1 Team C - MNXB01 Report

1.1 Introduction

The aim of this report is to briefly summarise how the project was approached from a coding perspective, and then discuss some analysis results. The base code was written in C++, however the graphs/histograms are plotted in Root.

The initial approach for coding was based upon plotting directly from the cleansed files, however it became apparent quickly that "date" or "time" are not objects that Root can handle by default. This led to a change in approach, of using vectors to store information and then doing analysis directly.

Following this; here are three points of analysis.

1.2 Analysis #1 - 2010 Volcanic Eruption

On March 20th 2010, there was a volcanic eruption in Eyjafjallajkull [1]. This eruption caused mass flight disruptions due to the large plumes of smoke rising from the volcano. The idea was to investigate whether this massive cloud caused cooling effects similar to that of a nuclear winter as the white smoke reflected the suns rays cooling the area beneath.

This first idea was to try and compare the year of the event 2010 and the year before to see if there was any obvious temperature fluctuation after the event. When these two years and their dates were plotted on the same graph taken from the Lund weather data the graph resembled the following.

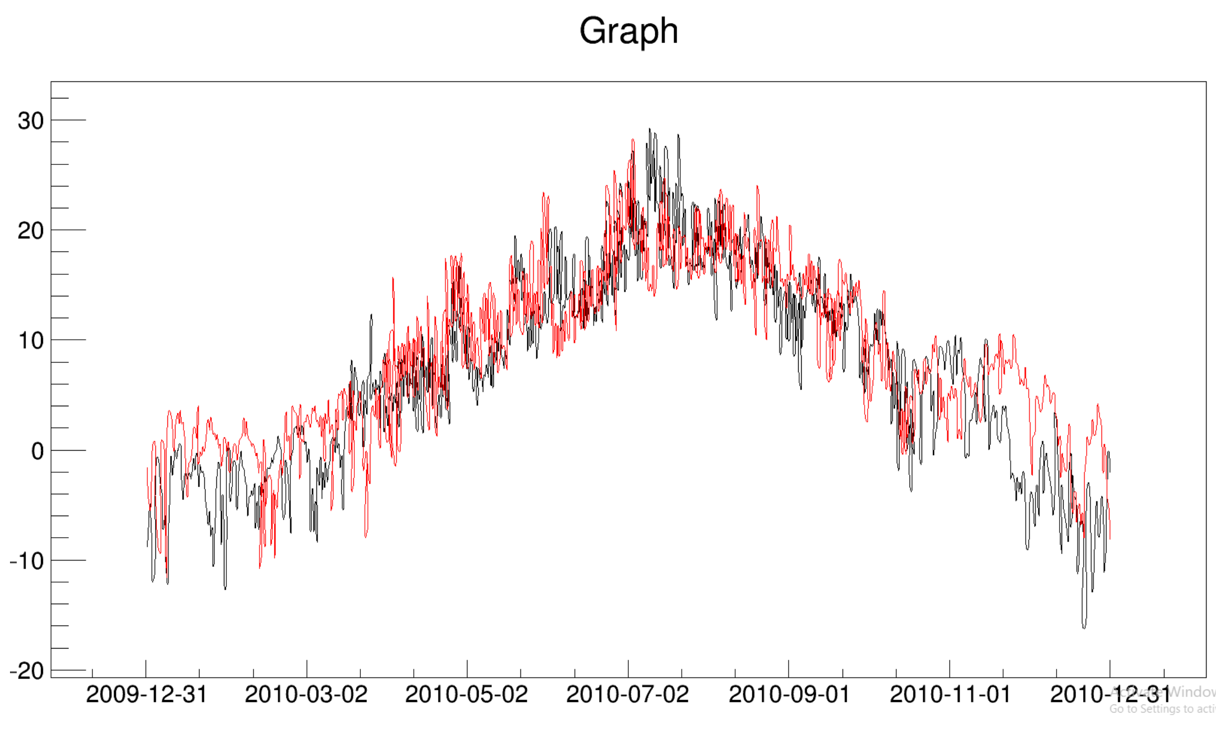


Figure 1: **Air temperature in Lund in 2009 (red) and 2010 (black)**

What was clear once the program worked is that simply comparing two years without context does not help in visualising any changes that might have occurred. To remedy this I decided the best way to show if there was any temperature fluctuation around the event of the volcanic eruption was to average the temperatures for a given span of years and then compare this to the year of the event.

