Climate Change Project

Christian Chimezie

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 temperatures are represented in terms of anomalies, which are departures 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

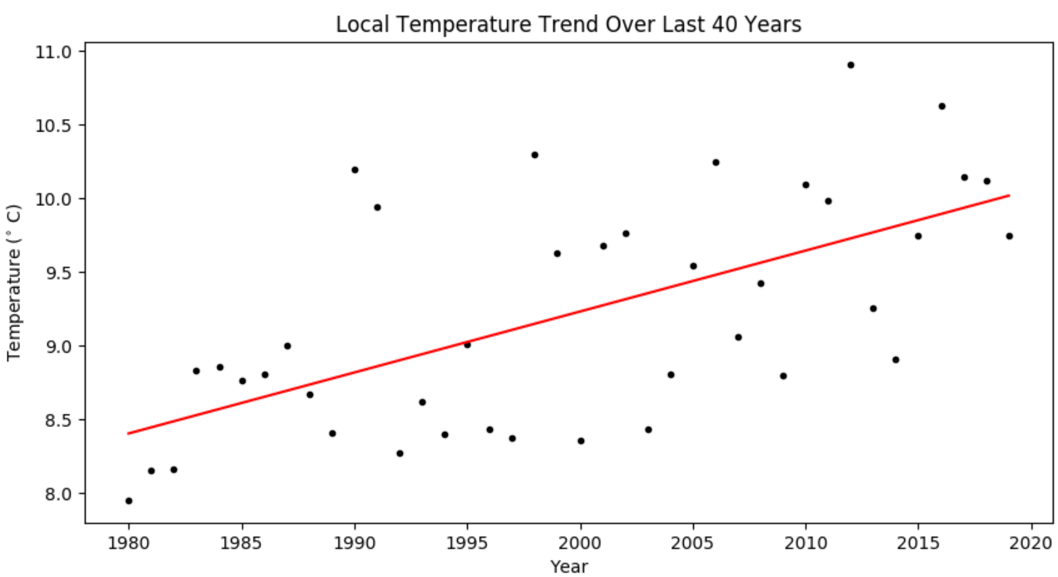

Figure 1. Degree 1 polynomial fit of local temperature as a function of time.

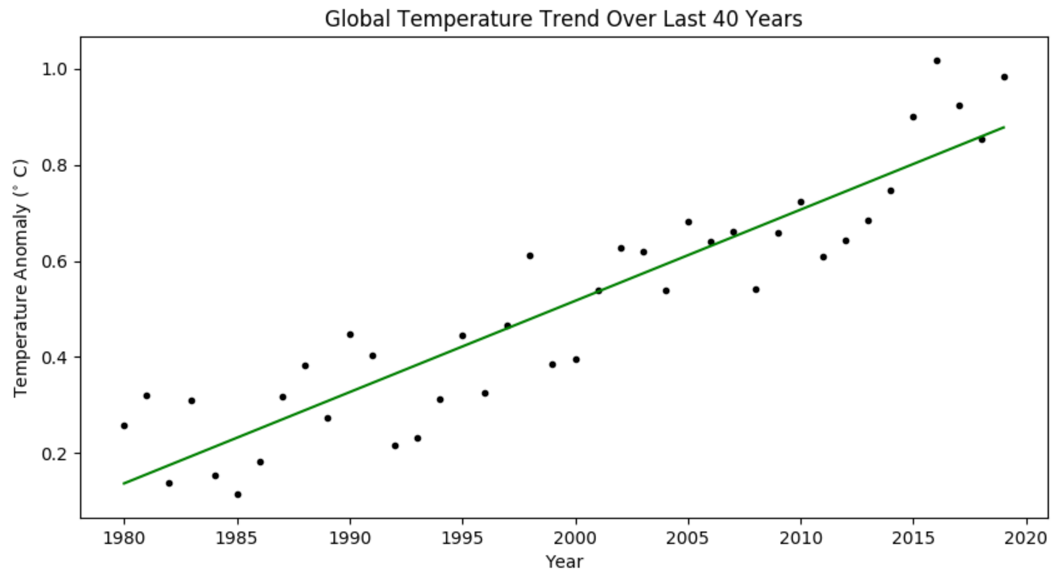

Figure 2. Degree 1 polynomial fit of global temperature anomaly as a function of time.

