Global warming: What does the data tell us?

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Abstract

We analyze global surface temperature data obtained at 13472 weather stations from the year 1702 to 1990. The mean annual temperature of a station fluctuates from year to year by typically $\approx \pm 0.6^o$C (one standard deviation). Superimposed on this fluctuation is a linear increase of the temperature by typically $\approx 0.40 \pm 0.01^o$C per century ever since reliable data is available, *i.e.* since 1702 (errors are statistical only, one standard deviation). The world population has doubled from 1952 to 1990, yet we see no statistically significant acceleration of global warming in this period. We conclude that the effect of humankind on global warming up to 1990 is 0.0 ± 0.1^oC. Therefore, contrary to popular belief, the data support the view that human activity has had no significant effect on global warming up to the year 1990 covered by this study.

1 Introduction

We present a study of global warming based on the data obtained at 13472 weather stations covering the period from 1702 to 1990. In particular we are interested in finding the effect of human activity on global warming. Since the world population doubled from 1952 to 1990, we search for any changes in the trend of global warming between the first and second halves of the 20'th century.

The data used in this study is described in Section 2, the analysis is presented in Section 3 and the conclusions are collected in Section 4.

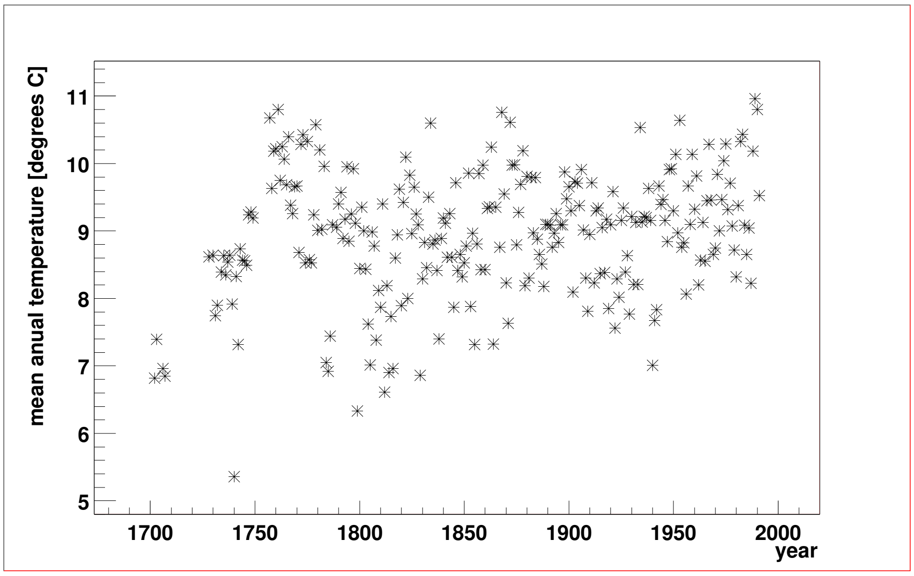

Figure 1: Mean annual temperature of station 617103840000 in Germany. Raw data. $a_1 = 0.27 \pm 0.08^o$C per century.

2 The data

The temperature data set used in this analysis is "The Global Historical Climatology Network (GHCN) version 2" released in 1997.[1] This data is a "comprehensive global surface baseline climate data set designed for monitoring and detecting climate change." In particular we used the "Adjusted Monthly Mean Temperature Data" (in file v2.mean.adj) and the "Raw Monthly Mean Temperature Data" (in file v2.mean). Each station is labeled by a 12 digit code.

3 Discussion

We define a "valid year" for a particular station as a year that has all twelve months with valid mean temperatures. We average these twelve monthly temperatures to obtain the "mean annual temperature" for that station. In Figures 1, 2 and 3 we present the mean annual temperatures T_i of the three oldest stations using the "Raw Monthly Mean Temperature Data" set. In Figure 4 we present the corresponding temperatures of our home city Quito.

