Coastal Analysis

Read in data

```
library("readxl")
library("lme4")
```

```
## Loading required package: Matrix
```

```
# 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 data from our 2020 study, created with: PM25 =
# data.frame(fips = aggregate_pm_census_cdc_test_beds$fips, mean_pm25
# = aggregate_pm_census_cdc_test_beds$mean_pm25) save(PM25, file =
# 'PM25.Rda')
load("PM25.Rda")
```

Create smaller dataset from previous dataset, 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 'region' to 'Inland', convert all characters to
# lowercase
coastal.new$region[is.na(coastal.new$region)] <- "Inland"
coastal.new$region = tolower(coastal.new$region)

# Merge with PM25 dataset
coastal.new = merge(coastal.new, PM25, by = "fips")
summary(coastal.new)
```

```
##      fips              state               cases              deaths
##  Length:3088        Length:3088         Min.   :      1    Min.   :    0.0
##  Class :character   Class :character    1st Qu.:   1025    1st Qu.:   18.0
##  Mode  :character   Mode  :character    Median :   2456    Median :   47.0
##                                         Mean   :   9416    Mean   :  165.9
##                                         3rd Qu.:   6160    3rd Qu.:  110.0
##                                         Max.   :1219237    Max.   :23101.0
##     region           coastal.distance population2019       popdensity
##  Length:3088        4:2417            Min.   :      169   Min.   :    0.1
##  Class :character   1: 300            1st Qu.:    11137   1st Qu.:   17.5
##  Mode  :character   2: 200            Median :    26163   Median :   45.3
##                     3: 171            Mean   :   102696   Mean   :  202.6
##                                       3rd Qu.:    68022   3rd Qu.:  112.7
##                                       Max.   :10039107    Max.   :17179.1
##     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.: 46212    1st Qu.:29.4
##  Median :0.1340    Median :0.1870    Median : 53242    Median :32.4
##  Mean   :0.1447    Mean   :0.1999    Mean   : 55573    Mean   :32.1
##  3rd Qu.:0.1750    3rd Qu.:0.2490    3rd Qu.: 61767    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:3088         Min.   :23.4    Length:3088
##  1st Qu.: 0.1375   Class :character    1st Qu.:38.2    Class :character
##  Median : 0.3859   Mode  :character    Median :41.4    Mode  :character
##  Mean   : 0.3203                       Mean   :41.5
##  3rd Qu.: 0.5666                       3rd Qu.:44.6
##  Max.   : 0.9309                       Max.   :67.4
##    mean_pm25
##  Min.   : 2.060
##  1st Qu.: 6.335
##  Median : 8.789
##  Mean   : 8.398
##  3rd Qu.:10.483
##  Max.   :15.786
```

PRELIMINARY ANALYSIS on only coastal counties

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

```
## [1] 671
```

```r
nrow(na.omit(coastal.only))
```

```
## [1] 633
```

```r
# Model cases
model.initial.cases = glmer(cases ~ (1 | state) + 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) + factor(humidity) +
    mean_pm25, family = poisson(link = "log"), data = coastal.only)
```

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, : Model is nearly unider
##  - Rescale variables?
```