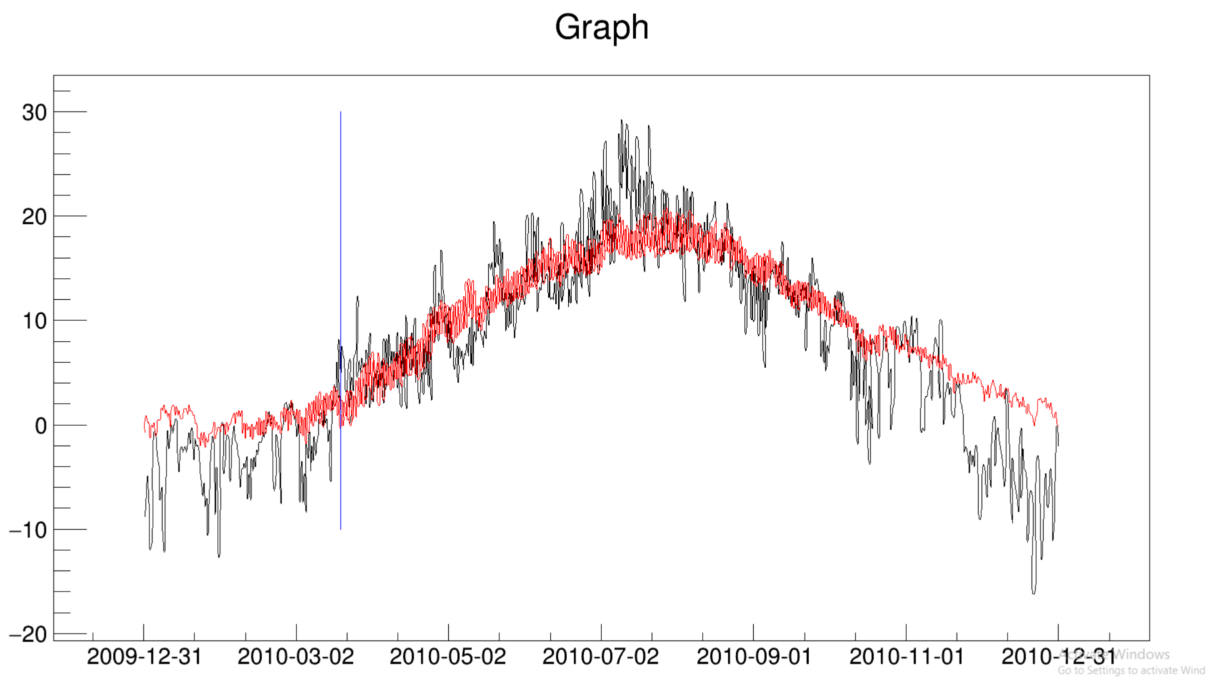
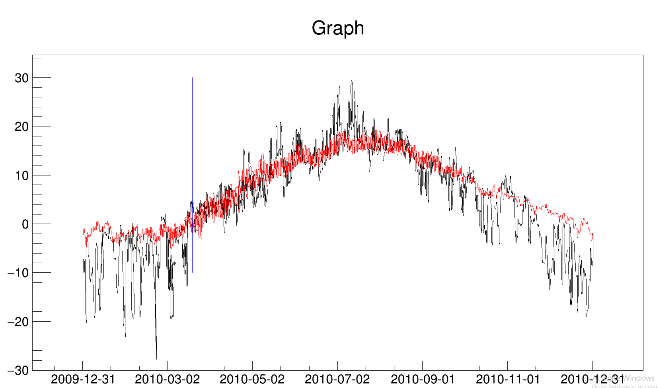
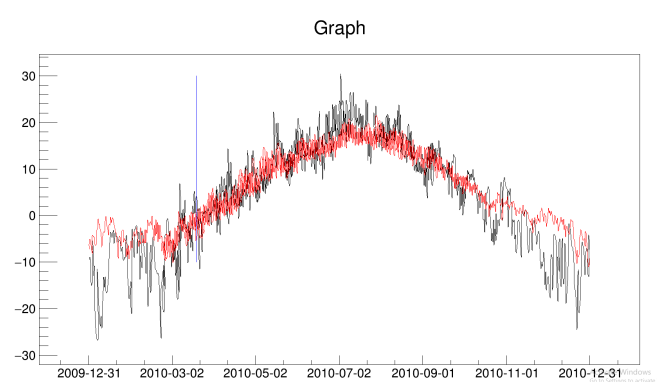