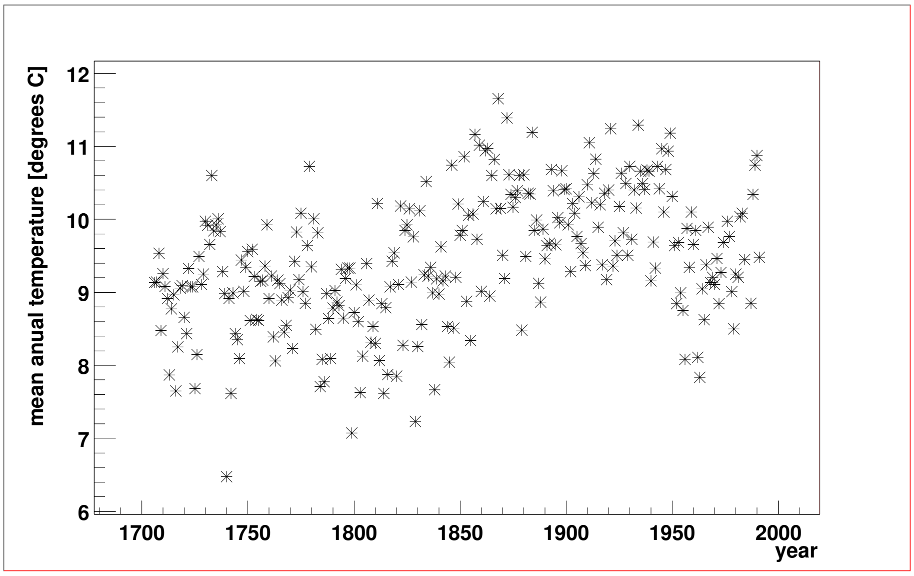

Figure 2: Mean annual temperature of station 633062600000 in the Netherlands. Raw data. $a_1 = 0.46 \pm 0.07^o$C per century.

We fit these temperatures to a straight line. The slopes a_1 for the period covered by the data are shown in the figure captions. All errors in this article are statistical and one standard deviation or 68% confidence. The high slope of the temperature measured in Quito may be due to the fact that the city grew around the weather station.

Figure 5 presents global warming at-a-glance. This figure was obtained as follows. We consider stations that have the first valid year less than or equal to 1900 and the last valid year greater than or equal to 1990. Furthermore we require at least 85 valid years between 1900 and 1990 inclusive. We chose these stations to be able to make meaningfull comparisons of global warming between the first and second halves of the 20'th century. We define the "reference temperature" of a station to be the average temperature of valid years between 1945 and 1955 inclusive (so at least one valid year in this interval is required). In Figure 5 we present the difference between the average temperature per 5 year bin and the reference temperature, averaged over all stations in the "Raw Monthly Mean Temperature Data" set passing the selection criteria. In Figure 6 we present the corresponding information for the "Adjusted Monthly Mean Temperature Data" set.

