

# Assignment 4: Data Wrangling

Marisa Fajardo

## OVERVIEW

This exercise accompanies the lessons in Environmental Data Analytics on Data Wrangling

## Directions

1. Change “Student Name” on line 3 (above) with your name.
2. Work through the steps, **creating code and output** that fulfill each instruction.
3. Be sure to **answer the questions** in this assignment document.
4. When you have completed the assignment, **Knit** the text and code into a single PDF file.
5. After Knitting, submit the completed exercise (PDF file) to the dropbox in Sakai. Add your last name into the file name (e.g., “Fay\_A04\_DataWrangling.Rmd”) prior to submission.

The completed exercise is due on Monday, Feb 7 @ 7:00pm.

## Set up your session

1. Check your working directory, load the `tidyverse` and `lubridate` packages, and upload all four raw data files associated with the EPA Air dataset. See the README file for the EPA air datasets for more information (especially if you have not worked with air quality data previously).
2. Explore the dimensions, column names, and structure of the datasets.

```
#1
library(tidyverse)
library(lubridate)
EPAair032018<- read.csv("../Data/Raw/EPAair_03_NC2018_raw.csv", stringsAsFactors = TRUE)
EPAair032019<- read.csv("../Data/Raw/EPAair_03_NC2019_raw.csv", stringsAsFactors = TRUE)
EPAairPM252018<-read.csv("../Data/Raw/EPAair_PM25_NC2018_raw.csv", stringsAsFactors = TRUE)
EPAairPM252019<- read.csv("../Data/Raw/EPAair_PM25_NC2019_raw.csv", stringsAsFactors = TRUE) #loading i
#2
dim(EPAair032018)

## [1] 9737    20

colnames(EPAair032018)

## [1] "Date"
## [2] "Source"
## [3] "Site.ID"
## [4] "POC"
```

```
## [5] "Daily.Max.8.hour.Ozone.Concentration"
## [6] "UNITS"
## [7] "DAILY_AQI_VALUE"
## [8] "Site.Name"
## [9] "DAILY_OBS_COUNT"
## [10] "PERCENT_COMPLETE"
## [11] "AQS_PARAMETER_CODE"
## [12] "AQS_PARAMETER_DESC"
## [13] "CBSA_CODE"
## [14] "CBSA_NAME"
## [15] "STATE_CODE"
## [16] "STATE"
## [17] "COUNTY_CODE"
## [18] "COUNTY"
## [19] "SITE_LATITUDE"
## [20] "SITE_LONGITUDE"
```

```
str(EPAair032018)
```

```
## 'data.frame': 9737 obs. of 20 variables:
## $ Date : Factor w/ 364 levels "01/01/2018","01/02/2018",...: 60 61 62
## $ Source : Factor w/ 1 level "AQS": 1 1 1 1 1 1 1 1 1 1 ...
## $ Site.ID : int 370030005 370030005 370030005 370030005 370030005 370030005 ...
## $ POC : int 1 1 1 1 1 1 1 1 1 1 ...
## $ Daily.Max.8.hour.Ozone.Concentration: num 0.043 0.046 0.047 0.049 0.047 0.03 0.036 0.044 0.049 0.049 ...
## $ UNITS : Factor w/ 1 level "ppm": 1 1 1 1 1 1 1 1 1 1 ...
## $ DAILY_AQI_VALUE : int 40 43 44 45 44 28 33 41 45 40 ...
## $ Site.Name : Factor w/ 40 levels "", "Beaufort",...: 35 35 35 35 35 35 35 35 35 35 ...
## $ DAILY_OBS_COUNT : int 17 17 17 17 17 17 17 17 17 17 ...
## $ PERCENT_COMPLETE : num 100 100 100 100 100 100 100 100 100 100 ...
## $ AQS_PARAMETER_CODE : int 44201 44201 44201 44201 44201 44201 44201 44201 44201 44201 ...
## $ AQS_PARAMETER_DESC : Factor w/ 1 level "Ozone": 1 1 1 1 1 1 1 1 1 1 ...
## $ CBSA_CODE : int 25860 25860 25860 25860 25860 25860 25860 25860 25860 25860 ...
## $ CBSA_NAME : Factor w/ 17 levels "", "Asheville, NC",...: 9 9 9 9 9 9 9 9 9 9 ...
## $ STATE_CODE : int 37 37 37 37 37 37 37 37 37 37 ...
## $ STATE : Factor w/ 1 level "North Carolina": 1 1 1 1 1 1 1 1 1 1 ...
## $ COUNTY_CODE : int 3 3 3 3 3 3 3 3 3 3 ...
## $ COUNTY : Factor w/ 32 levels "Alexander", "Avery",...: 1 1 1 1 1 1 1 1 1 1 ...
## $ SITE_LATITUDE : num 35.9 35.9 35.9 35.9 35.9 ...
## $ SITE_LONGITUDE : num -81.2 -81.2 -81.2 -81.2 -81.2 ...
```