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

```
## Generalized linear mixed model fit by maximum likelihood (Laplace
##    Approximation) [glmerMod]
##  Family: poisson  ( log )
## Formula:
## cases ~ (1 | state) + 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) + factor(humidity) + mean_pm25
##    Data: coastal.only
##
##       AIC       BIC    logLik  deviance  df.resid
##  489510.4  489572.7 -244741.2  489482.4       619
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -137.952  -12.341   -1.138    9.761  302.294
##
## Random effects:
##  Groups Name        Variance Std.Dev.
##  state  (Intercept) 0.04082  0.202
## Number of obs: 633, groups:  state, 29
##
## Fixed effects:
##                       Estimate Std. Error  z value Pr(>|z|)
## (Intercept)         -2.8945199  0.0905050  -31.982  < 2e-16 ***
## coastal.distance2   -0.0083465  0.0007805  -10.694  < 2e-16 ***
## coastal.distance3    0.0032707  0.0010161    3.219  0.00129 **
```

```
## scale(popdensity)          -0.0157230  0.0002362  -66.553  < 2e-16 ***
## scale(poverty)              0.0453624  0.0009874   45.939  < 2e-16 ***
## scale(log(median_income)) -0.0333711  0.0009787  -34.098  < 2e-16 ***
## scale(pct_obesity)         -0.0667857  0.0005562 -120.075  < 2e-16 ***
## scale(voter_margin_2020)    0.0539723  0.0006596   81.828  < 2e-16 ***
## scale(median_age)          -0.1103005  0.0005729 -192.535  < 2e-16 ***
## factor(party)Republican    -0.0055143  0.0010650   -5.178 2.25e-07 ***
## factor(humidity)Marine     -0.3254818  0.0018670 -174.337  < 2e-16 ***
## factor(humidity)Moist       0.1085565  0.0994371    1.092  0.27496
## mean_pm25                   0.0326665  0.0002082  156.909  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1


##
## Correlation matrix not shown by default, as p = 13 > 12.
## Use print(x, correlation=TRUE)  or
##     vcov(x)          if you need it


## optimizer (Nelder_Mead) convergence code: 0 (OK)
## Model is nearly unidentifiable: very large eigenvalue
##  - Rescale variables?
```

```r
# Model deaths
model.initial.deaths = glmer(deaths ~ (1 | state) + 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) + factor(humidity) + mean_pm25, family = poisson(link = "log"),
    data = coastal.only)
```

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, : Model is nearly uniden
##  - Rescale variables?
```

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

```
## Generalized linear mixed model fit by maximum likelihood (Laplace
##   Approximation) [glmerMod]
##  Family: poisson  ( log )
## Formula:
## deaths ~ (1 | state) + 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) + factor(humidity) + mean_pm25
##    Data: coastal.only
##
##      AIC      BIC   logLik deviance df.resid
##  19261.6  19323.9  -9616.8  19233.6      619
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -21.5020  -2.6453  -0.4458   2.1176  25.4407
##
## Random effects:
```

```
##   Groups Name          Variance Std.Dev.
##   state   (Intercept) 0.09803  0.3131
## Number of obs: 633, groups:  state, 29
##
## Fixed effects:
##                              Estimate Std. Error z value Pr(>|z|)
## (Intercept)                 -7.497281   0.146351 -51.228  < 2e-16 ***
## coastal.distance2            0.042181   0.005735   7.355 1.90e-13 ***
## coastal.distance3            0.023638   0.007407   3.191  0.00142 **
## scale(popdensity)           -0.019259   0.001658 -11.616  < 2e-16 ***
## scale(poverty)               0.217943   0.007131  30.563  < 2e-16 ***
## scale(log(median_income))   -0.021899   0.007304  -2.998  0.00271 **
## scale(pct_obesity)          -0.030917   0.004250  -7.275 3.46e-13 ***
## scale(voter_margin_2020)     0.023010   0.004848   4.746 2.07e-06 ***
## scale(median_age)            0.129801   0.004205  30.868  < 2e-16 ***
## factor(party)Republican      0.018457   0.007942   2.324  0.02012 *
## factor(humidity)Marine      -0.223662   0.015466 -14.462  < 2e-16 ***
## factor(humidity)Moist        0.280738   0.158825   1.768  0.07713 .
## mean_pm25                    0.085450   0.001641  52.064  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1


##
## Correlation matrix not shown by default, as p = 13 > 12.
## Use print(x, correlation=TRUE)  or
##     vcov(x)         if you need it


## optimizer (Nelder_Mead) convergence code: 0 (OK)
## Model is nearly unidentifiable: very large eigenvalue
##  - Rescale variables?
```

Redo: Create indicator for being a coast (levels 1,2,3) instead.

```r
# Indicator Coastal or NonCoastal
coastal.new$indicatorcoast = ifelse(coastal.new$coastal.distance == "1",
    "Coastal", "NonCoastal")