From these figures we see that the global temperature has been increasing

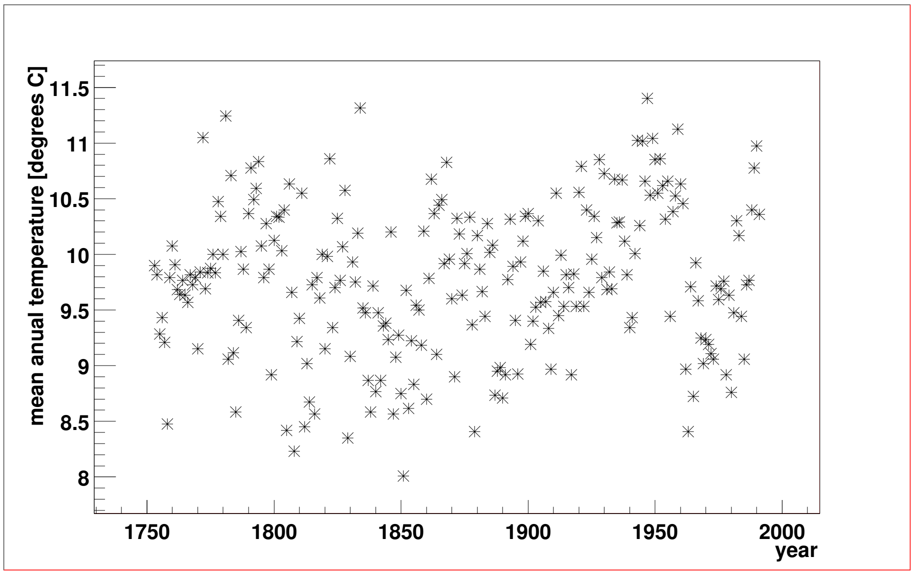

Figure 3: Mean annual temperature of station 646067000000 in Switzerland. Raw data. $a_1 = 0.12 \pm 0.06^o$C per century.

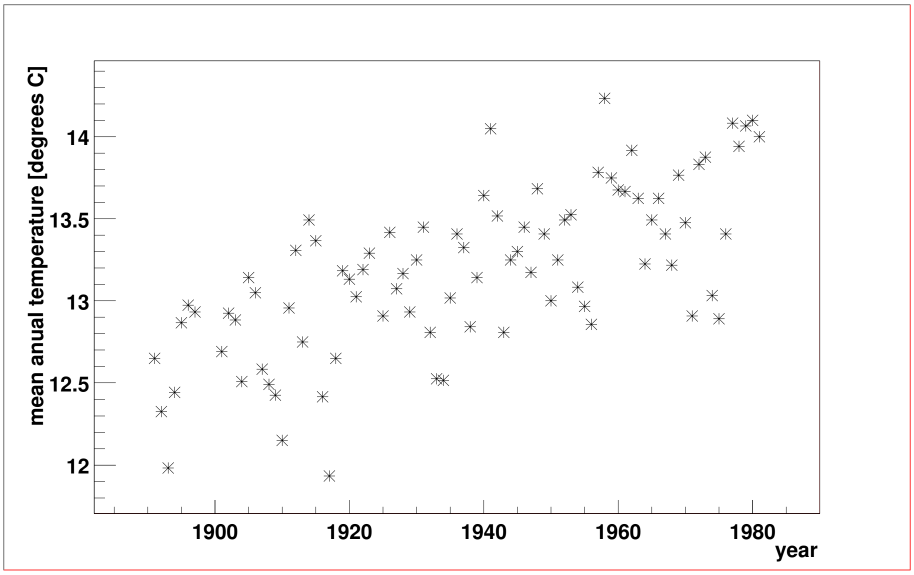

Figure 4: Mean annual temperature of station 306840710000 in Quito, Ecuador. Raw data. $a_1 = 1.3 \pm 0.2^o$C per century.