```
dim(EPAair032019)
```

```
## [1] 10592 20
```

```
colnames(EPAair032019)
```

```
## [1] "Date"
## [2] "Source"
## [3] "Site.ID"
## [4] "POC"
## [5] "Daily.Max.8.hour.Ozone.Concentration"
```

```
## [6] "UNITS"
## [7] "DAILY_AQI_VALUE"
## [8] "Site.Name"
## [9] "DAILY_OBS_COUNT"
## [10] "PERCENT_COMPLETE"
## [11] "AQ5_PARAMETER_CODE"
## [12] "AQ5_PARAMETER_DESC"
## [13] "CBSA_CODE"
## [14] "CBSA_NAME"
## [15] "STATE_CODE"
## [16] "STATE"
## [17] "COUNTY_CODE"
## [18] "COUNTY"
## [19] "SITE_LATITUDE"
## [20] "SITE_LONGITUDE"
```

```
str(EPAair032019)
```

```
## 'data.frame': 10592 obs. of 20 variables:
## $ Date : Factor w/ 365 levels "01/01/2019","01/02/2019",...: 1 2 3 4 5 ...
## $ Source : Factor w/ 2 levels "AirNow","AQ5": 1 1 1 1 1 1 1 1 1 1 ...
## $ Site.ID : int 370030005 370030005 370030005 370030005 370030005 370030005 ...
## $ POC : int 1 1 1 1 1 1 1 1 1 1 ...
## $ Daily.Max.8.hour.Ozone.Concentration: num 0.029 0.018 0.016 0.022 0.037 0.037 0.029 0.038 0.038 0.038 ...
## $ UNITS : Factor w/ 1 level "ppm": 1 1 1 1 1 1 1 1 1 1 ...
## $ DAILY_AQI_VALUE : int 27 17 15 20 34 34 27 35 35 28 ...
## $ Site.Name : Factor w/ 38 levels "", "Beaufort",...: 33 33 33 33 33 33 33 33 33 33 ...
## $ DAILY_OBS_COUNT : int 24 24 24 24 24 24 24 24 24 24 ...
## $ PERCENT_COMPLETE : num 100 100 100 100 100 100 100 100 100 100 ...
## $ AQ5_PARAMETER_CODE : int 44201 44201 44201 44201 44201 44201 44201 44201 44201 44201 ...
## $ AQ5_PARAMETER_DESC : Factor w/ 1 level "Ozone": 1 1 1 1 1 1 1 1 1 1 ...
## $ CBSA_CODE : int 25860 25860 25860 25860 25860 25860 25860 25860 25860 25860 ...
## $ CBSA_NAME : Factor w/ 15 levels "", "Asheville, NC",...: 8 8 8 8 8 8 8 8 8 8 ...
## $ STATE_CODE : int 37 37 37 37 37 37 37 37 37 37 ...
## $ STATE : Factor w/ 1 level "North Carolina": 1 1 1 1 1 1 1 1 1 1 ...
## $ COUNTY_CODE : int 3 3 3 3 3 3 3 3 3 3 ...
## $ COUNTY : Factor w/ 30 levels "Alexander", "Avery",...: 1 1 1 1 1 1 1 1 1 1 ...
## $ SITE_LATITUDE : num 35.9 35.9 35.9 35.9 35.9 35.9 ...
## $ SITE_LONGITUDE : num -81.2 -81.2 -81.2 -81.2 -81.2 ...
```

```
dim(EPAairPM252018)
```

```
## [1] 8983 20
```

```
colnames(EPAairPM252018)
```

```
## [1] "Date" "Source"
## [3] "Site.ID" "POC"
## [5] "Daily.Mean.PM2.5.Concentration" "UNITS"
## [7] "DAILY_AQI_VALUE" "Site.Name"
## [9] "DAILY_OBS_COUNT" "PERCENT_COMPLETE"
## [11] "AQ5_PARAMETER_CODE" "AQ5_PARAMETER_DESC"
```

```
## [13] "CBSA_CODE"           "CBSA_NAME"
## [15] "STATE_CODE"          "STATE"
## [17] "COUNTY_CODE"        "COUNTY"
## [19] "SITE_LATITUDE"       "SITE_LONGITUDE"
```

```
str(EPAairPM252018)
```

```
