Data 3450 Final Project

Hypothesis Test: Is Global Warming happening in Edmonton?
By: Azim Ibrahim, Baraka Aminiel & Kurtis Neumann.

Introduction

Is Global Warming happening in YEG?

According to the National Academics of Science, Engineering and Medicine (NASEM): As the Earth's climate has warmed, a new pattern of more frequent and more intense weather events has unfolded around the world. Scientists identify these extreme weather events based on the historical record of weather in a particular region. They consider extreme weather events to be those that produce unusually high or low levels or rain or snow, temperatures, wind, or other effects. Typically, these events are considered extreme if they are unlike 90% of similar weather events that happened before in that same area.

Overview

Hypothesis for the Project:

The temperature median of different years is the same. If the medians are the same, we can conclude that Global Warming effects cannot be felt in Edmonton. On the contrary (ie the Alternate Hypothesis), if the medians are not the same, then we can conclude that effects of Global Warming can be felt in Edmonton.

We are going to use Kruskal-Wallis H-test for independent samples. The reason we are using this test is because our data is not normally distributed. Because of this, the Anova test will not be as reliable. Nevertheless, we will also do Anova test to confirm results of the Kruskal test.

Kruskal Wallis H-test for independent samples.

The Kruskal-Wallis H-test tests the null hypothesis that the population median of all of the groups is equal. It is a non-parametric version of ANOVA. The test works on 2 or more independent samples, which may have different sizes. Note that rejecting the null hypothesis does not indicate which of the groups differs. Post hoc comparisons between groups are required to determine which groups are different (*Obtained from the test's official document page*).

How does this help to prove global warming?
By performing the test based on yearly temperature readings, we will be able to test whether all years are the same or if at least one year is different from the others. If the years are the same, then the test produce a P-value that is higher than the normal threshold (ie 0.1). If the test returns a P-Value of less than 0.1, then we will have to reject the Null hypothesis and agree that at least one of the yearly temperature samples is different from the rest.

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Note: Our threshold is 0.1 because according to the scientists, events are considered extreme if they are unlike 90% of similar weather events.

Data

We have obtained Edmonton Weather data tracing back to January 1, 2000.

Data Source:
https://data.edmonton.ca/Environmental-Services/Weather-Data-Hourly-Environment-Canada/ib2b-3mi4

Data includes 21 columns and indexed by RowID (the unique identifier that combines the Station-ID, the year, the month, the day, the hour, the minute and the second that the data was recorded.

Temperature recordings between year 2000 and 2021.

We our analysis, will be mostly interested in the Station Name and Temperature readings.

There are 11 Stations:

- Edmonton Blatchford
- Edmonton Stony Plain CS
- Edmonton Villeneuve A
- Edmonton International CS
- Thorsby AGDM
- New Sarepta AGCM
- Oliver AGDM
- Legal AGCM
- Edmonton Namao AWOS A
- Edmonton South Campus and
- Edmonton Stony Plain

Because our Hypothesis is based on Global Warming in Edmonton: only Edmonton Blatchford Station will be used for this test. Edmonton Blatchford Station is in the city centre and the station has been collecting data since year 2000 with over 183684 Temperature recordings.

