Bowling Green maxes, mins, and their standard deviations

Andy Long

Spring, 2020 -- year of the Covid-19 virus.

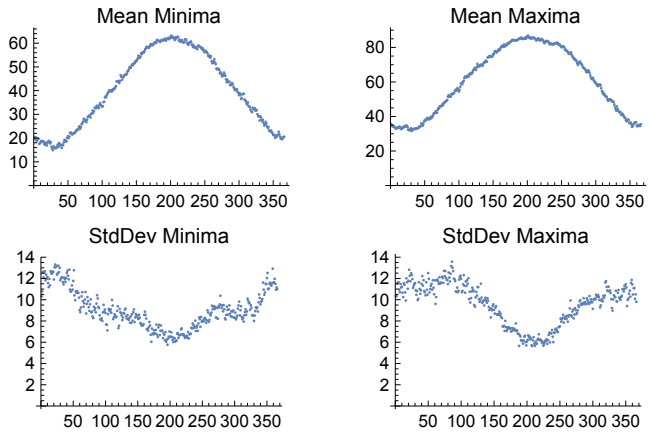
Let's read in the data, which was created with BGdata.lsp:

In[267]:=
```
(*
iris=Import["/Users/longa/Desktop/NKU/classes/000
      2020Spring/mat375/Fletcher/analysis/SummaryStatsBG.csv","CSV"];
*)
iris = Import[
   "http://ceadserv1.nku.edu/longa//classes/mat375/data/Fletcher/SummaryStatsBG.
     csv", "CSV"];
header = iris[[1]]
BG = iris[[2 ;;]];
{date, minmeans, minsds, maxmeans, maxsds} = Transpose[BG];
xs = date / 366;
```

Out[268]= {date, minmeans, minsds, maxmeans, maxsds}

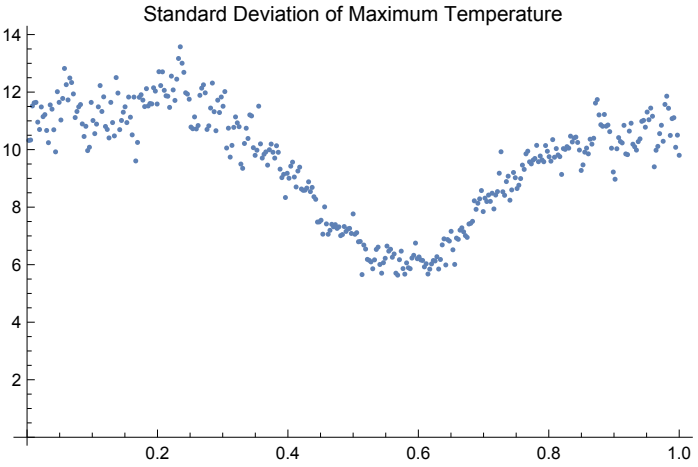
In[272]:=
```
GraphicsGrid[
 {{ListPlot[Transpose[{date, minmeans}], PlotLabel → "Mean Minima"],
   ListPlot[Transpose[{date, maxmeans}], PlotLabel → "Mean Maxima"]},
  {ListPlot[Transpose[{date, minsds}], PlotLabel → "StdDev Minima"],
   ListPlot[Transpose[{date, maxsds}], PlotLabel → "StdDev Maxima"]}}
]
```

Out[272]=



In[273]:=
```
data = Transpose[{xs, maxsds}];
dtrplot = ListPlot[data, PlotLabel → "Standard Deviation of Maximum Temperature"]
regMaxSD = LinearModelFit[data, {
    Cos[2 Pi x], Sin[2 Pi x],
    Sin[4 Pi x], Cos[4 Pi x],
    Sin[6 Pi x], Cos[6 Pi x],
    Sin[8 Pi x], Cos[8 Pi x],
    Sin[10 Pi x], Cos[10 Pi x],
    Sin[12 Pi x], Cos[12 Pi x]
   }
   , x]
regMaxSDfits = Table[regMaxSD[x], {x, xs}];
regMaxSD["ParameterTable"]
regMaxSD["RSquared"]
regMaxSD["AdjustedRSquared"]
regMaxSD["ANOVATable"]
regMaxSD["ParameterConfidenceIntervals"]
maxsdsWmodel = Show[dtrplot, Plot[regMaxSD[x], {x, 0, xs[[Length[xs]]]}]]
```

