The temperature trend in Sweden during the COVID19 pandemic: a qualitative investigation using SMHI open data

Love Kildetoft, Marwan Mohamed, Sherwan Jamo Abdi

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1 Introduction

The Swedish Meteorological and Hydrological institute (SMHI) regularly provides data sets open to the general public, which contain several variables which the institute monitors. One such variable is temperature, which has been regularly measured in several Swedish cities since the late 1800s.

It is well known that there is an ever increasing trend towards higher temperatures, owing to global warming. The aim of this report is to investigate the temperature trend for three Swedish cities that has been recorded for around 70 years. Another aim is to see if one could correlate to potential fluctuations in the temperature trend to human factors such as the COVID-19 pandemic. Although for the case here in Sweden, recent research has however indicated that this trend might have been temporarily broken during the worldwide COVID19 pandemic. Even though these effects may not have been significant to alter the prognosis for climate change, it is interesting to see if a similar effect was seen in Sweden as the government never imposed any strict lock downs. The main cause of the decrease in greenhouse gas emissions is generally attributed to lock downs, as these led to less travel and economic activities both domestically and internationally.

2 Method

In order to make use of the recorded data from SMHI, different programming resources have been used. These resources include Python and C++ where libraries from both Numpy and root have been used. Numpy was mainly used through Python in order to pre-process the data. The pre-processing involved cleaning the data to the relevant range and calculating mean and median values as these are the statistics of interest.

Thereon, comes the visualization of the data in the form of graphs. This was done using the root library through C++ where the data for date, mean/median temperatures and its corresponding errors obtained from the preprocessing part has been turned into separate vectors. These vectors were then plotted using TGraph and TGraphErrors class from root, where the latter includes the errors in the plotting of the graph. Moreover, a fitting method from root has been used where the graph has been fitted using a fourth degree polynomial. The data sets for the daily temperature of the cities Falun, Lund and Karlstad from 1940 to 2021 were used.

3 Results

The graph of the measured mean and median temperature in Lund from 1940 up to 2021 can be seen in figures 1 and 2 respectively.

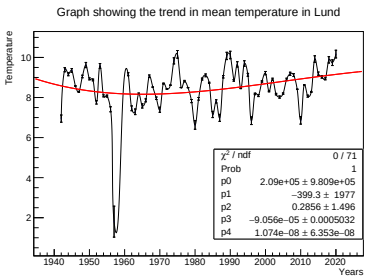

Figure 1: Measured mean temperatures in Lund from 1940 up to 2021.

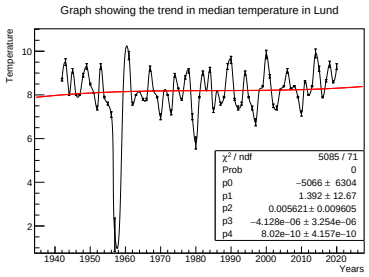

Figure 2: Measured median temperatures in Lund from 1940 up to 2021.

The graph of the measured mean and median temperature in Falun for each day from 1940 up to 2021 can be seen in figure 3 and 4 respectively.

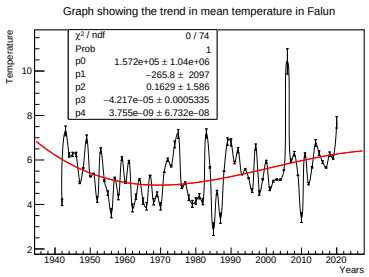

Figure 3: Measured mean temperatures in Falun from 1940 up to 2021.

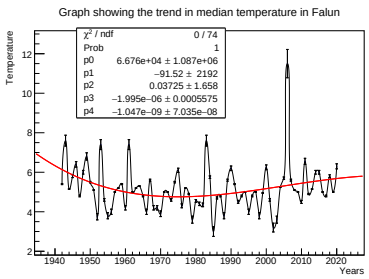

Figure 4: Measured median temperatures in Falun from 1940 up to 2021.

