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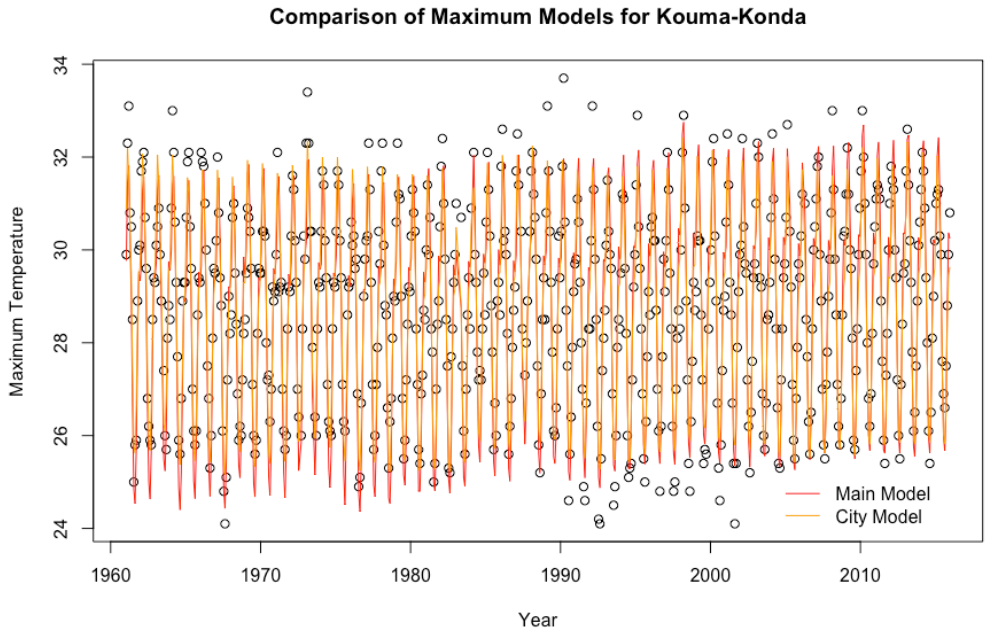
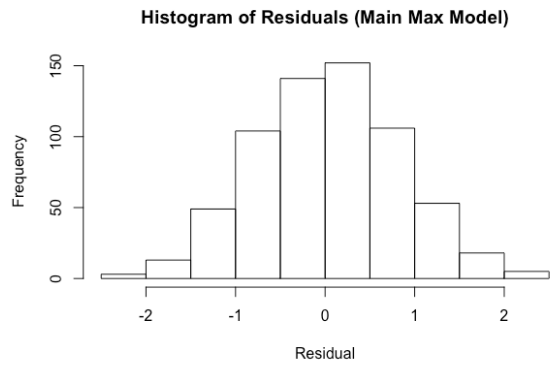
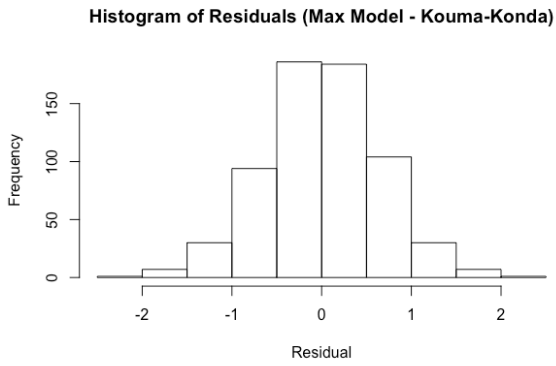
