# Final Model Fit to City

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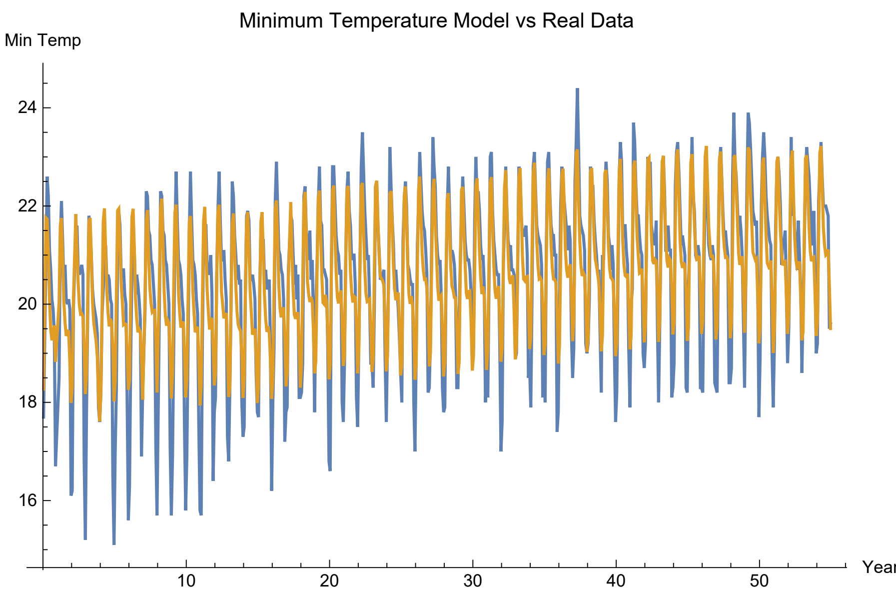
## Importing Sokode Data

```
decYear1 = Import["C:\\Users\\terra\\OneDrive\\Documents\\Dec Year.xlsx"];

decYear2 = Flatten[decYear1];

decYear = decYear2 - 1961;

maxTemp1 = Import["C:\\Users\\terra\\OneDrive\\Documents\\Max Temp.xlsx"];

maxTemp = Flatten[maxTemp1];

rainfall1 = Import["C:\\Users\\terra\\OneDrive\\Documents\\Rainfall.xlsx"];

rainfall = Flatten[rainfall1];

minTemp1 = Import["C:\\Users\\terra\\OneDrive\\Documents\\Min Temp.xlsx"];

minTemp = Flatten[minTemp1];

enso1 = Import["C:\\Users\\terra\\OneDrive\\Documents\\enso.xlsx"];

enso = Flatten[enso1];

sst1 = Import["C:\\Users\\terra\\OneDrive\\Documents\\sst.xlsx"];

sst = Flatten[sst1];

longitude = 1.15176;

latitude = 8.99517;

elevation = 387;
```

I could have imported these in an easier way but I wanted to be extra sure about what I was importing.
When looking at the SST and ENSO, there were many values of decimal dates that didn’t exist in our list of actual decimal dates, so I had to go through and delete those values so that everything would match up.

## Final Global Model for Minimum Sokode Data

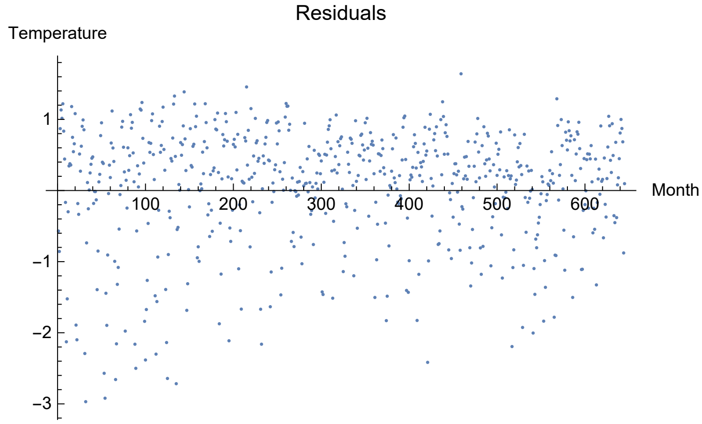
```
realDataMin = Table[{decYear[[i]], minTemp[[i]]}, {i, 1, 645}];

globalMin = 31.172254103120295` + 0.027385855676568465` * decYear +
   -0.8751637764024659` * Cos[4 π decYear] + 0.12959795880303776` * Sin[4 π decYear] +
   -1.0016316224214348` * Cos[2 π decYear] + 0.5793239334602998` * Sin[2 π decYear] +
   -0.22622842355713688` * Cos[6 π decYear] + -0.10277000253591956` * Sin[6 π decYear] +
   -0.041988410325544255` * Cos[2 π decYear / 13] + -0.06166305743032638` * Sin[2 π decYear / 13] +
   0.07458703707988648` * Cos[π decYear / 10] + 0.028493990756426047` * Sin[π decYear / 10] +
   -0.8802337198643833` * latitude * longitude + 0.4169986582275888` * (latitude)^2 +
   -3.698245146577038` * (longitude)^2 - 6.224750893928698` * latitude +
   15.071356816096722` * longitude + -0.0015133234173910037` * elevation +
   0.2945134843073395` * sst + -0.006160260581052885` * enso;

predictedDataMin = Table[{decYear[[i]], globalMin[[i]]}, {i, 1, 645}];

ListLinePlot[{realDataMin, predictedDataMin},
 PlotLabel → "Minimum Temperature Model vs Real Data",
 AxesLabel → {"Year", "Min Temp"}]
```




