DAPS Air Pollution Monitor Differences

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6/4/19

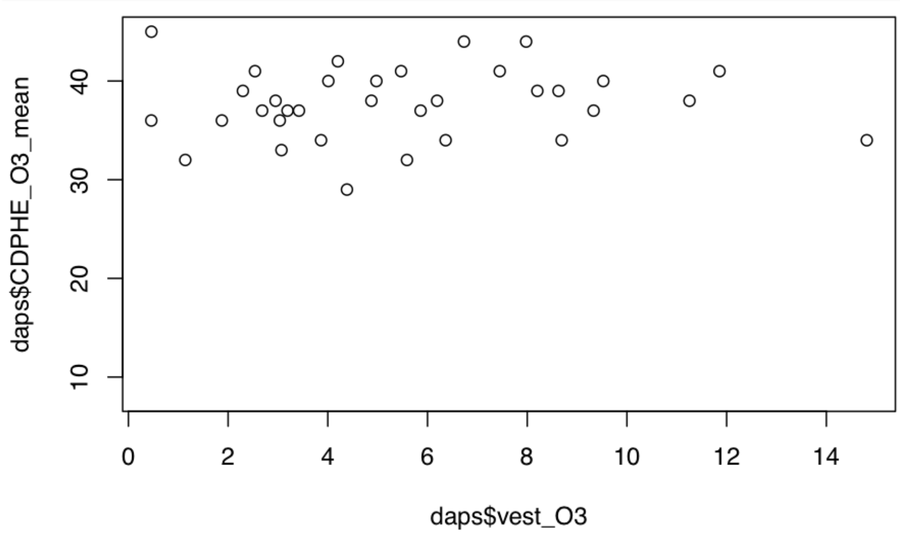
Data Steps:

Basic Correlations

```
#correlation of ozone
o3corr <- cor.test(daps$vest_O3, daps$CDPHE_O3_mean, method="pearson")
o3corr
```

```
##
##  Pearson's product-moment correlation
##
## data:  daps$vest_O3 and daps$CDPHE_O3_mean
## t = 0.42427, df = 32, p-value = 0.6742
## alternative hypothesis: true correlation is not equal to 0
## 95 percent confidence interval:
##  -0.2702091  0.4027696
## sample estimates:
##       cor
## 0.0747906
```

```
plot(daps$vest_O3, daps$CDPHE_O3_mean)
```




```
#correlation of pm10
pm10corr <- rmcorr(id, log_vest_pm10, log_msp_pm10,daps)
pm10corr
```

```
##
## Repeated measures correlation
##
## r
## 0.5022392
##
## degrees of freedom
## 72
##
## p-value
## 5.131506e-06
##
## 95% confidence interval
## 0.3061977 0.6574155
```

```r
pm10corr2 <-rmcorr(id, log_vest_pm10, log(daps$CDPHE_PM10_mean), daps)
pm10corr2
```

```
##
## Repeated measures correlation
##
## r
## -0.1460296
##
## degrees of freedom
## 74
##
## p-value
## 0.2081324
##
## 95% confidence interval
## -0.3624347 0.08531597
```

```r
pm10corr3 <- rmcorr(id, log_msp_pm10, log(CDPHE_PM10_mean), daps)
pm10corr3
```

```
##
## Repeated measures correlation
##
## r
## -0.06262704
##
## degrees of freedom
## 73
##
## p-value
## 0.5934931
##
## 95% confidence interval
## -0.2885369 0.1698881
```

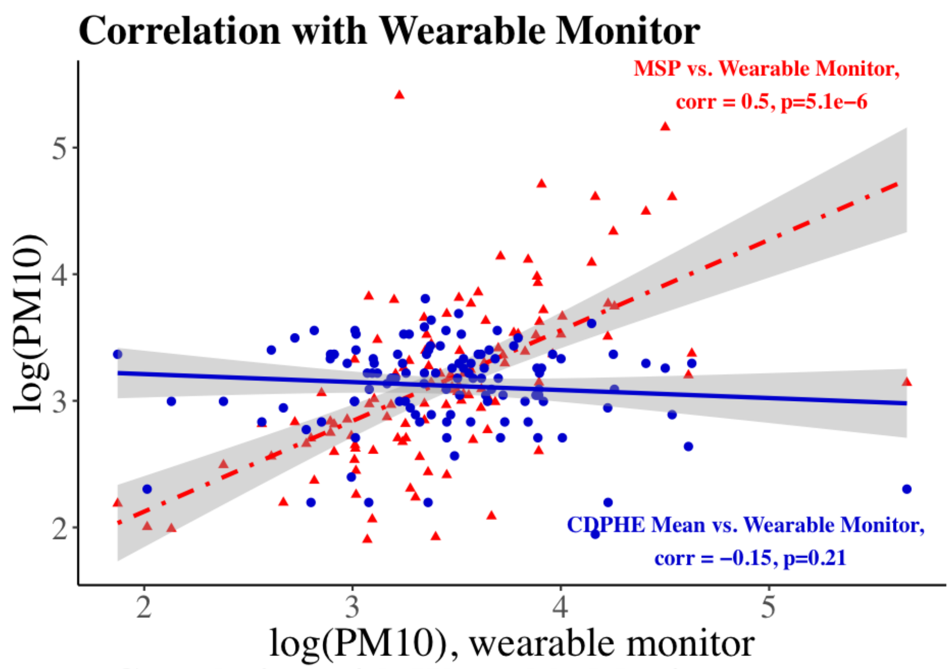
```r
rmcorr(id, log(daps$CDPHE_PM10_mean), daps$log_FeNO_avg, daps)
```

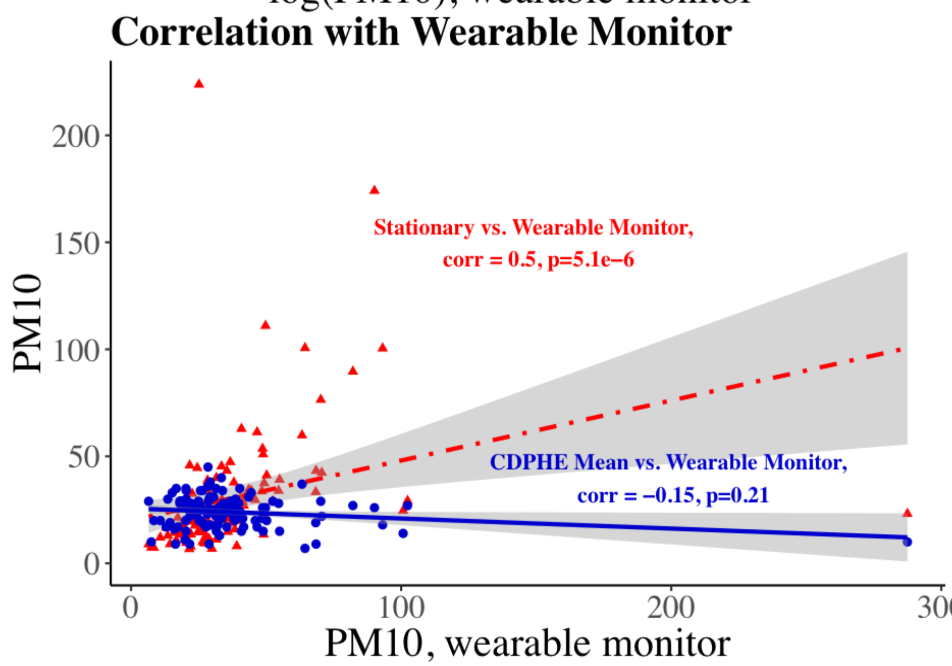
```
##
## Repeated measures correlation
```

```
##
## r
## 0.3924604
##
## degrees of freedom
## 73
##
## p-value
## 0.0004966465
##
## 95% confidence interval
## 0.1785113 0.5709732
```