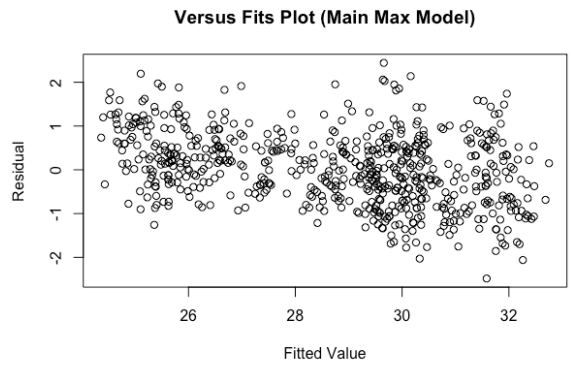
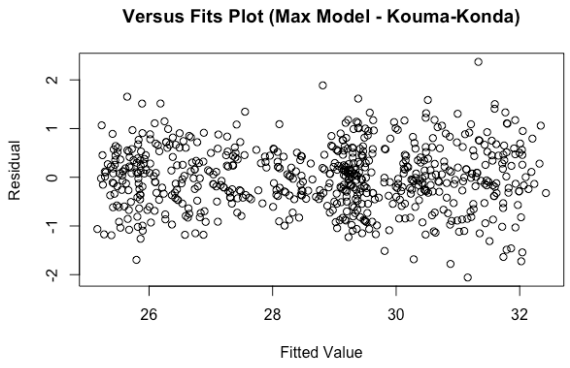
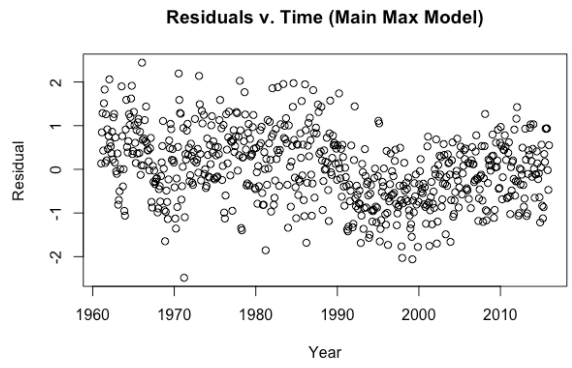
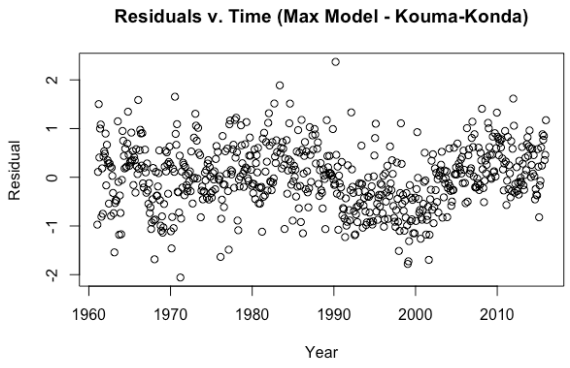
Prof. Long
MAT 375
29 April 2018

