Coastal Analysis

TLDR: To replicate tables in slides, run tab_model commands at the bottom (that is, after running all the models)

Read in data

```
library(readxl)
library(gee)
library(sjPlot)
library(sjmisc)
library(sjlabelled)

# Read in dataset with coastal coding. Read in summary sheet (sheet
# 13)
coastal <- read_excel("FIPS-based datasets_05232021.xlsx", sheet = 13)
```

```
## New names:
## * `` -> ...12
## * `` -> ...22
## * `` -> ...25
## * `` -> ...39
```

```
# summary(coastal)

# Read in PM25 and humidity data from our 2020 study, created with:
# confounding = data.frame(fips =
# aggregate_pm_census_cdc_test_beds$fips, median_house_value =
# aggregate_pm_census_cdc_test_beds$median_house_value,
# owner_occupied = aggregate_pm_census_cdc_test_beds$owner_occupied,
# blk_pct = aggregate_pm_census_cdc_test_beds$blk_pct, hispanic_pct =
# aggregate_pm_census_cdc_test_beds$hispanic_pct, white_pct =
# aggregate_pm_census_cdc_test_beds$white_pct, native_pct =
# aggregate_pm_census_cdc_test_beds$native_pct, asian_pct =
# aggregate_pm_census_cdc_test_beds$asian_pct, no_grad =
# aggregate_pm_census_cdc_test_beds$no_grad, date_since_social =
# aggregate_pm_census_cdc_test_beds$date_since_social, date_since =
# aggregate_pm_census_cdc_test_beds$date_since, beds =
# aggregate_pm_census_cdc_test_beds$beds, population.old =
# aggregate_pm_census_cdc_test_beds$population, smoke =
# aggregate_pm_census_cdc_test_beds$smoke, mean_summer_temp =
# aggregate_pm_census_cdc_test_beds$mean_summer_temp,
# mean_winter_temp =
# aggregate_pm_census_cdc_test_beds$mean_winter_temp, mean_pm25 =
# aggregate_pm_census_cdc_test_beds$mean_pm25, mean_summer_rm =
```

```
# aggregate_pm_census_cdc_test_beds$mean_summer_rm, mean_winter_rm =
# aggregate_pm_census_cdc_test_beds$mean_winter_rm) save(confounding,
# file = 'confounding.Rda')
load("confounding.Rda")
```

Create smaller datasets from previous datasets, dataclean, merge with PM25 dataset.

```
coastal.new = data.frame(coastal$`FIPS as Text`, coastal$state, coastal$cases,
    coastal$deaths, coastal$`Country REGION`, coastal$`Coastal Distance`,
    coastal$`Population 2019 Estimate`, coastal$`Population Density`, coastal$`All Ages in Poverty (%)`
    coastal$`Under 18s in Poverty`, coastal$`Median Income`, coastal$`percent adult obesity`,
    coastal$`diff/total`, coastal$`Politcal alignment 2020 election`, coastal$`median age 2019`,
    coastal$Humid)
colnames(coastal.new) = c("fips", "state", "cases", "deaths", "region",
    "coastal.distance", "population2019", "popdensity", "poverty", "under18poverty",
    "median_income", "pct_obesity", "voter_margin_2020", "party", "median_age",
    "humidity")

# change NAs in coastal.distance to level 4, and save as factor with
# reference level 4.
coastal.new$coastal.distance[is.na(coastal.new$coastal.distance)] <- 4
coastal.new$coastal.distance = as.factor(coastal.new$coastal.distance)
coastal.new <- within(coastal.new, coastal.distance <- relevel(coastal.distance,
    ref = 4))

# change NAs in coastal region to Inland, and save as factor with
# reference level Inland
coastal.new$region[is.na(coastal.new$region)] <- "Inland"
coastal.new$region[coastal.new$region == "0"] <- "Inland"
coastal.new$region[coastal.new$coastal.distance != 1] <- "Inland"
coastal.new$region = tolower(coastal.new$region)
coastal.new$region = as.factor(coastal.new$region)
coastal.new <- within(coastal.new, region <- relevel(region, ref = "inland"))

# Merge with confounding dataset
coastal.new = merge(coastal.new, confounding, by = "fips")

## Create indicator for being a coast (degree 1)
coastal.new$indicatorcoast = ifelse(coastal.new$coastal.distance == "1",
    "Coastal", "NonCoastal")
coastal.new$indicatorcoast = as.factor(coastal.new$indicatorcoast)
coastal.new <- within(coastal.new, indicatorcoast <- relevel(indicatorcoast,
    ref = "NonCoastal"))

summary(coastal.new)
```

```
##      fips              state               cases              deaths
##  Length:3100        Length:3100        Min.   :      1   Min.   :    0.0
##  Class :character   Class :character   1st Qu.:   1024   1st Qu.:   18.0
##  Mode  :character   Mode  :character   Median :   2445   Median :   47.0
```

```
##                                      Mean   :   9384   Mean   :  165.4
##                                      3rd Qu.:   6124   3rd Qu.:  109.0
##                                      Max.   :1219237   Max.   :23101.0
##
##             region     coastal.distance population2019       popdensity
##  inland        :2800   4:2426           Min.   :     169   Min.   :    0.10
##  atlantic      : 124   1: 300           1st Qu.:   11093   1st Qu.:   17.60
##  gulf of mexico:  56   2: 202           Median :   25884   Median :   45.55
##  pacific       :  40   3: 172           Mean   :  102342   Mean   :  208.15
##  michigan      :  33                    3rd Qu.:   67644   3rd Qu.:  114.12
##  superior      :  14                    Max.   :10039107   Max.   :17179.10
##  (Other)       :  33
##     poverty       under18poverty   median_income     pct_obesity
##  Min.   :0.0270   Min.   :0.0240   Min.   : 24732   Min.   :13.6
##  1st Qu.:0.1050   1st Qu.:0.1370   1st Qu.: 46177   1st Qu.:29.4
##  Median :0.1340   Median :0.1870   Median : 53216   Median :32.4
##  Mean   :0.1448   Mean   :0.2001   Mean   : 55538   Mean   :32.1
##  3rd Qu.:0.1750   3rd Qu.:0.2500   3rd Qu.: 61736   3rd Qu.:35.1
##  Max.   :0.4770   Max.   :0.6340   Max.   :151806   Max.   :49.5
##
##  voter_margin_2020    party             median_age      humidity
##  Min.   :-0.8675   Length:3100        Min.   :22.30   Length:3100
##  1st Qu.: 0.1362   Class :character   1st Qu.:38.20   Class :character
##  Median : 0.3849   Mode  :character   Median :41.40   Mode  :character
##  Mean   : 0.3189                      Mean   :41.48
##  3rd Qu.: 0.5663                      3rd Qu.:44.52
##  Max.   : 0.9309                      Max.   :67.40
##
##  median_house_value owner_occupied      blk_pct          hispanic_pct
##  Min.   : 19800     Min.   :0.2632   Min.   :0.000000   Min.   :0.00000
##  1st Qu.: 88075     1st Qu.:0.6750   1st Qu.:0.006274   1st Qu.:0.01932
##  Median :114150     Median :0.7257   Median :0.022637   Median :0.03800
##  Mean   :135060     Mean   :0.7134   Mean   :0.090870   Mean   :0.08949
##  3rd Qu.:157525     3rd Qu.:0.7669   3rd Qu.:0.103510   3rd Qu.:0.09049
##  Max.   :966600     Max.   :0.9309   Max.   :0.861849   Max.   :0.98959
##
##    white_pct         native_pct         asian_pct           no_grad
##  Min.   :0.04641   Min.   :0.000000   Min.   :0.000000   Min.   :0.05598
##  1st Qu.:0.77715   1st Qu.:0.001582   1st Qu.:0.002541   1st Qu.:0.16722
##  Median :0.90163   Median :0.003399   Median :0.005605   Median :0.20287
##  Mean   :0.83818   Mean   :0.016467   Mean   :0.011937   Mean   :0.21454
##  3rd Qu.:0.95471   3rd Qu.:0.007701   3rd Qu.:0.011992   3rd Qu.:0.25323
##  Max.   :1.00000   Max.   :0.930379   Max.   :0.343781   Max.   :0.54537
##
##  date_since_social   date_since         beds          population.old
##  Min.   :  0.0     Min.   :  0.0   Min.   :    0.00   Min.   :      76
##  1st Qu.:  0.0     1st Qu.:157.0   1st Qu.:   20.75   1st Qu.:   11128
##  Median :437.0     Median :166.0   Median :   50.00   Median :   25824
##  Mean   :312.9     Mean   :156.8   Mean   :  329.19   Mean   :   99194
##  3rd Qu.:443.0     3rd Qu.:170.0   3rd Qu.:  193.25   3rd Qu.:   67356
##  Max.   :449.0     Max.   :170.0   Max.   :30147.00   Max.   :10057155
##
##      smoke         mean_summer_temp mean_winter_temp   mean_pm25
##  Min.   :0.05909   Min.   :290.5    Min.   :264.7    Min.   : 1.959
```

```
##  1st Qu.:0.14941   1st Qu.:300.8    1st Qu.:275.1    1st Qu.: 6.152
##  Median :0.16967   Median :303.3    Median :280.2    Median : 8.360
##  Mean   :0.17459   Mean   :303.1    Mean   :280.4    Mean   : 7.853
##  3rd Qu.:0.19719   3rd Qu.:305.8    3rd Qu.:285.5    3rd Qu.: 9.537
##  Max.   :0.41491   Max.   :313.9    Max.   :298.3    Max.   :12.729
##
##  mean_summer_rm  mean_winter_rm     indicatorcoast
##  Min.   :31.64   Min.   :58.16   NonCoastal:2800
##  1st Qu.:88.09   1st Qu.:85.11   Coastal   : 300
##  Median :91.33   Median :88.03
##  Mean   :89.02   Mean   :87.50
##  3rd Qu.:94.82   3rd Qu.:90.75
##  Max.   :99.78   Max.   :97.67
##
```

Look at correlation of confounders with exposure and outcome - does not yet include party

```
coastal.new$caserate = coastal.new$cases/coastal.new$population2019
coastal.new$deathrate = coastal.new$deaths/coastal.new$population2019
coastal.new$bedrate = coastal.new$beds/coastal.new$population.old

# numeric variables
x = data.frame(log(coastal.new$popdensity), coastal.new$poverty, log(coastal.new$median_income),
    coastal.new$pct_obesity, coastal.new$voter_margin_2020, coastal.new$median_age,
    log(coastal.new$median_house_value), coastal.new$owner_occupied, coastal.new$blk_pct,
    coastal.new$hispanic_pct, coastal.new$white_pct, coastal.new$native_pct,
    coastal.new$asian_pct, coastal.new$no_grad, coastal.new$date_since,
    coastal.new$date_since_social, coastal.new$bedrate, coastal.new$smoke,
    coastal.new$mean_summer_temp, coastal.new$mean_winter_temp, coastal.new$mean_pm25,
    coastal.new$mean_summer_rm, coastal.new$mean_winter_rm, coastal.new$caserate,
    coastal.new$deathrate)
cormat = cor(x)

data.frame(corr_caserate = sort(cormat[, (ncol(x) - 1)], decreasing = T))  #correlation of confounders
```

```
##                                    corr_caserate
## coastal.new.caserate                 1.000000000
## coastal.new.deathrate                0.475465559
## coastal.new.mean_summer_temp         0.329132724
## coastal.new.no_grad                  0.256843711
## coastal.new.pct_obesity              0.242439046
## coastal.new.smoke                    0.218921644
## coastal.new.poverty                  0.205251534
## coastal.new.native_pct               0.161947849
## coastal.new.voter_margin_2020        0.156169823
## coastal.new.mean_pm25                0.144014607
## coastal.new.hispanic_pct             0.128362378
## coastal.new.bedrate                  0.115002117
## coastal.new.blk_pct                  0.095689874
## coastal.new.mean_summer_rm           0.085309123
## coastal.new.mean_winter_temp         0.067713648
## coastal.new.date_since               0.026554622
## coastal.new.mean_winter_rm           0.005891816
## log.coastal.new.popdensity.         -0.065931305
## coastal.new.owner_occupied          -0.092636552
## coastal.new.asian_pct               -0.115003178
## coastal.new.white_pct               -0.155241358
## log.coastal.new.median_income.      -0.181462540
## coastal.new.date_since_social       -0.206877674
## coastal.new.median_age              -0.319914797
## log.coastal.new.median_house_value. -0.331365294
```

```
data.frame(corr_deathrate = sort(cormat[, ncol(x)], decreasing = T))  #correlation of confounders with
```

```
##                                    corr_deathrate
## coastal.new.deathrate                 1.000000000
```

```
## coastal.new.caserate                    0.475465559
## coastal.new.no_grad                     0.336236933
## coastal.new.poverty                     0.329892246
## coastal.new.mean_summer_temp            0.328527350
## coastal.new.blk_pct                     0.236365404
## coastal.new.pct_obesity                 0.219068693
## coastal.new.smoke                       0.214796186
## coastal.new.mean_winter_temp            0.202132201
## coastal.new.mean_summer_rm              0.173737660
## coastal.new.mean_pm25                   0.144405977
## coastal.new.voter_margin_2020           0.115755224
## coastal.new.native_pct                  0.099207468
## coastal.new.hispanic_pct                0.098477326
## coastal.new.bedrate                     0.096845116
## coastal.new.owner_occupied              0.004456082
## coastal.new.median_age                 -0.023557105
## coastal.new.date_since                 -0.031177585
## coastal.new.mean_winter_rm             -0.034035323
## log.coastal.new.popdensity.            -0.123267006
## coastal.new.date_since_social          -0.132952846
## coastal.new.asian_pct                  -0.161800371
## coastal.new.white_pct                  -0.215868842
## log.coastal.new.median_income.         -0.347045271
## log.coastal.new.median_house_value.    -0.435398216
```

```
library(polycor)
polycors = rep(NA, ncol(x))
names(polycors) = names(x)
for (i in 1:ncol(x)) {
    polycors[i] = polyserial(x[, i], coastal.new$indicatorcoast)
}
data.frame(corr_indicatorcoast = sort(polycors, decreasing = T))
```

```
##                                    corr_indicatorcoast
## log.coastal.new.median_house_value.          0.52777523
## log.coastal.new.popdensity.                  0.45278908
## coastal.new.asian_pct                        0.39783497
## log.coastal.new.median_income.               0.33836705
## coastal.new.date_since_social                0.26324470
## coastal.new.mean_summer_rm                   0.19468695
## coastal.new.date_since                       0.18376478
## coastal.new.mean_winter_temp                 0.15689807
## coastal.new.median_age                       0.14708266
## coastal.new.mean_winter_rm                   0.11964671
## coastal.new.blk_pct                          0.10879676
## coastal.new.hispanic_pct                     0.08536699
## coastal.new.mean_pm25                        0.01108868
## coastal.new.bedrate                         -0.05559512
## coastal.new.native_pct                      -0.06288413
## coastal.new.owner_occupied                  -0.11995725
## coastal.new.white_pct                       -0.16292890
## coastal.new.no_grad                         -0.18957813
## coastal.new.poverty                         -0.20334857
## coastal.new.deathrate                       -0.21805627
```

```
## coastal.new.smoke                          -0.24172169
## coastal.new.pct_obesity                    -0.25758819
## coastal.new.mean_summer_temp               -0.26488895
## coastal.new.caserate                       -0.34902482
## coastal.new.voter_margin_2020              -0.48183468
```

Analysis of Coastal vs Noncoastal

```
# Model cases
model.indicator.cases = gee(cases ~ indicatorcoast + offset(log(population2019)) +
    scale(popdensity) + scale(poverty) + scale(log(median_income)) + scale(pct_obesity) +
    scale(voter_margin_2020) + scale(median_age) + factor(party) + mean_pm25 +
    mean_summer_rm + mean_winter_rm, family = poisson(link = "log"), data = coastal.new,
    id = as.factor(state))
```

```
## Beginning Cgee S-function, @(#) geeformula.q 4.13 98/01/27

## running glm to get initial regression estimate

##               (Intercept)     indicatorcoastCoastal         scale(popdensity)
##              -1.602530740               0.063349824              -0.002228131
##             scale(poverty) scale(log(median_income))        scale(pct_obesity)
##              -0.027518554              -0.086074054              -0.030807163
##  scale(voter_margin_2020)         scale(median_age)   factor(party)Republican
##               0.112018417              -0.106228379              -0.016285392
##                 mean_pm25            mean_summer_rm            mean_winter_rm
##               0.035212102              -0.001684755              -0.010277980
```

```
summary(model.indicator.cases)$coefficients
```