This is a decent fit. It seemingly incorporates all the important periods that we would want in there. It does have less of a difference between the lower temperatures and higher temperatures. Looks a little tidier than the actual data because we obviously can't fit it to every point. It is bound not to be perfect when we also have to fit this model to every city in Togo.

```
residsMin = minTemp - preTempMin;
```

```
ListPlot[residsMin, PlotLabel → "Residuals", AxesLabel → {"Month", "Temperature"}]
```




```
ybarmin = Mean[minTemp]
```

20.6064

$$\text{OurSquaredMax} = 1 - \left(\sum_{i=1}^{645} (\text{minTemp}[[i]] - \text{preTempMin}[[i]])^2 \Big/ \sum_{i=1}^{645} (\text{minTemp}[[i]] - \text{ybarmin})^2\right)$$

0.762921

Our squared is higher than it was with our last model. Previously it was approximately .608. It has increased by about .16, which is a great improvement when talking about r-squared.

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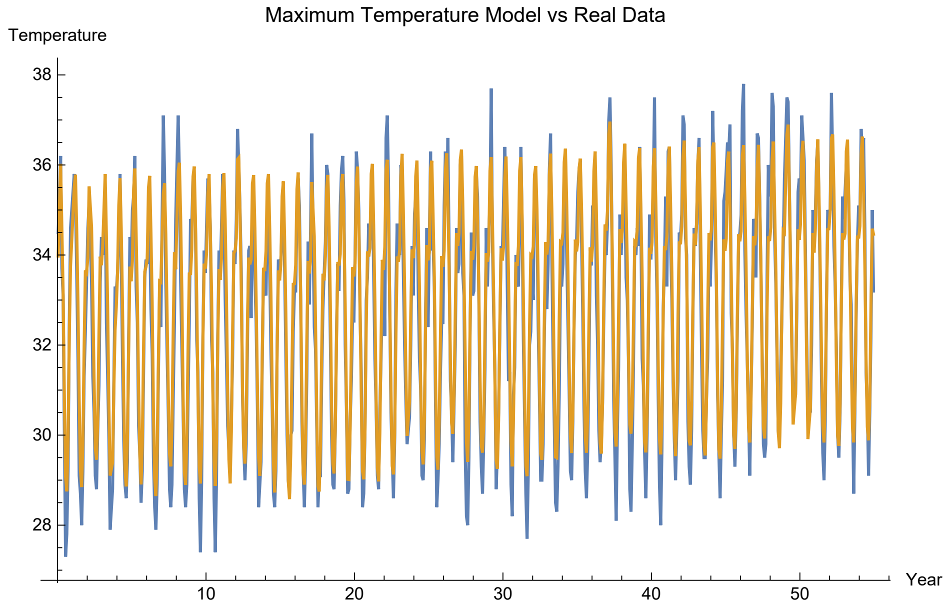
## Final Global Model for Maximum Sokode Data

```
realdataMax = Table[{decYear[[i]], maxTemp[[i]]}, {i, 1, 645}];
```

