Do weather changes matter?

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1 Introduction

According the the IPCC, the temperature has been changing about 0.X degrees per XX years – but how do these changes "map" onto a community that you care about? Can we find out how these changes will affect specific communities we care about? In other words, do weather changes matter to you?

1.1 Learning Goals

For this project, you will use weather station data to answer the questions above. How you answer the question is largely up to you, however, there are some learning goals associated with this project:

- Learn how to download and process weather data;
- Evaluate the trends in weather data;
- Determine the impact of weather in a human or non-human community; and
- Communicate your conclusions to the public.

1.2 Driving Question

Is my region's climate changing?
How is climate change affecting my community?

1.3 Public Product

Narrative Blog...
with professional graphics and statistics.
shiny apps

1.4 Approach

Students will have the following tools available.

- NOAA website where data can be downloaded...
- R Studio Server with some scripts to help you develop analyses.
- Gighub to store project codes
- Shiny app templates that might be used as a container for interactive content

2 Project Stages (i.e. Scafolding)

2.1 Day 1: How is temperature data collected?

2.1.1 Land Based

2.1.2 Marine Based

2.2 How are the data store, curated and checked for quality?

3 Data Sources

3.1 NOAA

3.1.1 Downloading Compressed Files

4 Using RStudio

4.1 Why R, Why Rstudio, and Why Open Source

5 R Coding an Analysis

```
library(tidyr)
library(dplyr)

##
## Attaching package:  'dplyr'
##
## The following objects are masked from 'package:stats':
##
##    filter, lag
##
## The following objects are masked from 'package:base':
```

```
##
##     intersect, setdiff, setequal, union
```

```
library(stringr)
library(reshape2)
```

```
# Uncompress the files.
# ghcnd_all
source("summarySE.R")

tarfile = "C:\\workspace\\GitHub\\RTricks\\300_Global_Warming\\Raw Data\\ghcnd_all.tar.gz"

#ftpsource = ftp://ftp.ncdc.noaa.gov/pub/data/ghcn/v3/ghcnm.tmax.latest.qca.tar.gz


#ghcnm.tmax.latests.qca.tar.gz
tarfile = "C:\\workspace\\GitHub\\RTricks\\300_Global_Warming\\Raw Data\\ghcnm.tmax.latest.q
# untar(tarfile)
```

```
stationfile = "/home/CAMPUS/mwl04747/github/Climate_Change_Narratives/Data/ghcnd-stations.tx
```

5.1 Obtain Stations

```
# read.table(stationfile, header=F, fill=T, row.names=NULL); head(stations)
stations = (read.fwf(stationfile, fill=T, widths= c(11, 9, 10, 7, 3, 32, 3, 4, 9), ))
names(stations)= c("ID", "LAT", "LONG", "ELEV", "STATE", "NAME", "GSN", "HCN_CRN", "WHOID")

head(stations)
```

```
##            ID     LAT     LONG  ELEV STATE
## 1 ACW00011604 17.1167 -61.7833  10.1
## 2 ACW00011647 17.1333 -61.7833  19.2
## 3 AE000041196 25.3330  55.5170  34.0
## 4 AEM00041194 25.2550  55.3640  10.4
## 5 AEM00041217 24.4330  54.6510  26.8
## 6 AEM00041218 24.2620  55.6090 264.9
##                                NAME GSN HCN_CRN WHOID
## 1  ST JOHNS COOLIDGE FLD                          NA
## 2  ST JOHNS                                       NA
## 3  SHARJAH INTER. AIRP             GSN         41196
## 4  DUBAI INTL                                     41194
## 5  ABU DHABI INTL                                 41217
## 6  AL AIN INTL                                    41218
```

```
str(stations)

## 'data.frame': 100747 obs. of  9 variables:
##  $ ID     : Factor w/ 100747 levels "ACW00011604",..: 1 2 3 4 5 6 7 8 9 10 ...
##  $ LAT    : num  17.1 17.1 25.3 25.3 24.4 ...
##  $ LONG   : num  -61.8 -61.8 55.5 55.4 54.7 ...
##  $ ELEV   : num  10.1 19.2 34 10.4 26.8 ...
##  $ STATE  : Factor w/ 76 levels "   "," AB"," AK",..: 1 1 1 1 1 1 1 1 1 1 ...
##  $ NAME   : Factor w/ 93968 levels " 'S HEERENHOEK                 ",..: 79235 79234 762
##  $ GSN    : Factor w/ 3 levels "","   ","GSN": 2 2 3 2 2 2 3 2 2 2 ...
##  $ HCN_CRN: Factor w/ 4 levels "","    "," CRN",..: 2 2 2 2 2 2 2 2 2 2 ...
##  $ WHOID  : num  NA NA 41196 41194 41217 ...
```