# Model cases
model.indicator.cases = glmer(cases ~ (1 | state) + factor(indicatorcoast) +
    offset(log(population2019)) + scale(popdensity) + scale(poverty) +
    scale(log(median_income)) + scale(pct_obesity) + scale(voter_margin_2020) +
    scale(median_age) + factor(party) + factor(humidity) + mean_pm25, family = poisson(link = "log"),
    data = coastal.new)
```

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, : Model is nearly unide
##  - Rescale variables?
```

```r
summary(model.indicator.cases)
```

```
## Generalized linear mixed model fit by maximum likelihood (Laplace
##   Approximation) [glmerMod]
##  Family: poisson  ( log )
## Formula:
## cases ~ (1 | state) + factor(indicatorcoast) + offset(log(population2019)) +
##     scale(popdensity) + scale(poverty) + scale(log(median_income)) +
##     scale(pct_obesity) + scale(voter_margin_2020) + scale(median_age) +
##     factor(party) + factor(humidity) + mean_pm25
##    Data: coastal.new
##
##       AIC      BIC   logLik deviance df.resid
##  965316.9  965394.9 -482645.4  965290.9     2973
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -148.11   -6.67   -0.42    6.51  350.45
##
## Random effects:
##  Groups Name        Variance Std.Dev.
##  state  (Intercept) 0.07185  0.2681
## Number of obs: 2986, groups:  state, 49
##
## Fixed effects:
##                                  Estimate Std. Error z value Pr(>|z|)
## (Intercept)                    -2.4332540  0.0383408  -63.46   <2e-16 ***
## factor(indicatorcoast)NonCoastal -0.0066361  0.0005517  -12.03   <2e-16 ***
## scale(popdensity)              -0.0017168  0.0001109  -15.47   <2e-16 ***
## scale(poverty)                  0.0154338  0.0006411   24.07   <2e-16 ***
## scale(log(median_income))      -0.0332828  0.0005583  -59.62   <2e-16 ***
## scale(pct_obesity)             -0.0129600  0.0003363  -38.53   <2e-16 ***
## scale(voter_margin_2020)        0.0832380  0.0004119  202.09   <2e-16 ***
## scale(median_age)              -0.0833038  0.0003370 -247.18   <2e-16 ***
## factor(party)Republican        -0.0222963  0.0007196  -30.98   <2e-16 ***
## factor(humidity)Marine         -0.2732304  0.0015830 -172.61   <2e-16 ***
```

```
## factor(humidity)Moist              -0.3765673  0.0016796 -224.20   <2e-16 ***
## mean_pm25                           0.0424528  0.0001587  267.51   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) fc()NC scl(pp) scl(pv) s((_)) scl(p_) s(__20 scl(m_)
## fctr(ndc)NC  -0.019
## scl(ppdnst)   0.008  0.189
## scal(pvrty)   0.001  0.009 -0.159
## scl(lg(m_))   0.004 -0.019 -0.088   0.868
## scl(pct_bs)   0.005 -0.101  0.116   0.077   0.342
## scl(__2020)   0.008 -0.045  0.238   0.150   0.117 -0.148
## scal(mdn_g)   0.001  0.193 -0.006   0.297   0.252  0.132  -0.179
## fctr(prty)R  -0.019  0.019 -0.102   0.007  -0.019 -0.077  -0.662 -0.074
## fctr(hmdty)Mr -0.015 0.167 -0.070  -0.100  -0.204 -0.097   0.157 -0.081
## fctr(hmdty)Ms -0.029 0.016  0.005   0.025  -0.014 -0.027   0.011 -0.085
## mean_pm25    -0.033  0.182 -0.243  -0.032  -0.096 -0.055   0.142  0.090
##             fct()R fctr(hmdty)Mr fctr(hmdty)Ms
## fctr(ndc)NC
## scl(ppdnst)
## scal(pvrty)
## scl(lg(m_))
## scl(pct_bs)
## scl(__2020)
## scal(mdn_g)
## fctr(prty)R
## fctr(hmdty)Mr -0.015
## fctr(hmdty)Ms  0.016 -0.021
## mean_pm25      0.062  0.409        -0.148
## optimizer (Nelder_Mead) convergence code: 0 (OK)
## Model is nearly unidentifiable: very large eigenvalue
##  - Rescale variables?
```

```r
# Model deaths
model.indicator.deaths = glmer(deaths ~ (1 | state) + factor(indicatorcoast) +
    offset(log(population2019)) + scale(popdensity) + scale(poverty) +
    scale(log(median_income)) + scale(pct_obesity) + scale(voter_margin_2020) +
    scale(median_age) + factor(party) + factor(humidity) + mean_pm25, family = poisson(link = "log"),
    data = coastal.new)
```