$$\begin{aligned}\text{globalMax} = {} & -8.370217764387549\text{`} + 0.01284224134394846\text{`} * \text{decYear} + \\ & -0.5997217902578864\text{`} * \text{Cos}[4\pi\,\text{decYear}] + -0.21332860261725842\text{`} * \text{Sin}[4\pi\,\text{decYear}] + \\ & 1.787110064643319\text{`} * \text{Cos}[2\pi\,\text{decYear}] + 1.3408081122027204\text{`} * \text{Sin}[2\pi\,\text{decYear}] + \\ & -0.3963867521214663\text{`} * \text{Cos}[6\pi\,\text{decYear}] + -0.0760526314408311\text{`} * \text{Sin}[6\pi\,\text{decYear}] + \\ & 0.10259139882343443\text{`} * \text{Cos}\left[\frac{2\pi\,\text{decYear}}{13}\right] + -0.06705672848541308\text{`} * \text{Sin}\left[\frac{2\pi\,\text{decYear}}{13}\right] + \\ & -0.16545991546044095\text{`} * \text{Cos}[8\pi\,\text{decYear}] + -0.05782000874783142\text{`} * \text{Sin}[8\pi\,\text{decYear}] + \\ & 0.6296608959862009\text{`} * \text{latitude} * \text{longitude} + 3.126751308042088\text{`} * (\text{longitude})^2 - \\ & 0.44202079315121207\text{`} * (\text{latitude})^2 + 7.723651317866367\text{`} * \text{latitude} + \\ & -11.281035421388053\text{`} * \text{longitude} + -0.008816619804524244\text{`} * \text{elevation} + \\ & 0.47106166411044276\text{`} * \text{sst} + -0.006627219227896763\text{`} * \text{enso};\end{aligned}$$

```
predictedDataMax = Table[{decYear[[i]], globalMax[[i]]}, {i, 1, 645}];
```

```
ListLinePlot[{realdataMax, predictedDataMax},
 PlotLabel → "Maximum Temperature Model vs Real Data",
 AxesLabel → {"Year", "Temperature"}]
```

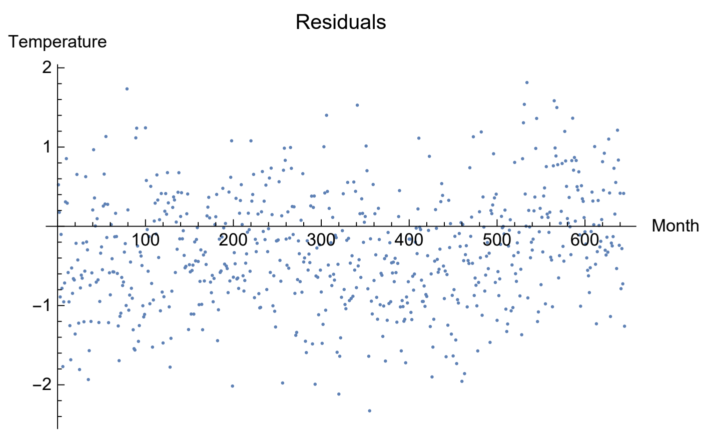



This is a really good fit. Even better than the minimum model. It almost covers the entirety of our data. I am very happy with how this turned out.

## Residuals

```
residsMax = maxTemp - globalMax;
```

```
ListPlot[residsMax, PlotLabel → "Residuals", AxesLabel → {"Month", "Temperature"}]
```




## Our Squared

```
ybarmax = Mean[maxTemp]
```

32.6388

```
OurSquaredMax = 1 - (Sum[(maxTemp[[i]] - globalMax[[i]])^2, {i, 1, 645}] / Sum[(maxTemp[[i]] - ybarmax)^2, {i, 1, 645}])
```

$$\text{OurSquaredMax} = 1 - \left(\sum_{i=1}^{645} (\text{maxTemp}[[i]] - \text{globalMax}[[i]])^2 \Big/ \sum_{i=1}^{645} (\text{maxTemp}[[i]] - \text{ybarmax})^2\right)$$

```
0.905514
```

Unsurprisingly, our squared is a lot better for the maximum model. This is a great result. Hopefully the other cities got results this good too.