Out[274]=



Out[275]= FittedModel[9.55005 + 2.0149 Cos[2 πx] − 0.774403 Cos[4 πx] + ≪10≫ + 0.08917 Sin[10 πx] + 0.163701 Sin[12 πx]]

Out[277]=

	Estimate	Standard Error	t-Statistic	P-Value
1	9.55005	0.0279105	342.167	0.
Cos[2 πx]	2.0149	0.0394715	51.047	4.8494×10^{-165}
Sin[2 πx]	1.43507	0.0394715	36.3571	2.13772×10^{-121}
Sin[4 πx]	−0.579229	0.0394715	−14.6746	2.13674×10^{-38}
Cos[4 πx]	−0.774403	0.0394715	−19.6193	1.76511×10^{-58}
Sin[6 πx]	0.150073	0.0394715	3.80206	0.000169021
Cos[6 πx]	0.0274265	0.0394715	0.694845	0.48761
Sin[8 πx]	0.00133136	0.0394715	0.0337296	0.973112
Cos[8 πx]	0.170055	0.0394715	4.3083	0.000021356
Sin[10 πx]	0.08917	0.0394715	2.2591	0.0244866
Cos[10 πx]	0.0451786	0.0394715	1.14459	0.253155
Sin[12 πx]	0.163701	0.0394715	4.14733	0.0000421792
Cos[12 πx]	−0.082823	0.0394715	−2.0983	0.0365887

Out[278]= 0.928577

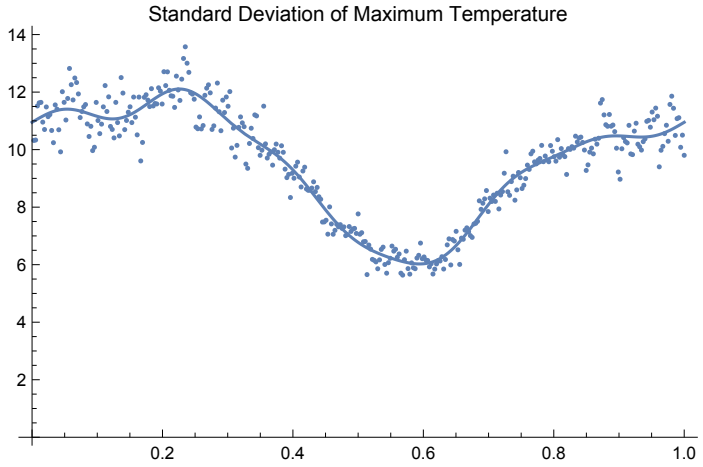
Out[279]= 0.926149

Out[280]=

	DF	SS	MS	F-Statistic	P-Value
Cos[2 πx]	1	742.946	742.946	2605.79	4.8494×10^{-165}
Sin[2 πx]	1	376.873	376.873	1321.84	2.13772×10^{-121}
Sin[4 πx]	1	61.3976	61.3976	215.345	2.13674×10^{-38}
Cos[4 πx]	1	109.745	109.745	384.918	1.76511×10^{-58}
Sin[6 πx]	1	4.12149	4.12149	14.4556	0.000169021
Cos[6 πx]	1	0.137655	0.137655	0.482809	0.48761
Sin[8 πx]	1	0.000324369	0.000324369	0.00113769	0.973112
Cos[8 πx]	1	5.2921	5.2921	18.5614	0.000021356
Sin[10 πx]	1	1.45509	1.45509	5.10354	0.0244866
Cos[10 πx]	1	0.373522	0.373522	1.31008	0.253155
Sin[12 πx]	1	4.90404	4.90404	17.2003	0.0000421792
Cos[12 πx]	1	1.25532	1.25532	4.40287	0.0365887
Error	353	100.645	0.285113		
Total	365	1409.15			

