Climate Change Project

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ATM 320

Introduction

The purpose of this project is to determine whether climate-change is happening on a global scale by analyzing atmospheric data recorded over the last 40 year period. Global temperature is represented in terms of an anomaly, which is a departure from a long-term average. The Southern Oscillation Index (SOI) is an index based on observed sea-level pressure differences between Tahita and Austria; this index might be useful in modeling atmospheric temperature trends. We will analyze trends in global temperature anomaly, SOI, and also local temperatures in Albany, New York. We hope that analyzing historical atmospheric data will give insight into the phenomenon of climate change.

Temperature and SOI Statistics

1980 - 1999

Local temperature:

T_{avg} (°C)	σT (°C)	T_{max} (°C)	T_{min} (°C)
8.58	10.48	22.4	-10.0

Global temperature anomaly:

T_{avg} (°C)	σT (°C)	T_{max} (°C)	T_{min} (°C)
0.3	0.1	0.52	0.13

Southern Oscillation Index:

avg	σ	max	min
0.12	0.93	2.0	-2.1

2000 - 2019

Local temperature:

T_{avg} (°C)	σT (°C)	T_{max} (°C)	T_{min} (°C)
9.24	9.6	24.7	-10.7

Global temperature anomaly:

T_{avg} (°C)	σT (°C)	T_{max} (°C)	T_{min} (°C)
0.52	0.26	1.37	-0.04

Southern Oscillation Index:

avg	σ	max	min
0.03	1.62	4.8	-6.0

1980 - 2019

Local temperature:

T_{avg} (°C)	σT (°C)	T_{max} (°C)	T_{min} (°C)
9.21	9.64	24.7	-10.7

Global temperature anomaly:

T_{avg} (°C)	σT (°C)	T_{max} (°C)	T_{min} (°C)
0.51	0.26	1.37	-0.04

Southern Oscillation Index:

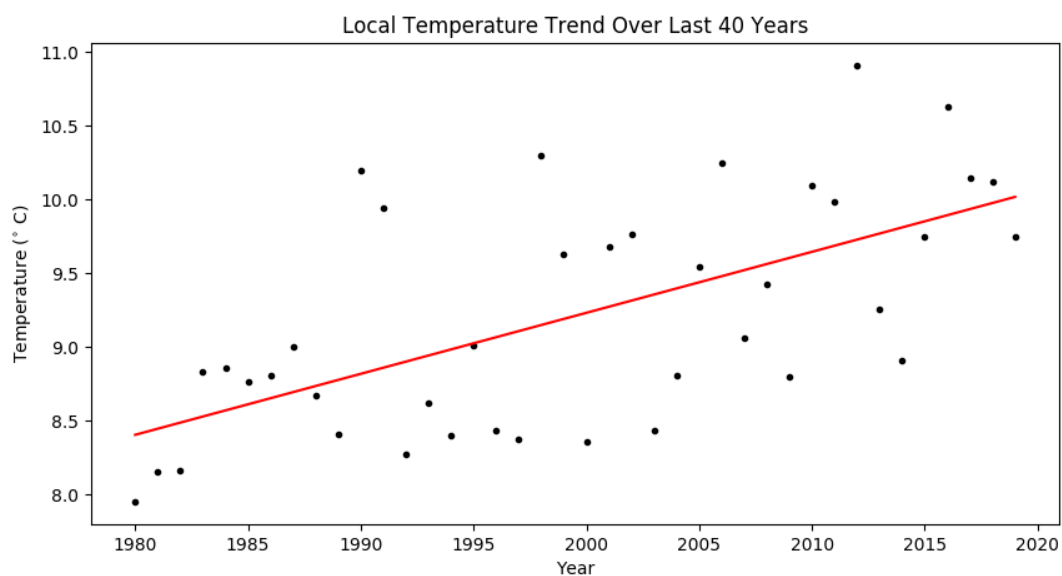| avg	σ	max	min
0.04	1.6	4.8	-6.0

Visualizing Temperature and SOI Trends

Figure 1. Degree 1 polynomial fit of local temperature as a function of time.
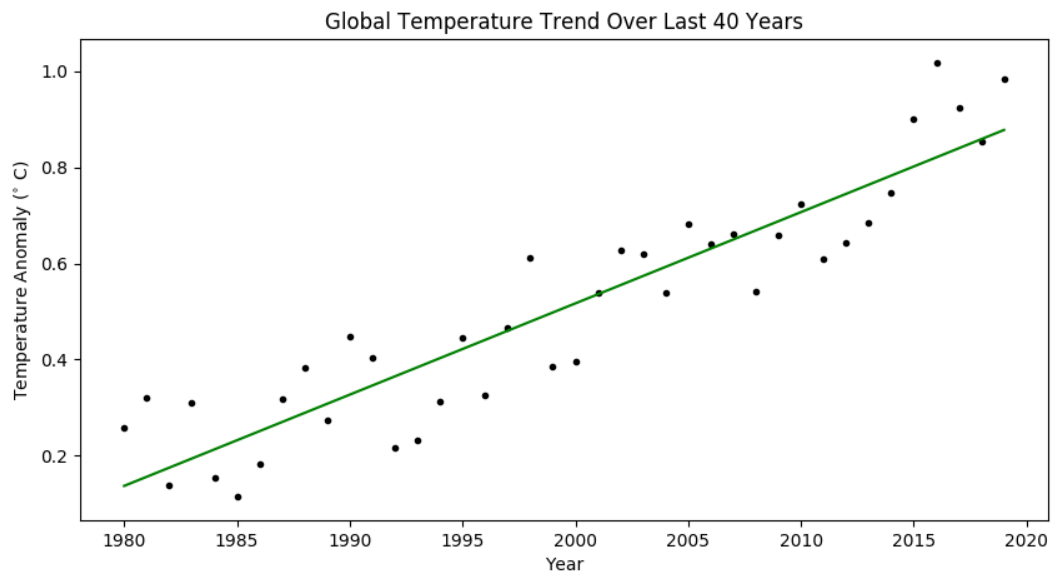
Figure 2. Degree 1 polynomial fit of global temperature anomaly as a function of time.
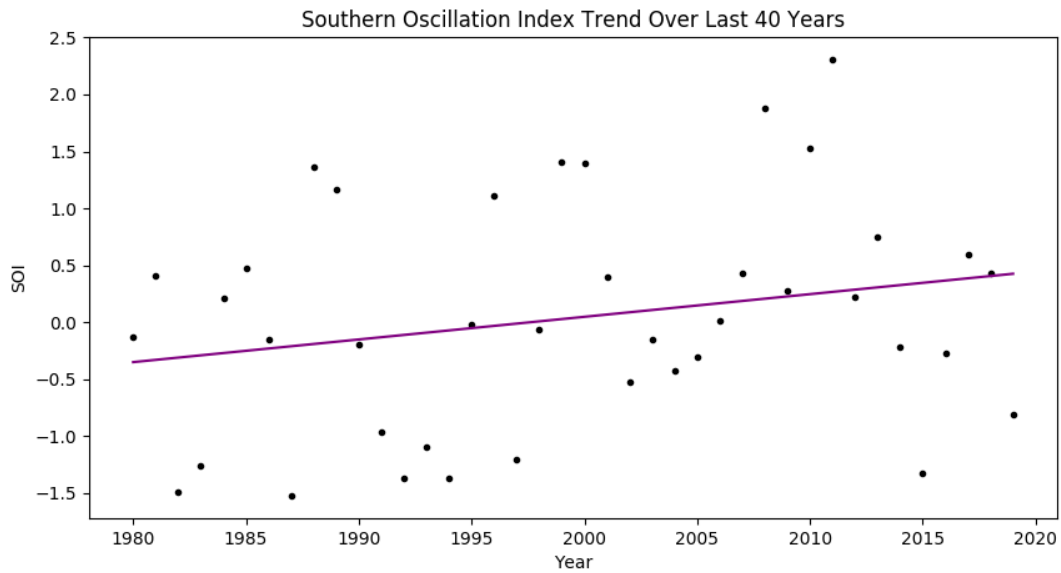

