

# Obtaining Climate Records

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## 1 Terrestrial Meteorological Data

### 1.1 Selected History of Climate Science

Geologists have known the earth's climate has been changing over the Earth's history. But what causes these changes has been a major research area for over 100 years. There are numerous drivers that contribute to changing climates – including the arrangement of the continents on the planet, the distance to the sun, energy generated by the sun, volcanic activity, and the composition of the Earth's atmosphere.

It's the last one that we'll spend time because the Earth's temperature are changing pretty dramatically over the last 100 years and the cause is no mystery – the human activity that has released CO<sub>2</sub> into the atmosphere. The two main sources of CO<sub>2</sub> is from land use change, e.g. deforestation, and the burning of fossil fuels, e.g. coal, oil, and natural gas.

The first to propose the role of CO<sub>2</sub> on the Earth's atmosphere was a XX scientist Arrhenius, who figured out that CO<sub>2</sub> absorbs infrared light. Moreover, he deduced that the Earth's temperature was actually warmer than it might otherwise be if CO<sub>2</sub> was not part of the Earth's atmosphere.

## 2 NOAA Data Records

### 2.1 rNOAA Package and R

### 2.2 Generate Temperature Record For Each State

#### 2.2.1 List of Cities

rNOAA has a simple function to list for each of the states and the weather stations in each. We'll use ncdf\_locs() functions to select each state and ncdf\_station() to obtain the station ids with the longest records.

```
# List of States (alpha beta)
ncdc_locs(locationcategoryid='ST', limit=55)
```

```
# Alabama
# ncdc_locs(locationid='FIPS:01', limit=52)
```

The function queries the NOAA website and retrieves state codes, “FIPS:XX”.

NOTE2: It would be nice to make a map of how concentrated the stations spatially.

### 2.2.2 Selection Stations

With the state ids, we can then, get metadata for all the weather stations, which will work to get the longest records, using `ncdc_stations()`.

First, we subset the data for stations that actively collecting data. Then we'll sort to the active stations to find the one with the longest records. We will use these stations for our analysis.

```
# alabama stations.. sorted by the most recent
# test <- ncdc_stations(datasetid='GHCND', datatypeid = c("TMAX", "TMIN"), locationid='FIPS'

get_locationid <- function(FIPS){
  fips = ncdc_locs(locationcategoryid='ST', limit=55)
  temp <- data.frame(State = fips$data$name[FIPS],
                      id = fips$data$id[FIPS])
  temp$id <- as.character(temp$id)
  temp$State <- as.character(temp$State)
  return(temp)
}
```

### 2.2.3 Select State

```
fips = get_locationid(18); str(fips);

## 'data.frame': 1 obs. of  2 variables:
## $ State: chr "Kentucky"
## $ id   : chr "FIPS:21"

GSOM_Stations <- ncdc_stations(datasetid='GSOM',
                                 datatypeid = c("TMAX", "TMIN"),
                                 locationid=fips$id, limit=1000,
                                 sortfield = 'maxdate', sortorder='desc')

GSOM_Recent = GSOM_Stations$data[GSOM_Stations$data$maxdate>='2021-11-01',]

GSOM_Coverage = GSOM_Recent[GSOM_Recent$datacoverage > 0.90,]
```

```

GSOM_Longest =
  GSOM_Coverage[GSOM_Coverage$mindate == min(GSOM_Coverage$mindate),]
GSOM_Longest = GSOM_Longest[1,] #Pick first if more than one.
GSOM_Longest

##   elevation      mindate      maxdate latitude          name
## 4     293.2 1872-11-01 2022-03-01 38.03391 LEXINGTON BLUEGRASS AIRPORT, KY US
##   datacoverage           id elevationUnit longitude
## 4     0.9242 GHCND:USW00093820        METERS -84.61138

```

## 2.2.4 Download GSOM Data using rnoaa

```

## [1] 1872

```

## 2.2.5 Functions to Collect and Clean GSOM

To collect the data, I used a short function, but the download time is painfully slow because only 1 year can be obtained at a time. Might want to get a work around for this at some point.

```

get_GSOM <- function(stid, datatype) {
  wtr<-list() # create an empty list
  for (i in startyear:2021) {
    start_date <- paste0(i, "-01-01")
    end_date <- paste0(i, "-12-31")

#save data portion to the list (elements named for the year
  wtr[[as.character(i)]] <- ncdc(datasetid='GSOM',
    stationid=stid, datatypeid=datatype, startdate =
    start_date, enddate = end_date, limit=400)$data
  }
  #return the full list of data frames
  return(wtr)
}

```

The function relies on two inputs, the station id and the measured parameter – TMAX and TMIN in this case. After that, the data needs to be clean up quite a bit.

```

GSOM_TMAX <- get_GSOM(GSOM_Longest$id, 'TMAX')

## Warning: Sorry, no data found
## Warning: Sorry, no data found

```



```

## 'data.frame': 1653 obs. of  3 variables:
##   $ Date    : Date, format: "1872-11-01" "1872-12-01" ...
##   $ station: chr  "GHCND:USW00093820" "GHCND:USW00093820" "GHCND:USW00093820" "GHCND:USW00093820"
##   $ TMAX   : num  44.1 34 36.7 43.7 51.4 ...

GSOM <- merge(dfTbl_TMAX, dfTbl_TMIN, by="Date")

GSOM$Month = as.numeric(format(as.Date(GSOM>Date), format = "%m"))
GSOM$Year = as.numeric(format(as.Date(GSOM>Date), format = "%Y"))

```

## 2.3 Function to Evaluate Months

Function to evaluate each month and determine if there is a trend. At somepoint, I'll have to the stats correcting for the autocorrelation.

Evaluate both TMAX and TMIN in GSOM by Year using MonthEvalStats() function.

```

MonthEvalStats <- function(GSOM) {
  sumstats = NA
  for (m in 1:12) {
    # m=2
    TMAX.lm = lm(TMAX~Date, GSOM[GSOM$Month==m,])
    TMIN.lm = lm(TMIN~Date, GSOM[GSOM$Month==m,])
    sumstats = rbind(sumstats, data.frame(Month = m,
                                           TMIN_Slope = coef(TMIN.lm)[2],
                                           TMIN_r2 = summary(TMIN.lm)$r.squared,
                                           TMIN_p_value= anova(TMIN.lm)$'Pr(>F)'[1],
                                           TMAX_Slope = coef(TMAX.lm)[2],
                                           TMAX_r2 = summary(TMAX.lm)$r.squared,
                                           TMAX_p_value= anova(TMAX.lm)$'Pr(>F)'[1]))
  }

  sumstats=data.frame(sumstats)[-1,]
  rownames(sumstats)<-NULL
  #sumstats <- subset(sumstats, TMAX_p_value <.05,
  # select=c(Month, TMIN_Slope, TMIN_p_value,
  # MAX_Slope, TMAX_p_value))
  sumstats$TMAX_Symbol <- sumstats$TMIN_Symbol <- ""
  sumstats$TMAX_Symbol[sumstats$TMAX_p_value < 0.05] = "*"
  sumstats$TMAX_Symbol[sumstats$TMAX_p_value < 0.01] = "**"
  sumstats$TMAX_Symbol[sumstats$TMAX_p_value < 0.001] = "***"
  sumstats[,c(7,9)]
  return(sumstats)
}

```

```
# test function
# sumstats = MonthEvalStats(GSOM[500:4000,])
```

### 2.3.1 Determine Months with Biggest Changes

```
# Selecting Most Important Month (TMAX overwrites)
sumstats = MonthEvalStats(GSOM)

maxmonth = sumstats$Month[sumstats$TMIN_Slope ==
                         max(sumstats$TMIN_Slope, na.rm=T)]

maxmonth = sumstats$Month[abs(sumstats$TMAX_Slope) ==
                         max(abs(sumstats$TMAX_Slope), na.rm=T)]
```

## 2.4 Plot Month with Biggest Changes

### 2.4.1 Function to report Probabilities

```
report_prob <-function(pvalue){
  if(pvalue > 0.05) return("> 0.05 (Not Significant)")
  if(pvalue < 0.05 & pvalue >= 0.001) return(
    paste("=", round(pvalue, 3), "(Statistically Significant)"))
  #if(pvalue < 0.01) print(round(pvalue, 4))
  if(pvalue < 0.001) return("< 0.001 (Statistically Significant)")
}

#test function
report_prob(0.0032)

report_prob2 <-function(lm){
  # lm=GSOM.lm
  if(anova(lm)$'Pr(>F)'[1] > 0.05) return("p-value > 0.05 (Not Significant)")
  if(anova(lm)$'Pr(>F)'[1] < 0.05 & anova(lm)$'Pr(>F)'[1] >= 0.001) return(
    paste("Change ", round(coef(lm)[2]*356.25*100, 1), "/100 years, ", "p-value =", round(
      if(anova(lm)$'Pr(>F)'[1] < 0.001) return(
        paste("Change ", round(coef(lm)[2]*325.25*100, 1), "/100 years, ", "p-value < 0.001 (S
    )
  }

#test function
summary(GSOM.lm); coef(GSOM.lm)

## Error in summary(GSOM.lm): object 'GSOM.lm' not found
## Error in coef(GSOM.lm): object 'GSOM.lm' not found
```

```

report_prob2(GSOM.lm)
## Error in anova(lm): object 'GSOM.lm' not found

```

## 2.5 Extreme Temperture Events

### 2.5.1 Functions to Collect and Clean CHCND

```

GSOM_Longest$id
## [1] "GHCND:USW00093820"

stid = substr(GSOM_Longest$id, 7, 17)

CHCND <- read.csv("https://www.nci.noaa.gov/data/global-historical-climatology-network-daily-temperature-and-precipitation-data-set")

get_CHCND <- function(stid) {
  #stid = "USC00013511"
  import <- read.csv(paste("https://www.nci.noaa.gov/data/global-historical-climatology-network-daily-temperature-and-precipitation-data-set"))
  selected = subset(import, select=c("DATE", "TMAX", "TMIN"))
  selected$TMAX = selected$TMAX/10*(9/5)+32
  selected$TMIN = selected$TMIN/10*(9/5)+32
  selected$Date = as.Date(selected$DATE)
  #head(selected)
  selected
}

CHCND <- get_CHCND(stid)
#str(CHCND)

CHCND$Month = as.numeric(format(as.Date(CHCND$Date), format = "%m"))
CHCND$Month.name = factor(format(as.Date(CHCND$Date), format = "%b"))
CHCND$TMAX[CHCND$TMAX>150] = NA
CHCND$Month.name <- reorder(CHCND$Month.name, CHCND$Month)
levels(CHCND$Month.name)

## [1] "Jan" "Feb" "Mar" "Apr" "May" "Jun" "Jul" "Aug" "Sep" "Oct" "Nov" "Dec"

CHCND$Year = as.numeric(format(as.Date(CHCND$Date), format = "%Y"))

#head(CHCND)

```

## 2.6 Extreme Temperatures

```

# Create Max for each Julian Date
df = data.frame(date=1:20, year=rep(1:5, each=4), julian=c(1:4), TMAX = c(3,0,1,0,4,0,1,2,0,0,
df$maxTMAX[df$year==1] <- df$TMAX[df$year==1]
for(i in 1:max(df$date)){
  df$year[df$date==i]
  df$julian[df$date==i]
  df$TMAX[df$date==i]
  max(df$maxTMAX[df$julian[df$date==i]], na.rm=T)
  if(df$TMAX[df$date==i] >
     max(df$maxTMAX[df$julian[df$date==i]], na.rm=T) ){
    df$maxTMAX[df$date==i] <- df$TMAX[df$date==i]
    print(i)
  } else df$maxTMAX[df$date==i] <- max(df$maxTMAX[df$julian[df$date==i]], na.rm=T)
}

## [1] 5
## [1] 8
## [1] 12
## [1] 16
## [1] 17
## [1] 18
## [1] 19
## [1] 20

#CHCND$Julian = as.numeric(format(CHCND$date, "%j"))
CHCND$mmdd <- format(CHCND$date, "%m-%d")
CHCND_Mean = mean(CHCND$TMAX, na.rm=T)

CHCND$maxTMAX = NA
for(i in 1:max(nrow(CHCND))){
  #for(i in 1:10){
  #i=2
  if(is.na(CHCND$TMAX[i])) next
  CHCND$maxTMAX[i] <- CHCND$TMAX[i]
  CHCND$mmdd <- CHCND$mmdd[i]

  if(CHCND$TMAX[i] <
     max(CHCND$TMAX[CHCND$mmdd==CHCND$mmdd], na.rm=T) ){
    CHCND$maxTMAX[i] <- NA} else
    {
      CHCND$maxTMAX[i] <- CHCND$TMAX[i]
    }
  }

  head(CHCND)
}

```

```

##           DATE    TMAX   TMIN      Date Month Month.name Year   mmdd maxTMAX
## 1 1872-10-11 48.02 35.96 1872-10-11     10      Oct 1872 10-11     NA
## 2 1872-10-12 55.04 37.94 1872-10-12     10      Oct 1872 10-12     NA
## 3 1872-10-13 55.04 39.92 1872-10-13     10      Oct 1872 10-13     NA
## 4 1872-10-14 48.02 32.00 1872-10-14     10      Oct 1872 10-14     NA
## 5 1872-10-15 59.00 33.08 1872-10-15     10      Oct 1872 10-15     NA
## 6 1872-10-16 66.92 46.94 1872-10-16     10      Oct 1872 10-16     NA

test = CHCND[!is.na(CHCND$maxTMAX),]; test[order(test$mmdd),]

##           DATE    TMAX   TMIN      Date Month Month.name Year   mmdd maxTMAX
## 24835 1952-01-01 71.06 42.98 1952-01-01     1      Jan 1952 01-01 71.06
## 44560 2006-01-02 66.92 48.92 2006-01-02     1      Jan 2006 01-02 66.92
## 8401 1907-01-03 68.00 53.96 1907-01-03     1      Jan 1907 01-03 68.00
## 42369 2000-01-03 68.00 53.06 2000-01-03     1      Jan 2000 01-03 68.00
## 43831 2004-01-04 68.00 48.92 2004-01-04     1      Jan 2004 01-04 68.00
## 41276 1997-01-05 66.02 35.96 1997-01-05     1      Jan 1997 01-05 66.02
## 44928 2007-01-05 66.02 55.04 2007-01-05     1      Jan 2007 01-05 66.02
## 22649 1946-01-06 71.06 51.08 1946-01-06     1      Jan 1946 01-06 71.06
## 45295 2008-01-07 69.98 57.02 2008-01-07     1      Jan 2008 01-07 69.98
## 19364 1937-01-08 71.06 51.08 1937-01-08     1      Jan 1937 01-08 71.06
## 16808 1930-01-09 69.98 37.04 1930-01-09     1      Jan 1930 01-09 69.98
## 49681 2020-01-10 66.92 57.02 2020-01-10     1      Jan 2020 01-10 66.92
## 49682 2020-01-11 75.02 50.00 2020-01-11     1      Jan 2020 01-11 75.02
## 2202 1890-01-12 71.06     NA 1890-01-12     1      Jan 1890 01-12 71.06
## 40553 1995-01-13 69.08 53.06 1995-01-13     1      Jan 1995 01-13 69.08
## 17543 1932-01-14 68.00 53.96 1932-01-14     1      Jan 1932 01-14 68.00
## 49686 2020-01-15 69.08 37.04 2020-01-15     1      Jan 2020 01-15 69.08
## 23755 1949-01-16 69.08 42.08 1949-01-16     1      Jan 1949 01-16 69.08
## 24851 1952-01-17 66.92 44.06 1952-01-17     1      Jan 1952 01-17 66.92
## 48593 2017-01-17 66.92 44.96 2017-01-17     1      Jan 2017 01-17 66.92
## 16452 1929-01-18 71.96 48.92 1929-01-18     1      Jan 1929 01-18 71.96
## 8417 1907-01-19 68.00 48.92 1907-01-19     1      Jan 1907 01-19 68.00
## 8053 1906-01-20 69.98 55.04 1906-01-20     1      Jan 1906 01-20 69.98
## 8054 1906-01-21 71.96 55.04 1906-01-21     1      Jan 1906 01-21 71.96
## 42023 1999-01-22 73.04 55.04 1999-01-22     1      Jan 1999 01-22 73.04
## 21570 1943-01-23 68.00 44.96 1943-01-23     1      Jan 1943 01-23 68.00
## 30336 1967-01-23 68.00 55.04 1967-01-23     1      Jan 1967 01-23 68.00
## 21571 1943-01-24 80.06 46.94 1943-01-24     1      Jan 1943 01-24 80.06
## 24129 1950-01-25 75.92 59.00 1950-01-25     1      Jan 1950 01-25 75.92
## 21938 1944-01-26 71.06 50.00 1944-01-26     1      Jan 1944 01-26 71.06
## 21939 1944-01-27 73.94 51.08 1944-01-27     1      Jan 1944 01-27 73.94
## 1205 1876-01-28 68.00 55.04 1876-01-28     1      Jan 1876 01-28 68.00
## 33264 1975-01-29 69.08 35.06 1975-01-29     1      Jan 1975 01-29 69.08
## 11715 1916-01-30 69.08 59.00 1916-01-30     1      Jan 1916 01-30 69.08
## 43128 2002-01-31 71.06 53.06 2002-01-31     1      Jan 2002 01-31 71.06

```

## 9891	1911-02-01	66.92	42.08	1911-02-01	2	Feb 1911 02-01	66.92
## 48243	2016-02-02	71.96	35.96	2016-02-02	2	Feb 2016 02-02	71.96
## 2224	1890-02-03	69.98	59.00	1890-02-03	2	Feb 1890 02-03	69.98
## 2225	1890-02-04	69.98	53.96	1890-02-04	2	Feb 1890 02-04	69.98
## 28522	1962-02-04	69.98	42.08	1962-02-04	2	Feb 1962 02-04	69.98
## 15739	1927-02-05	68.00	55.94	1927-02-05	2	Feb 1927 02-05	68.00
## 15010	1925-02-06	66.92	44.96	1925-02-06	2	Feb 1925 02-06	66.92
## 49344	2019-02-07	71.96	39.92	2019-02-07	2	Feb 2019 02-07	71.96
## 19395	1937-02-08	73.94	50.00	1937-02-08	2	Feb 1937 02-08	73.94
## 42772	2001-02-09	69.98	37.04	2001-02-09	2	Feb 2001 02-09	69.98
## 17570	1932-02-10	75.02	55.94	1932-02-10	2	Feb 1932 02-10	75.02
## 42043	1999-02-11	73.94	53.06	1999-02-11	2	Feb 1999 02-11	73.94
## 19764	1938-02-12	73.04	46.04	1938-02-12	2	Feb 1938 02-12	73.04
## 19765	1938-02-13	71.06	53.96	1938-02-13	2	Feb 1938 02-13	71.06
## 28531	1962-02-13	71.06	33.98	1962-02-13	2	Feb 1962 02-13	71.06
## 9904	1911-02-14	69.98	48.02	1911-02-14	2	Feb 1911 02-14	69.98
## 12461	1918-02-14	69.98	44.06	1918-02-14	2	Feb 1918 02-14	69.98
## 22324	1945-02-15	75.92	42.98	1945-02-15	2	Feb 1945 02-15	75.92
## 1872	1889-02-16	69.08	NA	1889-02-16	2	Feb 1889 02-16	69.08
## 48988	2018-02-16	69.08	37.04	2018-02-16	2	Feb 2018 02-16	69.08
## 15751	1927-02-17	71.96	48.92	1927-02-17	2	Feb 1927 02-17	71.96
## 23422	1948-02-18	69.98	39.92	1948-02-18	2	Feb 1948 02-18	69.98
## 20136	1939-02-19	75.02	50.00	1939-02-19	2	Feb 1939 02-19	75.02
## 48992	2018-02-20	80.06	62.06	2018-02-20	2	Feb 2018 02-20	80.06
## 48628	2017-02-21	71.96	55.04	2017-02-21	2	Feb 2017 02-21	71.96
## 13930	1922-02-22	69.98	55.04	1922-02-22	2	Feb 1922 02-22	69.98
## 40959	1996-02-23	80.06	50.00	1996-02-23	2	Feb 1996 02-23	80.06
## 48631	2017-02-24	78.98	57.92	2017-02-24	2	Feb 2017 02-24	78.98
## 42422	2000-02-25	73.94	53.96	2000-02-25	2	Feb 2000 02-25	73.94
## 21969	1944-02-26	75.92	55.94	1944-02-26	2	Feb 1944 02-26	75.92
## 40963	1996-02-27	73.04	53.96	1996-02-27	2	Feb 1996 02-27	73.04
## 12475	1918-02-28	75.02	44.96	1918-02-28	2	Feb 1918 02-28	75.02
## 32199	1972-02-29	75.02	46.04	1972-02-29	2	Feb 1972 02-29	75.02
## 33661	1976-03-01	73.04	50.00	1976-03-01	3	Mar 1976 03-01	73.04
## 33662	1976-03-02	75.02	57.02	1976-03-02	3	Mar 1976 03-02	75.02
## 6269	1901-03-03	75.92	41.00	1901-03-03	3	Mar 1901 03-03	75.92
## 33664	1976-03-04	80.96	59.00	1976-03-04	3	Mar 1976 03-04	80.96
## 36221	1983-03-05	78.08	57.92	1983-03-05	3	Mar 1983 03-05	78.08
## 9559	1910-03-06	77.00	42.08	1910-03-06	3	Mar 1910 03-06	77.00
## 32570	1973-03-06	77.00	46.94	1973-03-06	3	Mar 1973 03-06	77.00
## 32936	1974-03-07	78.08	60.08	1974-03-07	3	Mar 1974 03-07	78.08
## 32937	1974-03-08	78.08	55.94	1974-03-08	3	Mar 1974 03-08	78.08
## 15041	1925-03-09	78.08	42.98	1925-03-09	3	Mar 1925 03-09	78.08
## 32574	1973-03-10	77.00	53.96	1973-03-10	3	Mar 1973 03-10	77.00
## 38784	1990-03-11	78.08	57.02	1990-03-11	3	Mar 1990 03-11	78.08

## 9930	1911-03-12	77.00	41.00	1911-03-12	3	Mar	1911	03-12	77.00
## 30385	1967-03-13	80.96	55.04	1967-03-13	3	Mar	1967	03-13	80.96
## 32578	1973-03-14	80.96	62.06	1973-03-14	3	Mar	1973	03-14	80.96
## 21987	1944-03-15	80.96	48.92	1944-03-15	3	Mar	1944	03-15	80.96
## 22353	1945-03-16	82.94	59.00	1945-03-16	3	Mar	1945	03-16	82.94
## 18336	1934-03-17	75.92	NA	1934-03-17	3	Mar	1934	03-17	75.92
## 38425	1989-03-17	75.92	37.94	1989-03-17	3	Mar	1989	03-17	75.92
## 35869	1982-03-18	78.98	41.00	1982-03-18	3	Mar	1982	03-18	78.98
## 8476	1907-03-19	78.98	53.96	1907-03-19	3	Mar	1907	03-19	78.98
## 22356	1945-03-19	78.98	60.08	1945-03-19	3	Mar	1945	03-19	78.98
## 46828	2012-03-19	78.98	59.00	2012-03-19	3	Mar	2012	03-19	78.98
## 46829	2012-03-20	82.94	62.96	2012-03-20	3	Mar	2012	03-20	82.94
## 8478	1907-03-21	82.94	46.04	1907-03-21	3	Mar	1907	03-21	82.94
## 8479	1907-03-22	82.04	62.96	1907-03-22	3	Mar	1907	03-22	82.04
## 8480	1907-03-23	82.04	60.08	1907-03-23	3	Mar	1907	03-23	82.04
## 9577	1910-03-24	84.92	57.92	1910-03-24	3	Mar	1910	03-24	84.92
## 16518	1929-03-25	86.00	62.06	1929-03-25	3	Mar	1929	03-25	86.00
## 8483	1907-03-26	80.06	60.98	1907-03-26	3	Mar	1907	03-26	80.06
## 45008	2007-03-26	80.06	60.98	2007-03-26	3	Mar	2007	03-26	80.06
## 9580	1910-03-27	84.02	57.92	1910-03-27	3	Mar	1910	03-27	84.02
## 8485	1907-03-28	82.94	64.94	1907-03-28	3	Mar	1907	03-28	82.94
## 9581	1910-03-28	82.94	60.98	1910-03-28	3	Mar	1910	03-28	82.94
## 9582	1910-03-29	82.94	62.06	1910-03-29	3	Mar	1910	03-29	82.94
## 4105	1895-03-30	82.94	59.00	1895-03-30	3	Mar	1895	03-30	82.94
## 35517	1981-03-31	82.04	44.96	1981-03-31	3	Mar	1981	03-31	82.04
## 37343	1986-03-31	82.04	53.06	1986-03-31	3	Mar	1986	03-31	82.04
## 28943	1963-04-01	82.04	60.98	1963-04-01	4	Apr	1963	04-01	82.04
## 20544	1940-04-02	84.02	48.92	1940-04-02	4	Apr	1940	04-02	84.02
## 22735	1946-04-02	84.02	66.02	1946-04-02	4	Apr	1946	04-02	84.02
## 18353	1934-04-03	84.02	50.00	1934-04-03	4	Apr	1934	04-03	84.02
## 18354	1934-04-04	86.00	55.94	1934-04-04	4	Apr	1934	04-04	86.00
## 18355	1934-04-05	87.98	53.96	1934-04-05	4	Apr	1934	04-05	87.98
## 46115	2010-04-06	84.92	64.04	2010-04-06	4	Apr	2010	04-06	84.92
## 3383	1893-04-07	84.02	62.06	1893-04-07	4	Apr	1893	04-07	84.02
## 42829	2001-04-07	84.02	64.94	2001-04-07	4	Apr	2001	04-07	84.02
## 42830	2001-04-08	82.94	66.02	2001-04-08	4	Apr	2001	04-08	82.94
## 12880	1919-04-09	84.02	62.96	1919-04-09	4	Apr	1919	04-09	84.02
## 47215	2013-04-10	84.02	62.06	2013-04-10	4	Apr	2013	04-10	84.02
## 16900	1930-04-11	84.92	60.98	1930-04-11	4	Apr	1930	04-11	84.92
## 16901	1930-04-12	84.92	62.96	1930-04-12	4	Apr	1930	04-12	84.92
## 8136	1906-04-13	84.02	59.00	1906-04-13	4	Apr	1906	04-13	84.02
## 20920	1941-04-13	84.02	55.04	1941-04-13	4	Apr	1941	04-13	84.02
## 34070	1977-04-14	84.02	51.08	1977-04-14	4	Apr	1977	04-14	84.02
## 46124	2010-04-15	84.02	55.04	2010-04-15	4	Apr	2010	04-15	84.02
## 4488	1896-04-16	84.92	62.06	1896-04-16	4	Apr	1896	04-16	84.92

## 2662	1891-04-17	87.08	60.08	1891-04-17	4	Apr	1891	04-17	87.08
## 4490	1896-04-18	87.98	68.00	1896-04-18	4	Apr	1896	04-18	87.98
## 20926	1941-04-19	86.00	60.08	1941-04-19	4	Apr	1941	04-19	86.00
## 4492	1896-04-20	84.92	62.96	1896-04-20	4	Apr	1896	04-20	84.92
## 11430	1915-04-20	84.92	59.00	1915-04-20	4	Apr	1915	04-20	84.92
## 26771	1957-04-20	84.92	64.94	1957-04-20	4	Apr	1957	04-20	84.92
## 28963	1963-04-21	86.00	55.04	1963-04-21	4	Apr	1963	04-21	86.00
## 22025	1944-04-22	84.92	57.92	1944-04-22	4	Apr	1944	04-22	84.92
## 37000	1985-04-22	84.92	60.08	1985-04-22	4	Apr	1985	04-22	84.92
## 37730	1987-04-22	84.92	55.04	1987-04-22	4	Apr	1987	04-22	84.92
## 15086	1925-04-23	86.00	62.96	1925-04-23	4	Apr	1925	04-23	86.00
## 19469	1937-04-23	86.00	55.04	1937-04-23	4	Apr	1937	04-23	86.00
## 22756	1946-04-23	86.00	60.08	1946-04-23	4	Apr	1946	04-23	86.00
## 15087	1925-04-24	89.96	69.08	1925-04-24	4	Apr	1925	04-24	89.96
## 11435	1915-04-25	87.98	62.96	1915-04-25	4	Apr	1915	04-25	87.98
## 18741	1935-04-26	87.98	46.04	1935-04-26	4	Apr	1935	04-26	87.98
## 19837	1938-04-26	87.98	55.04	1938-04-26	4	Apr	1938	04-26	87.98
## 37370	1986-04-27	87.08	57.92	1986-04-27	4	Apr	1986	04-27	87.08
## 26779	1957-04-28	86.00	60.98	1957-04-28	4	Apr	1957	04-28	86.00
## 5596	1899-04-29	86.00	66.92	1899-04-29	4	Apr	1899	04-29	86.00
## 48695	2017-04-29	86.00	64.04	2017-04-29	4	Apr	2017	04-29	86.00
## 21302	1942-04-30	91.04	59.00	1942-04-30	4	Apr	1942	04-30	91.04
## 24590	1951-05-01	89.96	62.96	1951-05-01	5	May	1951	05-01	89.96
## 27513	1959-05-02	87.98	59.00	1959-05-02	5	May	1959	05-02	87.98
## 27514	1959-05-03	87.98	64.04	1959-05-03	5	May	1959	05-03	87.98
## 19845	1938-05-04	87.98	60.08	1938-05-04	5	May	1938	05-04	87.98
## 23863	1949-05-04	87.98	59.00	1949-05-04	5	May	1949	05-04	87.98
## 24960	1952-05-05	91.94	60.08	1952-05-05	5	May	1952	05-05	91.94
## 19117	1936-05-06	89.06	53.06	1936-05-06	5	May	1936	05-06	89.06
## 42858	2001-05-06	89.06	60.98	2001-05-06	5	May	2001	05-06	89.06
## 19118	1936-05-07	89.06	59.00	1936-05-07	5	May	1936	05-07	89.06
## 20579	1940-05-07	89.06	60.08	1940-05-07	5	May	1940	05-07	89.06
## 19119	1936-05-08	89.96	57.92	1936-05-08	5	May	1936	05-08	89.96
## 19120	1936-05-09	95.00	57.92	1936-05-09	5	May	1936	05-09	95.00
## 19121	1936-05-10	95.00	60.98	1936-05-10	5	May	1936	05-10	95.00
## 4513	1896-05-11	91.94	68.00	1896-05-11	5	May	1896	05-11	91.94
## 22045	1944-05-12	89.96	57.92	1944-05-12	5	May	1944	05-12	89.96
## 26429	1956-05-13	89.06	66.02	1956-05-13	5	May	1956	05-13	89.06
## 26794	1957-05-13	89.06	62.96	1957-05-13	5	May	1957	05-13	89.06
## 49075	2018-05-14	89.96	66.02	2018-05-14	5	May	2018	05-14	89.96
## 28622	1962-05-15	89.06	66.02	1962-05-15	5	May	1962	05-15	89.06
## 49076	2018-05-15	89.06	68.00	2018-05-15	5	May	2018	05-15	89.06
## 5978	1900-05-16	91.04	62.96	1900-05-16	5	May	1900	05-16	91.04
## 28623	1962-05-16	91.04	66.02	1962-05-16	5	May	1962	05-16	91.04
## 28624	1962-05-17	91.94	68.00	1962-05-17	5	May	1962	05-17	91.94