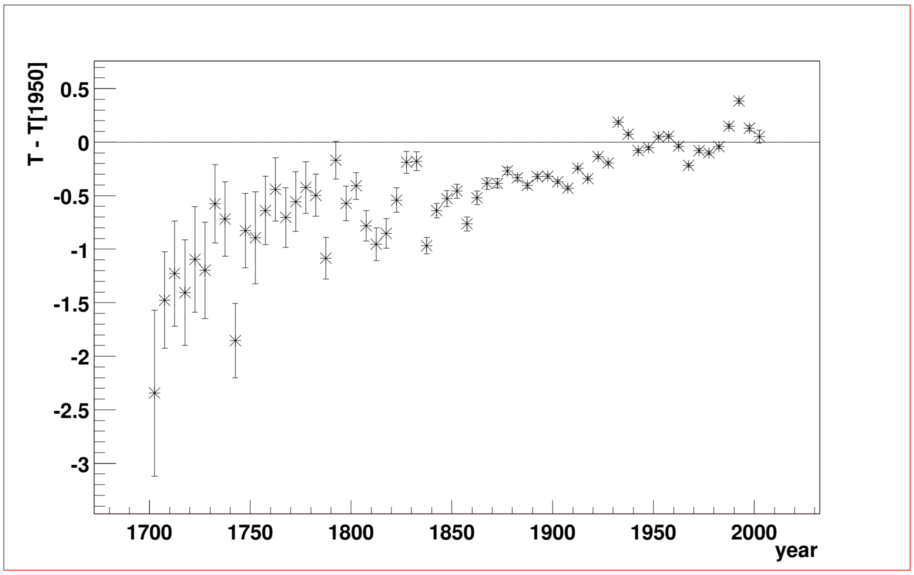

Figure 5: Temperature relative to 1950 averaged over 5 year bins and averaged over the 456 stations satisfying the selection criteria described in the text. Raw data. Errors are statistical, one standard deviation. $a_1 = 0.400 \pm 0.009^o$C per century. See text for details.

since the earliest measurements in 1702. We see no acceleration of global warming in the second half of the 20'th century compared to the first half.

The data shown in Figures 5 and 6 are dominated by stations in the USA as can be seen in Figure 7. However, the general conclusions, *i.e.* warming since the earliest measurements and no acceleration of the warming in the second half of the 20'th century, can be observed elsewhere as shown in Figures 8 to 11.

4 Conclusions

The mean annual temperature of a station fluctuates from year to year by typically $\approx \pm 0.6^o$C (one standard deviation). Superimposed on this fluctuation is a linear increase of temperature by typically $\approx 0.40 \pm 0.01^o$C per century ever since reliable data is available, *i.e.* since 1702, as shown in Figure 5. All errors are statistical only, one standard deviation. The world population has **doubled** from 1952 to 1990 as seen in Figure 12, yet we see no statistically significant acceleration of global warming in that period: see Figures 5 to 11. We conclude that the effect of humankind on global warm-

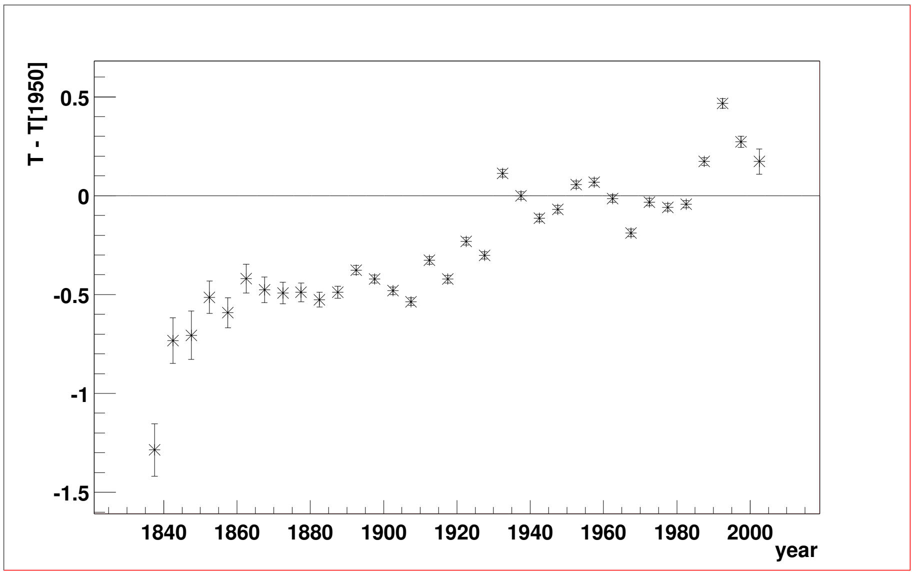

Figure 6: Temperature relative to 1950 averaged over 5 year bins and averaged over the 377 stations satisfying the criteria described in the text. Adjusted data. Errors are statistical, one standard deviation. $a_1 = 0.582 \pm 0.010^o$C per century. See text for details.

ing up to 1990 is 0.0 ± 0.1^oC. Therefore, contrary to popular belief, the data support the view that human activity has had no significant effect on global warming up to the year 1990 covered by this study.