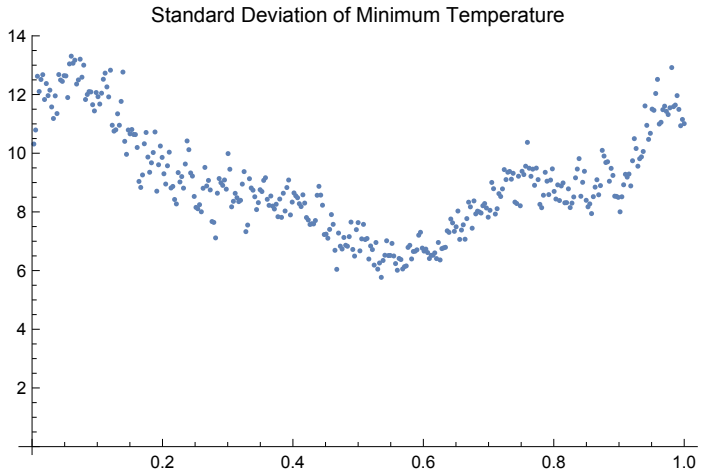
Out[281]= {{9.49516, 9.60494}, {1.93727, 2.09253}, {1.35744, 1.51269}, {−0.656858, −0.5016}, {−0.852032, −0.696774}, {0.0724439, 0.227701}, {−0.0502022, 0.105055}, {−0.0762974, 0.0789601}, {0.0924259, 0.247683}, {0.0115412, 0.166799}, {−0.0324502, 0.122807}, {0.0860722, 0.24133}, {−0.160452, −0.00519426}}

Out[282]=



In[283]:=
```
data = Transpose[{xs, minsds}];
dtrplot = ListPlot[data, PlotLabel → "Standard Deviation of Minimum Temperature"]
regminSD = LinearModelFit[data, {
    Cos[2 Pi x], Sin[2 Pi x],
    Sin[4 Pi x], Cos[4 Pi x],
    Sin[6 Pi x], Cos[6 Pi x],
    Sin[8 Pi x], Cos[8 Pi x],
    Sin[10 Pi x], Cos[10 Pi x],
    Sin[12 Pi x], Cos[12 Pi x]
   }
   , x]
regminSDfits = Table[regminSD[x], {x, xs}];
regminSD["ParameterTable"]
regminSD["RSquared"]
regminSD["AdjustedRSquared"]
regminSD["ANOVATable"]
regminSD["ParameterConfidenceIntervals"]
minsdsWmodel = Show[dtrplot, Plot[regminSD[x], {x, 0, xs[[Length[xs]]]}]]
```

Out[284]=



Out[285]= FittedModel[

$$9.03807 + 2.13087\,\text{Cos}[2\pi x] + 0.265583\,\text{Cos}[4\pi x] + \ll 9 \gg + 0.0388068\,\ll 1 \gg - 0.0697139\,\text{Sin}[10\pi x] - 0.0516454\,\text{Sin}[12\pi x]$$

]

Out[287]=

	Estimate	Standard Error	t-Statistic	P-Value
1	9.03807	0.0289443	312.257	0.
Cos[2 πx]	2.13087	0.0409335	52.0568	1.08044×10^{-167}
Sin[2 πx]	0.658444	0.0409335	16.0857	4.62226×10^{-44}
Sin[4 πx]	0.236517	0.0409335	5.77807	1.66078×10^{-8}
Cos[4 πx]	0.265583	0.0409335	6.48816	2.94065×10^{-10}
Sin[6 πx]	0.734591	0.0409335	17.946	1.23218×10^{-51}
Cos[6 πx]	0.395236	0.0409335	9.65558	9.96113×10^{-20}
Sin[8 πx]	0.0388068	0.0409335	0.948045	0.343755
Cos[8 πx]	0.115343	0.0409335	2.81782	0.00510727
Sin[10 πx]	−0.0697139	0.0409335	−1.7031	0.0894294
Cos[10 πx]	−0.0199994	0.0409335	−0.488582	0.625441
Sin[12 πx]	−0.0516454	0.0409335	−1.26169	0.207893
Cos[12 πx]	−0.0868647	0.0409335	−2.1221	0.0345257