Figure 2: **Air temperature in Lund in 2010 (black) compared to the average between 1996 and 2014 (red) the date of the event is also shown (blue)**

From this graph it is not very clear whether or not there is significant change given the fluctuations are no more different from normal fluctuations. There does seem to be some increase in temperature after the event which could be due to pyroclastic material in the atmosphere but the general upward trend before this point suggests this was natural. In order to try and get some more generalised information I then compared data with some points closer geographically to the volcano than Lund including Boras, Falun and Luleå. The data gathered is displayed in the graphs below.





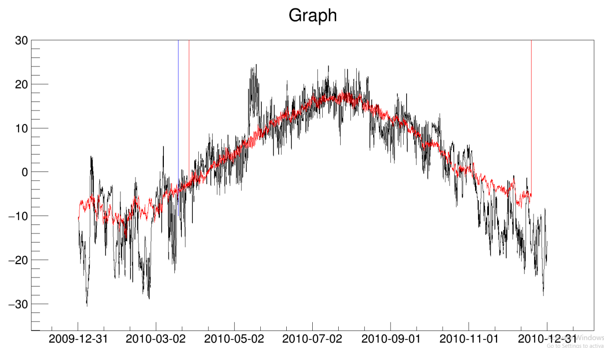


Figure 3: **Top Left:** Air termperature in Boras in 2010 (black) compared to 1996-2014 (red) event (blue). **Top Right:** Air termperature in Falun in 2010 (black) compared to 1998-2005 (red) event (blue). **Bottom:** Air temperature in Lulea in 2010 (black) compared to average 1998-2014 (red) event (blue)

Here we see that there is random fluctuations in each of the graphs with no general trends between increase or decrease in temperature after the event. Although the year seems to be colder than average this is most likely due to factors other than the volcano as this dip in temperature occurs well after the eruption. Although we did not find data to support temperature change due to the volcano this was still an int resting analysis and potentially used on a larger eruption would result in useful data.

1.3 Analysis #2 - Comparing Histograms of Temperature of Two Locations on the same latitude

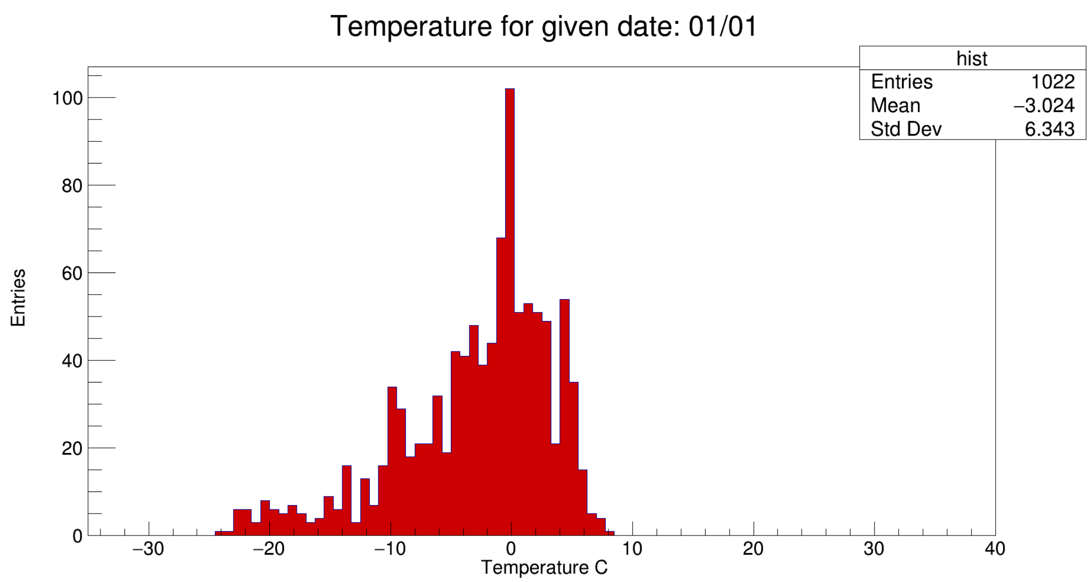


Figure 4: Histogram showing the temperature in Karlstad on January 1:st every year since 1951

