Dapaong Final Model City Report

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Importing the Data

In[56]:=
```
rainfall = Flatten[Import["E:\\Dapaong_Clean2.xlsx", {"Data", 1, All, 3}]];
Maxtemp = Flatten[Import["E:\\Dapaong_Clean2.xlsx", {"Data", 1, All, 5}]];
DecYear = Flatten[Import["E:\\Dapaong_Clean2.xlsx", {"Data", 1, All, 10}]];
Mintemp = Flatten[Import["E:\\Dapaong_Clean2.xlsx", {"Data", 1, All, 12}]];
enso = Flatten[Import["E:\\Dapaong_Clean2.xlsx", {"Data", 1, All, 15}]];
sst = Flatten[Import["E:\\Dapaong_Clean2.xlsx", {"Data", 1, All, 16}]];
```

Data Set-up

I am am using the latest set of City Data that was release by the data team. Dapaong had data that began in January 1961 and continued on until December 2015. The rainfall data provided for Dapaong contained some missing values for April, May, and June of 1966, June, October, November, and December of 1978, all of 1979, and October and November of 1991. I removed these values across the data because the length of the rainfall, max temperature model, minimum temperature model, El Nino Southern Oscillatory, and sea surface temperature need to all be the same. This is a consequence of the rainfall model using all of these as predictors. The period between October 1978 and December 1979, fifteen months, all being removed does can a jump in the residuals for the models. With six hundred and six remaining data points it is believed the goodness of fit for the Togo Model to the city of Dapaong can still be properly evaluated. All of this work was done within the reference file that the data was pulled from. I translated the data to begin at zero by subtracting 1961 from all the decimal year values. I set the longitude, latitude, and elevation of Dapaong as constants since they are fixed values that would not change. Both the translation and constants setting were done within the Mathematica file.

In[62]:=
```
DecYear = DecYear - 1961;
dataMax = Transpose[{DecYear, Maxtemp}];
dataMin = Transpose[{DecYear, Mintemp}];
dataRain = Transpose[{DecYear, rainfall}];
```

In[66]:=
```
lon = 0.22809;
la = 10.836;
elv = 230;
```

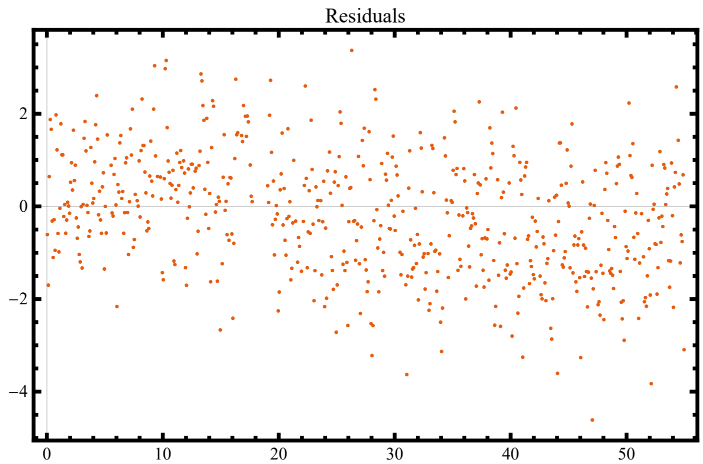
Maximum Model

The maximum model makes use of decimal year (time), latitude, longitude, sea surface temperature, and El Nino Southern Oscillatory values as predictors of the maximum temperature in Togo. The “Our”-Squared term was 79.6765%, meaning that the 79.6765% of the variability within the data for Dapaong is explained by the Maximum Model for Togo. The remaining 20.3235% is the variability is caused by within the data by predictors that are not in use or chance. The variance in the versus does not appear to be constant as there seems to be narrowing and widening of the residuals across the fifty five years. The Probability Plot shows some deviation from the normal plot, but the least of any of our models. This leads me to conclude that the Togo Maximum Temperature Model is likely not normal distributed for Dapaong and that it has not constant variance. It was mostly like there was some predictor that would improve this models fit to Dapaong that explain some of the wider oscillations that are occurring in the residuals.