Out[288]= 0.907845

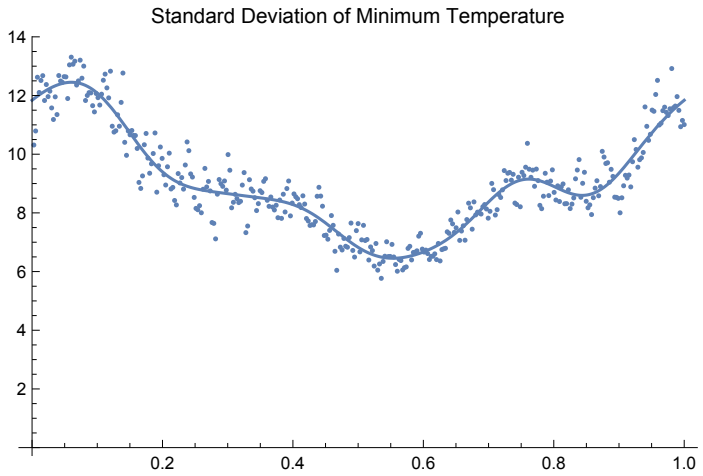
Out[289]= 0.904712

Out[290]=

	DF	SS	MS	F-Statistic	P-Value
Cos[2 πx]	1	830.929	830.929	2709.91	1.08044×10^{-167}
Sin[2 πx]	1	79.3394	79.3394	258.75	4.62226×10^{-44}
Sin[4 πx]	1	10.237	10.237	33.3861	1.66078×10^{-8}
Cos[4 πx]	1	12.9078	12.9078	42.0962	2.94065×10^{-10}
Sin[6 πx]	1	98.7512	98.7512	322.058	1.23218×10^{-51}
Cos[6 πx]	1	28.5868	28.5868	93.2302	9.96113×10^{-20}
Sin[8 πx]	1	0.275592	0.275592	0.898789	0.343755
Cos[8 πx]	1	2.43465	2.43465	7.94014	0.00510727
Sin[10 πx]	1	0.889384	0.889384	2.90055	0.0894294
Cos[10 πx]	1	0.0731954	0.0731954	0.238713	0.625441
Sin[12 πx]	1	0.488106	0.488106	1.59186	0.207893
Cos[12 πx]	1	1.38082	1.38082	4.50329	0.0345257
Error	353	108.239	0.306626		
Total	365	1174.53			

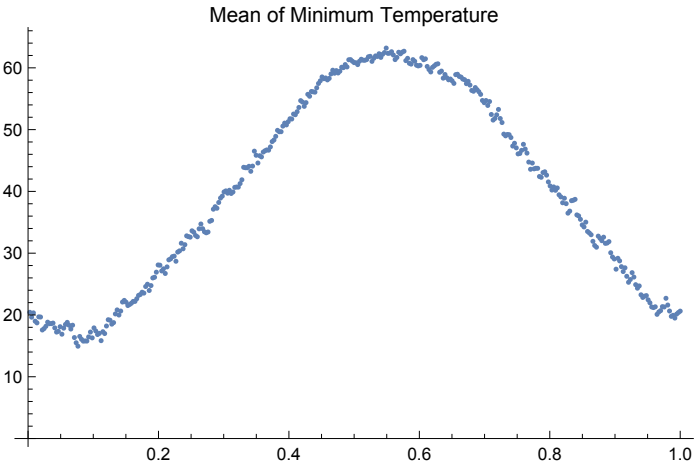
Out[291]= {{8.98114, 9.09499}, {2.05036, 2.21137}, {0.57794, 0.738948}, {0.156013, 0.317021}, {0.185079, 0.346087}, {0.654087, 0.815095}, {0.314732, 0.475741}, {-0.0416974, 0.119311}, {0.0348392, 0.195848}, {-0.150218, 0.0107903}, {-0.100504, 0.0605048}, {-0.13215, 0.0288588}, {-0.167369, -0.00636058}}