References

[1] "The Global Historical Climatology Network (GHCN) version 2" released in 1997. This data, reachable from http://www.ncdc.noaa.gov, is produced jointly by the National Climatic Data Center, Arizona State University, and the Carbon Dioxide Information Analysis Center at Oak Ridge National Laboratory.

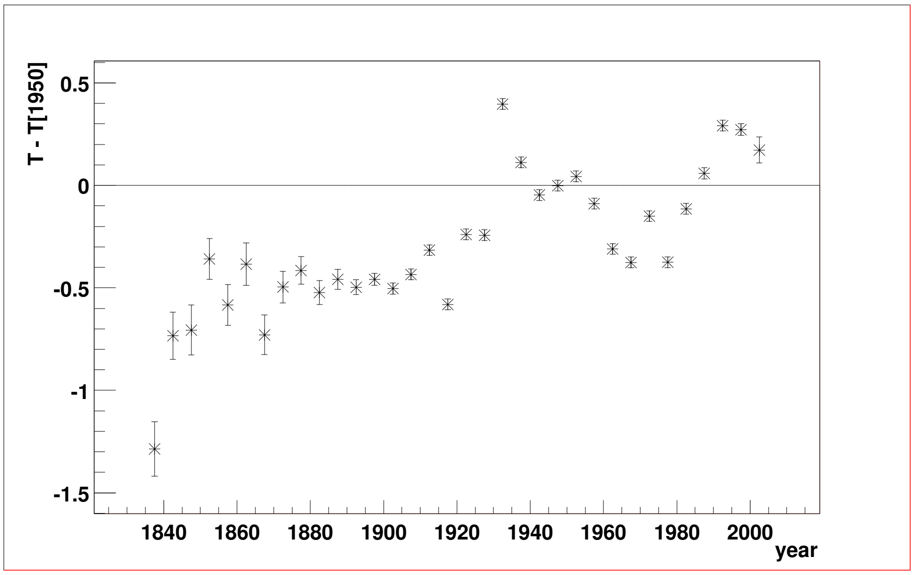

Figure 7: Temperature relative to 1950 averaged over 5 year bins and averaged over the 247 stations in the USA satisfying the criteria described in the text. Adjusted data. $a_1 = 0.462 \pm 0.013^o$C per century.

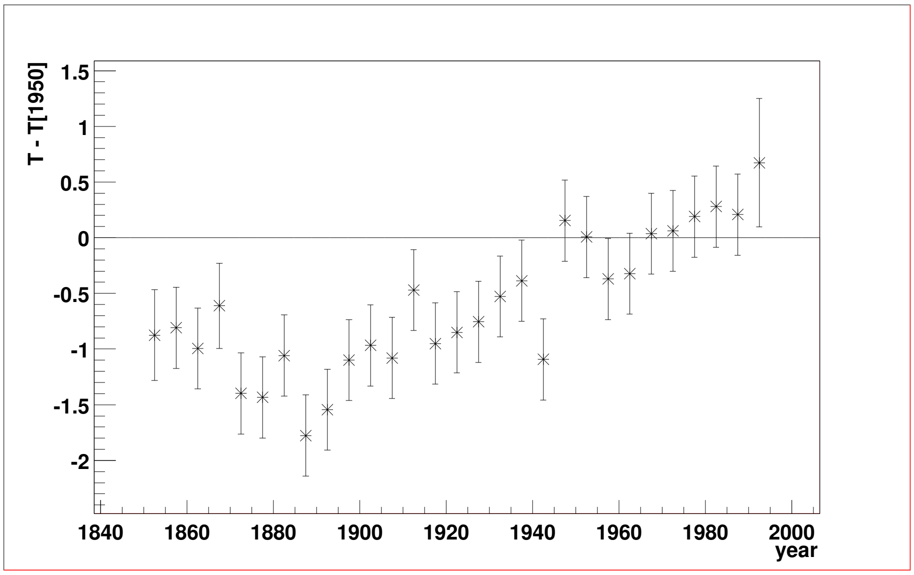

Figure 8: Temperature relative to 1950 averaged over 5 year bins and averaged over the 2 stations in Germany satisfying the criteria described in the text. Adjusted data. $a_1 = 1.18 \pm 0.13^o$C per century.