The graph of the measured mean and median temperature in Karlstad for each day from 1940 up to 2021 can be seen in figure 5 and 6 respectively.

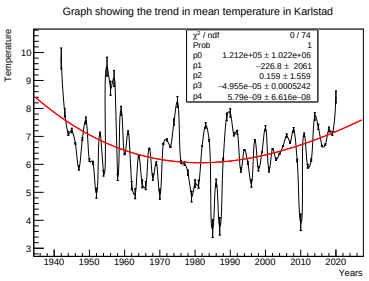

Figure 5: Measured mean temperatures in Karlstad from 1940 up to 2021.

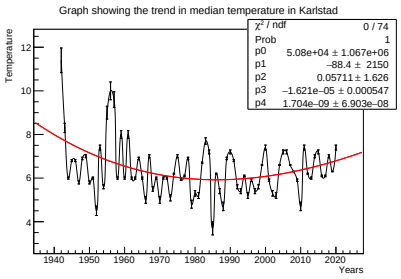

Figure 6: Measured median temperatures in Karlstad from 1940 up to 2021.

4 Discussion

As it can been seen from Figures 1 and 2 the fitted parabolas are increasing ever so slightly. It can also be seen that there a huge dip in temperature in around 1955. This can be considered an anomaly due to the summer starting with very cold and snowy weather up until June [1]. Despite that anomaly there is slight increase in overall temperature. Zooming into the two years of the pandemic 2020 and 2021, it can be seen that the mean and median temperatures have not changed by much but they are increasing ever so slightly.

Looking at Figures 3 and 4, it can also be seen that there is an overall temperature increase from the slop of the fitted polynomial. It is interesting to see that there is quite a difference from year to year. This suggests that Falun has a fluctuating climate environment. Some major events can be seen in this figures. Mainly the extreme cold winters in 1942 [2] and 2010 [3] as well as the heat wave that happened in 2007 [4]. All of these three events can be considered an anomaly, when looking at the overall trend. During the pandemic years of 2020 and 2021 it can be seen that there is an increase in mean temperature, this might be due to the hot summers experienced in both

years. Nonetheless the increase seems to be within reason.

Looking at Karlstad mean and median temperatures in Figures 5 and 6, it can be seen that the temperature is much more changing compared to the Lund and Falun. This fluctuation can not be explained by events. Regardless looking at the years 2020 and 2021, it can be seen that there is an increase mean temperatures following the same trend as Falun. This can be explained due to the hot summers that occurred in these two years.

5 Conclusion

In conclusion the results are inconclusive due to the inability to describe anomalies in the figures. Despite that a clear trend in increased temperature can be seen throughout the three cities.

References

[1] SHMI. *Skånes klimat*. [Online; accessed 28-October-2022]. 2022. URL: https://www.smhi.se/kunskapsbanken/klimat/klimatet-i-sveriges-landskap/skanes-klimat-1.4827#:~:text=Sk%C3%A5ne%20st%C3%A5tar%20med%20m%C3%A5nga%20v%C3%A4rmerekord,till%2017%C2%B0%20i%20Malm%C3%B6..

[2] SvD. *Vargavintrarna – när kylan höll Sverige i järngrepp*. [Online; accessed 28-October-2022]. 2016. URL: https://www.svd.se/a/f09ff3c3-ef17-4a1f-b863-831c078b3b73/vargavintrarna-nar-kylan-holl-sverige-i-jarngrepp..

[3] Wikipedia. *Vintern 2009–2010 i Europa*. [Online; accessed 28-October-2022]. 2021. URL: https://sv.wikipedia.org/wiki/Vintern_2009%E2%80%932010_i_Europa..

[4] SHMI. *Juni 2007 - Värmebölja följdes av översvämningar*. [Online; accessed 28-October-2022]. 2017. URL: https://www.smhi.se/klimat/klimatet-da-och-nu/manadens-vader-och-vatten-sverige/juni-2007-varmebolja-foljdes-av-oversvamningar-1.4228.