Out[292]=



In[293]:=
```
data = Transpose[{xs, minmeans}];
dtrplot = ListPlot[data, PlotLabel → "Mean of Minimum Temperature"]
regminmeans = LinearModelFit[data, {
    Cos[2 Pi x], Sin[2 Pi x],
    Sin[4 Pi x], Cos[4 Pi x],
    Sin[6 Pi x], Cos[6 Pi x],
    Sin[8 Pi x], Cos[8 Pi x],
    Sin[10 Pi x], Cos[10 Pi x],
    Sin[12 Pi x], Cos[12 Pi x]
  }
  , x]
regminmeansfits = Table[regminSD[x], {x, xs}];
regminmeans["ParameterTable"]
regminmeans["RSquared"]
regminmeans["AdjustedRSquared"]
regminmeans["ANOVATable"]
regminmeans["ParameterConfidenceIntervals"]
minmeansWmodel = Show[dtrplot, Plot[regminmeans[x], {x, 0, xs[[Length[xs]]]}]]
```

Out[294]=



Out[295]= FittedModel[<<18>> + 0.307314 Sin[10 π x] + 0.284522 Sin[12 π x]]

Out[297]=

	Estimate	Standard Error	t-Statistic	P-Value
1	40.0174	0.0398573	1004.02	0.
Cos[2 π x]	−20.6042	0.0563667	−365.538	0.
Sin[2 π x]	−8.19201	0.0563667	−145.334	5.33729×10^{-317}
Sin[4 π x]	−0.250854	0.0563667	−4.45039	0.0000115082
Cos[4 π x]	−0.0545827	0.0563667	−0.968349	0.333533
Sin[6 π x]	−0.402923	0.0563667	−7.14823	5.08377×10^{-12}
Cos[6 π x]	−0.174452	0.0563667	−3.09495	0.0021257
Sin[8 π x]	−0.340864	0.0563667	−6.04725	3.75333×10^{-9}
Cos[8 π x]	0.214391	0.0563667	3.8035	0.000168081
Sin[10 π x]	0.307314	0.0563667	5.45205	9.37297×10^{-8}
Cos[10 π x]	0.0132664	0.0563667	0.235359	0.814066
Sin[12 π x]	0.284522	0.0563667	5.0477	7.17683×10^{-7}
Cos[12 π x]	0.313488	0.0563667	5.56158	5.28681×10^{-8}

