

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)
```

```
## Install package "strengjacke" from GitHub ('devtools::install_github("strengjacke/strengjacke")')
```

```
library(sjmisc)
```

```
## Learn more about sjmisc with 'browseVignettes("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, coastal.new$under18poverty,
  log(coastal.new$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[, 25], decreasing = T)) #correlation of confounders with casera
```

##	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.under18poverty	0.138829088
## 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[, 26], decreasing = T)) #correlation of confounders with death
```

##	corr_deathrate
----	----------------

```
## coastal.new.deathrate 1.000000000
## coastal.new.caserate 0.475465559
## coastal.new.under18poverty 0.351272725
## 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.under18poverty -0.14725745
## 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
```



```
# 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
```

```
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
```

```
##### 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
## regionruhurion 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
## regionruhurion 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
## regionruhurion 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
## regionruhurion 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
## regionruhurion 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
##      regionruhurion 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
## regionruhurion 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
## regionruhurion 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
## regionruhurion 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.   :    0.30  
## 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

```

```
# 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
```

```
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
```

```
# 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
```

```
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(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)) + 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(popden
      + 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.addconfounders.nohumidity = 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.addconfounders.nohumidity = 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.addconfounders.nohumidity = gee(cases ~ region + 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
```

```
## 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.addconfounders.nohumidity = gee(deaths ~ region + 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

```

```

## 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(popu
+ 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
##      regionruhurion 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
##          regionruhurion 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.addconfounders.nohumidity = 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
##      regionruhurion 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.addconfounders.nohumidity = 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
##          regionruhurion 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)) + 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.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)) + 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), 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
##          36790.85021          -9646.62749
##          coastal.distance3          scale(popdensity)
##          -11544.86144          3497.33313
##          scale(poverty)          scale(log(median_income))
##          -9521.22567          -13867.20245
##          scale(pct_obesity)          scale(voter_margin_2020)
##          -9395.13591          13594.09331
##          scale(median_age)          factor(party)Republican
##          -69.27693          -15399.39172
## scale(log(median_house_value))          scale(owner_occupied)
##          2035.54157          -5405.54159
```

```
##           scale(blk_pct)           scale(hispanic_pct)
##           10476.48533             18967.31565
##           scale(native_pct)       scale(asian_pct)
##           3488.74507             12774.83026
##           scale(date_since_social) scale(date_since)
##           7144.29997             3467.43760
##           scale(beds/population.old) scale(smoke)
##           994.33531             -7491.69839
##           scale(mean_pm25)       scale(mean_summer_temp)
##           8952.64544             -2184.93241
##           scale(mean_winter_temp) scale(no_grad)
##           -6800.09203            -294.17772
```

```
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), 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
##           635.39117             -159.62122
##           coastal.distance3       scale(popdensity)
##           -202.77874             105.33091
##           scale(poverty)         scale(log(median_income))
##           -106.88512             -224.50737
##           scale(pct_obesity)     scale(voter_margin_2020)
##           -160.03034             188.15567
##           scale(median_age)      factor(party)Republican
##           48.03054             -255.06821
##           scale(log(median_house_value)) scale(owner_occupied)
##           46.05644             -89.63869
##           scale(blk_pct)         scale(hispanic_pct)
##           123.86731             296.31449
##           scale(native_pct)     scale(asian_pct)
##           47.37930             212.30959
##           scale(date_since_social) scale(date_since)
##           99.75063             48.12816
##           scale(beds/population.old) scale(smoke)
##           23.20395             -126.29351
##           scale(mean_pm25)       scale(mean_summer_temp)
##           237.63809             -74.11743
##           scale(mean_winter_temp) scale(no_grad)
##           -134.75417            43.26388
```

Print tables

```
# Run each line individually not all at once
tab_model(model.indicator.cases, robust = T, digits = 3)
tab_model(model.indicator.deaths, robust = T, digits = 3)
tab_model(model.indicator.cases.nohumidity, robust = T, digits = 3)
tab_model(model.indicator.deaths.nohumidity, robust = T, digits = 3)

tab_model(model.byregion.cases, robust = T, digits = 3)
tab_model(model.byregion.deaths, robust = T, digits = 3)
tab_model(model.byregion.cases.nohumidity, robust = T, digits = 3)
tab_model(model.byregion.deaths.nohumidity, robust = T, digits = 3)

tab_model(model.byregionru.cases, robust = T, digits = 3)
tab_model(model.byregionru.deaths, robust = T, digits = 3)
tab_model(model.byregionru.cases.nohumidity, robust = T, digits = 3)
tab_model(model.byregionru.deaths.nohumidity, robust = T, digits = 3)

tab_model(model.initial.cases, robust = T, digits = 3)
tab_model(model.initial.deaths, robust = T, digits = 3)
tab_model(model.initial.cases.nohumidity, robust = T, digits = 3)
tab_model(model.initial.deaths.nohumidity, robust = T, digits = 3)
```

Printing tablesL Confounders added

```
# Run each line individually not all at once
tab_model(model.indicator.cases.addconfounders, robust = T, digits = 3)
tab_model(model.indicator.cases.addconfounders.nohumidity, robust = T,
  digits = 3)
tab_model(model.indicator.deaths.addconfounders, robust = T, digits = 3)
tab_model(model.indicator.deaths.addconfounders.nohumidity, robust = T,
  digits = 3)

tab_model(model.byregion.cases.addconfounders, robust = T, digits = 3)
tab_model(model.byregion.cases.addconfounders.nohumidity, robust = T, digits = 3)
tab_model(model.byregion.deaths.addconfounders, robust = T, digits = 3)
tab_model(model.byregion.deaths.addconfounders.nohumidity, robust = T,
  digits = 3)

tab_model(model.byregionru.cases.addconfounders, robust = T, digits = 3)
tab_model(model.byregionru.cases.addconfounders.nohumidity, robust = T,
  digits = 3)
tab_model(model.byregionru.deaths.addconfounders, robust = T, digits = 3)
tab_model(model.byregionru.deaths.addconfounders.nohumidity, robust = T,
  digits = 3)

tab_model(model.initial.cases, robust = T, digits = 3)
tab_model(model.initial.cases.nohumidity, robust = T, digits = 3)
tab_model(model.initial.deaths, robust = T, digits = 3)
tab_model(model.initial.deaths.nohumidity, robust = T, digits = 3)
```