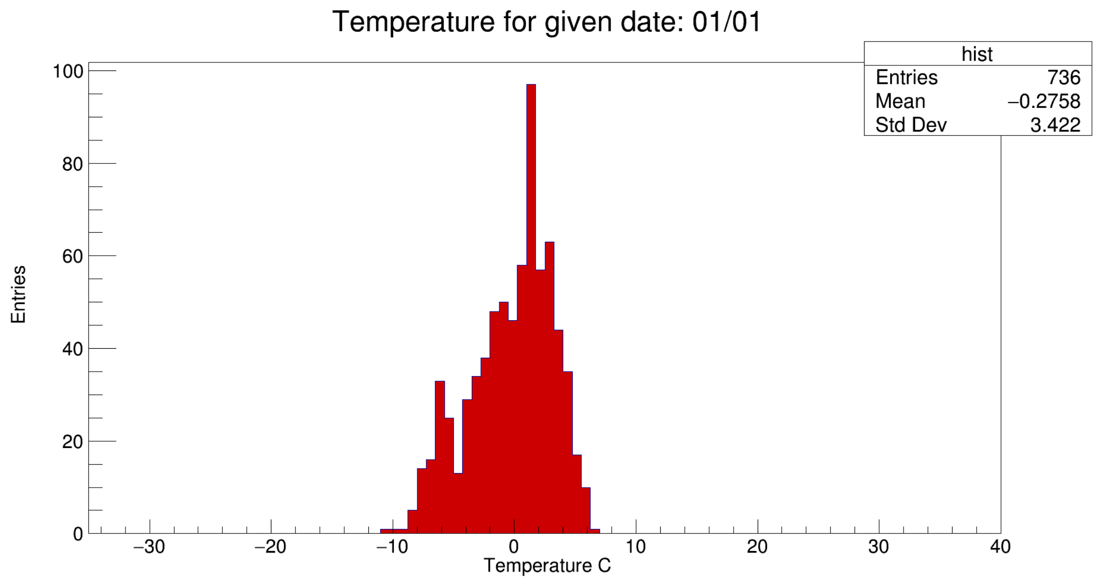


Figure 5: Histogram showing the temperature in Söderarm on January 1:st every year since 1951

Here we can see the histograms of the temperature on January first in Karlstad and Söderarm, 2 locations with the same latitude. The goal was to see if there was any notable difference with being and inland city, and a east coast city. With only 2 samples we can't really make any statistical conclusions, but we can see that Karlstad, an inland city, has almost the double standard deviation compared to Söderarm, which is on the east coast. Generally being a coast city should stabalize the temperature in the location since during winter the ocean temperature is heating the city and in summer it is cooling the city.

1.4 Analysis #3 - Global warming effect across Sweden

I will be investigating if global warming has had a bigger effect on different places in Sweden. Have northern towns been affecting more than say coastal towns or southern towns. I also want to look at how the weather profile has changed over the years. Have the winter months been affected greater than the summer months and is this a universal trend across Sweden for all the different places.

1.4.1 Southern: coastal town vs inland town

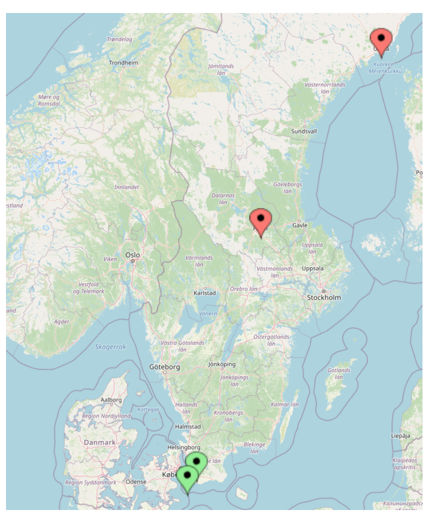


Figure 6: Location of Falsterbo,Lund in green and Falun and Umea in red from left to right.

The first investigation I made was to see if global warming has a greater effect on towns that are directly on the coast compared to towns that are further inland. Seas and oceans usually act as a temperature ballast so I expected the coastal town of Falsterbo to have smaller temperature variations compared to Lund. Figure 6 shows the locations of Lund and Falsterbo in southern Sweden.