```
##                               Estimate   Naive S.E.     Naive z Robust S.E.
## (Intercept)               -1.602530740 0.0578609626 -27.6962337 0.262845938
## indicatorcoastCoastal      0.063349824 0.0105135820   6.0255224 0.035530659
## scale(popdensity)         -0.002228131 0.0023539519  -0.9465492 0.005582572
## scale(poverty)            -0.027518554 0.0125523359  -2.1923054 0.046210038
## scale(log(median_income)) -0.086074054 0.0105492422  -8.1592642 0.052042445
## scale(pct_obesity)        -0.030807163 0.0062432987  -4.9344368 0.032538653
## scale(voter_margin_2020)   0.112018417 0.0083762230  13.3733804 0.029267170
## scale(median_age)         -0.106228379 0.0063584903 -16.7065409 0.016369592
## factor(party)Republican   -0.016285392 0.0154987849  -1.0507528 0.047857949
## mean_pm25                  0.035212102 0.0028394059  12.4012219 0.011278602
## mean_summer_rm            -0.001684755 0.0005509548  -3.0578832 0.002083177
## mean_winter_rm            -0.010277980 0.0008735142 -11.7662426 0.004616915
##                             Robust z
## (Intercept)               -6.0968442
## indicatorcoastCoastal      1.7829622
## scale(popdensity)         -0.3991227
## scale(poverty)            -0.5955103
## scale(log(median_income)) -1.6539203
## scale(pct_obesity)        -0.9467867
## scale(voter_margin_2020)   3.8274427
## scale(median_age)         -6.4893722
## factor(party)Republican   -0.3402860
## mean_pm25                  3.1220272
## mean_summer_rm            -0.8087433
## mean_winter_rm            -2.2261577
```

```r
# Model deaths
model.indicator.deaths = gee(deaths ~ indicatorcoast + offset(log(population2019)) +
    scale(popdensity) + scale(poverty) + scale(log(median_income)) + scale(pct_obesity) +
    scale(voter_margin_2020) + scale(median_age) + factor(party) + mean_pm25 +
    mean_summer_rm + mean_winter_rm, family = poisson(link = "log"), data = coastal.new,
    id = as.factor(state))
```

```
## Beginning Cgee S-function, @(#) geeformula.q 4.13 98/01/27
## running glm to get initial regression estimate

##               (Intercept)     indicatorcoastCoastal         scale(popdensity)
##              -4.884470052                0.067556274                0.012062196
##            scale(poverty) scale(log(median_income))        scale(pct_obesity)
##                0.198449213               -0.002085592                0.024619499
##  scale(voter_margin_2020)         scale(median_age)   factor(party)Republican
##                0.101637642                0.129991106               -0.089474878
##                  mean_pm25            mean_summer_rm            mean_winter_rm
##                0.042400136                0.001133713               -0.020862196
```

```r
summary(model.indicator.deaths)$coefficients
```

```
##                               Estimate   Naive S.E.     Naive z Robust S.E.
## (Intercept)               -4.884470052 0.0943462842 -51.7717268 0.343838253
## indicatorcoastCoastal      0.067556274 0.0169887220   3.9765366 0.031208510
## scale(popdensity)          0.012062196 0.0034588568   3.4873361 0.011039285
## scale(poverty)             0.198449213 0.0194043531  10.2270461 0.060380000
## scale(log(median_income)) -0.002085592 0.0168314117  -0.1239107 0.062588732
## scale(pct_obesity)         0.024619499 0.0099887696   2.4647179 0.024631660
## scale(voter_margin_2020)   0.101637642 0.0134309667   7.5674107 0.030367323
## scale(median_age)          0.129991106 0.0101278249  12.8350467 0.027402072
## factor(party)Republican   -0.089474878 0.0254711063  -3.5127991 0.042629373
## mean_pm25                  0.042400136 0.0046918590   9.0369588 0.019349492
## mean_summer_rm             0.001133713 0.0009371976   1.2096836 0.004782270
## mean_winter_rm            -0.020862196 0.0014678680 -14.2125831 0.007643095
##                                Robust z
## (Intercept)               -14.20572030
## indicatorcoastCoastal       2.16467476
## scale(popdensity)           1.09266098
## scale(poverty)              3.28667131
## scale(log(median_income))  -0.03332216
## scale(pct_obesity)          0.99950627
## scale(voter_margin_2020)    3.34694106
## scale(median_age)           4.74384231
## factor(party)Republican    -2.09890203
## mean_pm25                   2.19127900
## mean_summer_rm              0.23706578
## mean_winter_rm             -2.72954798
```

```r
############ Repeat above, - humidity ##############

# Model cases
model.indicator.cases.nohumidity = gee(cases ~ indicatorcoast + offset(log(population2019)) +
```

```
    scale(popdensity) + scale(poverty) + scale(log(median_income)) + scale(pct_obesity) +
    scale(voter_margin_2020) + scale(median_age) + factor(party) + mean_pm25,
    family = poisson(link = "log"), data = coastal.new, id = as.factor(state))
```

```
## Beginning Cgee S-function, @(#) geeformula.q 4.13 98/01/27
## running glm to get initial regression estimate

##               (Intercept)     indicatorcoastCoastal         scale(popdensity)
##             -2.5540943729              0.0263656026              0.0006959856
##            scale(poverty) scale(log(median_income))        scale(pct_obesity)
##              0.0018851573             -0.0669430868             -0.0572479051
##  scale(voter_margin_2020)         scale(median_age)   factor(party)Republican
##              0.1230363195             -0.1202846203             -0.0554930093
##                 mean_pm25
##              0.0289778033
```

```
summary(model.indicator.cases.nohumidity)$coefficients
```

```
##                               Estimate  Naive S.E.     Naive z Robust S.E.
## (Intercept)               -2.5540943729 0.027043433 -94.4441620 0.146410665
## indicatorcoastCoastal      0.0263656026 0.010853681   2.4291854 0.040891621
## scale(popdensity)          0.0006959856 0.002438615   0.2854020 0.008640851
## scale(poverty)             0.0018851573 0.012912811   0.1459912 0.044824606
## scale(log(median_income)) -0.0669430868 0.010902972  -6.1398937 0.052738189
## scale(pct_obesity)        -0.0572479051 0.006401774  -8.9425065 0.027585460
## scale(voter_margin_2020)   0.1230363195 0.008772570  14.0251168 0.030168144
## scale(median_age)         -0.1202846203 0.006490014 -18.5338009 0.020903915
## factor(party)Republican   -0.0554930093 0.016188488  -3.4279303 0.033836593
## mean_pm25                  0.0289778033 0.002498154  11.5996852 0.014857847
##                                Robust z
## (Intercept)               -17.44472897
## indicatorcoastCoastal       0.64476785
## scale(popdensity)           0.08054596
## scale(poverty)              0.04205630
## scale(log(median_income))  -1.26934747
## scale(pct_obesity)         -2.07529275
## scale(voter_margin_2020)    4.07835228
## scale(median_age)          -5.75416725
## factor(party)Republican    -1.64002946
## mean_pm25                   1.95033665
```

```
# Model deaths
model.indicator.deaths.nohumidity = gee(deaths ~ indicatorcoast + offset(log(population2019)) +
    scale(popdensity) + scale(poverty) + scale(log(median_income)) + scale(pct_obesity) +
    scale(voter_margin_2020) + scale(median_age) + factor(party) + mean_pm25,
    family = poisson(link = "log"), data = coastal.new, id = as.factor(state))
```

```
## Beginning Cgee S-function, @(#) geeformula.q 4.13 98/01/27
## running glm to get initial regression estimate

##               (Intercept)     indicatorcoastCoastal         scale(popdensity)
```

```
##               -6.53853593                0.01221231                0.01567935
##            scale(poverty) scale(log(median_income))        scale(pct_obesity)
##                0.24620870                0.03044379               -0.01372684
##  scale(voter_margin_2020)         scale(median_age)   factor(party)Republican
##                0.11438834                0.11371985               -0.14037140
##                 mean_pm25
##                0.04215293
```

```
summary(model.indicator.deaths.nohumidity)$coefficients
```

```
##                               Estimate  Naive S.E.      Naive z Robust S.E.
## (Intercept)                -6.53853593 0.044449319 -147.1009244  0.23565270
## indicatorcoastCoastal       0.01221231 0.017584593    0.6944893  0.04210152
## scale(popdensity)           0.01567935 0.003586530    4.3717322  0.01444359
## scale(poverty)              0.24620870 0.019946354   12.3435441  0.05990987
## scale(log(median_income))   0.03044379 0.017410225    1.7486157  0.07531244
## scale(pct_obesity)         -0.01372684 0.010281954   -1.3350416  0.03134830
## scale(voter_margin_2020)    0.11438834 0.014162572    8.0768051  0.03070833
## scale(median_age)           0.11371985 0.010384154   10.9512877  0.03366831
## factor(party)Republican    -0.14037140 0.026760096   -5.2455493  0.04789463
## mean_pm25                   0.04215293 0.004131639   10.2024704  0.02317297
##                               Robust z
## (Intercept)                -27.7464925
## indicatorcoastCoastal        0.2900681
## scale(popdensity)            1.0855576
## scale(poverty)               4.1096516
## scale(log(median_income))    0.4042333
## scale(pct_obesity)          -0.4378814
## scale(voter_margin_2020)     3.7249935
## scale(median_age)            3.3776530
## factor(party)Republican     -2.9308378
## mean_pm25                    1.8190556
```

Analysis by region

```
model.byregion.cases = gee(cases ~ region + offset(log(population2019)) +
    scale(popdensity) + scale(poverty) + scale(log(median_income)) + scale(pct_obesity) +
    scale(voter_margin_2020) + scale(median_age) + factor(party) + mean_pm25 +
    mean_summer_rm + mean_winter_rm, family = poisson(link = "log"), data = coastal.new,
    id = as.factor(state))
```

```
## Beginning Cgee S-function, @(#) geeformula.q 4.13 98/01/27

## running glm to get initial regression estimate

##               (Intercept)            regionatlantic                 regionerie
##              -1.688596979               0.204215671              -0.108356810
##     regiongreat salt lake      regiongulf of mexico               regionhuron
##               0.132565314              -0.043255529              -0.027030250
##            regionmichigan             regionontario             regionpacific
##               0.136491225              -0.127998621              -0.031779732
##            regionsuperior         scale(popdensity)            scale(poverty)
##               0.189020378              -0.007523609              -0.005643804
## scale(log(median_income))        scale(pct_obesity)  scale(voter_margin_2020)
##              -0.079744360              -0.040674317               0.108992803
##         scale(median_age)   factor(party)Republican                 mean_pm25
##              -0.109290739              -0.005730366               0.039942888
##            mean_summer_rm            mean_winter_rm
##              -0.002883539              -0.008642672
```

```
summary(model.byregion.cases)$coefficients
```

```
##                               Estimate   Naive S.E.     Naive z Robust S.E.
## (Intercept)               -1.688596979 0.0569905400 -29.6294258 0.274405880
## regionatlantic             0.204215671 0.0143892070  14.1922811 0.074237620
## regionerie                -0.108356810 0.0337973622  -3.2060730 0.066970699
## regiongreat salt lake      0.132565314 0.0535843278   2.4739568 0.074841729
## regiongulf of mexico      -0.043255529 0.0198768903  -2.1761719 0.042365107
## regionhuron               -0.027030250 0.1066409131  -0.2534698 0.050589334
## regionmichigan             0.136491225 0.0244595887   5.5802747 0.058853051
## regionontario             -0.127998621 0.0755540171  -1.6941339 0.042765958
## regionpacific             -0.031779732 0.0167978746  -1.8918900 0.085117999
## regionsuperior             0.189020378 0.1140577459   1.6572340 0.076303153
## scale(popdensity)         -0.007523609 0.0022833390  -3.2950030 0.004752741
## scale(poverty)            -0.005643804 0.0120976619  -0.4665202 0.044880995
## scale(log(median_income)) -0.079744360 0.0101711729  -7.8402325 0.046471802
## scale(pct_obesity)        -0.040674317 0.0061153075  -6.6512301 0.031164976
## scale(voter_margin_2020)   0.108992803 0.0081307940  13.4049397 0.024204307
## scale(median_age)         -0.109290739 0.0061271714 -17.8370625 0.014190845
## factor(party)Republican   -0.005730366 0.0148262127  -0.3865023 0.039452688
## mean_pm25                  0.039942888 0.0028397963  14.0654060 0.009740551
## mean_summer_rm            -0.002883539 0.0005871782  -4.9108410 0.001969371
## mean_winter_rm            -0.008642672 0.0008968655  -9.6365313 0.005163852
##                             Robust z
```

```
## (Intercept)               -6.1536472
## regionatlantic             2.7508381
## regionerie                -1.6179734
## regiongreat salt lake      1.7712754
## regiongulf of mexico      -1.0210178
## regionhuron               -0.5343073
## regionmichigan             2.3191869
## regionontario             -2.9930025
## regionpacific             -0.3733609
## regionsuperior             2.4772289
## scale(popdensity)         -1.5830043
## scale(poverty)            -0.1257504
## scale(log(median_income)) -1.7159731
## scale(pct_obesity)        -1.3051291
## scale(voter_margin_2020)   4.5030333
## scale(median_age)         -7.7014960
## factor(party)Republican   -0.1452465
## mean_pm25                  4.1006807
## mean_summer_rm            -1.4641925
## mean_winter_rm            -1.6736870
```

```
model.byregion.deaths = gee(deaths ~ region + offset(log(population2019)) +
    scale(popdensity) + scale(poverty) + scale(log(median_income)) + scale(pct_obesity) +
    scale(voter_margin_2020) + scale(median_age) + factor(party) + mean_pm25 +
    mean_summer_rm + mean_winter_rm, family = poisson(link = "log"), data = coastal.new,
    id = as.factor(state))
```

```
## Beginning Cgee S-function, @(#) geeformula.q 4.13 98/01/27
## running glm to get initial regression estimate
```

```
##               (Intercept)           regionatlantic                regionerie
##              -5.010724600              0.222892186              0.041660140
##     regiongreat salt lake      regiongulf of mexico               regionhuron
##              -0.600953792             -0.006739778              0.309363488
##            regionmichigan            regionontario             regionpacific
##               0.113333494             -0.127037900             -0.080022647
##            regionsuperior        scale(popdensity)            scale(poverty)
##               0.144067048              0.006698679              0.218769882
## scale(log(median_income))       scale(pct_obesity) scale(voter_margin_2020)
##               0.006159058              0.007762584              0.102217615
##         scale(median_age)   factor(party)Republican                 mean_pm25
##               0.119525317             -0.073145536              0.050680476
##            mean_summer_rm           mean_winter_rm
##              -0.001760438             -0.017492354
```

```
summary(model.byregion.deaths)$coefficients
```