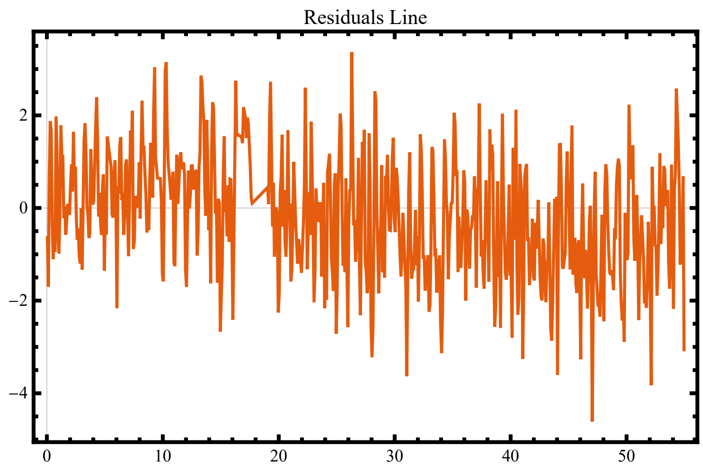
```
In[69]:= maxt = -8.370217764387549` + 0.01284224134394846` * DecYear +
    -0.5997217902578864` * Cos[4 π DecYear] + -0.21332860261725842` * Sin[4 π DecYear] +
    1.787110064643319` * Cos[2 π DecYear] + 1.3408081122027204` * Sin[2 π DecYear] +
    -0.3963867521214663` * Cos[6 π DecYear] + -0.0760526314408311` * Sin[6 π DecYear] +
    0.10259139882343443` * Cos[2 π DecYear / 13] + -0.06705672848541308` * Sin[2 π DecYear / 13] +
    -0.16545991546044095` * Cos[8 π DecYear] + -0.05782000874783142` * Sin[8 π DecYear] +
    0.6296608959862009` * la * lon + 3.126751308042088` * lon^2 + -0.44202079315121207` * la^2 +
    7.723651317866367` * la + -11.281035421388053` * lon + -0.008816619804524244` * elv +
    0.47106166411044276` * sst + -0.006627219227896763` * enso;

p1 = ListPlot[dataMax];
TogoMaxData = Transpose[{DecYear, maxt}];
p2 = ListPlot[TogoMaxData];
MaxRed = Maxtemp - maxt;
p3 = Transpose[{DecYear, MaxRed}];
ListPlot[p3, PlotTheme → "Scientific",
 PlotLabel → "Residuals", FrameStyle → Thickness[Large]]
ListLinePlot[p3, PlotTheme → "Scientific",
 PlotLabel → "Residuals Line", FrameStyle → Thickness[Large]]
y = Maxtemp;
ybar = Mean[y];
yhat = maxt;
MaxRSquared = 1 - (y - yhat).(y - yhat) / ((y - ybar).(y - ybar))
Histogram[MaxRed, Frame → Automatic, PlotTheme → "Scientific",
 FrameStyle → Thickness[Large], PlotLabel → "Histogram of Maximum Model Residuals"]
ProbabilityPlot[MaxRed, PlotTheme → "Scientific", FrameStyle → Thickness[Large],
 PlotLabel → "Maxiumum Model Probalbity Plot"]
```