Example of data:
AG000060680 22.8000 5.4331 1362.0 TAMANRASSET GSN 60680

5.2 Selecting and Example Location

Here's what the data look like:

ID 1-11 Character YEAR 12-15 Integer MONTH 16-17 Integer ELEMENT 18-21 Character VALUE1 22-26 Integer MFLAG1 27-27 Character QFLAG1 28-28 Character SFLAG1 29-29 Character VALUE2 30-34 Integer MFLAG2 35-35 Character QFLAG2 36-36 Character SFLAG2 37-37 Character . . . . . VALUE31 262-266 Integer MFLAG31 267-267 Character QFLAG31 268-268 Character SFLAG31 269-269 Character

Here's an example of data from Arizona...

```
stations[stations$ID=="US1AZMR0019",]

##                ID     LAT      LONG  ELEV STATE
## 48124 US1AZMR0019 33.5902 -111.9712 418.5    AZ
##                                   NAME GSN HCN_CRN WHOID
## 48124  SCOTTSDALE 8.8 SW                                NA

# head(stations[stations£HCN_CRN==" CRN",])
```

Let's get the a different site into R

```
# Read the file
dlyfile = "/home/CAMPUS/mwl04747/github/Climate_Change_Narratives/AGM00060515"
test = read.fwf(dlyfile,widths = c(11, 4, 2, 4, rep(c(5, 1, 1, 1),31)))

## Warning in file(file, "rt"):  cannot open file '/home/CAMPUS/mwl04747/github/Climate_Chan
No such file or directory
## Error in file(file, "rt"):  cannot open the connection

str(test)
```

```
## Error in str(test):  object 'test' not found
```

I often forget how to make loops, so I often use simple examples that help me remember, for example,

```
# practicing loops
for (year in c(2010,2011,2012,2013,2014,2015)){
  print(paste("The year is", year))
}

## [1] "The year is 2010"
## [1] "The year is 2011"
## [1] "The year is 2012"
## [1] "The year is 2013"
## [1] "The year is 2014"
## [1] "The year is 2015"
```

Since the data have a re-occuring set of variable names, I decided to create a vector of variable names, many of which are nearly the same. So, as you'll see, I had to create a loop to avoid having to type a ton (or 31 :-)) of different variables.

```
# Create New Varible Names
MFLAG=NA; QFLAG=NA; SFLAG=NA; VALUE=NA
for (i in 1:31){
VALUE[i] = paste("DATE", i, sep="")
MFLAG[i] = paste("MFLAG", i, sep="")
QFLAG[i] = paste("QFLAG", i, sep="")
SFLAG[i] = paste("SFLAG", i, sep="")
}

# Vector of variable names converted from a transposed matrix
tmp = as.vector(t(matrix(data=c(VALUE, MFLAG, QFLAG, SFLAG), ncol=4)))
Names = c("ID", "YEAR", "MONTH", "ELEMENT", tmp); length(Names)

## [1] 128
```

5.3 Process Selected Data Files

```
setwd("/home/CAMPUS/mwl04747/github/Climate_Change_Narratives/Data")

dly_list = list.files(pattern="*.dly"); head(dly_list)

## [1] "AGM00060515.dly" "US1AZCN0021.dly"
```

```r
#for (i in 1:length(dly_list))
for (i in 1:1){
tmp <- read.fwf(dly_list[i], widths = c(11, 4, 2, 4, rep(c(5, 1, 1, 1),31)))
names(tmp) <- Names
assign(dly_list[i], subset(tmp, ELEMENT=="TMAX", select=c(1:4, seq(5, by = 4, length.out=31)
}


tmp1 = melt(AGM00060515.dly, id=c("ID", "YEAR", "MONTH", "ELEMENT"))
head(tmp1)
```

```
##            ID YEAR MONTH ELEMENT variable value
## 1 AGM00060515 1984     3    TMAX    DATE1 -9999
## 2 AGM00060515 1984     4    TMAX    DATE1   190
## 3 AGM00060515 1984     5    TMAX    DATE1 -9999
## 4 AGM00060515 1984     6    TMAX    DATE1 -9999
## 5 AGM00060515 1984     7    TMAX    DATE1   430
## 6 AGM00060515 1984     8    TMAX    DATE1 -9999
```

```r
tmp1$Day = as.numeric(str_sub(tmp1$variable,6,7)); head(tmp1)
```

```
##            ID YEAR MONTH ELEMENT variable value Day
## 1 AGM00060515 1984     3    TMAX    DATE1 -9999  NA
## 2 AGM00060515 1984     4    TMAX    DATE1   190  NA
## 3 AGM00060515 1984     5    TMAX    DATE1 -9999  NA
## 4 AGM00060515 1984     6    TMAX    DATE1 -9999  NA
## 5 AGM00060515 1984     7    TMAX    DATE1   430  NA
## 6 AGM00060515 1984     8    TMAX    DATE1 -9999  NA
```