```
##                              Estimate  Naive S.E.     Naive z Robust S.E.
## (Intercept)               -5.010724600 0.095768741 -52.3210870 0.329535568
## regionatlantic             0.222892186 0.023390756   9.5290716 0.068120762
## regionerie                 0.041660140 0.048407530   0.8606128 0.075662685
## regiongreat salt lake     -0.600953792 0.152751891  -3.9341823 0.159531503
```

```
## regiongulf of mexico      -0.006739778 0.032609406  -0.2066820 0.052697418
## regionhuron                0.309363489 0.141701739   2.1832018 0.058291494
## regionmichigan             0.113333494 0.040654566   2.7877187 0.067708615
## regionontario             -0.127037900 0.127089249  -0.9995960 0.057253363
## regionpacific             -0.080022647 0.028721481  -2.7861602 0.099046829
## regionsuperior             0.144067048 0.195370869   0.7374029 0.114092929
## scale(popdensity)          0.006698679 0.003458165   1.9370617 0.009910443
## scale(poverty)             0.218769881 0.019257693  11.3601293 0.058880799
## scale(log(median_income))  0.006159058 0.016701316   0.3687768 0.061330486
## scale(pct_obesity)         0.007762584 0.010141833   0.7654025 0.024499782
## scale(voter_margin_2020)   0.102217615 0.013380483   7.6393070 0.031690419
## scale(median_age)          0.119525317 0.010019748  11.9289744 0.028693646
## factor(party)Republican   -0.073145536 0.025000109  -2.9258087 0.041152296
## mean_pm25                  0.050680476 0.004858210  10.4319229 0.017619827
## mean_summer_rm            -0.001760438 0.001015523  -1.7335289 0.004790069
## mean_winter_rm            -0.017492354 0.001551305 -11.2758931 0.007877458
##                              Robust z
## (Intercept)               -15.2054136
## regionatlantic              3.2720155
## regionerie                  0.5506035
## regiongreat salt lake      -3.7669914
## regiongulf of mexico       -0.1278958
## regionhuron                 5.3071806
## regionmichigan              1.6738416
## regionontario              -2.2188723
## regionpacific              -0.8079274
## regionsuperior              1.2627167
## scale(popdensity)           0.6759213
## scale(poverty)              3.7154707
## scale(log(median_income))   0.1004241
## scale(pct_obesity)          0.3168430
## scale(voter_margin_2020)    3.2255053
## scale(median_age)           4.1655673
## factor(party)Republican    -1.7774351
## mean_pm25                   2.8763322
## mean_summer_rm             -0.3675183
## mean_winter_rm             -2.2205582
```

```
#### Repeat above, - humidity ###############

model.byregion.cases.nohumidity = gee(cases ~ region + offset(log(population2019)) +
    scale(popdensity) + scale(poverty) + scale(log(median_income)) + scale(pct_obesity) +
    scale(voter_margin_2020) + scale(median_age) + factor(party) + mean_pm25,
    family = poisson(link = "log"), data = coastal.new, id = as.factor(state))
```

```
## Beginning Cgee S-function, @(#) geeformula.q 4.13 98/01/27
## running glm to get initial regression estimate

##               (Intercept)            regionatlantic                regionerie
##               -2.57369106                0.16264955               -0.13332726
##     regiongreat salt lake      regiongulf of mexico               regionhuron
##                0.19090444               -0.14180237               -0.08198547
##            regionmichigan             regionontario             regionpacific
```

```
##                0.11038854               -0.19432775               -0.02325864
##            regionsuperior         scale(popdensity)            scale(poverty)
##                0.06747165               -0.00359108                0.01758539
## scale(log(median_income))        scale(pct_obesity)  scale(voter_margin_2020)
##               -0.06627520               -0.06331005                0.12301459
##         scale(median_age)   factor(party)Republican                 mean_pm25
##               -0.12512998               -0.04798863                0.03084745
```

```
summary(model.byregion.cases.nohumidity)$coefficients
```

```
##                               Estimate  Naive S.E.     Naive z Robust S.E.
## (Intercept)                -2.57369106 0.026321422 -97.7793323 0.143822210
## regionatlantic              0.16264955 0.014549037  11.1794031 0.061241436
## regionerie                 -0.13332726 0.035643087  -3.7406204 0.063062538
## regiongreat salt lake       0.19090444 0.053856679   3.5446754 0.031958003
## regiongulf of mexico       -0.14180237 0.020493038  -6.9195387 0.046304561
## regionhuron                -0.08198547 0.113146625  -0.7245949 0.042588477
## regionmichigan              0.11038854 0.025286819   4.3654577 0.054197518
## regionontario              -0.19432775 0.080128750  -2.4251938 0.041402347
## regionpacific              -0.02325864 0.017832898  -1.3042546 0.105222239
## regionsuperior              0.06747165 0.120863905   0.5582448 0.077235530
## scale(popdensity)          -0.00359108 0.002374425  -1.5124000 0.007136096
## scale(poverty)              0.01758539 0.012609581   1.3946055 0.046322531
## scale(log(median_income)) -0.06627520 0.010661599  -6.2162531 0.050840161
## scale(pct_obesity)         -0.06331005 0.006314503 -10.0261333 0.028822474
## scale(voter_margin_2020)    0.12301459 0.008566576  14.3598327 0.023633829
## scale(median_age)          -0.12512998 0.006374749 -19.6290036 0.018642596
## factor(party)Republican    -0.04798863 0.015608439  -3.0745310 0.029268918
## mean_pm25                   0.03084745 0.002443926  12.6220908 0.014184089
##                               Robust z
## (Intercept)                -17.8949486
## regionatlantic               2.6558741
## regionerie                  -2.1142070
## regiongreat salt lake        5.9736037
## regiongulf of mexico        -3.0623845
## regionhuron                 -1.9250623
## regionmichigan               2.0367822
## regionontario               -4.6936409
## regionpacific               -0.2210430
## regionsuperior               0.8735831
## scale(popdensity)           -0.5032275
## scale(poverty)               0.3796293
## scale(log(median_income))   -1.3035993
## scale(pct_obesity)          -2.1965516
## scale(voter_margin_2020)     5.2050217
## scale(median_age)           -6.7120469
## factor(party)Republican     -1.6395765
## mean_pm25                    2.1747926
```

```
model.byregion.deaths.nohumidity = gee(deaths ~ region + offset(log(population2019)) +
    scale(popdensity) + scale(poverty) + scale(log(median_income)) + scale(pct_obesity) +
    scale(voter_margin_2020) + scale(median_age) + factor(party) + mean_pm25,
    family = poisson(link = "log"), data = coastal.new, id = as.factor(state))
```

```
## Beginning Cgee S-function, @(#) geeformula.q 4.13 98/01/27
## running glm to get initial regression estimate

##               (Intercept)            regionatlantic                regionerie
##               -6.55525139                0.17793505               -0.01724918
##     regiongreat salt lake      regiongulf of mexico                regionhuron
##               -0.59601442                -0.15909509                0.20395184
##            regionmichigan             regionontario             regionpacific
##                0.04481734                -0.23198628               -0.06033017
##            regionsuperior         scale(popdensity)            scale(poverty)
##               -0.03746627                0.01244111                0.25159682
## scale(log(median_income))        scale(pct_obesity)  scale(voter_margin_2020)
##                0.02636318                -0.02405789                0.11815459
##         scale(median_age)   factor(party)Republican                 mean_pm25
##                0.09670178                -0.12963447                0.04282456
```

```
summary(model.byregion.deaths.nohumidity)$coefficients
```

```
##                              Estimate  Naive S.E.      Naive z Robust S.E.
## (Intercept)               -6.55525139 0.044177198 -148.3854056  0.23728373
## regionatlantic             0.17793505 0.023456028    7.5858988  0.08798933
## regionerie                -0.01724918 0.050669649   -0.3404244  0.07669580
## regiongreat salt lake     -0.59601442 0.158525455   -3.7597395  0.06512395
## regiongulf of mexico      -0.15909509 0.033490982   -4.7503858  0.04724166
## regionhuron                0.20395184 0.149776495    1.3617079  0.05697602
## regionmichigan             0.04481734 0.041686010    1.0751171  0.07342439
## regionontario             -0.23198628 0.134332126   -1.7269605  0.06152517
## regionpacific             -0.06033017 0.030406994   -1.9840886  0.13293317
## regionsuperior            -0.03746627 0.206338766   -0.1815765  0.11848553
## scale(popdensity)          0.01244111 0.003543749    3.5107197  0.01305516
## scale(poverty)             0.25159682 0.019893668   12.6470808  0.06116511
## scale(log(median_income))  0.02636318 0.017373795    1.5174103  0.07695828
## scale(pct_obesity)        -0.02405789 0.010368814   -2.3202163  0.03341496
## scale(voter_margin_2020)   0.11815459 0.014066124    8.3999398  0.02977091
## scale(median_age)          0.09670178 0.010371716    9.3236046  0.03244031
## factor(party)Republican   -0.12963447 0.026263440   -4.9359286  0.04457407
## mean_pm25                  0.04282456 0.004129515   10.3703614  0.02324873
##                              Robust z
## (Intercept)               -27.6262150
## regionatlantic              2.0222343
## regionerie                 -0.2249039
## regiongreat salt lake      -9.1520011
## regiongulf of mexico       -3.3676859
## regionhuron                 3.5796082
## regionmichigan              0.6103877
## regionontario              -3.7705916
## regionpacific              -0.4538383
## regionsuperior             -0.3162096
## scale(popdensity)           0.9529648
## scale(poverty)              4.1134044
## scale(log(median_income))   0.3425645
## scale(pct_obesity)         -0.7199736
## scale(voter_margin_2020)    3.9687938
```

```
## scale(median_age)           2.9809140
## factor(party)Republican    -2.9082933
## mean_pm25                   1.8420174
```

By region, splitting into Urban and Rural

```
coastal.new$area = ifelse(coastal.new$popdensity >= 1500, "Urban", "Rural")
summary(as.factor(coastal.new$area))
```

```
## Rural Urban
##  3014    86
```

```
coastal.new$regionru = paste(as.character(coastal.new$region), coastal.new$area)
coastal.new$regionru[coastal.new$regionru == "inland Rural"] = "inland"
coastal.new$regionru[coastal.new$regionru == "inland Urban"] = "inland"
coastal.new$regionru = as.factor(coastal.new$regionru)
coastal.new <- within(coastal.new, regionru <- relevel(regionru, ref = "inland"))
summary(coastal.new$regionru)
```

```
##                inland        atlantic Rural        atlantic Urban
##                  2800                   105                    19
##            erie Rural            erie Urban great salt lake Rural
##                    10                     2                     3
##  gulf of mexico Rural  gulf of mexico Urban           huron Rural
##                    53                     3                    12
##        michigan Rural        michigan Urban         ontario Rural
##                    30                     3                     6
##         pacific Rural         pacific Urban        superior Rural
##                    35                     5                    14
```

```
model.byregionru.cases = gee(cases ~ regionru + offset(log(population2019)) +
    scale(popdensity) + scale(poverty) + scale(log(median_income)) + scale(pct_obesity) +
    scale(voter_margin_2020) + scale(median_age) + factor(party) + mean_pm25 +
    mean_summer_rm + mean_winter_rm, family = poisson(link = "log"), data = coastal.new,
    id = as.factor(state))
```

```
## Beginning Cgee S-function, @(#) geeformula.q 4.13 98/01/27

## running glm to get initial regression estimate

##                   (Intercept)        regionruatlantic Rural
##                  -1.733534725                   0.170139104
##        regionruatlantic Urban            regionruerie Rural
##                   0.272566689                  -0.053146583
##            regionruerie Urban regionrugreat salt lake Rural
##                  -0.155451912                   0.129765168
##  regionrugulf of mexico Rural  regionrugulf of mexico Urban
##                   0.023878507                  -0.162089950
##           regionruhuron Rural        regionrumichigan Rural
##                  -0.041222180                   0.132600033
##        regionrumichigan Urban         regionruontario Rural
##                   0.167079749                  -0.152458896
##         regionrupacific Rural         regionrupacific Urban
##                  -0.205226291                   0.102232281
```

```
##        regionrusuperior Rural             scale(popdensity)
##                     0.134793749                 -0.010894458
##                scale(poverty)    scale(log(median_income))
##                    -0.012272895                 -0.079999056
##             scale(pct_obesity)     scale(voter_margin_2020)
##                    -0.032508992                  0.109426415
##              scale(median_age)      factor(party)Republican
##                    -0.113262811                 -0.033038960
##                       mean_pm25               mean_summer_rm
##                     0.031790008                 -0.002437536
##                  mean_winter_rm
##                    -0.007513832
```

```
summary(model.byregionru.cases)$coefficients
```