Out[75]=

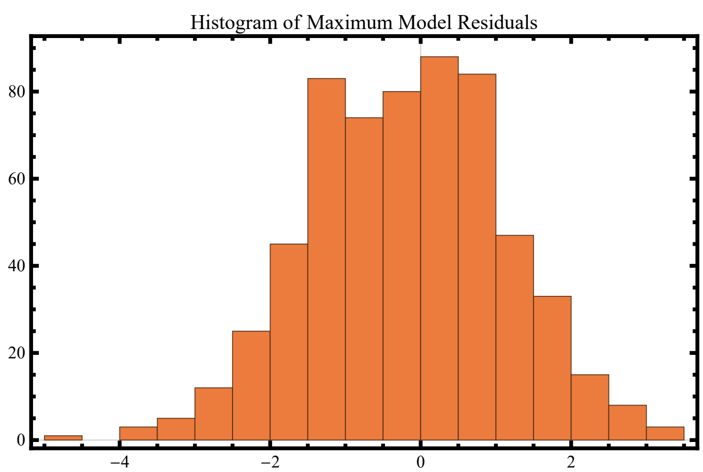


Out[76]=

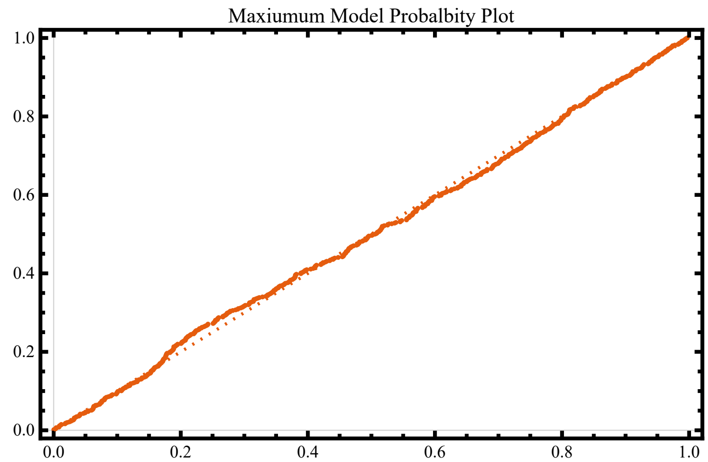


Out[80]= 0.796765

Out[81]=



Out[82]=

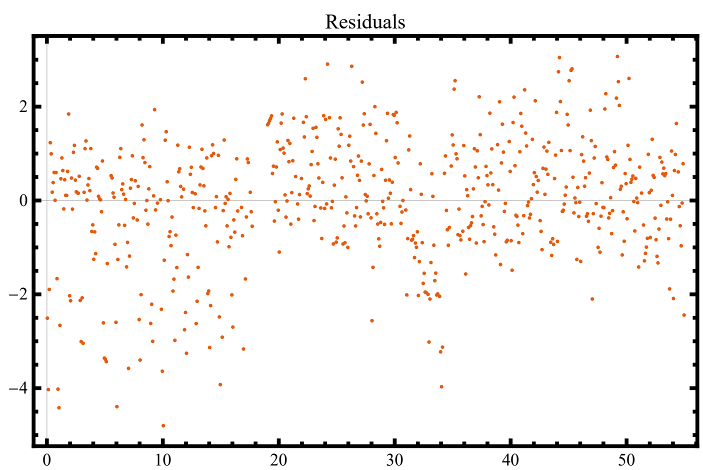


Minimum Temperature Model

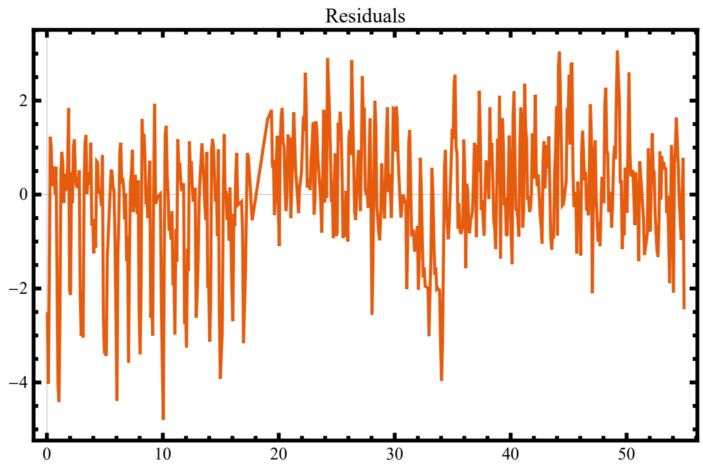
The minimum model also makes use of decimal year (time), latitude, longitude, sea surface temperature, and El Nino Southern Oscillatory values as predictors of the minimum temperature in Togo. The "Our"-Squared term was 65.419%, meaning that the 65.419% of the variability within the data for Dapaong is explained by the Minimum Model for Togo. The remaining 34.581% is the variability is caused by within the data by predictors that are not in use or chance. The variance in the versus does not appear to be constant as there seems to be narrowing and widening of the residuals across the fifty five years. The residuals narrow between twenty and twenty eight years which is easier to see in the Residuals Plot than in the Residuals. The Probability Plot shows definite deviation from the normal plot going above, below, and then back above the normal distribution line. The Histogram shows a higher concentration of values on the right while the values to the left go further from the mean of -0.0229497. This leads me to conclude that the Togo Minimum Temperature Model is not normal distributed for Dapaong and that it has not constant variance. It was most likely there was some predictor that would improve this models fit to Dapaong that explain why the residuals were wider and lower before year twenty one then narrowing around zero, but took a dip again around thirty one years.