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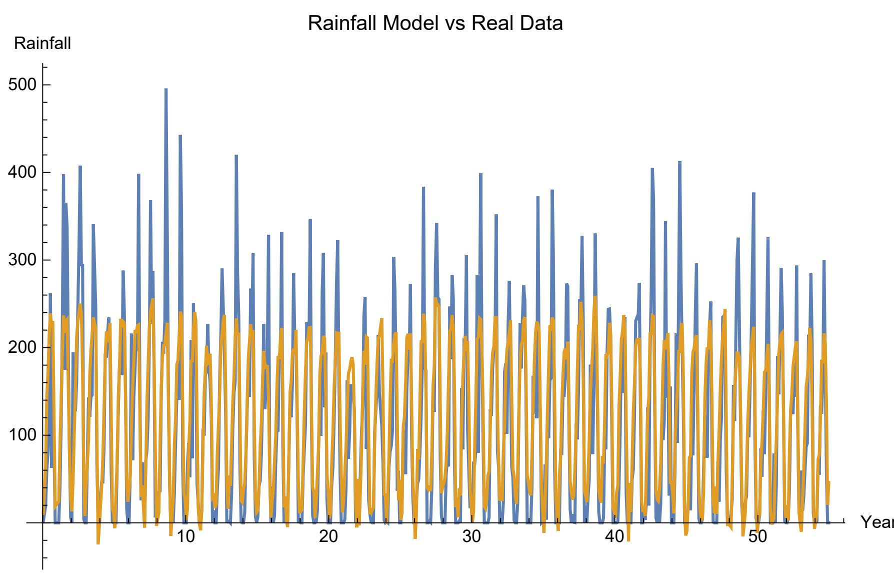
## Final Global Model for Sokode Rainfall Data

```
realdataRain = Table[{decYear[[i]], rainfall[[i]]}, {i, 1, 645}];
```

```
globalRain = -765.0902446275039` + -0.12388985589997356` * decYear +
    -33.96626612793046` * Sin[2 π decYear] + -66.7649721921797` * Cos[2 π decYear] +
    19.589235176494007` * Sin[4 π decYear] + -20.833393871896597` * Cos[4 π decYear] +
    8.985167676158206` * Sin[6 π decYear] + -1.0239431053431751` * Cos[6 π decYear] +
    -6.430606755528327` * Sin[8 π decYear] + 6.175963585212828` * Cos[8 π decYear] +
    231.44501875965295` * latitude + 28.922922751700945` * latitude * longitude +
    -14.194553415250773` * latitude^2 + -495.8774868055935` * longitude +
    130.9220050919206` * longitude^2 + -0.135764075867611` * elevation +
    3.1135832174648366` * minTemp + -23.472635997948792` * maxTemp +
    0.15615745123884783` * enso + 29.330300300689828` * sst;
```

```
predictedDataRain = Table[{decYear[[i]], globalRain[[i]]}, {i, 1, 645}];
```

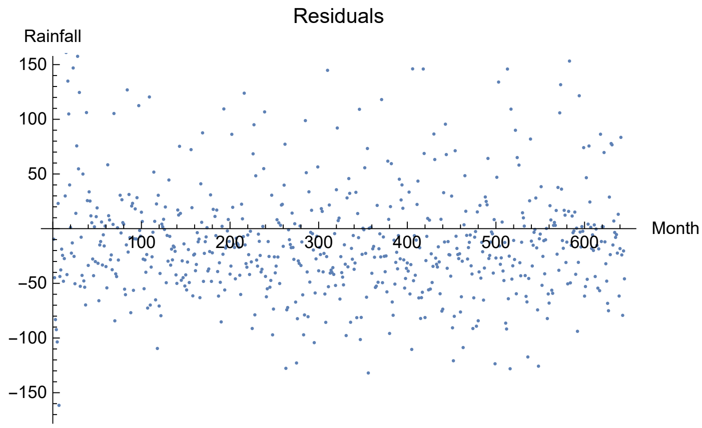
```
ListLinePlot[{realdataRain, predictedDataRain},
 PlotLabel → "Rainfall Model vs Real Data",
 AxesLabel → {"Year", "Rainfall"}]
```




## Residuals

```
residsRain = rainfall - globalRain;
```

```
ListPlot[residsRain, PlotLabel → "Residuals", AxesLabel → {"Month", "Rainfall"}]
```




## Our Squared

```
ybarrain = Mean[rainfall]
```

111.145

$$OurSquaredMax = 1 - \left(\sum_{i=1}^{645} (rainfall[[i]] - globalRain[[i]])^2 \Big/ \sum_{i=1}^{645} (rainfall[[i]] - ybarrain)^2\right)$$

0.722351

The global model's fit for rainfall is good. Especially since rainfall data is wack. Our squared is really decent. Not the highest it could be, but when is it ever?

The global models for minimum temperature, maximum temperature, and rainfall were fairly precise. When putting it against our clean data for our city, we could see how the global equation we were given correctly incorporated the variables that our city holds. Just looking at the data against the model, we can see how well it demonstrates the look that we want. Our adjusted r-squared's were high and our residuals seemed to be lacking any sort of pattern, which is what we want. These models were designed to be tailored to fit every city in Togo, so it's not going to be a perfect fit. There are variations from city to city within the periods and the difference in temperatures. These cities are in different areas and can be affected by different things such as by located near the ocean or a rainforest, or by just having a higher elevation. The way the model fits out city's data is satisfactory. It fits our maximum data splendidly; much better than our minimums. The model accounts for almost every nook and cranny of our data, thus it has the highest r-squared of our three models. I am very excited to see how well the global models fit everyone's individual cities! If it did as well as ours for all of them, then I consider this a success.