Kouma-Konda Final Model Evaluation

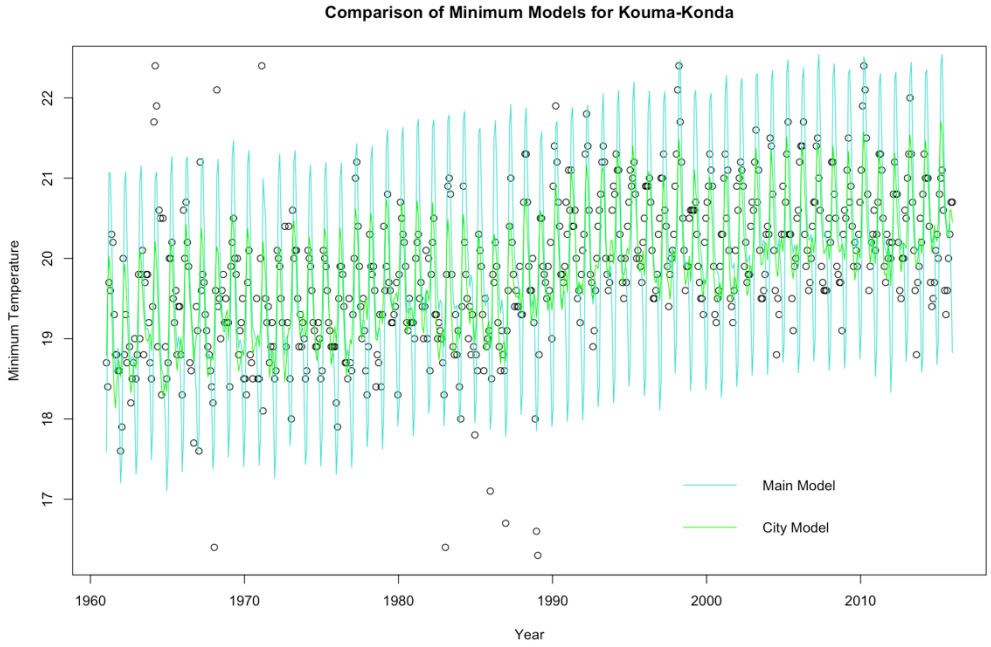
1. Maximum Model



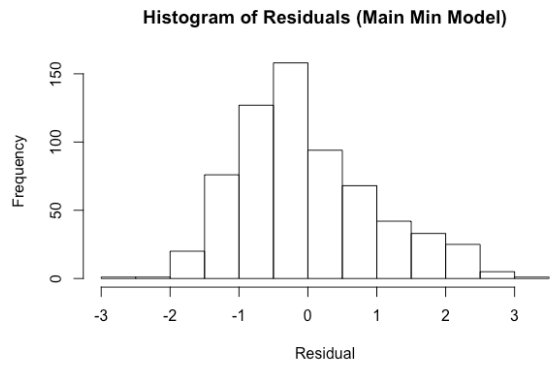
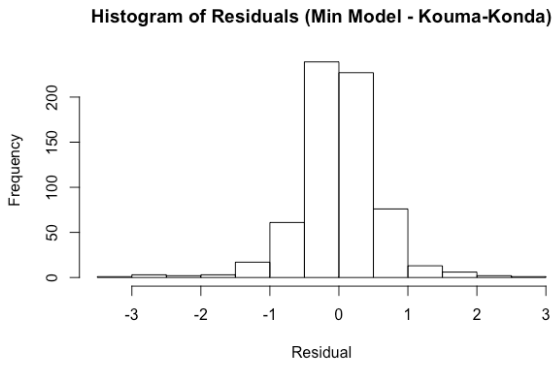
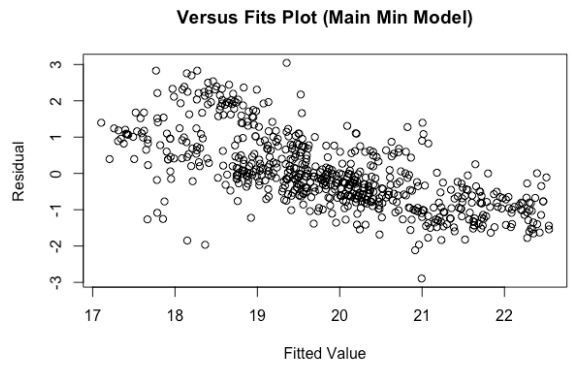
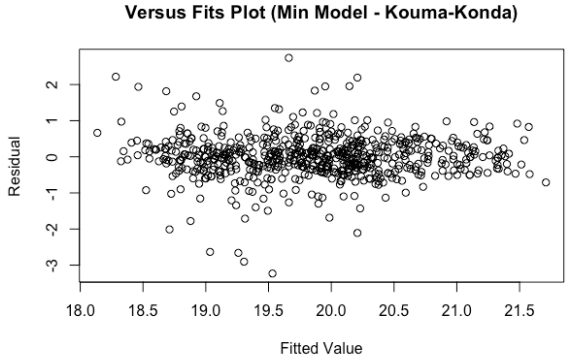
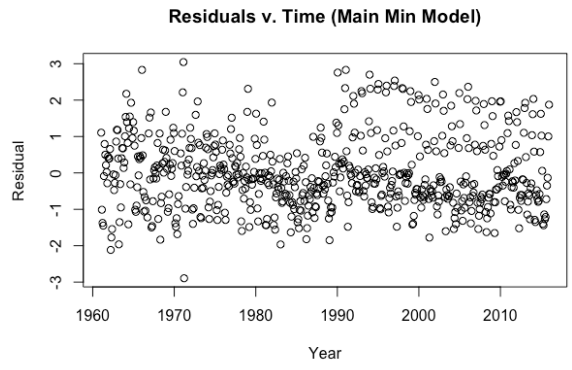
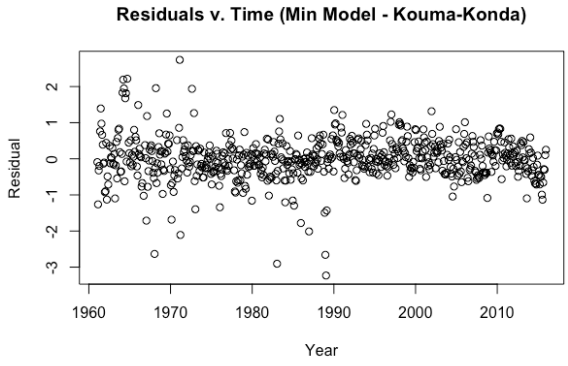
	main_est	main_95_lower	main_95_upper	city_est	contains95
(Intercept)	–8.37022	–10.98254	–5.75789	18.60878	N
*sin(DecYear0 * 2 * pi)*	1.34081	1.23571	1.44590	1.32526	Y
*cos(DecYear0 * 2 * pi)*	1.78711	1.72603	1.84819	1.69973	N
*sin(DecYear0 * 2 * pi/(1/2))*	–0.21333	–0.26732	–0.15934	0.03970	N
*cos(DecYear0 * 2 * pi/(1/2))*	–0.59972	–0.63462	–0.56482	–0.37274	N
*sin(DecYear0 * 2 * pi/(1/3))*	–0.07605	–0.10911	–0.04299	0.23937	N
*cos(DecYear0 * 2 * pi/(1/3))*	–0.39639	–0.42944	–0.36333	–0.25323	N
*sin(DecYear0 * 2 * pi/(1/4))*	–0.05782	–0.09073	–0.02491	0.05323	N
*cos(DecYear0 * 2 * pi/(1/4))*	–0.16546	–0.19892	–0.13200	–0.18747	Y
*sin(DecYear0 * 2 * pi/(13))*	–0.06706	–0.10055	–0.03356	0.02396	N
*cos(DecYear0 * 2 * pi/(13))*	0.10259	0.06825	0.13693	0.22535	N
DecYear0	0.01284	0.01118	0.01451	–0.00116	N
Enso	–0.00663	–0.00892	–0.00434	–0.00400	N
SST	0.47106	0.40926	0.53287	0.36908	N