## 'data.frame': 8983 obs. of 20 variables:
## $ Date : Factor w/ 365 levels "01/01/2018","01/02/2018",...: 2 5 8 11 14 17
## $ Source : Factor w/ 1 level "AQS": 1 1 1 1 1 1 1 1 1 1 ...
## $ Site.ID : int 370110002 370110002 370110002 370110002 370110002 370110002 ...
## $ POC : int 1 1 1 1 1 1 1 1 1 1 ...
## $ Daily.Mean.PM2.5.Concentration: num 2.9 3.7 5.3 0.8 2.5 4.5 1.8 2.5 4.2 1.7 ...
## $ UNITS : Factor w/ 1 level "ug/m3 LC": 1 1 1 1 1 1 1 1 1 1 ...
## $ DAILY_AQI_VALUE : int 12 15 22 3 10 19 8 10 18 7 ...
## $ Site.Name : Factor w/ 25 levels "", "Blackstone",...: 15 15 15 15 15 15 15 15 15 15 ...
## $ DAILY_OBS_COUNT : int 1 1 1 1 1 1 1 1 1 1 ...
## $ PERCENT_COMPLETE : num 100 100 100 100 100 100 100 100 100 100 ...
## $ AQS_PARAMETER_CODE : int 88502 88502 88502 88502 88502 88502 88502 88502 88502 88502 ...
## $ AQS_PARAMETER_DESC : Factor w/ 2 levels "Acceptable PM2.5 AQI & Speciation Mass",...: 1
## $ CBSA_CODE : int NA NA NA NA NA NA NA NA NA NA ...
## $ CBSA_NAME : Factor w/ 14 levels "", "Asheville, NC",...: 1 1 1 1 1 1 1 1 1 1 ...
## $ STATE_CODE : int 37 37 37 37 37 37 37 37 37 37 ...
## $ STATE : Factor w/ 1 level "North Carolina": 1 1 1 1 1 1 1 1 1 1 ...
## $ COUNTY_CODE : int 11 11 11 11 11 11 11 11 11 11 ...
## $ COUNTY : Factor w/ 21 levels "Avery", "Buncombe",...: 1 1 1 1 1 1 1 1 1 1 ...
## $ SITE_LATITUDE : num 36 36 36 36 36 ...
## $ SITE_LONGITUDE : num -81.9 -81.9 -81.9 -81.9 -81.9 ...
```

```
dim(EPAairPM252019)
```

```
## [1] 8581 20
```

```
colnames(EPAairPM252019)
```

```
## [1] "Date"           "Source"
## [3] "Site.ID"        "POC"
## [5] "Daily.Mean.PM2.5.Concentration" "UNITS"
## [7] "DAILY_AQI_VALUE" "Site.Name"
## [9] "DAILY_OBS_COUNT" "PERCENT_COMPLETE"
## [11] "AQS_PARAMETER_CODE" "AQS_PARAMETER_DESC"
## [13] "CBSA_CODE"        "CBSA_NAME"
## [15] "STATE_CODE"       "STATE"
## [17] "COUNTY_CODE"     "COUNTY"
## [19] "SITE_LATITUDE"    "SITE_LONGITUDE"
```

```
str(EPAairPM252019) #viewing dimensions, column names and structure of data sets, checking that data ha
```

```
## 'data.frame': 8581 obs. of 20 variables:
## $ Date : Factor w/ 365 levels "01/01/2019","01/02/2019",...: 3 6 9 12 15 18
## $ Source : Factor w/ 2 levels "AirNow", "AQS": 2 2 2 2 2 2 2 2 2 2 ...
```

```
## $ Site.ID : int 370110002 370110002 370110002 370110002 370110002 370110002
## $ POC : int 1 1 1 1 1 1 1 1 1 1 ...
## $ Daily.Mean.PM2.5.Concentration: num 1.6 1 1.3 6.3 2.6 1.2 1.5 1.5 3.7 1.6 ...
## $ UNITS : Factor w/ 1 level "ug/m3 LC": 1 1 1 1 1 1 1 1 1 1 ...
## $ DAILY_AQI_VALUE : int 7 4 5 26 11 5 6 6 15 7 ...
## $ Site.Name : Factor w/ 25 levels "", "Board Of Ed. Bldg.", ...: 14 14 14 14 14 14
## $ DAILY_OBS_COUNT : int 1 1 1 1 1 1 1 1 1 1 ...
## $ PERCENT_COMPLETE : num 100 100 100 100 100 100 100 100 100 100 ...
## $ AQS_PARAMETER_CODE : int 88502 88502 88502 88502 88502 88502 88502 88502 88502 88502
## $ AQS_PARAMETER_DESC : Factor w/ 2 levels "Acceptable PM2.5 AQI & Speciation Mass", ...: 1
## $ CBSA_CODE : int NA NA NA NA NA NA NA NA NA NA ...
## $ CBSA_NAME : Factor w/ 14 levels "", "Asheville, NC", ...: 1 1 1 1 1 1 1 1 1 1 ..
## $ STATE_CODE : int 37 37 37 37 37 37 37 37 37 37 ...
## $ STATE : Factor w/ 1 level "North Carolina": 1 1 1 1 1 1 1 1 1 1 ...
## $ COUNTY_CODE : int 11 11 11 11 11 11 11 11 11 11 ...
## $ COUNTY : Factor w/ 21 levels "Avery", "Buncombe", ...: 1 1 1 1 1 1 1 1 1 1 ..
## $ SITE_LATITUDE : num 36 36 36 36 36 ...
## $ SITE_LONGITUDE : num -81.9 -81.9 -81.9 -81.9 -81.9 ...
```