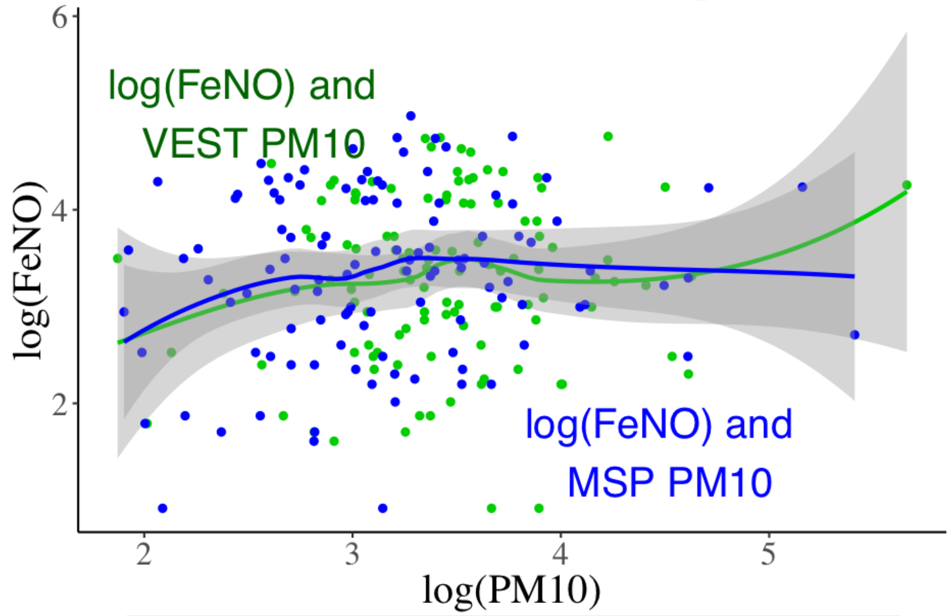
```r
rmcorr(id, log_vest_pm10, daps$log_FeNO_avg, daps)
```

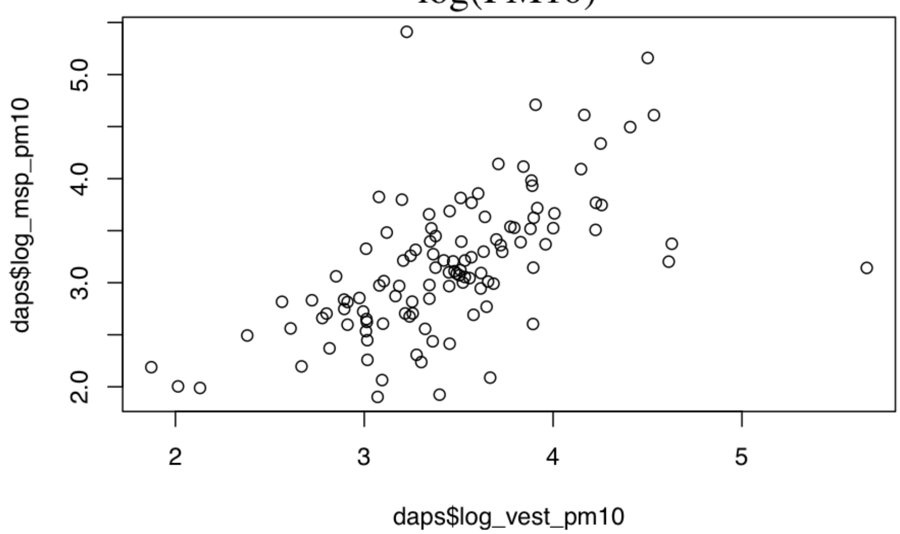
```
##
## Repeated measures correlation
##
## r
## 0.1095856
##
## degrees of freedom
## 71
##
## p-value
## 0.3560472
##
## 95% confidence interval
## -0.1269642 0.3343413
```

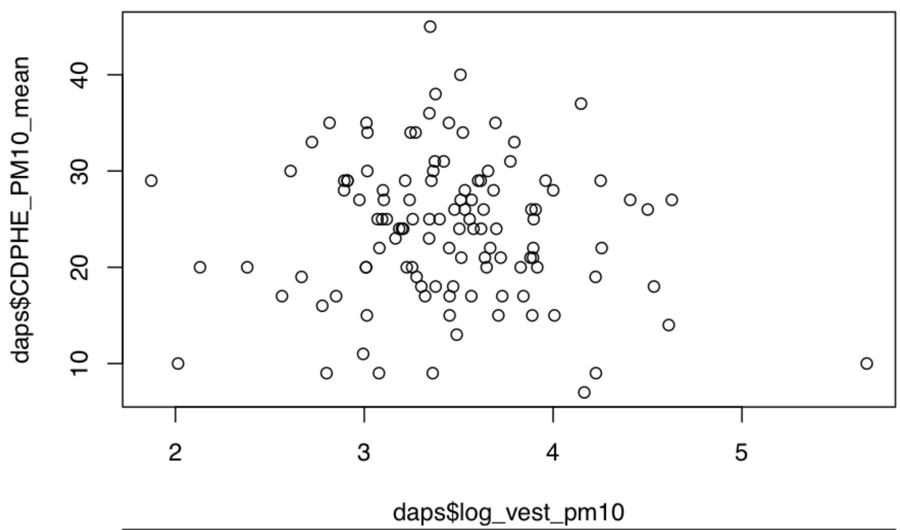

Correlation with Wearable Monitor
MSP vs. Wearable Monitor,
corr = 0.5, p=5.1e−6
CDPHE Mean vs. Wearable Monitor,
corr = −0.15, p=0.21
log(PM10)
log(PM10), wearable monitor
2
3
4
5