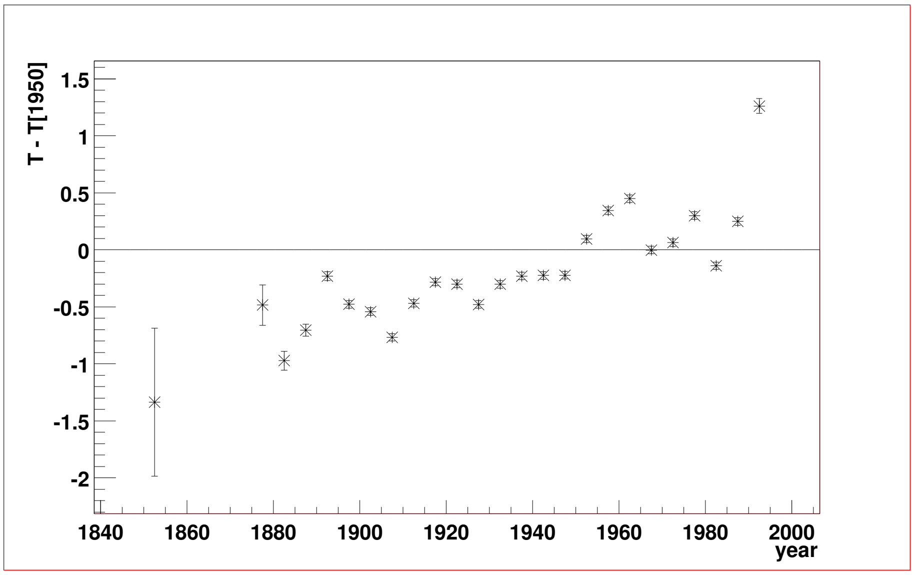

Figure 9: Temperature relative to 1950 averaged over 5 year bins and averaged over the 75 stations in Japan satisfying the criteria described in the text. Adjusted data. $a_1 = 0.987 \pm 0.022^o$C per century.

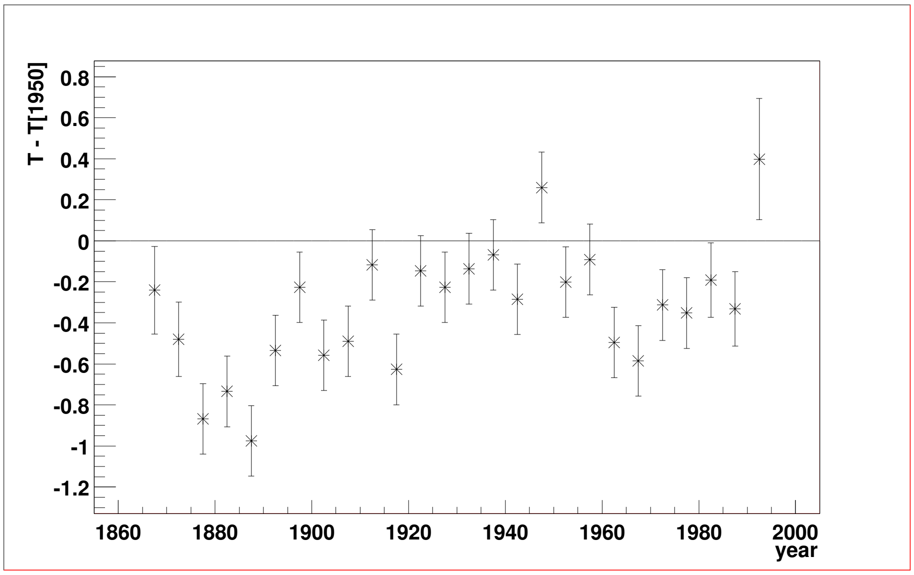

Figure 10: Temperature relative to 1950 averaged over 5 year bins and averaged over the 3 stations in the United Kingdom satisfying the criteria described in the text. Adjusted data. $a_1 = 0.41 \pm 0.08^o$C per century.