##	28625	1962-05-18	91.94	68.00	1962-05-18	5	May	1962	05-18	91.94
##	22052	1944-05-19	91.04	64.04	1944-05-19	5	May	1944	05-19	91.04
##	22053	1944-05-20	91.04	64.04	1944-05-20	5	May	1944	05-20	91.04
##	20958	1941-05-21	91.94	55.04	1941-05-21	5	May	1941	05-21	91.94
##	20959	1941-05-22	96.08	60.98	1941-05-22	5	May	1941	05-22	96.08
##	19134	1936-05-23	91.04	59.00	1936-05-23	5	May	1936	05-23	91.04
##	20229	1939-05-23	91.04	60.98	1939-05-23	5	May	1939	05-23	91.04
##	20230	1939-05-24	93.02	64.04	1939-05-24	5	May	1939	05-24	93.02
##	25345	1953-05-25	91.04	69.08	1953-05-25	5	May	1953	05-25	91.04
##	20232	1939-05-26	93.92	62.96	1939-05-26	5	May	1939	05-26	93.92
##	10006	1911-05-27	93.02	71.06	1911-05-27	5	May	1911	05-27	93.02
##	10007	1911-05-28	93.02	69.08	1911-05-28	5	May	1911	05-28	93.02
##	20965	1941-05-28	93.02	66.02	1941-05-28	5	May	1941	05-28	93.02
##	20966	1941-05-29	93.92	64.04	1941-05-29	5	May	1941	05-29	93.92
##	19506	1937-05-30	91.94	60.98	1937-05-30	5	May	1937	05-30	91.94
##	22063	1944-05-30	91.94	62.96	1944-05-30	5	May	1944	05-30	91.94
##	25350	1953-05-30	91.94	71.06	1953-05-30	5	May	1953	05-30	91.94
##	19507	1937-05-31	95.00	64.94	1937-05-31	5	May	1937	05-31	95.00
##	19508	1937-06-01	95.00	68.00	1937-06-01	6	Jun	1937	06-01	95.00
##	24622	1951-06-02	96.08	68.00	1951-06-02	6	Jun	1951	06-02	96.08
##	4170	1895-06-03	93.92	71.06	1895-06-03	6	Jun	1895	06-03	93.92
##	15128	1925-06-04	96.98	71.96	1925-06-04	6	Jun	1925	06-04	96.98
##	21338	1942-06-05	93.92	68.00	1942-06-05	6	Jun	1942	06-05	93.92
##	21704	1943-06-06	95.00	64.94	1943-06-06	6	Jun	1943	06-06	95.00
##	18053	1933-06-07	95.00	75.92	1933-06-07	6	Jun	1933	06-07	95.00
##	18054	1933-06-08	95.00	80.06	1933-06-08	6	Jun	1933	06-08	95.00
##	24994	1952-06-08	95.00	68.00	1952-06-08	6	Jun	1952	06-08	95.00
##	25359	1953-06-08	95.00	66.92	1953-06-08	6	Jun	1953	06-08	95.00
##	25360	1953-06-09	96.08	73.94	1953-06-09	6	Jun	1953	06-09	96.08
##	10020	1911-06-10	95.00	69.98	1911-06-10	6	Jun	1911	06-10	95.00
##	10021	1911-06-11	93.92	73.04	1911-06-11	6	Jun	1911	06-11	93.92
##	21710	1943-06-12	95.00	66.02	1943-06-12	6	Jun	1943	06-12	95.00
##	22076	1944-06-12	95.00	64.04	1944-06-12	6	Jun	1944	06-12	95.00
##	25728	1954-06-12	95.00	69.08	1954-06-12	6	Jun	1954	06-12	95.00
##	21711	1943-06-13	96.08	69.08	1943-06-13	6	Jun	1943	06-13	96.08
##	21712	1943-06-14	93.92	68.00	1943-06-14	6	Jun	1943	06-14	93.92
##	38149	1988-06-14	93.92	60.08	1988-06-14	6	Jun	1988	06-14	93.92
##	25001	1952-06-15	96.98	71.96	1952-06-15	6	Jun	1952	06-15	96.98
##	25002	1952-06-16	96.08	71.06	1952-06-16	6	Jun	1952	06-16	96.08
##	19159	1936-06-17	98.96	66.02	1936-06-17	6	Jun	1936	06-17	98.96
##	22081	1944-06-17	98.96	71.96	1944-06-17	6	Jun	1944	06-17	98.96
##	22082	1944-06-18	98.96	71.96	1944-06-18	6	Jun	1944	06-18	98.96
##	1630	1888-06-19	96.98	71.06	1888-06-19	6	Jun	1888	06-19	96.98
##	40345	1994-06-19	96.98	69.08	1994-06-19	6	Jun	1994	06-19	96.98
##	25371	1953-06-20	100.04	69.08	1953-06-20	6	Jun	1953	06-20	100.04

## 25372	1953-06-21	96.98	73.04	1953-06-21	6	Jun 1953 06-21	96.98
## 38156	1988-06-21	96.98	69.98	1988-06-21	6	Jun 1988 06-21	96.98
## 38157	1988-06-22	98.96	71.96	1988-06-22	6	Jun 1988 06-22	98.96
## 22087	1944-06-23	96.08	73.94	1944-06-23	6	Jun 1944 06-23	96.08
## 25374	1953-06-23	96.08	69.08	1953-06-23	6	Jun 1953 06-23	96.08
## 38158	1988-06-23	96.08	73.94	1988-06-23	6	Jun 1988 06-23	96.08
## 11130	1914-06-24	96.98	77.00	1914-06-24	6	Jun 1914 06-24	96.98
## 38160	1988-06-25	100.94	71.96	1988-06-25	6	Jun 1988 06-25	100.94
## 25742	1954-06-26	100.94	66.92	1954-06-26	6	Jun 1954 06-26	100.94
## 22091	1944-06-27	100.94	68.00	1944-06-27	6	Jun 1944 06-27	100.94
## 22092	1944-06-28	102.92	73.04	1944-06-28	6	Jun 1944 06-28	102.92
## 19171	1936-06-29	104.00	64.04	1936-06-29	6	Jun 1936 06-29	104.00
## 46931	2012-06-30	102.92	66.92	2012-06-30	6	Jun 2012 06-30	102.92
## 46932	2012-07-01	102.92	69.08	2012-07-01	7	Jul 2012 07-01	102.92
## 18808	1935-07-02	96.98	68.00	1935-07-02	7	Jul 1935 07-02	96.98
## 31592	1970-07-02	96.98	71.96	1970-07-02	7	Jul 1970 07-02	96.98
## 46933	2012-07-02	96.98	66.92	2012-07-02	7	Jul 2012 07-02	96.98
## 10043	1911-07-03	98.06	75.02	1911-07-03	7	Jul 1911 07-03	98.06
## 46935	2012-07-04	98.96	71.06	2012-07-04	7	Jul 2012 07-04	98.96
## 46936	2012-07-05	98.96	71.96	2012-07-05	7	Jul 2012 07-05	98.96
## 46937	2012-07-06	102.92	66.92	2012-07-06	7	Jul 2012 07-06	102.92
## 46938	2012-07-07	105.08	73.04	2012-07-07	7	Jul 2012 07-07	105.08
## 19180	1936-07-08	105.98	69.98	1936-07-08	7	Jul 1936 07-08	105.98
## 19181	1936-07-09	105.98	71.96	1936-07-09	7	Jul 1936 07-09	105.98
## 19182	1936-07-10	107.96	75.92	1936-07-10	7	Jul 1936 07-10	107.96
## 19183	1936-07-11	104.00	71.96	1936-07-11	7	Jul 1936 07-11	104.00
## 19184	1936-07-12	104.00	73.04	1936-07-12	7	Jul 1936 07-12	104.00
## 19185	1936-07-13	102.92	73.94	1936-07-13	7	Jul 1936 07-13	102.92
## 19186	1936-07-14	105.98	71.06	1936-07-14	7	Jul 1936 07-14	105.98
## 19187	1936-07-15	107.96	71.06	1936-07-15	7	Jul 1936 07-15	107.96
## 35259	1980-07-16	100.04	75.02	1980-07-16	7	Jul 1980 07-16	100.04
## 18823	1935-07-17	98.96	62.96	1935-07-17	7	Jul 1935 07-17	98.96
## 25764	1954-07-18	100.04	75.92	1954-07-18	7	Jul 1954 07-18	100.04
## 35262	1980-07-19	98.96	66.92	1980-07-19	7	Jul 1980 07-19	98.96
## 25766	1954-07-20	98.96	78.08	1954-07-20	7	Jul 1954 07-20	98.96
## 18462	1934-07-21	100.04	75.02	1934-07-21	7	Jul 1934 07-21	100.04
## 6410	1901-07-22	102.02	73.04	1901-07-22	7	Jul 1901 07-22	102.02
## 18464	1934-07-23	98.96	75.02	1934-07-23	7	Jul 1934 07-23	98.96
## 25039	1952-07-23	98.96	71.06	1952-07-23	7	Jul 1952 07-23	98.96
## 36361	1983-07-23	98.96	75.02	1983-07-23	7	Jul 1983 07-23	98.96
## 6412	1901-07-24	100.94	71.96	1901-07-24	7	Jul 1901 07-24	100.94
## 18466	1934-07-25	100.94	75.92	1934-07-25	7	Jul 1934 07-25	100.94
## 25042	1952-07-26	100.04	64.94	1952-07-26	7	Jul 1952 07-26	100.04
## 25043	1952-07-27	102.92	69.98	1952-07-27	7	Jul 1952 07-27	102.92
## 17008	1930-07-28	104.00	80.96	1930-07-28	7	Jul 1930 07-28	104.00

## 20662	1940-07-29	100.04	73.94	1940-07-29	7	Jul 1940	07-29	100.04
## 42212	1999-07-30	102.92	73.04	1999-07-30	7	Jul 1999	07-30	102.92
## 42213	1999-07-31	98.96	75.02	1999-07-31	7	Jul 1999	07-31	98.96
## 21395	1942-08-01	96.98	69.08	1942-08-01	8	Aug 1942	08-01	96.98
## 25413	1953-08-01	96.98	71.96	1953-08-01	8	Aug 1953	08-01	96.98
## 21396	1942-08-02	98.06	73.04	1942-08-02	8	Aug 1942	08-02	98.06
## 43311	2002-08-02	98.06	68.00	2002-08-02	8	Aug 2002	08-02	98.06
## 1675	1888-08-03	98.96	73.94	1888-08-03	8	Aug 1888	08-03	98.96
## 17015	1930-08-04	98.96	75.02	1930-08-04	8	Aug 1930	08-04	98.96
## 43313	2002-08-04	98.96	71.96	2002-08-04	8	Aug 2002	08-04	98.96
## 43314	2002-08-05	98.06	69.08	2002-08-05	8	Aug 2002	08-05	98.06
## 12634	1918-08-06	100.04	71.06	1918-08-06	8	Aug 1918	08-06	100.04
## 17018	1930-08-07	96.98	71.96	1930-08-07	8	Aug 1930	08-07	96.98
## 18844	1935-08-07	96.98	71.06	1935-08-07	8	Aug 1935	08-07	96.98
## 21036	1941-08-07	96.98	62.96	1941-08-07	8	Aug 1941	08-07	96.98
## 45142	2007-08-07	96.98	75.02	2007-08-07	8	Aug 2007	08-07	96.98
## 17019	1930-08-08	98.96	75.92	1930-08-08	8	Aug 1930	08-08	98.96
## 21037	1941-08-08	98.96	66.92	1941-08-08	8	Aug 1941	08-08	98.96
## 17020	1930-08-09	98.96	66.92	1930-08-09	8	Aug 1930	08-09	98.96
## 10081	1911-08-10	98.96	71.06	1911-08-10	8	Aug 1911	08-10	98.96
## 10082	1911-08-11	98.06	71.96	1911-08-11	8	Aug 1911	08-11	98.06
## 21040	1941-08-11	98.06	71.96	1941-08-11	8	Aug 1941	08-11	98.06
## 19215	1936-08-12	98.06	66.92	1936-08-12	8	Aug 1936	08-12	98.06
## 44417	2005-08-12	98.06	71.96	2005-08-12	8	Aug 2005	08-12	98.06
## 42226	1999-08-13	98.06	71.06	1999-08-13	8	Aug 1999	08-13	98.06
## 21773	1943-08-14	100.04	66.92	1943-08-14	8	Aug 1943	08-14	100.04
## 45150	2007-08-15	100.94	68.00	2007-08-15	8	Aug 2007	08-15	100.94
## 45151	2007-08-16	102.02	69.98	2007-08-16	8	Aug 2007	08-16	102.02
## 19220	1936-08-17	98.96	69.08	1936-08-17	8	Aug 1936	08-17	98.96
## 19221	1936-08-18	102.92	71.06	1936-08-18	8	Aug 1936	08-18	102.92
## 19222	1936-08-19	105.08	75.02	1936-08-19	8	Aug 1936	08-19	105.08
## 19223	1936-08-20	104.00	71.06	1936-08-20	8	Aug 1936	08-20	104.00
## 19224	1936-08-21	104.00	75.92	1936-08-21	8	Aug 1936	08-21	104.00
## 19225	1936-08-22	104.00	75.02	1936-08-22	8	Aug 1936	08-22	104.00
## 45158	2007-08-23	96.98	73.94	2007-08-23	8	Aug 2007	08-23	96.98
## 19227	1936-08-24	98.96	73.94	1936-08-24	8	Aug 1936	08-24	98.96
## 21783	1943-08-24	98.96	69.08	1943-08-24	8	Aug 1943	08-24	98.96
## 21784	1943-08-25	102.02	69.08	1943-08-25	8	Aug 1943	08-25	102.02
## 19229	1936-08-26	98.96	73.94	1936-08-26	8	Aug 1936	08-26	98.96
## 23612	1948-08-26	98.96	66.92	1948-08-26	8	Aug 1948	08-26	98.96
## 19230	1936-08-27	100.94	66.92	1936-08-27	8	Aug 1936	08-27	100.94
## 19231	1936-08-28	100.04	66.02	1936-08-28	8	Aug 1936	08-28	100.04
## 25441	1953-08-29	98.06	69.08	1953-08-29	8	Aug 1953	08-29	98.06
## 25442	1953-08-30	96.98	68.00	1953-08-30	8	Aug 1953	08-30	96.98
## 25443	1953-08-31	98.96	66.92	1953-08-31	8	Aug 1953	08-31	98.96

## 25444	1953-09-01	100.94	66.92	1953-09-01	9	Sep	1953	09-01	100.94
## 25445	1953-09-02	100.04	71.96	1953-09-02	9	Sep	1953	09-02	100.04
## 25446	1953-09-03	100.04	75.92	1953-09-03	9	Sep	1953	09-03	100.04
## 25812	1954-09-04	98.06	64.04	1954-09-04	9	Sep	1954	09-04	98.06
## 25813	1954-09-05	102.92	69.08	1954-09-05	9	Sep	1954	09-05	102.92
## 25814	1954-09-06	102.02	71.06	1954-09-06	9	Sep	1954	09-06	102.02
## 5727	1899-09-07	96.98	71.06	1899-09-07	9	Sep	1899	09-07	96.98
## 20336	1939-09-07	96.98	64.04	1939-09-07	9	Sep	1939	09-07	96.98
## 20337	1939-09-08	100.94	71.06	1939-09-08	9	Sep	1939	09-08	100.94
## 20338	1939-09-09	100.94	66.92	1939-09-09	9	Sep	1939	09-09	100.94
## 49559	2019-09-10	100.04	68.00	2019-09-10	9	Sep	2019	09-10	100.04
## 5001	1897-09-11	95.00	71.96	1897-09-11	9	Sep	1897	09-11	95.00
## 36411	1983-09-11	95.00	71.96	1983-09-11	9	Sep	1983	09-11	95.00
## 49560	2019-09-11	95.00	73.94	2019-09-11	9	Sep	2019	09-11	95.00
## 20341	1939-09-12	96.98	51.98	1939-09-12	9	Sep	1939	09-12	96.98
## 20342	1939-09-13	98.96	66.02	1939-09-13	9	Sep	1939	09-13	98.96
## 19248	1936-09-14	100.94	71.96	1936-09-14	9	Sep	1936	09-14	100.94
## 19249	1936-09-15	96.98	69.98	1936-09-15	9	Sep	1936	09-15	96.98
## 5006	1897-09-16	96.08	73.04	1897-09-16	9	Sep	1897	09-16	96.08
## 49565	2019-09-16	96.08	64.04	2019-09-16	9	Sep	2019	09-16	96.08
## 25825	1954-09-17	93.92	64.94	1954-09-17	9	Sep	1954	09-17	93.92
## 25461	1953-09-18	96.08	60.98	1953-09-18	9	Sep	1953	09-18	96.08
## 25827	1954-09-19	95.00	66.92	1954-09-19	9	Sep	1954	09-19	95.00
## 20715	1940-09-20	96.08	60.08	1940-09-20	9	Sep	1940	09-20	96.08
## 20716	1940-09-21	96.98	62.06	1940-09-21	9	Sep	1940	09-21	96.98
## 19256	1936-09-22	96.98	62.06	1936-09-22	9	Sep	1936	09-22	96.98
## 46285	2010-09-23	93.92	66.92	2010-09-23	9	Sep	2010	09-23	93.92
## 45190	2007-09-24	93.02	66.92	2007-09-24	9	Sep	2007	09-24	93.02
## 45191	2007-09-25	93.02	69.98	2007-09-25	9	Sep	2007	09-25	93.02
## 6111	1900-09-26	89.96	68.00	1900-09-26	9	Sep	1900	09-26	89.96
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## 25472	1953-09-29	96.98	57.92	1953-09-29	9	Sep	1953	09-29	96.98
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## 49581	2019-10-02	96.08	69.98	2019-10-02	10	Oct	2019	10-02	96.08
## 49582	2019-10-03	96.08	69.08	2019-10-03	10	Oct	2019	10-03	96.08
## 27668	1959-10-04	91.04	66.92	1959-10-04	10	Oct	1959	10-04	91.04
## 21095	1941-10-05	89.06	71.06	1941-10-05	10	Oct	1941	10-05	89.06
## 24747	1951-10-05	89.06	57.92	1951-10-05	10	Oct	1951	10-05	89.06
## 27669	1959-10-05	89.06	69.08	1959-10-05	10	Oct	1959	10-05	89.06
## 21096	1941-10-06	93.02	69.98	1941-10-06	10	Oct	1941	10-06	93.02
## 21097	1941-10-07	91.94	62.06	1941-10-07	10	Oct	1941	10-07	91.94
## 45204	2007-10-08	91.04	62.96	2007-10-08	10	Oct	2007	10-08	91.04

## 20368	1939-10-09	91.04	62.96	1939-10-09	10	Oct 1939	10-09	91.04
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## 20369	1939-10-10	87.08	53.96	1939-10-10	10	Oct 1939	10-10	87.08
## 20736	1940-10-11	87.08	46.04	1940-10-11	10	Oct 1940	10-11	87.08
## 21831	1943-10-11	87.08	46.04	1943-10-11	10	Oct 1943	10-11	87.08
## 20006	1938-10-12	86.00	55.94	1938-10-12	10	Oct 1938	10-12	86.00
## 18911	1935-10-13	87.98	57.92	1935-10-13	10	Oct 1935	10-13	87.98
## 5034	1897-10-14	86.00	62.06	1897-10-14	10	Oct 1897	10-14	86.00
## 5035	1897-10-15	87.98	62.96	1897-10-15	10	Oct 1897	10-15	87.98
## 5036	1897-10-16	87.08	60.08	1897-10-16	10	Oct 1897	10-16	87.08
## 20011	1938-10-17	87.08	51.98	1938-10-17	10	Oct 1938	10-17	87.08
## 20012	1938-10-18	87.08	50.00	1938-10-18	10	Oct 1938	10-18	87.08
## 48503	2016-10-19	87.08	66.02	2016-10-19	10	Oct 2016	10-19	87.08
## 29145	1963-10-20	86.00	57.02	1963-10-20	10	Oct 1963	10-20	86.00
## 25494	1953-10-21	84.92	55.04	1953-10-21	10	Oct 1953	10-21	84.92
## 23303	1947-10-22	84.92	53.06	1947-10-22	10	Oct 1947	10-22	84.92
## 29148	1963-10-23	84.02	51.98	1963-10-23	10	Oct 1963	10-23	84.02
## 20383	1939-10-24	82.04	46.04	1939-10-24	10	Oct 1939	10-24	82.04
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## 20751	1940-10-26	87.08	59.00	1940-10-26	10	Oct 1940	10-26	87.08
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## 20753	1940-10-28	84.92	53.96	1940-10-28	10	Oct 1940	10-28	84.92
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## 32077	1971-10-30	82.94	55.04	1971-10-30	10	Oct 1971	10-30	82.94
## 18929	1935-10-31	82.04	51.08	1935-10-31	10	Oct 1935	10-31	82.04
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## 37924	1987-11-02	82.04	53.96	1987-11-02	11	Nov 1987	11-02	82.04
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## 37925	1987-11-03	78.08	53.96	1987-11-03	11	Nov 1987	11-03	78.08
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## 48153	2015-11-04	78.08	53.06	2015-11-04	11	Nov 2015	11-04	78.08
## 34275	1977-11-05	78.98	62.96	1977-11-05	11	Nov 1977	11-05	78.98
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## 4327	1895-11-07	78.08	55.94	1895-11-07	11	Nov 1895	11-07	78.08
## 20032	1938-11-07	78.08	NA	1938-11-07	11	Nov 1938	11-07	78.08
## 49984	2020-11-08	77.00	50.00	2020-11-08	11	Nov 2020	11-08	77.00
## 49985	2020-11-09	78.08	51.98	2020-11-09	11	Nov 2020	11-09	78.08
## 49986	2020-11-10	77.00	57.02	2020-11-10	11	Nov 2020	11-10	77.00
## 6887	1902-11-11	75.02	55.04	1902-11-11	11	Nov 1902	11-11	75.02
## 24054	1949-11-11	75.02	51.98	1949-11-11	11	Nov 1949	11-11	75.02
## 20037	1938-11-12	75.02	51.98	1938-11-12	11	Nov 1938	11-12	75.02
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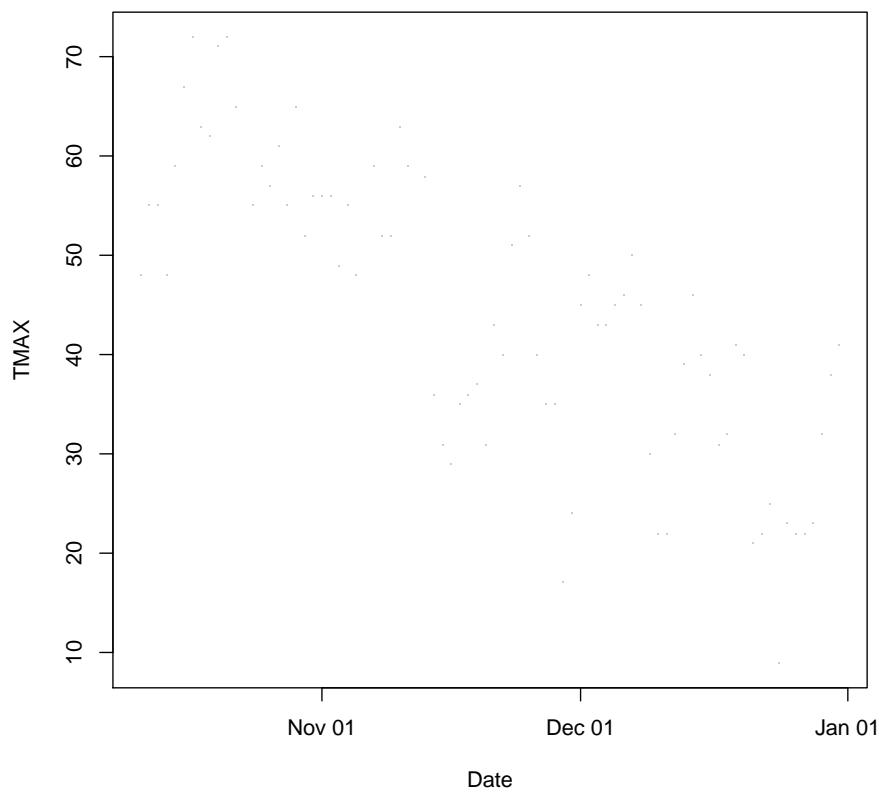
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## 27347	1958-11-17	80.06	62.06	1958-11-17	11	Nov 1958	11-17	80.06
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## 17122	1930-11-19	77.00	57.02	1930-11-19	11	Nov 1930	11-19	77.00
## 21505	1942-11-19	77.00	59.00	1942-11-19	11	Nov 1942	11-19	77.00
## 21506	1942-11-20	78.08	57.02	1942-11-20	11	Nov 1942	11-20	78.08
## 18585	1934-11-21	77.00	55.94	1934-11-21	11	Nov 1934	11-21	77.00
## 17490	1931-11-22	75.92	59.00	1931-11-22	11	Nov 1931	11-22	75.92
## 17491	1931-11-23	73.04	57.02	1931-11-23	11	Nov 1931	11-23	73.04
## 17492	1931-11-24	69.98	41.00	1931-11-24	11	Nov 1931	11-24	69.98
## 32833	1973-11-24	69.98	59.00	1973-11-24	11	Nov 1973	11-24	69.98
## 4711	1896-11-25	71.96	51.98	1896-11-25	11	Nov 1896	11-25	71.96
## 1424	1887-11-26	71.96	57.92	1887-11-26	11	Nov 1887	11-26	71.96
## 39045	1990-11-27	75.92	62.96	1990-11-27	11	Nov 1990	11-27	75.92
## 44525	2005-11-28	71.06	48.02	2005-11-28	11	Nov 2005	11-28	71.06
## 16036	1927-11-29	71.06	57.92	1927-11-29	11	Nov 1927	11-29	71.06
## 18228	1933-11-29	71.06	39.92	1933-11-29	11	Nov 1933	11-29	71.06
## 18594	1934-11-30	71.96	NA	1934-11-30	11	Nov 1934	11-30	71.96
## 31744	1970-12-01	69.98	57.02	1970-12-01	12	Dec 1970	12-01	69.98
## 36128	1982-12-02	75.02	62.06	1982-12-02	12	Dec 1982	12-02	75.02
## 36129	1982-12-03	75.02	60.08	1982-12-03	12	Dec 1982	12-03	75.02
## 36130	1982-12-04	73.94	55.94	1982-12-04	12	Dec 1982	12-04	73.94
## 43071	2001-12-05	71.96	50.00	2001-12-05	12	Dec 2001	12-05	71.96
## 41976	1998-12-06	71.96	60.08	1998-12-06	12	Dec 1998	12-06	71.96
## 24810	1951-12-07	68.00	51.98	1951-12-07	12	Dec 1951	12-07	68.00
## 35403	1980-12-07	68.00	46.94	1980-12-07	12	Dec 1980	12-07	68.00
## 41977	1998-12-07	68.00	51.08	1998-12-07	12	Dec 1998	12-07	68.00
## 14219	1922-12-08	68.00	37.04	1922-12-08	12	Dec 1922	12-08	68.00
## 25178	1952-12-09	68.00	50.00	1952-12-09	12	Dec 1952	12-09	68.00
## 32118	1971-12-10	71.96	53.06	1971-12-10	12	Dec 1971	12-10	71.96
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## 48191	2015-12-12	69.98	59.00	2015-12-12	12	Dec 2015	12-12	69.98
## 16050	1927-12-13	69.98	53.96	1927-12-13	12	Dec 1927	12-13	69.98
## 32122	1971-12-14	69.08	42.08	1971-12-14	12	Dec 1971	12-14	69.08
## 36871	1984-12-14	69.08	59.00	1984-12-14	12	Dec 1984	12-14	69.08
## 36872	1984-12-15	71.96	55.94	1984-12-15	12	Dec 1984	12-15	71.96
## 36873	1984-12-16	69.98	51.98	1984-12-16	12	Dec 1984	12-16	69.98
## 36874	1984-12-17	71.06	57.02	1984-12-17	12	Dec 1984	12-17	71.06
## 14960	1924-12-18	66.92	55.04	1924-12-18	12	Dec 1924	12-18	66.92
## 2178	1889-12-19	68.00	51.98	1889-12-19	12	Dec 1889	12-19	68.00
## 24093	1949-12-20	66.02	42.08	1949-12-20	12	Dec 1949	12-20	66.02
## 47470	2013-12-21	71.96	57.02	2013-12-21	12	Dec 2013	12-21	71.96