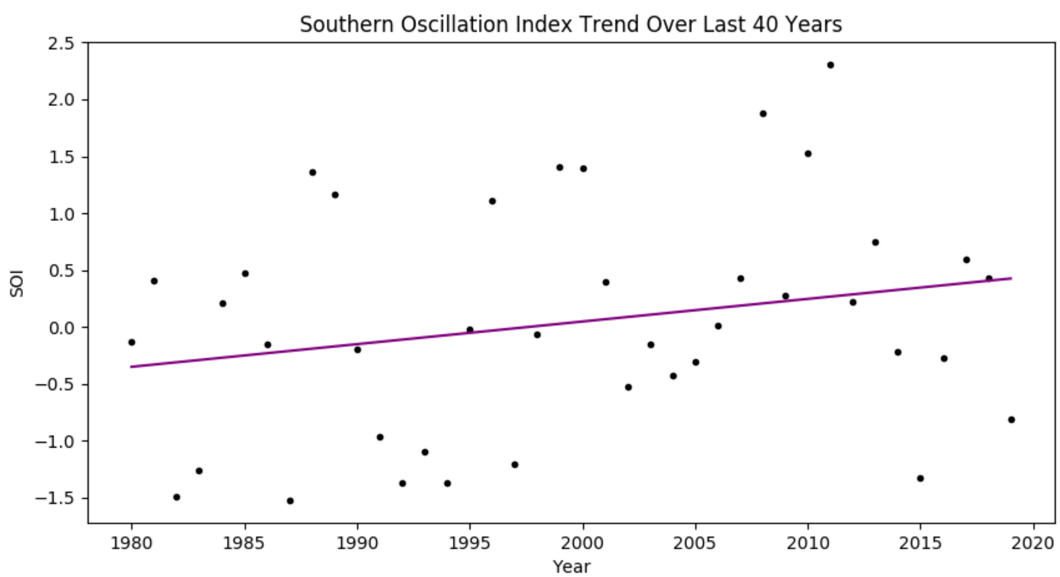

Figure 3. Degree 1 polynomial fit of SOI as a function of time.

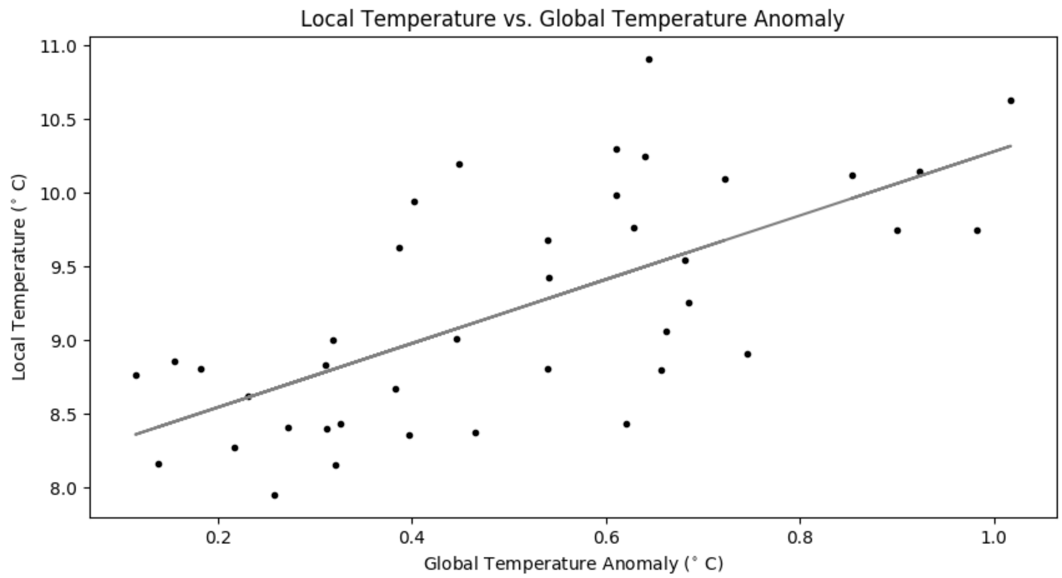

Figure 4. Degree 1 polynomial fit of local temperature compared to global temperatue anomaly.