Maximum Temperatures Residual Plots	
Main Model fits to Kouma-Konda data	Kouma-Konda fits to Kouma-Konda data
R-Squared = 0.963	R-Squared = 0.910
	
	
	

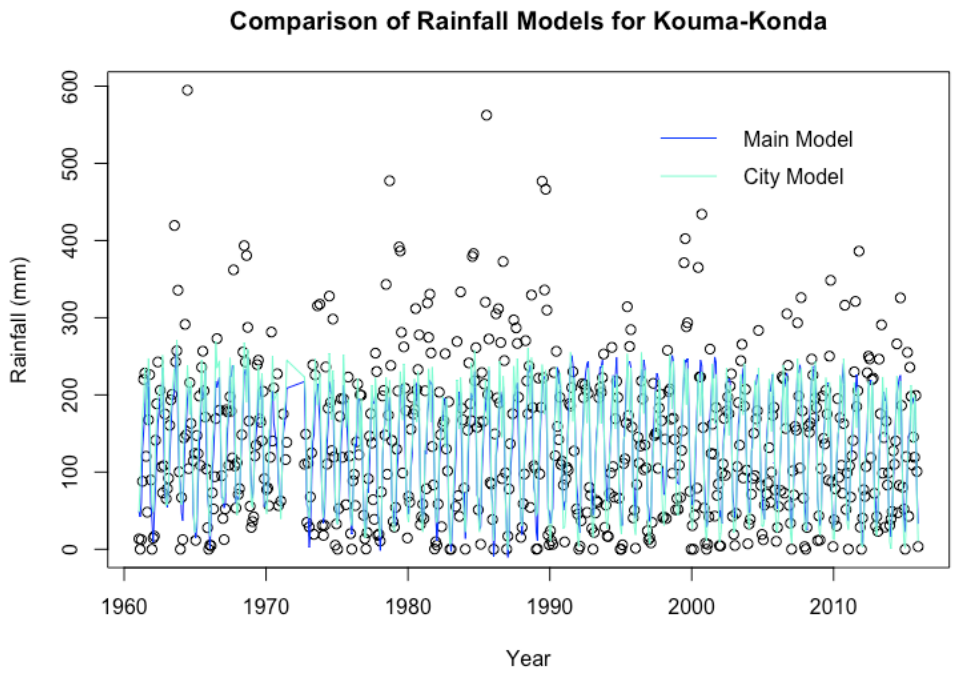
2. Minimum Model



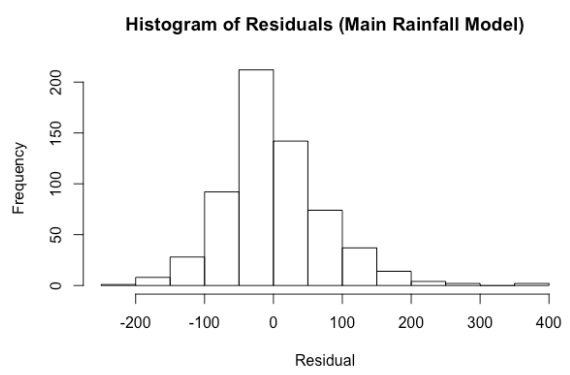
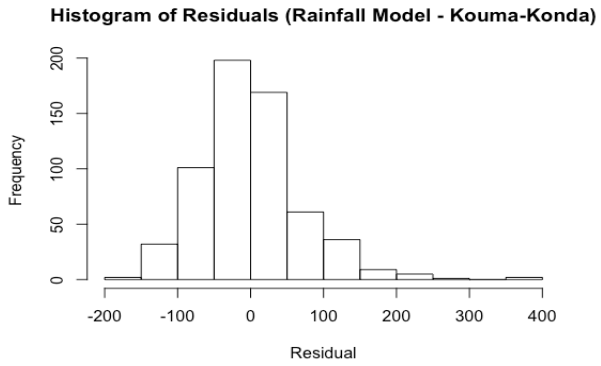
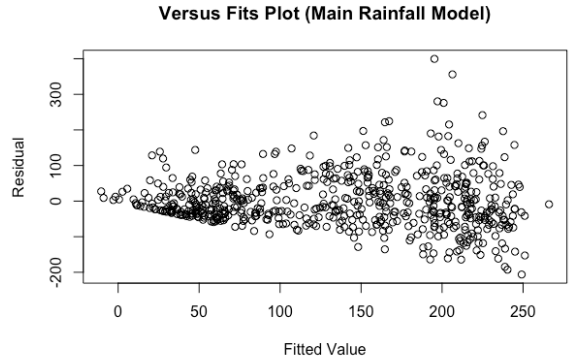
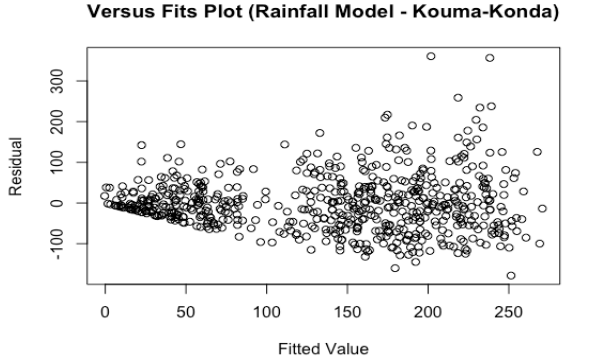
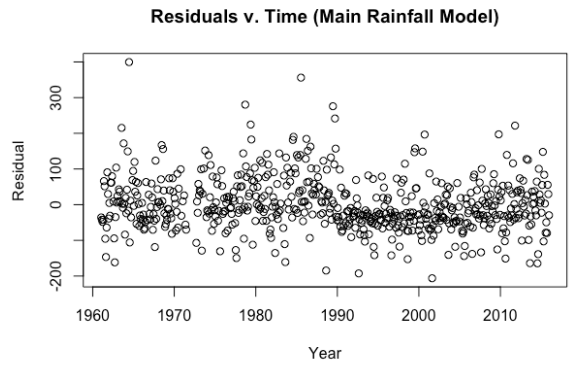
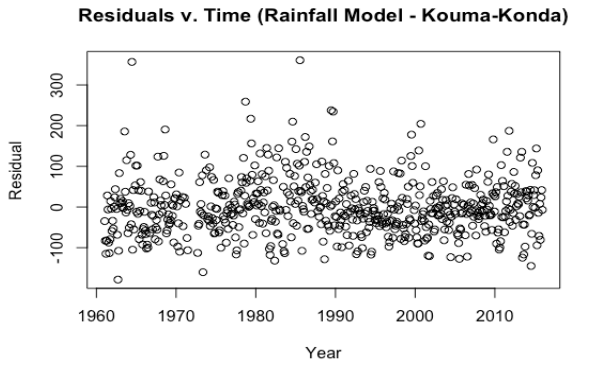
	main_est	main_95_lower	main_95_upper	city_est	contains95
(Intercept)	31.17225	27.93324	34.41126	–41.52926	N
*sin(DecYear0 * 2 * pi)*	0.57932	0.44826	0.71038	–0.08014	N
*cos(DecYear0 * 2 * pi)*	–1.00163	–1.07732	–0.92594	–0.33097	N
*sin(DecYear0 * 2 * pi/(1/2))*	0.12960	0.06271	0.19649	0.30016	N
*cos(DecYear0 * 2 * pi/(1/2))*	–0.87516	–0.91784	–0.83248	–0.22775	N
*sin(DecYear0 * 2 * pi/(1/3))*	–0.10277	–0.14314	–0.06240	–0.02115	N
*cos(DecYear0 * 2 * pi/(1/3))*	–0.22623	–0.26659	–0.18587	–0.11712	N
*sin(DecYear0 * 2 * pi/13)*	–0.06166	–0.10304	–0.02029	0.04865	N
*cos(DecYear0 * 2 * pi/13)*	–0.04199	–0.08490	0.00092	–0.17824	N
*sin(DecYear0 * 2 * pi/20)*	0.02849	–0.01436	0.07135	–0.16234	N
*cos(DecYear0 * 2 * pi/20)*	0.07459	0.03243	0.11675	–0.00313	N
DecYear0	0.02739	0.02528	0.02949	0.02457	N
Enso	–0.00616	–0.00896	–0.00336	–0.00227	N
SST	0.29451	0.21725	0.37177	0.45436	N

Minimum Temperatures Residual Plots	
Main Model fits to Kouma-Konda data	Kouma-Konda fits to Kouma-Konda data
R-Squared = 0.736	R-Squared = 0.596
	
	
	