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, : Model is nearly unider
##  - Rescale variables?
```

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

```
## Generalized linear mixed model fit by maximum likelihood (Laplace
##   Approximation) [glmerMod]
##  Family: poisson  ( log )
## Formula:
## deaths ~ (1 | state) + factor(indicatorcoast) + offset(log(population2019)) +
##     scale(popdensity) + scale(poverty) + scale(log(median_income)) +
##     scale(pct_obesity) + scale(voter_margin_2020) + scale(median_age) +
```

```
##     factor(party) + factor(humidity) + mean_pm25
##   Data: coastal.new
##
##      AIC      BIC   logLik deviance df.resid
##  56248.4  56326.4 -28111.2  56222.4     2973
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -24.3868  -1.8580  -0.1744   1.8524  28.3373
##
## Random effects:
##  Groups Name        Variance Std.Dev.
##  state  (Intercept) 0.1973   0.4442
## Number of obs: 2986, groups:  state, 49
##
## Fixed effects:
##                                  Estimate Std. Error z value Pr(>|z|)
## (Intercept)                    -6.4773342  0.0651787 -99.378  < 2e-16 ***
## factor(indicatorcoast)NonCoastal -0.0115666  0.0040629  -2.847  0.00442 **
## scale(popdensity)               0.0002414  0.0007636   0.316  0.75190
## scale(poverty)                  0.1470811  0.0046156  31.866  < 2e-16 ***
## scale(log(median_income))      -0.0794677  0.0041466 -19.165  < 2e-16 ***
## scale(pct_obesity)              0.0074566  0.0025492   2.925  0.00344 **
## scale(voter_margin_2020)        0.0930697  0.0030756  30.261  < 2e-16 ***
## scale(median_age)               0.1106983  0.0024700  44.818  < 2e-16 ***
## factor(party)Republican        -0.0315627  0.0054647  -5.776 7.66e-09 ***
## factor(humidity)Marine         -0.1808182  0.0129626 -13.949  < 2e-16 ***
## factor(humidity)Moist          -0.6391584  0.0118184 -54.082  < 2e-16 ***
## mean_pm25                       0.0792811  0.0012108  65.481  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) fc()NC scl(pp) scl(pv) s((_)) scl(p_) s(__20 scl(m_)
## fctr(ndc)NC -0.087
## scl(ppdnst)  0.036  0.188
## scal(pvrty)  0.005 -0.004 -0.175
## scl(lg(m_))  0.019 -0.024 -0.079  0.861
## scl(pct_bs)  0.026 -0.092  0.160  0.052  0.336
## scl(__2020)  0.039 -0.055  0.249  0.150  0.108 -0.131
## scal(mdn_g) -0.001  0.180  0.036  0.283  0.261  0.159  -0.172
## fctr(prty)R -0.086  0.024 -0.133  0.013 -0.006 -0.085  -0.664 -0.096
## fctr(hmdty)Mr -0.067  0.154 -0.060 -0.090 -0.192 -0.090   0.145 -0.073
## fctr(hmdty)Ms -0.117  0.028 -0.005  0.018 -0.026 -0.041  -0.007 -0.087
## mean_pm25    -0.147  0.183 -0.217 -0.034 -0.107 -0.056   0.149  0.106
##             fct()R fctr(hmdty)Mr fctr(hmdty)Ms
## fctr(ndc)NC
## scl(ppdnst)
## scal(pvrty)
## scl(lg(m_))
## scl(pct_bs)
## scl(__2020)
## scal(mdn_g)
## fctr(prty)R
```

```
## fctr(hmdty)Mr -0.007
## fctr(hmdty)Ms  0.026 -0.024
## mean_pm25      0.059  0.394          -0.154
## optimizer (Nelder_Mead) convergence code: 0 (OK)
## Model is nearly unidentifiable: very large eigenvalue
##  - Rescale variables?
```

Repeat above, - humidity

```
# Model cases
model.initial.cases.nohumidity = glmer(cases ~ (1 | state) + 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)
```

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, : Model is nearly uniden
##  - Rescale variables?
```

