Trend of the annually maximum temperatures in the Netherlands since 1900 first showing slow and after 1988 faster increases.

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Abstract

The data used were measured at the Royal Meteorological Institute (KNMI), De Bilt, Netherlands. Measurements were done since 1900 and continued up to now.
An initial trend-analysis was made by linear regression. Although there is a slightly rising trend, analysis of variance (ANOVA) proves that, statistically, this trend is significant. This significant trend could be the result of a climate change.
A second trend-analysis was done with segmented regression using the SegRegA software program. There appears to be a sudden change after 1981 followed by a faster rising trend. However, this change is statistically not significant as the ANOVA table shows absence of a statistical significance of the model.

Contents

1. Introduction

In a previous article [Ref. 1] it was shown that the yearly averages of the average day temperatures in de Bilt showed a sudden increase in the year 1988. In this article the yearly maxima of the maximum day temperatures in de Bilt will be analyzed.

2. Linear regression before correction

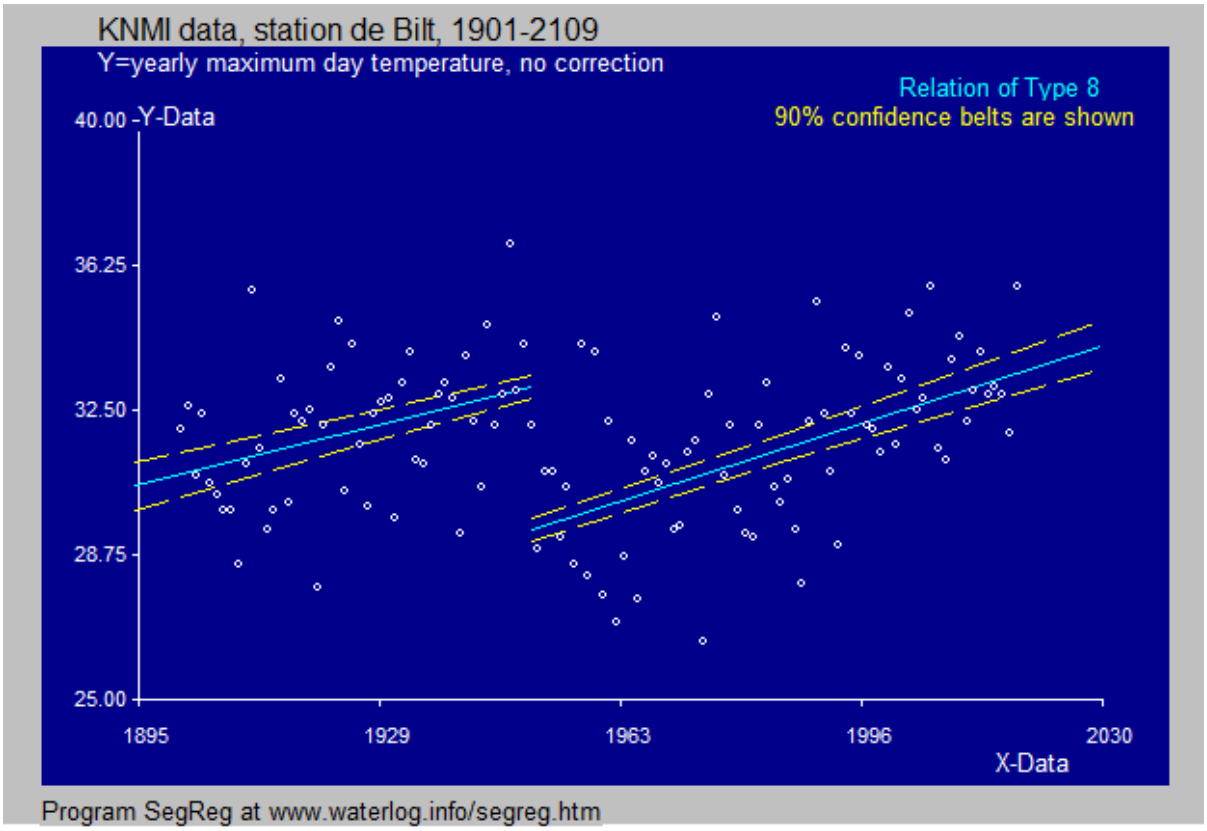

Figure 1. Linear regression of yearly Maximum temperatures on time in years. Data from KNMI station, de Bilt, Netherlands.

It appears that there is a jump of about 3 degrees centigrade in the year 1950. This is due to a change in the set up of the thermometer housing. The data before 1950, therefore, need a correction before they can be compared with the data after 1950.