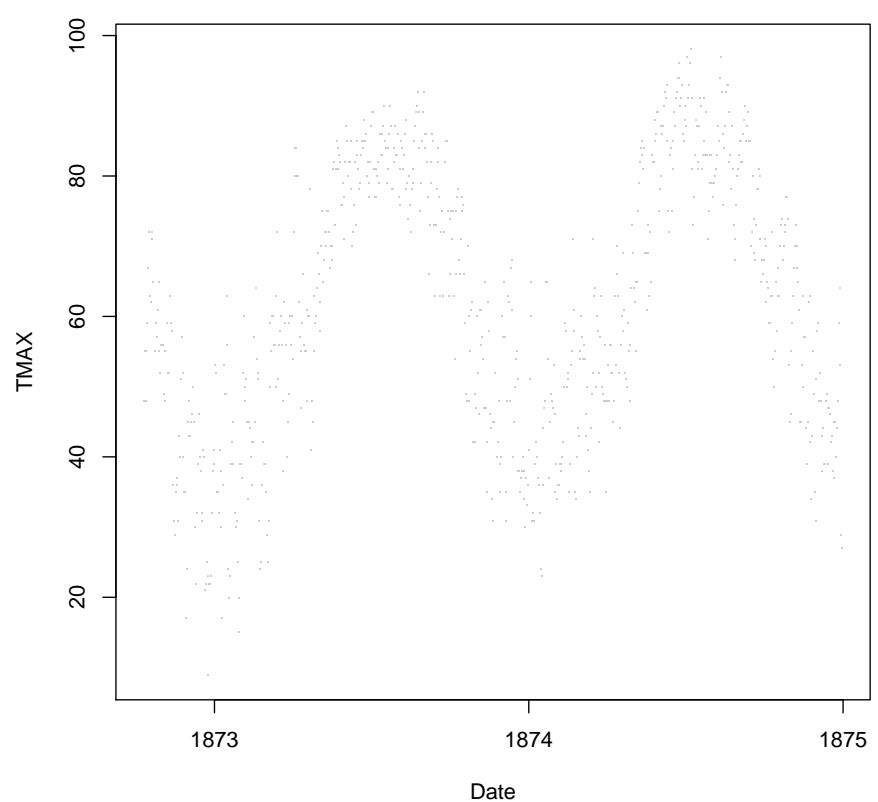
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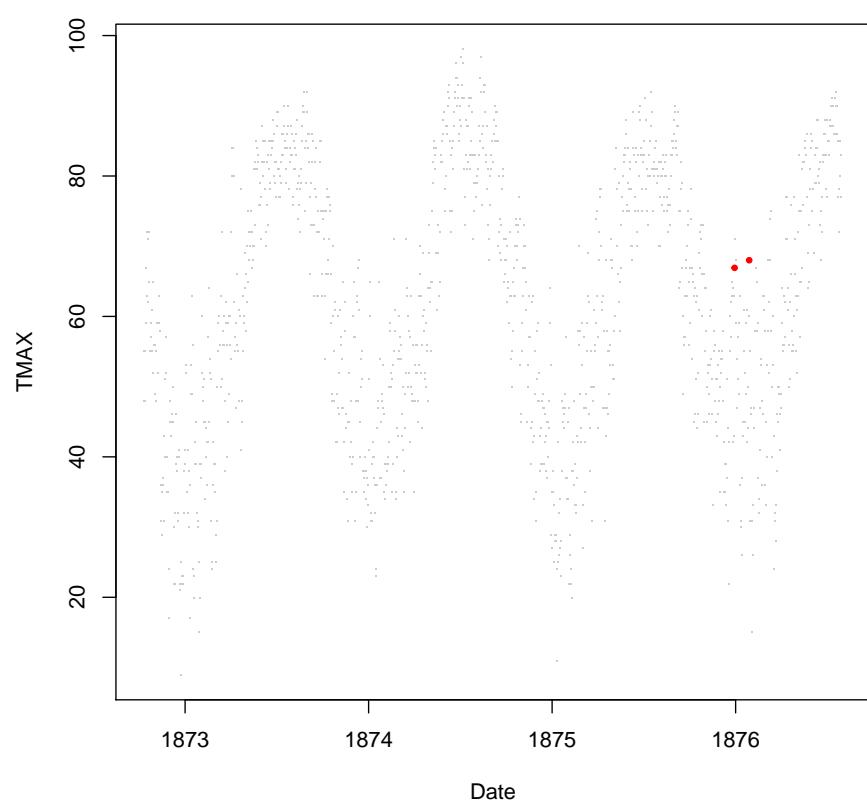
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## 31766 1970-12-23 68.00 26.96 1970-12-23 12 Dec 1970 12-23 68.00
## 2183 1889-12-24 68.00 44.06 1889-12-24 12 Dec 1889 12-24 68.00
## 29576 1964-12-24 68.00 53.06 1964-12-24 12 Dec 1964 12-24 68.00
## 36151 1982-12-25 69.98 57.92 1982-12-25 12 Dec 1982 12-25 69.98
## 50396 2021-12-25 69.98 50.00 2021-12-25 12 Dec 2021 12-25 69.98
## 48571 2016-12-26 73.94 55.04 2016-12-26 12 Dec 2016 12-26 73.94
## 45650 2008-12-27 69.98 55.94 2008-12-27 12 Dec 2008 12-27 69.98
## 48206 2015-12-27 69.98 42.08 2015-12-27 12 Dec 2015 12-27 69.98
## 36885 1984-12-28 66.92 57.02 1984-12-28 12 Dec 1984 12-28 66.92
## 50399 2021-12-28 66.92 42.98 2021-12-28 12 Dec 2021 12-28 66.92
## 36886 1984-12-29 68.00 60.08 1984-12-29 12 Dec 1984 12-29 68.00
## 1176 1875-12-30 66.92 50.00 1875-12-30 12 Dec 1875 12-30 66.92
## 24834 1951-12-31 71.96 55.04 1951-12-31 12 Dec 1951 12-31 71.96

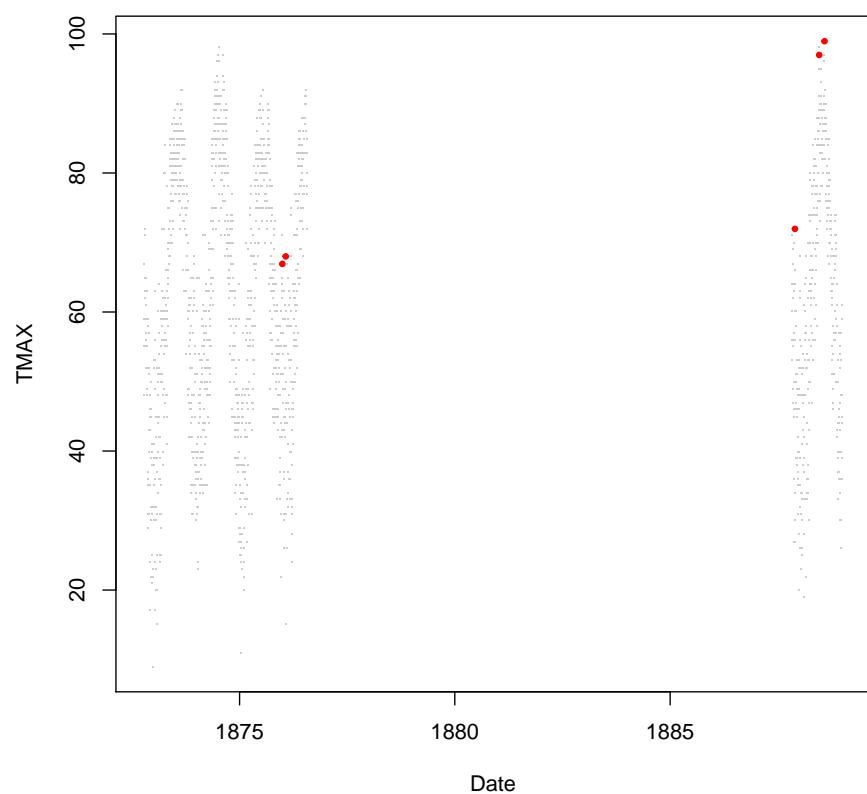
for(i in seq(min(CHCND$Year), max(CHCND$Year), by=2)){
  #i=52742
  plot(TMAX~Date, CHCND[CHCND$Year<=i], pch='.', col="grey80")
  points(maxTMAX~Date, data=CHCND[CHCND$Year<=i], pch=20, col="red", cex=.8 )
}

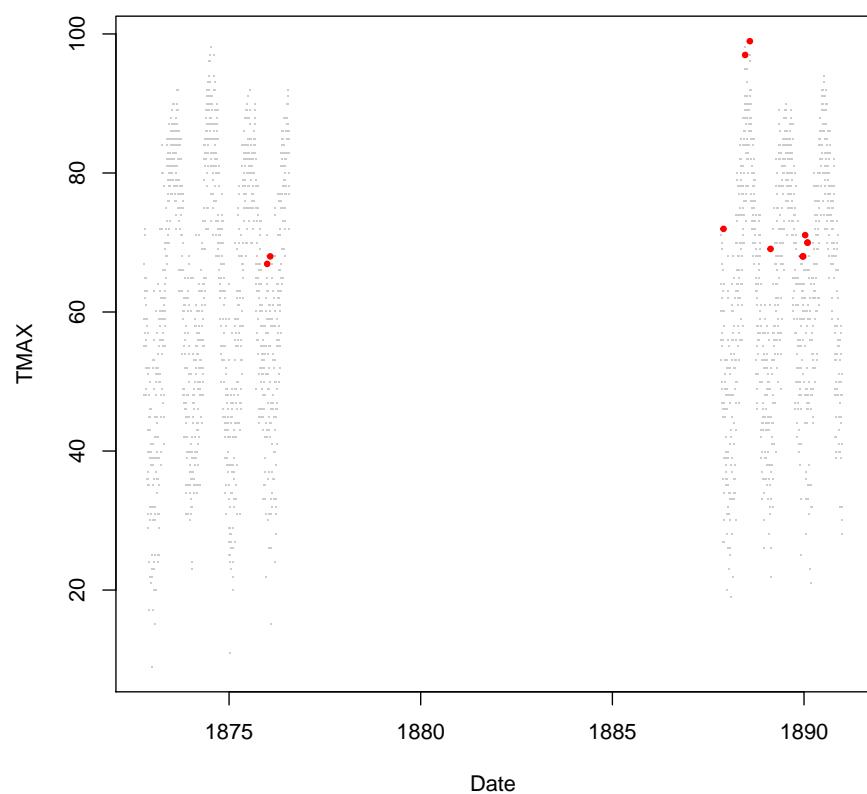
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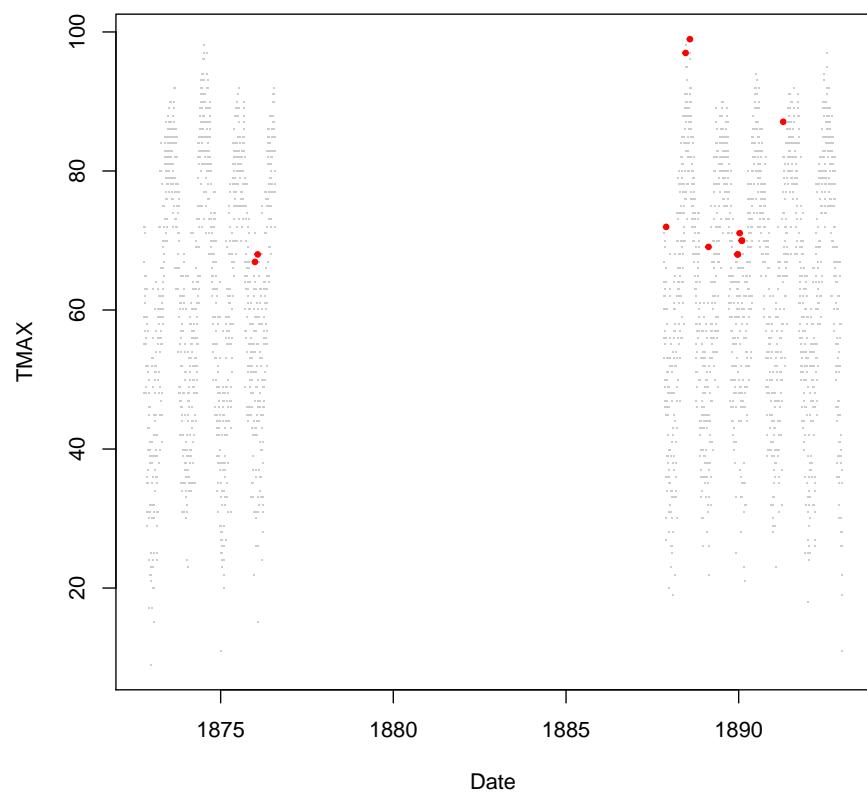


