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MAT 375

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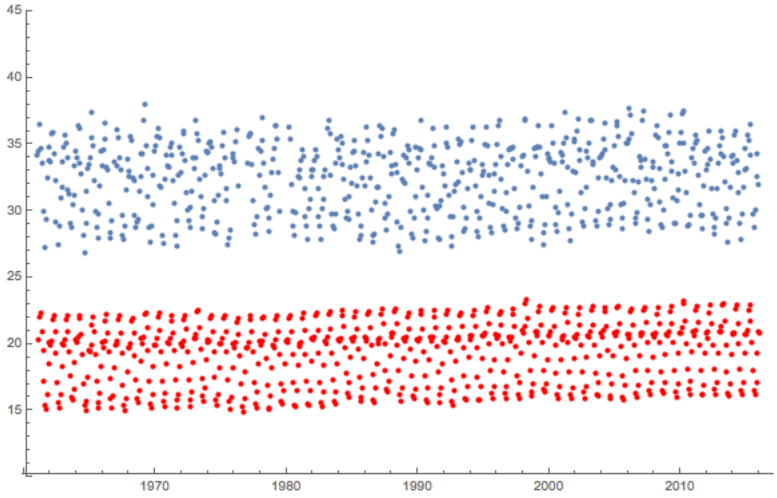
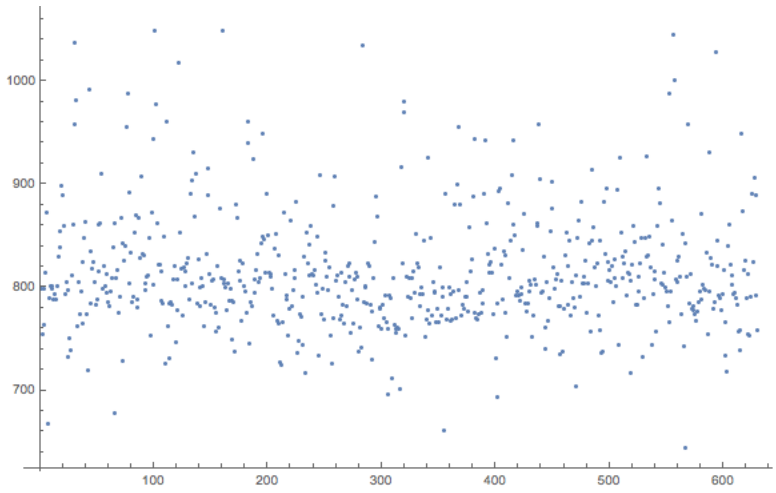
Niamtougou Final Model Analysis

In the past week, the modeling team has sent out a final model that models temperature and rainfall in ten different cities in Togo generated using monthly data over about a fifty-year period. In this report, I will evaluate our model's effectiveness in one city, Niamtougou.

Clayton (my partner) and I ran into some trouble early on when our maximum temperature model looked extremely inaccurate.