In[83]:=
```
mint = 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` * la * lon + 0.4169986582275888` * la^2 +
   -3.698245146577038` * lon^2 + -6.224750893928698` * la + 15.071356816096722` * lon +
   -0.0015133234173910037` * elv + 0.2945134843073395` * sst + -0.006160260581052885` * enso;
p4 = ListPlot[dataMin];
TogoMinData = Transpose[{DecYear, mint}];
p5 =  ListPlot[TogoMinData];
MinRed = Mintemp - mint;
p6 = Transpose[{DecYear, MinRed}];
ListPlot[p6, PlotTheme → "Scientific",
 PlotLabel → "Residuals", FrameStyle → Thickness[Large]]
ListLinePlot[p6, PlotTheme → "Scientific",
 PlotLabel → "Residuals", FrameStyle → Thickness[Large]]
y = Mintemp;
ybar = Mean[y];
yhat = mint;
MinRSquared = 1 - (y - yhat).(y - yhat) / ((y - ybar).(y - ybar))
Histogram[MinRed, PlotTheme → "Scientific",
 Frame → Automatic, FrameStyle → Thickness[Large]]
ProbabilityPlot[MinRed, PlotTheme → "Scientific",
 PlotLabel → "Miniumum Model Probalbity Plot", FrameStyle → Thickness[Large]]
```

