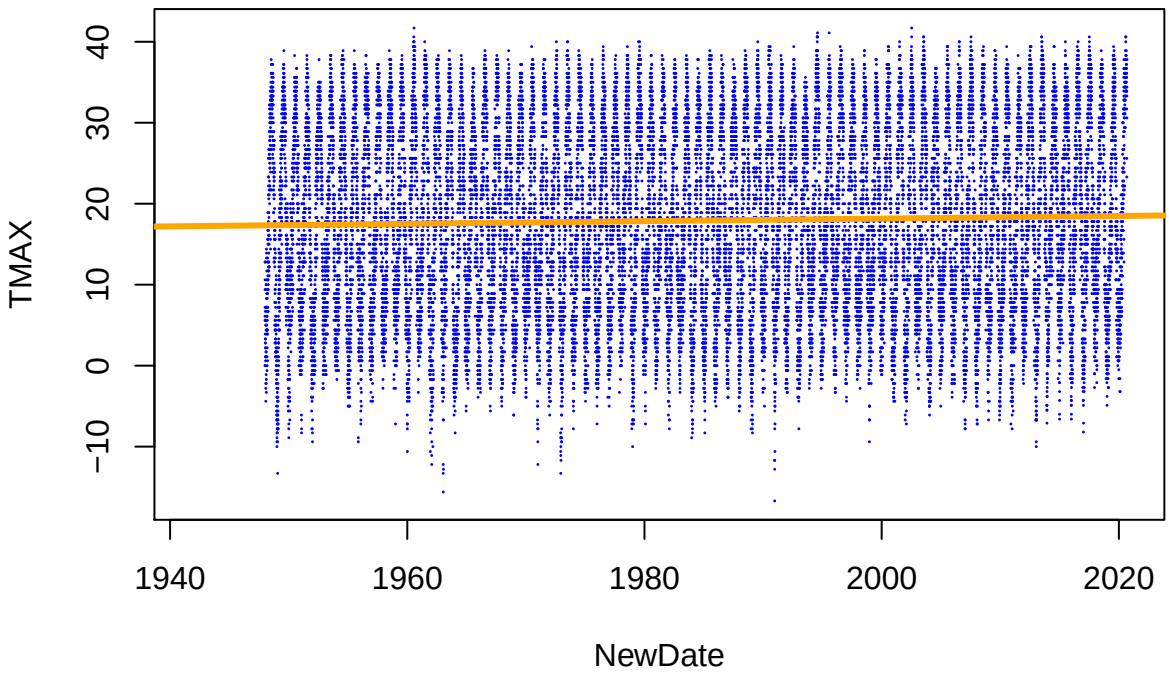
Bryan R Markdown

```
filepath = "/home/CAMPUS/mwl04747/github/Climate_Change_Narratives/Data/FA20/Williams_SaltLakeCityUT_da
# filepath = "/home/CAMPUS/bawa2018/Climate_Change_Narratives/Data/FA20/Williams_SaltLakeCityUT_data.cs
climate_data = read.csv(filepath)
strDates <- as.character(climate_data$DATE)
climate_data$NewDate <- as.Date(strDates, "%Y-%m-%d")
```

```
plot(TMAX~NewDate, climate_data, pch = 16, cex=.2, col = "blue")
TMAX.lm = lm(TMAX ~ NewDate, data = climate_data)
coef(TMAX.lm)
```

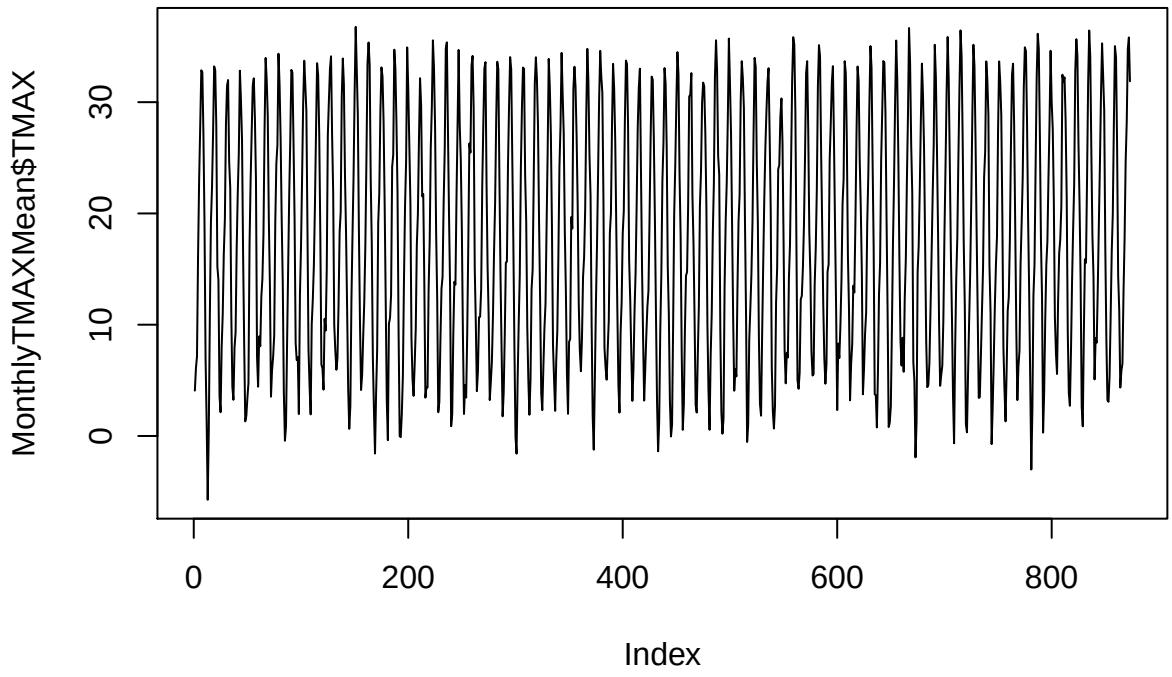
```
##  (Intercept)      NewDate
## 1.768352e+01 4.390910e-05
```

```
abline(coef(TMAX.lm),col ="orange", lwd = 3)
```




```
climate_data$Month = format(as.Date(climate_data$NewDate), format = "%m")
climate_data$Year = format(climate_data$NewDate, format="%Y")
MonthlyTMAXMean = aggregate(TMAX ~ Month + Year, climate_data, mean)
MonthlyTMAXMean$YEAR = as.numeric(MonthlyTMAXMean$Year)
MonthlyTMAXMean$MONTH = as.numeric(MonthlyTMAXMean$Month)
```

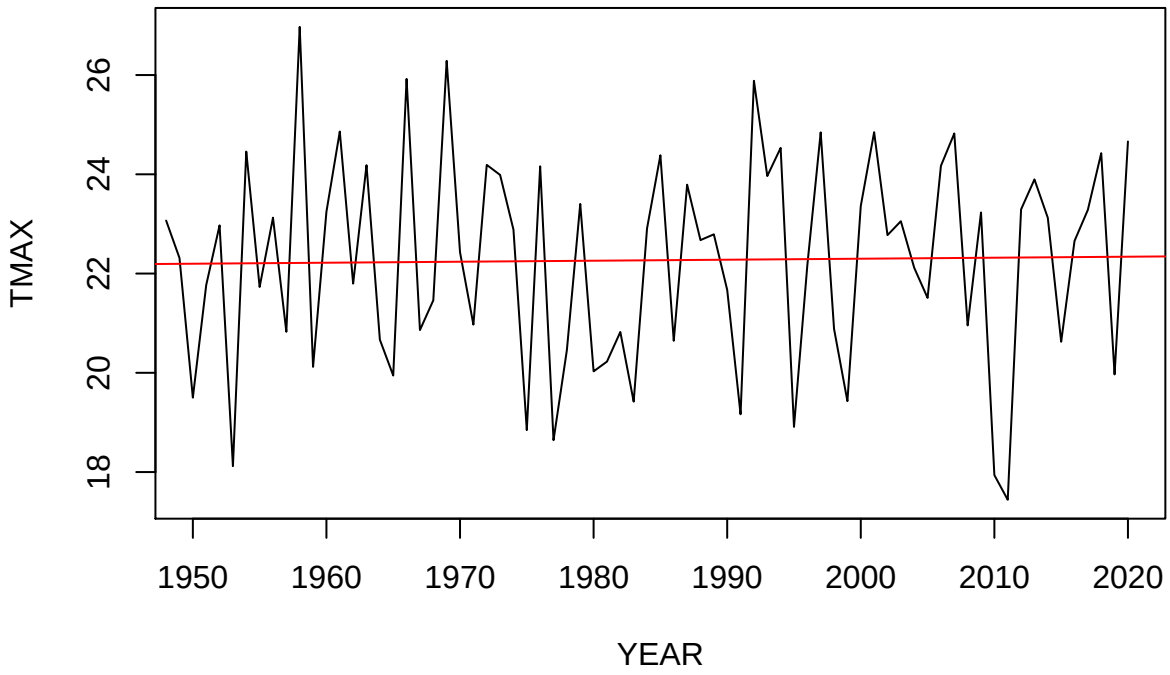
```r
plot(MonthlyTMAXMean$TMAX, ty='l')
```




```r
#plot(MonthlyTMAXMean£TMAX[MonthlyTMAXMean£Month=="05"], ty='l')
plot(TMAX~YEAR, data=MonthlyTMAXMean[MonthlyTMAXMean$Month=="05",],ty='l', xlim=c(1950, 2020))
May.lm <- lm(TMAX~YEAR, data=MonthlyTMAXMean[MonthlyTMAXMean$Month=="05",])
summary(May.lm)
```

```
##
## Call:
## lm(formula = TMAX ~ YEAR, data = MonthlyTMAXMean[MonthlyTMAXMean$Month ==
##     "05", ])
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -4.8792 -1.5588  0.3994  1.6796  4.7565
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) 18.275162  23.794808   0.768    0.445
## YEAR         0.002012   0.011993   0.168    0.867
##
## Residual standard error: 2.159 on 71 degrees of freedom
## Multiple R-squared:  0.0003962,  Adjusted R-squared:  -0.01368
## F-statistic: 0.02814 on 1 and 71 DF,  p-value: 0.8672
```

```
abline(coef(May.lm), col="red")
```