```
##                                    Estimate   Naive S.E.     Naive z Robust S.E.
## (Intercept)                    -1.733534725 0.0564480965 -30.7102424 0.279993550
## regionruatlantic Rural          0.170139104 0.0163050730  10.4347343 0.091987332
## regionruatlantic Urban          0.272566689 0.0226521478  12.0327084 0.104857941
## regionruerie Rural             -0.053146583 0.0453627395  -1.1715911 0.039011979
## regionruerie Urban             -0.155451912 0.0463509848  -3.3537996 0.084689500
## regionrugreat salt lake Rural   0.129765168 0.0522962816   2.4813460 0.074582290
## regionrugulf of mexico Rural    0.023878507 0.0235771577   1.0127814 0.037968689
## regionrugulf of mexico Urban   -0.162089950 0.0318099308  -5.0955769 0.045064273
## regionruhuron Rural            -0.041222180 0.1040565945  -0.3961515 0.048942362
## regionrumichigan Rural          0.132600033 0.0400649457   3.3096272 0.109695993
## regionrumichigan Urban          0.167079749 0.0292235495   5.7172983 0.059996624
## regionruontario Rural          -0.152458896 0.0737289434  -2.0678297 0.040419679
## regionrupacific Rural          -0.205226291 0.0245103365  -8.3730507 0.138994480
## regionrupacific Urban           0.102232281 0.0206969393   4.9394879 0.036980078
## regionrusuperior Rural          0.134793749 0.1113725068   1.2102964 0.071894978
## scale(popdensity)              -0.010894458 0.0023909913  -4.5564605 0.006171302
## scale(poverty)                 -0.012272895 0.0118636304  -1.0344974 0.042432028
## scale(log(median_income))      -0.079999056 0.0100799302  -7.9364693 0.040110107
## scale(pct_obesity)             -0.032508992 0.0061016134  -5.3279338 0.027262420
## scale(voter_margin_2020)        0.109426415 0.0079374117  13.7861584 0.022904223
## scale(median_age)              -0.113262811 0.0060101297 -18.8453190 0.014994658
## factor(party)Republican        -0.033038960 0.0146964200  -2.2480958 0.037656599
## mean_pm25                       0.031790008 0.0029145460  10.9073620 0.009877254
## mean_summer_rm                 -0.002437536 0.0005783202  -4.2148547 0.002060133
## mean_winter_rm                 -0.007513832 0.0008901843  -8.4407600 0.005173484
##                                  Robust z
## (Intercept)                    -6.1913381
## regionruatlantic Rural          1.8495928
## regionruatlantic Urban          2.5993900
## regionruerie Rural             -1.3623144
## regionruerie Urban             -1.8355512
## regionrugreat salt lake Rural   1.7398925
## regionrugulf of mexico Rural    0.6289000
## regionrugulf of mexico Urban   -3.5968615
## regionruhuron Rural            -0.8422597
## regionrumichigan Rural          1.2087956
## regionrumichigan Urban          2.7848192
## regionruontario Rural          -3.7718978
```

```
## regionrupacific Rural         -1.4765068
## regionrupacific Urban          2.7645232
## regionrusuperior Rural         1.8748702
## scale(popdensity)             -1.7653419
## scale(poverty)                -0.2892366
## scale(log(median_income))     -1.9944862
## scale(pct_obesity)            -1.1924471
## scale(voter_margin_2020)       4.7775651
## scale(median_age)             -7.5535443
## factor(party)Republican       -0.8773750
## mean_pm25                      3.2185065
## mean_summer_rm                -1.1831934
## mean_winter_rm                -1.4523737
```

```
model.byregionru.deaths = gee(deaths ~ regionru + offset(log(population2019)) +
    scale(popdensity) + scale(poverty) + scale(log(median_income)) + scale(pct_obesity) +
    scale(voter_margin_2020) + scale(median_age) + factor(party) + mean_pm25 +
    mean_summer_rm + mean_winter_rm, family = poisson(link = "log"), data = coastal.new,
    id = as.factor(state))
```

```
## Beginning Cgee S-function, @(#) geeformula.q 4.13 98/01/27
## running glm to get initial regression estimate

##                   (Intercept)        regionruatlantic Rural
##                  -5.116174369                   0.120947248
##        regionruatlantic Urban            regionruerie Rural
##                   0.416176040                   0.003893615
##           regionruerie Urban regionrugreat salt lake Rural
##                   0.079966653                  -0.604281740
##  regionrugulf of mexico Rural  regionrugulf of mexico Urban
##                   0.068027947                  -0.169230030
##           regionruhuron Rural        regionrumichigan Rural
##                   0.270956806                   0.060102893
##        regionrumichigan Urban         regionruontario Rural
##                   0.189949127                  -0.167570437
##         regionrupacific Rural         regionrupacific Urban
##                  -0.350387316                   0.109709879
##        regionrusuperior Rural             scale(popdensity)
##                   0.048101281                  -0.001521227
##                scale(poverty)     scale(log(median_income))
##                   0.200465035                  -0.006069958
##            scale(pct_obesity)      scale(voter_margin_2020)
##                   0.014802788                   0.102529618
##             scale(median_age)       factor(party)Republican
##                   0.115075634                  -0.114635698
##                     mean_pm25                mean_summer_rm
##                   0.038824847                  -0.001163866
##                mean_winter_rm
##                  -0.015221065
```

```
summary(model.byregionru.deaths)$coefficients
```

```
##                                 Estimate   Naive S.E.      Naive z
```

```
## (Intercept)                   -5.116174369 0.0951115741 -53.79129112
## regionruatlantic Rural         0.120947249 0.0271455143   4.45551509
## regionruatlantic Urban         0.416176040 0.0349339051  11.91324128
## regionruerie Rural             0.003893615 0.0698870794   0.05571295
## regionruerie Urban             0.079966653 0.0616723876   1.29663624
## regionrugreat salt lake Rural -0.604281740 0.1487233413  -4.06312644
## regionrugulf of mexico Rural   0.068027948 0.0379779132   1.79125028
## regionrugulf of mexico Urban  -0.169230029 0.0538295989  -3.14380996
## regionruhuron Rural            0.270956806 0.1380255727   1.96309134
## regionrumichigan Rural         0.060102893 0.0703534831   0.85429875
## regionrumichigan Urban         0.189949127 0.0472109905   4.02340906
## regionruontario Rural         -0.167570437 0.1237653091  -1.35393705
## regionrupacific Rural         -0.350387316 0.0456582253  -7.67413349
## regionrupacific Urban          0.109709879 0.0340267916   3.22422050
## regionrusuperior Rural         0.048101282 0.1903743718   0.25266679
## scale(popdensity)             -0.001521227 0.0036295288  -0.41912531
## scale(poverty)                 0.200465035 0.0188315014  10.64519663
## scale(log(median_income))     -0.006069958 0.0165137678  -0.36756954
## scale(pct_obesity)             0.014802787 0.0101126552   1.46378841
## scale(voter_margin_2020)       0.102529618 0.0130285948   7.86958379
## scale(median_age)              0.115075634 0.0098021927  11.73978492
## factor(party)Republican       -0.114635698 0.0247722987  -4.62757611
## mean_pm25                      0.038824847 0.0049806894   7.79507488
## mean_summer_rm                -0.001163866 0.0009989164  -1.16512845
## mean_winter_rm                -0.015221065 0.0015404868  -9.88068572
##                               Robust S.E.     Robust z
## (Intercept)                   0.348311210 -14.68851481
## regionruatlantic Rural        0.063222720   1.91303456
## regionruatlantic Urban        0.113622223   3.66280493
## regionruerie Rural            0.068202395   0.05708913
## regionruerie Urban            0.109766597   0.72851536
## regionrugreat salt lake Rural 0.155172845  -3.89424927
## regionrugulf of mexico Rural  0.092832868   0.73280023
## regionrugulf of mexico Urban  0.090413234  -1.87173960
## regionruhuron Rural           0.059491246   4.55456601
## regionrumichigan Rural        0.059687153   1.00696532
## regionrumichigan Urban        0.093432351   2.03301239
## regionruontario Rural         0.054132452  -3.09556341
## regionrupacific Rural         0.125746420  -2.78645957
## regionrupacific Urban         0.084363798   1.30043789
## regionrusuperior Rural        0.112079210   0.42917221
## scale(popdensity)             0.009946328  -0.15294362
## scale(poverty)                0.054920949   3.65006501
## scale(log(median_income))     0.057148397  -0.10621397
## scale(pct_obesity)            0.023370361   0.63340004
## scale(voter_margin_2020)      0.032487584   3.15596318
## scale(median_age)             0.032562061   3.53404028
## factor(party)Republican       0.043421757  -2.64005203
## mean_pm25                     0.017794293   2.18187069
## mean_summer_rm                0.004883593  -0.23832164
## mean_winter_rm                0.007947677  -1.91515897
```

```
model.byregionru.cases.nohumidity = gee(cases ~ regionru + offset(log(population2019)) +
    scale(popdensity) + scale(poverty) + scale(log(median_income)) + scale(pct_obesity) +
```

```
    scale(voter_margin_2020) + scale(median_age) + factor(party) + mean_pm25,
    family = poisson(link = "log"), data = coastal.new, id = as.factor(state))
```

```
## Beginning Cgee S-function, @(#) geeformula.q 4.13 98/01/27
## running glm to get initial regression estimate
```

```
##                   (Intercept)        regionruatlantic Rural
##                   -2.469395382                   0.113593065
##        regionruatlantic Urban            regionruerie Rural
##                    0.296284409                  -0.085569563
##            regionruerie Urban regionrugreat salt lake Rural
##                   -0.159611137                   0.177901599
##  regionrugulf of mexico Rural  regionrugulf of mexico Urban
##                   -0.056230951                  -0.238673862
##           regionruhuron Rural        regionrumichigan Rural
##                   -0.096595552                   0.094910100
##        regionrumichigan Urban         regionruontario Rural
##                    0.173260778                  -0.216138661
##         regionrupacific Rural         regionrupacific Urban
##                   -0.262479208                   0.174531428
##        regionrusuperior Rural             scale(popdensity)
##                    0.011759752                  -0.010952735
##                scale(poverty)     scale(log(median_income))
##                    0.001328331                  -0.072381845
##            scale(pct_obesity)      scale(voter_margin_2020)
##                   -0.047892107                   0.118822396
##             scale(median_age)       factor(party)Republican
##                   -0.126449400                  -0.074314297
##                      mean_pm25
##                    0.021313480
```

```
summary(model.byregionru.cases.nohumidity)$coefficients
```

```
##                                 Estimate  Naive S.E.     Naive z Robust S.E.
## (Intercept)                  -2.469395382 0.026021092 -94.8997601  0.11992347
## regionruatlantic Rural        0.113593065 0.016341104   6.9513705  0.07135056
## regionruatlantic Urban        0.296284409 0.022877891  12.9506869  0.11698561
## regionruerie Rural           -0.085569563 0.047050961  -1.8186571  0.03652486
## regionruerie Urban           -0.159611137 0.047949804  -3.3287130  0.08270693
## regionrugreat salt lake Rural 0.177901599 0.051467427   3.4565862  0.02914999
## regionrugulf of mexico Rural -0.056230951 0.024073918  -2.3357624  0.02206322
## regionrugulf of mexico Urban -0.238673862 0.032705373  -7.2976958  0.04295127
## regionruhuron Rural          -0.096595552 0.108103148  -0.8935498  0.03872954
## regionrumichigan Rural        0.094910100 0.041483814   2.2878827  0.12057892
## regionrumichigan Urban        0.173260778 0.029695530   5.8345743  0.04614607
## regionruontario Rural        -0.216138661 0.076550955  -2.8234613  0.03730012
## regionrupacific Rural        -0.262479208 0.025259962 -10.3911166  0.15208850
## regionrupacific Urban         0.174531428 0.021167941   8.2450830  0.03830799
## regionrusuperior Rural        0.011759752 0.115503963   0.1018125  0.07060074
## scale(popdensity)            -0.010952735 0.002458778  -4.4545445  0.00926321
## scale(poverty)                0.001328331 0.012164374   0.1091984  0.04273280
## scale(log(median_income))    -0.072381845 0.010377690  -6.9747553  0.04271274
```

```
## scale(pct_obesity)            -0.047892107 0.006222851  -7.6961674  0.02320282
## scale(voter_margin_2020)       0.118822396 0.008195459  14.4985650  0.02180123
## scale(median_age)             -0.126449400 0.006120126 -20.6612412  0.01876220
## factor(party)Republican       -0.074314297 0.015095170  -4.9230512  0.02920429
## mean_pm25                      0.021313480 0.002449322   8.7017876  0.01186660
##                                   Robust z
## (Intercept)                   -20.59142690
## regionruatlantic Rural          1.59204170
## regionruatlantic Urban          2.53265683
## regionruerie Rural             -2.34277591
## regionruerie Urban             -1.92984000
## regionrugreat salt lake Rural   6.10297310
## regionrugulf of mexico Rural   -2.54862874
## regionrugulf of mexico Urban   -5.55685216
## regionruhuron Rural            -2.49410551
## regionrumichigan Rural          0.78712018
## regionrumichigan Urban          3.75461586
## regionruontario Rural          -5.79458380
## regionrupacific Rural          -1.72583210
## regionrupacific Urban           4.55600630
## regionrusuperior Rural          0.16656698
## scale(popdensity)              -1.18239087
## scale(poverty)                  0.03108457
## scale(log(median_income))      -1.69461967
## scale(pct_obesity)             -2.06406432
## scale(voter_margin_2020)        5.45026136
## scale(median_age)              -6.73958153
## factor(party)Republican        -2.54463676
## mean_pm25                       1.79608946
```

```
model.byregionru.deaths.nohumidity = gee(deaths ~ regionru + offset(log(population2019)) +
    scale(popdensity) + scale(poverty) + scale(log(median_income)) + scale(pct_obesity) +
    scale(voter_margin_2020) + scale(median_age) + factor(party) + mean_pm25,
    family = poisson(link = "log"), data = coastal.new, id = as.factor(state))
```

```
## Beginning Cgee S-function, @(#) geeformula.q 4.13 98/01/27
## running glm to get initial regression estimate

##                   (Intercept)        regionruatlantic Rural
##                  -6.391521544                   0.046869406
##        regionruatlantic Urban            regionruerie Rural
##                   0.475780226                  -0.061602493
##           regionruerie Urban regionrugreat salt lake Rural
##                   0.049166912                  -0.609905934
##  regionrugulf of mexico Rural  regionrugulf of mexico Urban
##                  -0.057500717                  -0.282285016
##           regionruhuron Rural        regionrumichigan Rural
##                   0.166492782                  -0.015784678
##        regionrumichigan Urban         regionruontario Rural
##                   0.167470698                  -0.266238507
##         regionrupacific Rural         regionrupacific Urban
##                  -0.442210483                   0.223350850
##        regionrusuperior Rural             scale(popdensity)
```

```
##                   -0.133129929                   -0.001257640
##                scale(poverty)     scale(log(median_income))
##                    0.217480467                    0.002357260
##            scale(pct_obesity)      scale(voter_margin_2020)
##                   -0.006692977                    0.112052781
##             scale(median_age)       factor(party)Republican
##                    0.097380308                   -0.169861748
##                      mean_pm25
##                    0.028739584
```

```
summary(model.byregionru.deaths.nohumidity)$coefficients
```