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

```
## Generalized linear mixed model fit by maximum likelihood (Laplace
##    Approximation) [glmerMod]
##  Family: poisson  ( log )
## Formula:
## cases ~ (1 | state) + 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
##    Data: coastal.only
##
##       AIC       BIC    logLik  deviance  df.resid
##  527346.4  527400.5 -263661.2  527322.4       659
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -134.073  -12.358   -0.726    9.286  307.251
##
## Random effects:
##  Groups Name        Variance Std.Dev.
##  state  (Intercept) 0.05554  0.2357
## Number of obs: 671, groups:  state, 30
##
## Fixed effects:
##                            Estimate Std. Error z value Pr(>|z|)
## (Intercept)              -2.9758995  0.0430803  -69.08   <2e-16 ***
## coastal.distance2         0.0126640  0.0007663   16.53   <2e-16 ***
## coastal.distance3         0.0220155  0.0010005   22.00   <2e-16 ***
## scale(popdensity)        -0.0181007  0.0002334  -77.57   <2e-16 ***
## scale(poverty)            0.0239593  0.0009704   24.69   <2e-16 ***
## scale(log(median_income)) -0.0812242 0.0009311  -87.23   <2e-16 ***
```

```
## scale(pct_obesity)         -0.0810283  0.0005513 -146.97   <2e-16 ***
## scale(voter_margin_2020)    0.0828887  0.0006381  129.91   <2e-16 ***
## scale(median_age)          -0.1150409  0.0005626 -204.47   <2e-16 ***
## factor(party)Republican    -0.0225069  0.0010564  -21.30   <2e-16 ***
## mean_pm25                   0.0510268  0.0001765  289.11   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##            (Intr) cstl.2 cstl.3 scl(pp) scl(pv) s((_)) scl(p_) s(__20 scl(m_)
## cstl.dstnc2 -0.011
## cstl.dstnc3 -0.013  0.361
## scl(ppdnst)  0.008  0.197  0.156
## scal(pvrty)  0.007 -0.104 -0.131 -0.206
## scl(lg(m_))  0.002 -0.154 -0.081 -0.157   0.844
## scl(pct_bs) -0.001 -0.130 -0.110  0.107   0.070   0.392
## scl(__2020)  0.016 -0.170 -0.237  0.237   0.280   0.202 -0.113
## scal(mdn_g)  0.003  0.232  0.118  0.017   0.304   0.198  0.140  -0.051
## fctr(prty)R -0.019  0.042  0.092 -0.124  -0.055  -0.044 -0.099  -0.624 -0.188
## mean_pm25   -0.040  0.116  0.128 -0.224  -0.088  -0.010  0.088  -0.070  0.103
##            fct()R
## cstl.dstnc2
## cstl.dstnc3
## scl(ppdnst)
## scal(pvrty)
## scl(lg(m_))
## scl(pct_bs)
## scl(__2020)
## scal(mdn_g)
## fctr(prty)R
## mean_pm25     0.086
## optimizer (Nelder_Mead) convergence code: 0 (OK)
## Model is nearly unidentifiable: very large eigenvalue
##  - Rescale variables?
```

```r
# Model deaths
model.initial.deaths.nohumidity = glmer(deaths ~ (1 | state) + 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)
```

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, : Model is nearly unider
##  - Rescale variables?
```