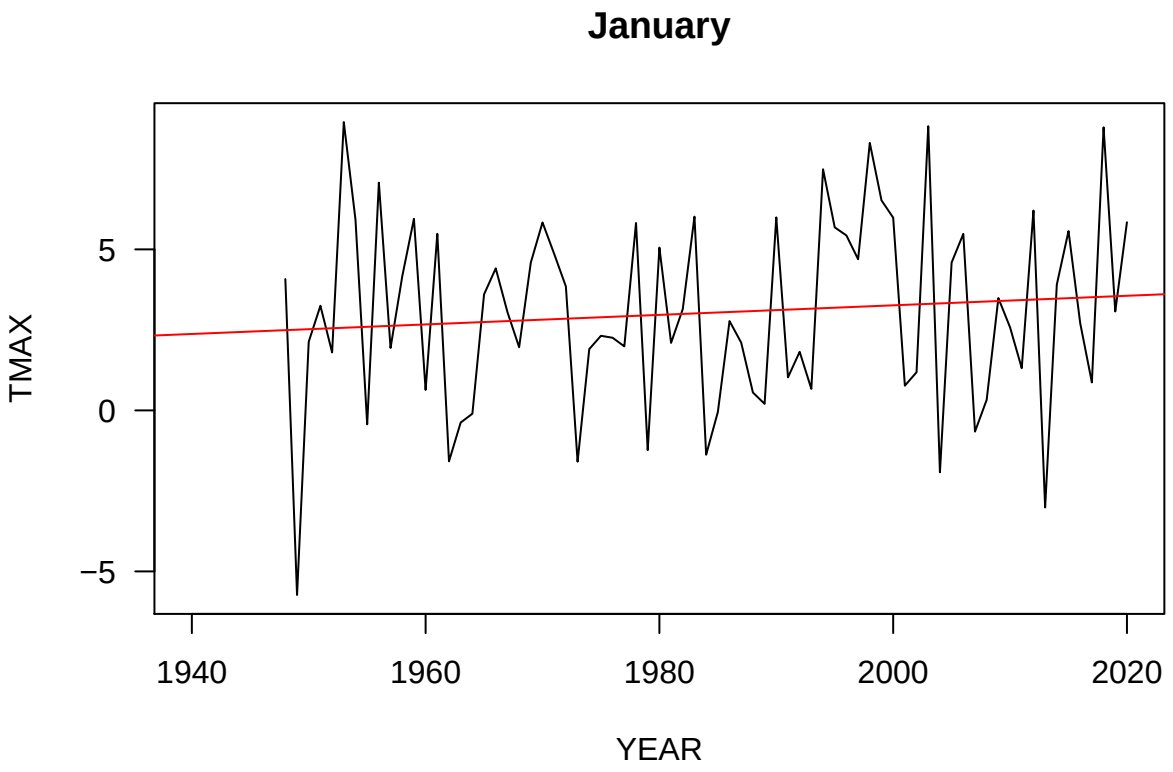


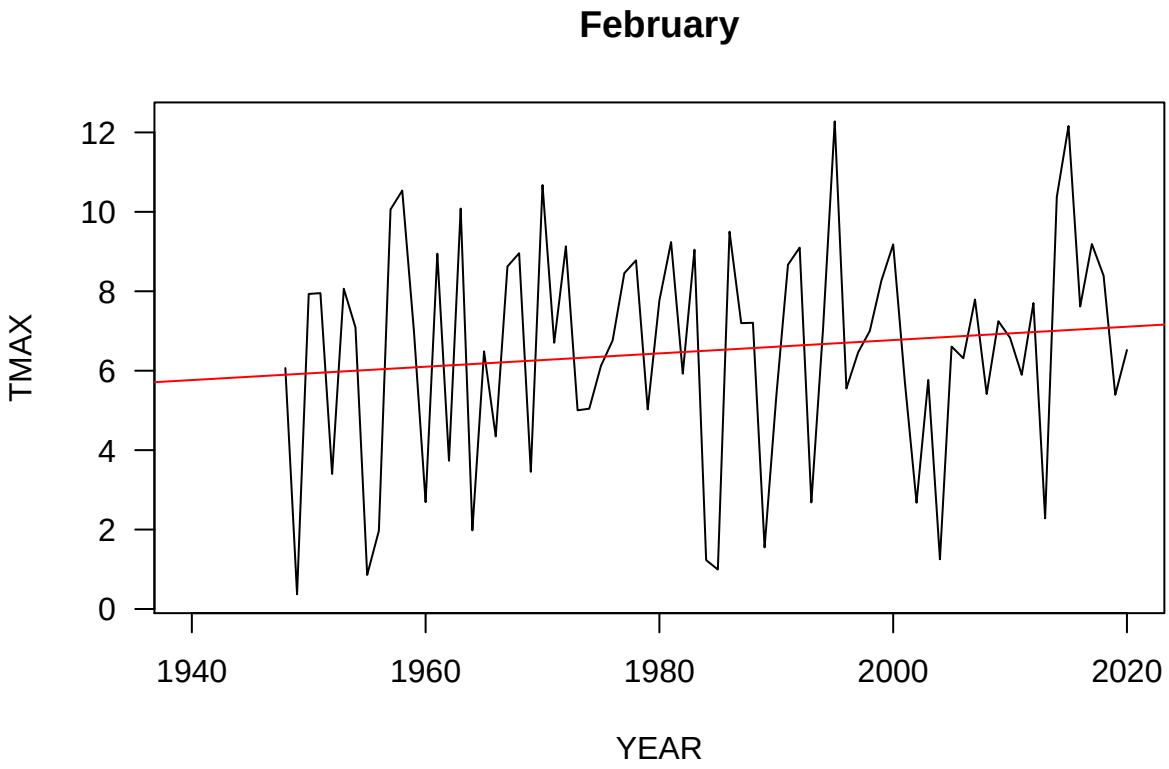

```
MonthlyTMINMean = aggregate(TMIN ~ Month + Year, climate_data, mean)
MonthlyTMINMean$YEAR = as.numeric(MonthlyTMINMean$Year)
# Fixing the Format of Month and Year as numeric
MonthlyTMINMean$YEAR = as.numeric(MonthlyTMINMean$Year)
MonthlyTMINMean$MONTH = as.numeric(MonthlyTMINMean$Month)
head(MonthlyTMINMean)
```

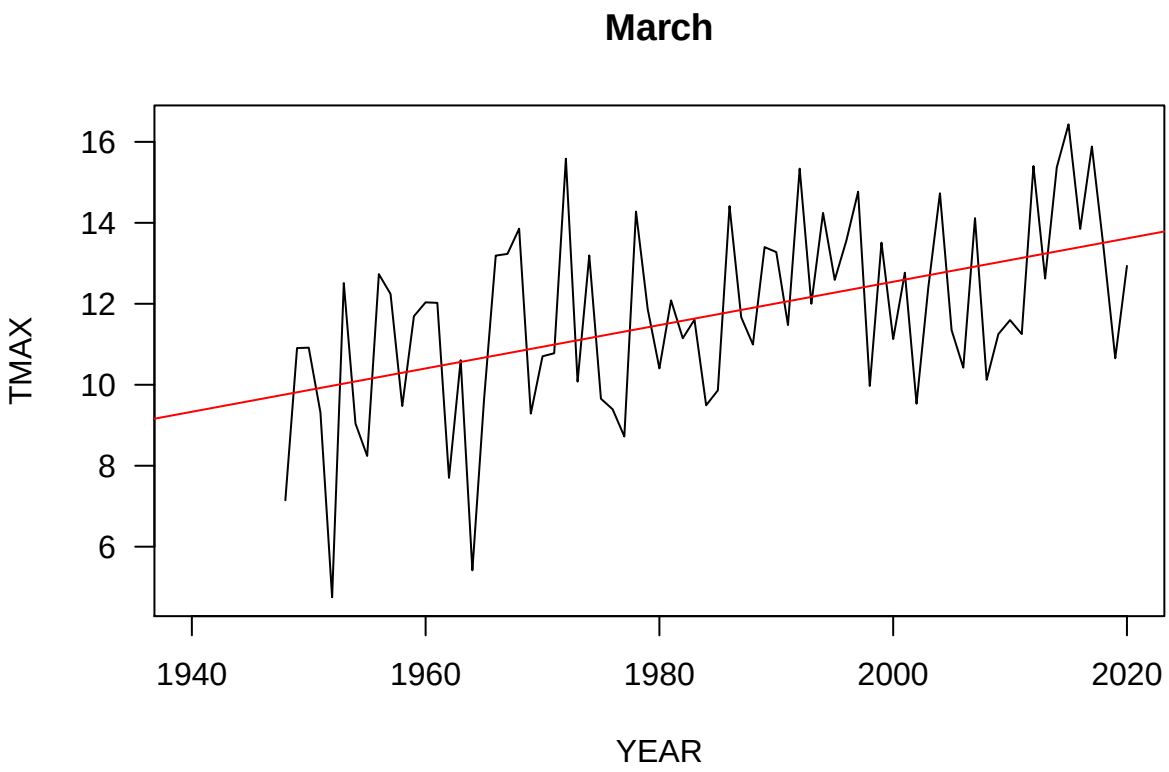
```
##   Month Year      TMIN YEAR MONTH
## 1    01 1948 -6.183871 1948     1
## 2    02 1948 -4.727586 1948     2
## 3    03 1948 -3.093548 1948     3
## 4    04 1948  3.580000 1948     4
## 5    05 1948  6.990323 1948     5
## 6    06 1948 12.203333 1948     6
```

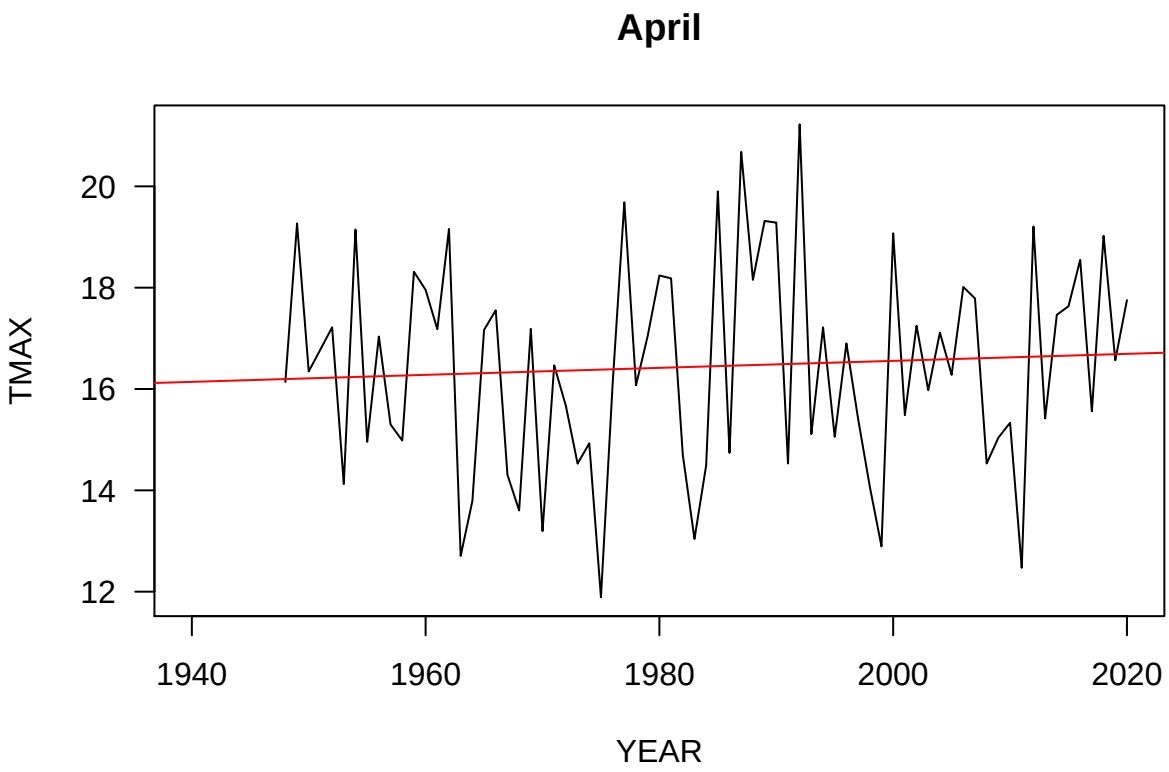
```
# First I create a vector of months
Months = c("January", "February", "March", "April",
"May", "June", "July", "August", "September", "October",
"November", "December")
# Create a panel so I can see all the figures at
# once.
par(mfrow = c(4, 3), mar = c(5, 4, 3, 2) + 0.1)
TMAXresult <-NA; TMINresult <- NA
```

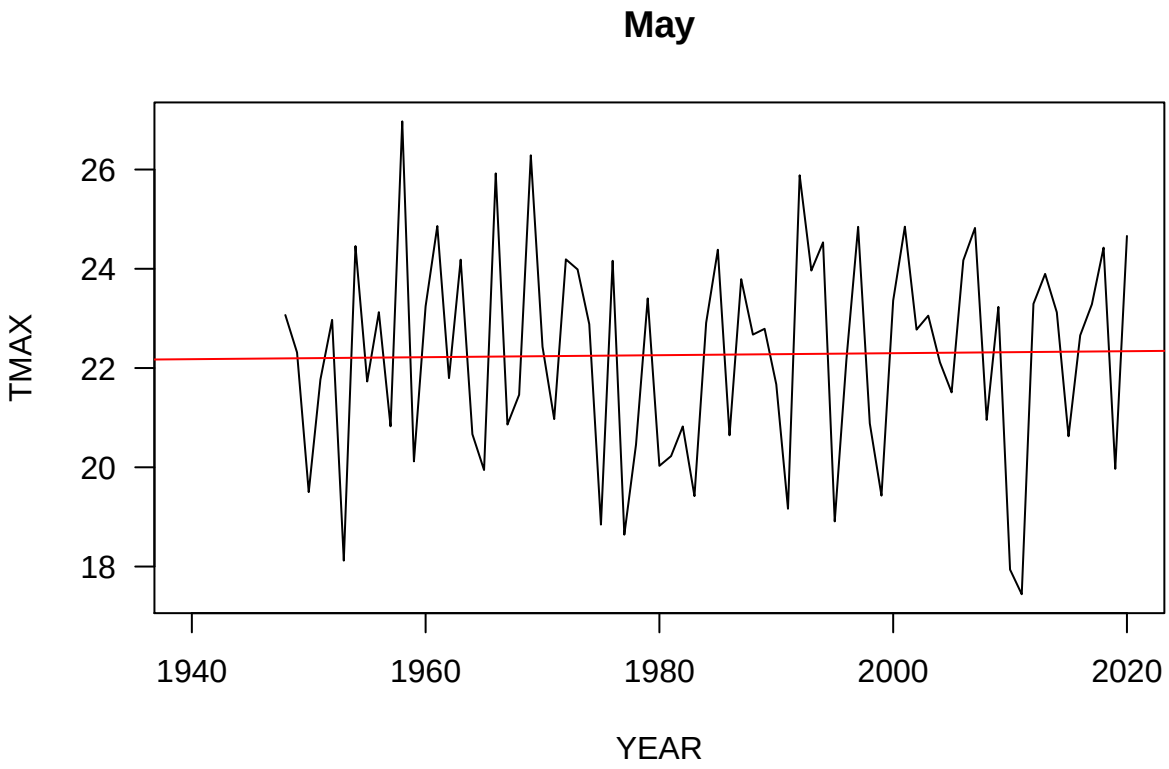
```r
for (i in 1:12) {
    # plot(MonthlyTMAXMean£TMAX[MonthlyTMAXMean£Month==i],
    # ty='l')
    plot(TMAX ~ YEAR, data = MonthlyTMAXMean[MonthlyTMAXMean$MONTH == i, ], ty = "l", las = 1, xlim = c
  Month.lm <- lm(TMAX ~ YEAR, data = MonthlyTMAXMean[MonthlyTMAXMean$MONTH == i, ])
  summary(Month.lm)
  abline(coef(Month.lm), col = "red")
  TMAXresult <- rbind(TMAXresult, cbind(Months[i],
  round(coef(Month.lm)[2], 4), round(summary(Month.lm)$coefficients[2, 4], 4), round(summary(Month.lm)$
  }
```

