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MAT 375

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Mini Project, Group #2

Tabligbo, Togo Temperature

Background on Tabligbo, Togo

Tabligbo is a small city in the country of Togo, with a little less than 20,000 people living in the area. The city is in the maritime region of the country so compared to most of the cities studied it is close to the gulf coast. Lome is the other city on the coast being studied, Tabligbo is further inland at about 50 km away from the water. Beyond this geographic data, little information is readily available for this city. It appears that there is a major cement plant, starting in 1980 it operated off and on until 1998 where it has remained open since. It would follow that there is some infrastructure in the area that allows the movement in and out of the cement factory.

Yearly Average Compared

The yearly averages used by the previous group matched the yearly averages we calculated from our monthly data sets. This helps to add confidence to the over all data that was collected.

Outliers

Within the data, there were a few points for each of the sets that appear to be outliers. Below is a table from both the sets with the dates and temperatures that are outliers:

Outliers		
Max		
Month	**Year**	**Temperature**
Jul	1961	27.8
Mar	1979	35.5
Aug	1981	29.2
Aug	1982	28.8
Apr	1983	35.9
Min		
Mar	1973	25.1
Jan	1983	17.7
Jan	1989	18.2
Mar	1998	25.5
Apr	1998	25.7
Jan	2008	18.6

Modeling Our Data

The goal of our report is to see if we can model the monthly maximum and minimum temperature data given to us for the city of Tabligbo, Togo. The model will try to find a cyclical change over time. This will give us a model consisting of parameters:

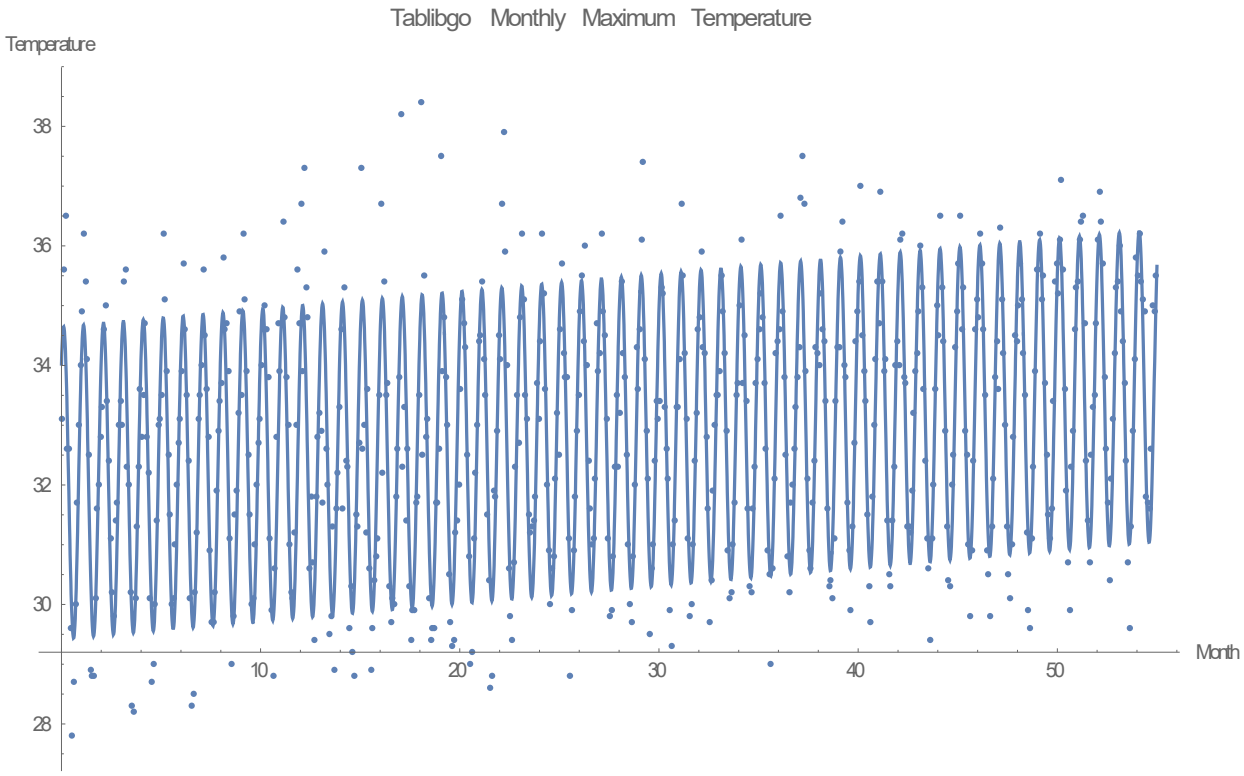
$$\boldsymbol{Temperature(Time) = a + bx + \alpha\ \cos[2\pi x] + \beta\ \sin[2\pi x]}$$