```
##                                    Estimate  Naive S.E.      Naive z Robust S.E.
## (Intercept)                    -6.391521545 0.043627859 -146.5009226  0.20142626
## regionruatlantic Rural          0.046869406 0.027120491    1.7281916  0.06524722
## regionruatlantic Urban          0.475780227 0.034891409   13.6360279  0.13148619
## regionruerie Rural             -0.061602493 0.072180434   -0.8534514  0.06537690
## regionruerie Urban              0.049166912 0.063348817    0.7761299  0.11064600
## regionrugreat salt lake Rural -0.609905933 0.151135681   -4.0354860  0.06178095
## regionrugulf of mexico Rural  -0.057500716 0.038584862   -1.4902403  0.09315697
## regionrugulf of mexico Urban  -0.282285016 0.055170408   -5.1166019  0.07883638
## regionruhuron Rural             0.166492782 0.142827293    1.1656930  0.05359757
## regionrumichigan Rural         -0.015784678 0.072562171   -0.2175332  0.06520613
## regionrumichigan Urban          0.167470698 0.047646530    3.5148561  0.10566097
## regionruontario Rural          -0.266238507 0.128068267   -2.0788796  0.05575313
## regionrupacific Rural          -0.442210483 0.046965206   -9.4157042  0.15577119
## regionrupacific Urban           0.223350850 0.034711280    6.4345323  0.08894265
## regionrusuperior Rural         -0.133129928 0.196775676   -0.6765568  0.10892125
## scale(popdensity)              -0.001257640 0.003685882   -0.3412047  0.01366765
## scale(poverty)                  0.217480467 0.019163291   11.3488055  0.05705784
## scale(log(median_income))       0.002357260 0.016898974    0.1394913  0.06724088
## scale(pct_obesity)             -0.006692977 0.010227196   -0.6544294  0.02409307
## scale(voter_margin_2020)        0.112052781 0.013414333    8.3532130  0.03012613
## scale(median_age)               0.097380308 0.009927665    9.8089841  0.03556135
## factor(party)Republican        -0.169861748 0.025402307   -6.6868631  0.04440686
## mean_pm25                       0.028739584 0.004128948    6.9605102  0.01955551
##                                    Robust z
## (Intercept)                    -31.73132249
## regionruatlantic Rural           0.71833571
## regionruatlantic Urban           3.61848048
## regionruerie Rural              -0.94226702
## regionruerie Urban               0.44436231
## regionrugreat salt lake Rural  -9.87207048
## regionrugulf of mexico Rural   -0.61724543
## regionrugulf of mexico Urban   -3.58064399
## regionruhuron Rural              3.10634917
## regionrumichigan Rural          -0.24207355
## regionrumichigan Urban           1.58498168
## regionruontario Rural           -4.77531011
## regionrupacific Rural           -2.83884638
## regionrupacific Urban            2.51117837
## regionrusuperior Rural          -1.22225854
## scale(popdensity)               -0.09201581
## scale(poverty)                   3.81157879
```

```
## scale(log(median_income))       0.03505695
## scale(pct_obesity)             -0.27779674
## scale(voter_margin_2020)        3.71945530
## scale(median_age)               2.73837485
## factor(party)Republican        -3.82512380
## mean_pm25                       1.46964100
```

Comparing 1st vs 2nd vs 3rd degree Coastal

```
# Subset coastal counties only
coastal.only = coastal.new[coastal.new$coastal.distance != 4, ]
nrow(coastal.only)
```

```
## [1] 674
```

```
nrow(na.omit(coastal.only))  #check nas
```

```
## [1] 636
```

```
coastal.only$coastal.distance = factor(coastal.only$coastal.distance)  #drops level 4
summary(coastal.only)
```

```
##      fips              state               cases             deaths
##  Length:674         Length:674         Min.   :     36   Min.   :    0.0
##  Class :character   Class :character   1st Qu.:   1899   1st Qu.:   36.0
##  Mode  :character   Mode  :character   Median :   4696   Median :   84.0
##                                        Mean   :  20660   Mean   :  376.3
##                                        3rd Qu.:  16346   3rd Qu.:  272.5
##                                        Max.   :1219237   Max.   :23101.0
##
##             region    coastal.distance population2019       popdensity
##  inland        :374   1:300            Min.   :     404   Min.   :    0.30
##  atlantic      :124   2:202            1st Qu.:   25248   1st Qu.:   39.62
##  gulf of mexico: 56   3:172            Median :   62987   Median :   99.15
##  pacific       : 40                    Mean   :  235470   Mean   :  457.59
##  michigan      : 33                    3rd Qu.:  208981   3rd Qu.:  339.38
##  superior      : 14                    Max.   :10039107   Max.   :17179.10
##  (Other)       : 33
##     poverty       under18poverty   median_income     pct_obesity
##  Min.   :0.0350   Min.   :0.0350   Min.   : 30998   Min.   :15.20
##  1st Qu.:0.0940   1st Qu.:0.1260   1st Qu.: 49410   1st Qu.:28.50
##  Median :0.1270   Median :0.1840   Median : 56748   Median :31.40
##  Mean   :0.1341   Mean   :0.1897   Mean   : 61179   Mean   :31.14
##  3rd Qu.:0.1660   3rd Qu.:0.2410   3rd Qu.: 68682   3rd Qu.:34.40
##  Max.   :0.3250   Max.   :0.4890   Max.   :137849   Max.   :44.40
##
##  voter_margin_2020     party             median_age      humidity
##  Min.   :-0.80526   Length:674         Min.   :24.80   Length:674
##  1st Qu.:-0.09234   Class :character   1st Qu.:37.90   Class :character
##  Median : 0.15212   Mode  :character   Median :41.35   Mode  :character
##  Mean   : 0.11991                      Mean   :41.85
##  3rd Qu.: 0.32801                      3rd Qu.:45.27
##  Max.   : 0.82867                      Max.   :67.40
##
##  median_house_value owner_occupied      blk_pct         hispanic_pct
##  Min.   : 48400     Min.   :0.3078   Min.   :0.00000   Min.   :0.001731
##  1st Qu.:104725     1st Qu.:0.6560   1st Qu.:0.01084   1st Qu.:0.026059
##  Median :150450     Median :0.7147   Median :0.06126   Median :0.056348
```

```
##  Mean   :180388     Mean   :0.7055   Mean   :0.11843   Mean   :0.110651
##  3rd Qu.:217975     3rd Qu.:0.7679   3rd Qu.:0.17099   3rd Qu.:0.118732
##  Max.   :966600     Max.   :0.9019   Max.   :0.76813   Max.   :0.989589
##
##    white_pct         native_pct         asian_pct          no_grad
##  Min.   :0.09558   Min.   :0.000000   Min.   :0.00000   Min.   :0.1020
##  1st Qu.:0.70704   1st Qu.:0.002118   1st Qu.:0.00480   1st Qu.:0.1633
##  Median :0.83260   Median :0.003968   Median :0.01042   Median :0.1918
##  Mean   :0.79651   Mean   :0.011127   Mean   :0.02216   Mean   :0.2053
##  3rd Qu.:0.92431   3rd Qu.:0.007322   3rd Qu.:0.02335   3rd Qu.:0.2372
##  Max.   :0.98972   Max.   :0.855059   Max.   :0.34378   Max.   :0.5454
##
##  date_since_social   date_since         beds         population.old
##  Min.   :  0.0     Min.   :  0.0   Min.   :    0.0   Min.   :     558
##  1st Qu.:434.0     1st Qu.:164.0   1st Qu.:   25.0   1st Qu.:   25260
##  Median :441.0     Median :170.0   Median :  134.5   Median :   61694
##  Mean   :399.8     Mean   :163.6   Mean   :  709.5   Mean   :  229086
##  3rd Qu.:444.0     3rd Qu.:170.0   3rd Qu.:  560.2   3rd Qu.:  200351
##  Max.   :449.0     Max.   :170.0   Max.   :30147.0   Max.   :10057155
##
##      smoke         mean_summer_temp mean_winter_temp   mean_pm25
##  Min.   :0.05909   Min.   :292.6    Min.   :265.9    Min.   : 2.717
##  1st Qu.:0.14390   1st Qu.:299.1    1st Qu.:274.0    1st Qu.: 6.338
##  Median :0.16384   Median :301.8    Median :280.6    Median : 8.469
##  Mean   :0.16399   Mean   :302.1    Mean   :281.3    Mean   : 7.893
##  3rd Qu.:0.18661   3rd Qu.:305.5    3rd Qu.:289.2    3rd Qu.: 9.371
##  Max.   :0.33580   Max.   :313.8    Max.   :298.3    Max.   :12.334
##
##  mean_summer_rm  mean_winter_rm     indicatorcoast    caserate
##  Min.   :40.76   Min.   :62.11   NonCoastal:374    Min.   :0.00728
##  1st Qu.:89.65   1st Qu.:85.15   Coastal   :300    1st Qu.:0.06251
##  Median :92.78   Median :89.75                     Median :0.08118
##  Mean   :90.95   Mean   :88.69                     Mean   :0.08099
##  3rd Qu.:96.83   3rd Qu.:92.58                     3rd Qu.:0.09965
##  Max.   :99.78   Max.   :97.67                     Max.   :0.19222
##
##    deathrate            bedrate             area
##  Min.   :0.0000000   Min.   :0.000000   Length:674
##  1st Qu.:0.0009024   1st Qu.:0.001104   Class :character
##  Median :0.0014681   Median :0.002091   Mode  :character
##  Mean   :0.0015713   Mean   :0.002582
##  3rd Qu.:0.0020613   3rd Qu.:0.003410
##  Max.   :0.0070336   Max.   :0.042582
##
##                  regionru
##  inland               :374
##  atlantic Rural       :105
##  gulf of mexico Rural: 53
##  pacific Rural        : 35
##  michigan Rural       : 30
##  atlantic Urban       : 19
##  (Other)              : 58
```

```r
# Model cases
model.initial.cases = gee(cases ~ coastal.distance + offset(log(population2019)) +
    scale(popdensity) + scale(poverty) + scale(log(median_income)) + scale(pct_obesity) +
    scale(voter_margin_2020) + scale(median_age) + factor(party) + mean_pm25 +
    mean_summer_rm + mean_winter_rm, family = poisson(link = "log"), data = coastal.only,
    id = as.factor(state))
```

```
## Beginning Cgee S-function, @(#) geeformula.q 4.13 98/01/27

## running glm to get initial regression estimate

##               (Intercept)         coastal.distance2         coastal.distance3
##              -1.597849570              -0.006831130              -0.052687564
##         scale(popdensity)            scale(poverty) scale(log(median_income))
##              -0.004160461              -0.020643848              -0.122516361
##        scale(pct_obesity)  scale(voter_margin_2020)         scale(median_age)
##              -0.091723849               0.117514404              -0.069315640
##   factor(party)Republican                 mean_pm25            mean_summer_rm
##              -0.026073926               0.050880753              -0.001384356
##            mean_winter_rm
##              -0.012797151
```

```r
summary(model.initial.cases)$coefficients
```

```
##                               Estimate  Naive S.E.     Naive z Robust S.E.
## (Intercept)               -1.597849570 0.146405307 -10.9138774 0.299036072
## coastal.distance2         -0.006831130 0.025932859  -0.2634160 0.028248618
## coastal.distance3         -0.052687564 0.034381462  -1.5324411 0.039478312
## scale(popdensity)         -0.004160461 0.008122541  -0.5122117 0.011734619
## scale(poverty)            -0.020643848 0.030570607  -0.6752842 0.069130245
## scale(log(median_income)) -0.122516361 0.028533082  -4.2938355 0.084945077
## scale(pct_obesity)        -0.091723849 0.014928053  -6.1443947 0.051911706
## scale(voter_margin_2020)   0.117514404 0.020087827   5.8500307 0.047429533
## scale(median_age)         -0.069315640 0.017865804  -3.8797941 0.032636748
## factor(party)Republican   -0.026073926 0.037000743  -0.7046866 0.082188461
## mean_pm25                  0.050880753 0.006846732   7.4313928 0.017927148
## mean_summer_rm            -0.001384356 0.001283815  -1.0783146 0.003186362
## mean_winter_rm            -0.012797151 0.001929554  -6.6321803 0.004835806
##                             Robust z
## (Intercept)               -5.3433339
## coastal.distance2         -0.2418217
## coastal.distance3         -1.3345951
## scale(popdensity)         -0.3545459
## scale(poverty)            -0.2986225
## scale(log(median_income)) -1.4423009
## scale(pct_obesity)        -1.7669203
## scale(voter_margin_2020)   2.4776631
## scale(median_age)         -2.1238525
## factor(party)Republican   -0.3172456
## mean_pm25                  2.8381957
## mean_summer_rm            -0.4344630
## mean_winter_rm            -2.6463325
```

```r
# Model deaths
model.initial.deaths = gee(deaths ~ coastal.distance + offset(log(population2019)) +
    scale(popdensity) + scale(poverty) + scale(log(median_income)) + scale(pct_obesity) +
    scale(voter_margin_2020) + scale(median_age) + factor(party) + mean_pm25 +
    mean_summer_rm + mean_winter_rm, family = poisson(link = "log"), data = coastal.only,
    id = as.factor(state))
```

```
## Beginning Cgee S-function, @(#) geeformula.q 4.13 98/01/27
## running glm to get initial regression estimate
```

```
##               (Intercept)         coastal.distance2         coastal.distance3
##              -5.212192182               0.086454400               0.066194187
##         scale(popdensity)            scale(poverty) scale(log(median_income))
##               0.010520519               0.217726126               0.018070364
##        scale(pct_obesity)  scale(voter_margin_2020)         scale(median_age)
##              -0.016660883               0.062220236               0.190298559
##   factor(party)Republican                 mean_pm25            mean_summer_rm
##              -0.082366443               0.074815247               0.006357866
##            mean_winter_rm
##              -0.026837688
```

```r
summary(model.initial.deaths)$coefficients
```

```
##                                Estimate  Naive S.E.     Naive z Robust S.E.
## (Intercept)                -5.212192182 0.206333208 -25.2610437 0.374365953
## coastal.distance2           0.086454400 0.035850269   2.4115412 0.051926963
## coastal.distance3           0.066194187 0.047433875   1.3955045 0.064277866
## scale(popdensity)           0.010520519 0.010313949   1.0200282 0.022938314
## scale(poverty)              0.217726126 0.040977749   5.3132768 0.094003664
## scale(log(median_income))   0.018070364 0.039054710   0.4626936 0.078896092
## scale(pct_obesity)         -0.016660883 0.020358895  -0.8183589 0.037055088
## scale(voter_margin_2020)    0.062220236 0.027210734   2.2866063 0.048132318
## scale(median_age)           0.190298559 0.024290431   7.8343014 0.022143582
## factor(party)Republican    -0.082366443 0.051543069  -1.5980120 0.063807959
## mean_pm25                   0.074815248 0.009605103   7.7891142 0.023049458
## mean_summer_rm              0.006357866 0.001905080   3.3373219 0.004918870
## mean_winter_rm             -0.026837688 0.002773013  -9.6781704 0.007754542
##                                Robust z
## (Intercept)                -13.9227196
## coastal.distance2            1.6649231
## coastal.distance3            1.0298131
## scale(popdensity)            0.4586439
## scale(poverty)               2.3161451
## scale(log(median_income))    0.2290400
## scale(pct_obesity)          -0.4496247
## scale(voter_margin_2020)     1.2926914
## scale(median_age)            8.5938471
## factor(party)Republican     -1.2908491
## mean_pm25                    3.2458572
## mean_summer_rm               1.2925460
## mean_winter_rm              -3.4608992
```

```
##### Repeat above, - humidity ###### Model cases
model.initial.cases.nohumidity = gee(cases ~ coastal.distance + offset(log(population2019)) +
    scale(popdensity) + scale(poverty) + scale(log(median_income)) + scale(pct_obesity) +
    scale(voter_margin_2020) + scale(median_age) + factor(party) + mean_pm25,
    family = poisson(link = "log"), data = coastal.only, id = as.factor(state))
```

```
## Beginning Cgee S-function, @(#) geeformula.q 4.13 98/01/27
## running glm to get initial regression estimate

##               (Intercept)         coastal.distance2         coastal.distance3
##             -2.9702526710              0.0003152536             -0.0033867427
##         scale(popdensity)            scale(poverty) scale(log(median_income))
##             -0.0098893337              0.0019116678             -0.0964438865
##        scale(pct_obesity)  scale(voter_margin_2020)         scale(median_age)
##             -0.1315778859              0.0976526723             -0.1100270831
##   factor(party)Republican                 mean_pm25
##             -0.0127519414              0.0601696977
```

```
summary(model.initial.cases.nohumidity)$coefficients
```