Fig1: Boxplot for Edmonton Blatchford Station from 2000 to 2021

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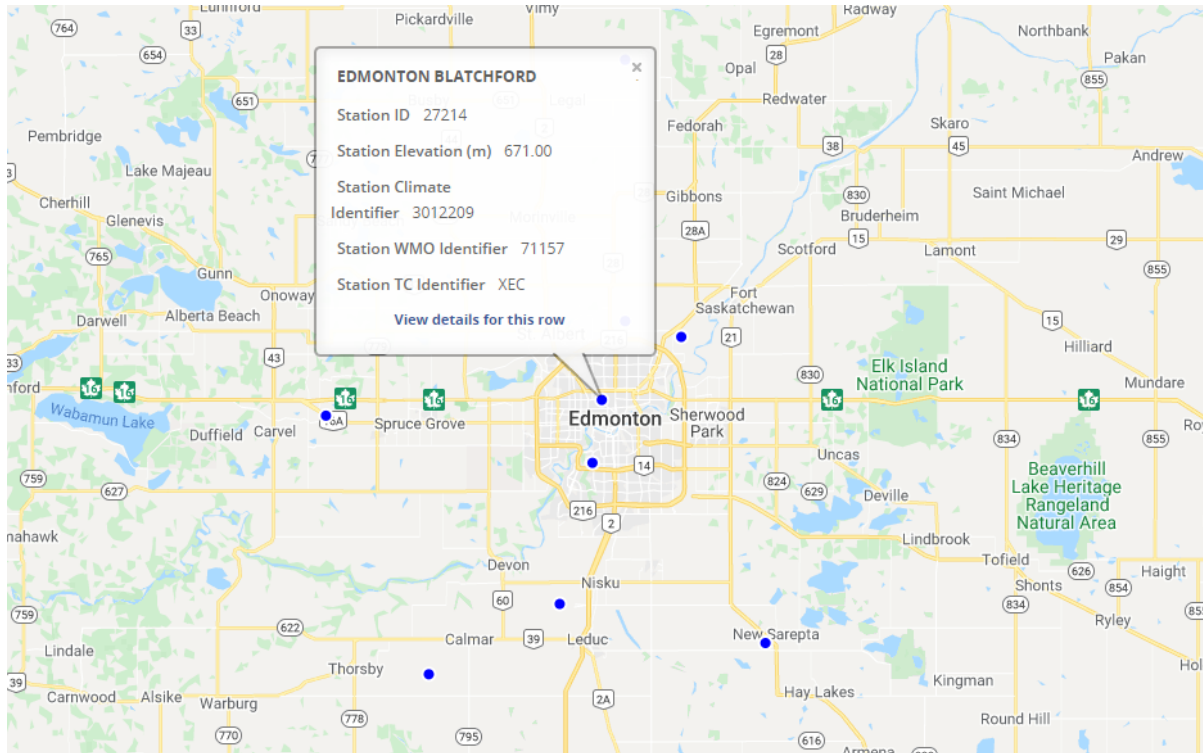By: Baraka Aminiel, Kurtis Neumann & Azim Ibrahim.

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Fig1: Map of Edmonton Blatchford location in the City of Edmonton

We also picked this station because all the other stations (except Edmonton South Campus-in service since 2016) are outside the city. Hence this could skew our data because temperatures outside (rural locations) the city are normally always a little lower than the temperatures in the city itself.

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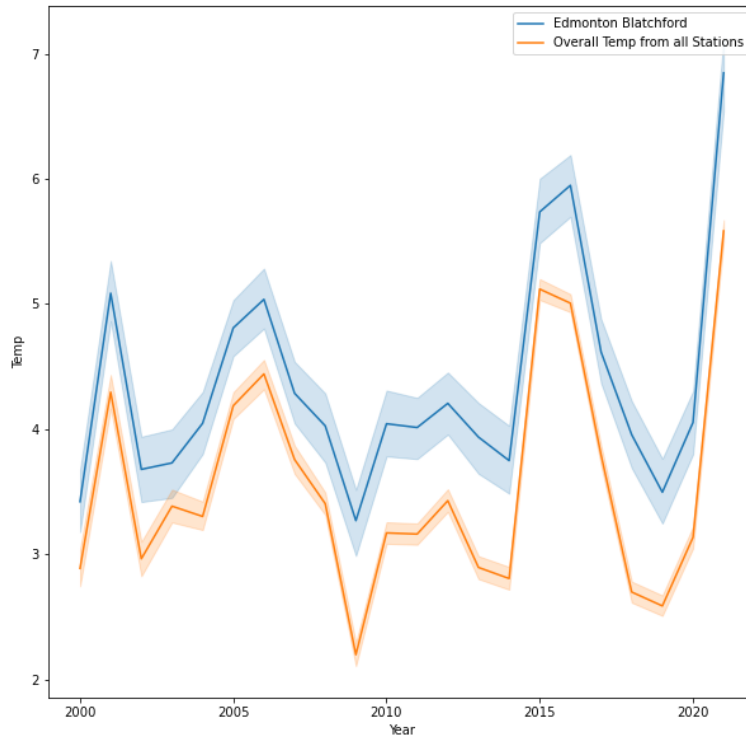By: Baraka Aminiel, Kurtis Neumann & Azim Ibrahim.

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Fig2: Line plot of Temperature readings for Edmonton Blatchford Station from 2000 to 2021 and line plot of Overall Temperature Readings from all the stations around the City of Edmonton.

Kruskal Analysis:

We did three different Kruskal Tests based on yearly temperature, seasonal temperature (we picked summer) and monthly temperature (we picked February). For all three tests, our P values were below the threshold which means we can reject the null hypothesis.

ANOVA Analysis:

We also performed Anova Test based on these different sets of data as explained above. For all three tests, the P-values were below the threshold which also supports findings of the Kruskal Test.

Limitations of our Analysis

1. Insufficient Data.
   To test such a hypothesis, one needs years' worth of data. We only have 21 years' worth of data which is not long enough.
2. Test Limitations.
   The test performed only indicates if there is a difference in medians but fails to indicate which year is different from the other. We would need to investigate further into individual years and how the relate to derive a definitive answer.