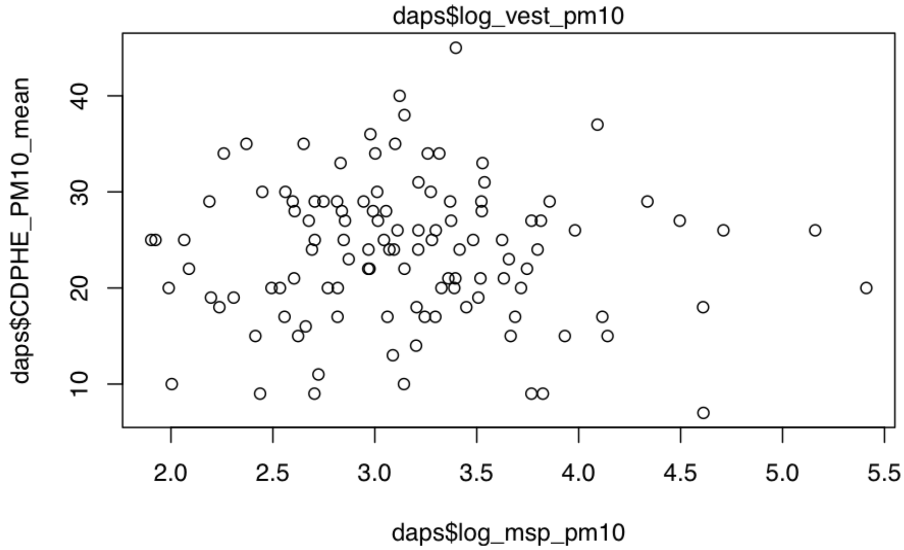

Correlation with Wearable Monitor
Stationary vs. Wearable Monitor,
corr = 0.5, p=5.1e−6
CDPHE Mean vs. Wearable Monitor,
corr = −0.15, p=0.21
PM10
PM10, wearable monitor
0
50
100
150
200
300

Exhaled Nitric Oxide and PM10 Exposure










```r
#correlation of no2

no2corr <- rmcorr(id, log_vest_NO2, log_stat_NO2,daps)
no2corr
```

```
##
## Repeated measures correlation
##
## r
## 0.9508126
##
## degrees of freedom
```

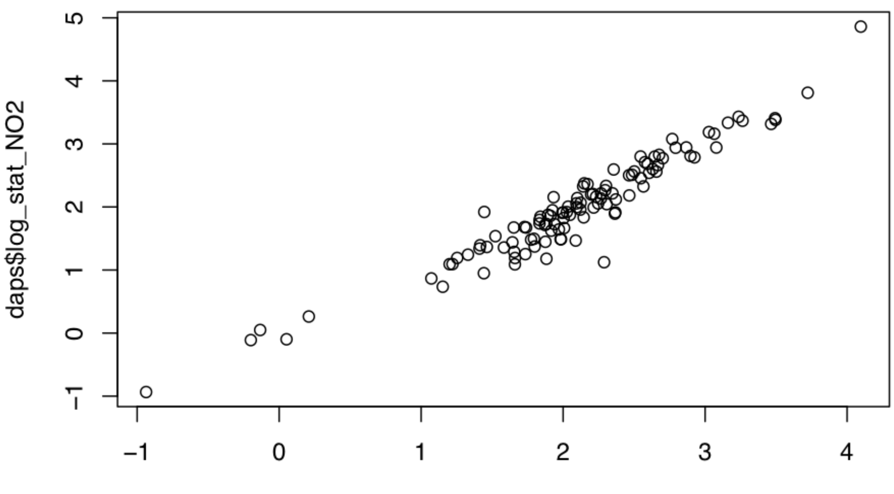
```
## 68
##
## p-value
## 2.487073e-36
##
## 95% confidence interval
## 0.9212276 0.9694628
```

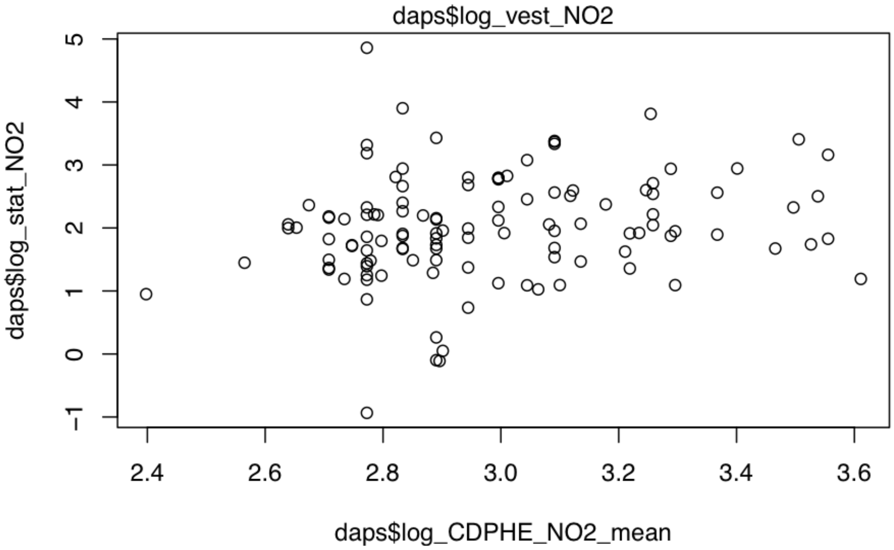
```r
no2corr2 <- rmcorr(id,log_vest_NO2, log(log_CDPHE_NO2_mean), daps)
no2corr2
```

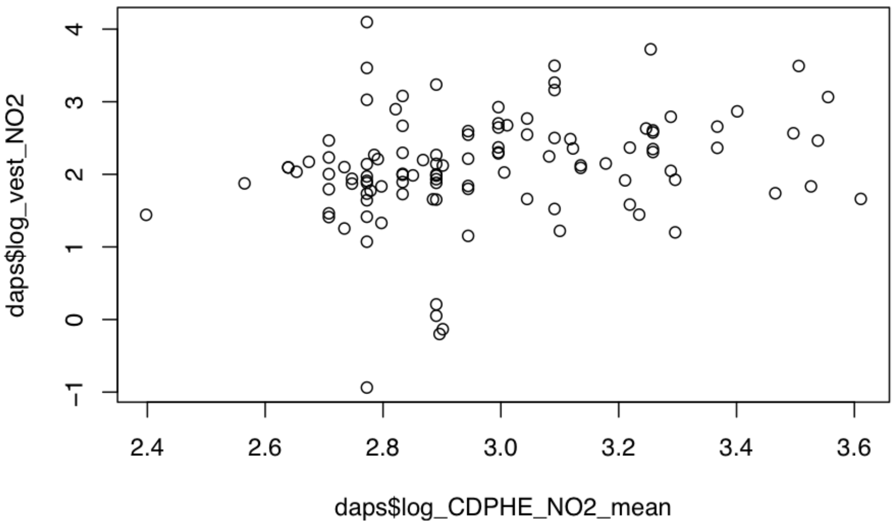
```
##
## Repeated measures correlation
##
## r
## 0.2338877
##
## degrees of freedom
## 68
##
## p-value
## 0.05132745
##
## 95% confidence interval
## -0.004805375 0.4473656
```

```r
no2corr3 <- rmcorr(id, log_stat_NO2, log(log_CDPHE_NO2_mean), daps)
no2corr3
```