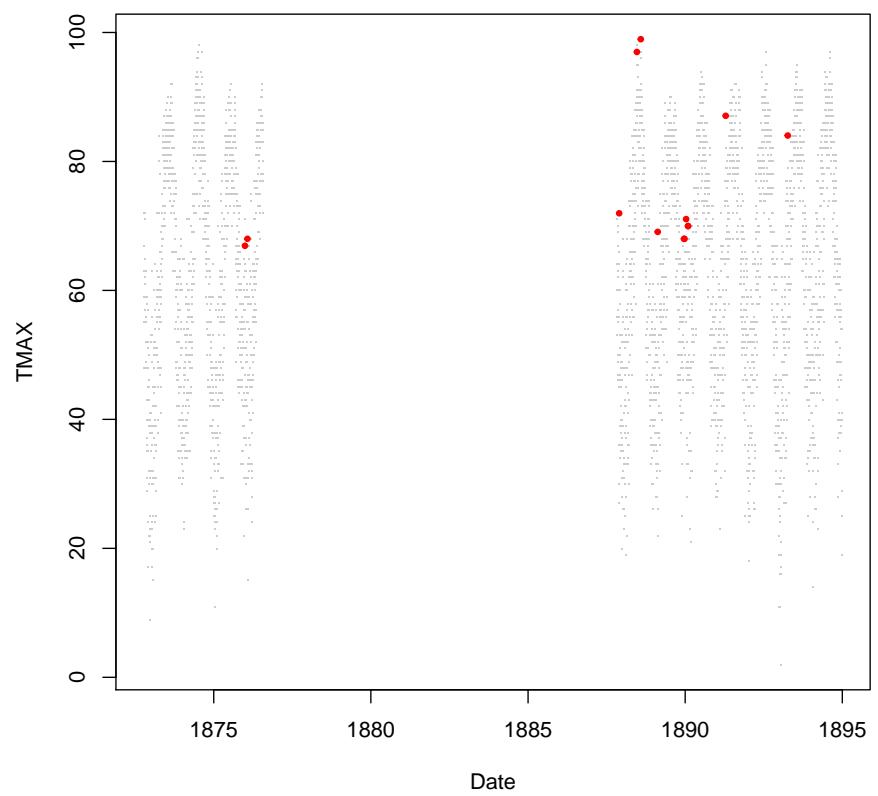


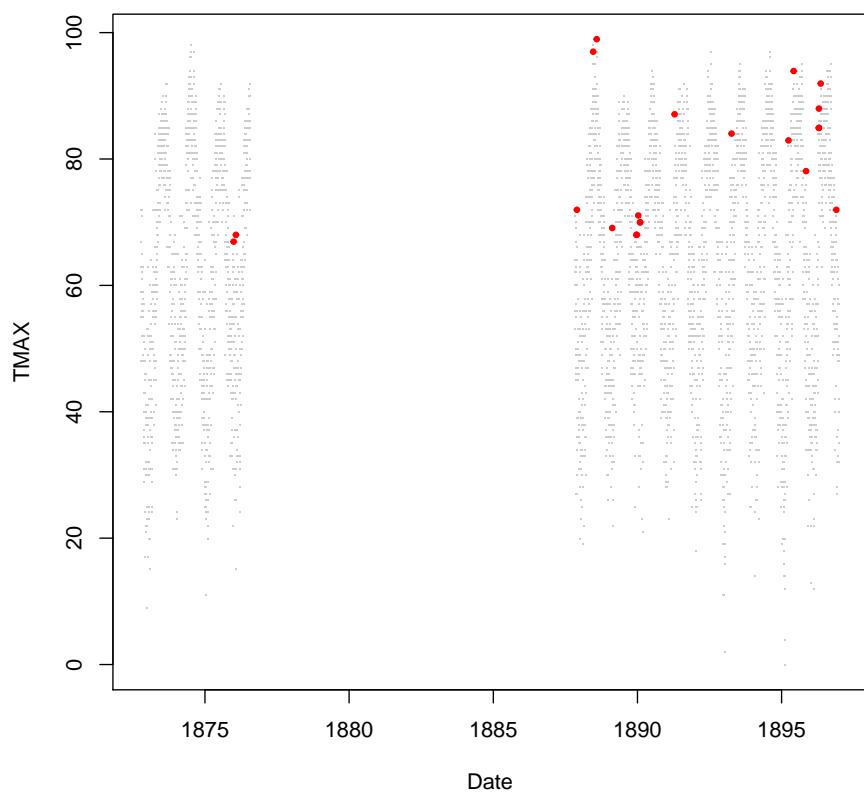


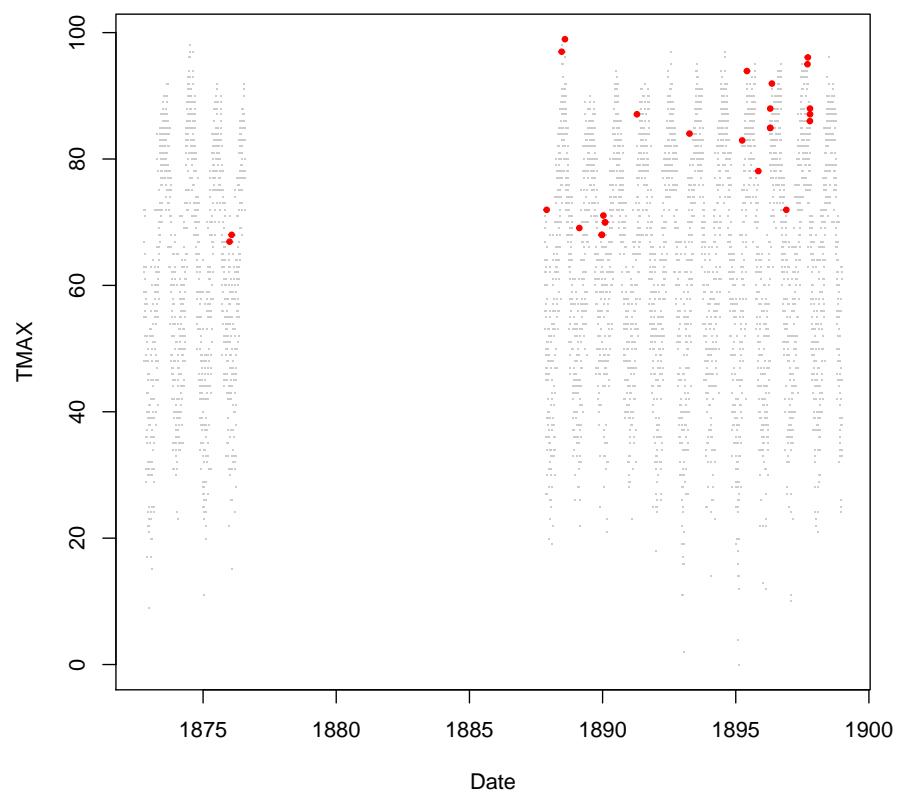


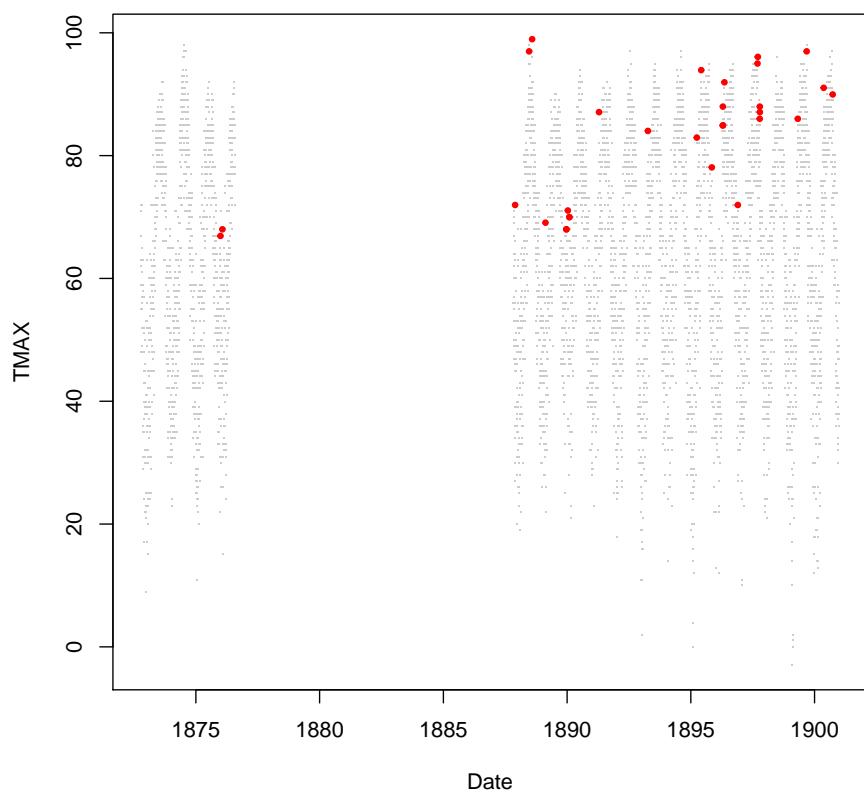


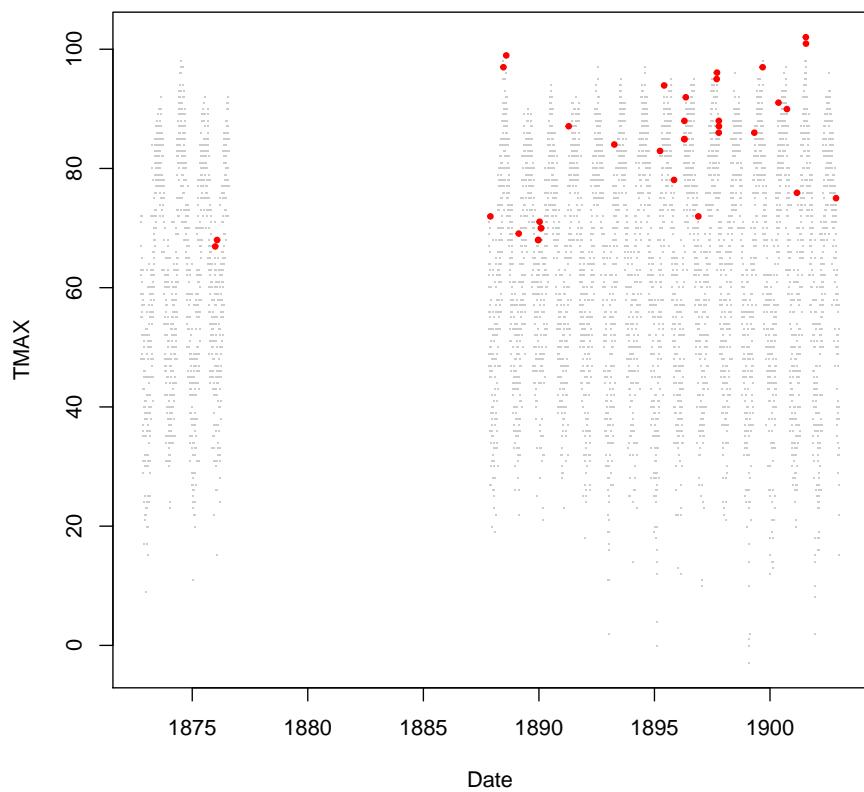


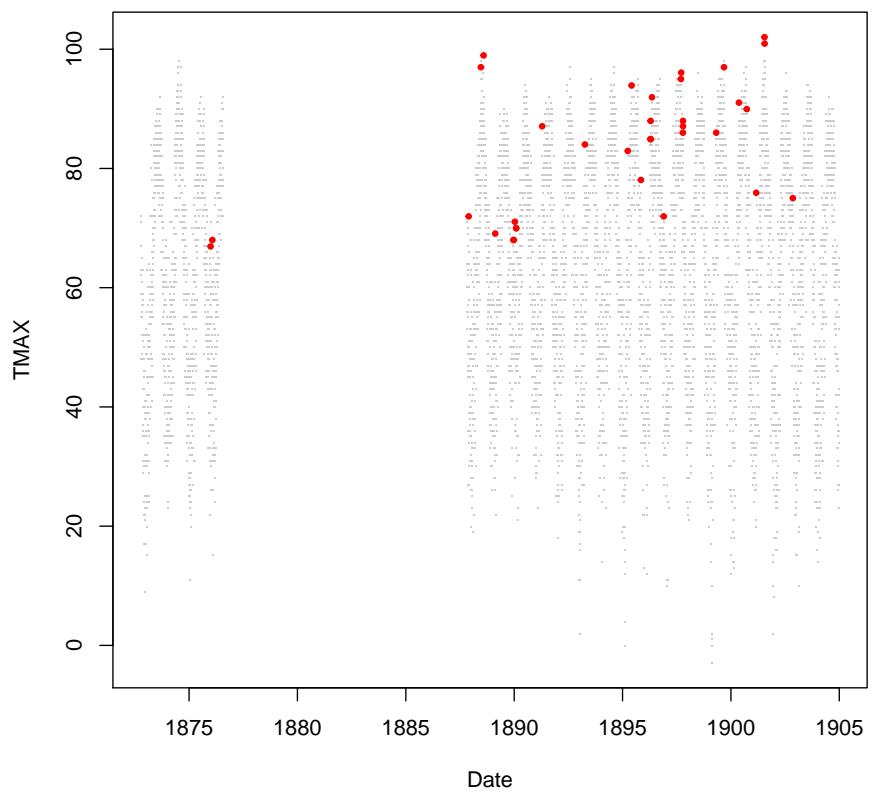


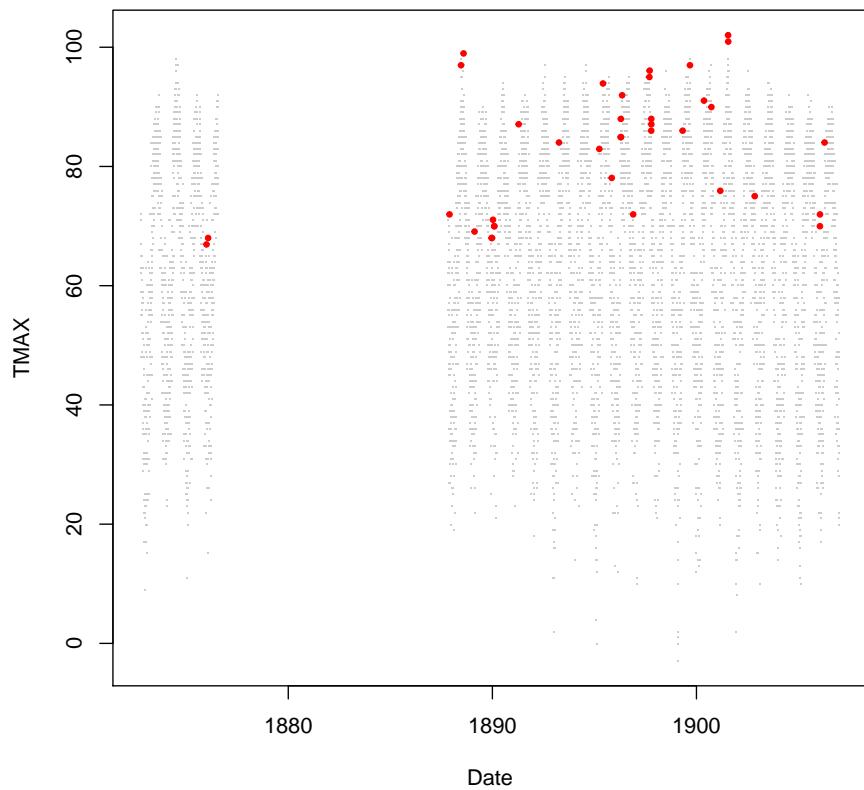


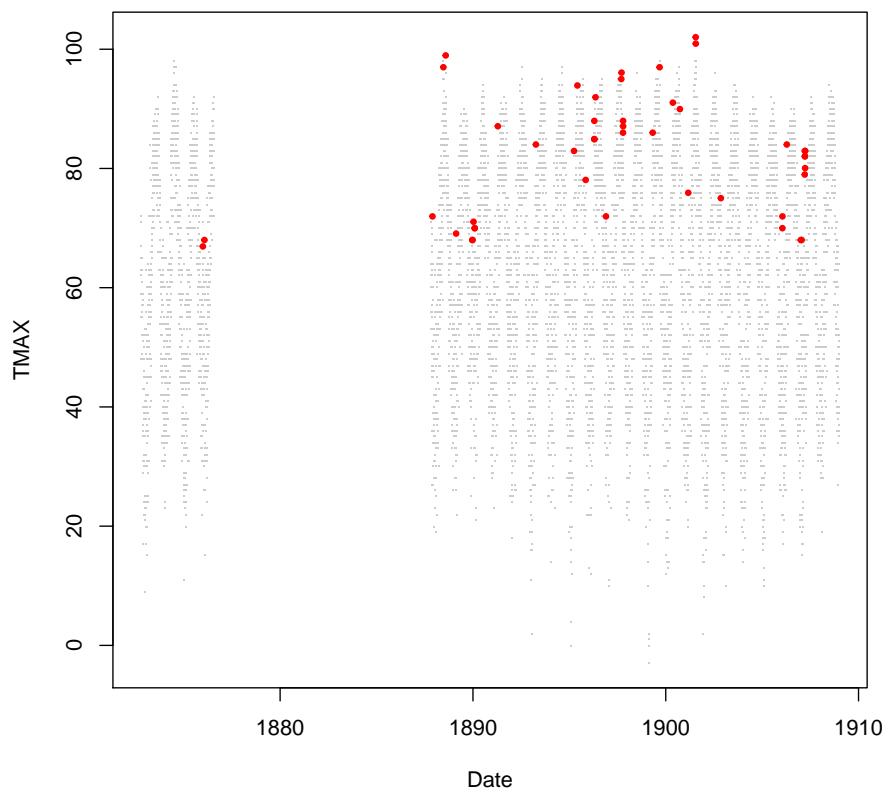


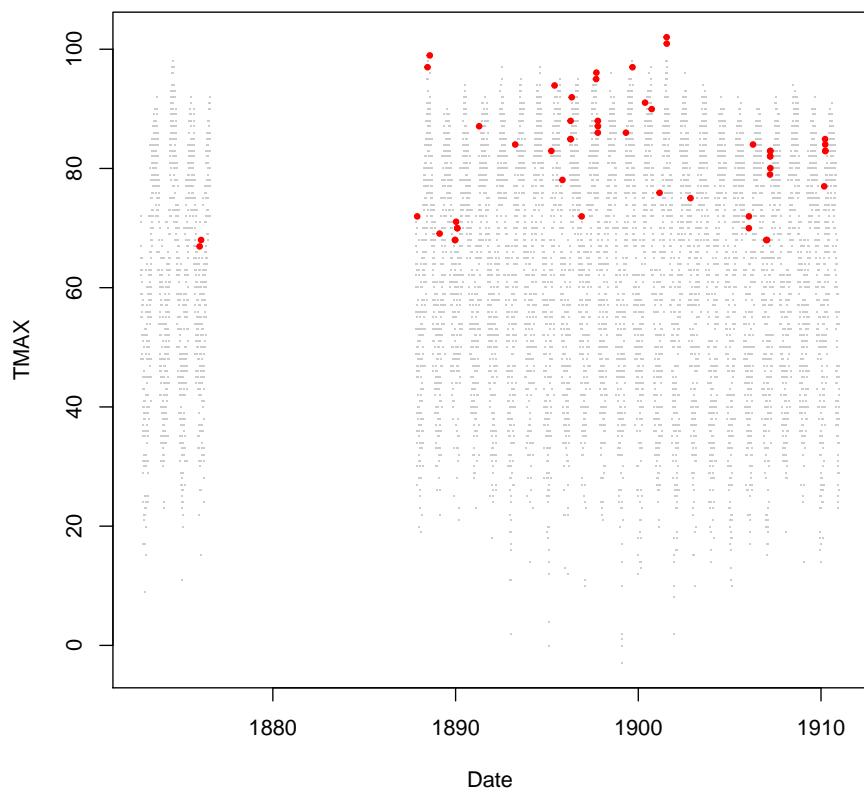


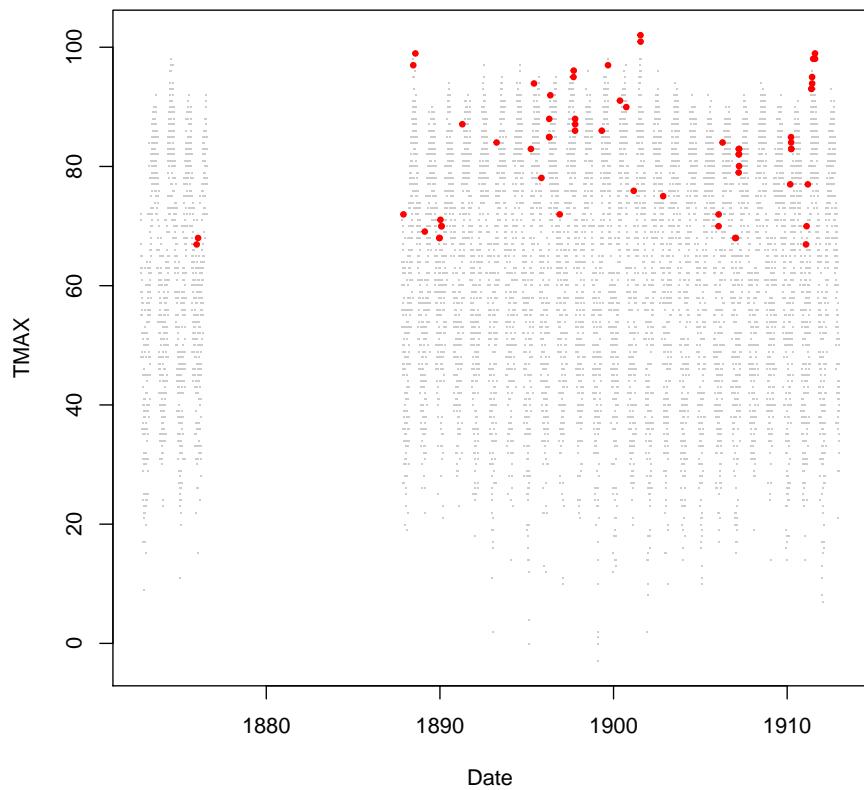


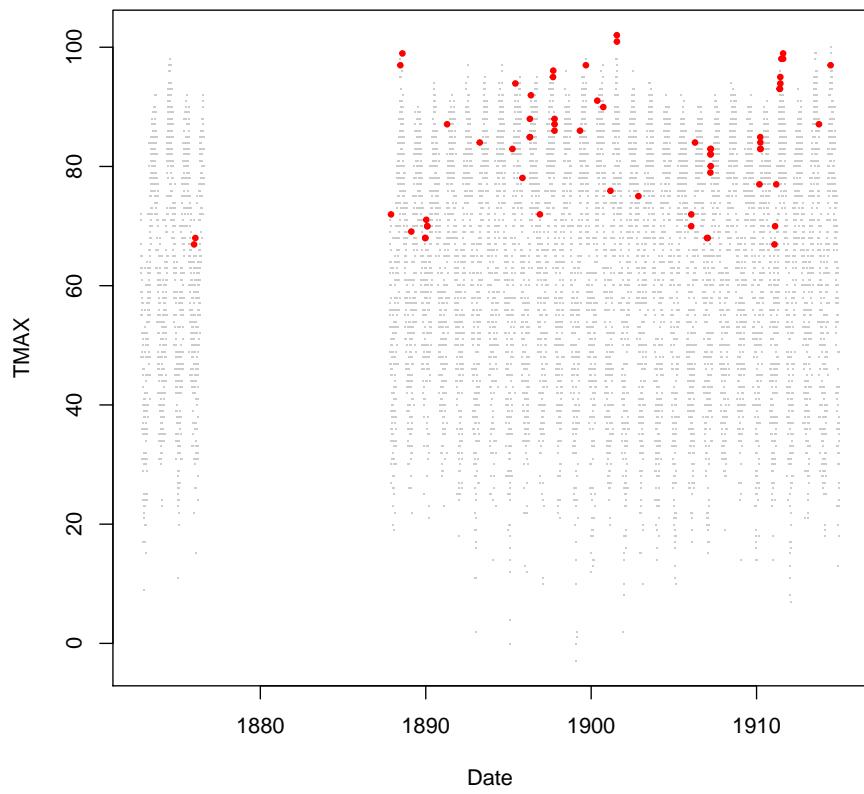


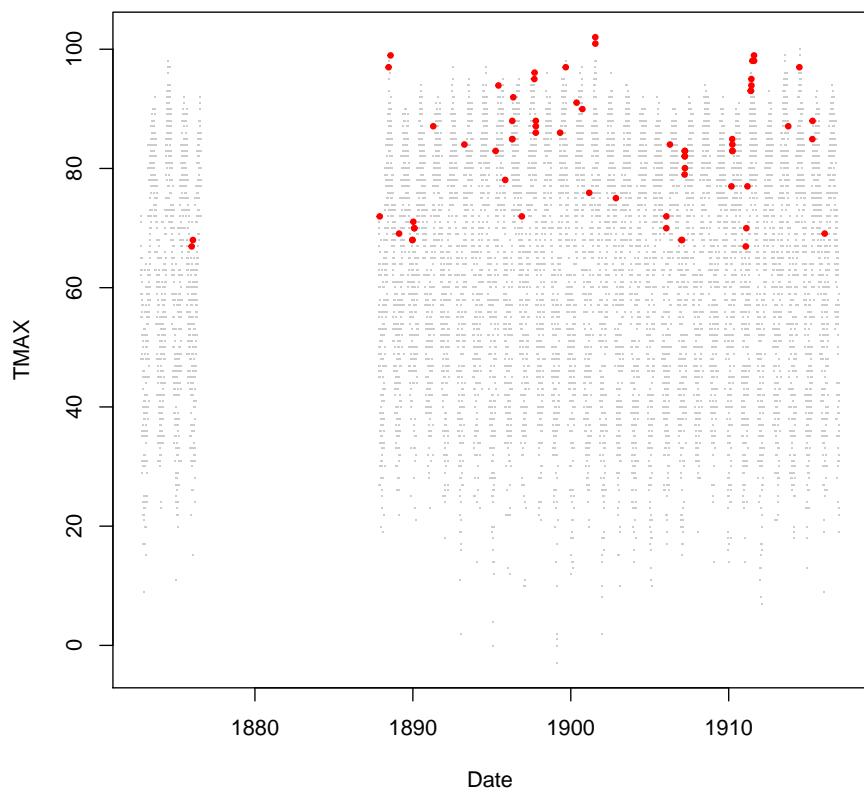


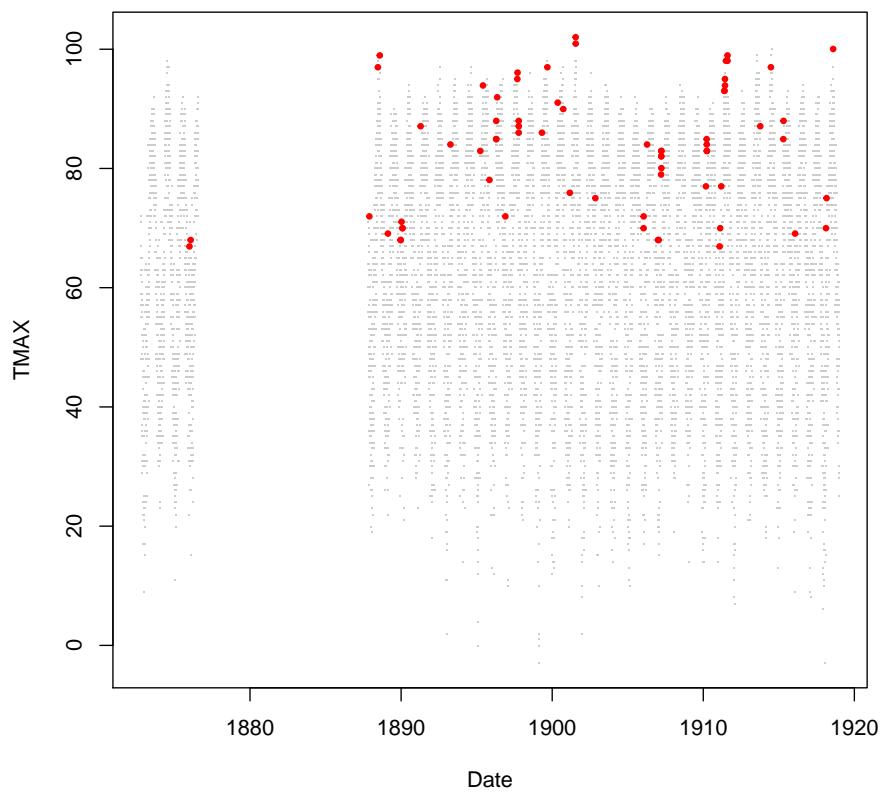


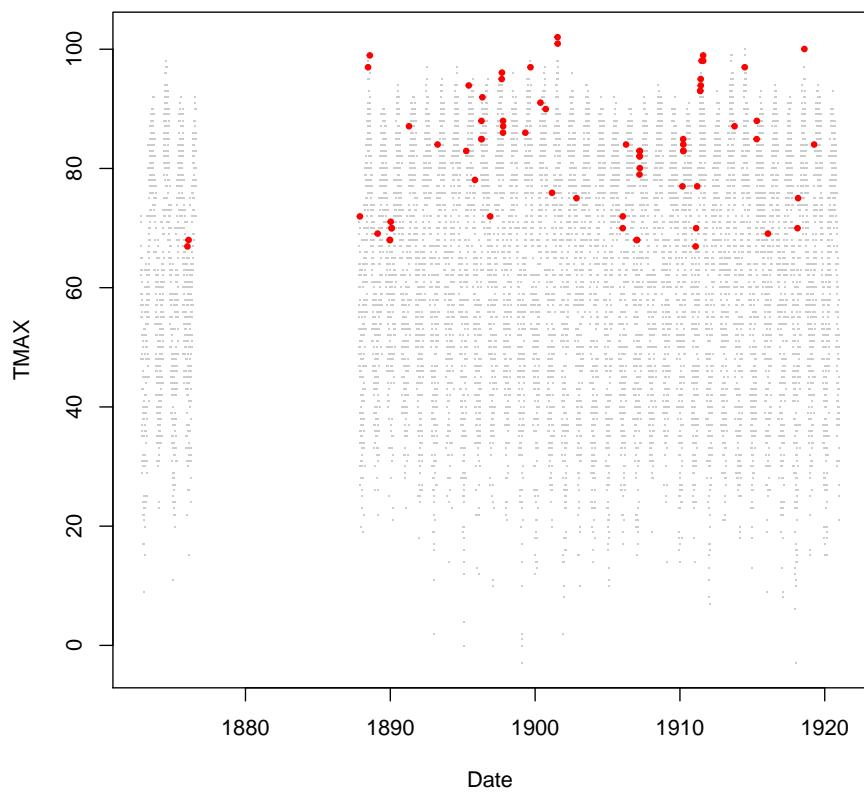


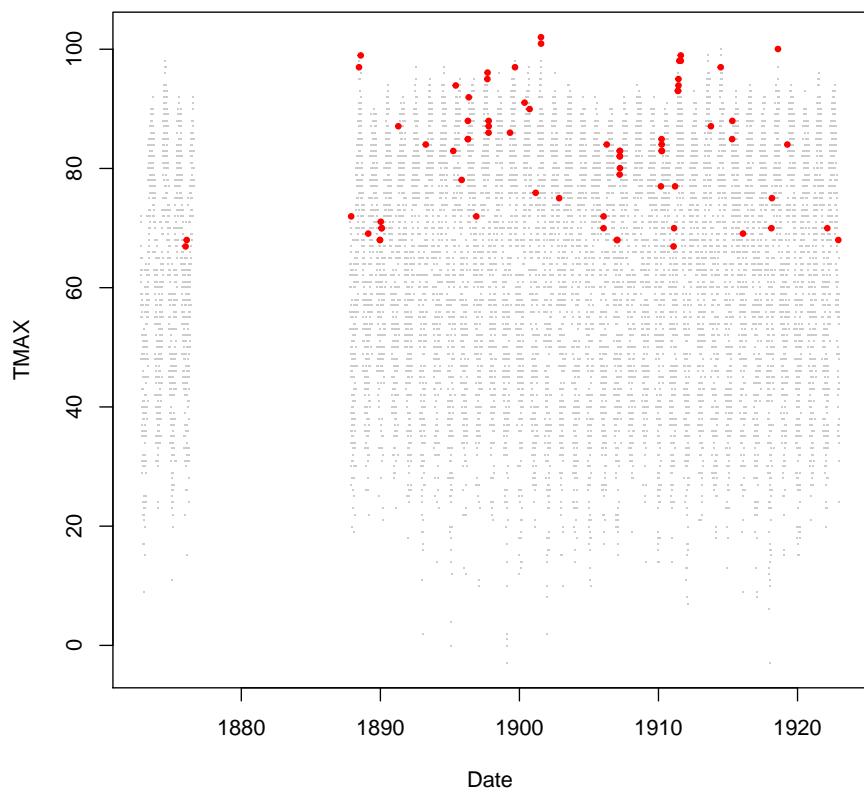


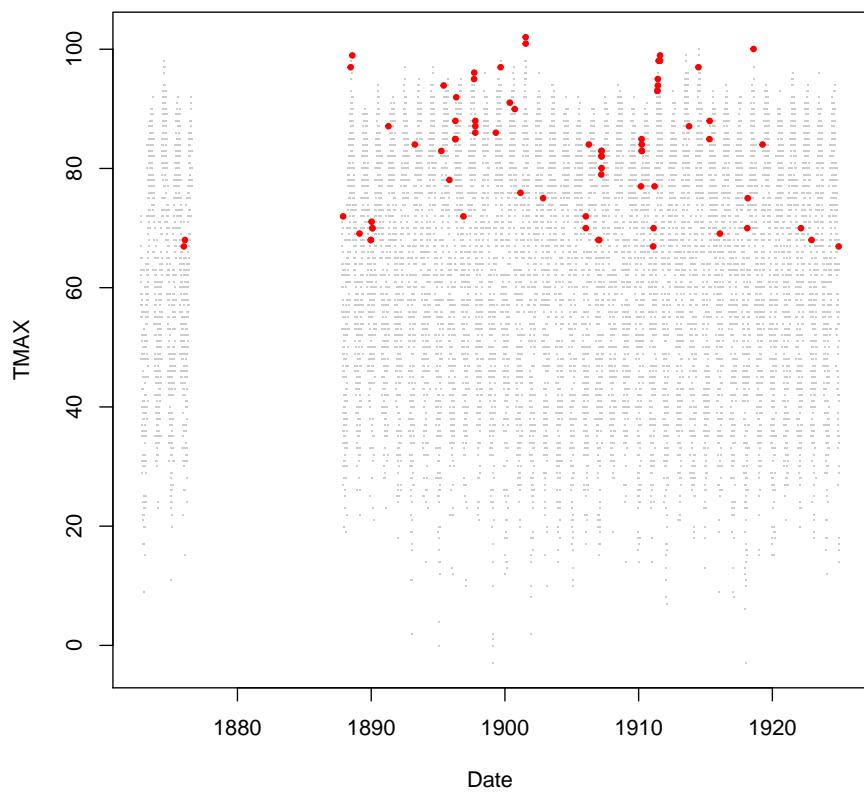


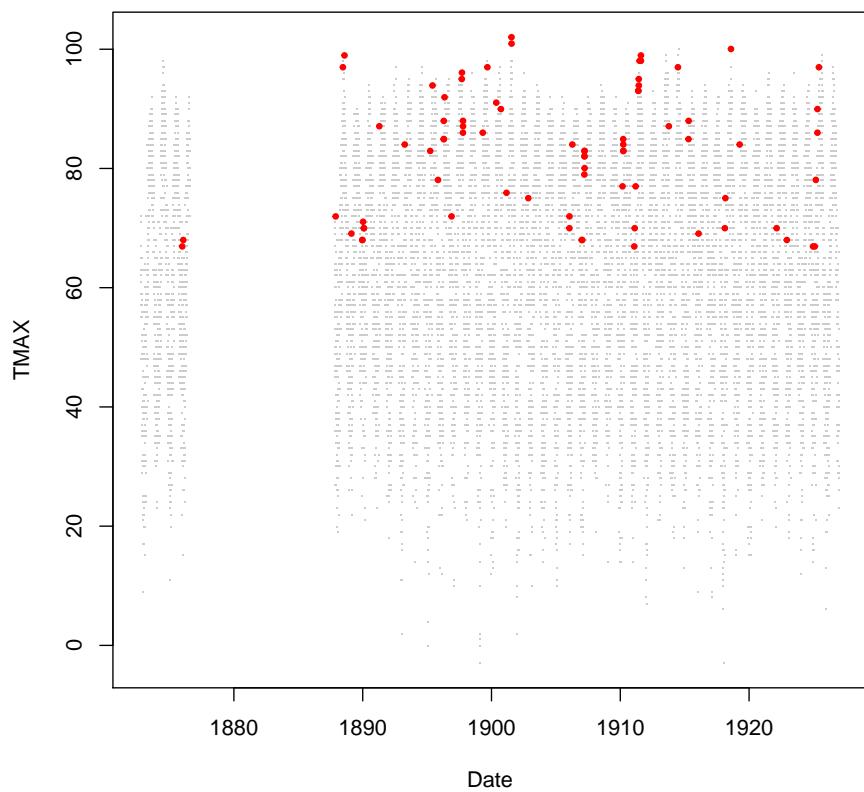


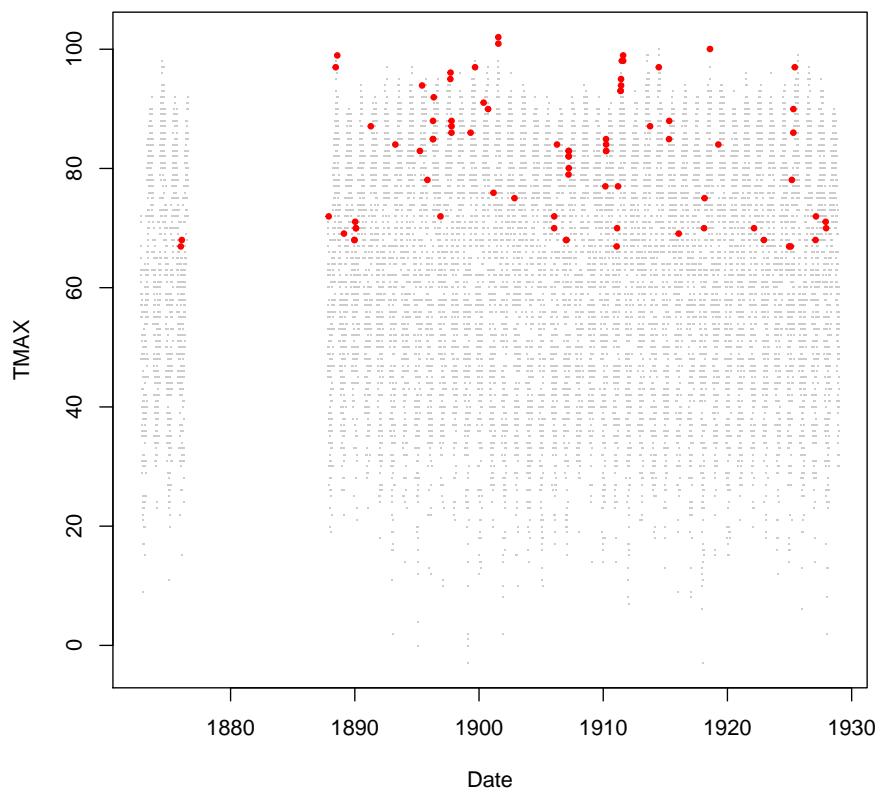


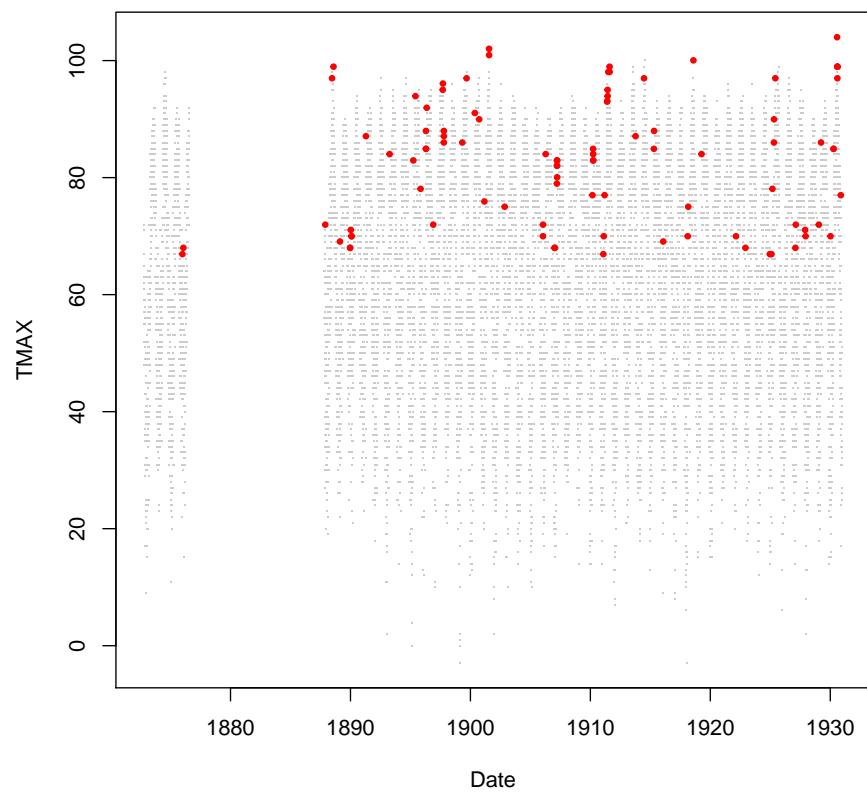


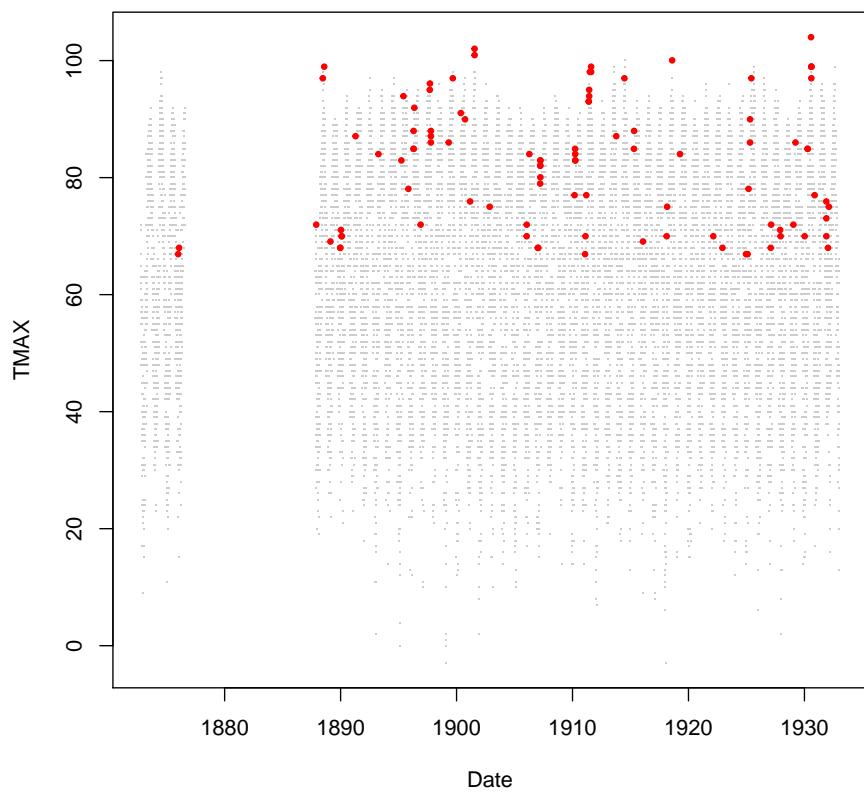


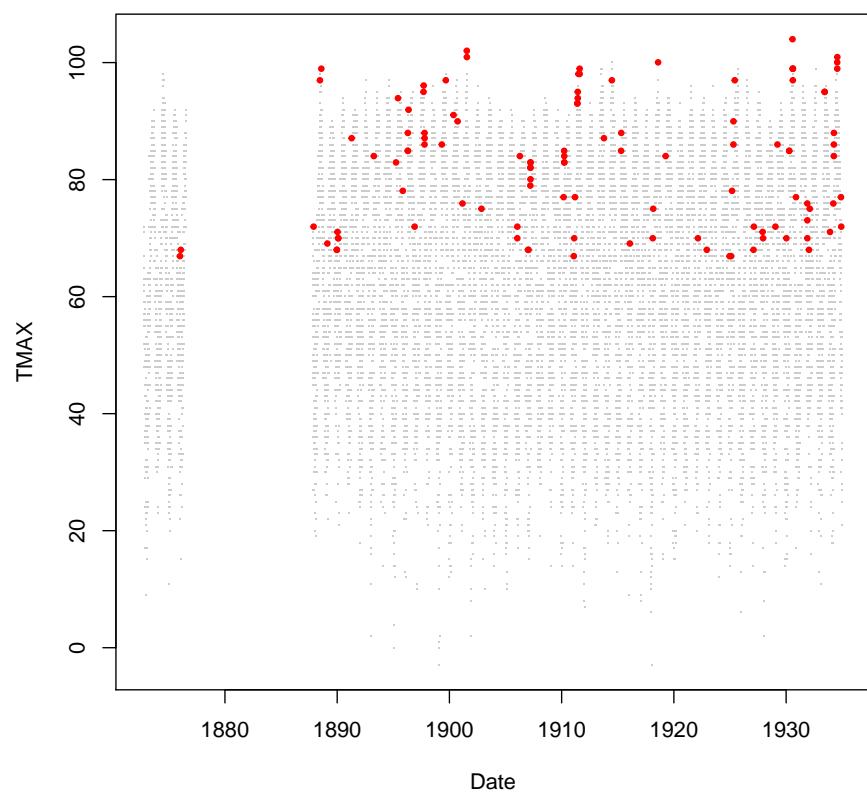


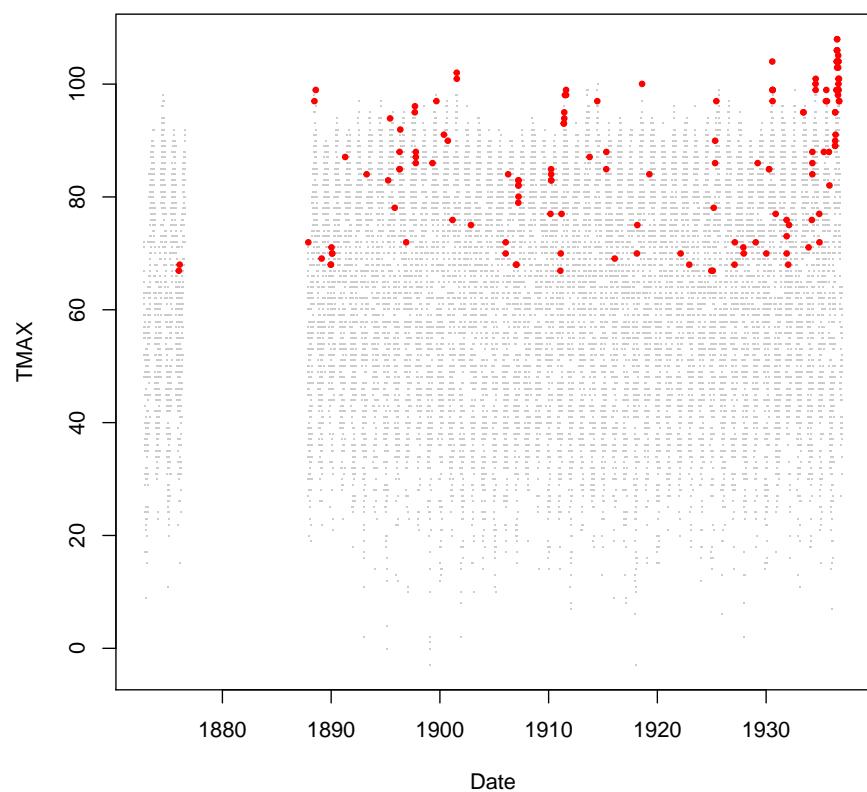


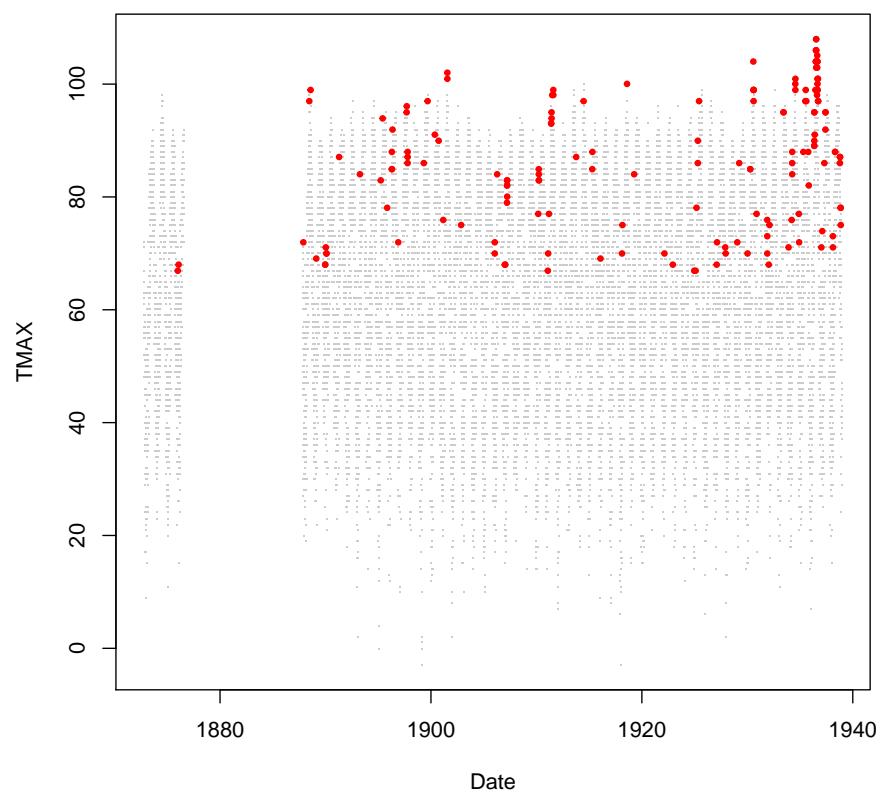


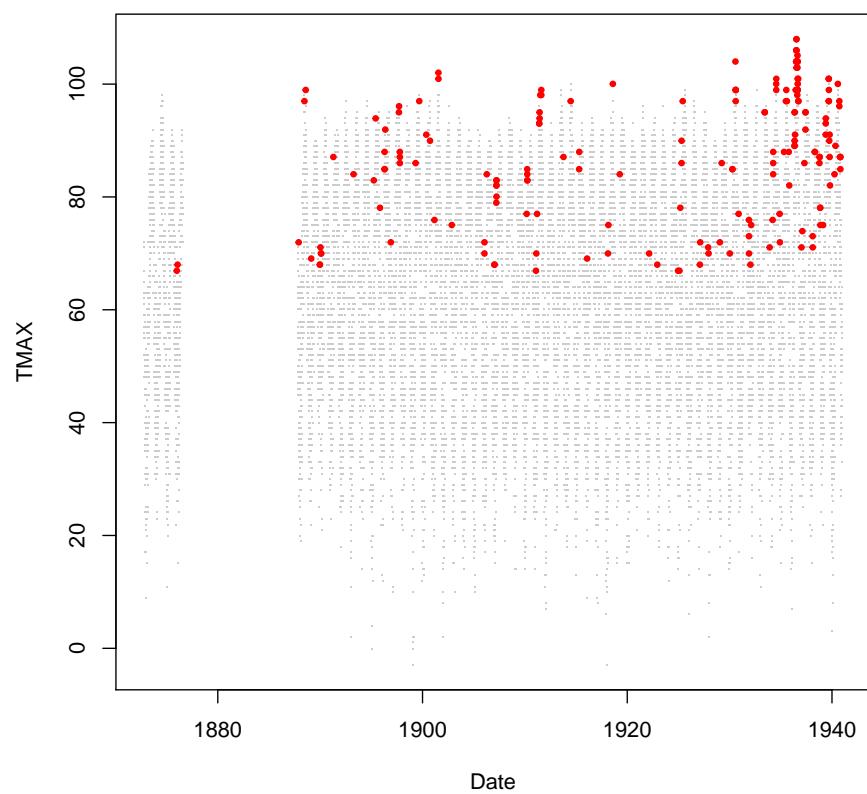


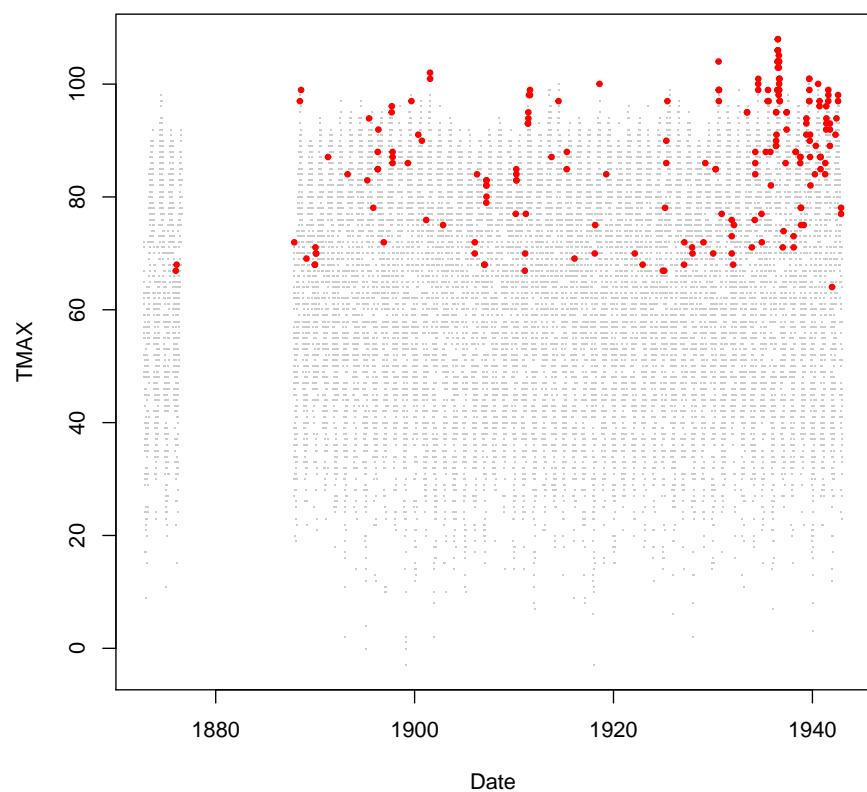


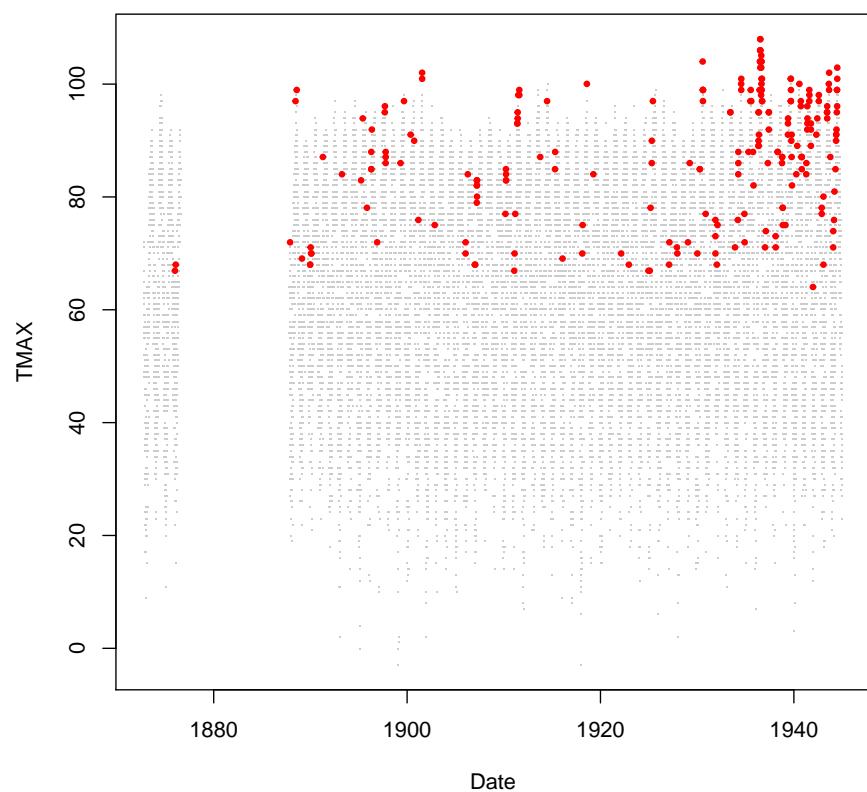


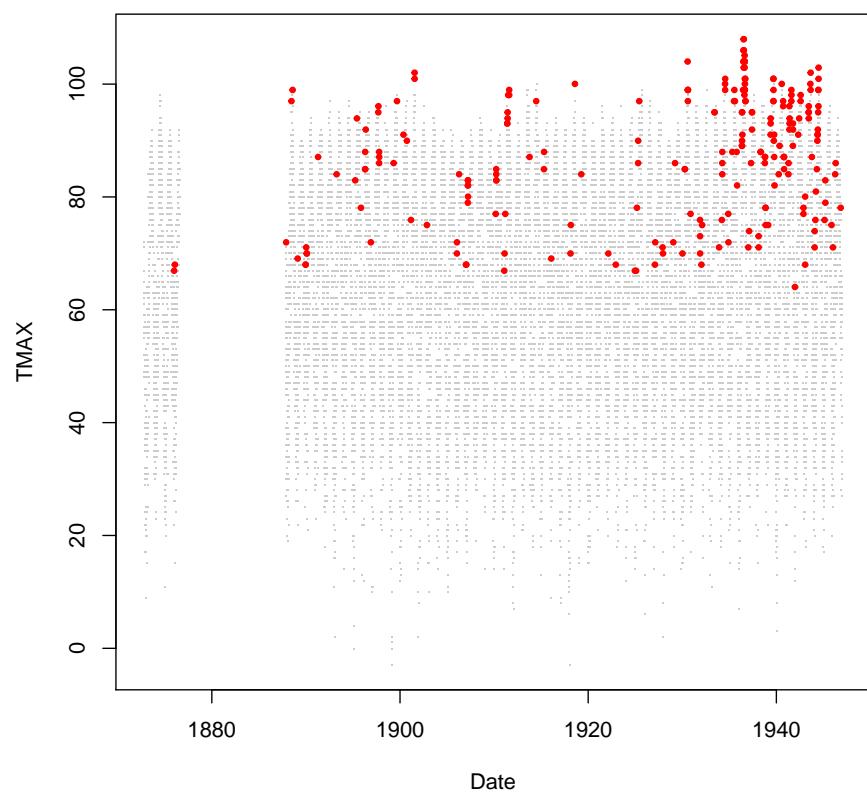


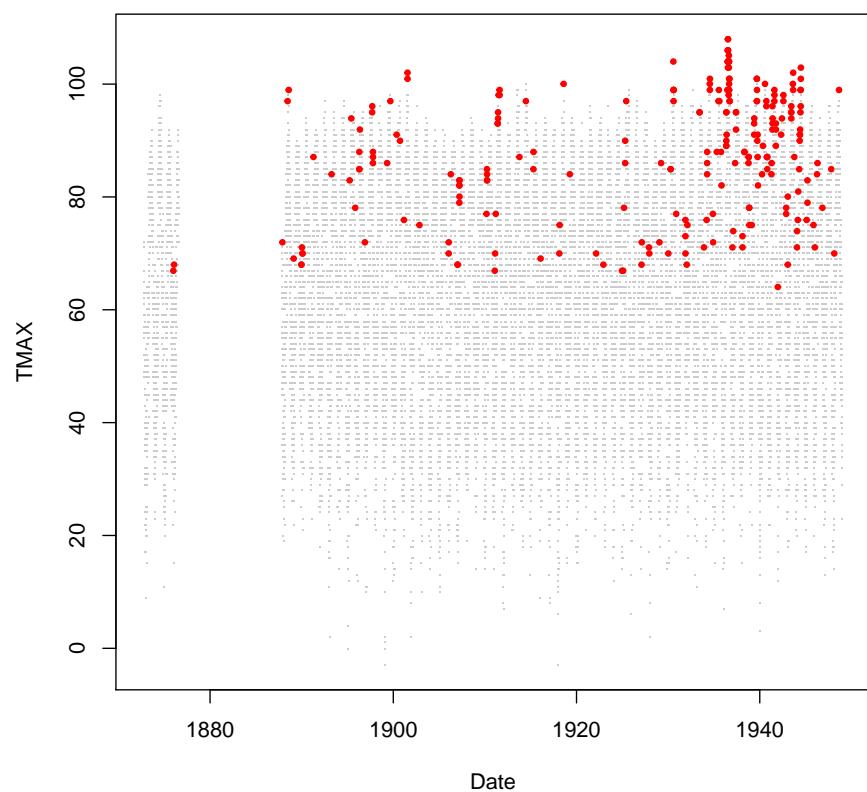


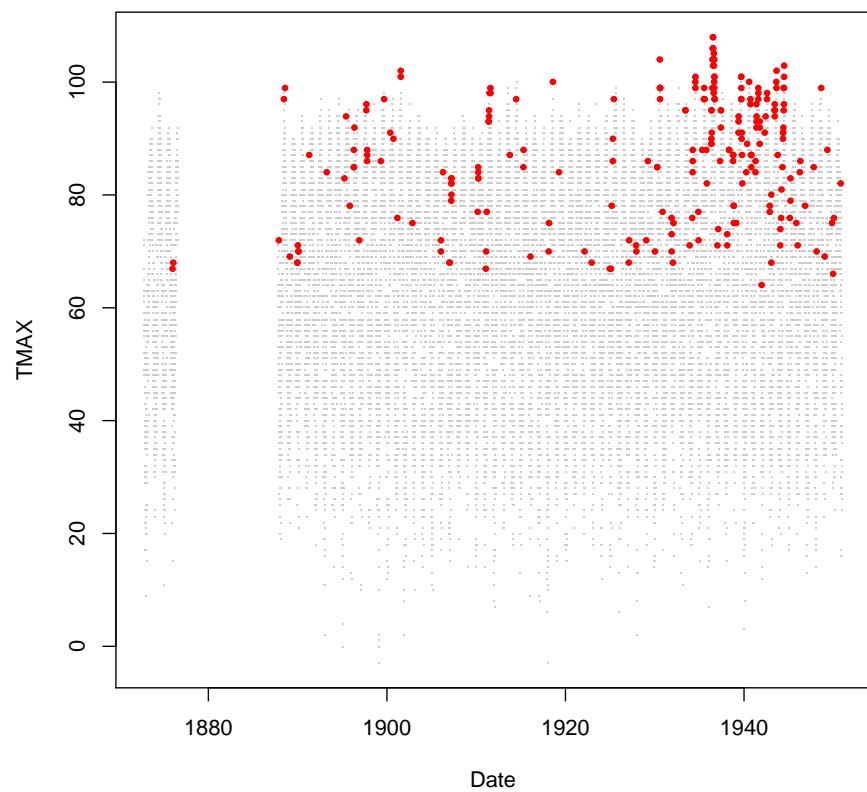


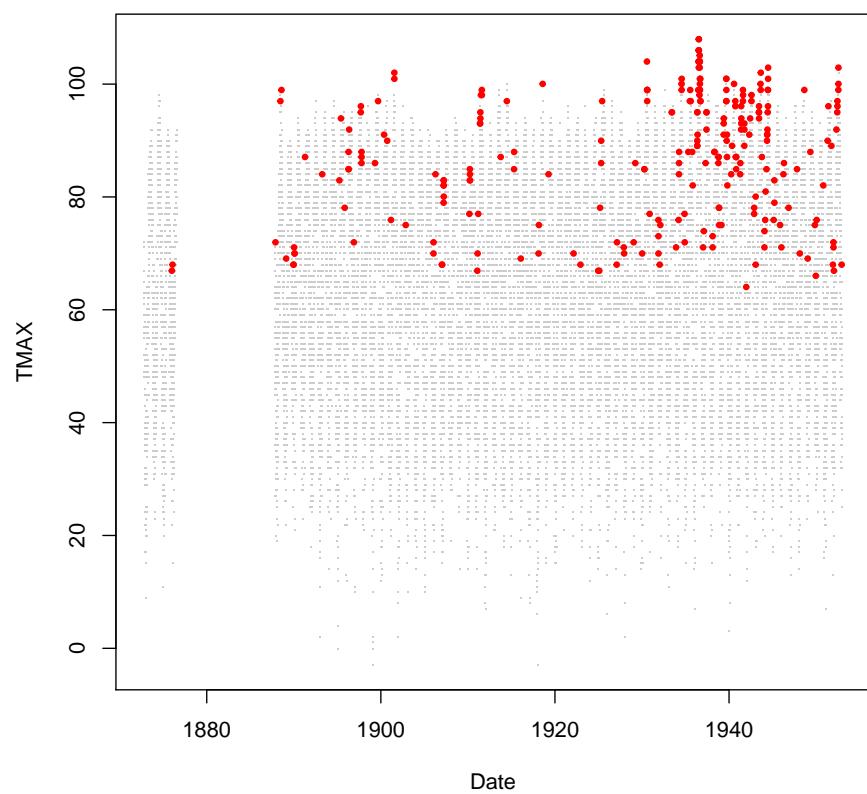


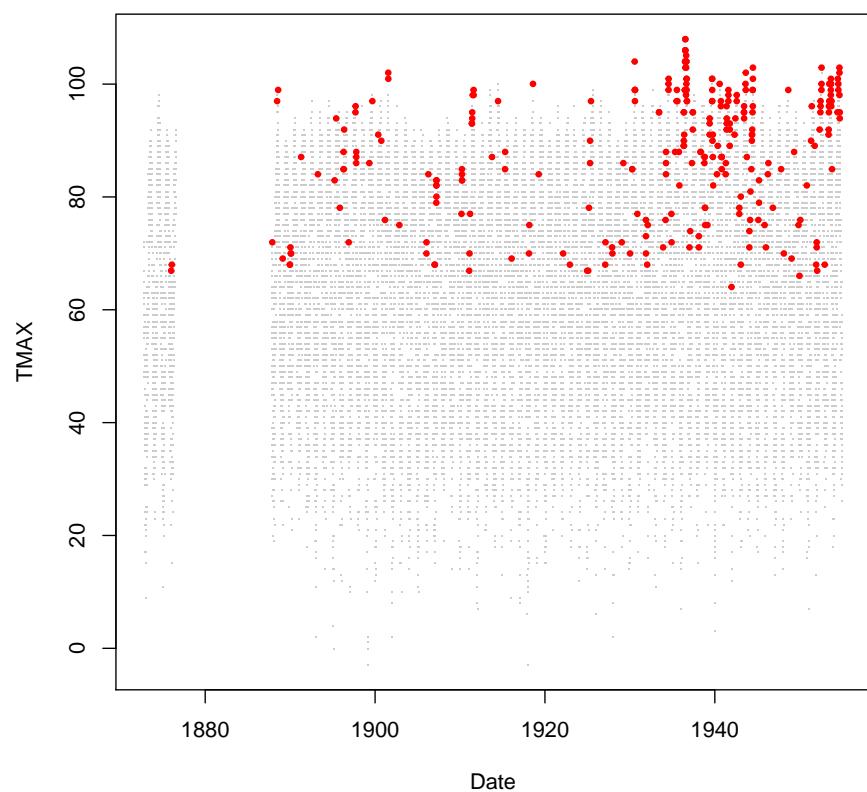


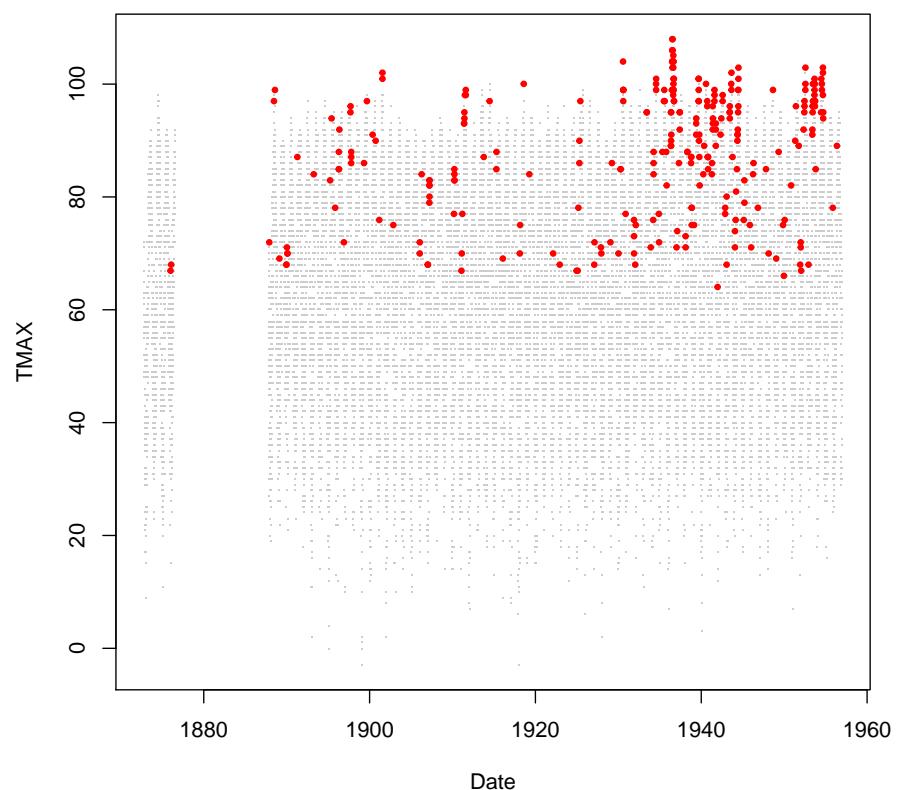


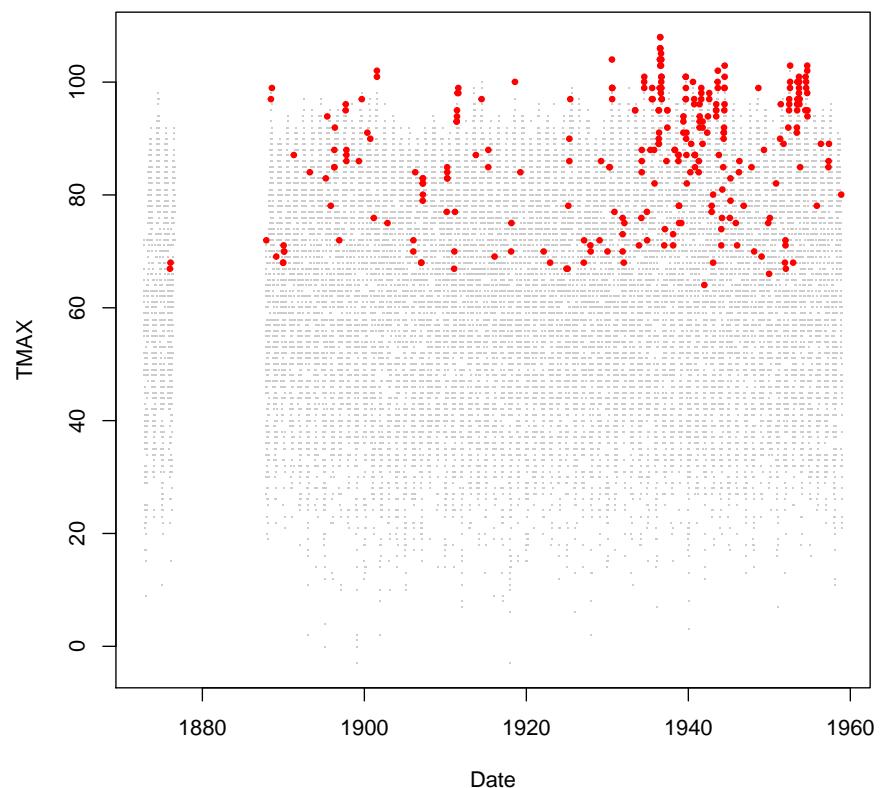


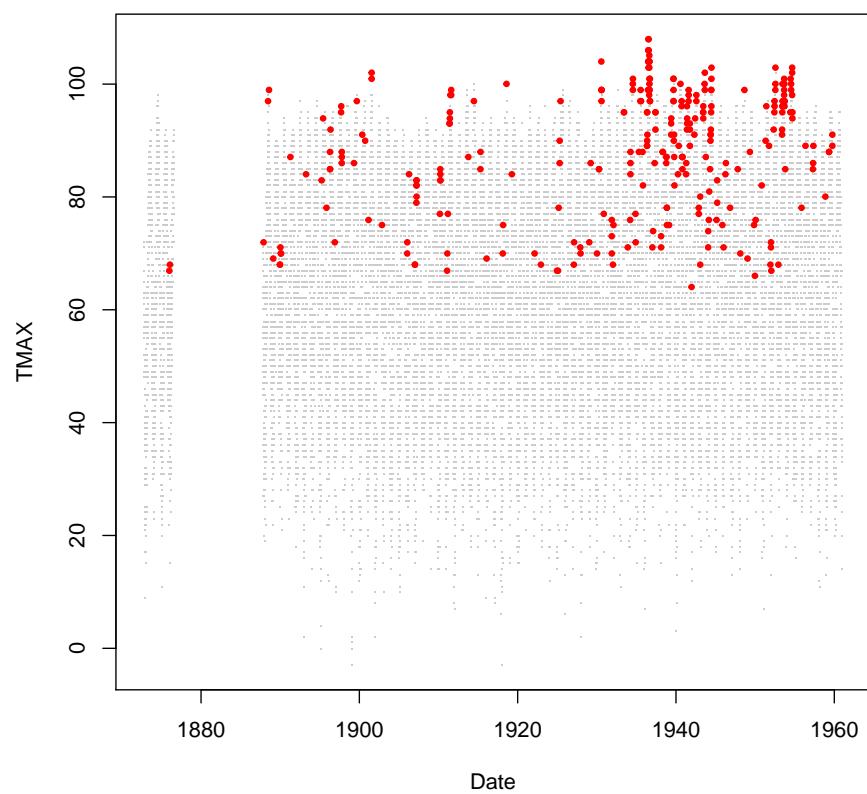


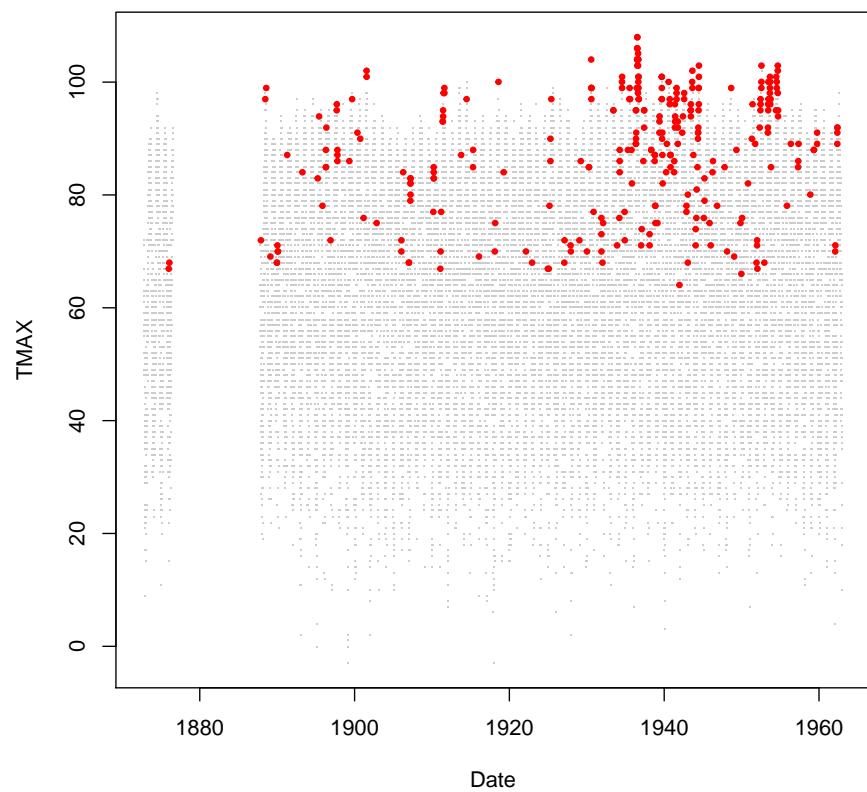


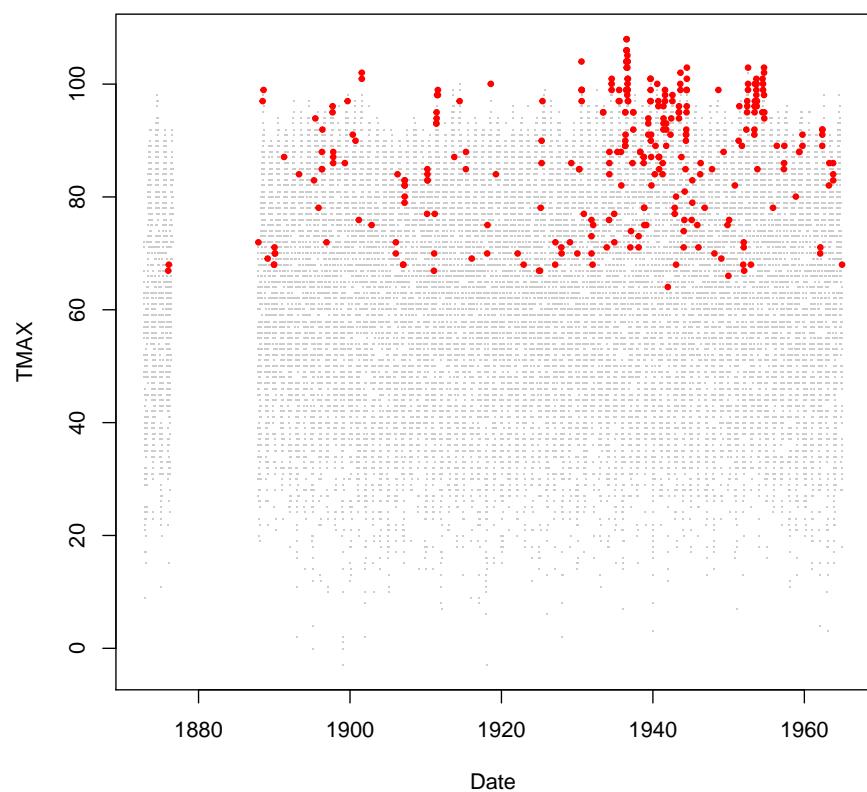


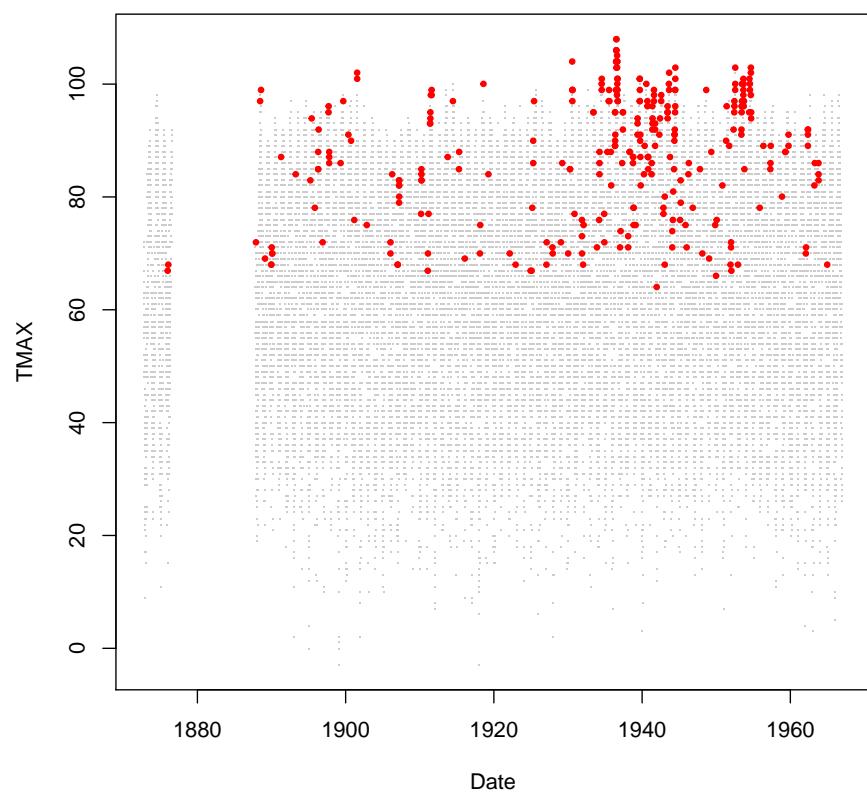


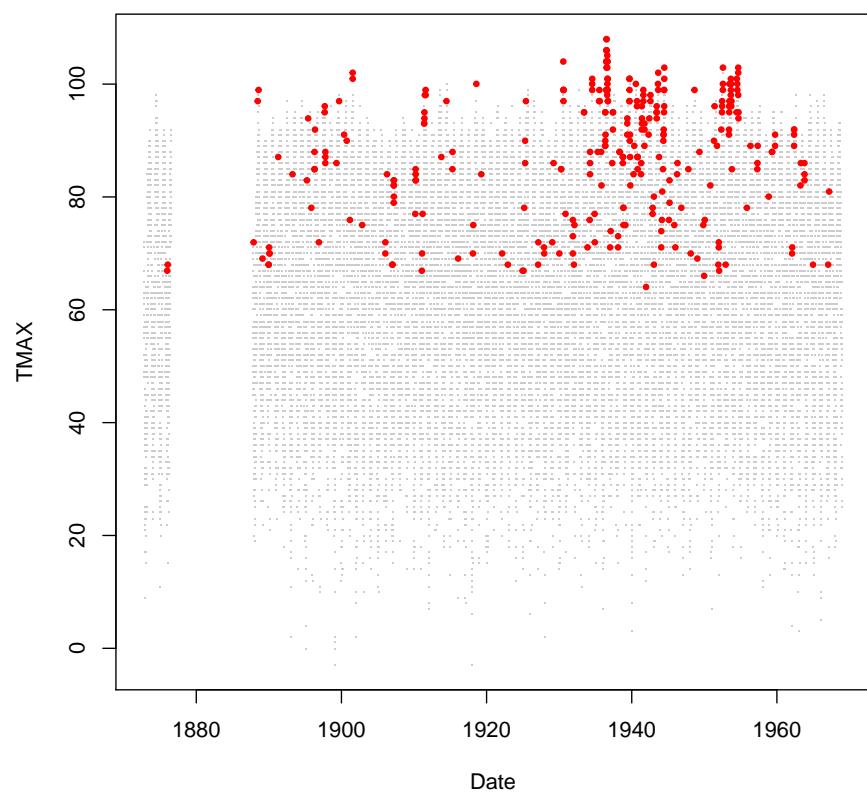


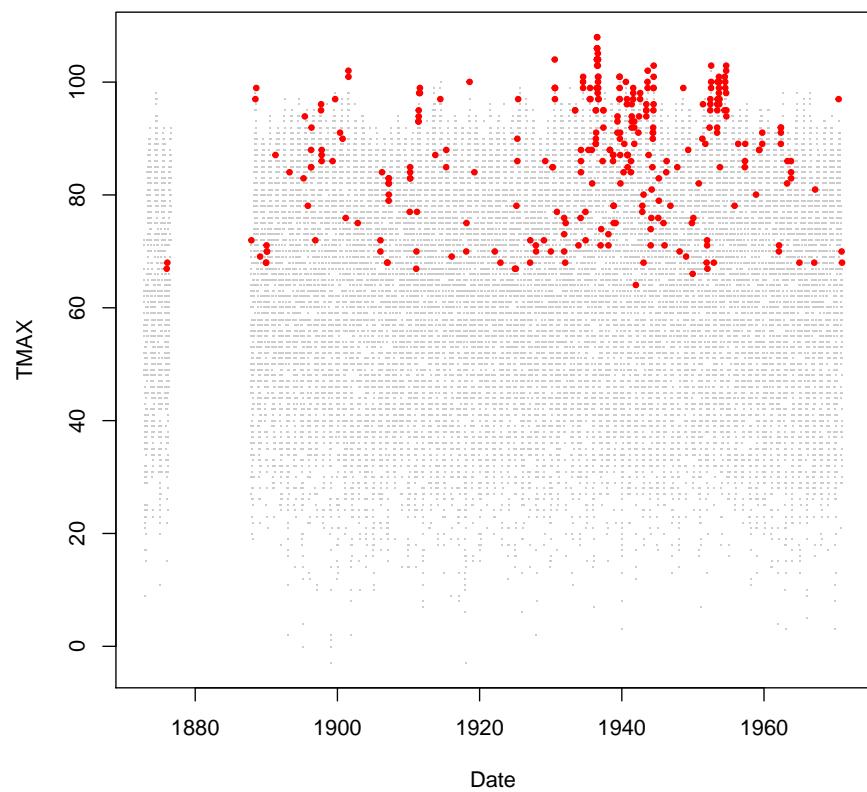


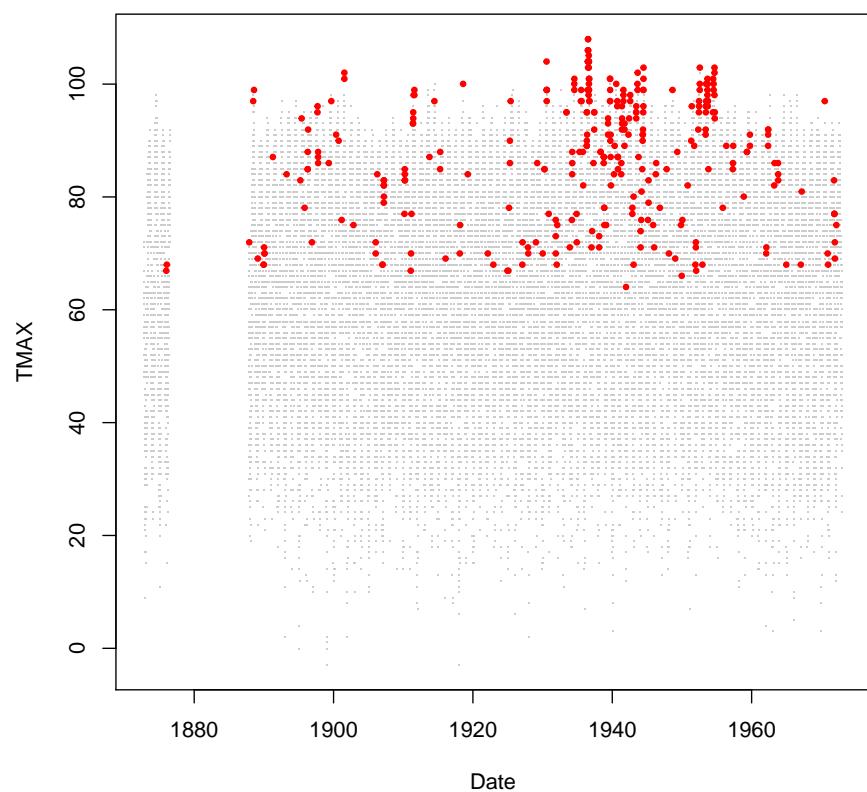


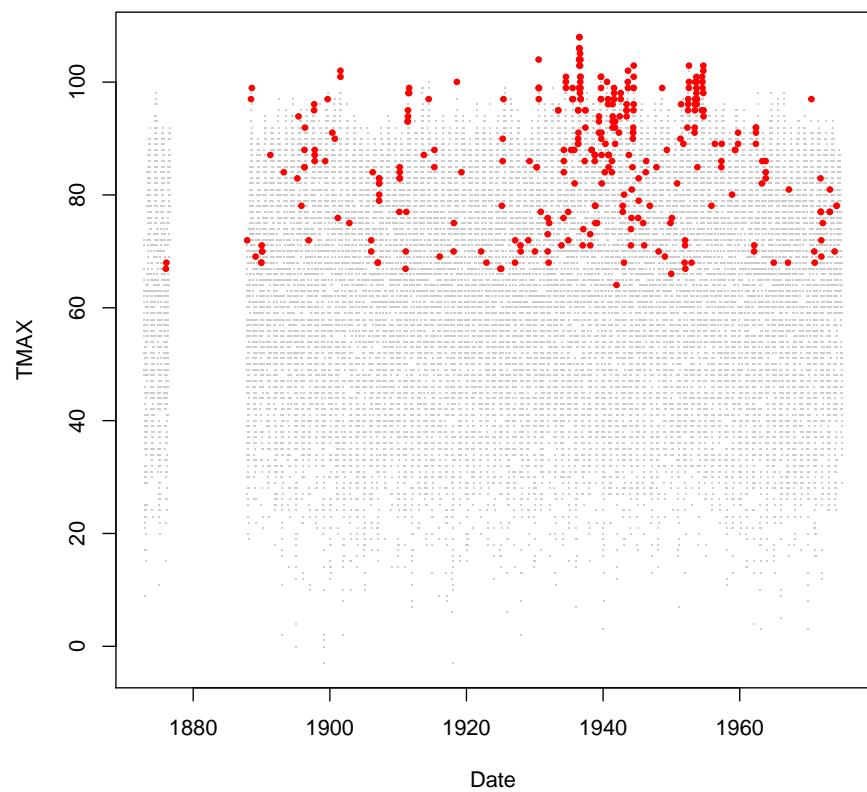


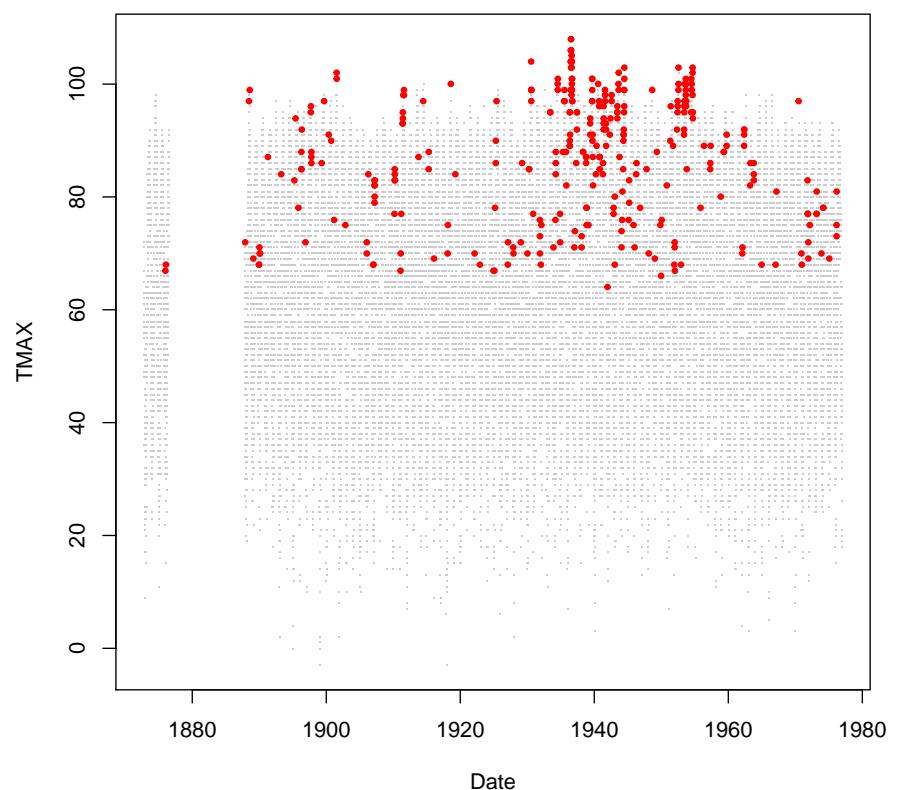


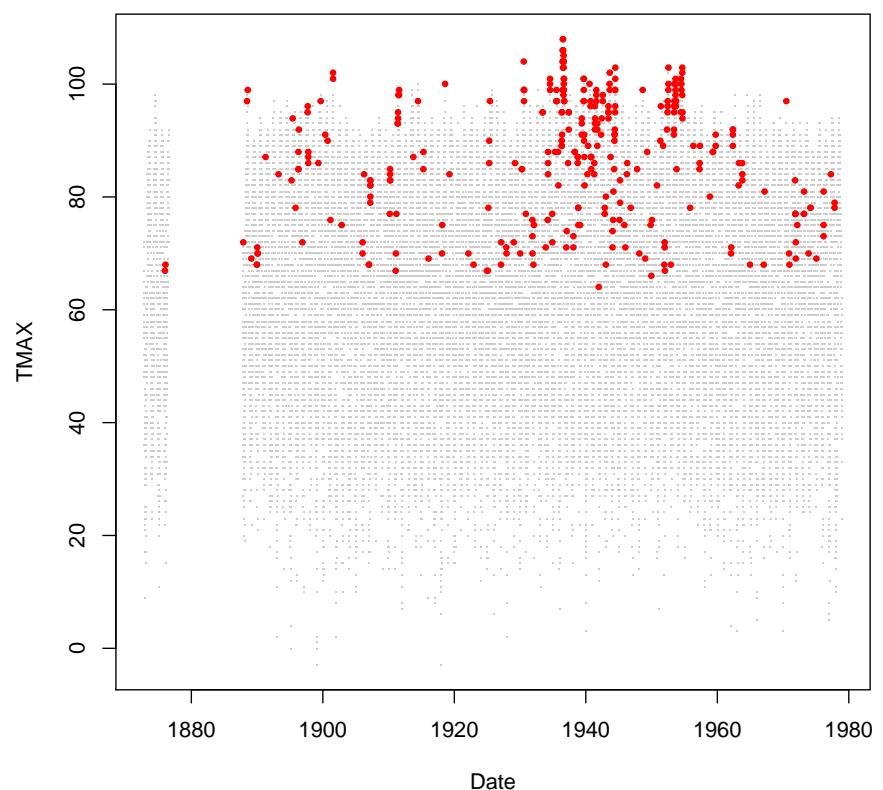


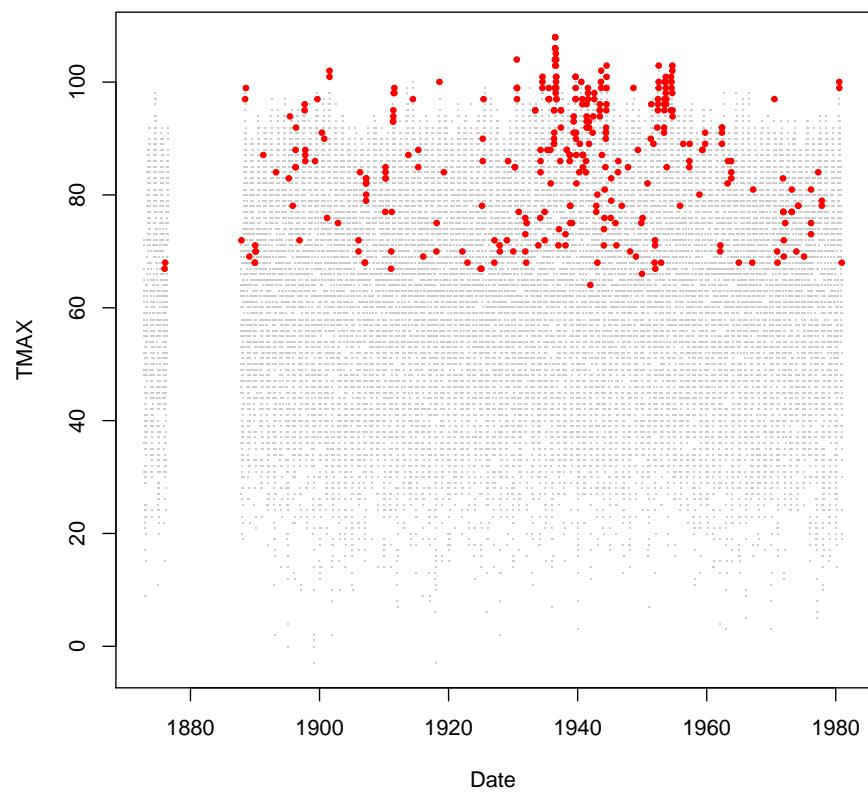


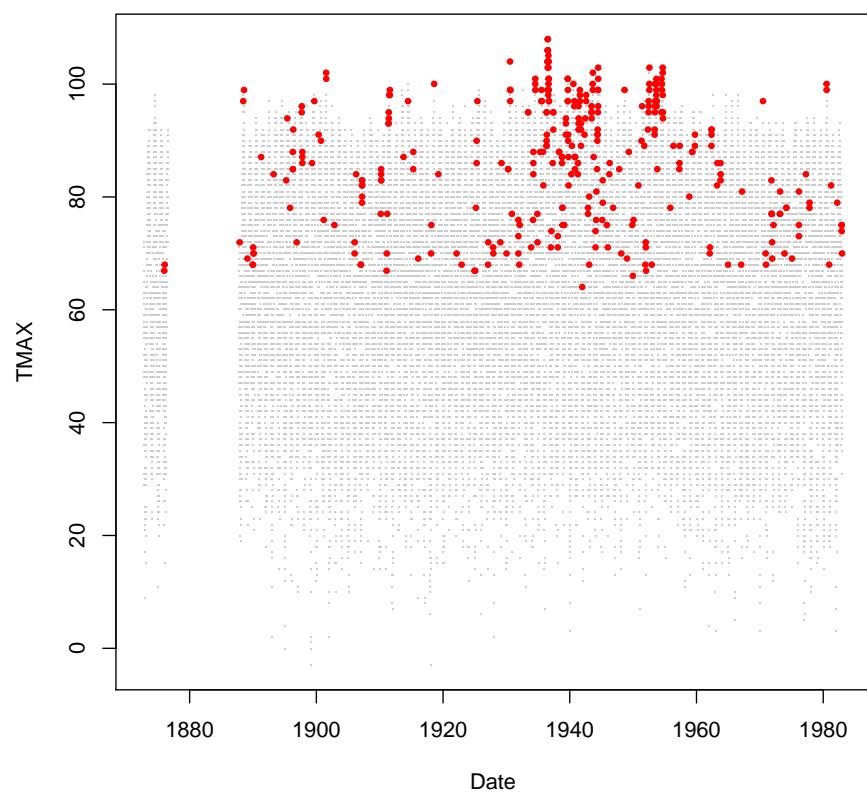


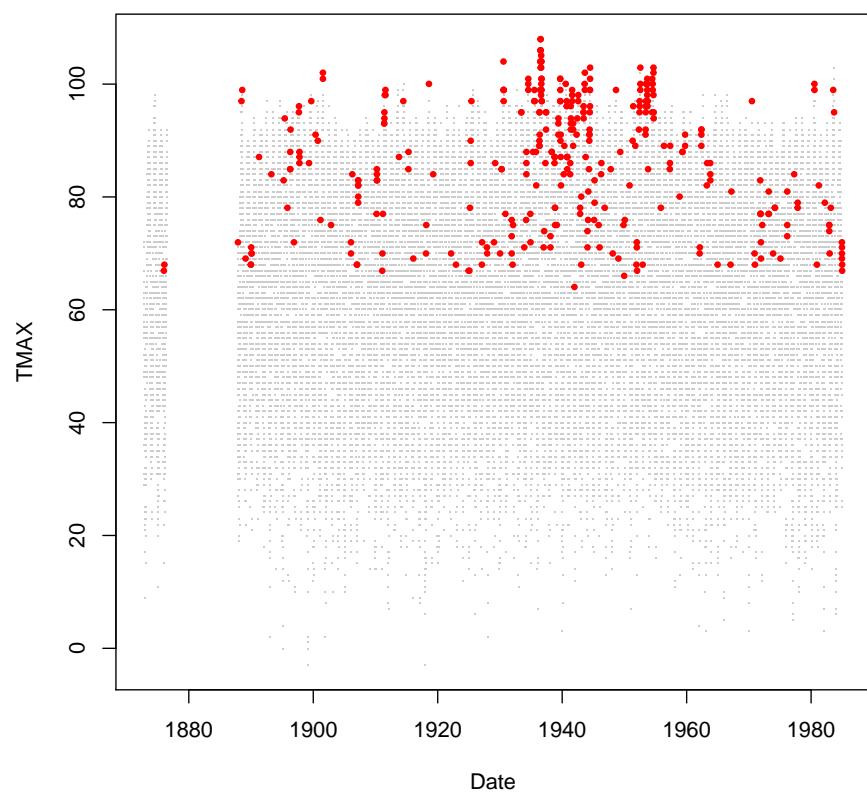


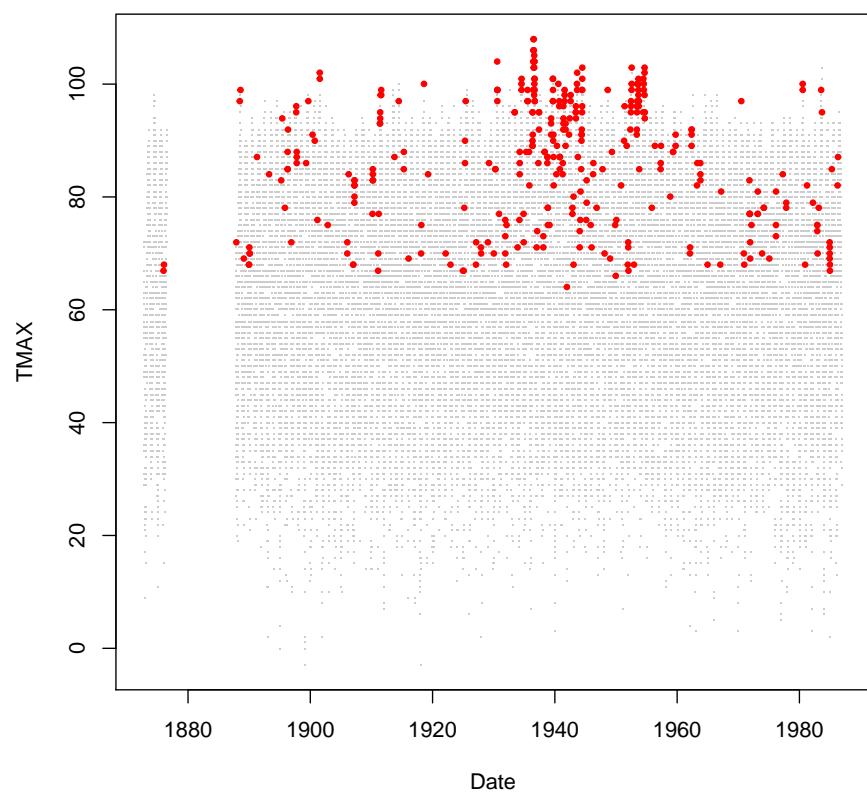


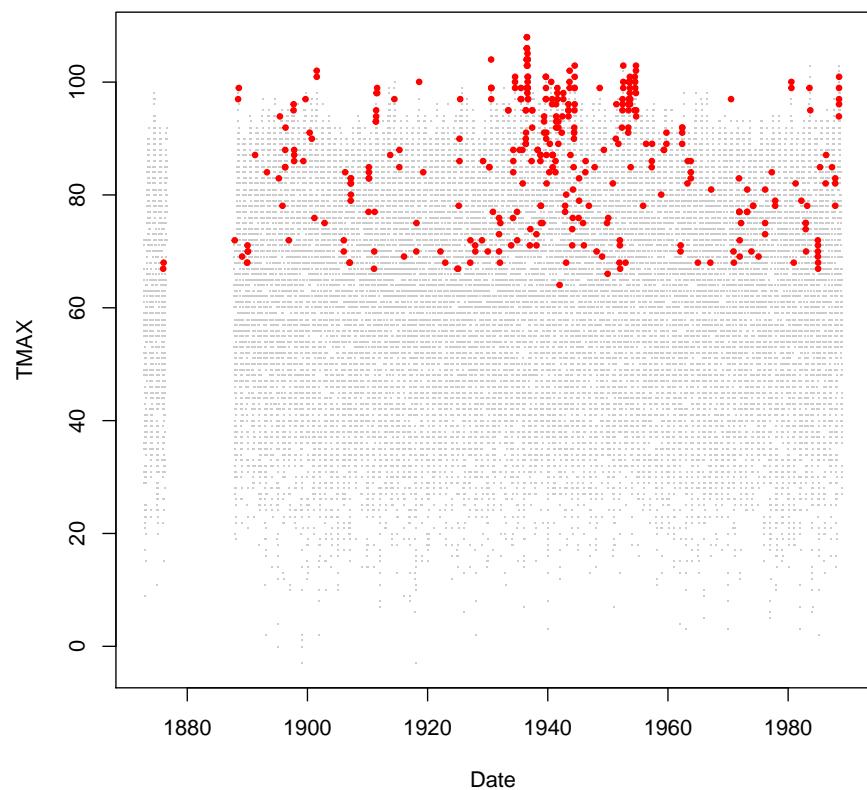


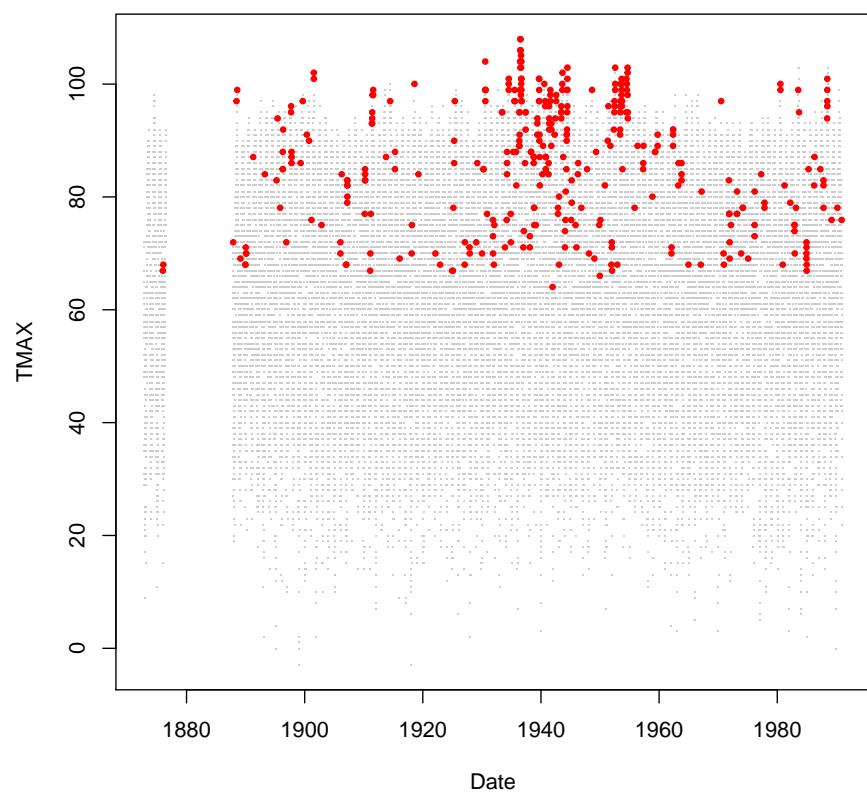


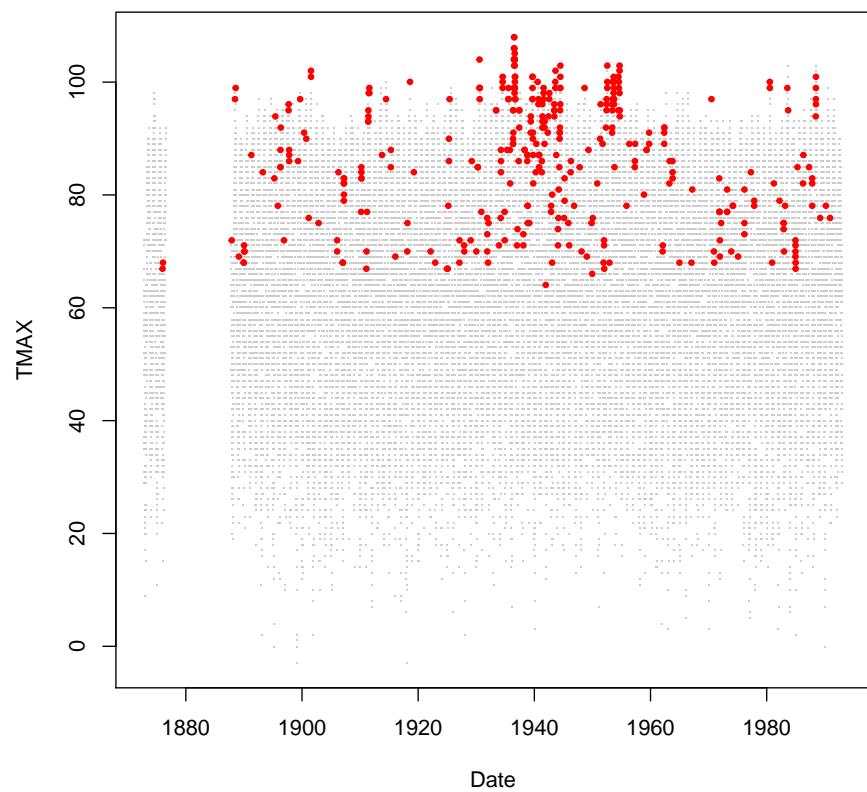


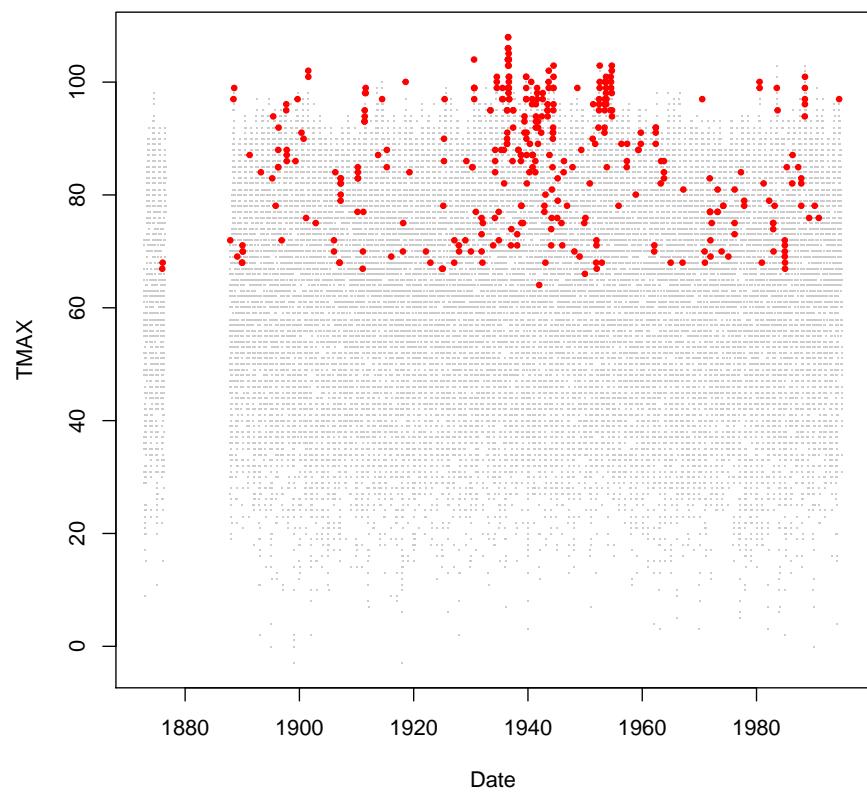


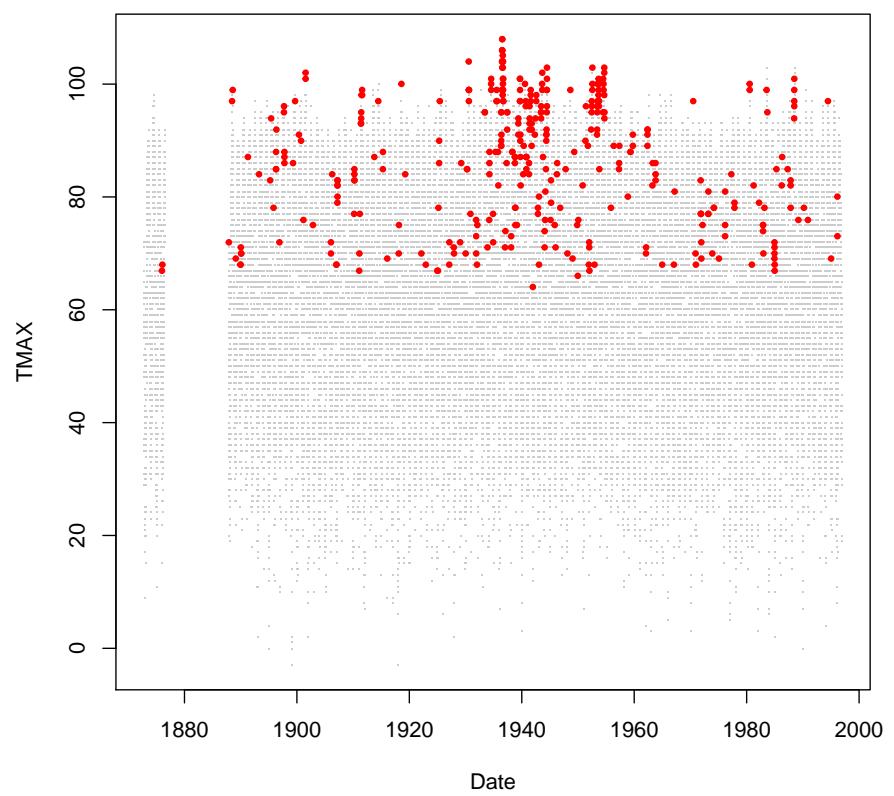


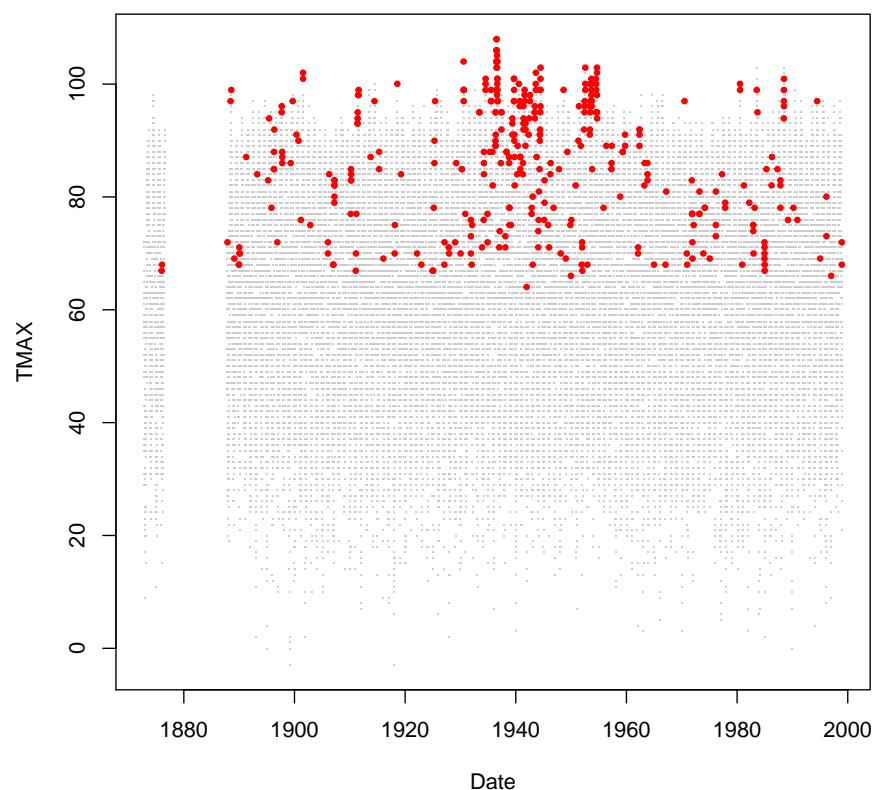


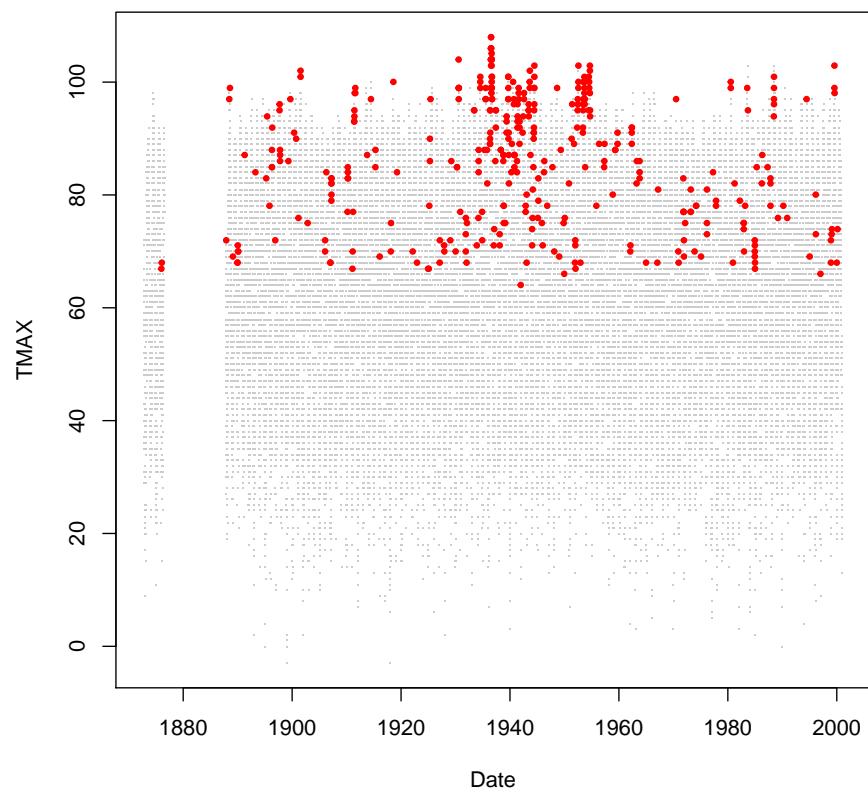


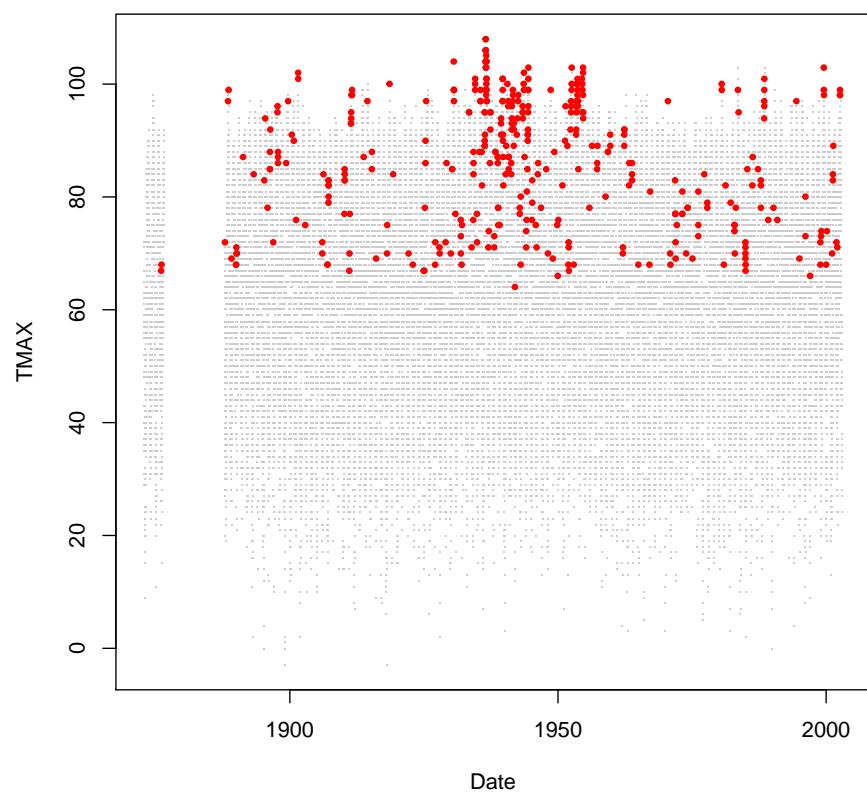


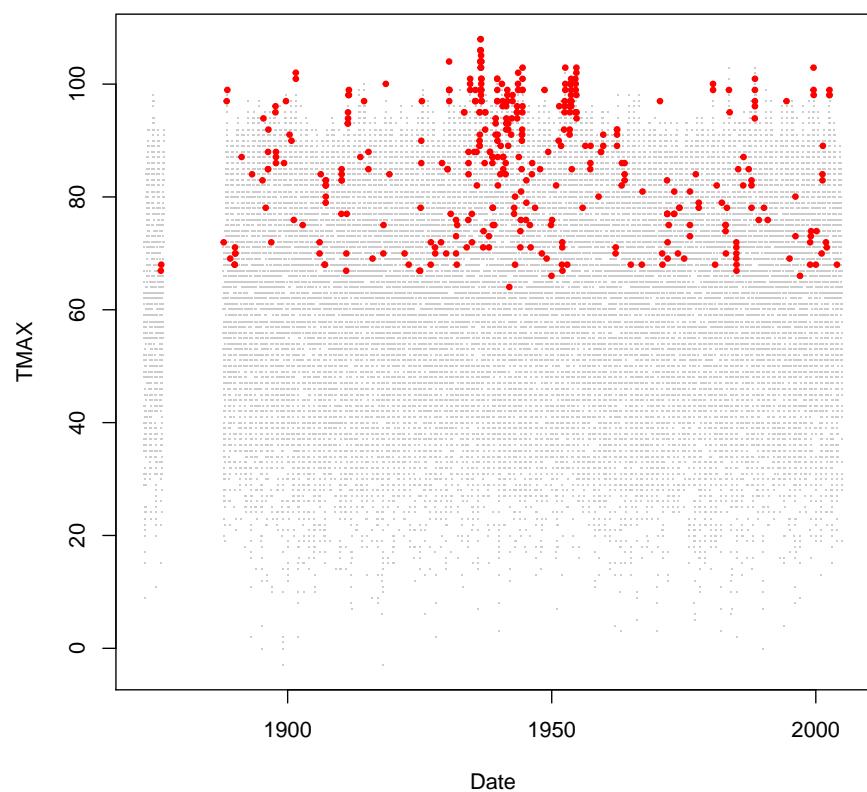


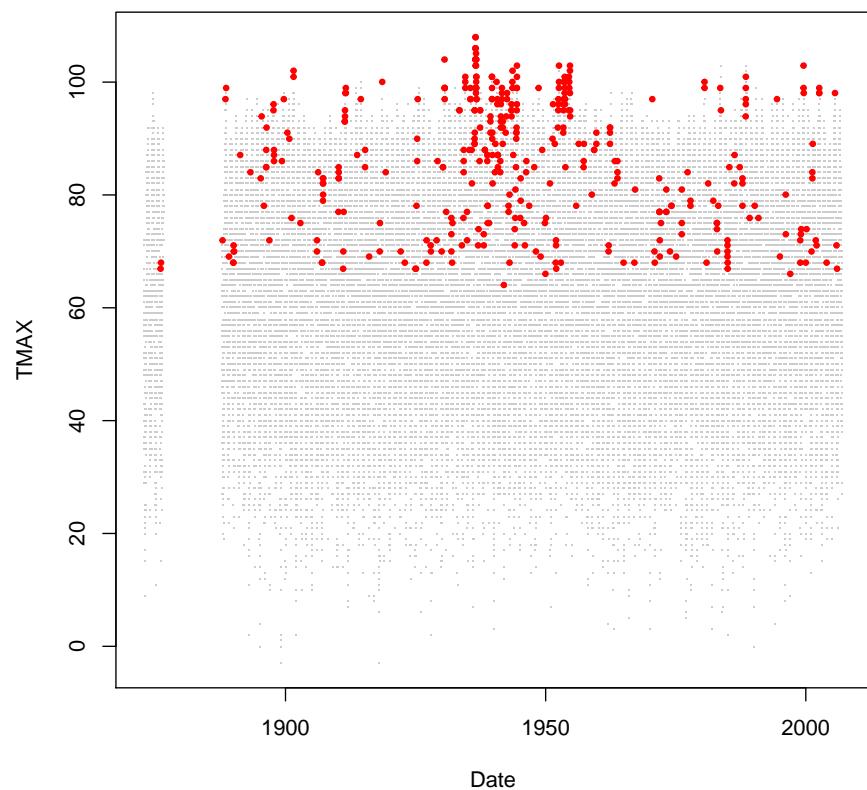


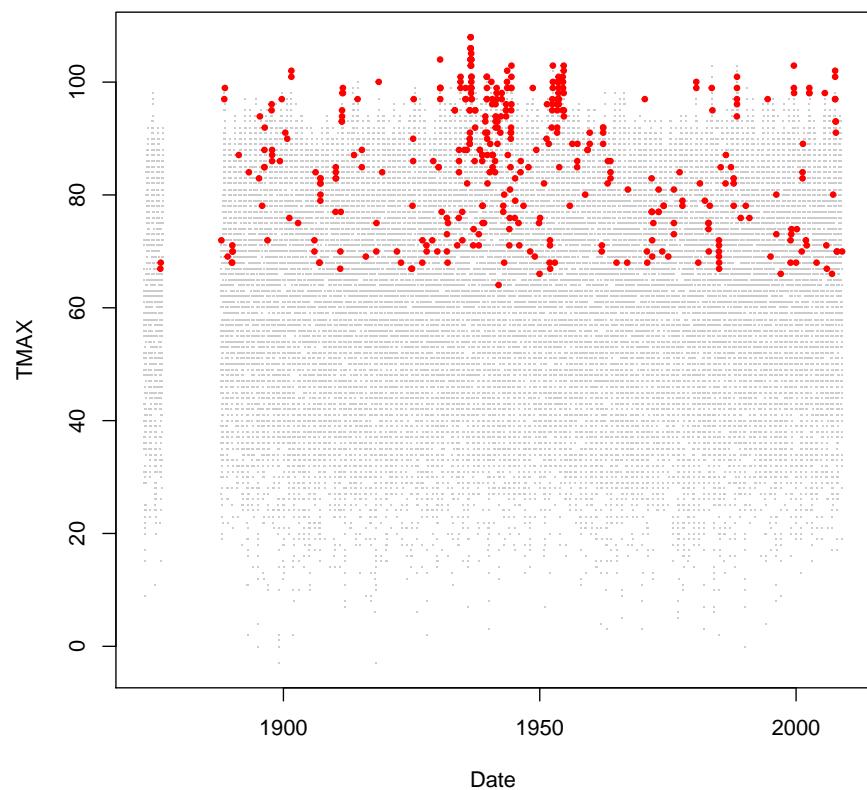


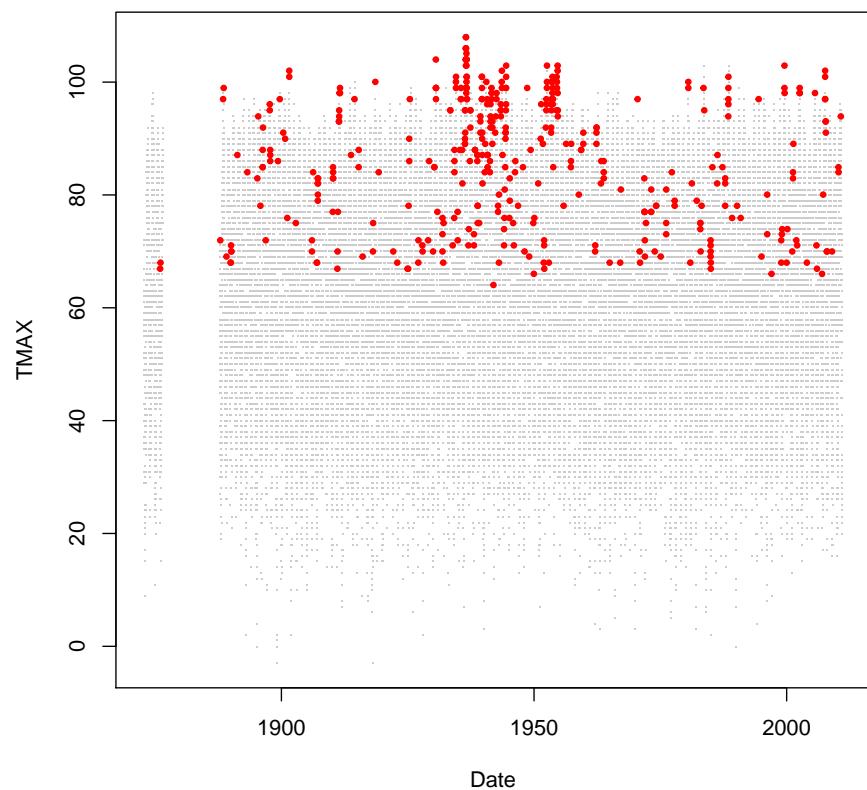


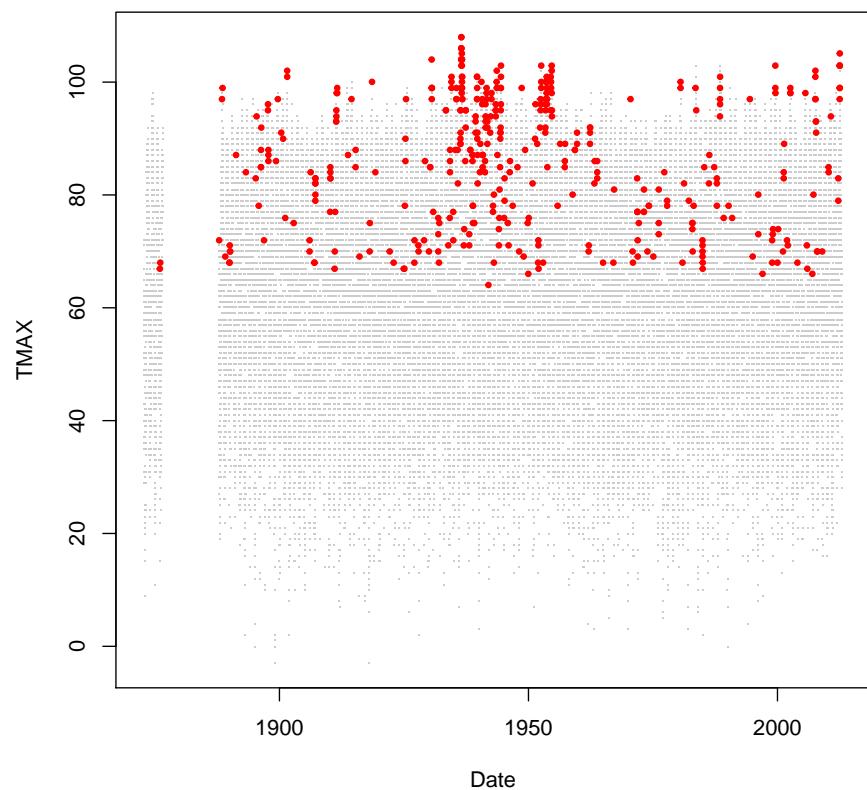


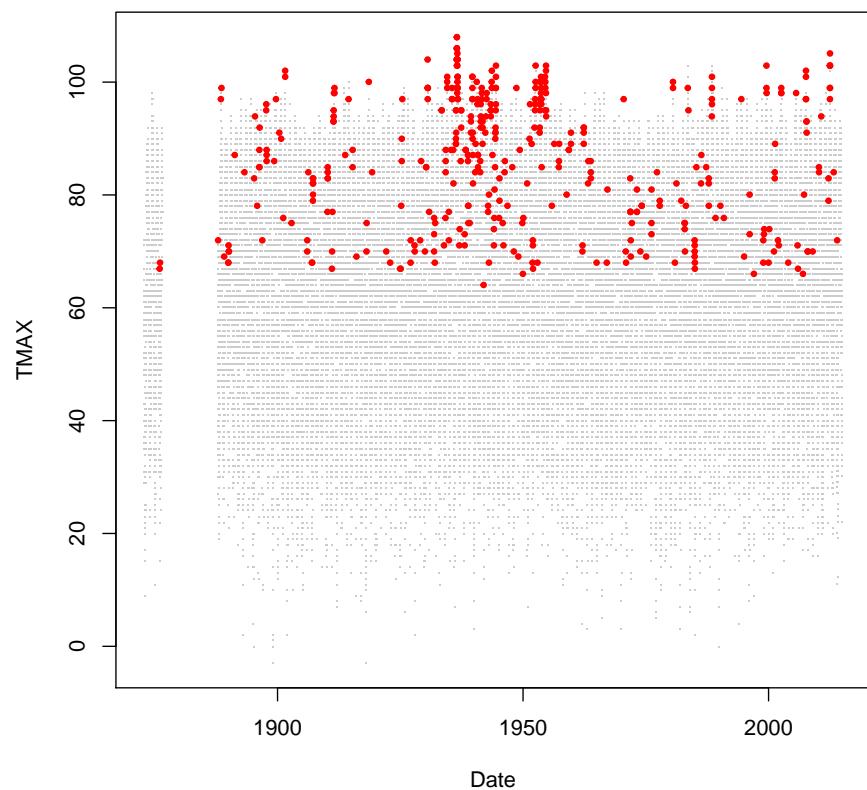


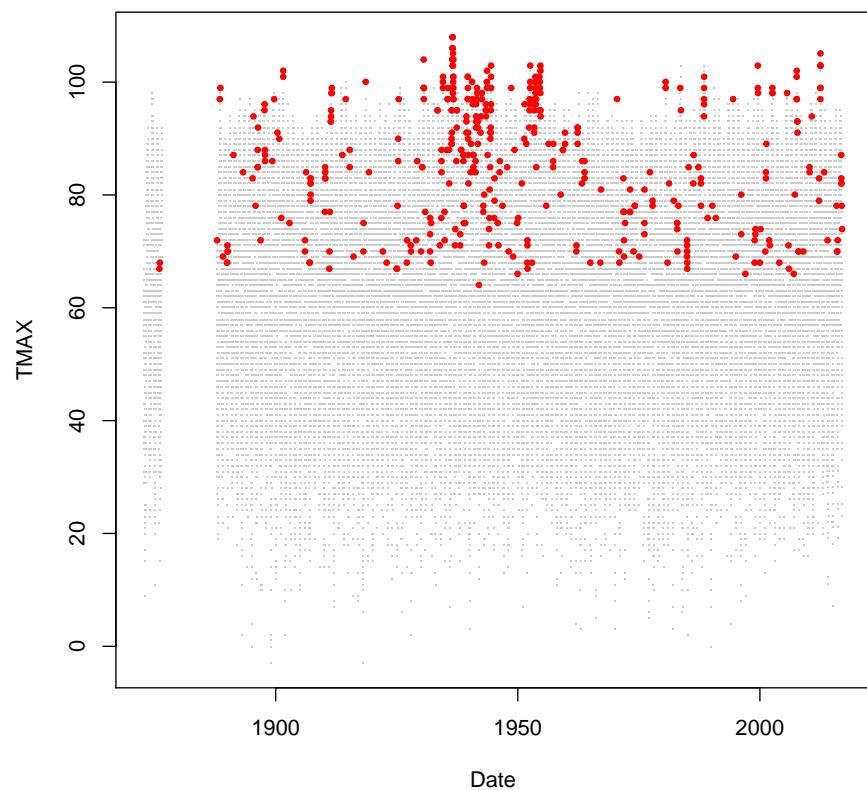


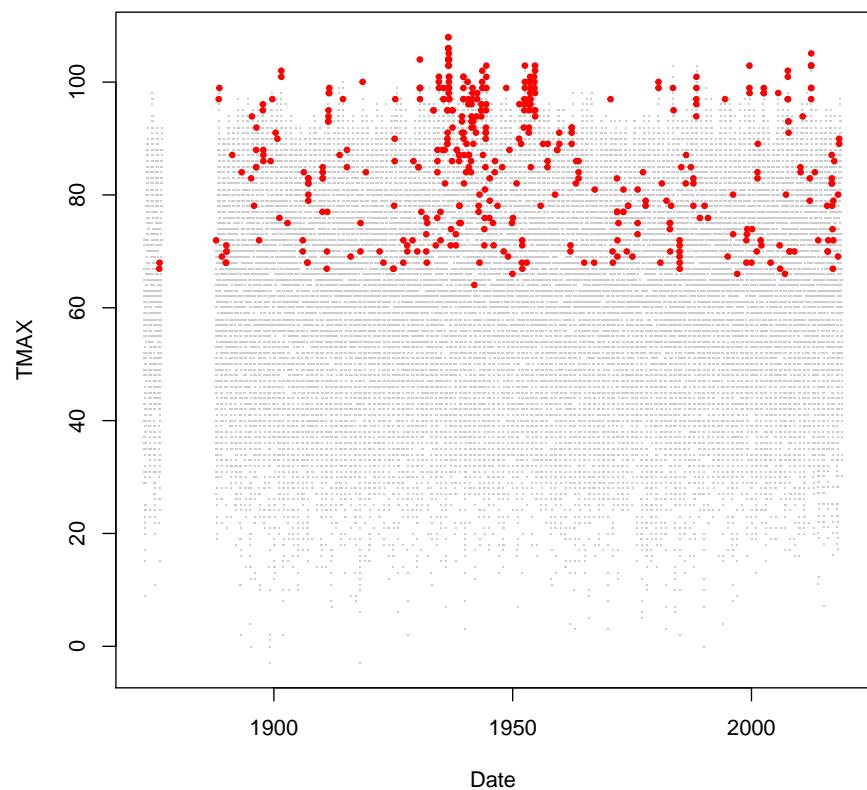


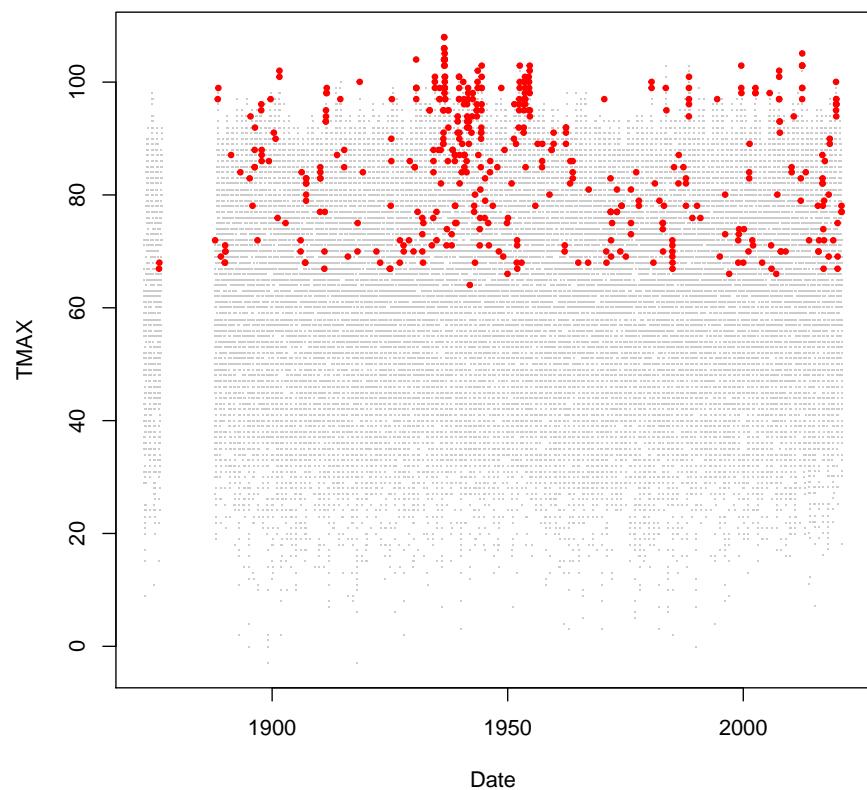


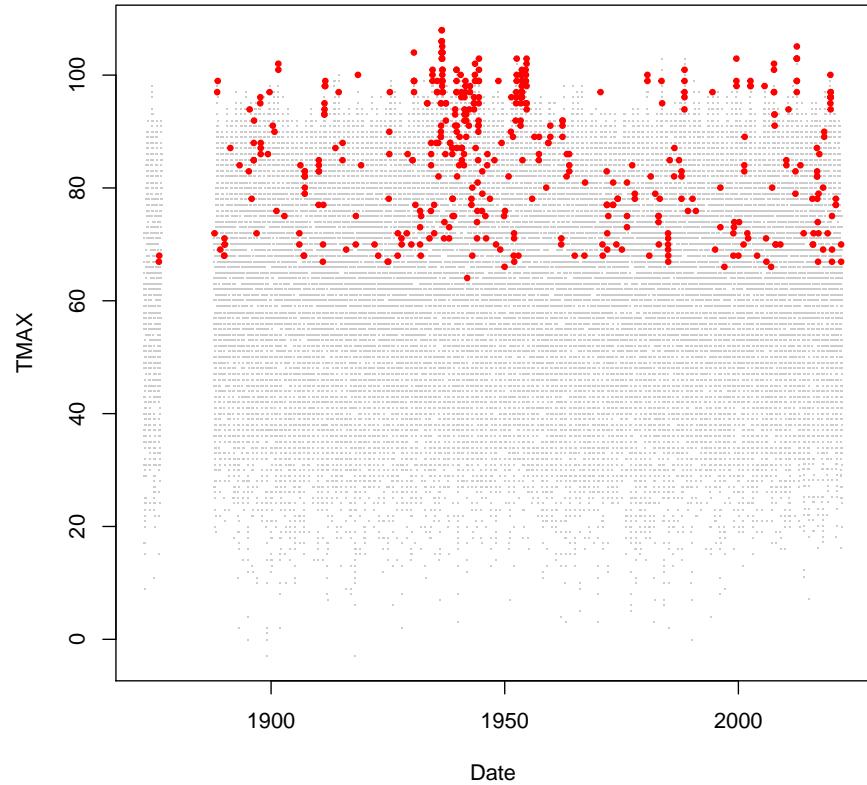












## 2.7 Iterate Boxplots

# 3 Plot Results

## 3.1 Static Plots

To test the code, I have created graphics that can then be used in the animation process, i.e. try to create code that doesn't get too complicated and then fail!

## 3.2 Animation

So far, this creates a gif file, but I haven't been able to get the gif in the pdf directly yet. I will need an additional package or create separate png that are combined. For now, we'll create a gif file to be used in separate documents.

```

#setwd("/home/CAMPUS/mwl04747/github/Climate_Change_Narratives/docs/Social_Media")

#par(las=1, mfrw=c(2,1), mar= c(2, 4, 2, 1) + 0.1)
img <- image_graph(600, 480, res = 96)
# START -----
ylim_new=NA
for(i in seq(min(GSOM$Year), max(GSOM$Year), by=2))
{
