

Hamilton Temp Analysis

Nick

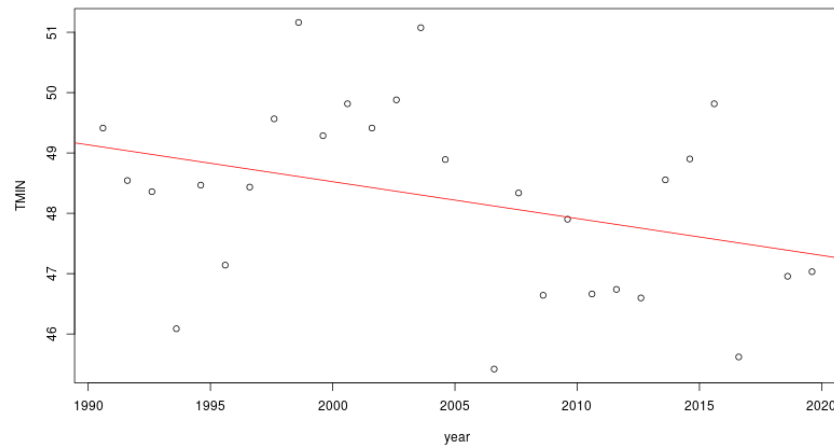
August 10, 2020

Contents

| | | |
|----------|-------------------------------------------------------------|----------|
| 1 | Summer trend in minimum temperature starting in 1990 | 1 |
| 2 | Summer trend in minimum temperature starting in 1980 | 3 |
| 3 | Summer trend in minimum temperature starting in 1950 | 4 |
| 4 | Summer trend in maximum temperature starting in 1950 | 5 |
| 5 | Winter trend in minimum temperature starting in 1950 | 6 |
| 6 | Winter trend in maximum temperature starting in 1950 | 7 |

1 Summer trend in minimum temperature starting in 1990

It is true that if we look at the Hamilton weather station data from 1990 to present that there is a decreasing trend in minimum temperature over that time period. This is the time period that Bruce originally used for his evaluation.



And the trend is fairly significant ($p = 0.07$). The summary statistics on that trend look like this:

```
summary(mod1)
```

Call:

```
lm(formula = paste(var.nm, " ~ year"), data = metv.season)
```

Residuals:

| | Min | 1Q | Median | 3Q | Max |
|--|---------|---------|---------|--------|--------|
| | -2.8268 | -1.0954 | -0.1639 | 0.9188 | 2.7730 |

Coefficients:

| | Estimate | Std. Error | t value | Pr(> t) |
|-------------|------------|------------|---------|------------|
| (Intercept) | 5.036e+01 | 1.159e+00 | 43.458 | <2e-16 *** |
| year | -1.672e-04 | 8.886e-05 | -1.882 | 0.0711 . |

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

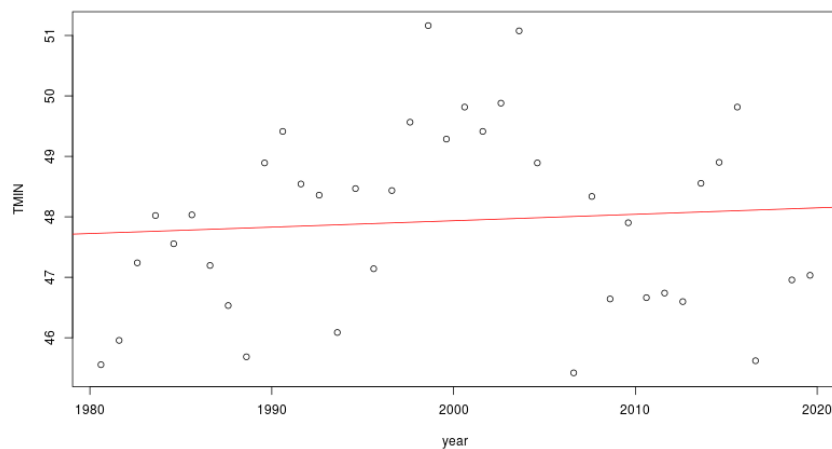
Residual standard error: 1.482 on 26 degrees of freedom

Multiple R-squared: 0.1199, Adjusted R-squared: 0.086

F-statistic: 3.541 on 1 and 26 DF, p-value: 0.07112

2 Summer trend in minimum temperature starting in 1980

However, if we just add 10-years to the data by going back to 1980, take a look at what happens to the trend.