Out[298]= 0.997727

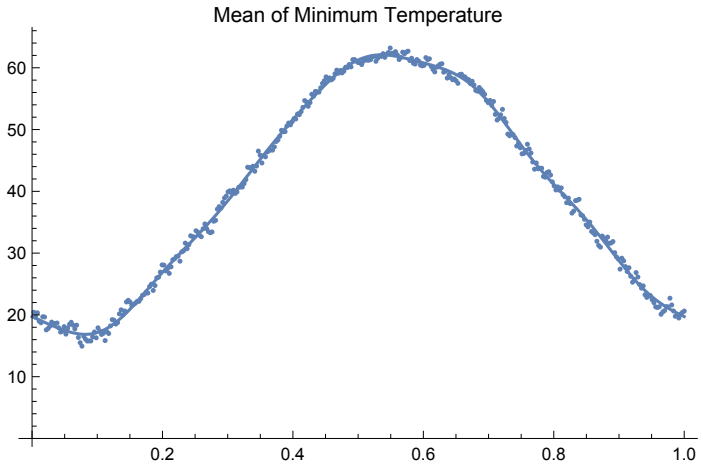
Out[299]= 0.99765

Out[300]=

	DF	SS	MS	F-Statistic	P-Value
Cos[2 πx]	1	77689.3	77689.3	133618.	0.
Sin[2 πx]	1	12281.	12281.	21122.	5.33729×10^{-317}
Sin[4 πx]	1	11.5158	11.5158	19.806	0.0000115082
Cos[4 πx]	1	0.545206	0.545206	0.9377	0.333533
Sin[6 πx]	1	29.7094	29.7094	51.0973	5.08377×10^{-12}
Cos[6 πx]	1	5.56934	5.56934	9.5787	0.0021257
Sin[8 πx]	1	21.2624	21.2624	36.5693	3.75333×10^{-9}
Cos[8 πx]	1	8.41129	8.41129	14.4666	0.000168081
Sin[10 πx]	1	17.2829	17.2829	29.7249	9.37297×10^{-8}
Cos[10 πx]	1	0.0322077	0.0322077	0.055394	0.814066
Sin[12 πx]	1	14.8144	14.8144	25.4792	7.17683×10^{-7}
Cos[12 πx]	1	17.9843	17.9843	30.9312	5.28681×10^{-8}
Error	353	205.244	0.581429		
Total	365	90302.6			

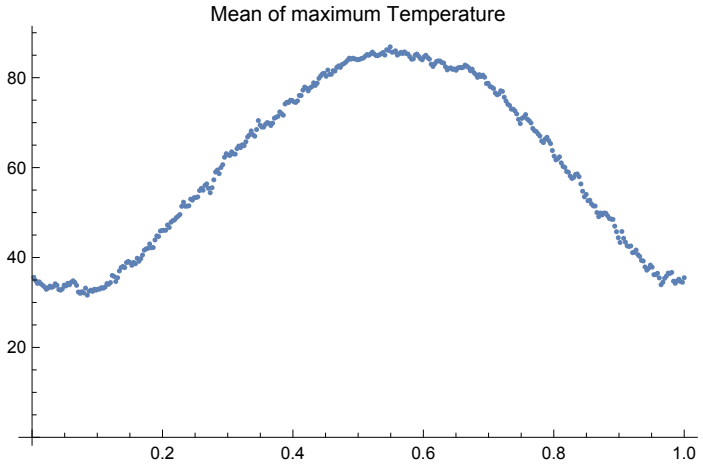
Out[301]= {{39.939, 40.0958}, {-20.715, -20.4933},
{-8.30287, -8.08115}, {-0.361711, -0.139997}, {-0.16544, 0.0562742},
{-0.513779, -0.292066}, {-0.285309, -0.0635953},
{-0.451721, -0.230007}, {0.103534, 0.325247}, {0.196458, 0.418171},
{-0.0975904, 0.124123}, {0.173665, 0.395379}, {0.202631, 0.424345}}

Out[302]=



In[303]:=
```
data = Transpose[{xs, maxmeans}];
dtrplot = ListPlot[data, PlotLabel → "Mean of maximum Temperature"]
regmaxmeans = LinearModelFit[data, {
    Cos[2 Pi x], Sin[2 Pi x],
    Sin[4 Pi x], Cos[4 Pi x],
    Sin[6 Pi x], Cos[6 Pi x],
    Sin[8 Pi x], Cos[8 Pi x],
    Sin[10 Pi x], Cos[10 Pi x],
    Sin[12 Pi x], Cos[12 Pi x]
  }
  , x]
regmaxmeans["ParameterTable"]
regmaxmeans["RSquared"]
regmaxmeans["AdjustedRSquared"]
regmaxmeans["ANOVATable"]
regmaxmeans["ParameterConfidenceIntervals"]
maxmeansWmodel = Show[dtrplot, Plot[regmaxmeans[x], {x, 0, xs[[Length[xs]]]}]]
```

Out[304]=



Out[305]= FittedModel[≪16≫ + 0.231796 Sin[10 πx] + 0.300352 Sin[12 πx]]