  par(las=1, mfrw=c(4,1), mar= c(2, 4, 2, 1) + 0.1)
  GSOMsub <- GSOM[GSOM$Month==maxmonth & GSOM$Year<=i,]
  if(nrow(GSOMsub)<10) next
  plot(TMIN~Date, GSOMsub[GSOMsub$Month==maxmonth,],
    col='gray70', pch=20, xlab="",
    main=paste("Mean", format(GSOMsub>Date,"%B")[1], "Min. Temp", GSOM_Longest$name))
  GSOM.lm = lm(TMIN~Date, GSOMsub)
  pred_dates <-data.frame(Date = GSOMsub>Date); str(pred_dates)
  #Predicts the values with confidence interval
  ci <- predict(GSOM.lm, newdata = pred_dates, interval = 'confidence')
  # str(ci)
  lines(pred_dates$Date, as.numeric(ci[,1]), col="darkred")
  lines(pred_dates$Date, as.numeric(ci[,2]), col="darkorange")
  lines(pred_dates$Date, ci[,3], col="darkorange")

  location_index = round(length(GSOMsub>Date) * 0.99,0)

  text(pred_dates$Date[location_index], ci[location_index,3],
    paste(report_prob2(GSOM.lm)), pos=2)

# Box Plot of -----
CHCNDsub = subset(CHCND, CHCND$Year<=i,
  select=c(Month, Month.name, TMAX, TMIN))

boxplot(TMAX ~ Month.name, data=CHCNDsub,
  main="")
symbol.y = (par()$yaxp[2])-diff(par()$yaxp[1:2])*0.99
#symbol.y = (par()$yaxp[2])
text(sumstats$Month, symbol.y, sumstats$TMAX_Symbol, col="red", cex=2)
mtext(paste("Maximum Daily Temperatures", min(CHCND$Year), "-",
  i, GSOM_Longest$name), line=1)
mtext("(NOTE: Red asterisks correspond to significant changes)", line=0, cex=.7)

# TMAX -----

ylim = range(GSOMsub$TMAX)
#if(!is.na(ylim_new)) ylim[2]=ylim_new

```

```

plot(TMAX~Date, GSOMsub, col='gray70', pch=20, xlab="",
      ylim=ylim,
      main=paste("Mean", format(GSOMsub$Date, "%B") [1],
                 "Max. Temp", GSOM_Longest$name))
GSOM.lm = lm(TMAX~Date, GSOMsub)

ci <- predict(GSOM.lm, newdata = pred_dates, interval = 'confidence')
# str(ci)
lines(pred_dates$Date, as.numeric(ci[,1]), col="darkred")
lines(pred_dates$Date, as.numeric(ci[,2]), col="darkorange")
lines(pred_dates$Date, ci[,3], col="darkorange")

text(pred_dates$Date[location_index], ci[location_index,3],
      paste(report_prob2(GSOM.lm)), pos=2)

plot(TMAX~Date, CHCND[CHCND$Year<=i,], pch='.', col="grey80",
      main="Recorded Daily High Temperatures")
points(maxTMAX~Date, data=CHCND[CHCND$Year<=i,], pch=20, col="red", cex=.8 )

}
# END -----
dev.off()

```

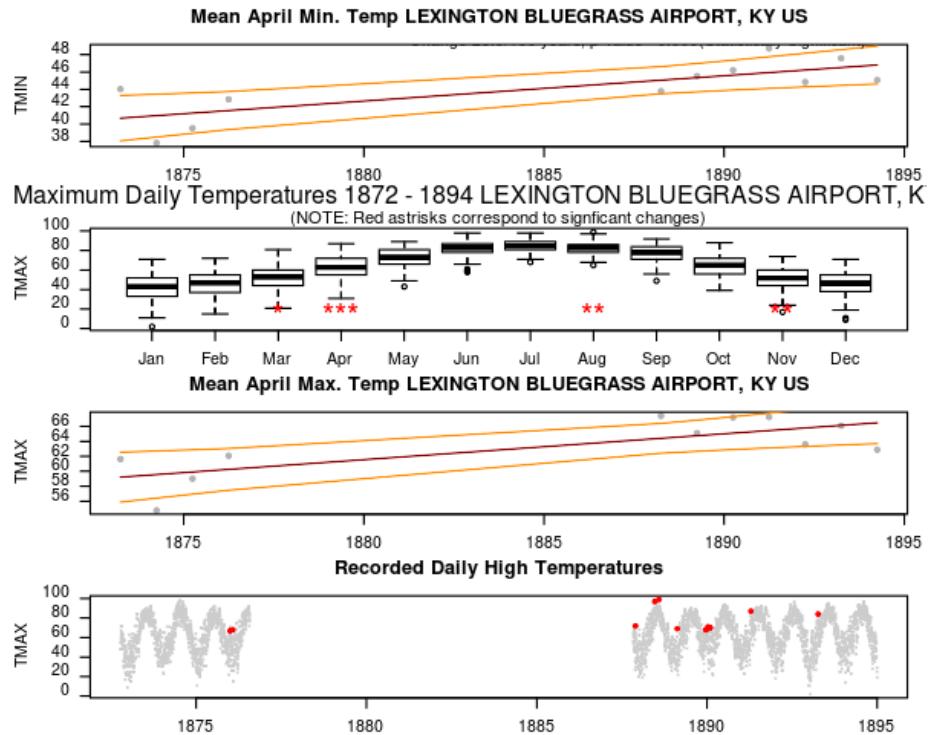
The file is saved in the main directory.

```

print(img)

## # A tibble: 64 x 7
##   format width height colorspace matte filesize density
##   <chr>  <int>  <int> <chr>     <lgl>    <int> <chr>
## 1 PNG      600    480 sRGB      TRUE        0 96x96
## 2 PNG      600    480 sRGB      TRUE        0 96x96
## 3 PNG      600    480 sRGB      TRUE        0 96x96
## 4 PNG      600    480 sRGB      TRUE        0 96x96
## 5 PNG      600    480 sRGB      TRUE        0 96x96
## 6 PNG      600    480 sRGB      TRUE        0 96x96
## 7 PNG      600    480 sRGB      TRUE        0 96x96
## 8 PNG      600    480 sRGB      TRUE        0 96x96
## 9 PNG      600    480 sRGB      TRUE        0 96x96
## 10 PNG     600    480 sRGB      TRUE        0 96x96
## # ... with 54 more rows

```



```

GSOM_animation <- image_animate(img, fps = 1, loop=2, optimize = TRUE)
print(GSOM_animation)

## # A tibble: 64 x 7
##   format width height colorspace matte filesize density
##   <chr>   <int>  <int> <chr>      <lgl>    <int> <chr>
## 1 gif     600    480 sRGB       TRUE      0 96x96
## 2 gif     569    456 sRGB       TRUE      0 96x96
## 3 gif     526    449 sRGB       TRUE      0 96x96
## 4 gif     547    449 sRGB       TRUE      0 96x96
## 5 gif     547    449 sRGB       TRUE      0 96x96
## 6 gif     519    449 sRGB       TRUE      0 96x96
## 7 gif     498    449 sRGB       TRUE      0 96x96
## 8 gif     565    456 sRGB       TRUE      0 96x96
## 9 gif     521    449 sRGB       TRUE      0 96x96
## 10 gif    504    449 sRGB      TRUE      0 96x96
## # ... with 54 more rows

setwd("/home/CAMPUS/mwl04747/github/Climate_Change_Narratives/docs/Social_Media/gif")