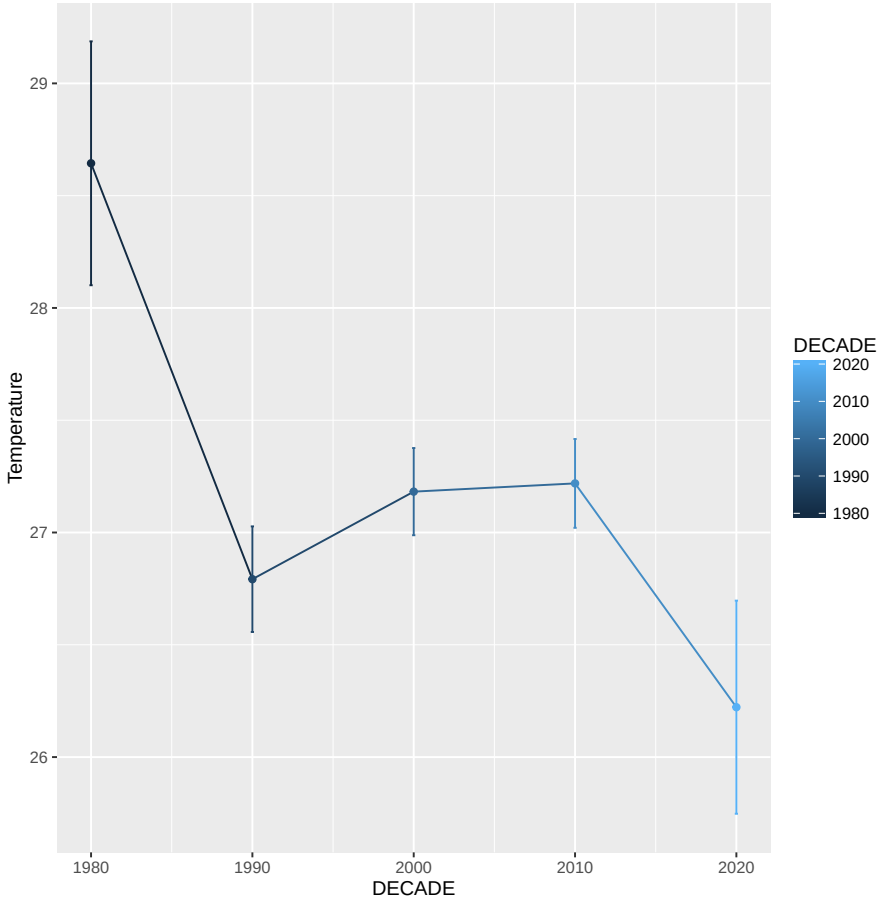
```r
tmp1$value[tmp1$value==-9999] = NA; head(tmp1)
```

```
##            ID YEAR MONTH ELEMENT variable value Day
## 1 AGM00060515 1984     3    TMAX    DATE1    NA  NA
## 2 AGM00060515 1984     4    TMAX    DATE1   190  NA
## 3 AGM00060515 1984     5    TMAX    DATE1    NA  NA
## 4 AGM00060515 1984     6    TMAX    DATE1    NA  NA
## 5 AGM00060515 1984     7    TMAX    DATE1   430  NA
## 6 AGM00060515 1984     8    TMAX    DATE1    NA  NA
```

```r
tmp1$Temperature = tmp1$value/10

drops <- c("variable","value")
tmp1 <-tmp1[ , !(names(tmp1) %in% drops)]
tmp1$DECADE = round(tmp1$YEAR, -1)
# names(tmp1)
```