Additional parameters or functions can be attempted or added to see if any will give a better fit the data. However, from the data we believe there is significant evidence that there is a change in the maximum and minimum temperatures over time. Following are graphs of the data and the models that we have produced.

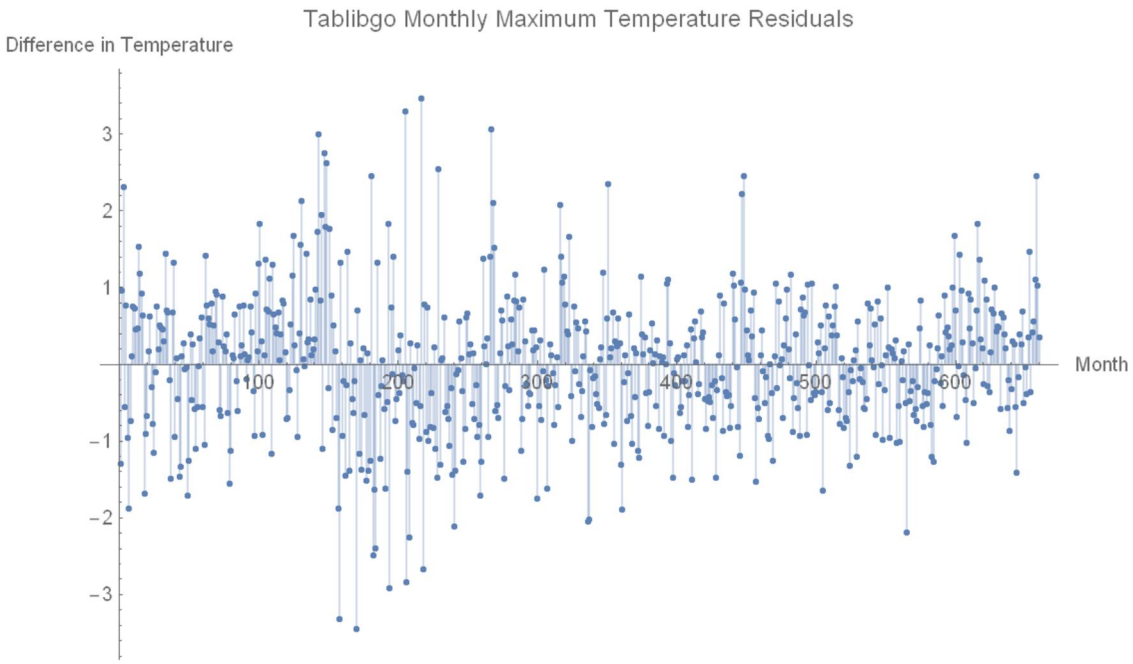
Monthly Maximum Model:

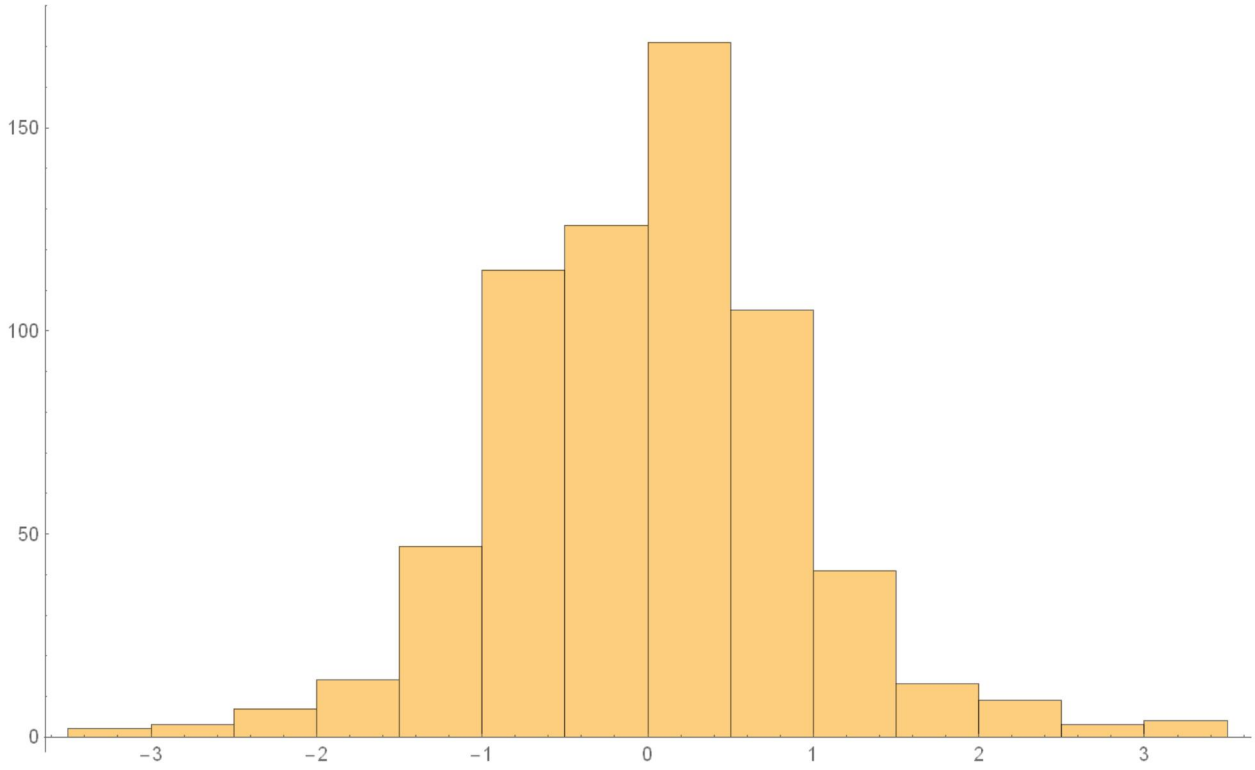
$$\boldsymbol{Temperature(Time) = 32.0314 + 0.0297x + 1.9937\ \cos[2\pi x] + 1.6903\ \sin[2\pi x]}$$

Monthly Maximum Model Fit



Plot of Residuals from the Maximum Temperature Model





The histogram of the residuals of the maximum monthly temperatures shows an almost perfect normal distribution, with very few values further than 2 points away from the model in the positive or negative y direction.

With the model that we produced for the maximum data, we have high confidence that none of the variables are 0.