image_write(GSOM_animation, paste(fips$State, "_GSOM.gif", sep=""))

```

### 3.3 Show Map of Location

```
library(ggmap)

## Google's Terms of Service: https://cloud.google.com/maps-platform/terms/
## Please cite ggmap if you use it! See citation("ggmap") for details.

#API = "AIzaSyBfkMN5PYsBOA92RbOxo1bc51y-5aitKDI"
#register_google(key = API, write = TRUE)

GSOM_Longest$name

## [1] "LEXINGTON BLUEGRASS AIRPORT, KY US"

locus=c(lat = GSOM_Longest$latitude, lon = GSOM_Longest$longitude)
locus

##      lat      lon
## 38.03391 -84.61138

# You may also use the coordinates (latitude and longitude),
# if you have them locus=c(lat = 45.4344700786, lon = 12.3394828851)
# Now we require the information from Google, by also zooming on the map

#myMap <- c(left = -125, bottom = 25.75, right = -67, top = 49)
#get_stamenmap(us, zoom = 5, maptype = "toner-lite") %>% ggmap()

#myMap <- get_map(location=locus, zoom= 18, source="google", maptype="roadmap", crop=TRUE)

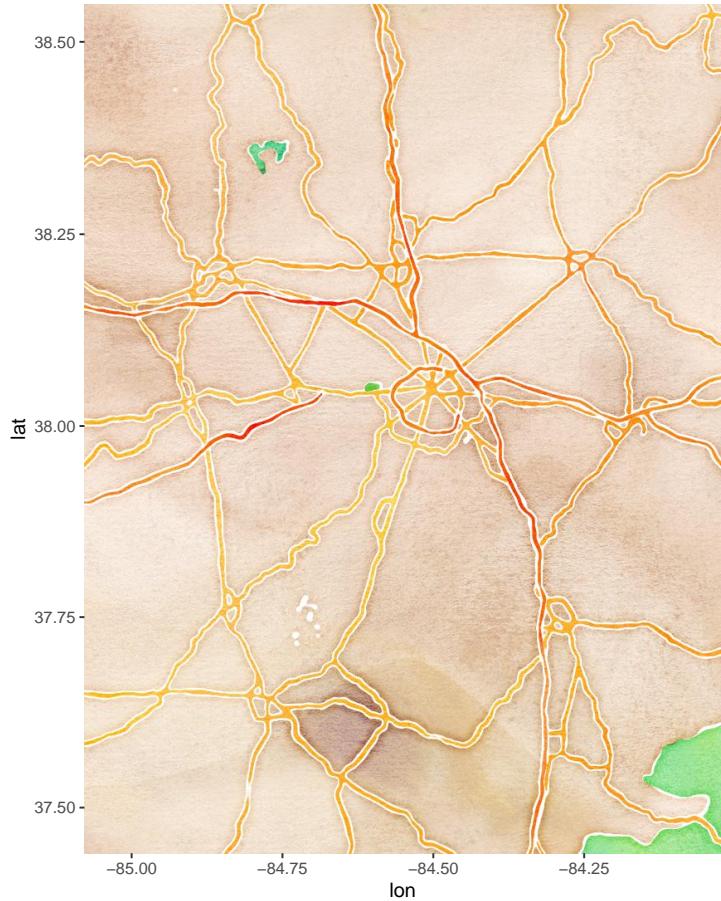
#ggmap(myMap) +
#geom_point(aes(x = locus[1], y = locus[2]),
#alpha = .5, color="darkred", size = 3)

myLocation <- c(lon = -95.3632715, lat = 29.7632836)
myLocation <- locus
myMap <- get_map(location=myLocation,
source="stamen", maptype="watercolor", crop=FALSE)

## note : locations should be specified in the lon/lat format, not
## lat/lon.
## Source : https://maps.googleapis.com/maps/api/staticmap?center=38.03391,-84.61138&zoom=18
## Source : http://tile.stamen.com/watercolor/10/270/393.jpg
## Source : http://tile.stamen.com/watercolor/10/271/393.jpg
## Source : http://tile.stamen.com/watercolor/10/272/393.jpg
```

```
## Source : http://tile.stamen.com/watercolor/10/270/394.jpg
## Source : http://tile.stamen.com/watercolor/10/271/394.jpg
## Source : http://tile.stamen.com/watercolor/10/272/394.jpg
## Source : http://tile.stamen.com/watercolor/10/270/395.jpg
## Source : http://tile.stamen.com/watercolor/10/271/395.jpg
## Source : http://tile.stamen.com/watercolor/10/272/395.jpg
## Source : http://tile.stamen.com/watercolor/10/270/396.jpg
## Source : http://tile.stamen.com/watercolor/10/271/396.jpg
## Source : http://tile.stamen.com/watercolor/10/272/396.jpg

ggmap(myMap)
```



```
ggmap(myMap)+  
geom_point(aes(x = lon, y = lat), data = locus, alpha = .5, color="darkred", size = 3)  
## Error in 'fortify()':
```

```

## ! 'data' must be a data frame, or other object coercible by 'fortify()',
not a numeric vector.

#A) Download the main crime incident dataset

incidents= read.csv('https://raw.githubusercontent.com/lgellis/MiscTutorial/master/ggmap/i2s.csv')

#B) Download the extra dataset with the most dangerous Seattle cities as per:
# https://housely.com/dangerous-neighborhoods-seattle/

n <- read.csv('https://raw.githubusercontent.com/lgellis/MiscTutorial/master/ggmap/n.csv', sep = ",")

# Look at the data sets

dim(incidents)
head(incidents)
attach(incidents)

dim(n)
head(n)
attach(n)

# Create some color variables for graphing later
col1 = "#011f4b"; col2 = "#6497b1"; col3 = "#b3cde0"; col4 = "#CC0000"

#add year to the incidents data frame
incidents$ymd <- mdy_hms(Event.Clearance.Date)
incidents$year <- year(incidents$ymd)