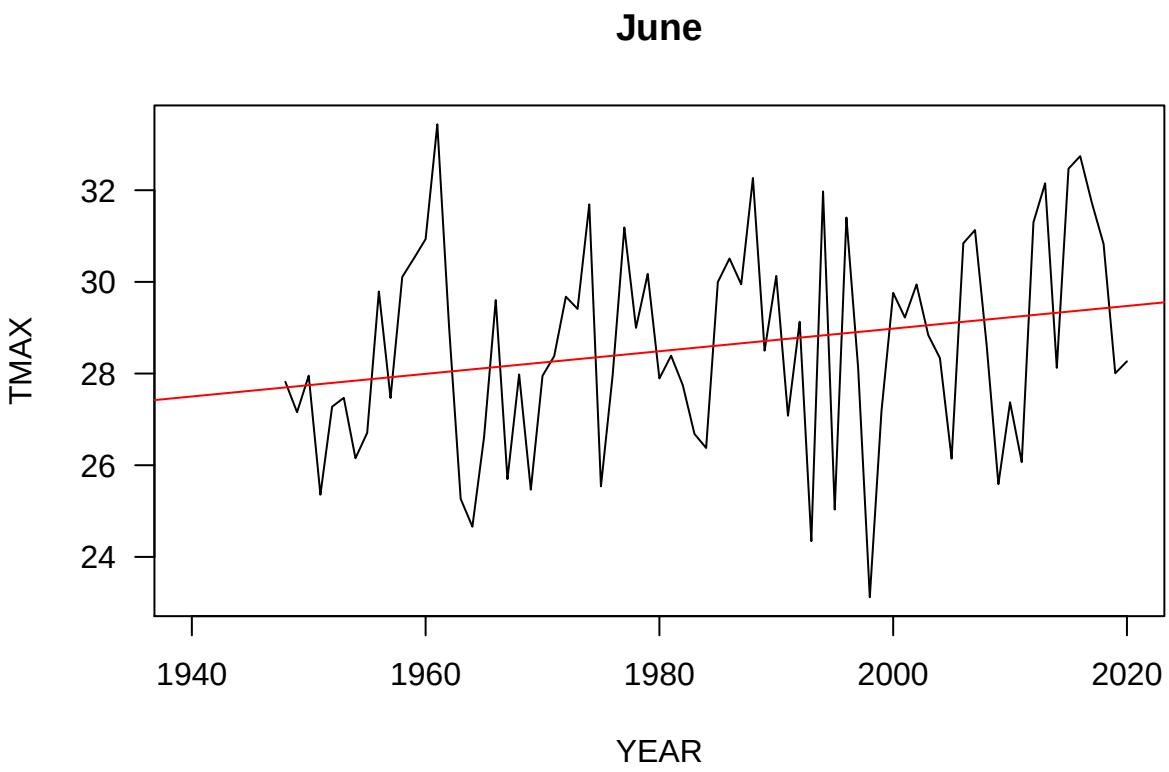


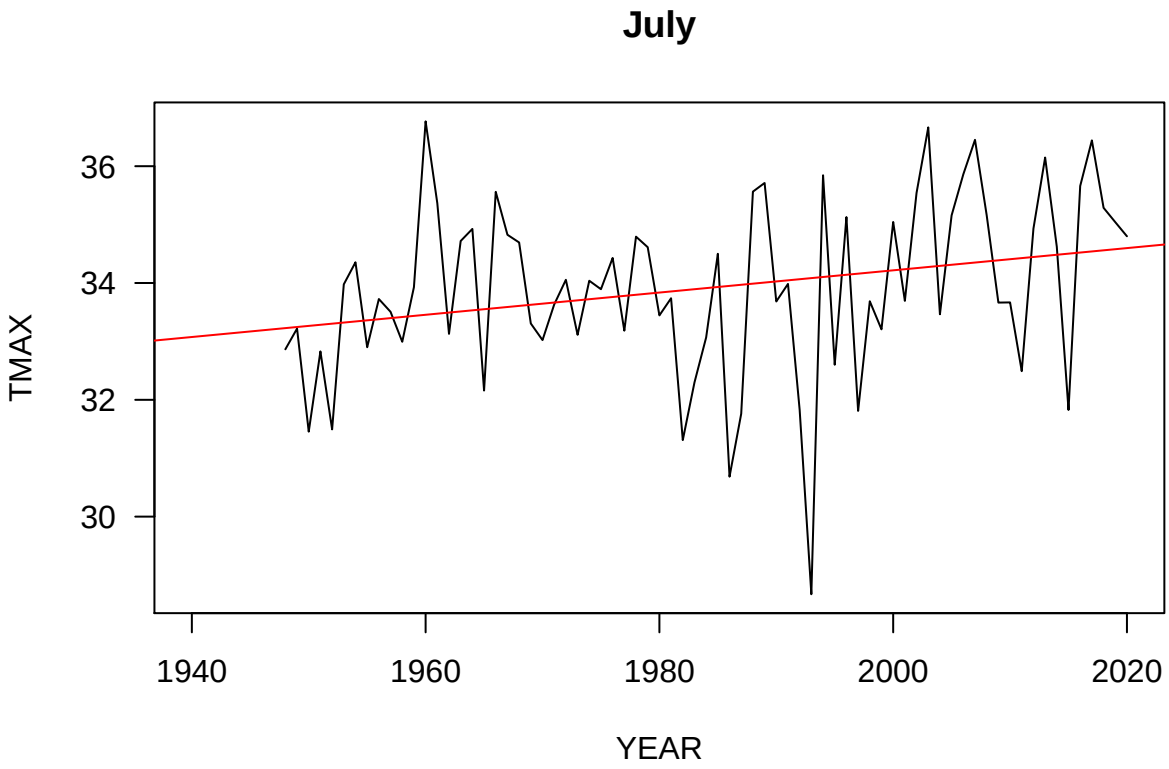

February
TMAX
YEAR
0
2
4
6
8
10
12
1940
1960
1980
2000
2020

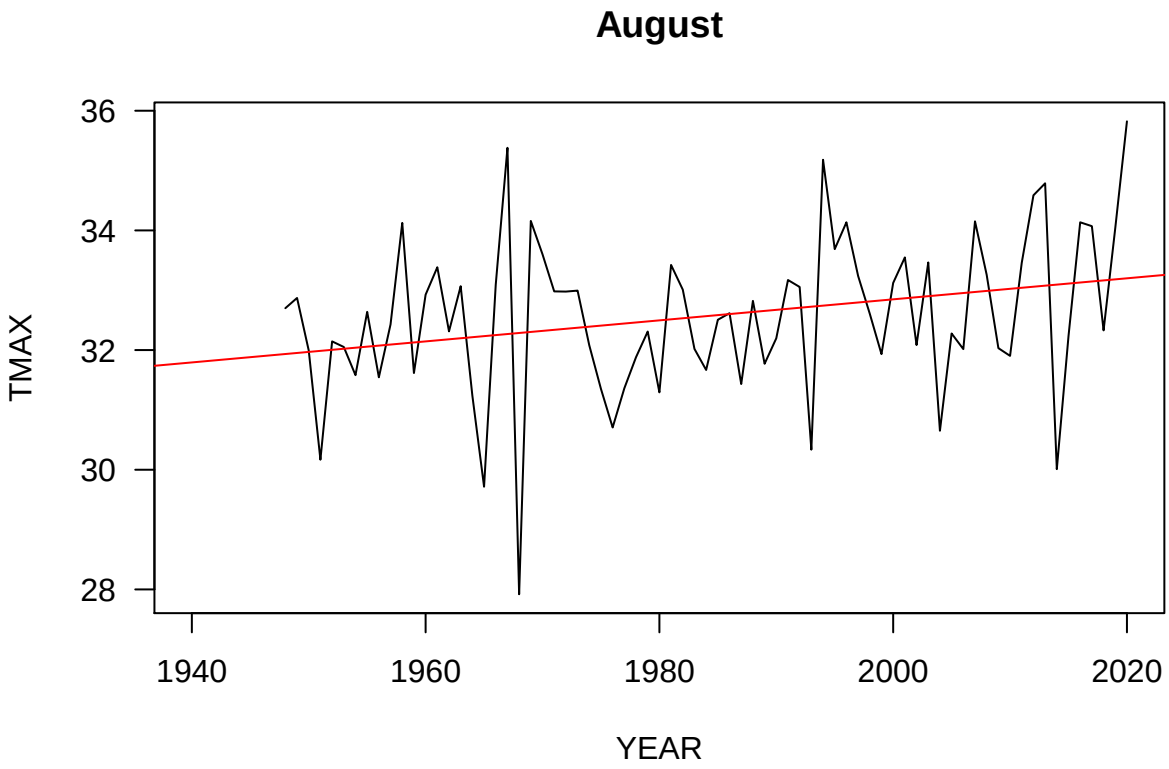

March
TMAX
16
14
12
10
8
6
1940
1960
1980
2000
2020
YEAR

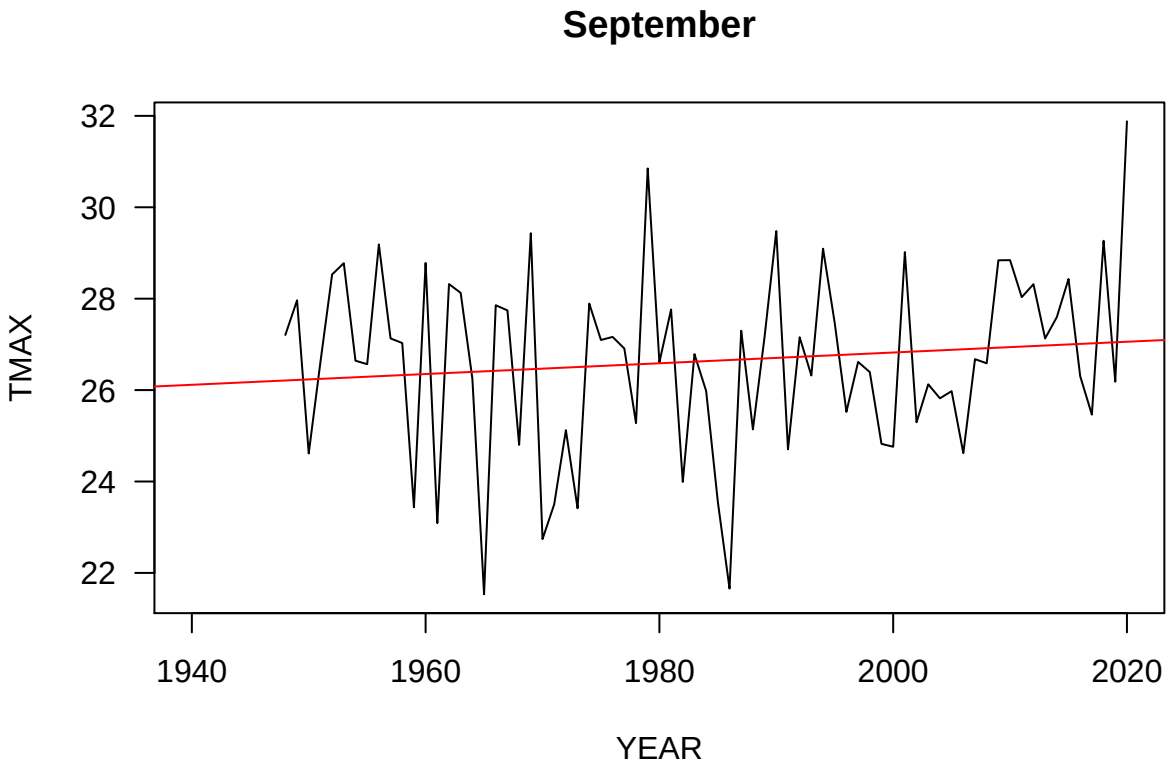

April
TMAX
20
18
16
14
12
1940
1960
1980
2000
2020
YEAR

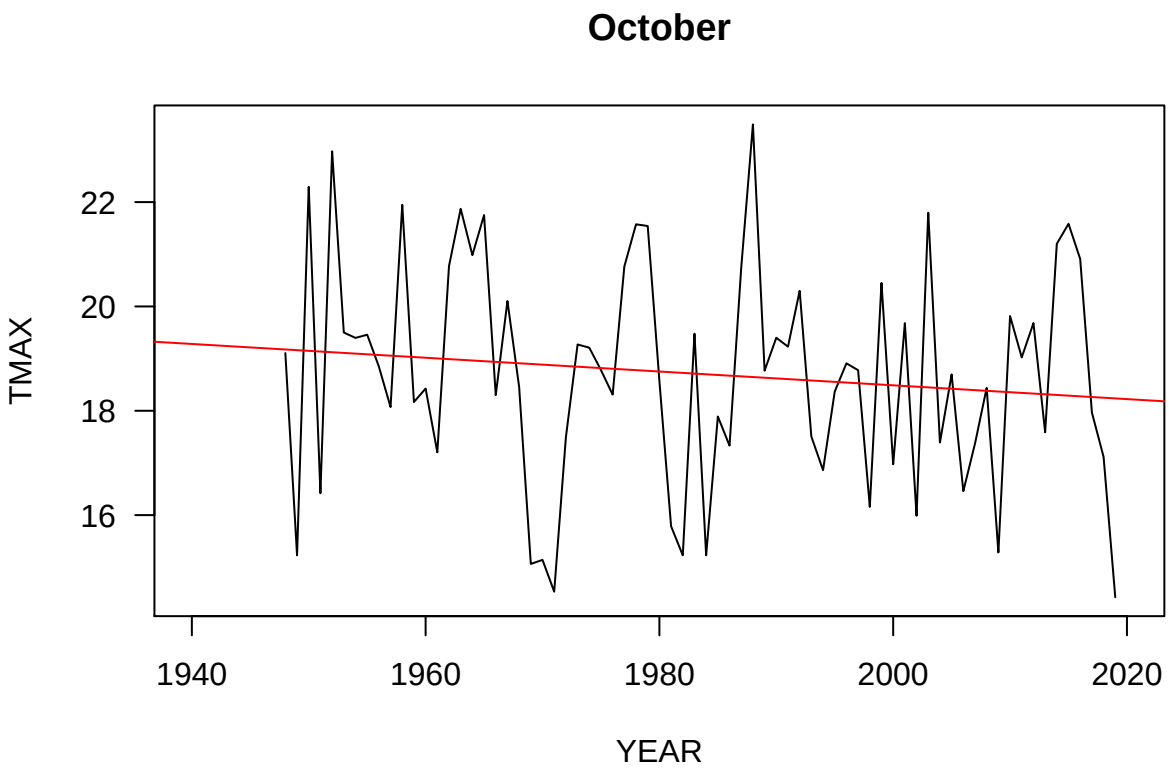

May
TMAX
26
24
22
20
18
1940
1960
1980
2000
2020
YEAR

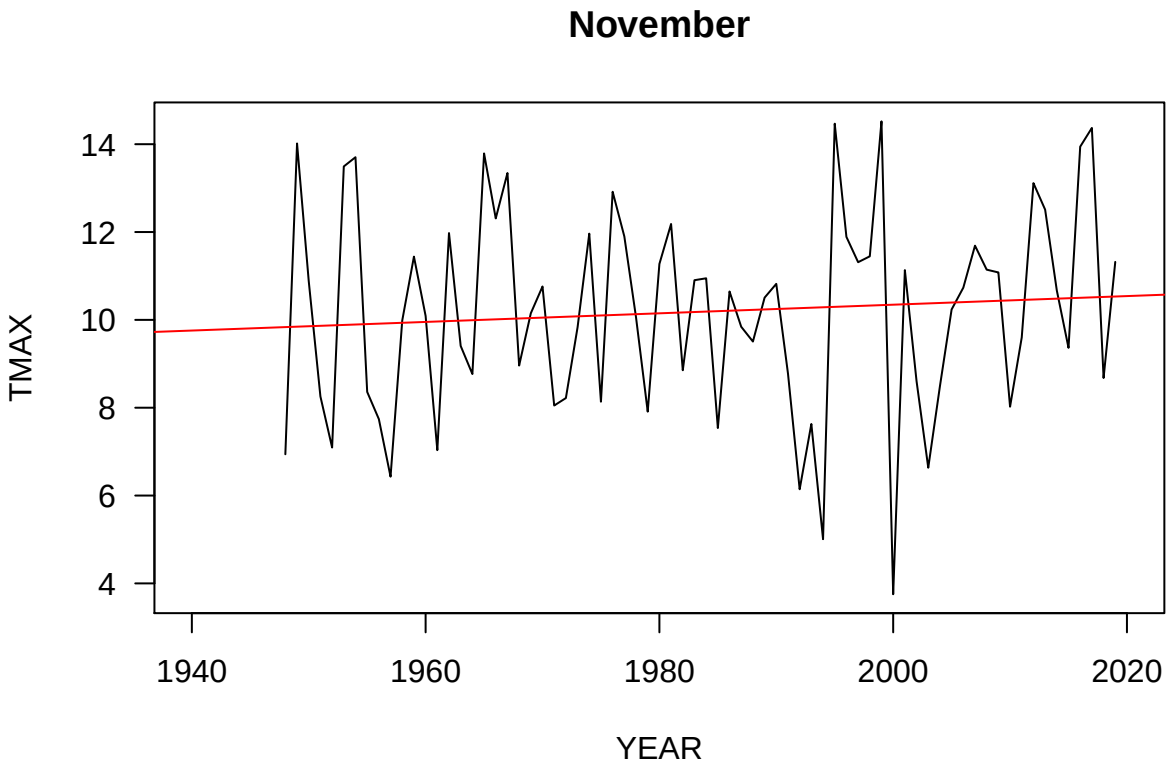

June
TMAX
32