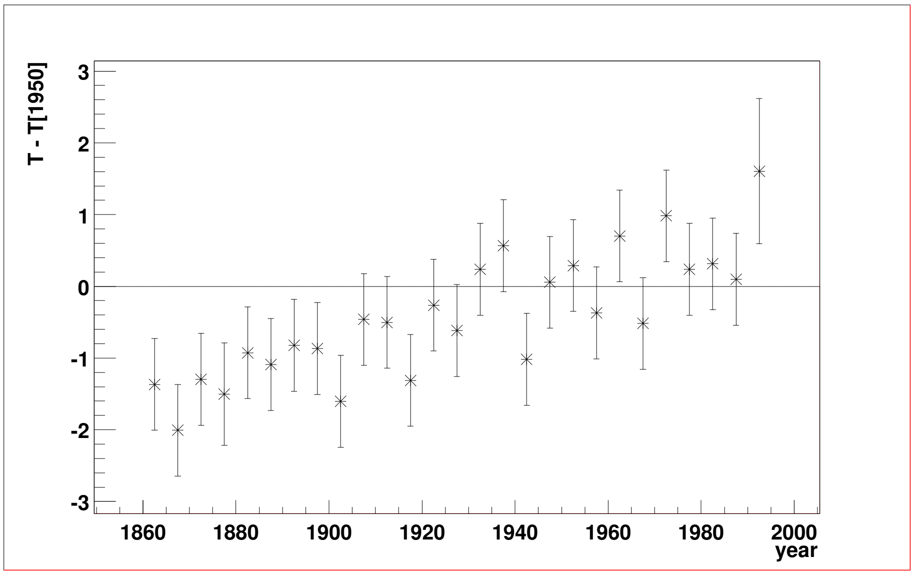

Figure 11: Temperature relative to 1950 averaged over 5 year bins of the single station in Sweeden satisfying the criteria described in the text. Adjusted data. $a_1 = 1.75 \pm 0.30^o$C per century.

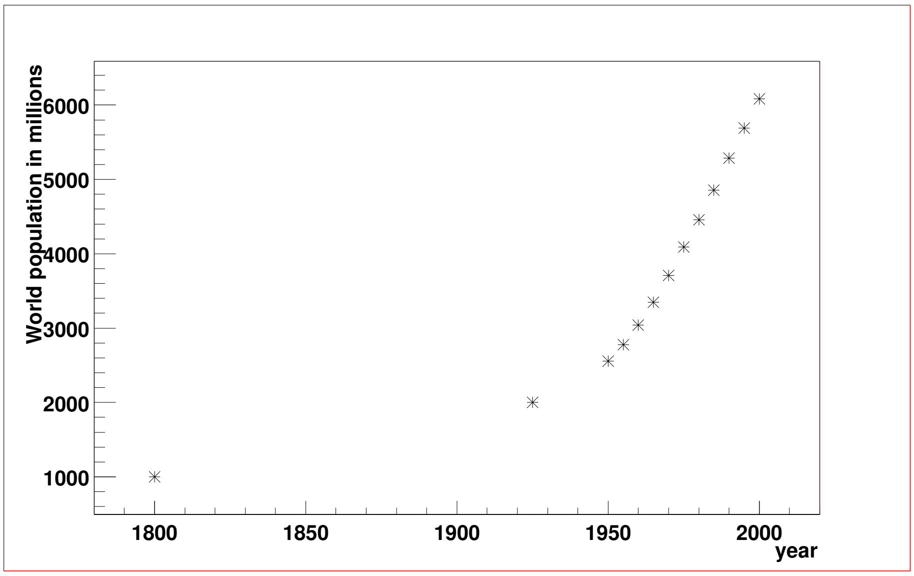

Figure 12: World population in millions (from data collected by the United Nations, except for the first two points which are estimates).