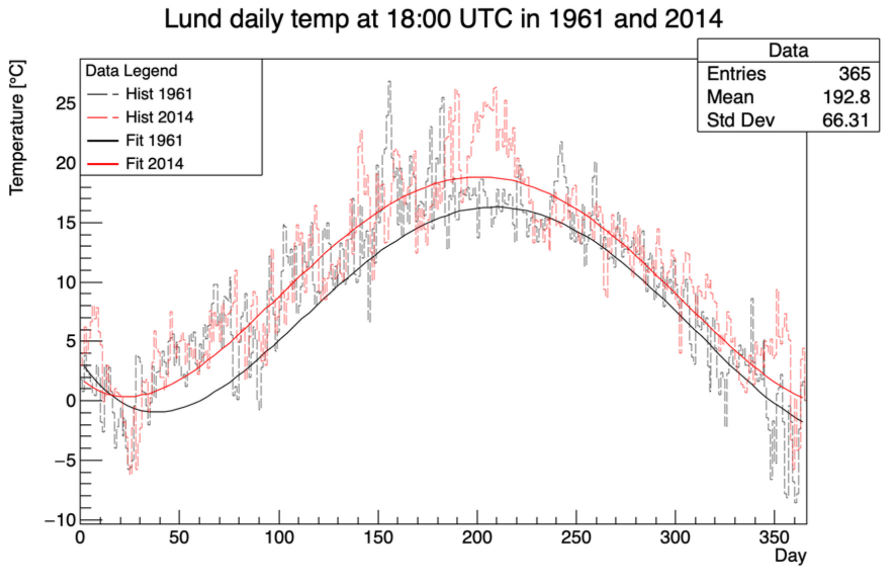


Figure 7: **Lund temp changes 1961 vs 2014 histogram with pol4 fit.**

Here we can see a small increase in temperatures over 50 years. There is a small shift towards later in the year but the change is not drastic. It appears that towns inland have been affected less by global warming in the period between 1961 and 2011. The peak temperature of the fitted curve is about 2.5 degrees centigrade and the peak occurs about 5 days earlier in the year.

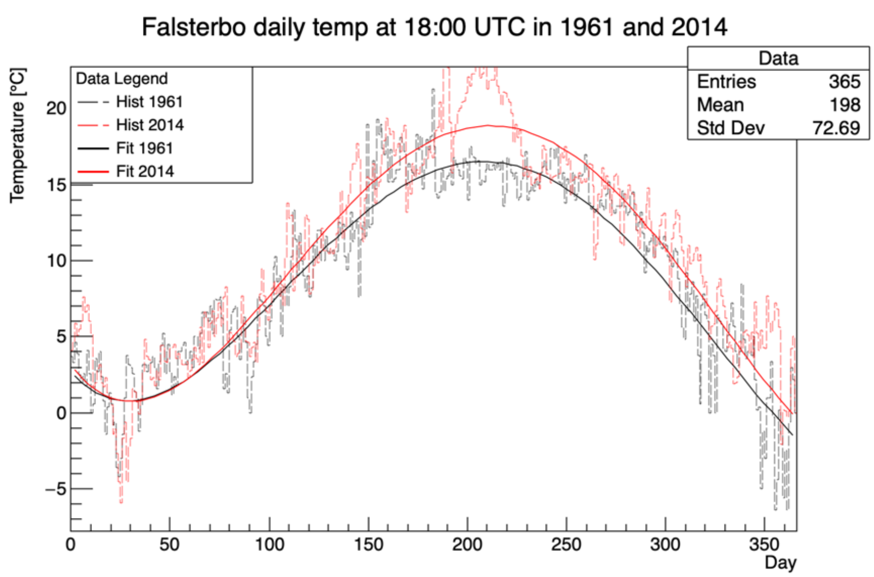


Figure 8: **Falsterbo temp changes 1961 vs 2014 histogram with pol4 fit.**

Here we can see a much greater increase in the temperature increases and a shift towards later in the year for Falsterbo. This could indicate that the water around the area is warming faster than the land does and temperature changes are felt more than places inland. The peaks differ by about 3.5 degrees centigrade and the peaks occur about 7 days later in the year.

1.4.2 Northern: coastal town vs inland town

Next I compared the northern town Umea that is quite close to the coast against Falun a town much further south but also inland.