30
28
26
24
1940
1960
1980
2000
2020
YEAR

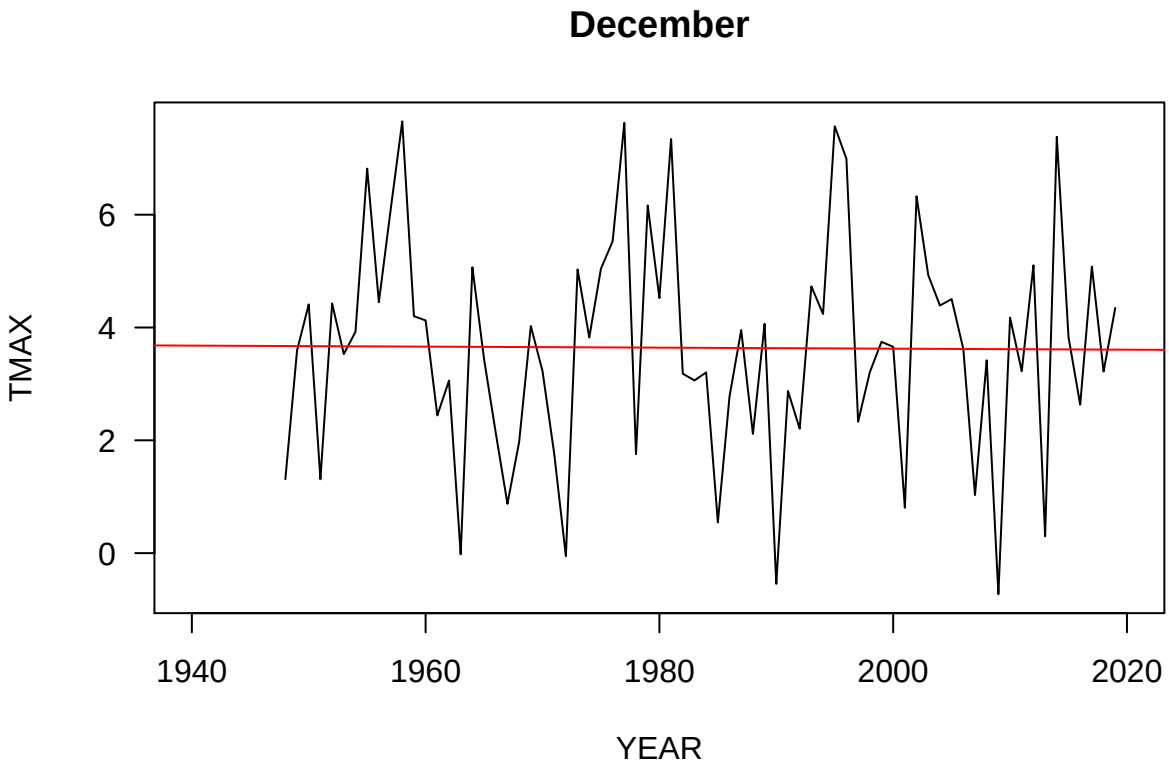

July
TMAX
36
34
32
30
1940
1960
1980
2000
2020
YEAR


August
36
34
32
30
28
TMAX
1940
1960
1980
2000
2020
YEAR

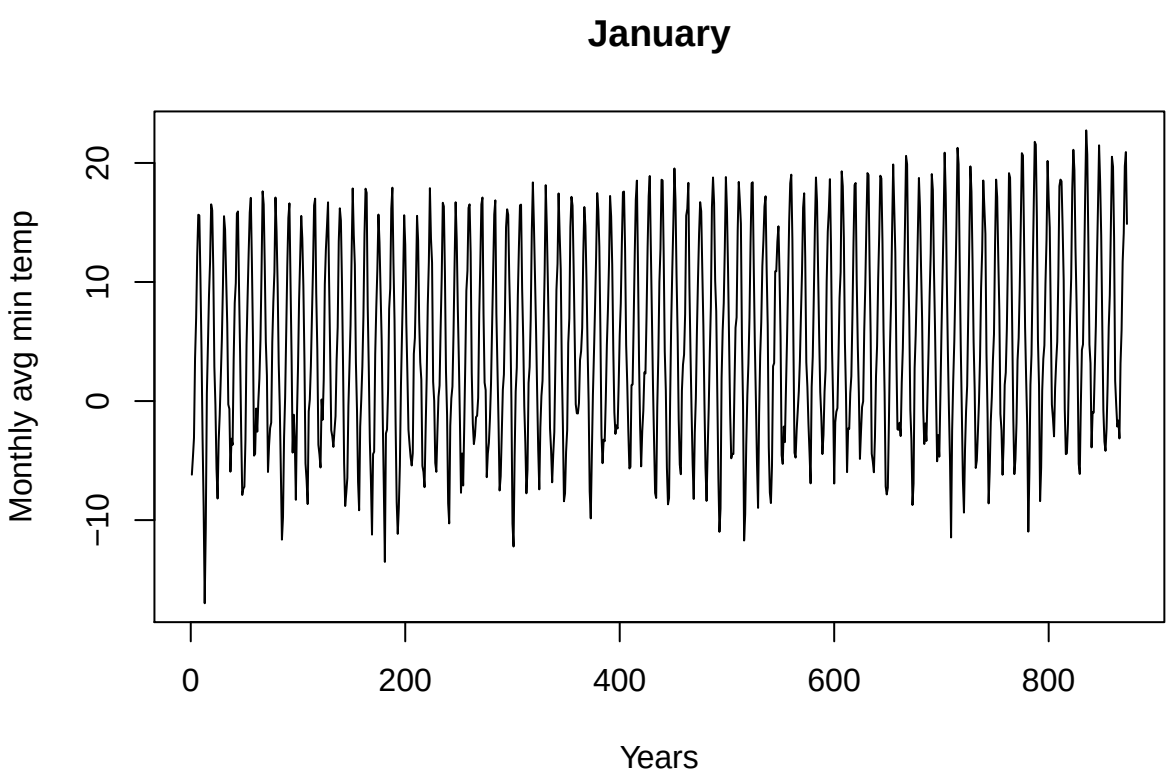

September
TMAX
32
30
28
26
24
22
1940
1960
1980
2000
2020
YEAR

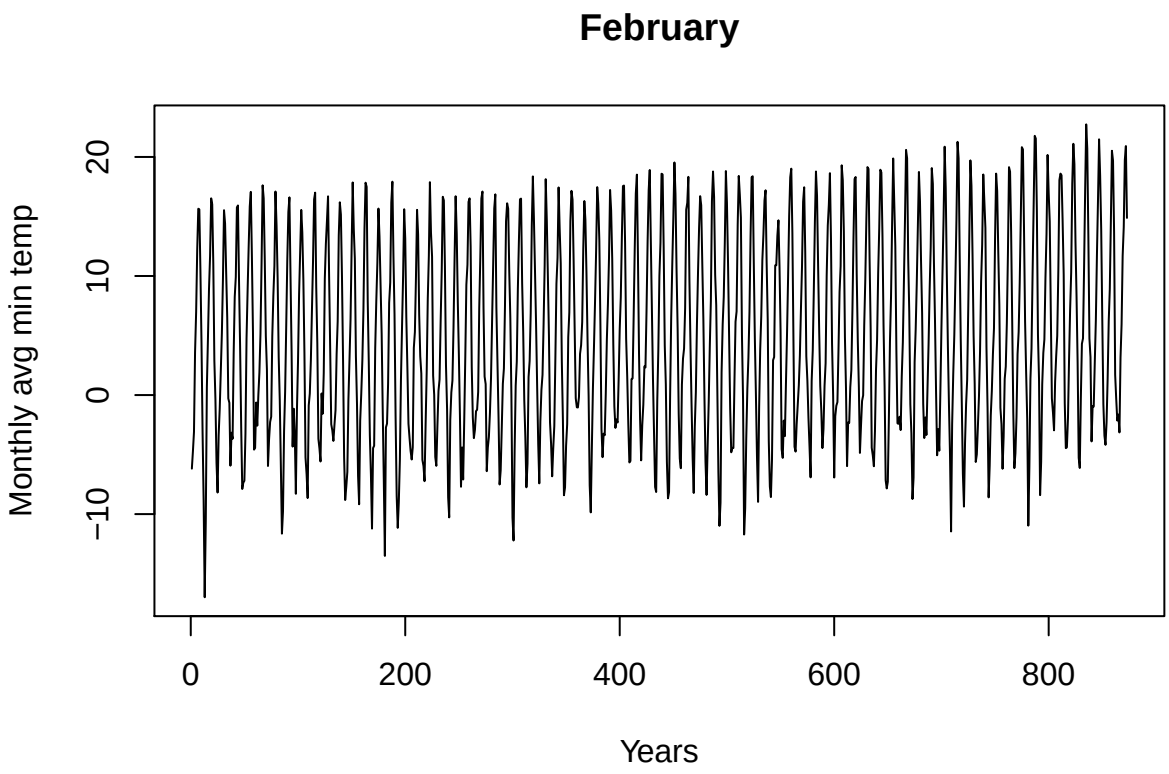

October
TMAX
22
20
18
16
1940
1960
1980
2000
2020
YEAR

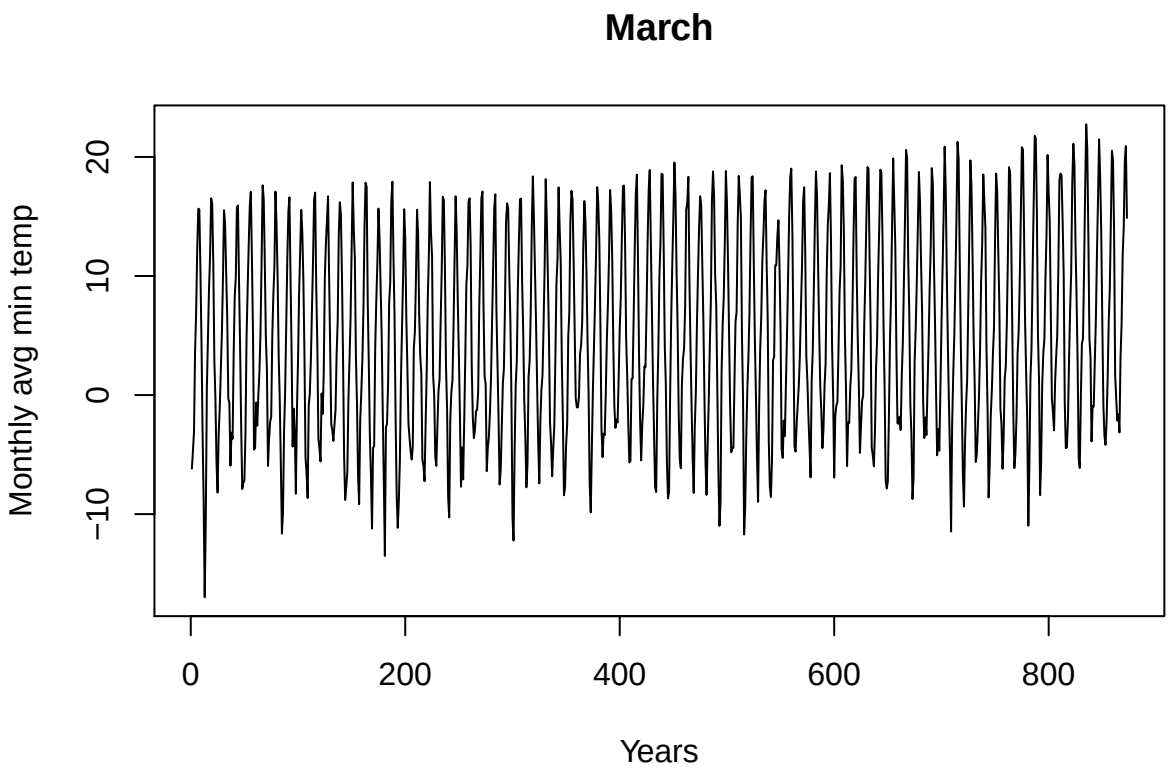

November
TMAX
14
12
10
8
6
4
1940
1960
1980
2000
2020