6 Presenting the Results

```
# call summarySE function....somehow...


library(ggplot2)

summarydf <- summarySE(tmp1, "Temperature", "DECADE", na.rm=T)

## ------------------------------------------------------------------------------
## You have loaded plyr after dplyr - this is likely to cause problems.
## If you need functions from both plyr and dplyr, please load plyr
first, then dplyr:
## library(plyr); library(dplyr)
## ------------------------------------------------------------------------------
##
## Attaching package:  'plyr'
##
## The following objects are masked from 'package:dplyr':
##
##    arrange, count, desc, failwith, id, mutate, rename, summarise,
##    summarize

ggplot(summarydf, aes(y=Temperature, x=DECADE, color= DECADE)) + geom_errorbar(aes(ymin=Temp
```



6.1 NOAA dataset

New NOAA Directory – ftp://ftp.ncdc.noaa.gov/pub/data/noaa/

```
library(raster)

## Loading required package:  sp
##
## Attaching package:  'raster'
##
## The following object is masked from 'package:dplyr':
##
##    select
##
## The following object is masked from 'package:tidyr':
```

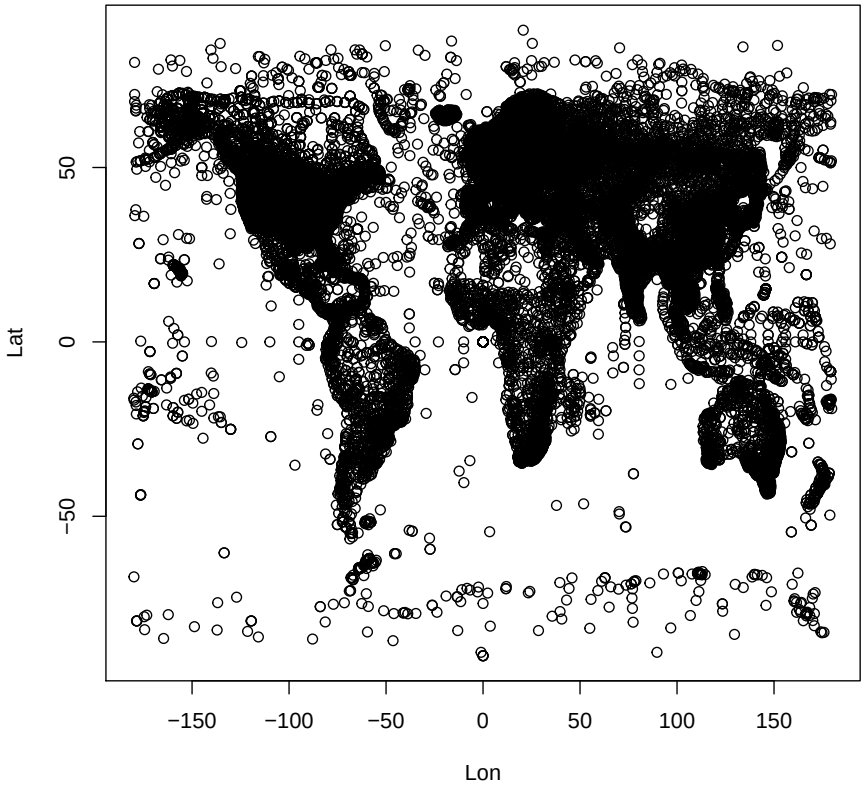
```
##
##    extract

library(XML)

coords.fwt <- read.fwf("ftp://ftp.ncdc.noaa.gov/pub/data/noaa/isd-history.txt",widths=c(6,1,
Names = c("USAF", "X1", "WBAN", "X2", "STATION_NAME", "X3", "CTRY", "X4", "ST", "X5", "CALL"
Widths = c(6,       1,    5,      1,        29,         1,    2,      3,    2,    1,    4,

coords.fwt <- read.fwf("ftp://ftp.ncdc.noaa.gov/pub/data/noaa/isd-history.txt",widths=Widths
```

```
coords <- data.frame(ID=paste(as.factor(coords.fwt[,1])),WBAN=paste(as.factor(coords.fwt[,3]
```

```
## Warning in data.frame(ID = paste(as.factor(coords.fwt[, 1])), WBAN
= paste(as.factor(coords.fwt[, :  NAs introduced by coercion
## Warning in data.frame(ID = paste(as.factor(coords.fwt[, 1])), WBAN
= paste(as.factor(coords.fwt[, :  NAs introduced by coercion
```

NOAA Locations

```
plot(Lat ~ Lon, data=coords, xlim=c(-180, 180) )
```


Lat
50
0
−50
−150
−100
−50
0
50
100
150
Lon