Preparing Regional Weather Data Analysis Project

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1 Background

1.1 Project Goals

Create a public product (video) that explains climate change trends in a state; what the state is doing to mitigate climate change; and what the state and it's residents could do to improve its efforts to mitigate climate change.

1.2 Project Stages

1. Data Collection
2. Data Processing
3. Data Analysis
4. Data Visualization
5. Communicating Project

1.3 Global Weather Station Data

1.4 Download Station Inventory

```
library(here)

## here() starts at /home/mwl04747/RTricks

# Get Stations Data (Inventory)
inventory = read.table("https://www.ncei.noaa.gov/pub/data/ghcn/daily/ghcnd-inventory.txt")

# Define Variable Names
inventory_names = c("ID", #            1-11   Character
                    "LATITUDE", #     13-20   Real
```

```
                      "LONGITUDE", #    22-30   Real
                      "ELEMENT", #      32-35   Character
                      "FIRSTYEAR", #    37-40   Integer
                      "LASTYEAR") #     42-45   Integer

# Assign Variable Names
names(inventory) = inventory_names

# Check the structure of the data
str(inventory)
```

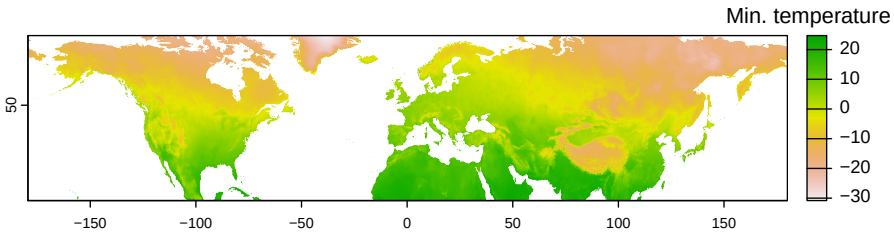
```
## 'data.frame': 747094 obs. of  6 variables:
##  $ ID       : chr  "ACW00011604" "ACW00011604" "ACW00011604" "ACW00011604" ...
##  $ LATITUDE : num  17.1 17.1 17.1 17.1 17.1 ...
##  $ LONGITUDE: num  -61.8 -61.8 -61.8 -61.8 -61.8 ...
##  $ ELEMENT  : chr  "TMAX" "TMIN" "PRCP" "SNOW" ...
##  $ FIRSTYEAR: int  1949 1949 1949 1949 1949 1949 1949 1949 1949 1949 ...
##  $ LASTYEAR : int  1949 1949 1949 1949 1949 1949 1949 1949 1949 1949 ...
```

```
library(geodata)
```

```
## Loading required package:  terra
## terra 1.7.55
##
## Attaching package:  'terra'
## The following object is masked from 'package:knitr':
##
##     spin
```

```
d <- worldclim_country(country = "USA", var = "tmin",
                       path = tempdir())
terra::plot(mean(d), plg = list(title = "Min. temperature (C)"))
```

```
##
|---------|---------|---------|---------|
=========================================
```



1.5 Visualizing of Active Weather Stations with Maximum Daily Temperature Readings

```
# Subset data for TMAX  (Max Temperature) Element
inventory.TMAX = subset(inventory, subset=ELEMENT=="TMAX")

str(inventory.TMAX)

## 'data.frame': 40395 obs. of  6 variables:
##  $ ID       : chr  "ACW00011604" "ACW00011647" "AE000041196" "AEM00041194" ...
##  $ LATITUDE : num  17.1 17.1 25.3 25.3 24.4 ...
##  $ LONGITUDE: num  -61.8 -61.8 55.5 55.4 54.7 ...
##  $ ELEMENT  : chr  "TMAX" "TMAX" "TMAX" "TMAX" ...
##  $ FIRSTYEAR: int  1949 1961 1944 1983 1983 1994 1973 1973 1966 1973 ...
```

```
##  $ LASTYEAR : int  1949 1961 2024 2024 2024 2024 1992 2020 2021 2020 ...

#plot(inventory.TMAX$LONGITUDE, inventory.TMAX$LATITUDE)

#plot(inventory.TMAX$LONGITUDE, inventory.TMAX$LATITUDE, pch=20, cex=.4)

# Selective ~Active Stations

inventory.TMAX = subset(inventory.TMAX, subset=LASTYEAR>=2022); str(inventory.TMAX)

## 'data.frame': 12745 obs. of  6 variables:
##  $ ID       : chr  "AE000041196" "AEM00041194" "AEM00041217" "AEM00041218" ...
##  $ LATITUDE : num  25.3 25.3 24.4 24.3 36.7 ...
##  $ LONGITUDE: num  55.52 55.36 54.65 55.61 3.25 ...
##  $ ELEMENT  : chr  "TMAX" "TMAX" "TMAX" "TMAX" ...
##  $ FIRSTYEAR: int  1944 1983 1983 1994 1940 1940 1958 1886 1878 1880 ...
##  $ LASTYEAR : int  2024 2024 2024 2024 2024 2024 2024 2023 2024 2024 ...

#plot(inventory.TMAX$LONGITUDE, inventory.TMAX$LATITUDE, pch=20, cex=.4, xlab="Long", ylab=

#par(mfrow=c(2,2))
```