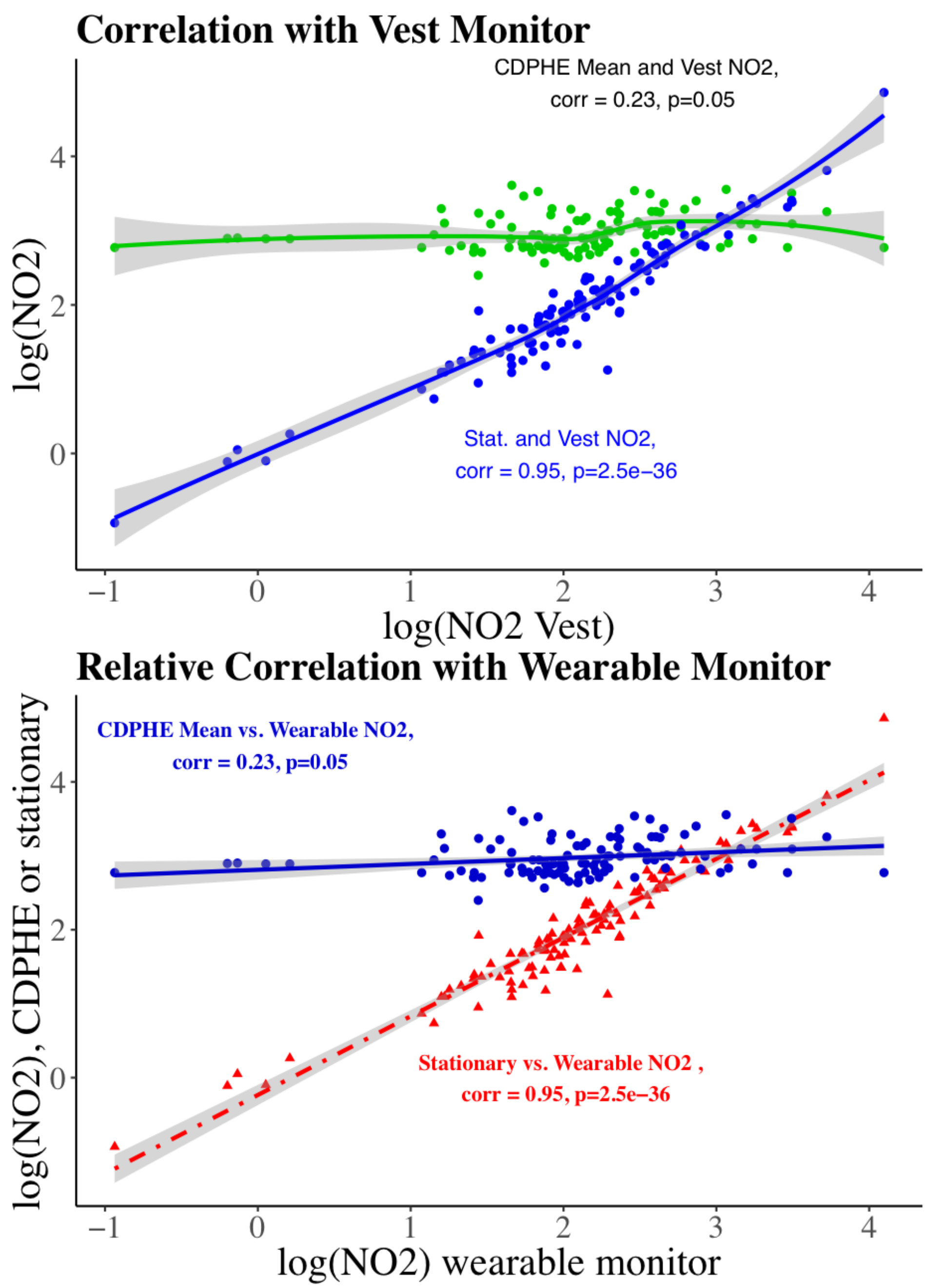
```
##
## Repeated measures correlation
##
## r
## 0.1900236
##
## degrees of freedom
## 75
##
## p-value
## 0.09786429
##
## 95% confidence interval
## -0.03860308 0.3997452
```

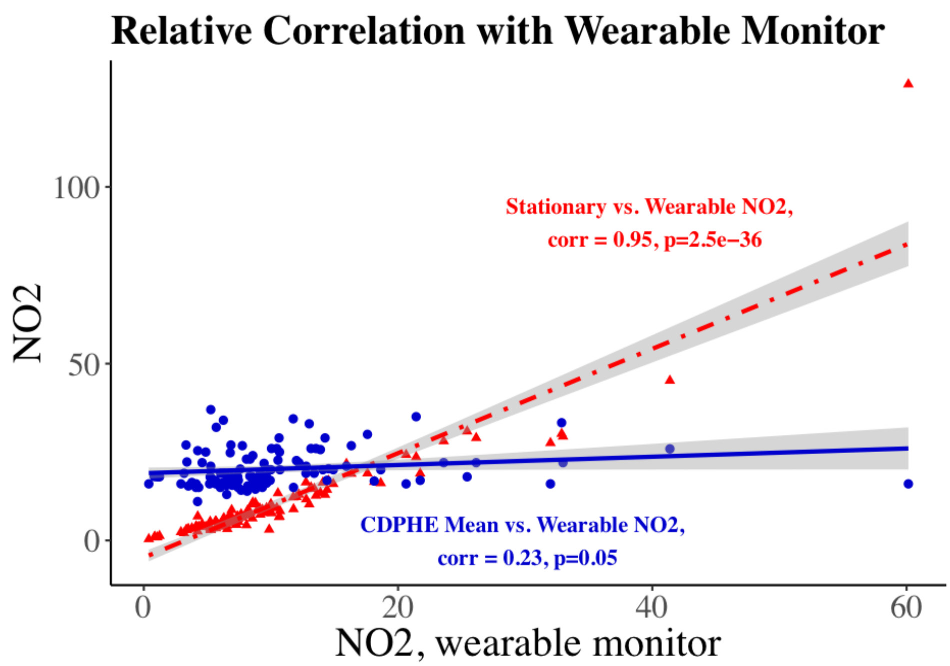

daps$log_stat_NO2
daps$log_vest_NO2


daps$log_stat_NO2
daps$log_CDPHE_NO2_mean




```
##
##  Pearson's product-moment correlation
##
## data:  daps$gluc_m3 and log(daps$endo_m3)
## t = 3.6936, df = 39, p-value = 0.0006762
## alternative hypothesis: true correlation is not equal to 0
## 95 percent confidence interval:
##  0.2388288 0.7061327
## sample estimates:
##       cor
## 0.5090746
```


Correlation with Vest Monitor
CDPHE Mean and Vest NO2,
corr = 0.23, p=0.05
Stat. and Vest NO2,
corr = 0.95, p=2.5e−36
log(NO2)
log(NO2 Vest)
Relative Correlation with Wearable Monitor
CDPHE Mean vs. Wearable NO2,
corr = 0.23, p=0.05
Stationary vs. Wearable NO2 ,
corr = 0.95, p=2.5e−36
log(NO2), CDPHE or stationary
log(NO2) wearable monitor



Ok. So, part of what we're interested in is estimating the mean bias and mean variance. If we assume that the "true" value is that from the wearable monitor, how do we estimate the mean bias? What about the mean variance?