```
##                               Estimate  Naive S.E.      Naive z Robust S.E.
## (Intercept)               -2.9702526710 0.067746367 -43.84371888  0.21481827
## coastal.distance2          0.0003152536 0.027423227   0.01149586  0.04585919
## coastal.distance3         -0.0033867427 0.035497804  -0.09540711  0.05654169
## scale(popdensity)         -0.0098893337 0.008576404  -1.15308628  0.01999667
## scale(poverty)             0.0019116678 0.031872139   0.05997927  0.08874663
## scale(log(median_income)) -0.0964438865 0.029671707  -3.25036533  0.10610851
## scale(pct_obesity)        -0.1315778859 0.015307367  -8.59572297  0.02849082
## scale(voter_margin_2020)   0.0976526723 0.021172066   4.61233552  0.06101117
## scale(median_age)         -0.1100270831 0.017400638  -6.32316373  0.04597389
## factor(party)Republican   -0.0127519414 0.039260917  -0.32479989  0.07432528
## mean_pm25                  0.0601696977 0.006499028   9.25826161  0.02046223
##                               Robust z
## (Intercept)               -13.826815719
## coastal.distance2           0.006874382
## coastal.distance3          -0.059898151
## scale(popdensity)          -0.494549117
## scale(poverty)              0.021540737
## scale(log(median_income))  -0.908917510
## scale(pct_obesity)         -4.618255290
## scale(voter_margin_2020)    1.600570380
## scale(median_age)          -2.393251476
## factor(party)Republican    -0.171569372
## mean_pm25                   2.940525028
```

```
# Model deaths
model.initial.deaths.nohumidity = gee(deaths ~ coastal.distance + offset(log(population2019)) +
    scale(popdensity) + scale(poverty) + scale(log(median_income)) + scale(pct_obesity) +
    scale(voter_margin_2020) + scale(median_age) + factor(party) + mean_pm25,
    family = poisson(link = "log"), data = coastal.only, id = as.factor(state))
```

```
## Beginning Cgee S-function, @(#) geeformula.q 4.13 98/01/27
## running glm to get initial regression estimate
```

```
##               (Intercept)         coastal.distance2         coastal.distance3
##             -7.270084241               0.073984550               0.089801376
##         scale(popdensity)            scale(poverty) scale(log(median_income))
##               0.001520705               0.279667961               0.086807996
##        scale(pct_obesity)  scale(voter_margin_2020)         scale(median_age)
##             -0.053282240               0.042709432               0.175395994
##   factor(party)Republican                 mean_pm25
##             -0.072869688               0.103936577
```

```
summary(model.initial.deaths.nohumidity)$coefficients
```

```
##                               Estimate  Naive S.E.     Naive z Robust S.E.
## (Intercept)               -7.270084241 0.098172637 -74.0540792  0.25252352
## coastal.distance2          0.073984550 0.039062967   1.8939819  0.05517380
## coastal.distance3          0.089801376 0.050653543   1.7728548  0.05689974
## scale(popdensity)          0.001520705 0.011223474   0.1354932  0.03258369
## scale(poverty)             0.279667961 0.043856076   6.3769491  0.10926278
## scale(log(median_income))  0.086807996 0.041632648   2.0850943  0.13350163
## scale(pct_obesity)        -0.053282240 0.021460562  -2.4827980  0.04097083
## scale(voter_margin_2020)   0.042709432 0.029472397   1.4491333  0.06040924
## scale(median_age)          0.175395994 0.024790619   7.0750955  0.04837195
## factor(party)Republican   -0.072869688 0.056298683  -1.2943409  0.07546056
## mean_pm25                  0.103936577 0.009443543  11.0060999  0.02457496
##                               Robust z
## (Intercept)               -28.78973112
## coastal.distance2           1.34093625
## coastal.distance3           1.57823878
## scale(popdensity)           0.04667073
## scale(poverty)              2.55959038
## scale(log(median_income))   0.65023920
## scale(pct_obesity)         -1.30049214
## scale(voter_margin_2020)    0.70700164
## scale(median_age)           3.62598580
## factor(party)Republican    -0.96566589
## mean_pm25                   4.22936841
```

Same Analysis with Our Additional Confounders

```
model.indicator.cases.addconfounders = gee(cases ~  indicatorcoast + offset(log(population2019)) + scale
                              + scale(log(median_house_value)) + scale(owner_occupied)
                              + scale(blk_pct) + scale(hispanic_pct)
                              + scale(native_pct) + scale(asian_pct)
                              + scale(date_since_social) + scale(date_since)
                              + scale(beds/population.old) + scale(smoke)
                              + scale(mean_pm25)
                              + scale(mean_summer_rm) + scale(mean_winter_rm)
                              + scale(mean_summer_temp) + scale(mean_winter_temp)
                              + scale(no_grad), family = poisson(link = "log"),
                              data = coastal.new, id = as.factor(state))
```

```
## Beginning Cgee S-function, @(#) geeformula.q 4.13 98/01/27

## running glm to get initial regression estimate

##                     (Intercept)          indicatorcoastCoastal
##                    -2.371907184                    0.069505331
##              scale(popdensity)                 scale(poverty)
##                    -0.008832605                   -0.063809862
##      scale(log(median_income))             scale(pct_obesity)
##                    -0.094909282                   -0.042286415
##       scale(voter_margin_2020)              scale(median_age)
##                     0.194935200                   -0.036895118
##        factor(party)Republican scale(log(median_house_value))
##                    -0.013310950                    0.106644914
##          scale(owner_occupied)                 scale(blk_pct)
##                    -0.014010961                    0.109218708
##            scale(hispanic_pct)              scale(native_pct)
##                     0.135786496                    0.085715334
##               scale(asian_pct)       scale(date_since_social)
##                    -0.011112411                    0.007096280
##              scale(date_since)     scale(beds/population.old)
##                     0.014151267                    0.055855223
##                    scale(smoke)               scale(mean_pm25)
##                     0.023863721                    0.064980312
##          scale(mean_summer_rm)          scale(mean_winter_rm)
##                     0.011578980                   -0.019715252
##        scale(mean_summer_temp)        scale(mean_winter_temp)
##                     0.118165044                   -0.175594732
##                  scale(no_grad)
##                     0.006501935
```

```
model.indicator.deaths.addconfounders = gee(deaths ~  indicatorcoast + offset(log(population2019)) + sca
                              + scale(log(median_house_value)) + scale(owner_occupied)
                              + scale(blk_pct) + scale(hispanic_pct)
                              + scale(native_pct) + scale(asian_pct)
                              + scale(date_since_social) + scale(date_since)
                              + scale(beds/population.old) + scale(smoke)
                              + scale(mean_pm25)
```

```
                              + scale(mean_summer_rm) + scale(mean_winter_rm)
                              + scale(mean_summer_temp) + scale(mean_winter_temp)
                              + scale(no_grad), family = poisson(link = "log"),
                              data = coastal.new, id = as.factor(state))
```

```
## Beginning Cgee S-function, @(#) geeformula.q 4.13 98/01/27
## running glm to get initial regression estimate
```

```
##                     (Intercept)          indicatorcoastCoastal
##                    -6.280193773                    0.096188444
##               scale(popdensity)                 scale(poverty)
##                     0.007993000                    0.151269895
##      scale(log(median_income))             scale(pct_obesity)
##                    -0.014856411                   -0.009359635
##       scale(voter_margin_2020)              scale(median_age)
##                     0.192995074                    0.208846652
##        factor(party)Republican scale(log(median_house_value))
##                    -0.081470285                    0.014475400
##          scale(owner_occupied)                 scale(blk_pct)
##                     0.011987483                    0.103605257
##            scale(hispanic_pct)              scale(native_pct)
##                     0.173477374                    0.106424062
##               scale(asian_pct)       scale(date_since_social)
##                     0.012181409                    0.054941387
##              scale(date_since)     scale(beds/population.old)
##                     0.117283127                    0.091727143
##                    scale(smoke)               scale(mean_pm25)
##                    -0.025551567                    0.054163292
##          scale(mean_summer_rm)          scale(mean_winter_rm)
##                     0.088467893                   -0.095356991
##        scale(mean_summer_temp)        scale(mean_winter_temp)
##                     0.144901778                   -0.263532641
##                 scale(no_grad)
##                     0.053221693
```

```
model.byregion.cases.addconfounders = gee(cases ~  region + offset(log(population2019)) + scale(popdens
                              + scale(log(median_house_value)) + scale(owner_occupied)
                              + scale(blk_pct) + scale(hispanic_pct)
                              + scale(native_pct) + scale(asian_pct)
                              + scale(date_since_social) + scale(date_since)
                              + scale(beds/population.old) + scale(smoke)
                              + scale(mean_pm25)
                              + scale(mean_summer_rm) + scale(mean_winter_rm)
                              + scale(mean_summer_temp) + scale(mean_winter_temp)
                              + scale(no_grad), family = poisson(link = "log"),
                              data = coastal.new, id = as.factor(state))
```

```
## Beginning Cgee S-function, @(#) geeformula.q 4.13 98/01/27
## running glm to get initial regression estimate
```

```
##                     (Intercept)                 regionatlantic
##                    -2.374765478                    0.149013968
```

```
##                     regionerie          regiongreat salt lake
##                   -0.067034386                    0.357566104
##           regiongulf of mexico                    regionhuron
##                   -0.061450545                   -0.065551877
##                 regionmichigan                  regionontario
##                    0.051681838                   -0.053900228
##                  regionpacific                 regionsuperior
##                    0.139138902                    0.167915524
##              scale(popdensity)                scale(poverty)
##                   -0.009727410                   -0.051152015
##      scale(log(median_income))             scale(pct_obesity)
##                   -0.064089730                   -0.046162102
##       scale(voter_margin_2020)              scale(median_age)
##                    0.188191092                   -0.027506238
##        factor(party)Republican scale(log(median_house_value))
##                   -0.004790626                    0.060648780
##          scale(owner_occupied)                 scale(blk_pct)
##                   -0.023912618                    0.102880047
##            scale(hispanic_pct)              scale(native_pct)
##                    0.139176991                    0.084174906
##               scale(asian_pct)       scale(date_since_social)
##                   -0.010316208                    0.013132115
##              scale(date_since)     scale(beds/population.old)
##                    0.022399450                    0.054403197
##                   scale(smoke)               scale(mean_pm25)
##                    0.026985128                    0.067803618
##          scale(mean_summer_rm)          scale(mean_winter_rm)
##                    0.013426780                   -0.017080450
##        scale(mean_summer_temp)        scale(mean_winter_temp)
##                    0.126576438                   -0.178034773
##                 scale(no_grad)
##                    0.002631247
```

```
model.byregion.deaths.addconfounders = gee(deaths ~  region + offset(log(population2019)) + scale(popde
                              + scale(log(median_house_value)) + scale(owner_occupied)
                              + scale(blk_pct) + scale(hispanic_pct)
                              + scale(native_pct) + scale(asian_pct)
                              + scale(date_since_social) + scale(date_since)
                              + scale(beds/population.old) + scale(smoke)
                              + scale(mean_pm25)
                              + scale(mean_summer_rm) + scale(mean_winter_rm)
                              + scale(mean_summer_temp) + scale(mean_winter_temp)
                              + scale(no_grad), family = poisson(link = "log"),
                              data = coastal.new, id = as.factor(state))
```

```
## Beginning Cgee S-function, @(#) geeformula.q 4.13 98/01/27
## running glm to get initial regression estimate
```

```
##                     (Intercept)                 regionatlantic
##                   -6.287729677                    0.213707074
##                     regionerie          regiongreat salt lake
##                    0.034835495                   -0.284628176
##           regiongulf of mexico                    regionhuron
```

```
##                   0.050532478                   0.126361711
##                regionmichigan                 regionontario
##                  -0.054651462                  -0.138755118
##                 regionpacific                regionsuperior
##                   0.147816341                  -0.018802653
##             scale(popdensity)                scale(poverty)
##                   0.008197462                   0.149940250
##     scale(log(median_income))             scale(pct_obesity)
##                  -0.012355809                  -0.012228681
##      scale(voter_margin_2020)              scale(median_age)
##                   0.180749772                   0.202219990
##       factor(party)Republican scale(log(median_house_value))
##                  -0.071785558                  -0.019275798
##         scale(owner_occupied)                 scale(blk_pct)
##                   0.014630195                   0.098552187
##           scale(hispanic_pct)              scale(native_pct)
##                   0.166191560                   0.104265827
##              scale(asian_pct)       scale(date_since_social)
##                   0.011253187                   0.050595336
##             scale(date_since)     scale(beds/population.old)
##                   0.121647855                   0.090912307
##                  scale(smoke)                scale(mean_pm25)
##                  -0.037866405                   0.075246388
##         scale(mean_summer_rm)          scale(mean_winter_rm)
##                   0.060729972                  -0.080111207
##       scale(mean_summer_temp)        scale(mean_winter_temp)
##                   0.141129943                  -0.262576119
##                scale(no_grad)
##                   0.054425931
```

```
# - humidity
model.indicator.cases.nohumidity.addconfounders = gee(cases ~  indicatorcoast + offset(log(population20
                              + scale(log(median_house_value)) + scale(owner_occupied)
                              + scale(blk_pct) + scale(hispanic_pct)
                              + scale(native_pct) + scale(asian_pct)
                              + scale(date_since_social) + scale(date_since)
                              + scale(beds/population.old) + scale(smoke)
                              + scale(mean_pm25)
                              #+ scale(mean_summer_rm) + scale(mean_winter_rm)
                              + scale(mean_summer_temp) + scale(mean_winter_temp)
                              + scale(no_grad), family = poisson(link = "log"),
                              data = coastal.new, id = as.factor(state))
```

```
## Beginning Cgee S-function, @(#) geeformula.q 4.13 98/01/27
## running glm to get initial regression estimate
```

```
##                   (Intercept)          indicatorcoastCoastal
##                  -2.368417328                   0.066313119
##             scale(popdensity)                scale(poverty)
##                  -0.008055437                  -0.062167996
##     scale(log(median_income))             scale(pct_obesity)
##                  -0.100894153                  -0.042405229
##      scale(voter_margin_2020)              scale(median_age)
```

```
##                   0.196211225                   -0.032587132
##       factor(party)Republican scale(log(median_house_value))
##                  -0.017229835                    0.125446163
##         scale(owner_occupied)                 scale(blk_pct)
##                  -0.013604351                    0.111358031
##           scale(hispanic_pct)              scale(native_pct)
##                   0.133832495                    0.085405385
##              scale(asian_pct)       scale(date_since_social)
##                  -0.011477723                    0.006494461
##             scale(date_since)     scale(beds/population.old)
##                   0.013692188                    0.055423862
##                  scale(smoke)               scale(mean_pm25)
##                   0.024720478                    0.068891003
##       scale(mean_summer_temp)        scale(mean_winter_temp)
##                   0.134940116                   -0.183872566
##                scale(no_grad)
##                   0.011315760
```