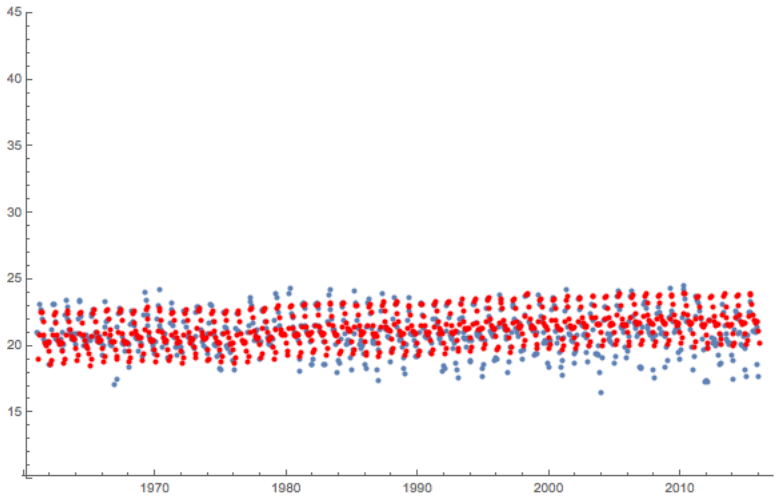


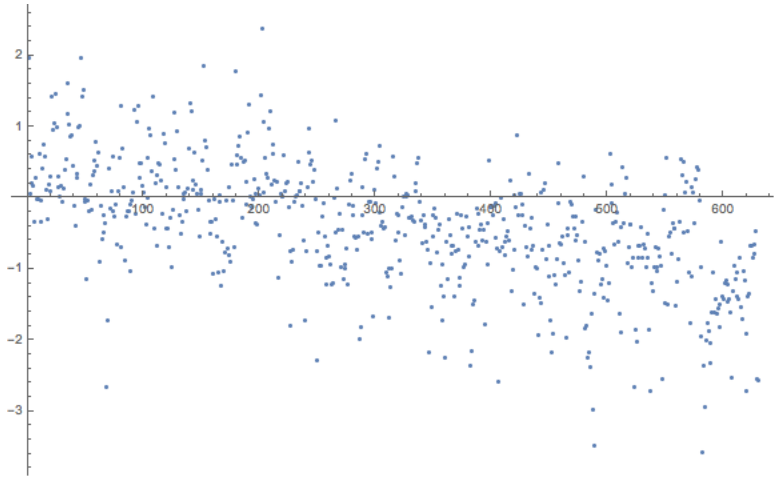


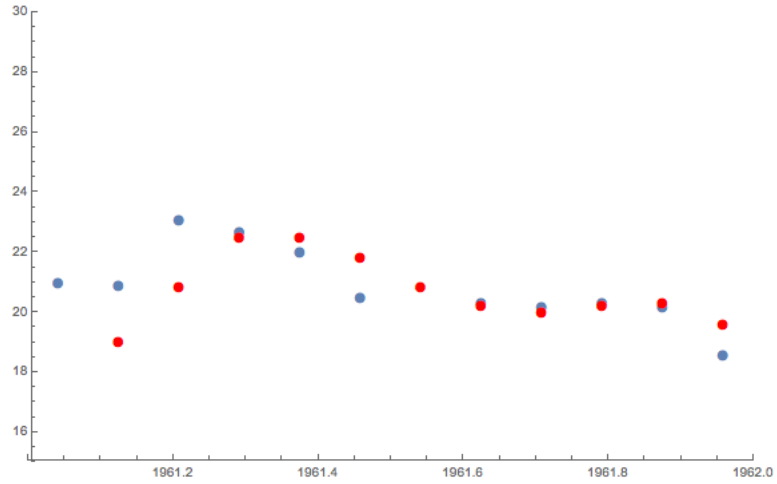
The blue points are the actual minimum temperature measurements while the red dots are the model predictions. It seemed to us that the model extremely underpredicted minimum temperatures, which made us believe we made some kind of mistake. After some trial and error, we found out that the minimum and maximum temperature models required different ENSO and SST datasets. The minimum temperature model used ENSO data with each term minus the ENSO mean while the maximum model used the raw ENSO data. The same is true for the SST data, the minimum temperature model used numbers minus the mean while the maximum temperature model used the raw numbers.

So, although there is some inconsistently as to what ENSO and SST dataset each model used, it was easy at first glance to tell which dataset a particular model used.

Next, I would like to evaluate how effectively the general temperature and rainfall models fit Niamtougou. Below you can see a plot of the minimum temperature data points as well as its model predictions and residuals. The model predicts a steady increase in temperature in Niamtougou when temperatures remain relatively flat over the fifty-year period. This can be seen in the residuals where a clear negative linear trend is apparent.