Out[89]=

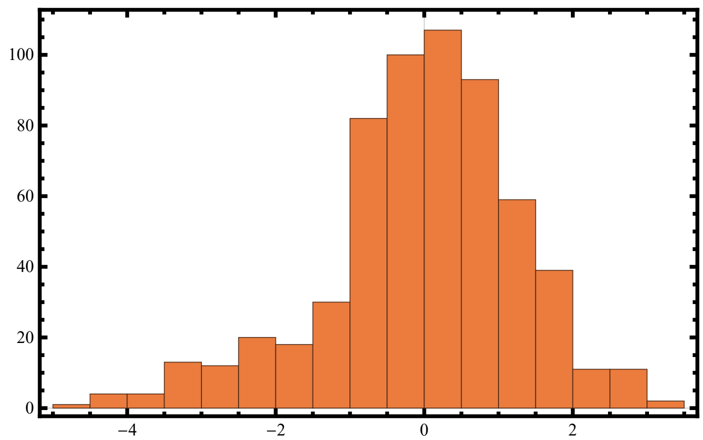


Out[90]=

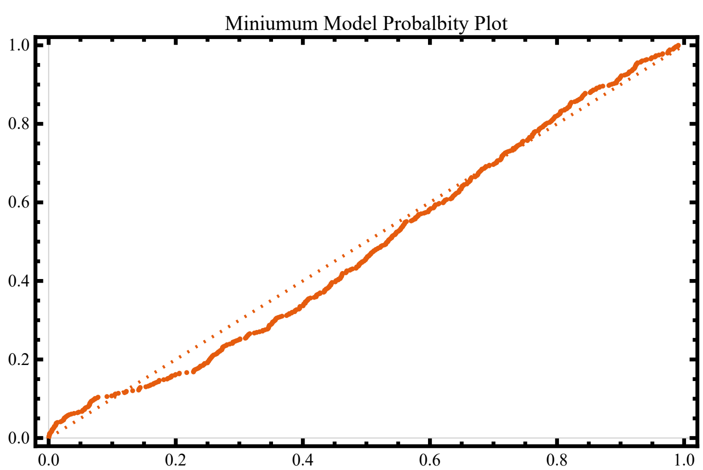


Out[94]= 0.65419

Out[95]=



Out[96]=



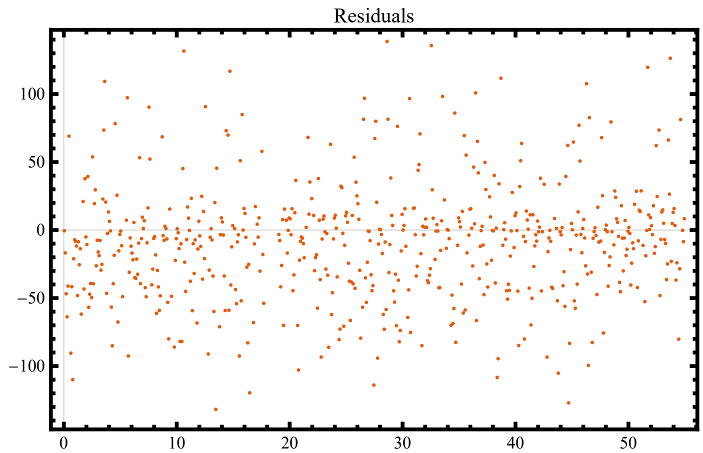
Both the Maximum and Minimum models are better fits now than the first model that was released. With both raising up about 14-15% in the “Our”-Squared values.

Rain Model

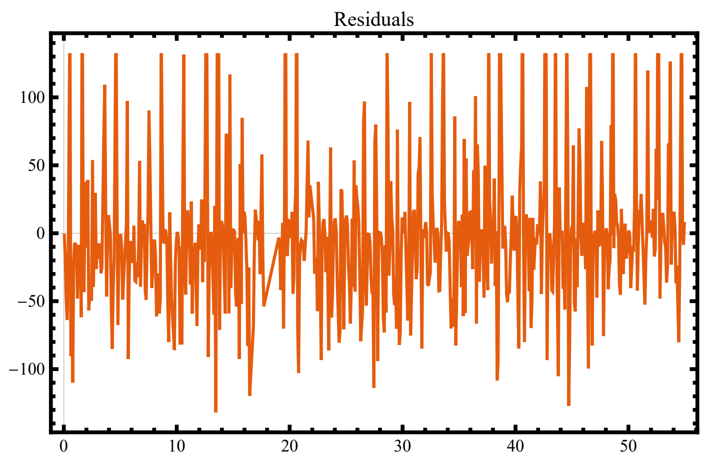
The rainfall model makes use of decimal year (time), latitude, longitude, Minimum Temperature Model for Togo, Maximum Temperature Model for Togo, sea surface temperature, and El Nino Southern Oscillatory values as predictors of the rainfall temperature in Togo. The “Our”-Squared term was 68.668%, meaning that the 68.668% of the variability within the data for Dapaong is explained by the Rainfall Model for Togo. The remaining 31.332% is the variability is caused by within the data by predictors that are not in use or chance. The variance in the versus does not appear to be constant as there seems to be a period in the residuals across the fifty five years that we aren’t accounting for. The residuals have a lot of high spikes which are easy to see in the Residuals Plot. There seems to be more below the zero line in the residuals plot than above zero. The Probability Plot shows definite deviation from the normal plot going below, above, and then below the normal distribution line. The Histogram shows a higher concentration of values on the left while the values to the right go further from the mean of -1.48088. This leads me to conclude that the Togo Rainfall Temperature Model is likely not normal distributed for Dapaong and that it has not constant variance. It was most like there was some predictor that would improve this models fit to Dapaong that explain some of the wider oscillations that are occurring in the residuals.

```
In[97]:= raint = -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` * la + 28.922922751700945` * la * lon +
    -14.194553415250773` * la^2 + -495.8774868055935` * lon + 130.9220050919206` * lon^2 +
    -0.135764075867611` * elv + 3.1135832174648366` * mint + -23.472635997948792` * maxt +
    0.15615745123884783` * enso + 29.330300300689828` * sst;
p7 = ListPlot[dataRain];
TogoRainData = Transpose[{DecYear, raint}];
p8 =  ListPlot[TogoRainData];
RainRed = rainfall - raint;
p9 = Transpose[{DecYear, RainRed}];
ListPlot[p9, PlotTheme → "Scientific",
 PlotLabel → "Residuals", FrameStyle → Thickness[Large]]
ListLinePlot[p9, PlotTheme → "Scientific",
 PlotLabel → "Residuals", FrameStyle → Thickness[Large]]
y = rainfall;
ybar = Mean[y];
yhat = raint;
MaxRSquared = 1 - (y - yhat).(y - yhat) / ((y - ybar).(y - ybar))
Histogram[RainRed, PlotTheme → "Scientific",
 Frame → Automatic, FrameStyle → Thickness[Large]]
ProbabilityPlot[RainRed, PlotTheme → "Scientific",
 PlotLabel → "Rainfall Model Probalbity Plot", FrameStyle → Thickness[Large]]
```