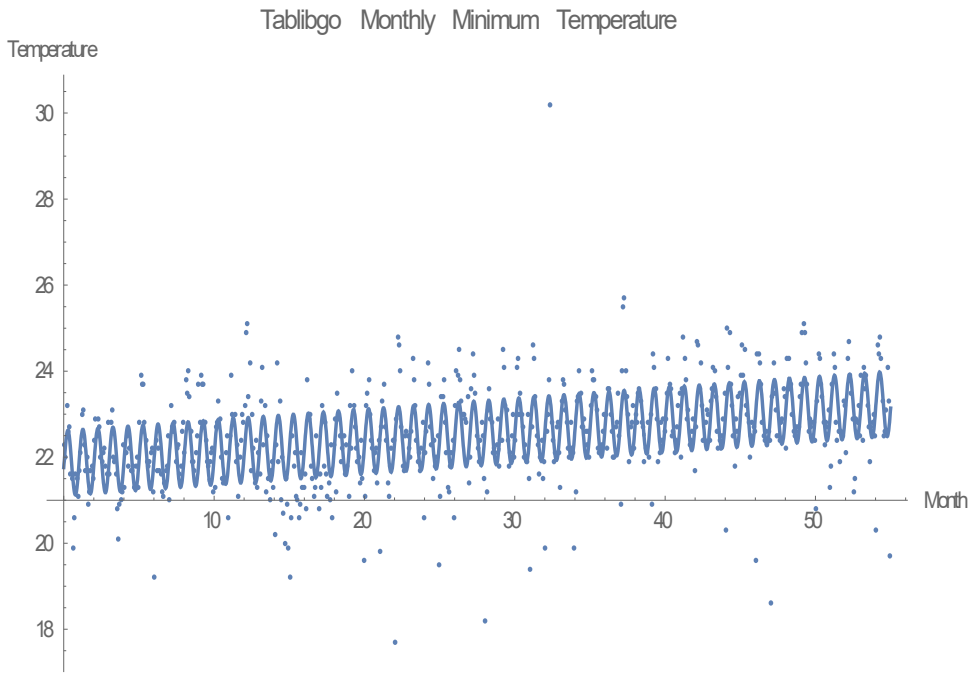
	Estimate	Standard Error	t-Statistic	P-Value
1	32.0314	0.0712039	449.854	$3.649428926062 \times 10^{-819}$
x	0.0296796	0.0022424	13.2357	1.2973×10^{-35}
Cos[2 π x]	1.99365	0.0503448	39.5998	4.40357×10^{-176}
Sin[2 π x]	1.69033	0.05035	33.5716	1.42911×10^{-144}

R^2=0.813313

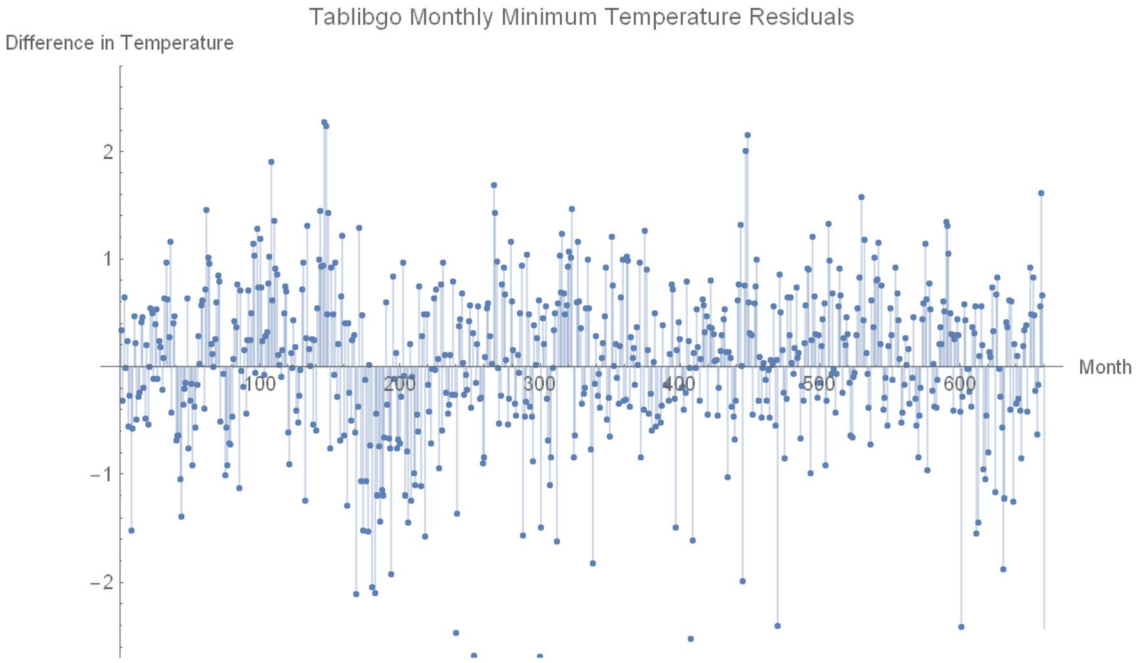
Monthly Minimum Model:

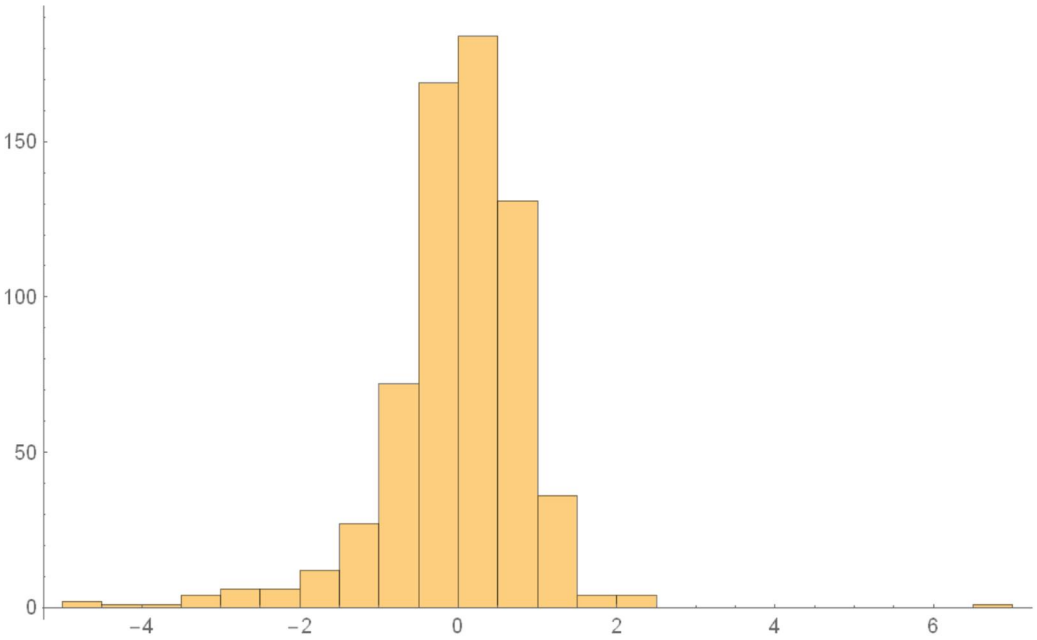
$$\boldsymbol{Temperature(Time) = 21.8591 + 0.0252t - 0.1006\ \cos[2\pi x] + 0.7485\ \sin[2\pi x]}$$

Monthly Minimum Model Fit



Plot of the Residuals from the Minimum Model





The histogram of our residuals shows a slightly normal distribution, with only a few data points being further than 2 points away in the positive or negative y direction.

From our model for the minimum temperature fit, we have a high confidence that none of our variables are 0.

	Estimate	Standard Error	t-Statistic	P-Value
1	21.8591	0.07041	310.454	$5.282806301724 \times 10^{-714}$
x	0.0251582	0.0022174	11.3458	2.28605×10^{-27}
Cos[2 π x]	−0.100617	0.0497835	−2.0211	0.0436753
Sin[2 π x]	0.748545	0.0497886	15.0345	4.09406×10^{-44}

R^2=0.350511

Conclusions

Our model for the maximum temperature shows a much larger variation between the months due to the positive nature of the coefficients for the Sine and Cosine terms, while the model for the minimum temperature shows significantly less variation because the coefficient of the Cosine term is negative while the coefficient for the Sine term is positive. Our R^2 values were not particularly high, especially for the minimum model, however, by all other metrics, our models had statistical significance.

As for questions that we have, were the temperatures taken at a consistent time of day, were they taken at the same place (did they have to change locations, were they close to many buildings, were they by any source of water), was the same instrument used, and what was the elevation of where temps were taken.