YEAR

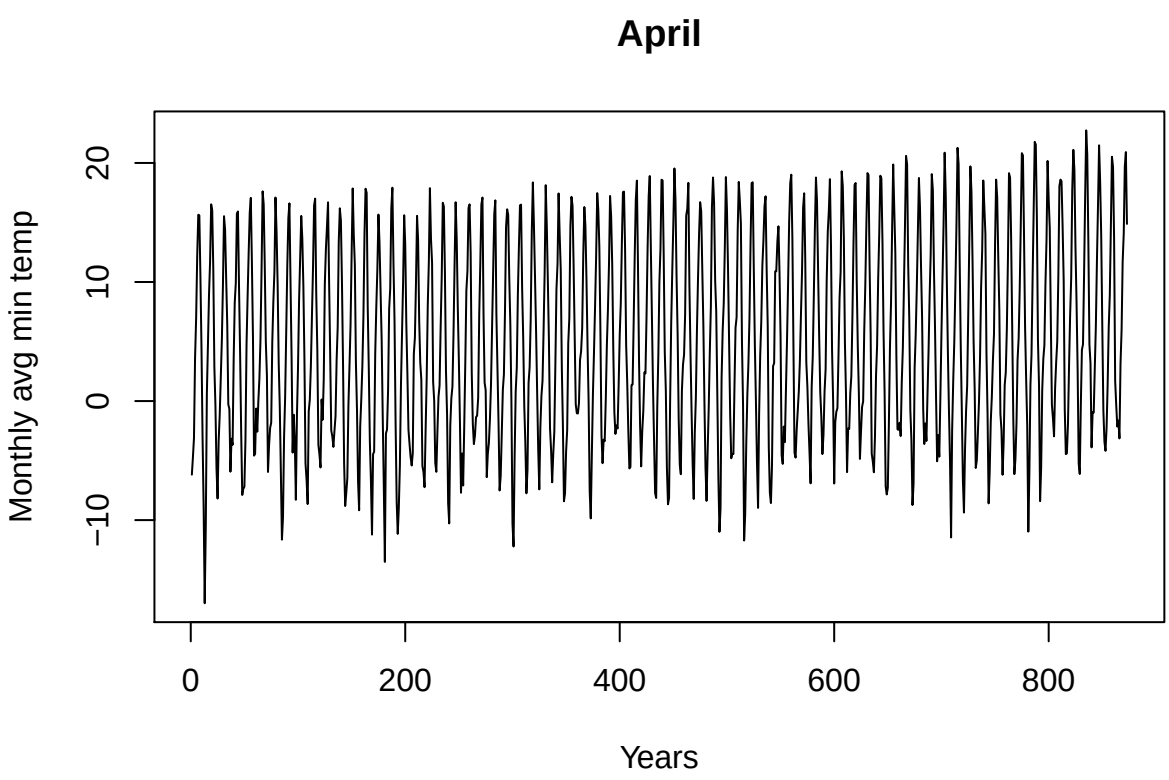


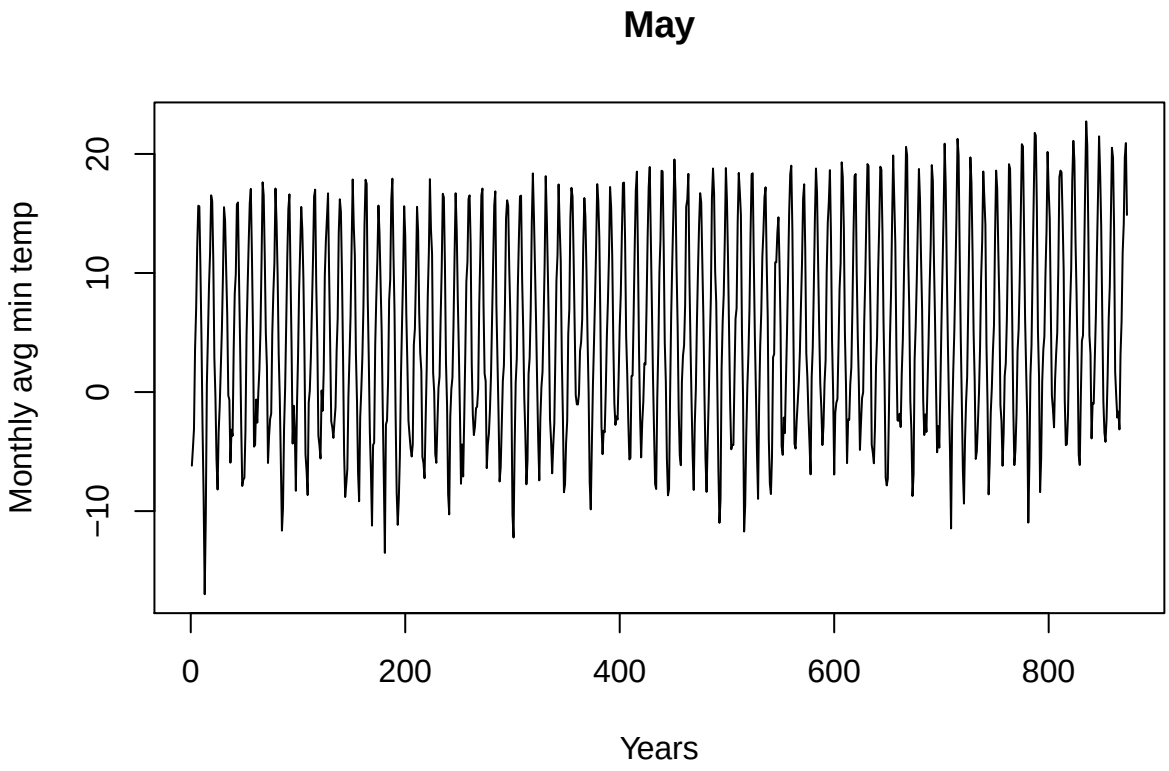

```
#par(mfrow=c(4,3),mar=c(5,4,1,1))
for (i in 1:12) {
MonthMin_lm <- lm(TMIN ~ YEAR, data=MonthlyTMINMean[MonthlyTMINMean$MONTH == i, ])
TMINresult <- rbind(TMINresult, cbind(Months[i],round(coef(MonthMin_lm)[2], 4), round(summary(MonthMin_l
summary(MonthMin_lm)
plot(MonthlyTMINMean$TMIN, ty='l', ylab='Monthly avg min temp', xlab='Years',main=Months[i]
)
abline(coef(MonthMin_lm),col='blue')
}
```