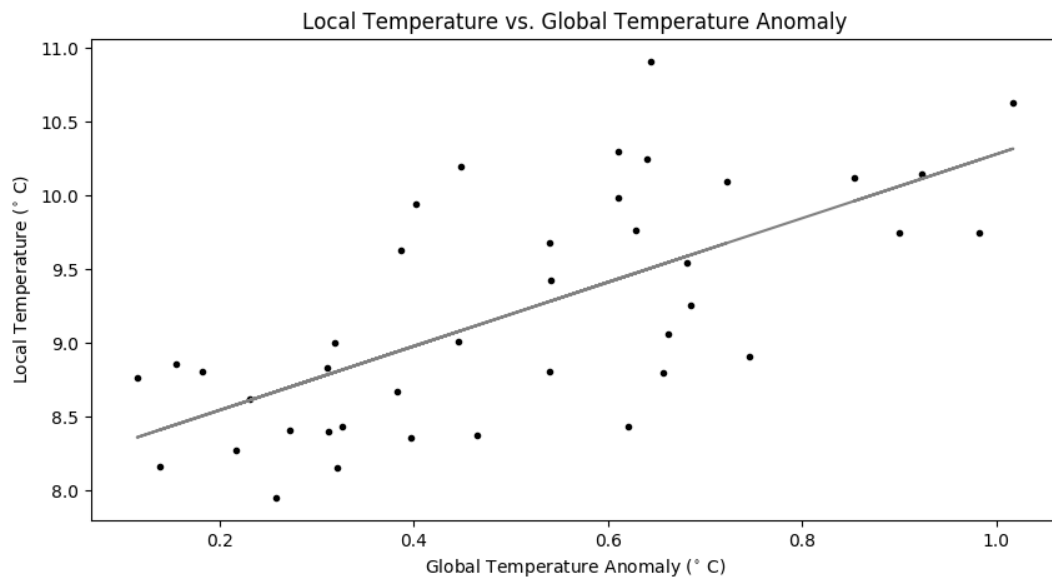**Figure 3.** Degree 1 polynomial fit of SOI as a function of time.

Figure 4. Degree 1 polynomial fit of local temperature compared to global temperatue anomaly.
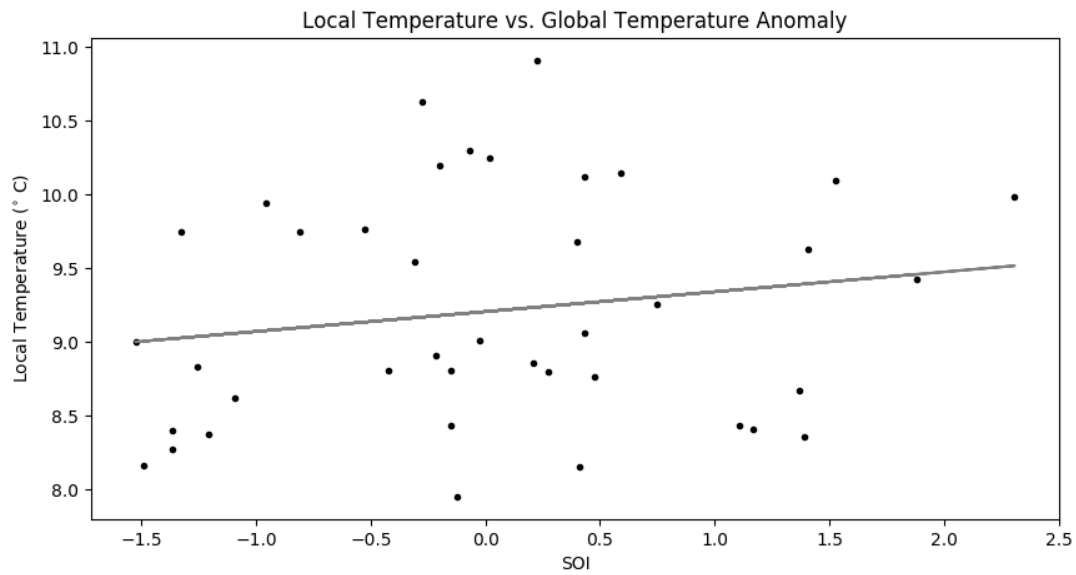