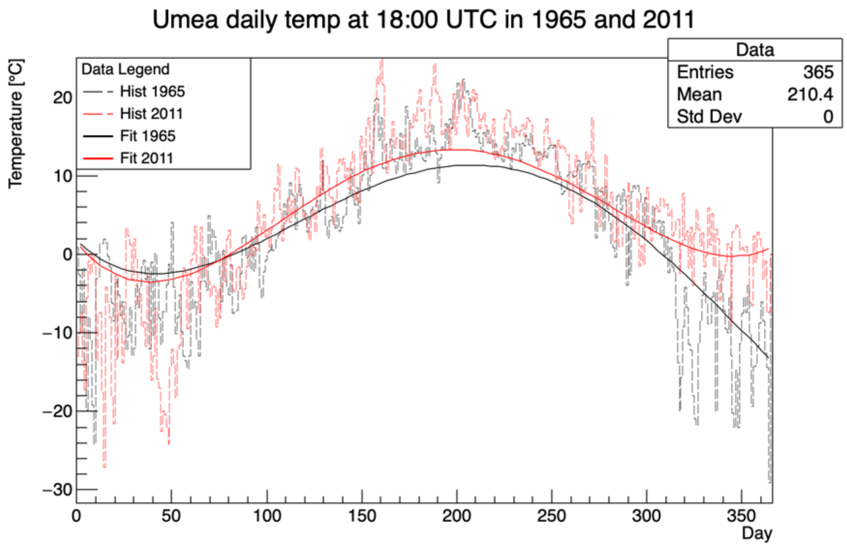


Figure 9: **Umea temp changes 1965 vs 2011 histogram with pol4 fit.**

In this plot we can see that the temperatures have again risen for the peak summer temperatures by around 1 degree. Although interestingly the late winter period appears to be unaffected as the beginning of 2011 is actually colder, although this could be an outlier year. A big change in the chart is the much lower temperatures at the end of 1965 Umea for the start of winter.

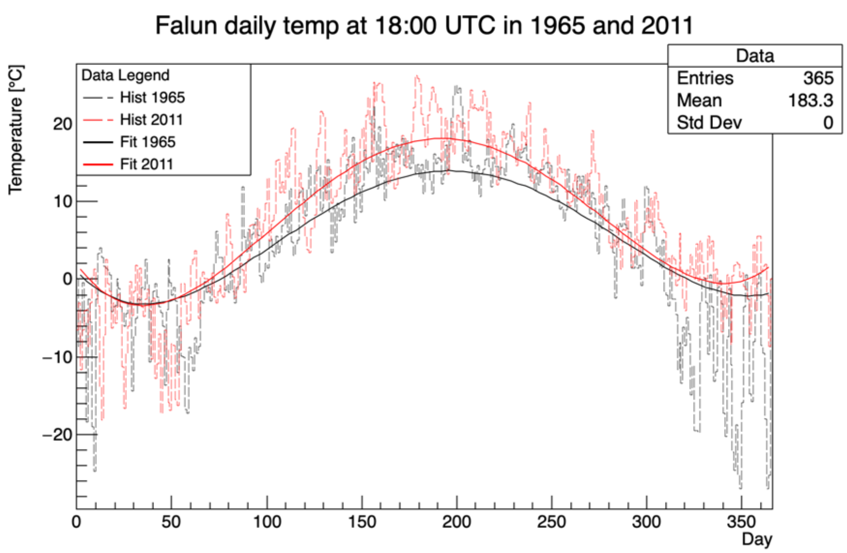


Figure 10: **Falun temp changes 1965 vs 2011 histogram with pol4 fit.**

In the plot for Falun we can see that the winter months at the start and end of the data are quite well aligned. This hows that in Falun the winter months a similar to how they were 46 years ago. The big change in the plot is the summer months which are shifted upwards by about 2 degrees. From these two plots and this quick analysis it would appear that in more northern places the winter temperatures have been affected less than the summer months. The proximity of Umea to the water also seems to have shielded it from the same large increase in summer temperatures that Falun has experienced.

1.5 Analysis #4 - Average Temperature With All Data

A question which might have somewhat an obvious answer is "which are the average temperatures of different parts of Sweden?

The graphic, seeing as it is one that encompasses all of Sweden, is a very large graphic and hence is shown in Appendix A (figure 12) at the end of the document, before Bibliography.
The temperatures were taken by plotting a histogram and reading off the mean. See figure 11.