## Wrangle individual datasets to create processed files.

3. Change date to a date object
4. Select the following columns: Date, DAILY\_AQI\_VALUE, Site.Name, AQS\_PARAMETER\_DESC, COUNTY, SITE\_LATITUDE, SITE\_LONGITUDE
5. For the PM2.5 datasets, fill all cells in AQS\_PARAMETER\_DESC with “PM2.5” (all cells in this column should be identical).
6. Save all four processed datasets in the Processed folder. Use the same file names as the raw files but replace “raw” with “processed”.

*#3*

```
class(EPAair032018$Date) #viewing original class of data
```

```
## [1] "factor"
```

```
View(EPAair032018$Date) #checking date format
```

```
EPAair032018$Date<- as.Date(EPAair032018$Date, format = "%m/%d/%Y") #recognizing column entries as date
```

```
class(EPAair032018$Date) #checking success of previous code
```

```
## [1] "Date"
```

```
class(EPAair032019$Date)
```

```
## [1] "factor"
```

```
EPAair032019$Date<- as.Date(EPAair032019$Date, format = "%m/%d/%Y")
```

```
class(EPAair032019$Date)
```

```
## [1] "Date"
```

```
class(EPAairPM252018$Date)
```

```
## [1] "factor"
```

```
EPAairPM252018$Date<- as.Date(EPAairPM252018$Date, format = "%m/%d/%Y")  
class(EPAairPM252018$Date)
```

```
## [1] "Date"
```

```
class(EPAairPM252019$Date)
```

```
## [1] "factor"
```

```
EPAairPM252019$Date<- as.Date(EPAairPM252019$Date, format = "%m/%d/%Y")  
class(EPAairPM252019$Date) #repeatign first steps for each data frame
```

```
## [1] "Date"
```

```
#4
```

```
EPAair032018.subset<- select(EPAair032018, Date, DAILY_AQI_VALUE, Site.Name, AQS_PARAMETER_DESC, COUNTY)  
dim(EPAair032018.subset) #checking dimensions to see if the correct number of columns are in place
```

```
## [1] 9737 7
```

```
EPAair032019.subset<- select(EPAair032019, Date, DAILY_AQI_VALUE, Site.Name, AQS_PARAMETER_DESC, COUNTY)  
dim(EPAair032019.subset)
```

```
## [1] 10592 7
```

```
EPAairPM252018.subset<- select(EPAairPM252018, Date, DAILY_AQI_VALUE, Site.Name, AQS_PARAMETER_DESC, COUNTY)  
dim(EPAairPM252018.subset)
```

```
## [1] 8983 7
```

```
EPAairPM252019.subset<- select(EPAairPM252019, Date, DAILY_AQI_VALUE, Site.Name, AQS_PARAMETER_DESC, COUNTY)  
dim(EPAairPM252019.subset) #repeating procedure of columns selection for all 4 data sets
```

```
## [1] 8581 7
```

```
#5
```

```
View(EPAairPM252018.subset$AQS_PARAMETER_DESC) #viewing column  
length(EPAairPM252018.subset$AQS_PARAMETER_DESC) #checking column length
```

```
## [1] 8983
```

```

EPAairPM252018.subset$AQS_PARAMETER_DESC = "PM2.5" #changing data cells to PM2.5

EPAairPM252019.subset$AQS_PARAMETER_DESC = "PM2.5" #changing data cells to PM2.5
View(EPAairPM252019.subset) #checking if conversion worked
#6
write.csv(EPAair032018.subset, row.names = FALSE, file = "../Data/Processed/EPAair_03_NC2018_processed.csv")
write.csv(EPAair032019.subset, row.names = FALSE, file = "../Data/Processed/EPAair_03_NC2019_processed.csv")