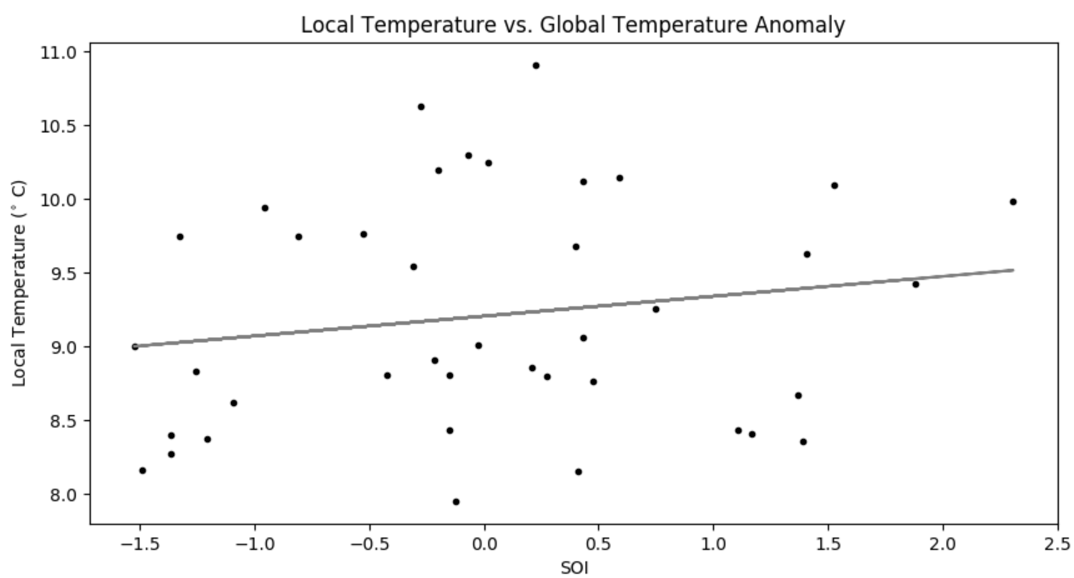

Figure 5. Degree 1 polynomial fit of local temperature compared to SOI.

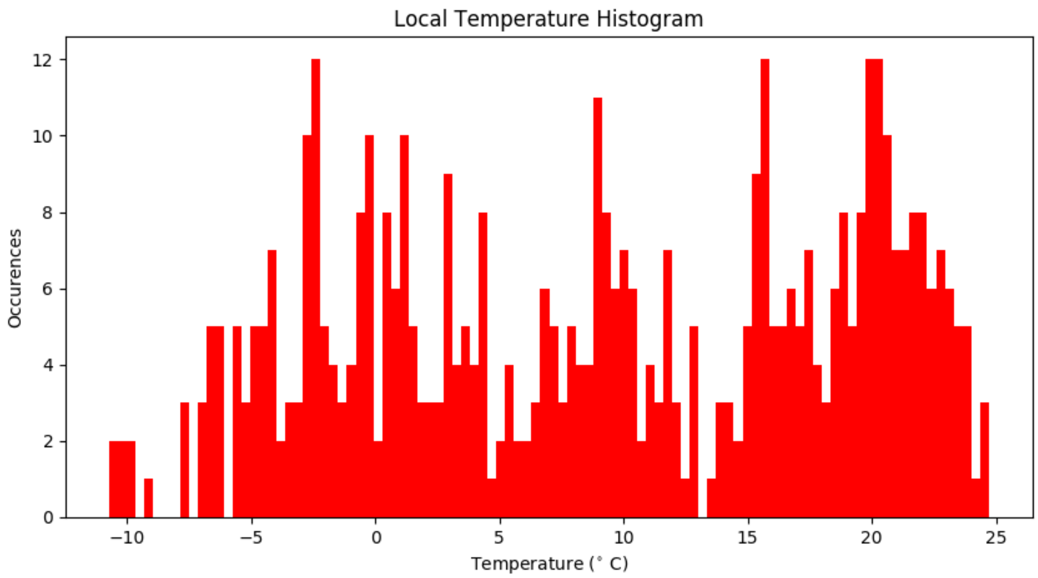

Figure 6. Histogram of monthly local temperature values.