3. Rainfall Model

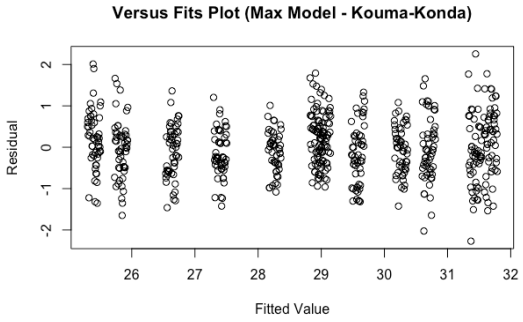


	main_est	main_95_lower	main_95_upper	city_est	contains95
(Intercept)	−765.09024	−950.35637	−579.82412	−432.51630	N
*sin(DecYear0 * 2 * pi)*	−33.96627	−41.46089	−26.47164	−59.98242	N
*cos(DecYear0 * 2 * pi)*	−66.76497	−72.35649	−61.17346	−99.88477	N
*sin(DecYear0 * 2 * pi/(1/2))*	19.58924	15.90290	23.27557	12.31282	N
*cos(DecYear0 * 2 * pi/(1/2))*	−20.83339	−23.61490	−18.05189	−28.80606	N
*sin(DecYear0 * 2 * pi/(1/3))*	8.98517	6.74394	11.22639	20.47678	N
*cos(DecYear0 * 2 * pi/(1/3))*	−1.02394	−3.36741	1.31953	−16.03321	N
*sin(DecYear0 * 2 * pi/(1/4))*	−6.43061	−8.66014	−4.20107	−7.59127	Y
*cos(DecYear0 * 2 * pi/(1/4))*	6.17596	3.89724	8.45469	23.39893	N
DecYear0	−0.12389	−0.24337	−0.00441	−0.63606	N
MinTemp	3.11358	1.64282	4.58435	−3.65880	N
MaxTemp	−23.47264	−25.26244	−21.68283	−7.13247	N
Enso	0.15616	0.00625	0.30607	0.43696	N
SST	29.33030	25.03501	33.62559	31.44748	Y

Rainfall Residual Plots	
Main Model fits to Kouma-Konda data	Kouma-Konda fits to Kouma-Konda data
R-Squared = 0.515	R-Squared = 0.530
	
	
	

Discussion of Model Fits:

The maximum temperature model fits Kouma-Konda very well. It is able to explain 96.3% of the variation in maximum temperatures, which is about 6% more than the model trained on only Kouma-Konda data. Visually, the fitted values appear to be very similar between the two models. There is nothing too alarming in the residuals. They are not perfectly normal, but they are symmetric and in a bell-shaped curve. The Versus Fits and Versus Time plots appear to have a relatively random scatter, minus the strange change around 1990 that we have been noticing with a lot of the data. I was happy to see the Versus Fits plot looking much better than it did with the original model (to the right), where the predictions seemed to almost be "discrete" in a way. With the new model, we no longer see these bands.



The global minimum temperature model also fits well to the city of Kouma-Konda. The "Our-Squared" indicates that 73.6% of the variation in minimum temperatures is explained by the model, which is a vast improvement over the 59.6% we achieve using just the city's data to build the model. However, the histogram of residuals is asymmetric and certainly not normal. The Versus Time plot is not too alarming to me, but the Versus Fits plot is. This plot indicates that increasing predictions correspond to more negative residuals. In other words, the higher temperature the model predicts, the more likely we are to overestimate the actual data. This would be more concerning if we were not talking about fitting Kouma-Konda, as this region typically has lower temperatures. I would imagine the global model would be more accurate for other cities. I do not think it is an issue with the variables, but rather with trying to fit Kouma-Konda with the same model we are trying to fit all of the other cities in Togo with.

Last but not least, the global rainfall model performed fairly well for Kouma-Konda. It was able to explain 51.5% of the variation in rainfall, as opposed to 53% when the model is built just on Kouma-Konda data. Considering the erratic nature of rainfall throughout Togo, I think this is a pretty good fit. The residual plot is not perfectly normal, but it does resemble a bit of a bell-shaped curve. Obviously, there are some residuals very far from 0, but I recall thinking this histogram was probably one of the better ones when we examined other cities. There is nothing too disturbing or unexpected in the Versus Fits and Versus Time plots. The main issue here continues to be the fact there is a hard cutoff for residuals, as rainfall cannot fall below 0 mm.

In terms of comparing my coefficients with those generated by the global models, only a handful were within the 95% CIs of the global model. This did not worry me too much, however, as it appears that the sign is the same for the ENSO, SST, time, and temperature terms. I also think that if we extended the radius to being within a 99% CI we would catch much more. In general, I was very happy to the "Our-Squareds" from the overall model outperform those from the models I was able to build on only Kouma-Konda's data.