write.csv(EPAairPM252018.subset, row.names = FALSE, file = "../Data/Processed/EPAair_PM25_NC2018_processed.csv")
write.csv(EPAairPM252019.subset, row.names = FALSE, file = "../Data/Processed/EPAair_PM25_NC2019_processed.csv")

```

## Combine datasets

7. Combine the four datasets with `rbind`. Make sure your column names are identical prior to running this code.
8. Wrangle your new dataset with a pipe function (`%>%`) so that it fills the following conditions:
  - Filter records to include just the sites that the four data frames have in common: “Linville Falls”, “Durham Armory”, “Leggett”, “Hattie Avenue”, “Clemmons Middle”, “Mendenhall School”, “Frying Pan Mountain”, “West Johnston Co.”, “Garinger High School”, “Castle Hayne”, “Pitt Agri. Center”, “Bryson City”, “Millbrook School”. (The `intersect` function can figure out common factor levels if we didn’t give you this list...)
  - Some sites have multiple measurements per day. Use the split-apply-combine strategy to generate daily means: group by date, site, aqs parameter, and county. Take the mean of the AQI value, latitude, and longitude.
  - Add columns for “Month” and “Year” by parsing your “Date” column (hint: `lubridate` package)
  - Hint: the dimensions of this dataset should be 14,752 x 9.
9. Spread your datasets such that AQI values for ozone and PM2.5 are in separate columns. Each location on a specific date should now occupy only one row.
10. Call up the dimensions of your new tidy dataset.
11. Save your processed dataset with the following file name: “EPAair\_O3\_PM25\_NC2122\_Processed.csv”

```

#7
processedEPA032018<- read.csv("../Data/Processed/EPAair_03_NC2018_processed.csv", stringsAsFactors = TRUE)
processedEPA032019<- read.csv("../Data/Processed/EPAair_03_NC2019_processed.csv", stringsAsFactors = TRUE)
processedEPAPM252018 <- read.csv("../Data/Processed/EPAair_PM25_NC2018_processed.csv", stringsAsFactors = TRUE)
processedEPAPM252019<- read.csv("../Data/Processed/EPAair_PM25_NC2019_processed.csv", stringsAsFactors = TRUE)

EPAcombined<- rbind (processedEPA032018, processedEPA032019, processedEPAPM252018, processedEPAPM252019)
#8
library(lubridate)
EPAcombinedprocessed<-
  EPAcombined %>%
  filter(Site.Name == c("Linville Falls", "Durham Armory", "Leggett", "Hattie Avenue", "Clemmons Middle", "Mendenhall School", "Frying Pan Mountain", "West Johnston Co.", "Garinger High School", "Castle Hayne", "Pitt Agri. Center", "Bryson City", "Millbrook School"))
  group_by(Date, Site.Name, AQS_PARAMETER_DESC, COUNTY) %>%
  summarise(meanAQS = mean(DAILY_AQI_VALUE),
             meanlat = mean(SITE_LATITUDE),
             meanlong = mean(SITE_LONGITUDE)) %>%
  mutate(month = month(Date), year = year(Date)) #fitting data to above conditions using a pipe

## Warning in '==.default'(Site.Name, c("Linville Falls", "Durham Armory", : longer
## object length is not a multiple of shorter object length