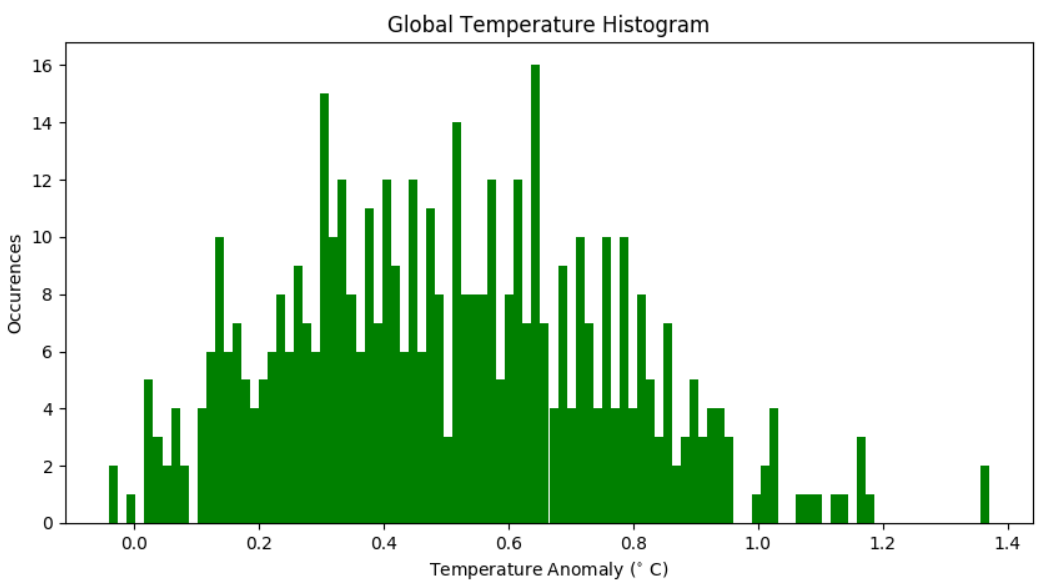

Figure 7. Histogram of monthly global temperature anomaly values.

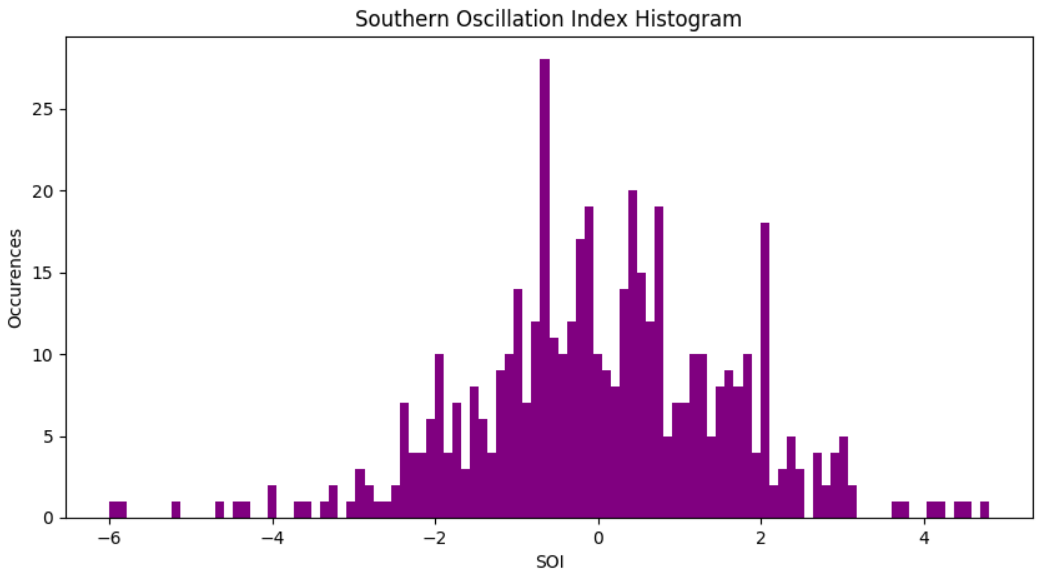

Figure 8. Histogram of SOI values.

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 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 $P = 0.291$. The p-value is larger than the threshold hold, so we conclude that there is no correlation between local temperatue and the Southern Oscillation Index.

Analysis of Local Temperature Trends

The question of whether climate is getting warmer at the location in question, Albany, New York, is clearly answered by 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 that global temperatue is steadily increasing. Then, we look to the 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 the local warming is due to in part to increasing warming.