3. Linear regression after correction

After subtracting the jump from the data before 1950, the linear regression looks as follows:

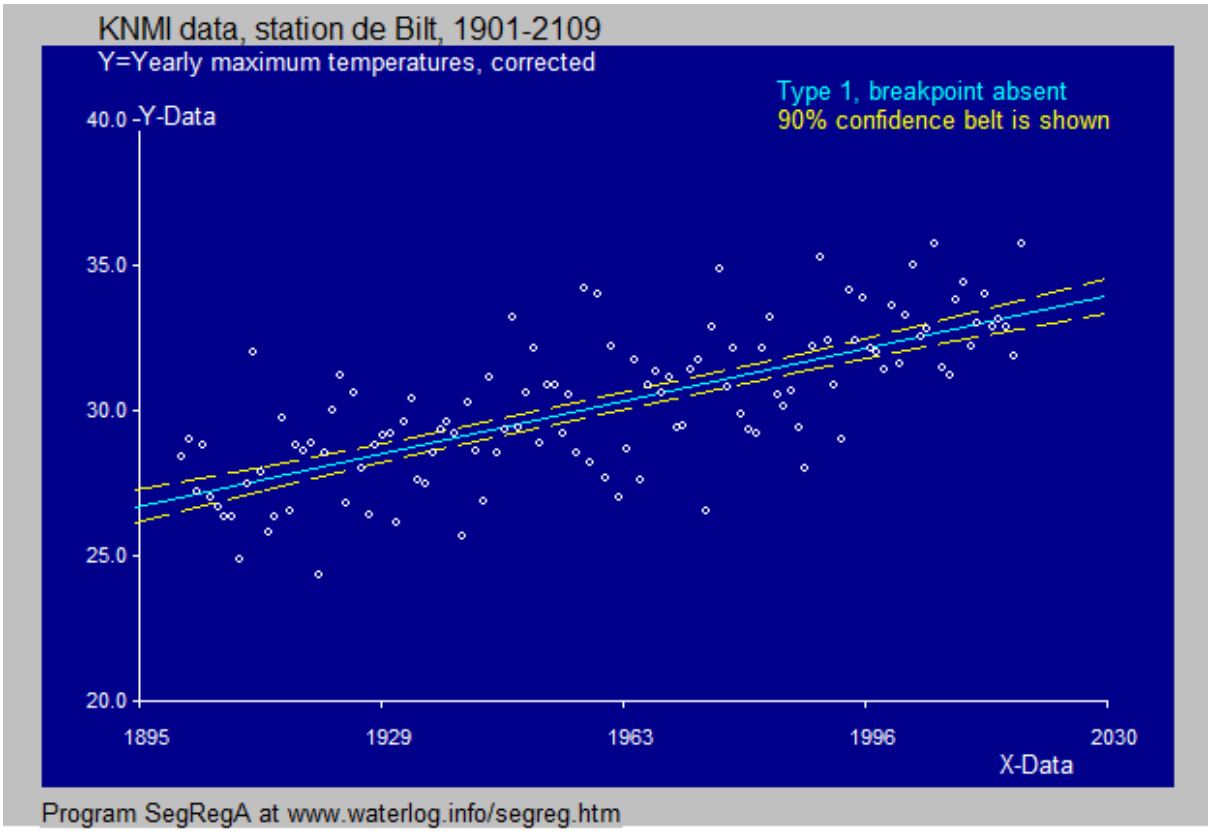

Figure 2. Linear regression of yearly maximum temperatures, after correction, on time in years. Data from KNMI station, de Bilt, Netherlands.

The R^2 value equals 0.525 and the slope is 0.054 degrees per year. Fisher's F-test [Ref. 2] yields a probability of 99.9% so that that the regression line gives a better estimate of the trend than a horizontal line through the central point of the data.

Perhaps a segmented regression gives a further improvement.

4. Segmented regression after correction

The segmented linear regression can be done with the program SegRegA [Ref. 3].

The result is shown in the following figure.

The analysis of variance (table 1), to test the significance of the segmented linear regression lines compared to a simple linear regression is shown in the following table as prepared by SegRegA.