#Create a more manageable data frame with only 2017 and 2018 data
i2 <- incidents %>% filter(year>=2017 & year<=2018)

#Only include complete cases
i2[complete.cases(i2), ]

#create a display label to the n data frame (dangerous neighbourhoods)
n$label <- paste(Rank, Location, sep="-")

##1) Create a map with all of the crime locations plotted.

p <- ggmap(get_googlemap(center = c(lon = -122.335167, lat = 47.608013),
                           zoom = 11, scale = 2,
                           maptype ='terrain',
                           color = 'color'))

```

```
p + geom_point(aes(x = Longitude, y = Latitude, colour = Initial.Type.Group), data = i2, size = 1)
```

### 3.4 OLD version

## 4 Other attempts...

```
ncdc_locs(locationcategoryid='CITY', sortfield='name',
           sortorder='desc')

# ncdc_locs(locationcategoryid='CITY',
#   locationid='FIPS:01', sortfield='name', sortorder='desc')

#ncdc_datasets(locationcategoryid='CITY',
#   locationid='FIPS:01', sortfield='name', sortorder='desc')

out <- ncdc(datasetid='NORMAL_DLY', stationid='GHCND:USW00014895',
             datatypeid='dly-tmax-normal', startdate = '2010-05-01',
             enddate = '2010-05-10')

with_units <- ncdc(datasetid='GHCND', stationid='GHCND:USW00014895',
                     datatypeid='TMAX', startdate = '2010-05-01',
                     enddate = '2010-10-31', limit=500, add_units = TRUE)
head( with_units$data )

## # A tibble: 6 x 9
##   date          datatype station    value fl_m fl_q fl_so fl_t units
##   <chr>        <chr>     <chr>    <int> <chr> <chr> <chr> <chr>
## 1 2010-05-01T00:00:00 TMAX GHCND:USW0~    222   ""    ""    0    2400 celciu~
## 2 2010-05-02T00:00:00 TMAX GHCND:USW0~    222   ""    ""    0    2400 celciu~
## 3 2010-05-03T00:00:00 TMAX GHCND:USW0~    233   ""    ""    0    2400 celciu~
## 4 2010-05-04T00:00:00 TMAX GHCND:USW0~    222   ""    ""    0    2400 celciu~
## 5 2010-05-05T00:00:00 TMAX GHCND:USW0~    272   ""    ""    0    2400 celciu~
## 6 2010-05-06T00:00:00 TMAX GHCND:USW0~    194   ""    ""    0    2400 celciu~
```

### 4.1 Evaluating Records

TBD

### 4.2 Export Options

TBD

## 5 Sea Surface Temperature Data – SURP PROJECT WAITING TO HAPPEN

In contrast to terrestrial data, sea surface temperature (SST) is quite difficult to obtain and process. There are numerous tools to access the data, but they often require knowledge of complex software tools that are not easy to set up or programming experience with python or others.

<https://climexp.knmi.nl/select.cgi?id=someone@somewhere&field=ersstv5>

There are, however, a few tools build for R users that seem to accomplish all that we need.

[https://rda.ucar.edu/index.html?hash=data\\_user&action=register](https://rda.ucar.edu/index.html?hash=data_user&action=register)

<https://rda.ucar.edu/datasets/ds277.9/>

Alternatively, we can download flat ASCII tables of gridded data:

<https://www1.ncdc.noaa.gov/pub/data/cmb/ersst/v5/ascii/>

```
library(chron)
library(RColorBrewer)
library(lattice)
#library(ncdf)
library(ncdf4)
#library(greenbrown) # for gridded trend analysis

ersst.nc = "/home/CAMPUS/mwl04747/github/Climate_Change_Narratives/Data/FA19/ersst.v5.185401
Y1854 = "https://www1.ncdc.noaa.gov/pub/data/cmb/ersst/v5/ascii/ersst.v5.1854.asc"
Y1864 = "https://www1.ncdc.noaa.gov/pub/data/cmb/ersst/v5/ascii/ersst.v5.1864.asc"
Y1874 = "https://www1.ncdc.noaa.gov/pub/data/cmb/ersst/v5/ascii/ersst.v5.1874.asc"
Y1884 = "https://www1.ncdc.noaa.gov/pub/data/cmb/ersst/v5/ascii/ersst.v5.1884.asc"
Y1894 = "https://www1.ncdc.noaa.gov/pub/data/cmb/ersst/v5/ascii/ersst.v5.1894.asc"