Figure 5. Degree 1 polynomial fit of local temperature compared to SOI.
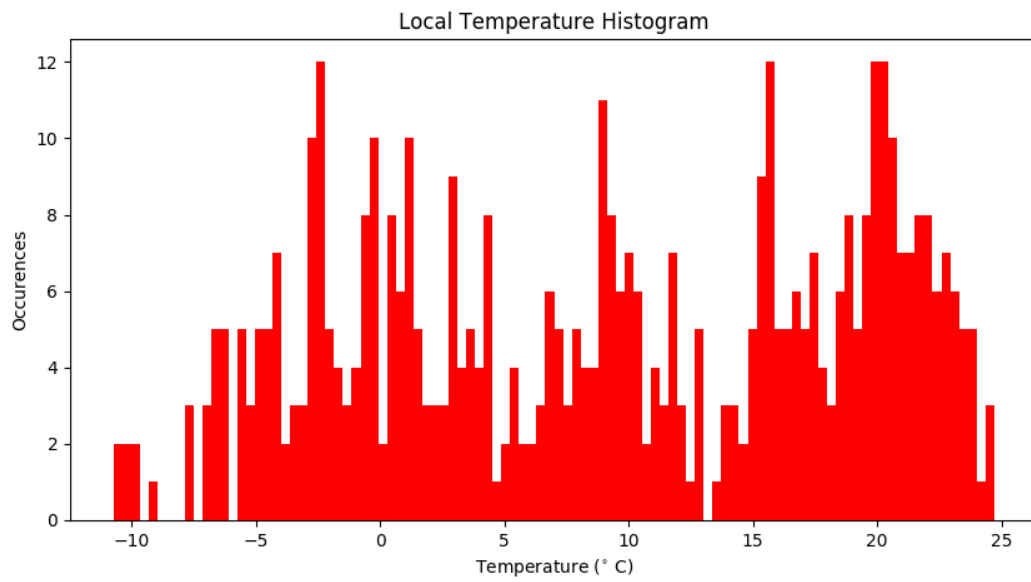
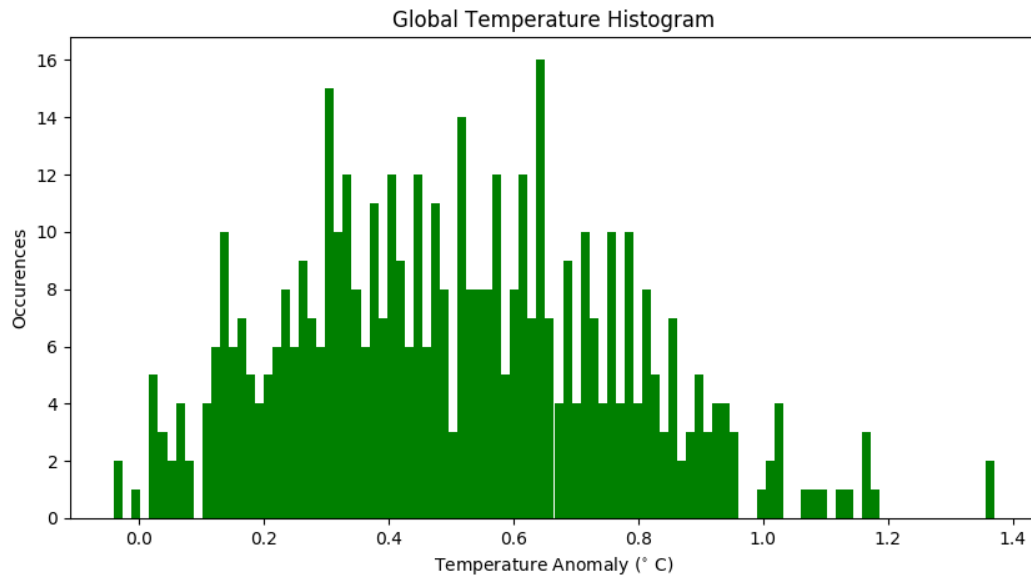**Figure 6.** Histogram of monthly local temperature values.

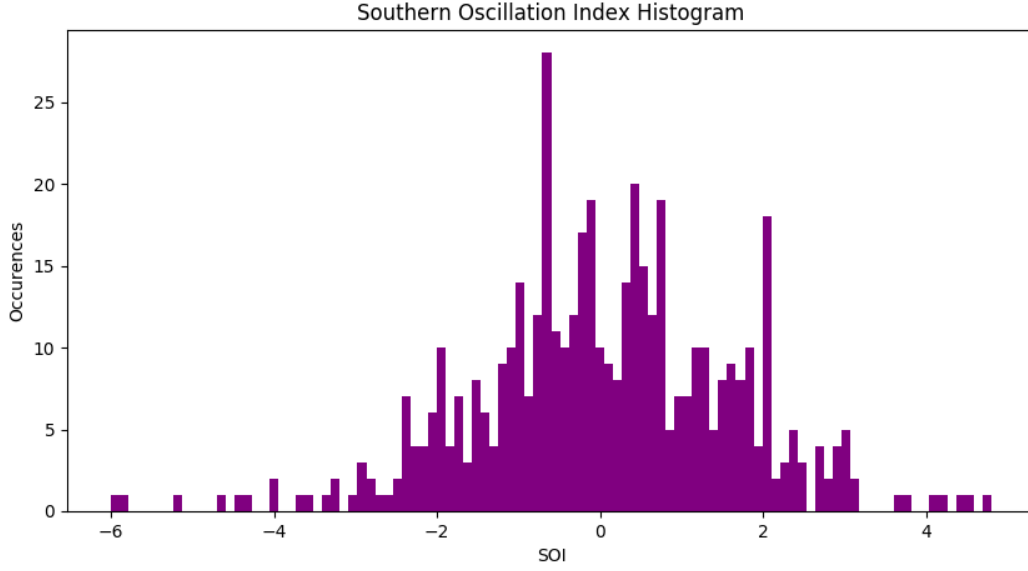**Figure 7.** Histogram of monthly global temperature anomaly values.

