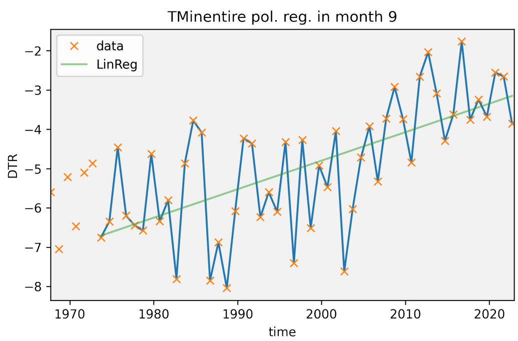
(e) T_{min} between 75 and 80°



(f) T_{min} between 75 and 80°

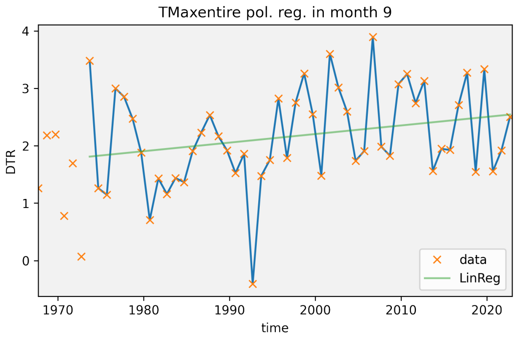


(g) T_{min} between 80 and 82°

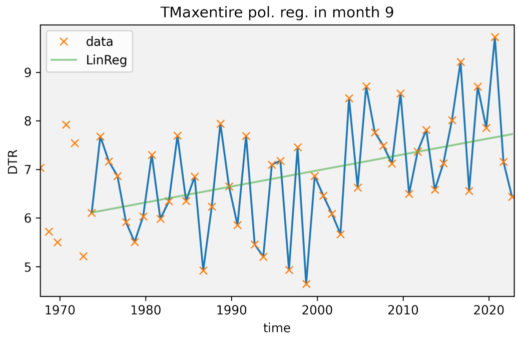


(h) T_{min} between 80 and 82°

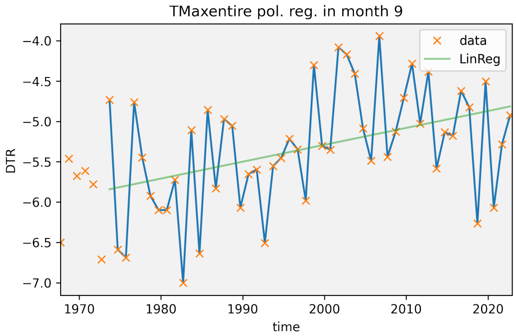
Figure A.1: Temperature for left and right hemisphere



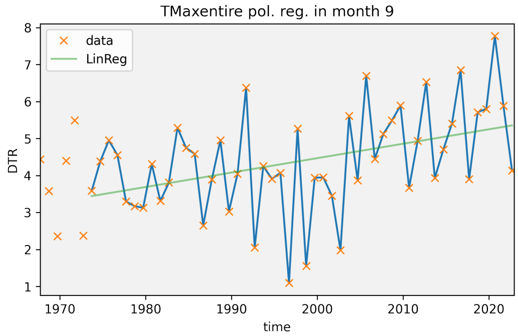
(a) T_{max} for the left hemisphere between 66 and 70°



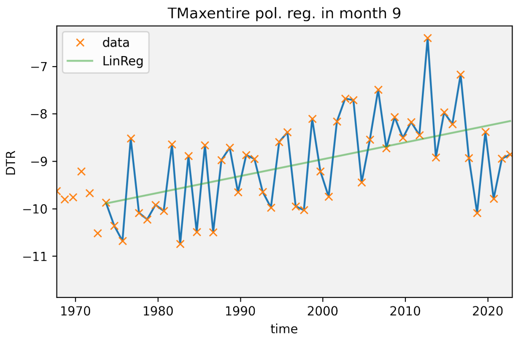
(b) T_{max} for the right hemisphere between 66 and 70°



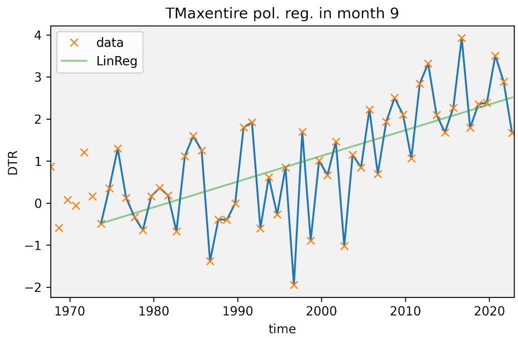
(c) T_{max} between 70 and 75°



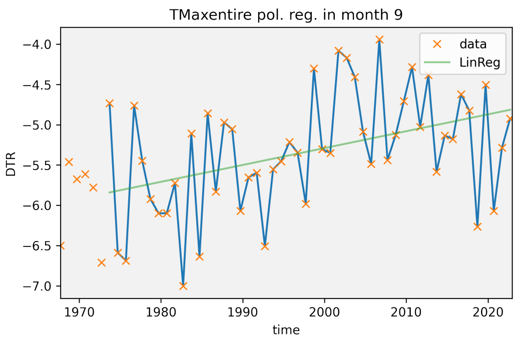
(d) T_{max} between 70 and 75°



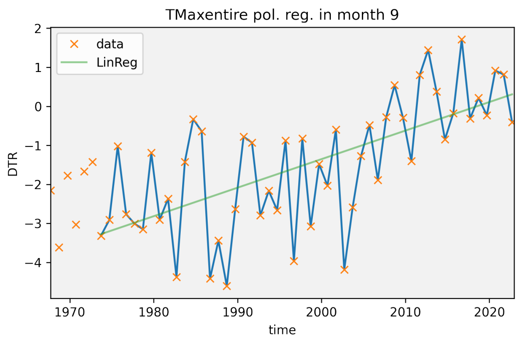
(e) T_{max} between 75 and 80°



(f) T_{max} between 75 and 80°



(g) T_{max} between 80 and 82°



(h) T_{max} between 80 and 82°

Figure A.2: Temperature for left and right hemisphere

Bibliography

[1] H. Chen et al. Gold nanorods and their plasmonic properties. *Chemical Society Reviews*, 42:2679–2724, 2013.

[2] Experimentalphysik III. Versuch Nanoplasmonik: Dunkelfeldspektroskopie von plasmonischen Nanorods.

[3] S. Link, M. B. Mohamed, and M. A. El-Sayed. Simulation of the Optical Absorption Spectra of Gold Nanorods as a Function of Their Aspect Ratio and the Effect of the Medium Dielectric Constant. *The Journal of Physical Chemistry B*, 103(16):3073–3077, 1999.