Y1904 = "https://www1.ncdc.noaa.gov/pub/data/cmb/ersst/v5/ascii/ersst.v5.1904.asc"
Y1914 = "https://www1.ncdc.noaa.gov/pub/data/cmb/ersst/v5/ascii/ersst.v5.1914.asc"
Y1924 = "https://www1.ncdc.noaa.gov/pub/data/cmb/ersst/v5/ascii/ersst.v5.1924.asc"
Y1934 = "https://www1.ncdc.noaa.gov/pub/data/cmb/ersst/v5/ascii/ersst.v5.1934.asc"
Y1944 = "https://www1.ncdc.noaa.gov/pub/data/cmb/ersst/v5/ascii/ersst.v5.1944.asc"
Y1954 = "https://www1.ncdc.noaa.gov/pub/data/cmb/ersst/v5/ascii/ersst.v5.1954.asc"
Y1964 = "https://www1.ncdc.noaa.gov/pub/data/cmb/ersst/v5/ascii/ersst.v5.1964.asc"
Y1974 = "https://www1.ncdc.noaa.gov/pub/data/cmb/ersst/v5/ascii/ersst.v5.1974.asc"
Y1984 = "https://www1.ncdc.noaa.gov/pub/data/cmb/ersst/v5/ascii/ersst.v5.1984.asc"
Y1994 = "https://www1.ncdc.noaa.gov/pub/data/cmb/ersst/v5/ascii/ersst.v5.1994.asc"
Y2004 = "https://www1.ncdc.noaa.gov/pub/data/cmb/ersst/v5/ascii/ersst.v5.2004.asc"
Y2014 = "https://www1.ncdc.noaa.gov/pub/data/cmb/ersst/v5/ascii/ersst.v5.2014.asc"

temp = rbind(read.table(Y1854)[75,67], read.table(Y1864)[75,67], read.table(Y1874)[75,67],
read.table(Y1884)[75,67], read.table(Y1894)[75,67], read.table(Y1904)[75,67],
read.table(Y1914)[75,67], read.table(Y1924)[75,67], read.table(Y1934)[75,67],
read.table(Y1944)[75,67], read.table(Y1954)[75,67], read.table(Y1964)[75,67],
```

```

read.table(Y1974) [75,67], read.table(Y1984) [75,67], read.table(Y1994) [75,67],
read.table(Y2004) [75,67], read.table(Y2014) [75,67])

temp.df = data.frame(Temp = as.vector(temp)/100); temp.df
temp.df$Year = seq(1854, 2014, 10)
plot(Temp~Year, temp.df)
abline(coef(lm(Temp~Year, data=temp.df)), col="red")
#automating this process!

directory = "/pub/data/cmb/ersst/v5/ascii"

B195401 = nc_open(ersst.nc)

# str(B195401)
# print(B195401)

ncin = B195401

print(ncin)
lon <- ncvar_get(ncin, "lon")
nlon <- dim(lon)
head(lon)

lat <- ncvar_get(ncin, "lat", verbose = F)
nlat <- dim(lat)
head(lat)

print(c(nlon, nlat))

t <- ncvar_get(ncin, "time")
tunits <- ncatt_get(ncin, "time", "units")
nt <- dim(t); nt

lat.sel = 67; lon.set = 75

#ncvar_get(ncin, sst) #object 'sst' not found

#ncvar_get(ncin, varfsst) object of type 'closure' is not subsettable
#ncvar_get(ncin, var) second argument to ncvar_get must be an object of type ncvar or ncdim

ncvar_get(ncin, "sst") #spits out the temperatures. but why the negative numbers!

# tmp.array <- ncvar_get(ncin, dname) # doesn't work...

```

```

tmp.array <- ncvar_get(ncin, "sst")
dim(tmp.array)

tmp.array[75, 67]

tmp.array[67,]

dlname <- ncatt_get(ncin, "sst", "long_name")
dunits <- ncatt_get(ncin, "sst", "units")
fillvalue <- ncatt_get(ncin, "sst", "_FillValue")
dim(tmp.array)

title <- ncatt_get(ncin, 0, "title")
institution <- ncatt_get(ncin, 0, "institution")
datasource <- ncatt_get(ncin, 0, "source")
references <- ncatt_get(ncin, 0, "references")
history <- ncatt_get(ncin, 0, "history")
Conventions <- ncatt_get(ncin, 0, "Conventions")

# split the time units string into fields
tustr <- strsplit(tunits$value, " ")
tdstr <- strsplit(unlist(tustr)[3], "-")
tmonth = as.integer(unlist(tdstr)[2])
tday = as.integer(unlist(tdstr)[3])
tyear = as.integer(unlist(tdstr)[1])
chron(t, origin = c(tmonth, tday, tyear))

# tmp.array[tmp.array == fillvalue] <- NA

# length(na.omit(as.vector(tmp.array[, , 1])))

m <- 1
tmp.slice <- tmp.array[, , m]

image(lon, lat, tmp.array, col = rev(brewer.pal(10, "RdBu")))
# image(lon, lat, tmp.slice, col = rev(brewer.pal(10, "RdBu")))

```

## 6 Satellite Data

TBD

## **7 Ice-Core Data**

TBD