Figure 8. ¡¡¡¡¡¡¡ HEAD Histogram of monthly SOI values. ======= Histogram of SOI values. ¿¿¿¿¿¿¿ 607bfba2ab0830c6dbadc95c9d5db15e38fb4158

Local and Global Temperature Correlation

The correlation coefficient is a quantification of the strength of the linear relationship between two variables. Correlations of -1 or +1 imply an exact linear relationship, while 0 implies no correlation. The Pearson correlation coefficient is calculated using the equation 1.

$$r = \frac{\sum(x - \overline{x})(y - \overline{y})}{\sqrt{\sum(x - \overline{x})^2 \sum(y - \overline{y})^2}} \tag{1}$$

The statistical significance of the correlation coefficient can be interpreted using the p-value method. The p-value P is calculated using a t-distribution with $n - 2$ degrees of freedom as shown in equation 2.

$$t = \frac{r\sqrt{n - 2}}{\sqrt{1 - r^2}} \tag{2}$$

We use $\alpha = 0.05$ as the threshold significance level.

- If $P < \alpha$, the variables *are* linear because r *is* sufficiently different from zero.

- If $P > \alpha$, the variables *are not* linear because r *is not* sufficiently different from zero.

We calculate a correlation coefficient of $r = 0.673$ for the local temperature and global temperature anomaly, and the corresponding p-value is $P = 1.94 \times 10^{-6}$. The p-value is far below the threshold, so we conclude that there is a correlation between local temperature and global temperature anomaly.

For local temperature and SOI, we calculate a correlation coefficient of $r = 0.171$ and a p-value of $P = 0.291$. ¡¡¡¡¡¡¡ HEAD The p-value is larger than the threshold, so we =======
The p-value is larger than the threshold hold, so we ¿¿¿¿¿¿¿ 607bfba2ab0830c6dbadc95c9d5db15e38fb4158 conclude that there is no correlation between local temperature and the Southern Oscillation Index.

Analysis of Local Temperature Trends

The question of whether the climate is getting warmer at the location in question, Albany, New York, is answered by the trend in figure 1. From 1980 to 2019, the local temperature has steadily increased, as indicated by the upward trend illustrated by the best-fit line.

But is this local warming related to global warming? To answer this question we must first look at trends in global temperature anomaly. The strong upward trend in figure 2 tells us global temperature is steadily increasing. Then, we look to our calculation of the correlation coefficient of for local temperature and global temperature anomaly; our calculation indicates that local temperature is directly correlated with global temperature anomaly. Therefore, the data proves that local warming is due to in part to global warming.

El Niño-Southern Oscillation (ENSO), the periodic fluctuation in surface sea temperatures over the Pacific Ocean, is likely not the cause of this local climate variation. This is because the ENSO fluctuation occurs over a 2-7 year timescale, and the local temperature has risen over a 40 year time period. In addition to this, Albany, New York is landlocked, and it is not sufficiently close to the Pacific Ocean such that surface sea temperature fluctuations would significantly affect its climate.

Conclusion

After doing an extensive analysis of global temperature trends, we have concluded that global climate change is undoubtedly a real thing. We analyzed the climate of a particular location over a 40 year period and concluded that the upward temperature trend is due to global warming and is not perpetrated by ENSO. Though there will always be naysayers, society as a whole must face the facts: the earth is getting warmer. Making predictions on the implications of this global temperature rise is beyond the scope of this project, but this is a very important topic to explore since climate-change will affect every single living being on this planet regardless of personal beliefs or political affiliation. So, it is imperative that further research into the effects of climate-change is not hampered by those who wish to pretend that this aforementioned change is not occurring when the data clearly states otherwise.