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3. Sample Collection Error
   We are using data that is collected from a weather station located inside the city limits. The temperature readings could be skewed due to activities (heat, lights, pollution, etc.) within the city.

Conclusion:

Based on all the set of tests conducted, we achieved a P-Value lower than the threshold, of 0.1. This means we cannot accept the null hypothesis. The effects of Global Warming can be felt in the City of Edmonton.

Weather is one of the hardest things to predict. Even when looking at the weather app three days in advance there is still a possibility for that prediction to be wrong. Metrologists have lots of data and the predictions they make can be decent but not full prove. Knowing this we got the mean of the temperatures from 2000-2020. The sum of the differences between the years is trending up and is a raising the rolling average. The amount of the increase is around 0.7 Celsius for all the years (2000-2020). Knowing that the City of Edmonton, the 5th largest city in Canada and the northernmost city in North America (based on latitude), this is a substantial amount and can lead to gradual growth in years to come. We also tried just the summer months and the increase was around 1.27 degrees higher than the average. And for the winter month of February the average was around 1.78 degrees higher. Understanding this trend there is value in looking into it for the future and seeing if the rolling average is growing or shrinking.
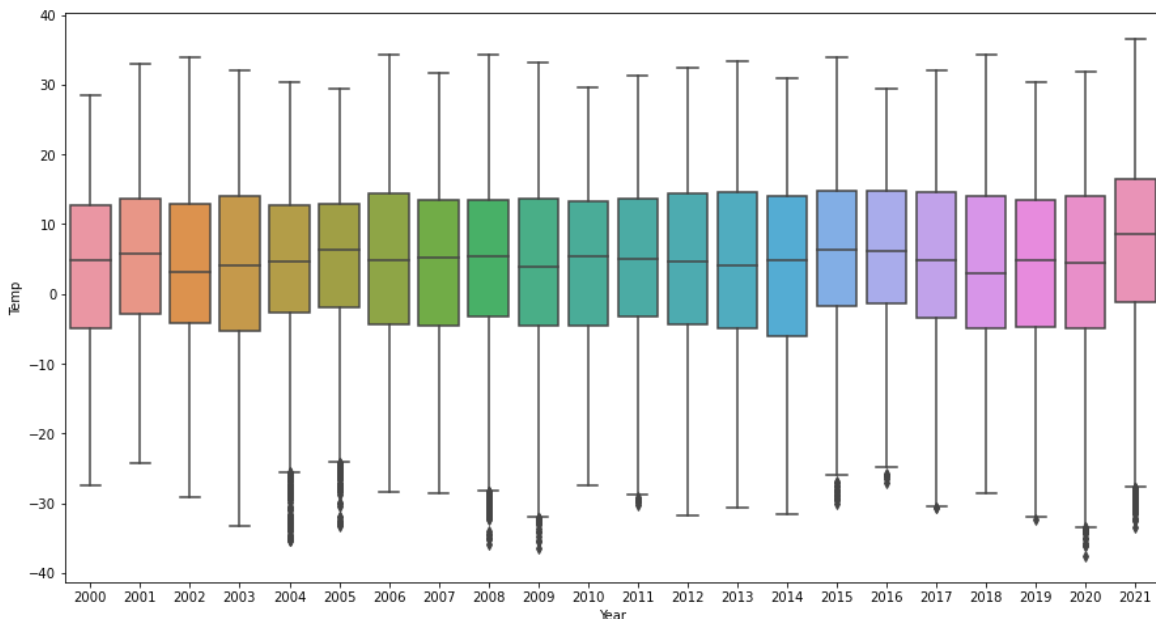

Fig3: Boxplot for Edmonton Blatchford Station from 2000 to 2021

One thing that looks good is our boxplots throughout the years we have a mean that is consistently around the 5 degrees mark which looks normal and year to year looks similar. Some of the tails of the

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box plots do not get incredibly low temperatures such as 2001 and 2016. What reason could this be? El Nino is the cause of trade wind not blowing as hard and shifts a warm body of water to Mexico. This causes warmer weather in the Northwest America. Then there is La Nino which blows chilly air up north, the trade winds blow harder, and a cold body of water is shifted near Mexico. It is the reverse effect of El Nino. https://oceanservice.noaa.gov/facts/ninonina.html. There is a two-minute video explaining it on this website.

Final Thoughts:

Global warming is clearly not about the change in climate of a local area and not about how we feel about the temperature when:

- the temperature at your place soars past 30C, that does not prove global warming
- the temperature at your place drops below -40C that does not deny global warming.

However, having said that, there are plenty of evidence to show that we might be in a climate crisis.

https://climate.nasa.gov/evidence/

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Citations:

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