In this case the trend is not significant, but is actually increasing:

```
summary(mod2)
```

Call:

```
lm(formula = paste(var.nm, " ~ year"), data = metv.season)
```

Residuals:

| | Min | 1Q | Median | 3Q | Max |
|--|---------|---------|--------|--------|--------|
| | -2.5871 | -1.3083 | 0.2544 | 1.0256 | 3.2416 |

Coefficients:

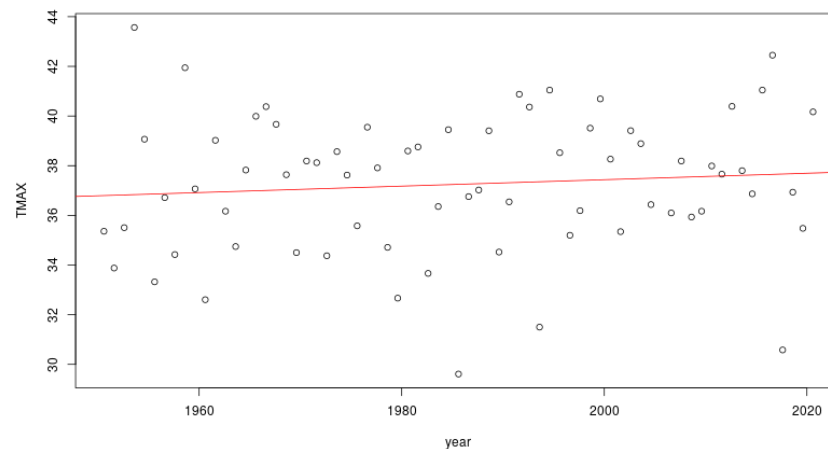
| | Estimate | Std. Error | t value | Pr(> t) |
|-------------|-----------|------------|---------|------------|
| (Intercept) | 4.762e+01 | 6.916e-01 | 68.847 | <2e-16 *** |
| year | 2.908e-05 | 5.984e-05 | 0.486 | 0.63 |

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.542 on 36 degrees of freedom
Multiple R-squared: 0.006515, Adjusted R-squared: -0.02108
F-statistic: 0.2361 on 1 and 36 DF, p-value: 0.63

3 Summer trend in minimum temperature starting in 1950

The standard time period for evaluating historical trends starts in 1950. If we use this as our starting point the trend looks very similar to the trend starting in 1980. Slightly increasing but statistically insignificant.



```
summary(mod3)
```

Call:

```
lm(formula = paste(var.nm, " ~ year"), data = metv.season)
```

Residuals:

| Min | 1Q | Median | 3Q | Max |
|----------|----------|----------|---------|---------|
| -2.59886 | -0.93249 | -0.04234 | 0.90798 | 3.15724 |

Coefficients:

| | Estimate | Std. Error | t value | Pr(> t) |
|-------------|-----------|------------|---------|------------|
| (Intercept) | 4.796e+01 | 2.036e-01 | 235.536 | <2e-16 *** |

```

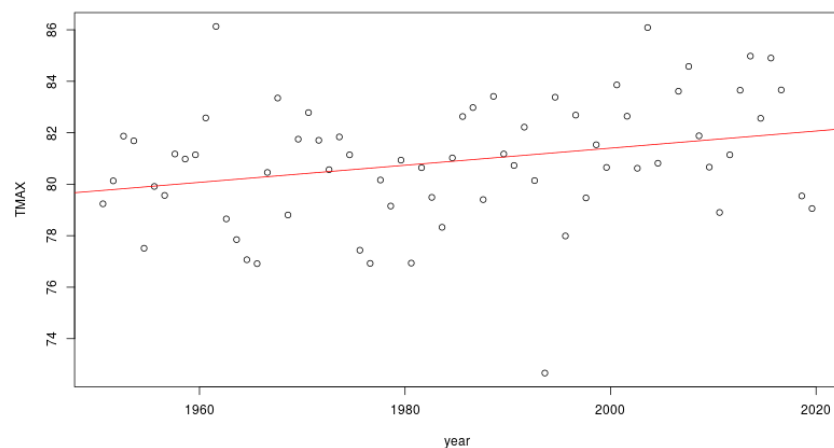
year          4.247e-06  2.270e-05  0.187    0.852
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.364 on 66 degrees of freedom
Multiple R-squared:  0.0005301, Adjusted R-squared:  -0.01461
F-statistic: 0.035 on 1 and 66 DF,  p-value: 0.8522

```

All other trends (seasons and variables) are increasing at the Hamilton station when you evaluate them from 1950. See below for figures and statistics.