Variance is defined as:

$$\text{Var}[\hat{x}] = E[(\hat{x} - E[\hat{x}])^2]$$

$$\text{Var}[\hat{x}] = E[\hat{x}^2] - E[\hat{x}]^2$$

Bias is defined as follows:

$$\text{Bias}[\hat{x}] = E[\hat{x} - x] = E[\hat{x}] - x$$

```
##### PM10 #####
wearable <- exp(daps$log_vest_pm10)
stationary <- exp(daps$log_msp_pm10)
cdphe_mean <- (daps$CDPHE_PM10_mean)
cdphe_max <- exp(daps$log_CDPHE_PM10_max)


PM10 <- as.data.frame(cbind(id, visit, season, wearable, stationary, cdphe_mean, cdphe_max))

pm10 <- melt(PM10, id.vars = c("id", "visit", "season"), measure.vars = c( "wearable", "stationary","cd
  factorsAsStrings = TRUE)

names(pm10) <- c("id", "visit", "season", "type", "PM10")
```

```r
#Mean Bias of the CDPHE MEAN
mean(mean(cdphe_mean, na.rm=TRUE) - wearable, na.rm=TRUE)
```

```
## [1] -13.23269
```

```r
#Mean Variance of the CDPHE MEAN:

  #Mean of the Sample Squared:
ss <- mean(cdphe_mean*cdphe_mean, na.rm=TRUE)

  #Mean of the Squared Sample:
ess <-(mean(cdphe_mean, na.rm=TRUE)*mean(cdphe_mean, na.rm=TRUE))

ss-ess
```

```
## [1] 54.01609
```

```r
var(cdphe_mean, na.rm=TRUE)
```

```
## [1] 54.47776
```

```r
#Mean Bias of the Stationary Monitor
mean(mean(stationary, na.rm=TRUE)-wearable, na.rm=TRUE)
```

```
## [1] -6.665394
```

```r
#Mean Variance of the Stationary Monitor
  #Mean of the Sample Squared:
ss <- mean(stationary*stationary, na.rm=TRUE)

  #Mean of the Squared Sample:
ess <-(mean(stationary, na.rm=TRUE)*mean(stationary, na.rm=TRUE))

ss-ess
```

```
## [1] 878.225
```

```r
var(stationary, na.rm=TRUE)
```

```
## [1] 885.9288
```

```r
mean_stat <- rep((mean(stationary, na.rm=TRUE)), length(wearable))
mean_cdphe <- rep((mean(cdphe_mean, na.rm=TRUE)), length(wearable))

dat2 <- as.data.frame(cbind(wearable, mean_stat, mean_cdphe))
```

```r
#### NO2 #####
wearable <- exp(daps$log_vest_NO2)
stationary <- exp(daps$log_stat_NO2)
cdphe_mean <- exp(daps$log_CDPHE_NO2_mean)
cdphe_max <- exp(daps$log_CDPHE_NO2_max)

NO2 <- as.data.frame(cbind(id, visit, season, wearable, stationary, cdphe_mean, cdphe_max))

no2 <- melt(NO2, id.vars = c("id", "visit", "season"), measure.vars = c( "wearable", "stationary","cdph
  variable.name = "type", value.name = "NO2",
  factorsAsStrings = TRUE)
```

```r
names(no2) <- c("id", "visit", "season", "type", "NO2")

#Mean Bias of the CDPHE MEAN
mean(mean(cdphe_mean, na.rm=TRUE) - wearable, na.rm=TRUE)
```

```
## [1] 9.806204
```

```r
#Mean Variance of the CDPHE MEAN:

  #Mean of the Sample Squared:
ss <- mean(cdphe_mean*cdphe_mean, na.rm=TRUE)

  #Mean of the Squared Sample:
ess <-(mean(cdphe_mean, na.rm=TRUE)*mean(cdphe_mean, na.rm=TRUE))

ss-ess
```

```
## [1] 28.94186
```

```r
var(cdphe_mean, na.rm=TRUE)
```

```
## [1] 29.18923
```

```r
#Mean Bias of the Stationary Monitor
mean(mean(stationary, na.rm=TRUE)-wearable, na.rm=TRUE)
```

```
## [1] 0.3155416
```

```r
#Mean Variance of the Stationary Monitor
  #Mean of the Sample Squared:
ss <- mean(stationary*stationary, na.rm=TRUE)

  #Mean of the Squared Sample:
ess <-(mean(stationary, na.rm=TRUE)*mean(stationary, na.rm=TRUE))

ss-ess
```

```
## [1] 190.236
```

```r
var(stationary, na.rm=TRUE)
```

```
## [1] 191.876
```

```r
mean_stat <- rep((mean(stationary, na.rm=TRUE)), length(wearable))
mean_cdphe <- rep((mean(cdphe_mean, na.rm=TRUE)), length(wearable))

dat2 <- as.data.frame(cbind(wearable, mean_stat, mean_cdphe))
```

```r
#### O3 #####
wearable <- daps$vest_O3
cdphe_mean <- daps$CDPHE_O3_mean
cdphe_max <- daps$CDPHE_O3_max

O3 <- as.data.frame(cbind(id, visit, season, wearable, cdphe_mean, cdphe_max))

o3 <- melt(O3, id.vars = c("id", "visit", "season"), measure.vars = c( "wearable", "cdphe_mean", "cdphe_
  variable.name = "type", value.name = "O3",
  factorsAsStrings = TRUE)
```

```r
names(o3) <- c("id", "visit", "season", "type", "O3")

#Mean Bias of the CDPHE MEAN
mean(mean(cdphe_mean, na.rm=TRUE) - wearable, na.rm=TRUE)
```