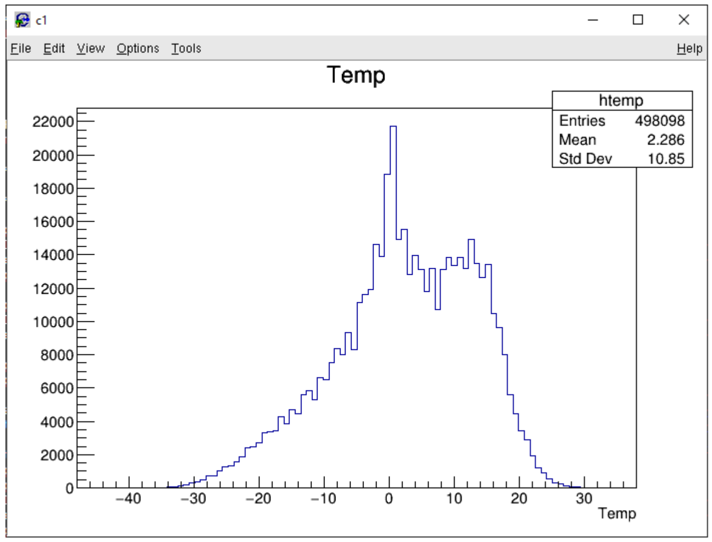


Figure 11: Temperature frequencies in Lulea

1.6 Appendix A

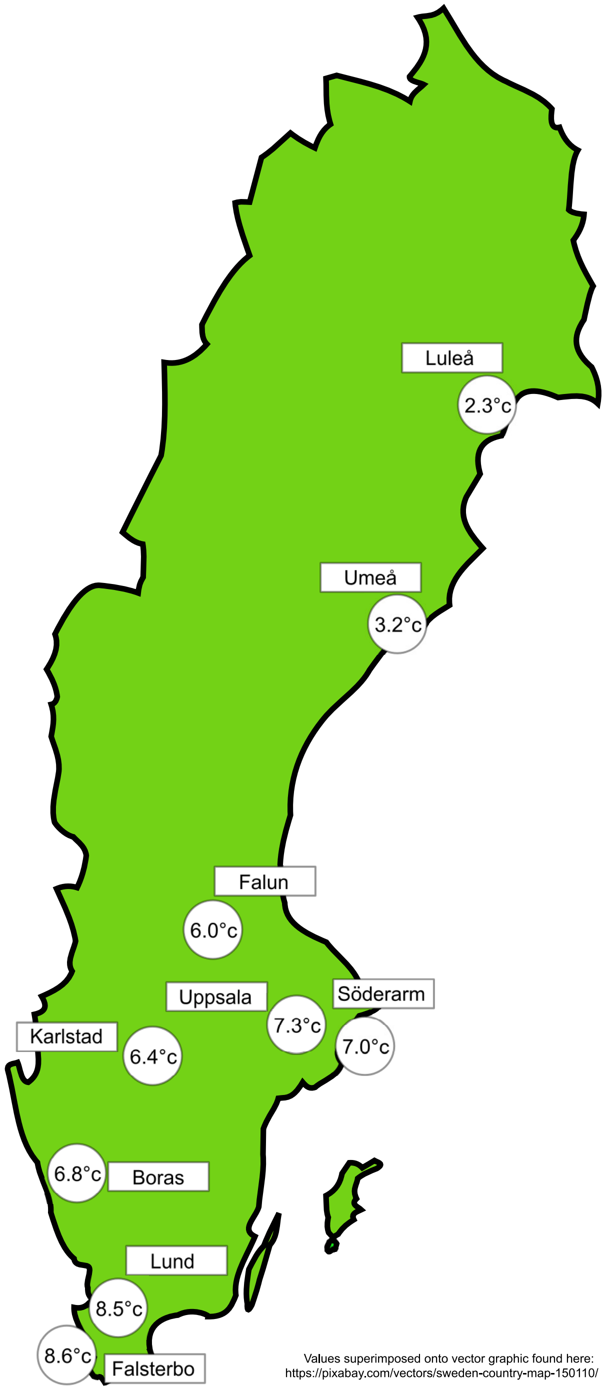


Figure 12: The average temperature in different parts of Sweden

1.7 Bibliography

References

[1] Wikipedia
`https://en.wikipedia.org/wiki/2010_eruptions_of_Eyjafjallaj%C3%B6kull`