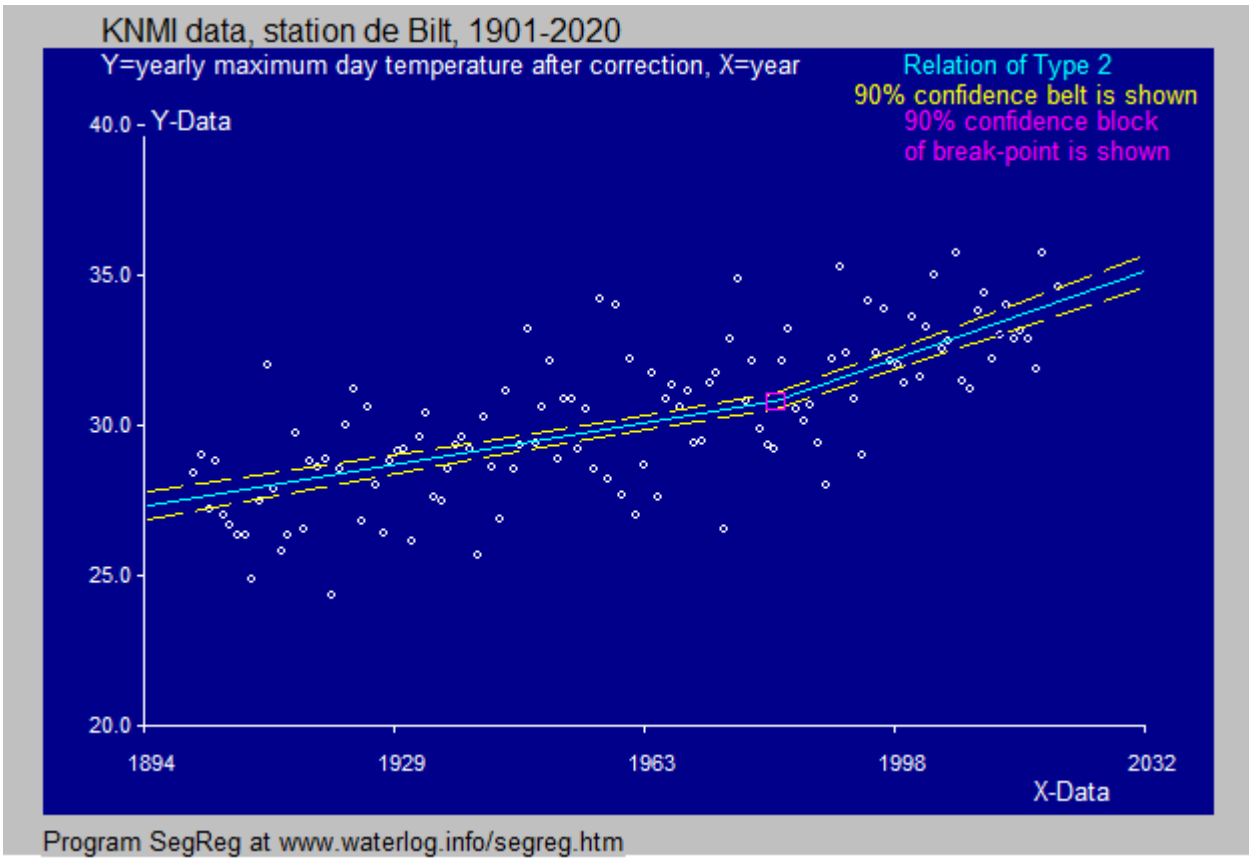

Figure 3. Segmented linear regression of yearly maximum temperatures, after correction, on time in years. Data from KNMI station, de Bilt, Netherlands. There is a break point in the year 1981. The slope before 1981 is 0.040 (degrees per year) whereas after that year the slope is steeper: 0.085 degrees per year. The R^2 value is 0.527, slightly higher than for the straightforward linear regression.

Table 1.

Variance Analysis, ANOVA table, Regression Type: 2
File Name : Segmented linear regression of yearly maximum temperatures

Sum[(Y-Av.Y)sq.] = 779.000 (total sum of squares of deviations)

Total nr. of data = 119
Degrees of freedom = 118

Sum of squares of deviations	Degrees of freedom	Variance	F-Test	Probability/ Significance
explained by linear regression				
409.000	1	409.000	F(1,117)= 129.764	99.9 %
remaining unexplained				
370.000	117	3.162		
extra expl. by break-point				
1.656	3	0.522	F(3,116)= 0.171	4.4 %
remaining unexplained				
368.344	116	3.231		
total expl. by break-point				
410.656	3	136.885	F(3,114)= 42.365	99.9 %

The above table tells us that the introduction of the breakpoint does not reduce the deviations significantly and that the overall result of the segmented regression unfortunately is statistically not better than the linear regression

5. Conclusion

Since 1900 there is a slow gradual increase in the maximum temperature at a rate of 0.054 degrees per year. Statistically, there is no evidence that after 1981 the slope becomes steeper

6. References

[Ref. 1] Trend of annual averages of daily average temperatures in the Netherlands since 1900 first showing slow and then fast increases. On line: https://www.researchgate.net/publication/335541155_Trend_of_annual_averages_of_daily_average_temperatures_in_the_Netherlands_since_1900_first_showing_slow_and_then_fast_increases

[Ref. 2] F-tester, free software calculator for Fisher's F-test. Download from: https://www.waterlog.info/f-test.htm

[Ref. 3] SegRegA, free software for segmented regressions. Download from: https://www.waterlog.info/segreg.htm