Out[103]=

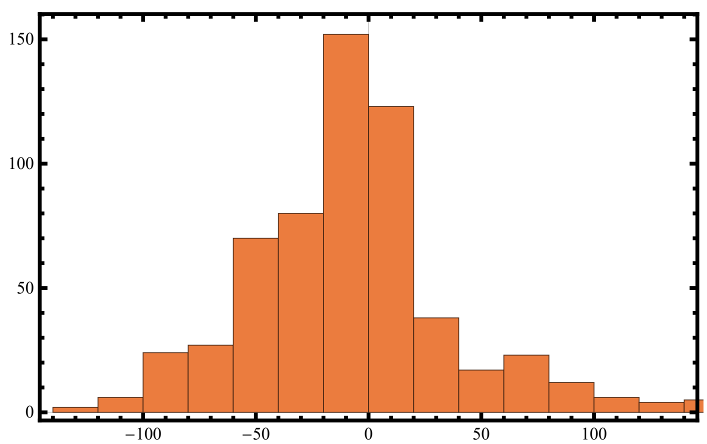


Out[104]=

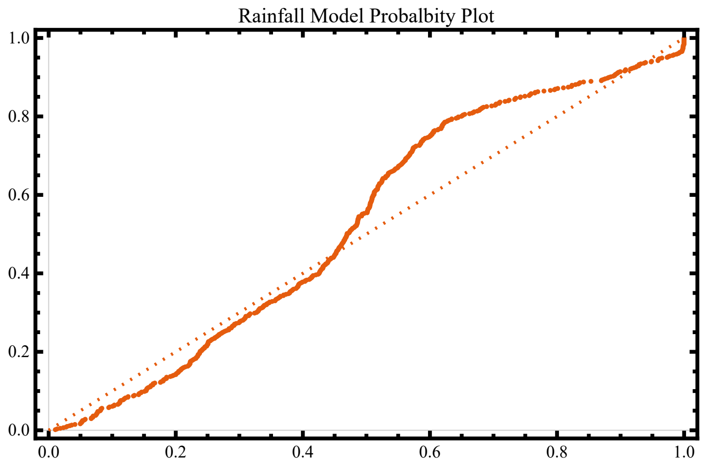


Out[108]= 0.68668

Out[109]=



Out[110]=



Summary

The final maximum model fits the city of Dapaong's maximum temperature data well. The model managed to capture 79.7% of the variability in the data. The Togo Maximum Model provides a good reference for predicting the maximum temperature of Dapaong. The final minimum model decently fit the Dapaong data. The model explains 65.4% of the variability within the data which suggest there may be a variable that we are failing to use that would help better predict these values. The Togo minimum Model is an adequate model for predicting the minimum temperature of the city of Dapaong but should be improved as there may be a predictor we are not utilizing that would improve our modeling of the minimum temperatures. The model has less variation after approximately 1980, so evaluating what made those values more accurate is a necessary step. The Togo rainfall model does not satisfactory model the rainfall of the city of Dapaong well. 68.7% of the variance in the data was explained by the Togo rainfall model. In the probablity plot we can observe a large There was a large amount of variability and non-normality suggest that improvement need to be made to better model Dapaong's monthly rainfall.