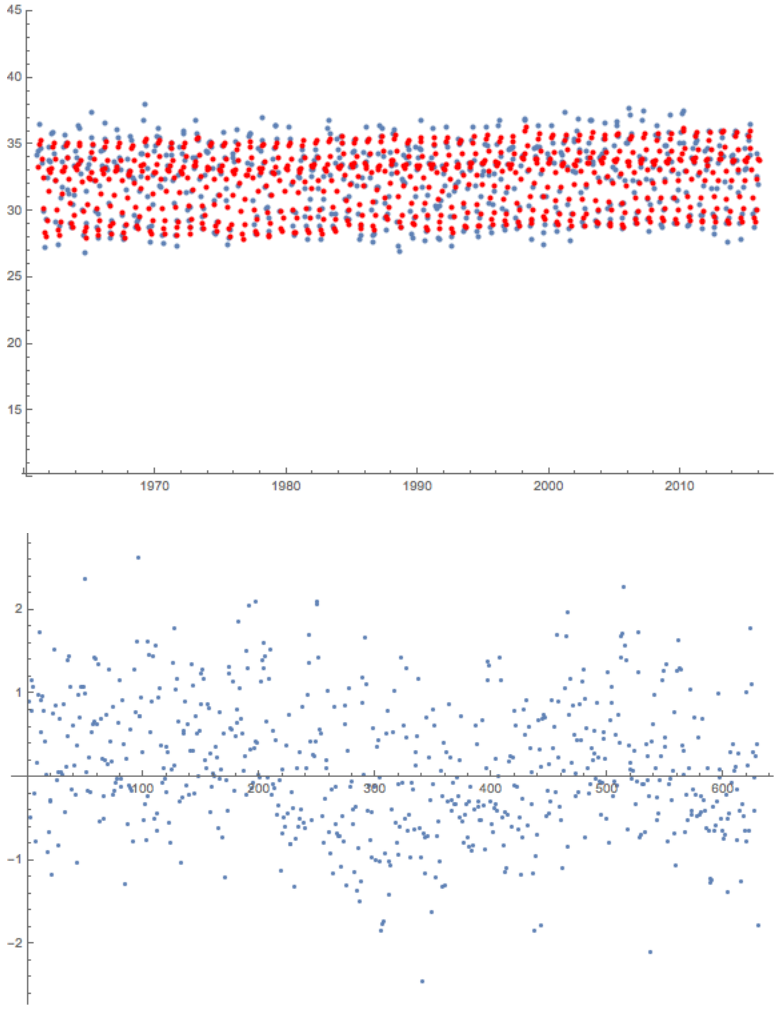

45
40
35
30
25
20
15
1970
1980
1990
2000
2010

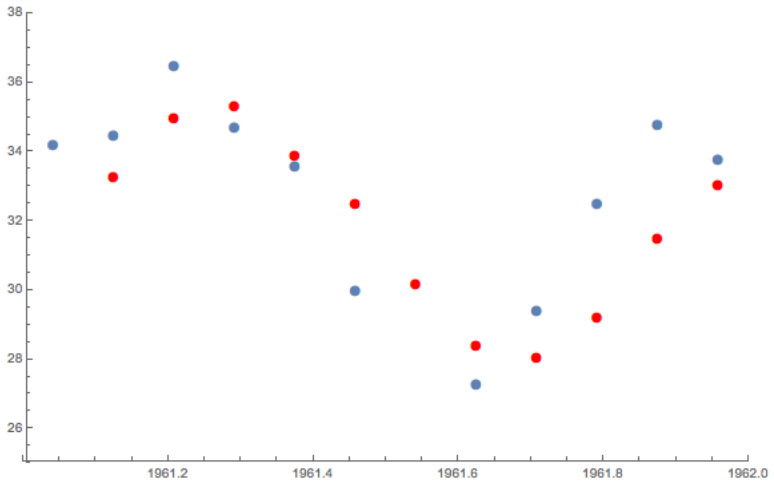

2
1
−1
−2
−3
100
200
300
400
500
600


30
28
26
24
22
20
18
16
1961.2
1961.4
1961.6
1961.8
1962.0

Above is a plot of the minimum temperature data and model predictions in 1961. It seems like the annual oscillations are well handled by the model but the long-term trends that are present in other Togolese cities are not present in Niamtougou.

Next, let's look at how well our maximum temperature model predicts maximum temperature's in Niamtougou. Below is a scatterplot as well as a residual plot.