```
model.indicator.deaths.nohumidity.addconfounders = gee(deaths ~  indicatorcoast + offset(log(population
                              + scale(log(median_house_value)) + scale(owner_occupied)
                              + scale(blk_pct) + scale(hispanic_pct)
                              + scale(native_pct) + scale(asian_pct)
                              + scale(date_since_social) + scale(date_since)
                              + scale(beds/population.old) + scale(smoke)
                              + scale(mean_pm25)
                              #+ scale(mean_summer_rm) + scale(mean_winter_rm)
                              + scale(mean_summer_temp) + scale(mean_winter_temp)
                              + scale(no_grad), family = poisson(link = "log"),  data = coastal.new, id
```

```
## Beginning Cgee S-function, @(#) geeformula.q 4.13 98/01/27
## running glm to get initial regression estimate
```

```
##                   (Intercept)          indicatorcoastCoastal
##                  -6.264977465                    0.081326307
##              scale(popdensity)                 scale(poverty)
##                   0.011478207                    0.158613959
##      scale(log(median_income))             scale(pct_obesity)
##                  -0.032714970                   -0.010130927
##       scale(voter_margin_2020)              scale(median_age)
##                   0.200082665                    0.225070077
##       factor(party)Republican scale(log(median_house_value))
##                  -0.094245191                    0.088731580
##         scale(owner_occupied)                 scale(blk_pct)
##                   0.020919991                    0.122842281
##           scale(hispanic_pct)              scale(native_pct)
##                   0.160193043                    0.103320122
##              scale(asian_pct)       scale(date_since_social)
##                   0.007496189                    0.038495278
##             scale(date_since)     scale(beds/population.old)
##                   0.108140245                    0.092261422
##                  scale(smoke)               scale(mean_pm25)
##                  -0.018575522                    0.090596715
##       scale(mean_summer_temp)        scale(mean_winter_temp)
```

```
##                     0.185052697                    -0.272356573
##                  scale(no_grad)
##                     0.072771702
```

```
model.byregion.cases.nohumidity.addconfounders = gee(cases ~  region + offset(log(population2019)) + sca
                              + scale(log(median_house_value)) + scale(owner_occupied)
                              + scale(blk_pct) + scale(hispanic_pct)
                              + scale(native_pct) + scale(asian_pct)
                              + scale(date_since_social) + scale(date_since)
                              + scale(beds/population.old) + scale(smoke)
                              + scale(mean_pm25)
                              #+ scale(mean_summer_rm) + scale(mean_winter_rm)
                              + scale(mean_summer_temp) + scale(mean_winter_temp)
                              + scale(no_grad), family = poisson(link = "log"),  data = coastal.new, id
```

```
## Beginning Cgee S-function, @(#) geeformula.q 4.13 98/01/27
## running glm to get initial regression estimate
```

```
##                     (Intercept)                 regionatlantic
##                    -2.372201790                    0.153720470
##                      regionerie          regiongreat salt lake
##                    -0.068157621                    0.307114064
##           regiongulf of mexico                     regionhuron
##                    -0.069103861                   -0.069298350
##                  regionmichigan                  regionontario
##                     0.038021234                   -0.045985419
##                   regionpacific                 regionsuperior
##                     0.155290419                    0.175553393
##               scale(popdensity)                 scale(poverty)
##                    -0.008585543                   -0.049553626
##      scale(log(median_income))              scale(pct_obesity)
##                    -0.067107735                   -0.047038242
##       scale(voter_margin_2020)               scale(median_age)
##                     0.188922232                    -0.024978939
##        factor(party)Republican scale(log(median_house_value))
##                    -0.007622346                    0.071719372
##          scale(owner_occupied)                  scale(blk_pct)
##                    -0.021816116                    0.105748969
##            scale(hispanic_pct)                scale(native_pct)
##                     0.137147092                    0.083526423
##                scale(asian_pct)        scale(date_since_social)
##                    -0.011738785                    0.011009941
##               scale(date_since)     scale(beds/population.old)
##                     0.022951355                    0.054374360
##                   scale(smoke)                scale(mean_pm25)
##                     0.027325861                    0.073602238
##         scale(mean_summer_temp)         scale(mean_winter_temp)
##                     0.139623871                   -0.184241381
##                   scale(no_grad)
##                     0.005380132
```

```
model.byregion.deaths.nohumidity.addconfounders = gee(deaths ~  region + offset(log(population2019)) + s
                              + scale(log(median_house_value)) + scale(owner_occupied)
                              + scale(blk_pct) + scale(hispanic_pct)
                              + scale(native_pct) + scale(asian_pct)
                              + scale(date_since_social) + scale(date_since)
                              + scale(beds/population.old) + scale(smoke)
                              + scale(mean_pm25)
                              #+ scale(mean_summer_rm) + scale(mean_winter_rm)
                              + scale(mean_summer_temp) + scale(mean_winter_temp)
                              + scale(no_grad), family = poisson(link = "log"),  data = coastal.new, id
```

```
## Beginning Cgee S-function, @(#) geeformula.q 4.13 98/01/27
## running glm to get initial regression estimate

##                     (Intercept)                 regionatlantic
##                    -6.273003638                    0.238420046
##                      regionerie          regiongreat salt lake
##                     0.029446140                   -0.515130281
##           regiongulf of mexico                     regionhuron
##                     0.012526260                    0.102360233
##                  regionmichigan                  regionontario
##                    -0.124433479                   -0.105878025
##                  regionpacific                 regionsuperior
##                     0.220978449                    0.005865810
##              scale(popdensity)                 scale(poverty)
##                     0.013639091                    0.156246391
##      scale(log(median_income))              scale(pct_obesity)
##                    -0.028673808                   -0.016165418
##       scale(voter_margin_2020)               scale(median_age)
##                     0.184319882                    0.213318851
##        factor(party)Republican scale(log(median_house_value))
##                    -0.083288137                    0.033995028
##          scale(owner_occupied)                  scale(blk_pct)
##                     0.023149186                    0.110086855
##            scale(hispanic_pct)               scale(native_pct)
##                     0.155032315                    0.102287991
##               scale(asian_pct)       scale(date_since_social)
##                     0.005141916                    0.042287518
##              scale(date_since)     scale(beds/population.old)
##                     0.122736767                    0.091092401
##                    scale(smoke)                scale(mean_pm25)
##                    -0.039023110                    0.099716405
##        scale(mean_summer_temp)         scale(mean_winter_temp)
##                     0.204289306                   -0.295777227
##                  scale(no_grad)
##                     0.071878661
```

```
# Analysis by region, rural/urban split
model.byregionru.cases.addconfounders = gee(cases ~  regionru + offset(log(population2019)) + scale(popo
                              + scale(log(median_house_value)) + scale(owner_occupied)
                              + scale(blk_pct) + scale(hispanic_pct)
                              + scale(native_pct) + scale(asian_pct)
                              + scale(date_since_social) + scale(date_since)
```

```
                              + scale(beds/population.old) + scale(smoke)
                              + scale(mean_pm25)
                              + scale(mean_summer_rm) + scale(mean_winter_rm)
                              + scale(mean_summer_temp) + scale(mean_winter_temp)
                              + scale(no_grad), family = poisson(link = "log"),  data = coastal.new, id
```

```
## Beginning Cgee S-function, @(#) geeformula.q 4.13 98/01/27
## running glm to get initial regression estimate

##                     (Intercept)         regionruatlantic Rural
##                    -2.341028128                    0.128319274
##         regionruatlantic Urban             regionruerie Rural
##                     0.224400660                   -0.002114276
##             regionruerie Urban  regionrugreat salt lake Rural
##                    -0.141026360                    0.335204713
##   regionrugulf of mexico Rural   regionrugulf of mexico Urban
##                     0.029560835                   -0.214796875
##             regionruhuron Rural         regionrumichigan Rural
##                    -0.071246166                    0.077053066
##         regionrumichigan Urban          regionruontario Rural
##                     0.074950100                   -0.078422279
##          regionrupacific Rural          regionrupacific Urban
##                     0.026999959                    0.337274992
##         regionrusuperior Rural              scale(popdensity)
##                     0.120863473                   -0.010770944
##                scale(poverty)      scale(log(median_income))
##                    -0.045307477                   -0.039355554
##             scale(pct_obesity)       scale(voter_margin_2020)
##                    -0.048553912                    0.188179950
##              scale(median_age)        factor(party)Republican
##                    -0.029000809                   -0.038950838
## scale(log(median_house_value))          scale(owner_occupied)
##                     0.041565666                   -0.025340309
##                scale(blk_pct)            scale(hispanic_pct)
##                     0.107504720                    0.130343570
##              scale(native_pct)               scale(asian_pct)
##                     0.078053688                   -0.016365761
##       scale(date_since_social)              scale(date_since)
##                     0.012524300                    0.029051840
##     scale(beds/population.old)                   scale(smoke)
##                     0.048580493                    0.028604789
##               scale(mean_pm25)          scale(mean_summer_rm)
##                     0.046946721                    0.014471103
##          scale(mean_winter_rm)        scale(mean_summer_temp)
##                    -0.007411228                    0.144163092
##        scale(mean_winter_temp)                 scale(no_grad)
##                    -0.186964655                    0.007052864
```

```
model.byregionru.deaths.addconfounders = gee(deaths ~  regionru + offset(log(population2019)) + scale(p
                              + scale(log(median_house_value)) + scale(owner_occupied)
                              + scale(blk_pct) + scale(hispanic_pct)
                              + scale(native_pct) + scale(asian_pct)
                              + scale(date_since_social) + scale(date_since)
```

```
                              + scale(beds/population.old) + scale(smoke)
                              + scale(mean_pm25)
                              + scale(mean_summer_rm) + scale(mean_winter_rm)
                              + scale(mean_summer_temp) + scale(mean_winter_temp)
                              + scale(no_grad), family = poisson(link = "log"),
                              data = coastal.new, id = as.factor(state))
```

```
## Beginning Cgee S-function, @(#) geeformula.q 4.13 98/01/27
## running glm to get initial regression estimate

##                     (Intercept)         regionruatlantic Rural
##                    -6.240574732                    0.165550783
##          regionruatlantic Urban             regionruerie Rural
##                     0.332928054                    0.020533433
##              regionruerie Urban  regionrugreat salt lake Rural
##                     0.041963526                   -0.315017610
##   regionrugulf of mexico Rural   regionrugulf of mexico Urban
##                     0.175990930                   -0.191956008
##            regionruhuron Rural         regionrumichigan Rural
##                     0.116740483                   -0.069868080
##          regionrumichigan Urban          regionruontario Rural
##                     0.002020714                   -0.167313187
##           regionrupacific Rural          regionrupacific Urban
##                    -0.021035521                    0.366732047
##          regionrusuperior Rural              scale(popdensity)
##                    -0.079653157                    0.006091509
##                  scale(poverty)      scale(log(median_income))
##                     0.147420813                    0.006038178
##              scale(pct_obesity)       scale(voter_margin_2020)
##                    -0.015445207                    0.182368980
##               scale(median_age)        factor(party)Republican
##                     0.199211351                   -0.117400454
## scale(log(median_house_value))          scale(owner_occupied)
##                    -0.037691223                    0.012815341
##                  scale(blk_pct)            scale(hispanic_pct)
##                     0.102237734                    0.155182669
##               scale(native_pct)               scale(asian_pct)
##                     0.098200858                    0.004852079
##       scale(date_since_social)              scale(date_since)
##                     0.046418377                    0.131516290
##     scale(beds/population.old)                   scale(smoke)
##                     0.084105835                   -0.035526019
##                scale(mean_pm25)          scale(mean_summer_rm)
##                     0.049898786                    0.063036362
##           scale(mean_winter_rm)        scale(mean_summer_temp)
##                    -0.068464017                    0.160509375
##         scale(mean_winter_temp)                 scale(no_grad)
##                    -0.269458929                    0.058052402
```

```
model.byregionru.cases.nohumidity.addconfounders = gee(cases ~  regionru + offset(log(population2019)) +
                              + scale(log(median_house_value)) + scale(owner_occupied)
                              + scale(blk_pct) + scale(hispanic_pct)
                              + scale(native_pct) + scale(asian_pct)
```

```
                              + scale(date_since_social) + scale(date_since)
                              + scale(beds/population.old) + scale(smoke)
                              + scale(mean_pm25)
                              #+ scale(mean_summer_rm) + scale(mean_winter_rm)
                              + scale(mean_summer_temp) + scale(mean_winter_temp)
                              + scale(no_grad), family = poisson(link = "log"),
                              data = coastal.new, id = as.factor(state))
```

```
## Beginning Cgee S-function, @(#) geeformula.q 4.13 98/01/27
## running glm to get initial regression estimate

##                     (Intercept)          regionruatlantic Rural
##                     -2.342411391                     0.132066032
##          regionruatlantic Urban              regionruerie Rural
##                     0.236185468                    -0.006181541
##              regionruerie Urban  regionrugreat salt lake Rural
##                    -0.153228573                     0.283547568
##    regionrugulf of mexico Rural   regionrugulf of mexico Urban
##                     0.026245230                    -0.214017726
##             regionruhuron Rural         regionrumichigan Rural
##                    -0.070732686                     0.074183332
##          regionrumichigan Urban          regionruontario Rural
##                     0.066606592                    -0.074365131
##           regionrupacific Rural          regionrupacific Urban
##                     0.027258800                     0.338028560
##          regionrusuperior Rural              scale(popdensity)
##                     0.135315723                    -0.010906051
##                  scale(poverty)      scale(log(median_income))
##                    -0.044937613                    -0.037961211
##              scale(pct_obesity)       scale(voter_margin_2020)
##                    -0.048687360                     0.187486997
##               scale(median_age)        factor(party)Republican
##                    -0.028494452                    -0.038389031
## scale(log(median_house_value))          scale(owner_occupied)
##                     0.041338974                    -0.023157741
##                  scale(blk_pct)            scale(hispanic_pct)
##                     0.110453611                     0.128829332
##               scale(native_pct)               scale(asian_pct)
##                     0.077076786                    -0.017333941
##       scale(date_since_social)              scale(date_since)
##                     0.007881505                     0.028168465
##     scale(beds/population.old)                   scale(smoke)
##                     0.048874554                     0.030083928
##                scale(mean_pm25)        scale(mean_summer_temp)
##                     0.055135148                     0.138101155
##        scale(mean_winter_temp)                 scale(no_grad)
##                    -0.179768859                     0.006197200
```