Out[306]=

	Estimate	Standard Error	t-Statistic	P-Value
1	60.5631	0.0408167	1483.78	0.
Cos[2 πx]	−25.0046	0.0577236	−433.177	0.
Sin[2 πx]	−9.03313	0.0577236	−156.489	0.
Sin[4 πx]	−0.431461	0.0577236	−7.4746	6.16648×10^{-13}
Cos[4 πx]	−1.80019	0.0577236	−31.1864	1.8691×10^{-103}
Sin[6 πx]	0.166189	0.0577236	2.87904	0.00423201
Cos[6 πx]	0.0170479	0.0577236	0.295338	0.76791
Sin[8 πx]	0.158998	0.0577236	2.75447	0.00618327
Cos[8 πx]	0.496052	0.0577236	8.59357	2.76562×10^{-16}
Sin[10 πx]	0.231796	0.0577236	4.01563	0.0000724578
Cos[10 πx]	−0.087846	0.0577236	−1.52184	0.128945
Sin[12 πx]	0.300352	0.0577236	5.20327	3.32808×10^{-7}
Cos[12 πx]	0.313793	0.0577236	5.43613	1.0179×10^{-7}

Out[307]= 0.998348

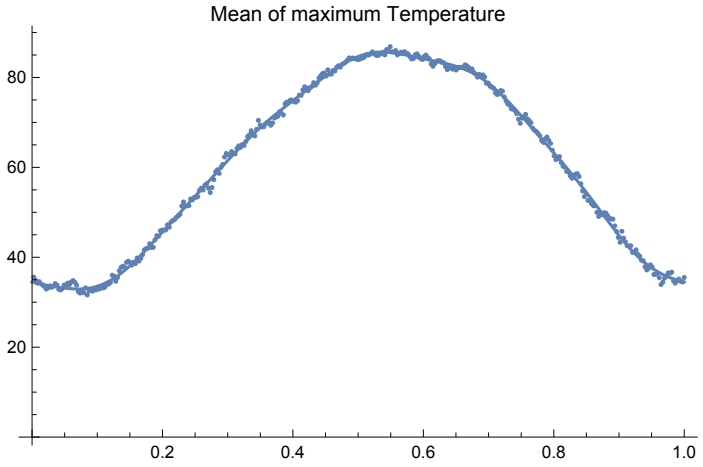
Out[308]= 0.998292

Out[309]=

	DF	SS	MS	F-Statistic	P-Value
Cos[2 πx]	1	114417.	114417.	187643.	0.
Sin[2 πx]	1	14932.3	14932.3	24488.9	0.
Sin[4 πx]	1	34.067	34.067	55.8697	6.16648×10^{-13}
Cos[4 πx]	1	593.044	593.044	972.589	1.8691×10^{-103}
Sin[6 πx]	1	5.05421	5.05421	8.28888	0.00423201
Cos[6 πx]	1	0.0531858	0.0531858	0.0872243	0.76791
Sin[8 πx]	1	4.62629	4.62629	7.58709	0.00618327
Cos[8 πx]	1	45.0303	45.0303	73.8494	2.76562×10^{-16}
Sin[10 πx]	1	9.83251	9.83251	16.1253	0.0000724578
Cos[10 πx]	1	1.4122	1.4122	2.31599	0.128945
Sin[12 πx]	1	16.5086	16.5086	27.074	3.32808×10^{-7}
Cos[12 πx]	1	18.0193	18.0193	29.5515	1.0179×10^{-7}
Error	353	215.245	0.609759		
Total	365	130292.			

Out[310]= {{60.4828, 60.6434}, {-25.1181, -24.891},
{-9.14666, -8.91961}, {-0.544986, -0.317935}, {-1.91371, -1.68666},
{0.0526632, 0.279714}, {-0.0964775, 0.130573},
{0.0454724, 0.272523}, {0.382526, 0.609577}, {0.118271, 0.345322},
{-0.201371, 0.0256794}, {0.186826, 0.413877}, {0.200268, 0.427318}}

Out[311]=



In[312]:= GraphicsGrid[{{minmeansWmodel, maxmeansWmodel}, {minsdsWmodel, maxsdsWmodel}}]

Out[312]=