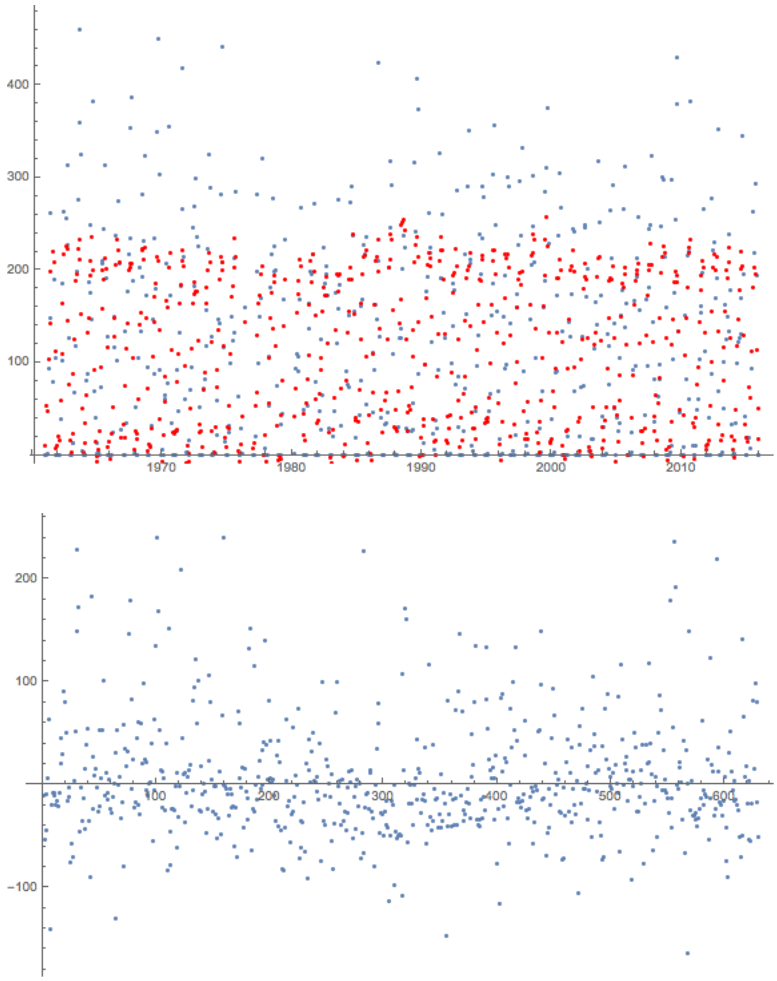




Our model seems to predict maximum temperature with a strong degree of accuracy. Each prediction is within two degrees of the actual value and annual oscillations are well modeled. However, there does appear to be a wave-like pattern in the residuals with a period of about thirty years. Maybe this could the result of a large period present in the ENSO or SST data not present in maximum temperatures in Niamtougou or a thirty year oscillation in maximum temperatures not captured by our model parameters.

Above is a plot of maximum temperatures for the year of 1961. Like the minimum temperature model, the maximum temperature does a good job of capturing seasonal oscillations in temperature.

Next, let's look at how well our model predicts monthly rainfall measurements. Below is a plot of Niamtougou's monthly rainfall in mm as well as the model predictions and residuals.



The model is poor at capturing infrequent months with large amounts of rainfall. Although these months are somewhat infrequent, they do seem to occur on at least an annual basis, so it's important for our model to predict these values. Months with less than about 250 millimeters of rainfall are predicted with decent accuracy and there doesn't appear to be a pattern in the residuals. Also, although the residuals may look bad, ~73% of months are predicted to at least 50 mm of accuracy and ~54% of months are predicted to at least 30 mm of accuracy.

Moreover, there doesn't look to be any obvious long-term trends in either the model or in our data.

In summary, the global Togo model seems to fit Niamtougou fairly well. Seasonal oscillations in temperature and rainfall are well captured and temperatures are modeled very

closely with their actual values. Some things I'm concerned with are the wave-like pattern in the maximum temperature residuals, the negative trend in minimum temperature residuals, and how poorly months with a lot of rain are modeled. The positive linear terms in temperature models do not seem to work well in Niamtougou, although they may work better in other cities.

Another thing that jumps out at me is because that we are using sea surface temperatures to model temperatures in Togo, if temperatures in Togo correlate with sea surface temperatures it wouldn't be sufficient to say that temperatures in Togo are rising because a positive linear term. That positive linear term would just mean that temperatures in Togo are rising slightly more than sea surface temperatures, if my understanding is correct.