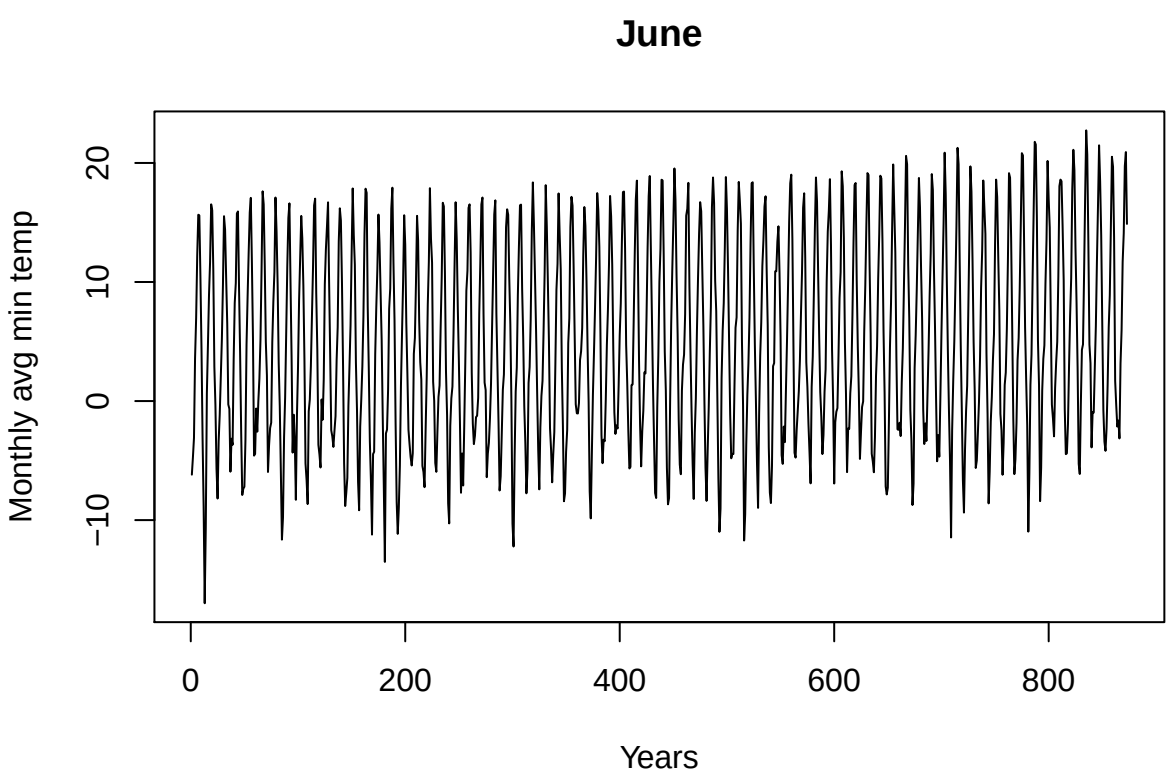

January
Monthly avg min temp
20
10
0
−10
0
200
400
600
800
Years

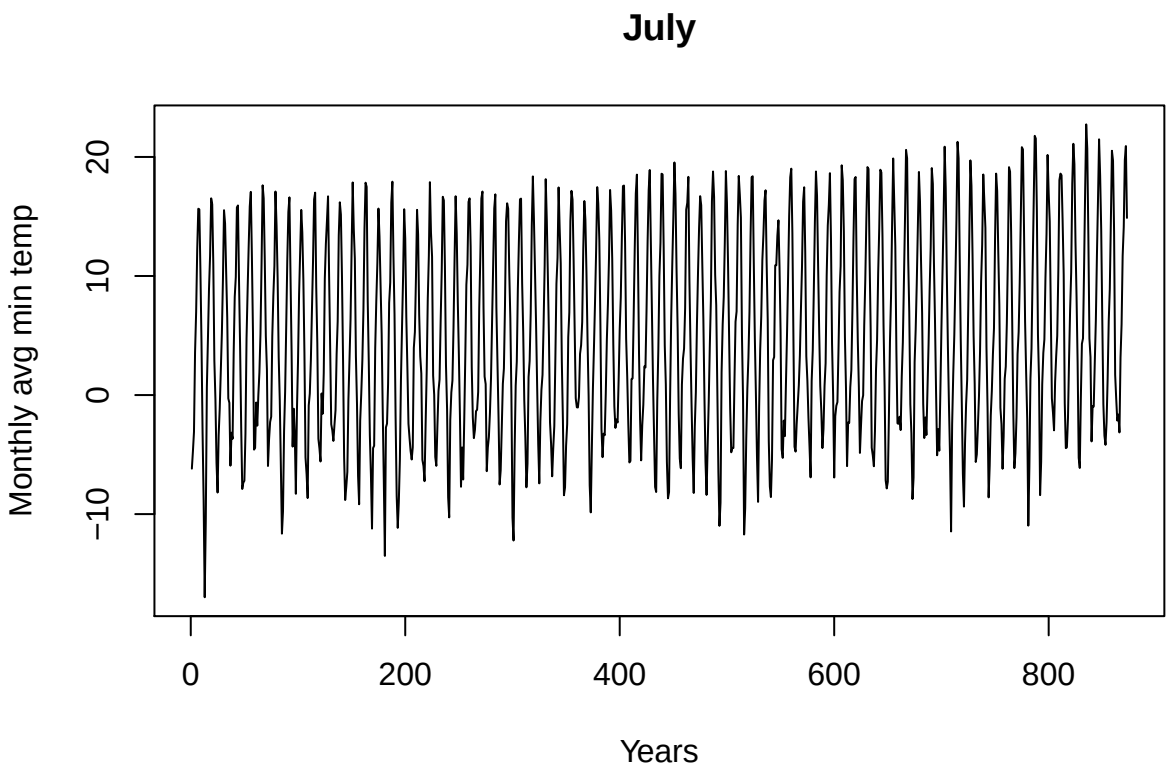

February
Monthly avg min temp
20
10
0
−10
0
200
400
600
800
Years

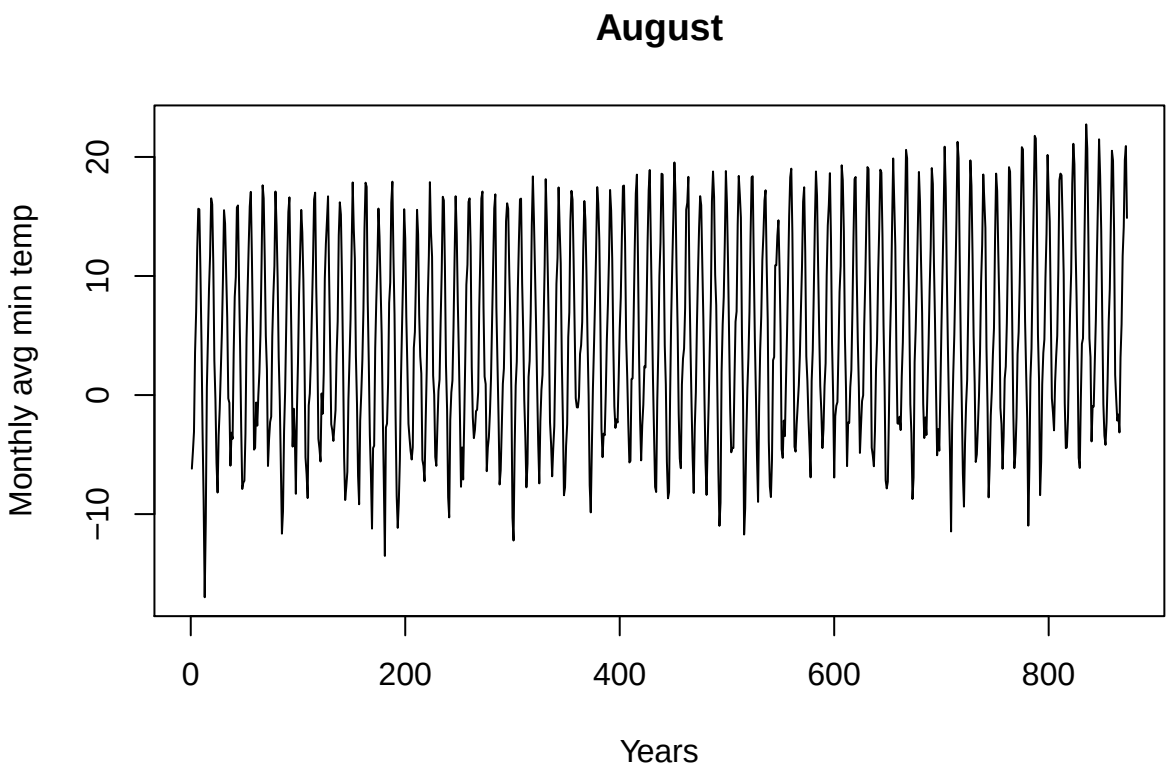

March
Monthly avg min temp
20
10
0
−10
0
200
400
600
800
Years

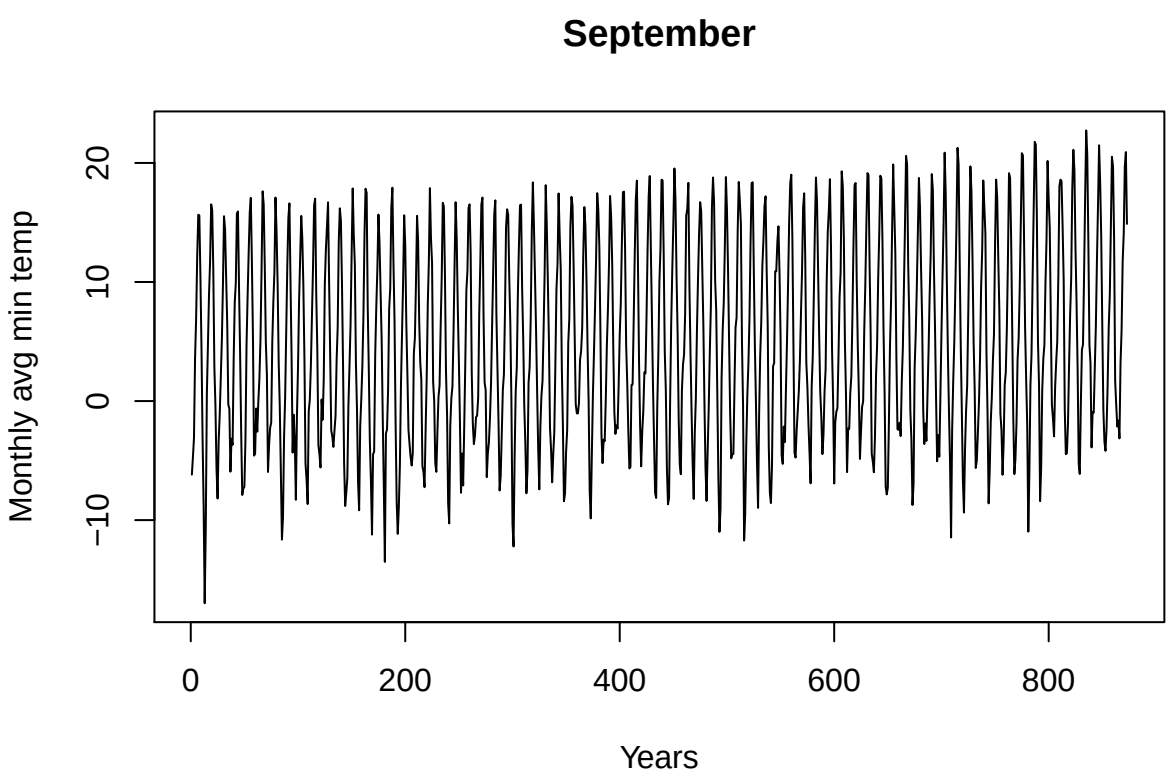

April
Monthly avg min temp
20
10
0
−10
0
200
400
600
800
Years

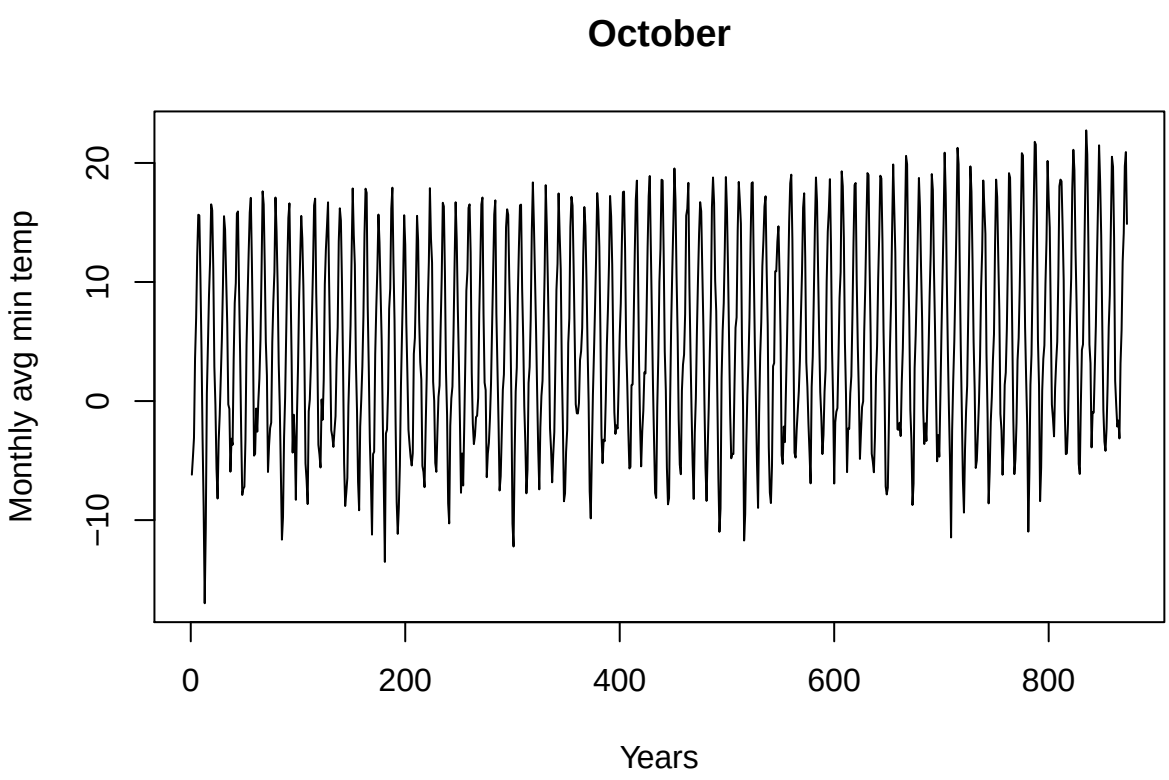

May
Monthly avg min temp
20
10
0
−10
0
200
400
600
800
Years

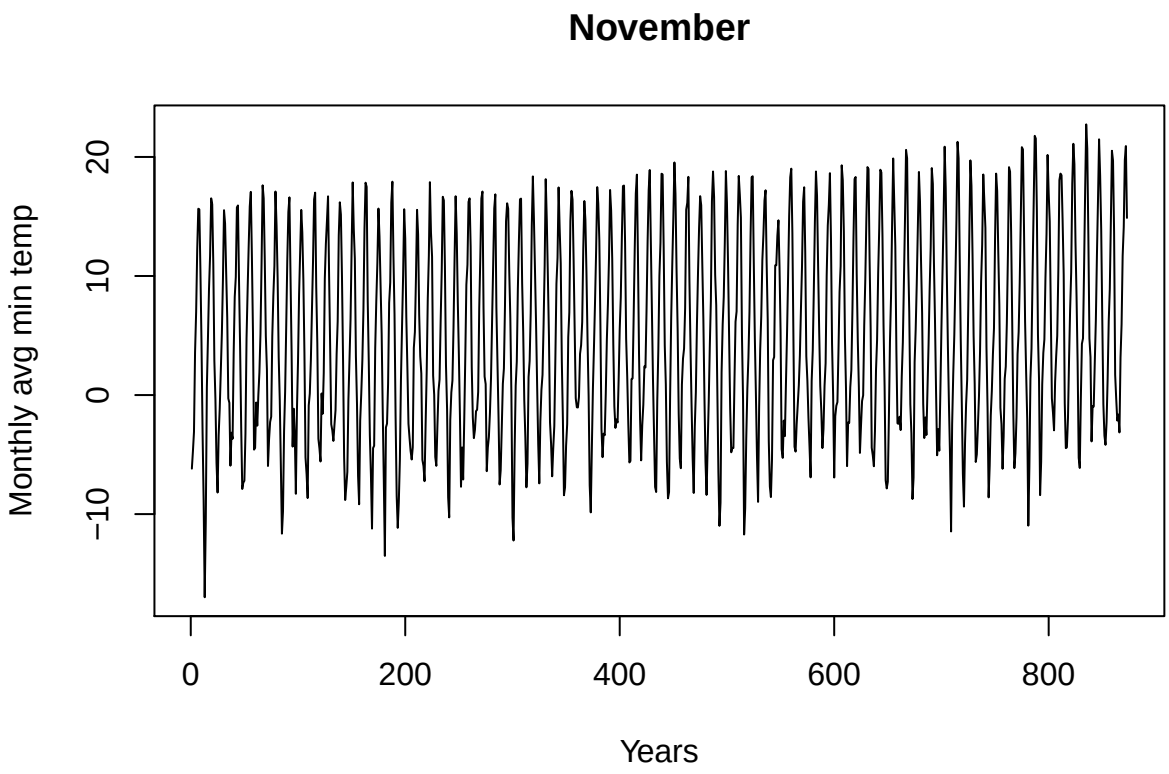

June
Monthly avg min temp
20
10
0
−10
0
200
400
600
800
Years

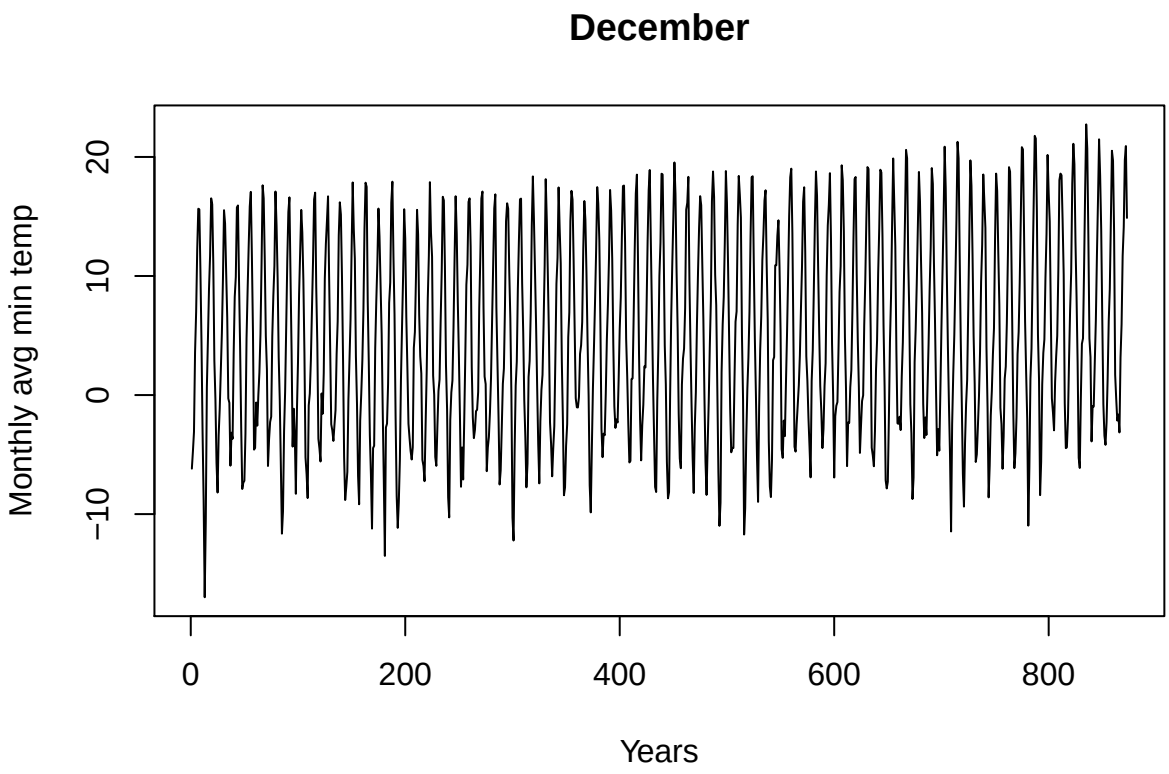

July
Monthly avg min temp
20
10
0
−10
0
200
400
600
800
Years


August
Monthly avg min temp
20
10
0
−10
0
200
400
600
800
Years


September
Monthly avg min temp
20
10
0
−10
0
200
400
600
800
Years


October
Monthly avg min temp
20
10
0
−10
0
200
400
600
800
Years


November