2 Creating Up-to-Date Weather Datasets

To prepare for the project, we need to accomplish two things:

1. Select a region, i.e. State, of interest
2. Read in the most recent EPA information on the state.

3 Updated Station Selection Dataset

3.1 Download Recent

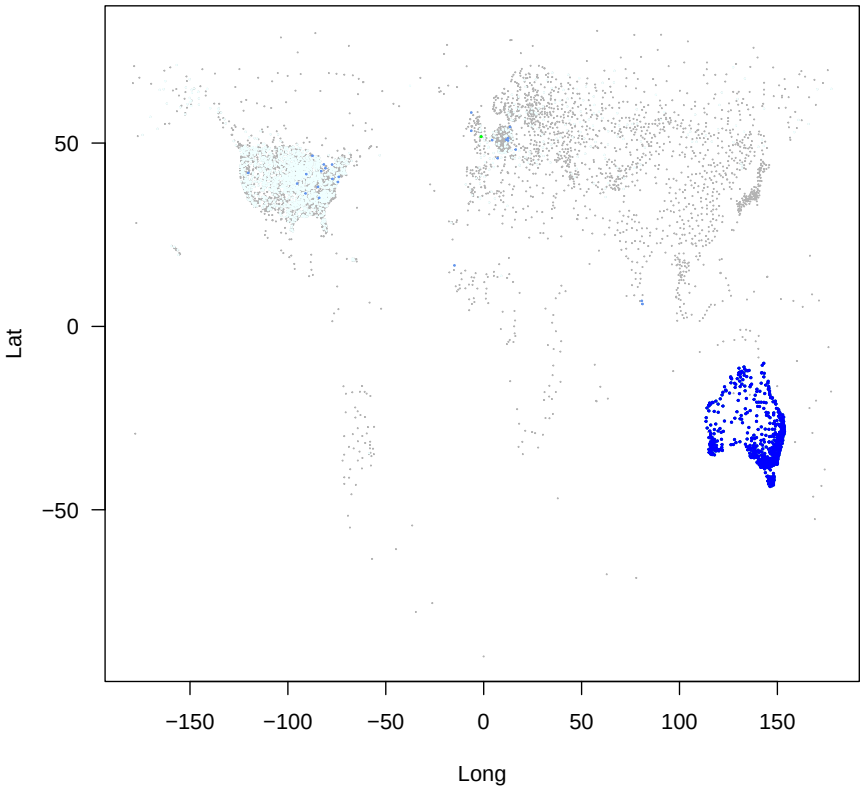
3.2 States in GHCND-station Dataset

The inventory has a list of stations and map coordinates (latitude and longitude). However, it's not easy to select a region, like a state, from the inventory. Thus, we need to merge the inventory with a dataset that includes state names.

It's a bit strange, but the dataset includes US states and Canadian Provinces, plus various territories of the US.

```
station_names = c("ID",             #  1-11   Character   11
                  "LATITUDE",       # 13-20   Real        8
                  "LONGITUDE",      # 22-30   Real        9
```

Figure 1: A plot of the global weather stations. Note the increase in stations over time and spatial distribution. Austrailia has most of it's stations with 1750 start dates, but I suspect most of these stations have lots of missing data.



```
                  "ELEVATION",      # 32-37   Real        6
                  "STATE",          # 39-40   Character   2
                  "NAME",           # 42-71   Character
                  "GSN FLAG",       # 73-75   Character
                  "HCN/CRN FLAG",   # 77-79   Character
                  "WMO ID"          # 81-85   Character
                   )

Stations = read.fwf("https://www.ncei.noaa.gov/pub/data/ghcn/daily/ghcnd-stations.txt", col.
        widths=c(11, -1, 8, -1, 9, -1, 6, -1, 2, -1, 30, -1, 3, -1, 3, -1, 5 ))

# NOTE: Got to be a better way to get these data!

str(Stations) # Missing State Name

## 'data.frame': 125988 obs. of  9 variables:
##  $ ID          : chr  "ACW00011604" "ACW00011647" "AE000041196" "AEM00041194" ...
##  $ LATITUDE    : num  17.1 17.1 25.3 25.3 24.4 ...
##  $ LONGITUDE   : num  -61.8 -61.8 55.5 55.4 54.7 ...
##  $ ELEVATION   : num  10.1 19.2 34 10.4 26.8 ...
##  $ STATE       : chr  "   " "   " "   " "   " ...
##  $ NAME        : chr  "ST JOHNS COOLIDGE FLD         " "ST JOHNS                       " "
##  $ GSN.FLAG    : chr  "   " "   " "GSN" "   " ...
##  $ HCN.CRN.FLAG: chr  "   " "   " "   " "   " ...
##  $ WMO.ID      : int  NA NA 41196 41194 41217 41218 40930 40938 40948 40990 ...

# Read ghcnd-states.txt

State_names = c("STATE", #         1-2    Character 2
                "STATE_NAME") #         4-50    Character 46


States = read.fwf("https://www.ncei.noaa.gov/pub/data/ghcn/daily/ghcnd-states.txt", col.name


str(States)

## 'data.frame': 74 obs. of  2 variables:
##  $ STATE     : chr  "AB" "AK" "AL" "AR" ...
##  $ STATE_NAME: chr  "ALBERTA" "ALASKA" "ALABAMA                                   " "

StateIDs = subset(Stations, select=c("ID", "STATE"))
StateIDs = merge(StateIDs, States, by="STATE") # Add State Names

temp.TMAX = merge(inventory.TMAX, StateIDs, by="ID")
# Note: Some outer join would be better, to be completed later.
```

```r
stations.USCan = subset(temp.TMAX, subset=(STATE!="  ")) # Remove Stations that STATE = bla
```