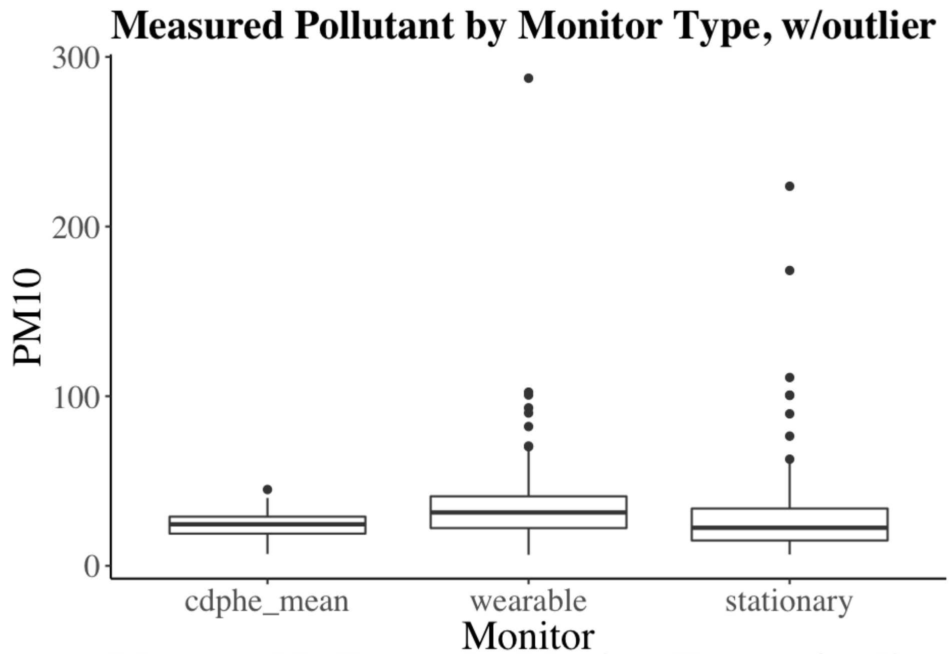
```
## [1] 21.16721
```

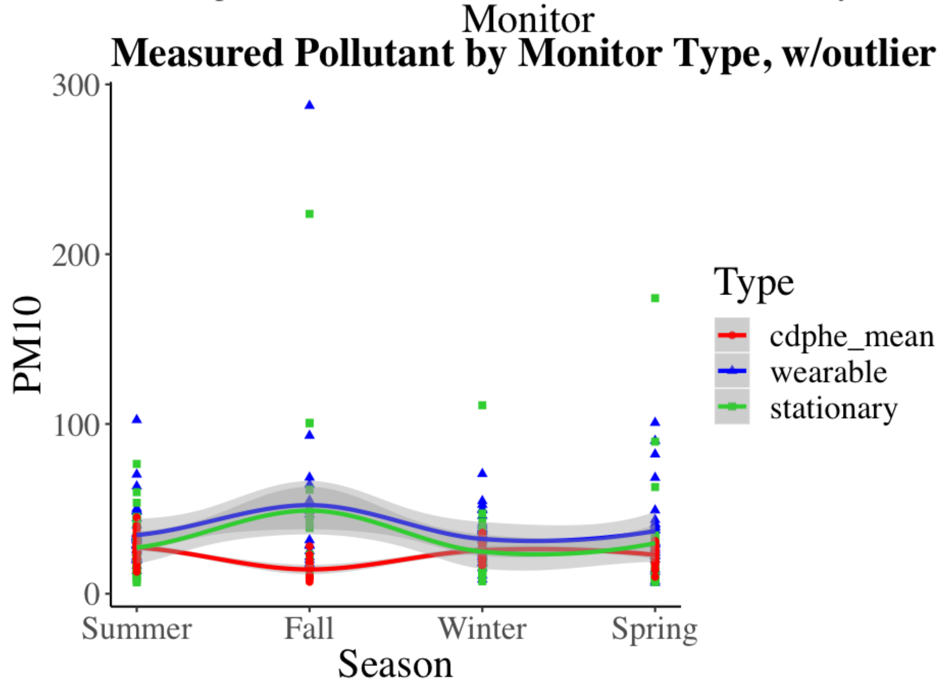
```r
#Mean Variance of the CDPHE MEAN:

  #Mean of the Sample Squared:
ss <- mean(cdphe_mean*cdphe_mean, na.rm=TRUE)

  #Mean of the Squared Sample:
ess <-(mean(cdphe_mean, na.rm=TRUE)*mean(cdphe_mean, na.rm=TRUE))

ss-ess
```

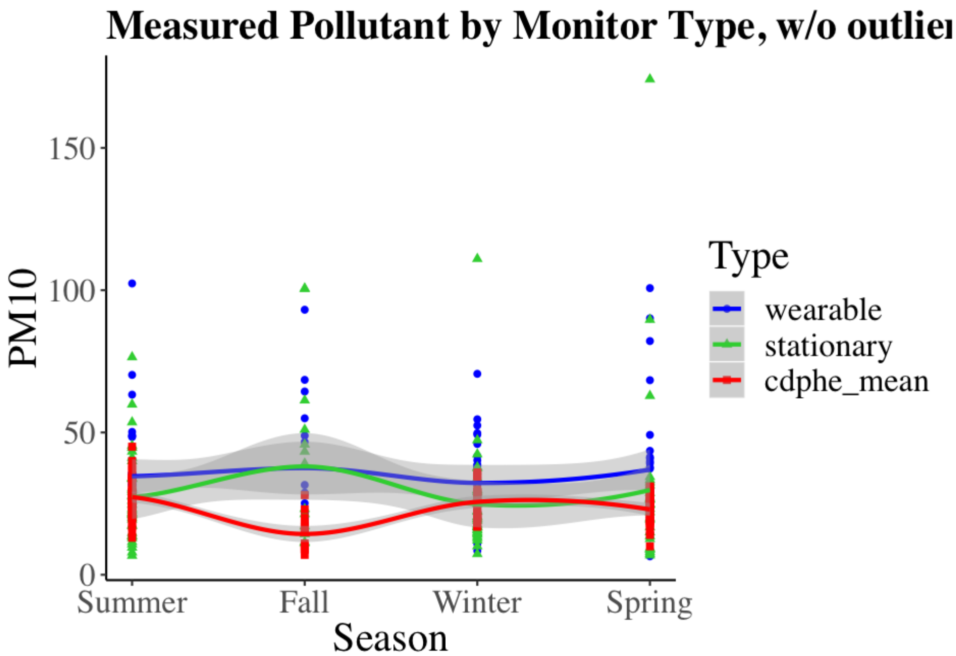
```
## [1] 93.15053
```

```r
var(cdphe_mean, na.rm=TRUE)
```

```
## [1] 93.94669
```


Measured Pollutant by Monitor Type, w/outlier
300
200
100
0
PM10
cdphe_mean
wearable
stationary
Monitor


Measured Pollutant by Monitor Type, w/outlier
300
200
100
0
PM10
Summer
Fall
Winter
Spring
Season
Type
cdphe_mean
wearable
stationary



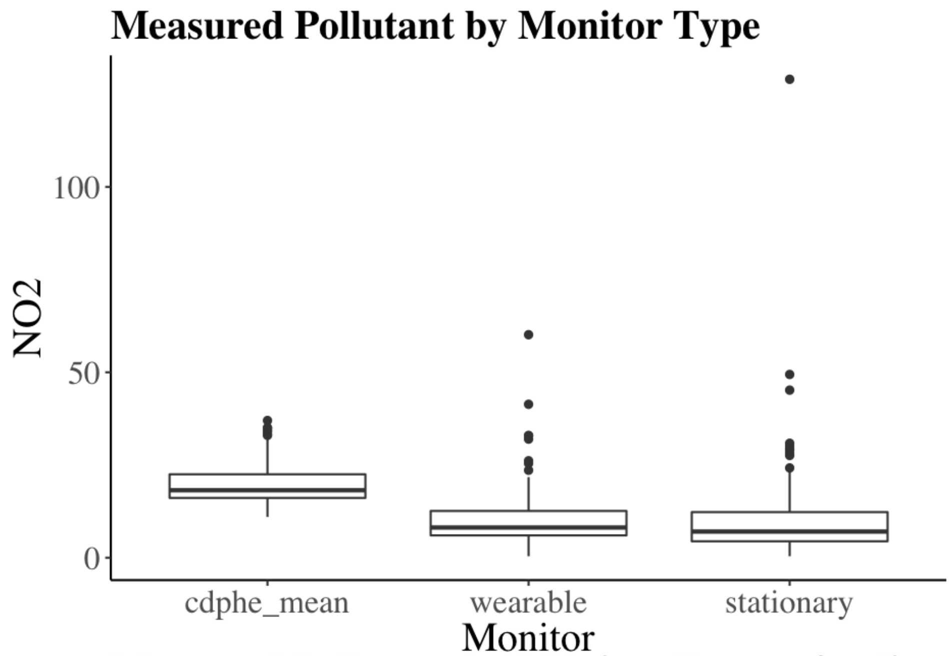

```
##
## PM10 Monitor Differences
## ==========================================================
##                                Dependent variable:
##                      --------------------------------------
##                                       PM10
##                             (1)                 (2)
## ----------------------------------------------------------
## Vest                     7.5589***          -8.8388***
##                      (3.9383, 11.1796)  (-12.4323, -5.2452)
##                         t = 4.0918         t = -4.8208
##                        p = 0.00005        p = 0.000002
## MSP                       1.2798             7.5589***
##                      (-2.3426, 4.9023)   (3.9383, 11.1796)
##                         t = 0.6925          t = 4.0918
##                         p = 0.4887          p = 0.00005
## CDPHE Mean               -1.5252             -1.5252
##                      (-5.5129, 2.4626)   (-5.5129, 2.4626)
##                        t = -0.7496         t = -0.7496
##                         p = 0.4535          p = 0.4535
## Fall                     7.2817**            7.2817**
##                      (1.8978, 12.6656)   (1.8978, 12.6656)
##                         t = 2.6508          t = 2.6508
##                         p = 0.0081          p = 0.0081
## Winter                   -3.5210             -3.5210
##                      (-7.7069, 0.6650)   (-7.7069, 0.6650)
##                        t = -1.6486         t = -1.6486
```