Monthly avg min temp
20
10
0
−10
0
200
400
600
800
Years




```
library(htmlTable)
Results <- data.frame(Month = TMINresult[c(2:13),1],
TMINSlope = TMINresult[c(2:13),2],
TMIN_P = as.numeric(TMINresult[c(2:13),3]),
TMINRsq = TMINresult[c(2:13),4],
TMAXSlope = TMAXresult[c(2:13),2],
TMAX_P = as.numeric(TMAXresult[c(2:13),3]),
TMAXRsq = TMAXresult[c(2:13),4])
Results$starTMIN = "NS"
Results$starTMIN[Results$TMIN_P <= .05] = "*"
Results$starTMIN[Results$TMIN_P < 0.01] = "**"
Results$starTMIN[Results$TMIN_P < 0.001] = "***"
Results$starTMAX = "NS"
Results$starTMAX[Results$TMAX_P < 0.05] = "*"
Results$starTMAX[Results$TMAX_P < 0.01] = "**"
Results$starTMAX[Results$TMAX_P < 0.001] = "***"
Results$TMINslope=paste(Results$TMINSlope, Results$starTMIN)
Results$TMAXslope=paste(Results$TMAXSlope, Results$starTMAX)
colnames(Results) <- c("Month", "2", "3", "R^2", "5", "6",
"R^2", "8", "9", "Slope TMIN", "Slope TMAX")
htmlTable(Results[,c(1, 10, 4, 11, 7)])
```