3.3 Select Active Stations

How many stations are in the state? 'r nrow(stations.USCan)'!

```r
stations.active = subset(stations.USCan, subset=LASTYEAR>=2022)
str(stations.active)

## 'data.frame': 7751 obs. of  8 variables:
##  $ ID        : chr  "AQW00061705" "CA001011500" "CA001012055" "CA001012475" ...
##  $ LATITUDE  : num  -14.3 48.9 48.8 48.4 48.4 ...
##  $ LONGITUDE : num  -171 -124 -124 -123 -123 ...
##  $ ELEMENT   : chr  "TMAX" "TMAX" "TMAX" "TMAX" ...
##  $ FIRSTYEAR : int  1966 1979 1960 1997 1991 1991 2007 1972 1970 1996 ...
##  $ LASTYEAR  : int  2024 2024 2023 2024 2024 2024 2024 2024 2022 2024 ...
##  $ STATE     : chr  "AS" "BC" "BC" "BC" ...
##  $ STATE_NAME: chr  "AMERICAN SAMOA" "BRITISH COLUMBIA" "BRITISH COLUMBIA" "BRITISH COLUM

nrow(stations.active)

## [1] 7751
```

3.4 Select 5 Stations for Each State

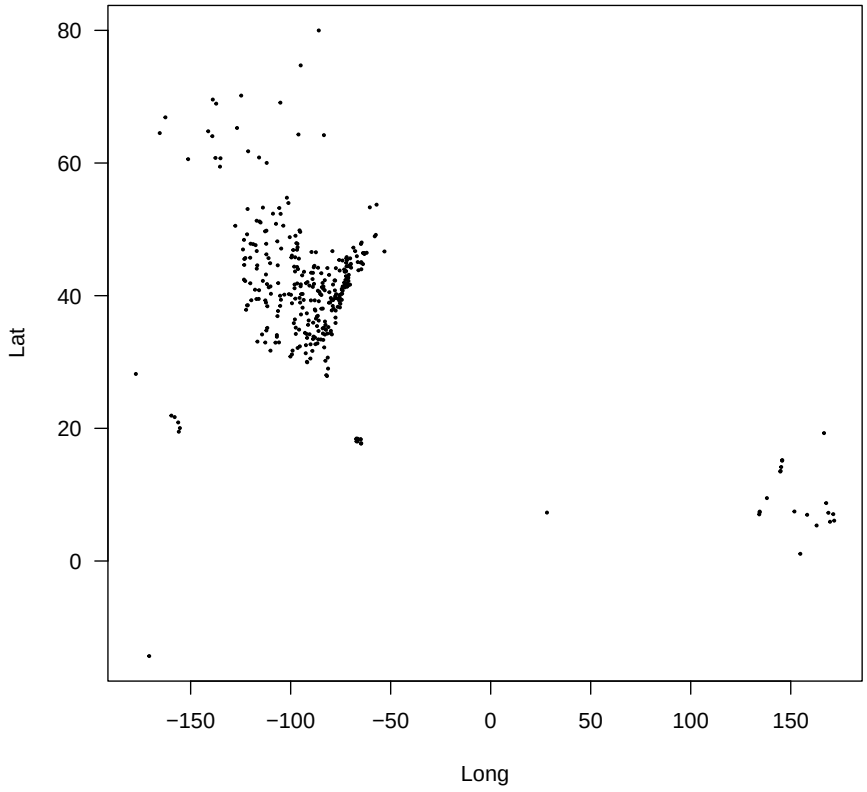
To accomplish this, I need to do a loop to select the first 5 stations for each state.

```r
# Loop to select 5 stations for each state
#stations.active.oldest = subset(stations.active, subset=FIRSTYEAR==min(FIRSTYEAR))

for(i in 1:nrow(States)) {
  state.df = subset(stations.active, subset=STATE==States$STATE[i])
  if(nrow(state.df) > 5) {
    state.df = state.df[order(state.df$FIRSTYEAR),][1:5,]
  }
  if(i==1) {
    stations.active.oldest = state.df
  } else {
    stations.active.oldest = rbind(stations.active.oldest, state.df)
  }
}
```

4 Plot Results

```
plot(stations.active.oldest$LONGITUDE, stations.active.oldest$LATITUDE, pch=20, cex=.4, xlab
```



4.1 Next Steps

```
# export file to csv
write.csv(stations.active.oldest, here("04_Regional_Climate_Trends", "stations.active.oldest
```