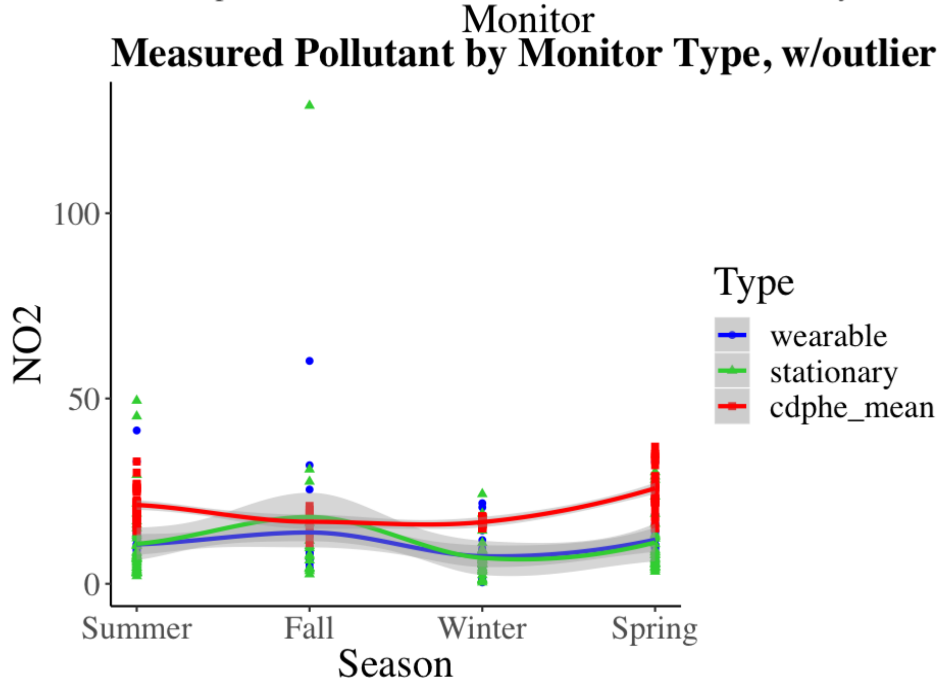
```
##                          p = 0.0993         p = 0.0993
## Spring                    -2.6651            6.4351*
##                      (-8.2757, 2.9455)   (0.8419, 12.0283)
##                         t = -0.9310        t = 2.2550
##                          p = 0.3519         p = 0.0242
## Vest*Fall                 -3.7700            -2.6651
##                      (-9.4048, 1.8647)   (-8.2757, 2.9455)
##                         t = -1.3114        t = -0.9310
##                          p = 0.1898         p = 0.3519
## MSP*Fall                   6.0754           -15.2129***
##                      (-1.2472, 13.3979) (-22.4476, -7.9782)
##                          t = 1.6261         t = -4.1214
##                          p = 0.1040         p = 0.00004
## CDPHE*Fall                 9.1376*           6.0754
##                      (1.8143, 16.4609)  (-1.2472, 13.3979)
##                          t = 2.4455         t = 1.6261
##                          p = 0.0145         p = 0.1040
## Vest*Winter               -2.8868            6.8615*
##                      (-8.6878, 2.9142)   (1.0774, 12.6457)
##                         t = -0.9754        t = 2.3250
##                          p = 0.3294         p = 0.0201
## MSP*Winter                -3.9747            -2.8868
##                      (-9.8047, 1.8553)   (-8.6878, 2.9142)
##                         t = -1.3363        t = -0.9754
##                          p = 0.1815         p = 0.3294
## CDPHE*Winter             31.3133***         31.3133***
##                      (28.1364, 34.4903) (28.1364, 34.4903)
##                          t = 19.3181        t = 19.3181
##                          p = 0.0000         p = 0.0000
## ----------------------------------------------------------
## Observations                349                349
## Log Likelihood         -1,576.6580        -1,576.6580
## Akaike Inf. Crit.       3,181.3160         3,181.3160
## Bayesian Inf. Crit.     3,235.2870         3,235.2870
## ==========================================================
## Note:                          *p<0.05; **p<0.01; ***p<0.001
```

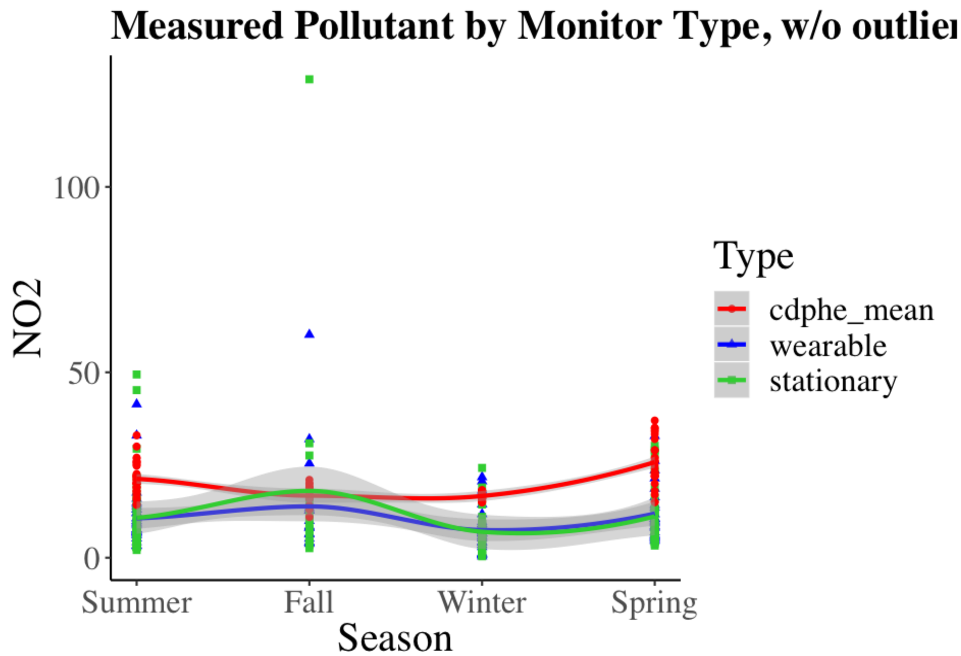
NO2 MEASUREMENT DIFFERENCES

```
## [1] "cdphe_mean" "wearable"   "stationary" "cdphe_max"
```

```
## [1] "wearable"   "stationary" "cdphe_mean" "cdphe_max"
```