Month

Slope TMIN

R^2

Slope TMAX

R^2.1

1

January

0.0454 *

0.081

0.0148 NS

0.011

2

February

0.039 **

0.097

0.0168 NS

0.016

3

March

0.0661 ***

0.434

0.0535 ***

0.236

4

April

0.0381 ***

0.245

0.0069 NS

0.005

5

May

0.0435 ***

0.29

0.002 NS

0

6

June

0.0604 ***

0.434

0.0247 *

0.054

7

July

0.0688 ***

0.588

0.019 *

0.07

8

August

0.0624 ***

0.454

0.0176 *

0.076

9

September

0.0605 ***

0.429

0.0118 NS

0.015

10

October

0.0352 ***

0.198

-0.0132 NS

0.017

11

November

0.0343 **

0.141

0.0098 NS

0.008

12

December

0.0217 NS

0.039

-9e-04 NS

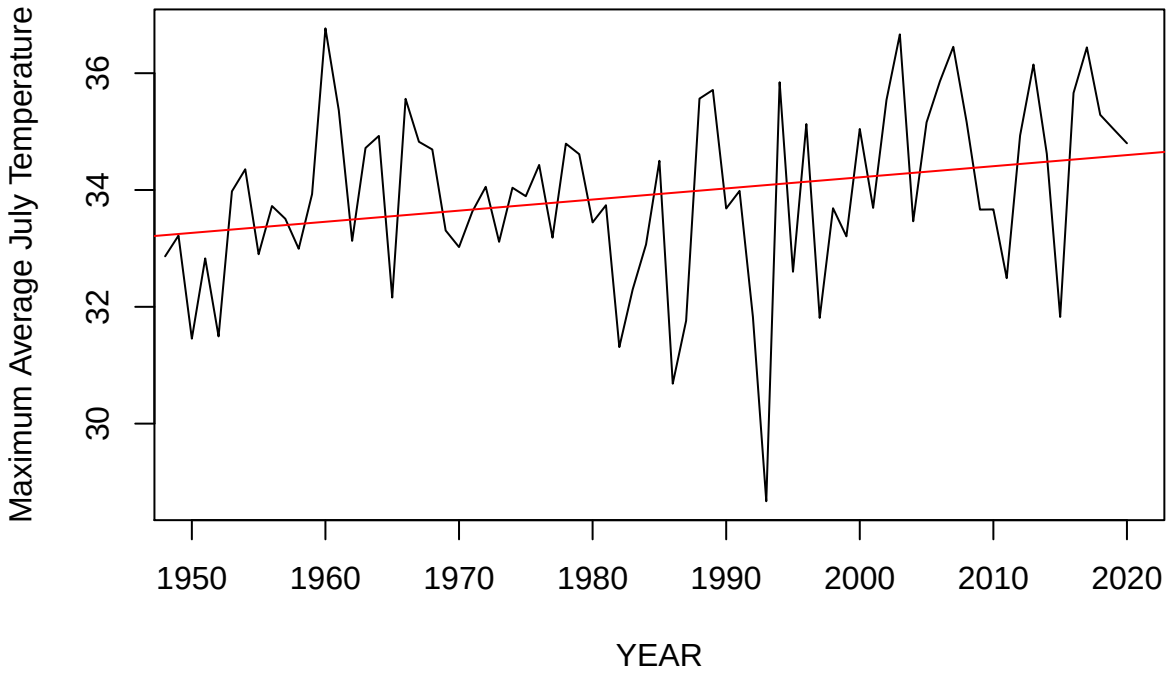
0

Based on my analysis, my data indicate that there is a trend of increasing temperature in Salt Lake City for the month of July, rejecting the null hypothesis. (slope = 0.019, r2 = 0, p-value = 0.024).

```
month_i <- 7
plot(TMAX~YEAR, data=MonthlyTMAXMean[MonthlyTMAXMean$MONTH==month_i,],ty='l', xlim=c(1950, 2020), ylab=
July.lm <- lm(TMAX~YEAR, data=MonthlyTMAXMean[MonthlyTMAXMean$MONTH==month_i,])
summary(July.lm)
```

```
##
## Call:
## lm(formula = TMAX ~ YEAR, data = MonthlyTMAXMean[MonthlyTMAXMean$MONTH ==
##     month_i, ])
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -5.4129 -0.6236  0.1359  0.9951  3.3119
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) -3.842114  16.337022  -0.235   0.8147
## YEAR         0.019030   0.008234   2.311   0.0237 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.482 on 71 degrees of freedom
## Multiple R-squared:  0.06997,    Adjusted R-squared:  0.05687
## F-statistic: 5.341 on 1 and 71 DF,  p-value: 0.02373
```

```
abline(coef(July.lm), col="red")
```

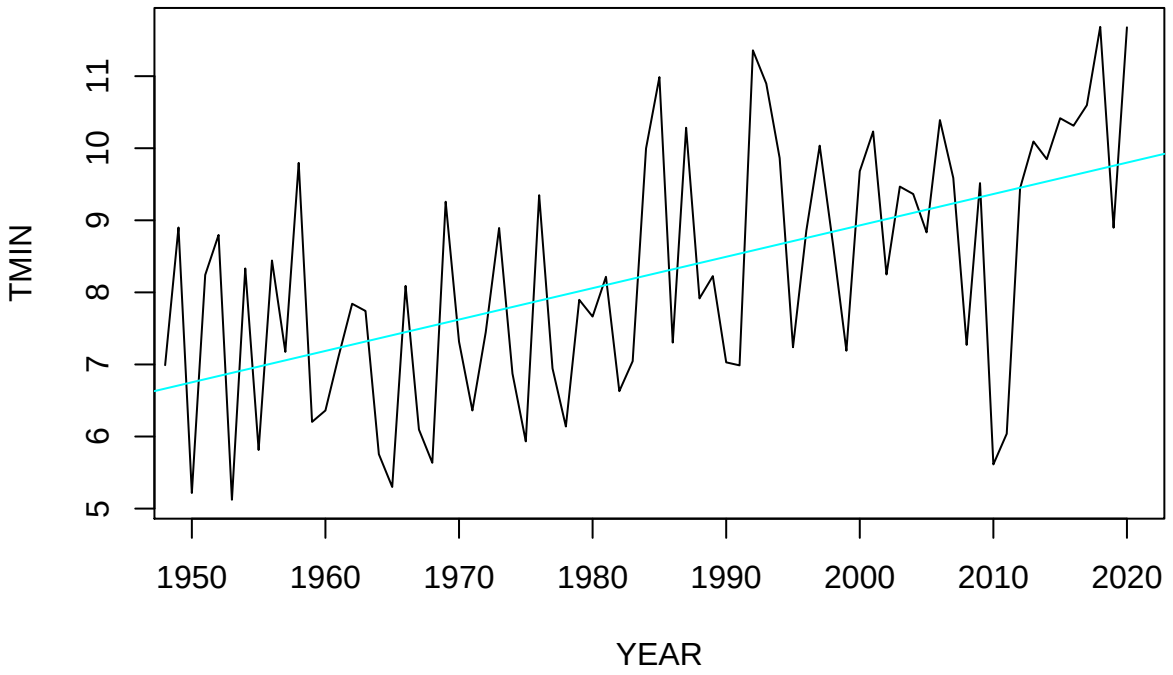


Based on my analysis, my data indicate that there is not a trend of increasing temperature in Salt Lake City for the month of January, failing to reject the null hypothesis (slope = 0.0435, r2 = 0, p-value = 0.29).

```
#plot(MonthlyTMAXMean£TMAX[MonthlyTMAXMean£Month=="05"], ty='l')
plot(TMIN~YEAR, data=MonthlyTMINMean[MonthlyTMINMean$Month=="05",],ty='l', xlim=c(1950, 2020))
Jan.lm <- lm(TMIN~YEAR, data=MonthlyTMINMean[MonthlyTMINMean$Month=="05",])
summary(Jan.lm)
```

```
##
## Call:
## lm(formula = TMIN ~ YEAR, data = MonthlyTMINMean[MonthlyTMINMean$Month ==
##     "05", ])
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -3.7519 -1.1439  0.0996  1.1964  2.7771
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept) -78.160236  16.042214  -4.872 6.49e-06 ***
## YEAR          0.043545   0.008085   5.386 8.89e-07 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.456 on 71 degrees of freedom
## Multiple R-squared:   0.29,  Adjusted R-squared:   0.28
## F-statistic: 29.01 on 1 and 71 DF,  p-value: 8.89e-07
```

```
abline(coef(Jan.lm), col="cyan")
```




```
Janresult <- NULL
Janresult <- rbind(Janresult, cbind(Months[i],
  round(coef(Jan.lm)[2], 4), round(summary(Jan.lm)$coefficients[2, 4], 4), round(summary(Jan.lm)$r.squa
Janresult
```

```
##      [,1]       [,2]     [,3] [,4]
## YEAR "December" "0.0435" "0"  "0.29"
```

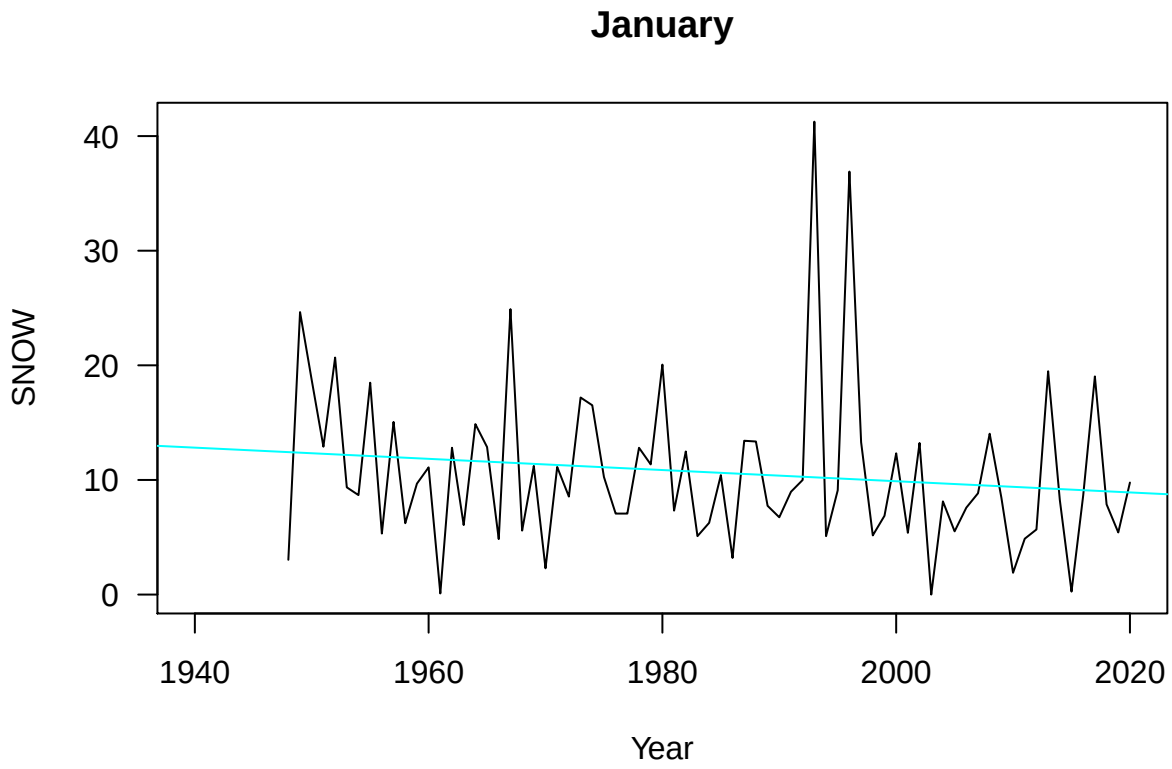
Based on my analysis, my data indicate that there is a trend of decreasing snowfall in Salt Lake City for the month of January, rejecting the null hypothesis (slope = -0.0488, r2 = 0.2271, p-value = 0.02).

```
i <- 1
MonthlySNOWMean = aggregate(SNOW ~ Month + Year, climate_data, mean)
MonthlySNOWMean$Month <- as.numeric(MonthlySNOWMean$Month)
MonthlySNOWMean$Year <- as.numeric(MonthlySNOWMean$Year)
plot(SNOW ~ Year, data = MonthlySNOWMean[MonthlySNOWMean$Month == i, ], ty = "l", las = 1, xlim = c(194
  SNOWMonth.lm <- lm(SNOW ~ Year, data = MonthlySNOWMean[MonthlySNOWMean$Month == i, ])
  summary(SNOWMonth.lm)
```

```
##
## Call:
## lm(formula = SNOW ~ Year, data = MonthlySNOWMean[MonthlySNOWMean$Month ==
##     i, ])
##
## Residuals:
##      Min       1Q   Median       3Q      Max
```

```
## -11.6948  -4.1263  -0.9954   2.8821  31.0295
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) 107.57645   79.54161   1.352    0.181
## Year         -0.04884    0.04009  -1.218    0.227
##
## Residual standard error: 7.217 on 71 degrees of freedom
## Multiple R-squared:  0.02048,    Adjusted R-squared:  0.006684
## F-statistic: 1.485 on 1 and 71 DF,  p-value: 0.2271
```

```
  abline(coef(SNOWMonth.lm), col = "cyan")
```




```
  SNOWresult <- NULL
  SNOWresult <- rbind(SNOWresult, cbind(Months[i],
  round(coef(SNOWMonth.lm)[2], 4), round(summary(SNOWMonth.lm)$coefficients[2, 4], 4), round(summary(SNO
SNOWresult
```

```
##      [,1]      [,2]      [,3]     [,4]
## Year "January" "-0.0488" "0.2271" "0.02"
```