4 Summer trend in maximum temperature starting in 1950



```
summary(mod4)
```

Call:

```
lm(formula = paste(var.nm, " ~ year"), data = metv.season)
```

Residuals:

| Min | 1Q | Median | 3Q | Max |
|---------|---------|--------|--------|--------|
| -8.5280 | -1.5163 | 0.1465 | 1.7059 | 6.0032 |

Coefficients:

| | Estimate | Std. Error | t value | Pr(> t) |
|-------------|-----------|------------|---------|------------|
| (Intercept) | 8.041e+01 | 3.506e-01 | 229.351 | <2e-16 *** |
| year | 9.101e-05 | 3.908e-05 | 2.329 | 0.0229 * |

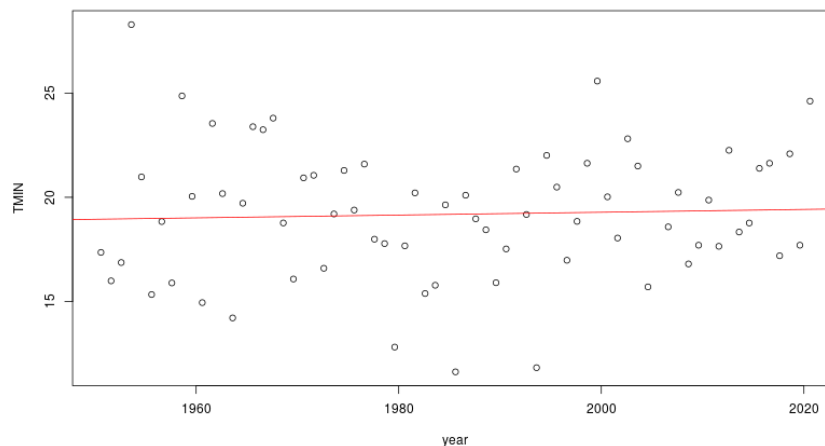
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 2.348 on 66 degrees of freedom

Multiple R-squared: 0.07593, Adjusted R-squared: 0.06193

F-statistic: 5.423 on 1 and 66 DF, p-value: 0.02294

5 Winter trend in minimum temperature starting in 1950



```
summary(mod5)
```

Call:

```
lm(formula = paste(var.nm, " ~ year"), data = metv.season)
```

Residuals:

| Min | 1Q | Median | 3Q | Max |
|---------|---------|---------|--------|--------|
| -7.5648 | -2.0013 | -0.1073 | 2.0961 | 9.3177 |

Coefficients:

| | Estimate | Std. Error | t value | Pr(> t) |
|-------------|-----------|------------|---------|------------|
| (Intercept) | 1.908e+01 | 4.756e-01 | 40.124 | <2e-16 *** |
| year | 1.846e-05 | 5.088e-05 | 0.363 | 0.718 |

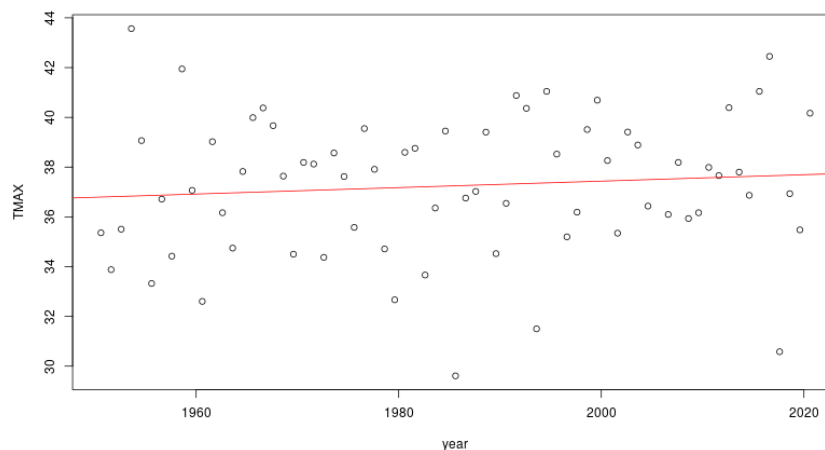
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 3.187 on 68 degrees of freedom

Multiple R-squared: 0.001932, Adjusted R-squared: -0.01275

F-statistic: 0.1316 on 1 and 68 DF, p-value: 0.7179

6 Winter trend in maximum temperature starting in 1950



```
summary(mod6)
```

Call:

```
lm(formula = paste(var.nm, " ~ year"), data = metv.season)
```

Residuals:

| Min | 1Q | Median | 3Q | Max |
|---------|---------|--------|--------|--------|
| -7.6401 | -1.5973 | 0.1692 | 2.0891 | 6.7300 |

Coefficients:

| | Estimate | Std. Error | t value | Pr(> t) |
|-------------|-----------|------------|---------|------------|
| (Intercept) | 3.705e+01 | 4.156e-01 | 89.136 | <2e-16 *** |
| year | 3.547e-05 | 4.447e-05 | 0.798 | 0.428 |

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 2.786 on 68 degrees of freedom

Multiple R-squared: 0.009269, Adjusted R-squared: -0.0053

F-statistic: 0.6362 on 1 and 68 DF, p-value: 0.4279