```

```
## Warning in is.na(e1) | is.na(e2): longer object length is not a multiple of
## shorter object length
```

```
## Warning: tz(): Don't know how to compute timezone for object of class factor;
## returning "UTC". This warning will become an error in the next major version of
## lubridate.
```

```
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```

```
## lubridate.  
  
## Warning: tz(): Don't know how to compute timezone for object of class factor;  
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```



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[illegible]

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[illegible]

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[illegible]





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```

```
View(EPAcombinedprocessed) #viewing data set to see if pipe worked  
summary(EPAcombinedprocessed) #viewing summary of new data
```

```
##           Date           Site.Name   AQS_PARAMETER_DESC
## 2018-06-25:    7   Millbrook School   :165   Ozone:523
## 2018-07-08:    7   Garinger High School:138   PM2.5:745
## 2018-07-21:    7   Hattie Avenue     :110
## 2018-08-03:    7   Durham Armory      :108
## 2018-03-04:    6   Pitt Agri. Center  :102
## 2018-06-12:    6   Clemmons Middle    : 96
## (Other)      :1228 (Other)           :549
##           COUNTY      meanAQS      meanlat      meanlong
## Forsyth      :206   Min.    : 0.00   Min.    :34.36   Min.    :-83.44
## Wake         :165   1st Qu.:25.00   1st Qu.:35.43   1st Qu.: -80.79
## Mecklenburg:138   Median :35.00   Median :35.86   Median : -78.90
## Durham       :108   Mean    :34.91   Mean    :35.68   Mean    :-79.61
## Pitt         :102   3rd Qu.:44.00   3rd Qu.:36.03   3rd Qu.: -78.46
## Johnston     : 95   Max.    :97.00   Max.    :36.11   Max.    :-77.36
## (Other)      :454
##           month           year
## Min.      : 1.000   Min.    :2018
## 1st Qu.: 4.000   1st Qu.:2018
## Median : 6.000   Median :2019
## Mean    : 6.345   Mean    :2019
## 3rd Qu.: 9.000   3rd Qu.:2019
## Max.    :12.000   Max.    :2019
##
```

#9

```
EPACombinedprocessed.spread<-pivot_wider(EPACombinedprocessed, names_from = AQS_PARAMETER_DESC, values_
View(EPACombinedprocessed.spread)
```

#10

```
dim(EPACombinedprocessed.spread)
```

```
## [1] 1254    9
```

#11

```
write.csv(EPACombinedprocessed.spread, row.names = FALSE, file = "../Data/Processed/EPAair_03_PM25_NC21")
```

## Generate summary tables

12a. Use the split-apply-combine strategy to generate a summary data frame from your results from Step 9 above. Data should be grouped by site, month, and year. Generate the mean AQI values for ozone and PM2.5 for each group.

12b. BONUS: Add a piped statement to 12a that removes rows where both mean ozone and mean PM2.5 have missing values.

13. Call up the dimensions of the summary dataset.

#12(a,b)

```
EPACombinedprocessed.spread.summaries <-
  EPACombinedprocessed.spread %>%
```

```
group_by(Site.Name, month, year) %>%  
summarise(meanAQI.ozone = mean(Ozone),  
           meanAQI.PM2.5 = mean(PM2.5)) %>% #using split apply combine to get summary results  
drop_na(meanAQI.ozone, meanAQI.PM2.5) #dropping NAs from data
```

## 'summarise()' has grouped output by 'Site.Name', 'month'. You can override using the '.groups' argument

```
#13  
dim(EPAcombinedprocessed.spread.summaries) #checking dimensions of summaries
```

## [1] 1 5

14. Why did we use the function `drop_na` rather than `na.omit`?

Answer: `drop_na` deletes rows with NAs, while `na.omit` removes NAs from an entire data frame.