```
model.byregionru.deaths.nohumidity.addconfounders = gee(deaths ~  regionru + offset(log(population2019))
                              + scale(log(median_house_value)) + scale(owner_occupied)
                              + scale(blk_pct) + scale(hispanic_pct)
                              + scale(native_pct) + scale(asian_pct)
                              + scale(date_since_social) + scale(date_since)
```

```
                              + scale(beds/population.old) + scale(smoke)
                              + scale(mean_pm25)
                              #+ scale(mean_summer_rm) + scale(mean_winter_rm)
                              + scale(mean_summer_temp) + scale(mean_winter_temp)
                              + scale(no_grad), family = poisson(link = "log"),
                              data = coastal.new, id = as.factor(state))
```

```
## Beginning Cgee S-function, @(#) geeformula.q 4.13 98/01/27
## running glm to get initial regression estimate

##                     (Intercept)         regionruatlantic Rural
##                   -6.2264802621                   0.1681111284
##          regionruatlantic Urban             regionruerie Rural
##                    0.4052264935                   0.0184079383
##              regionruerie Urban  regionrugreat salt lake Rural
##                    0.0169630806                  -0.5495415333
##    regionrugulf of mexico Rural   regionrugulf of mexico Urban
##                    0.1309288793                  -0.2107554243
##             regionruhuron Rural         regionrumichigan Rural
##                    0.0973041747                  -0.0990716728
##          regionrumichigan Urban          regionruontario Rural
##                   -0.0521036174                  -0.1446140177
##           regionrupacific Rural          regionrupacific Urban
##                   -0.0010872485                   0.4540779852
##          regionrusuperior Rural              scale(popdensity)
##                   -0.0525177006                   0.0085809997
##                  scale(poverty)      scale(log(median_income))
##                    0.1522234920                  -0.0001520647
##              scale(pct_obesity)       scale(voter_margin_2020)
##                   -0.0177696105                   0.1812033354
##               scale(median_age)        factor(party)Republican
##                    0.2070781202                  -0.1283401254
## scale(log(median_house_value))          scale(owner_occupied)
##                   -0.0040203267                   0.0221241611
##                  scale(blk_pct)            scale(hispanic_pct)
##                    0.1135443709                   0.1436472681
##               scale(native_pct)              scale(asian_pct)
##                    0.0939245509                  -0.0023265223
##       scale(date_since_social)              scale(date_since)
##                    0.0347726392                   0.1307472855
##     scale(beds/population.old)                    scale(smoke)
##                    0.0835037245                  -0.0333946784
##                scale(mean_pm25)        scale(mean_summer_temp)
##                    0.0745334834                   0.1959671037
##        scale(mean_winter_temp)                scale(no_grad)
##                   -0.2781440135                   0.0682756954
```

```
# Comparing 1st vs 2nd vs 3rd degree coastal counties
model.initial.cases.addconfounders = gee(cases ~  coastal.distance + offset(log(population2019)) + scal
                              + scale(log(median_house_value)) + scale(owner_occupied)
                              + scale(blk_pct) + scale(hispanic_pct)
                              + scale(native_pct) + scale(asian_pct)
                              + scale(date_since_social) + scale(date_since)
```

```
                              + scale(beds/population.old) + scale(smoke)
                              + scale(mean_pm25)
                              + scale(mean_summer_rm) + scale(mean_winter_rm)
                              + scale(mean_summer_temp) + scale(mean_winter_temp)
                              + scale(no_grad), family = poisson(link = "log"),
                              data = coastal.only, id = as.factor(state))
```

```
## Beginning Cgee S-function, @(#) geeformula.q 4.13 98/01/27
## running glm to get initial regression estimate
```

```
##                     (Intercept)              coastal.distance2
##                   -2.4957075279                  -0.0292151243
##               coastal.distance3              scale(popdensity)
##                   -0.0789262050                  -0.0093441258
##                  scale(poverty)      scale(log(median_income))
##                   -0.0913772119                  -0.1031229382
##              scale(pct_obesity)       scale(voter_margin_2020)
##                   -0.1050521191                   0.2294241707
##               scale(median_age)        factor(party)Republican
##                   -0.0310354005                   0.0079930609
## scale(log(median_house_value))          scale(owner_occupied)
##                    0.1132619984                   0.0070077727
##                  scale(blk_pct)            scale(hispanic_pct)
##                    0.1912994358                   0.2003264094
##               scale(native_pct)               scale(asian_pct)
##                    0.0368908203                  -0.0284749606
##       scale(date_since_social)              scale(date_since)
##                    0.0337083641                   0.0328952534
##     scale(beds/population.old)                    scale(smoke)
##                    0.0791187609                   0.0216443222
##                scale(mean_pm25)          scale(mean_summer_rm)
##                    0.0488922100                  -0.0007651958
##           scale(mean_winter_rm)        scale(mean_summer_temp)
##                   -0.0271656525                   0.0634054020
##         scale(mean_winter_temp)                 scale(no_grad)
##                   -0.1951459956                   0.0156212781
```

```
model.initial.deaths.addconfounders = gee(deaths ~  coastal.distance + offset(log(population2019)) + sca
                              + scale(log(median_house_value)) + scale(owner_occupied)
                              + scale(blk_pct) + scale(hispanic_pct)
                              + scale(native_pct) + scale(asian_pct)
                              + scale(date_since_social) + scale(date_since)
                              + scale(beds/population.old) + scale(smoke)
                              + scale(mean_pm25)
                              + scale(mean_summer_rm) + scale(mean_winter_rm)
                              + scale(mean_summer_temp) + scale(mean_winter_temp)
                              + scale(no_grad), family = poisson(link = "log"),
                              data = coastal.only, id = as.factor(state))
```

```
## Beginning Cgee S-function, @(#) geeformula.q 4.13 98/01/27
## running glm to get initial regression estimate
```

```
##                     (Intercept)              coastal.distance2
##                    -6.458572836                    0.011349633
##              coastal.distance3              scale(popdensity)
##                     0.006236538                    0.001238300
##                  scale(poverty)      scale(log(median_income))
##                     0.128576676                   -0.009236889
##             scale(pct_obesity)       scale(voter_margin_2020)
##                    -0.059507154                    0.091785028
##              scale(median_age)        factor(party)Republican
##                     0.257317605                   -0.038119936
## scale(log(median_house_value))          scale(owner_occupied)
##                     0.076324915                    0.010523486
##                  scale(blk_pct)            scale(hispanic_pct)
##                     0.015647765                    0.145440364
##              scale(native_pct)               scale(asian_pct)
##                    -0.134162633                    0.011691318
##       scale(date_since_social)              scale(date_since)
##                     0.040664331                    0.170520296
##     scale(beds/population.old)                   scale(smoke)
##                     0.082241374                    0.064753788
##                scale(mean_pm25)          scale(mean_summer_rm)
##                     0.047772363                    0.156316559
##           scale(mean_winter_rm)        scale(mean_summer_temp)
##                    -0.140165596                    0.166348377
##        scale(mean_winter_temp)                 scale(no_grad)
##                    -0.353019060                    0.166170265
```

```
model.initial.cases.nohumidity.addconfounders = gee(cases ~  coastal.distance + offset(log(population20
                              + scale(log(median_house_value)) + scale(owner_occupied)
                              + scale(blk_pct) + scale(hispanic_pct)
                              + scale(native_pct) + scale(asian_pct)
                              + scale(date_since_social) + scale(date_since)
                              + scale(beds/population.old) + scale(smoke)
                              + scale(mean_pm25)
                              #+ scale(mean_summer_rm) + scale(mean_winter_rm)
                              + scale(mean_summer_temp) + scale(mean_winter_temp)
                              + scale(no_grad), family = poisson(link = "log"),
                              data = coastal.only, id = as.factor(state))
```

```
## Beginning Cgee S-function, @(#) geeformula.q 4.13 98/01/27
## running glm to get initial regression estimate
```

```
##                     (Intercept)              coastal.distance2
##                    -2.487489833                   -0.035104556
##              coastal.distance3              scale(popdensity)
##                    -0.082942058                   -0.006977331
##                  scale(poverty)      scale(log(median_income))
##                    -0.090918542                   -0.135218457
##             scale(pct_obesity)       scale(voter_margin_2020)
##                    -0.103980079                    0.229737583
##              scale(median_age)        factor(party)Republican
##                    -0.036882192                    0.001076219
## scale(log(median_house_value))          scale(owner_occupied)
```

```
##                    0.169618804                    0.011742606
##                 scale(blk_pct)            scale(hispanic_pct)
##                    0.186479517                    0.188036237
##              scale(native_pct)               scale(asian_pct)
##                    0.038846529                   -0.026552738
##       scale(date_since_social)              scale(date_since)
##                    0.034697056                    0.037601639
##     scale(beds/population.old)                   scale(smoke)
##                    0.078073594                    0.019746904
##               scale(mean_pm25)        scale(mean_summer_temp)
##                    0.046484046                    0.107754440
##        scale(mean_winter_temp)                 scale(no_grad)
##                   -0.229149544                    0.030753899
```

```
model.initial.deaths.nohumidity.addconfounders = gee(deaths ~  coastal.distance + offset(log(population
                              + scale(log(median_house_value)) + scale(owner_occupied)
                              + scale(blk_pct) + scale(hispanic_pct)
                              + scale(native_pct) + scale(asian_pct)
                              + scale(date_since_social) + scale(date_since)
                              + scale(beds/population.old) + scale(smoke)
                              + scale(mean_pm25)
                              #+ scale(mean_summer_rm) + scale(mean_winter_rm)
                              + scale(mean_summer_temp) + scale(mean_winter_temp)
                              + scale(no_grad), family = poisson(link = "log"),
                              data = coastal.only, id = as.factor(state))
```

```
## Beginning Cgee S-function, @(#) geeformula.q 4.13 98/01/27
## running glm to get initial regression estimate
```

```
##                    (Intercept)              coastal.distance2
##                   -6.428753144                    0.021370263
##              coastal.distance3              scale(popdensity)
##                   -0.022103317                    0.003846140
##                 scale(poverty)      scale(log(median_income))
##                    0.173327305                    0.003000765
##             scale(pct_obesity)       scale(voter_margin_2020)
##                   -0.044772637                    0.119265664
##              scale(median_age)        factor(party)Republican
##                    0.301506896                   -0.080451936
## scale(log(median_house_value))          scale(owner_occupied)
##                    0.230215751                    0.025071364
##                 scale(blk_pct)            scale(hispanic_pct)
##                    0.055792826                    0.121955363
##              scale(native_pct)               scale(asian_pct)
##                   -0.141483857                   -0.004328673
##       scale(date_since_social)              scale(date_since)
##                   -0.007977171                    0.130713190
##     scale(beds/population.old)                   scale(smoke)
##                    0.082548377                    0.115477881
##               scale(mean_pm25)        scale(mean_summer_temp)
##                    0.110867830                    0.184791512
##        scale(mean_winter_temp)                 scale(no_grad)
##                   -0.343074843                    0.168593542
```

Print tables

```
# Run each line individually not all at once
tab_model(model.indicator.cases, model.indicator.cases.nohumidity, robust = T,
    digits = 3, dv.labels = c("Cases (Humidity +)", "Cases (Humidity -)"))
tab_model(model.indicator.deaths, model.indicator.deaths.nohumidity, robust = T,
    digits = 3, dv.labels = c("Deaths (Humidity +)", "Deaths (Humidity -)"))

tab_model(model.byregion.cases, model.byregion.cases.nohumidity, robust = T,
    digits = 3, dv.labels = c("Cases (Humidity +)", "Cases (Humidity -)"))
tab_model(model.byregion.deaths, model.byregion.deaths.nohumidity, robust = T,
    digits = 3, dv.labels = c("Deaths (Humidity +)", "Deaths (Humidity -)"))

tab_model(model.byregionru.cases, model.byregionru.cases.nohumidity, robust = T,
    digits = 3, dv.labels = c("Cases (Humidity +)", "Cases (Humidity -)"))
tab_model(model.byregionru.deaths, model.byregionru.deaths.nohumidity,
    robust = T, digits = 3, dv.labels = c("Deaths (Humidity +)", "Deaths (Humidity -)"))

tab_model(model.initial.cases, model.initial.cases.nohumidity, robust = T,
    digits = 3, dv.labels = c("Cases (Humidity +)", "Cases (Humidity -)"))
tab_model(model.initial.deaths, model.initial.deaths.nohumidity, robust = T,
    digits = 3, dv.labels = c("Deaths (Humidity +)", "Deaths (Humidity -)"))

## Add additional confounders
tab_model(model.indicator.cases.addconfounders, model.indicator.cases.nohumidity.addconfounders,
    robust = T, digits = 3, dv.labels = c("Cases (Humidity +)", "Cases (Humidity -)"))
tab_model(model.indicator.deaths.addconfounders, model.indicator.deaths.nohumidity.addconfounders,
    robust = T, digits = 3, dv.labels = c("Deaths (Humidity +)", "Deaths (Humidity -)"))

tab_model(model.byregion.cases.addconfounders, model.byregion.cases.nohumidity.addconfounders,
    robust = T, digits = 3, dv.labels = c("Cases (Humidity +)", "Cases (Humidity -)"))
tab_model(model.byregion.deaths.addconfounders, model.byregion.deaths.nohumidity.addconfounders,
    robust = T, digits = 3, dv.labels = c("Deaths (Humidity +)", "Deaths (Humidity -)"))

tab_model(model.byregionru.cases.addconfounders, model.byregionru.cases.nohumidity.addconfounders,
    robust = T, digits = 3, dv.labels = c("Cases (Humidity +)", "Cases (Humidity -)"))
tab_model(model.byregionru.deaths.addconfounders, model.byregionru.deaths.nohumidity.addconfounders,
    robust = T, digits = 3, dv.labels = c("Deaths (Humidity +)", "Deaths (Humidity -)"))

tab_model(model.initial.cases.addconfounders, model.initial.cases.nohumidity.addconfounders,
    robust = T, digits = 3, dv.labels = c("Cases (Humidity +)", "Cases (Humidity -)"))
tab_model(model.initial.deaths.addconfounders, model.initial.deaths.nohumidity.addconfounders,
    robust = T, digits = 3, dv.labels = c("Deaths (Humidity +)", "Deaths (Humidity -)"))
```