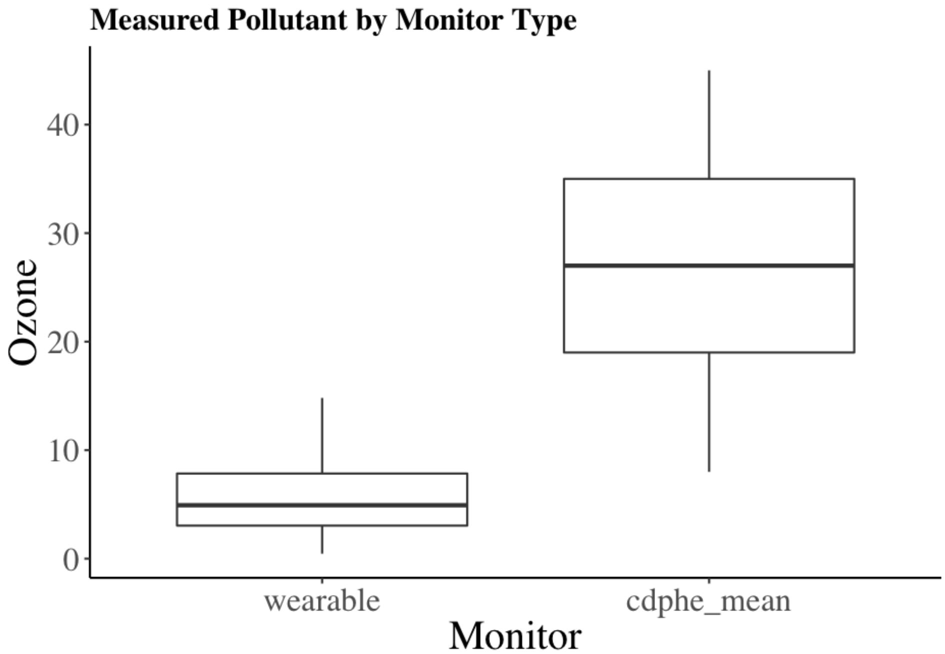

Measured Pollutant by Monitor Type
NO2
100
50
0
cdphe_mean
wearable
stationary
Monitor


Measured Pollutant by Monitor Type, w/outlier
NO2
100
50
0
Summer
Fall
Winter
Spring
Season
Type
wearable
stationary
cdphe_mean




```
##
## NO2 Monitor Differences
## =========================================================
##                                Dependent variable:
##                         ------------------------------------
##                                        NO2
##                              (1)                (2)
## ---------------------------------------------------------
## Wearable                 -3.2763***          5.8460***
##                     (-4.5232, -2.0294)  (4.6212, 7.0709)
##                         t = -5.1500         t = 9.3544
##                        p = 0.000001        p = 0.0000
## MSP                      -2.5697***         -3.2763***
##                     (-3.8006, -1.3389) (-4.5232, -2.0294)
##                         t = -4.0919        t = -5.1500
##                         p = 0.00005        p = 0.000001
## CDPHE Mean                0.1091              0.1091
##                     (-1.2668, 1.4849)  (-1.2668, 1.4849)
##                         t = 0.1554          t = 0.1554
##                         p = 0.8766          p = 0.8766
## Fall                      1.2246              1.2246
##                     (-0.7069, 3.1562)  (-0.7069, 3.1562)
##                         t = 1.2426          t = 1.2426
##                         p = 0.2141          p = 0.2141
## Winter                   -3.3871***         -3.3871***
##                     (-4.8577, -1.9165) (-4.8577, -1.9165)
##                         t = -4.5142        t = -4.5142
```

```
##                           p = 0.00001        p = 0.00001
## Spring                     -0.0214             1.0482
##                     (-1.9693, 1.9265)  (-0.8606, 2.9570)
##                        t = -0.0215        t = 1.0763
##                         p = 0.9829         p = 0.2818
## Wearable*Fall              -1.0269            -0.0214
##                     (-2.9394, 0.8857)  (-1.9693, 1.9265)
##                        t = -1.0523        t = -0.0215
##                         p = 0.2927         p = 0.9829
## MSP*Fall                    0.8492          -5.1762***
##                     (-1.6477, 3.3460)  (-7.6385, -2.7139)
##                         t = 0.6666        t = -4.1202
##                         p = 0.5051         p = 0.00004
## CDPHE*Fall               4.3270***            0.8492
##                      (1.8382, 6.8158)  (-1.6477, 3.3460)
##                         t = 3.4076         t = 0.6666
##                         p = 0.0007         p = 0.5051
## Wearable*Winter            0.3695             0.4332
##                     (-1.6349, 2.3739)  (-1.5379, 2.4044)
##                         t = 0.3613         t = 0.4308
##                         p = 0.7179         p = 0.6667
## MSP*Winter                 -0.8027             0.3695
##                     (-2.7776, 1.1721)  (-1.6349, 2.3739)
##                        t = -0.7967         t = 0.3613
##                         p = 0.4257         p = 0.7179
## CDPHE*Winter             14.1318***         14.1318***
##                     (12.2828, 15.9808) (12.2828, 15.9808)
##                        t = 14.9800        t = 14.9800
##                         p = 0.0000         p = 0.0000
## ------------------------------------------------------------
## Observations                345                345
## Log Likelihood          -1,220.5840        -1,220.5840
## Akaike Inf. Crit.        2,469.1690         2,469.1690
## Bayesian Inf. Crit.      2,522.9780         2,522.9780
## ============================================================
## Note:                         *p<0.05; **p<0.01; ***p<0.001
```




```
##
## Ozone Monitor Differences
## =========================================================
##                               Dependent variable:
##                     -------------------------------------
##                                      O3
## ---------------------------------------------------------
## CDPHE Mean                       -10.5836***
##                              (-12.2443, -8.9229)
##                                  t = -12.4910
##                                   p = 0.0000
## Wearable                          16.0944***
##                               (14.4337, 17.7550)
##                                  t = 18.9949
##                                   p = 0.0000
## ---------------------------------------------------------
## Observations                         152
## R2                                  0.5098
## Adjusted R2                         0.5066
## Residual Std. Error           8.7061 (df = 150)
## F Statistic         156.0254*** (df = 1; 150) (p = 0.0000)
## =========================================================
## Note:                       *p<0.05; **p<0.01; ***p<0.001
```