```r
summary(model.initial.deaths.nohumidity)
```

```
## Generalized linear mixed model fit by maximum likelihood (Laplace
##   Approximation) [glmerMod]
##  Family: poisson  ( log )
## Formula:
## deaths ~ (1 | state) + 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
##    Data: coastal.only
##
##      AIC      BIC   logLik deviance df.resid
##  20037.7  20091.8 -10006.8  20013.7      659
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -21.9505  -2.7575  -0.4996   2.0563  25.8188
##
## Random effects:
##  Groups Name        Variance Std.Dev.
##  state  (Intercept) 0.1185   0.3442
## Number of obs: 671, groups:  state, 30
##
## Fixed effects:
##                            Estimate Std. Error  z value Pr(>|z|)
## (Intercept)               -7.367694   0.064917 -113.493  < 2e-16 ***
## coastal.distance2          0.057546   0.005621   10.239  < 2e-16 ***
## coastal.distance3          0.036126   0.007306    4.945 7.63e-07 ***
## scale(popdensity)         -0.020616   0.001644  -12.543  < 2e-16 ***
## scale(poverty)             0.202320   0.007016   28.838  < 2e-16 ***
## scale(log(median_income)) -0.056214   0.006948   -8.091 5.93e-16 ***
## scale(pct_obesity)        -0.043184   0.004192  -10.303  < 2e-16 ***
## scale(voter_margin_2020)   0.039597   0.004702    8.422  < 2e-16 ***
## scale(median_age)          0.128092   0.004131   31.010  < 2e-16 ***
## factor(party)Republican    0.009171   0.007901    1.161    0.246
## mean_pm25                  0.096793   0.001379   70.176  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##            (Intr) cstl.2 cstl.3 scl(pp) scl(pv) s((_)) scl(p_) s(__20 scl(m_)
## cstl.dstnc2 -0.056
## cstl.dstnc3 -0.062  0.348
## scl(ppdnst)  0.042  0.209  0.171
## scal(pvrty)  0.033 -0.113 -0.131 -0.211
## scl(lg(m_))  0.012 -0.164 -0.081 -0.133   0.840
## scl(pct_bs) -0.003 -0.107 -0.097  0.150   0.071   0.411
## scl(__2020)  0.070 -0.154 -0.214  0.239   0.248   0.160 -0.129
## scal(mdn_g)  0.006  0.201  0.119  0.061   0.310   0.229  0.179 -0.074
## fctr(prty)R -0.092  0.050  0.079 -0.147  -0.042  -0.033 -0.106 -0.615 -0.203
## mean_pm25   -0.206  0.126  0.118 -0.199  -0.091  -0.034  0.072 -0.022  0.102
##            fct()R
## cstl.dstnc2
## cstl.dstnc3
## scl(ppdnst)
## scal(pvrty)
## scl(lg(m_))
## scl(pct_bs)
## scl(__2020)
## scal(mdn_g)
## fctr(prty)R
```

```
## mean_pm25    0.064
## optimizer (Nelder_Mead) convergence code: 0 (OK)
## Model is nearly unidentifiable: very large eigenvalue
##  - Rescale variables?
```

```r
# Model cases
model.indicator.cases.nohumidity = glmer(cases ~ (1 | state) + factor(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)
```

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, : Model is nearly uniden
##  - Rescale variables?
```

```r
summary(model.indicator.cases.nohumidity)
```

```
## Generalized linear mixed model fit by maximum likelihood (Laplace
##   Approximation) [glmerMod]
##  Family: poisson  ( log )
## Formula:
## cases ~ (1 | state) + factor(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
##    Data: coastal.new
##
##      AIC      BIC   logLik deviance df.resid
##  1058254  1058320  -529116  1058232     3077
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -155.63   -6.48   -0.34    6.61  350.89
##
## Random effects:
##  Groups Name        Variance Std.Dev.
##  state  (Intercept) 0.06215  0.2493
## Number of obs: 3088, groups:  state, 49
##
## Fixed effects:
##                                 Estimate Std. Error z value Pr(>|z|)
## (Intercept)                   -2.7888748  0.0356456  -78.24   <2e-16 ***
## factor(indicatorcoast)NonCoastal 0.0113348  0.0005398   21.00   <2e-16 ***
## scale(popdensity)             -0.0030231  0.0001093  -27.66   <2e-16 ***
## scale(poverty)                 0.0072247  0.0006343   11.39   <2e-16 ***
## scale(log(median_income))     -0.0558493  0.0005436 -102.75   <2e-16 ***
## scale(pct_obesity)            -0.0209702  0.0003335  -62.89   <2e-16 ***
## scale(voter_margin_2020)       0.0955407  0.0004050  235.88   <2e-16 ***
## scale(median_age)             -0.0924895  0.0003315 -278.99   <2e-16 ***
## factor(party)Republican       -0.0232713  0.0007156  -32.52   <2e-16 ***
## mean_pm25                      0.0487934  0.0001410  346.07   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
## 
## Correlation of Fixed Effects:
##             (Intr) fc()NC scl(pp) scl(pv) s((_)) scl(p_) s(__20 scl(m_) fct()R
## fctr(ndc)NC -0.017
## scl(ppdnst)  0.007  0.201
## scal(pvrty)  0.000  0.026 -0.169
## scl(lg(m_))  0.000  0.014 -0.109  0.870
## scl(pct_bs)  0.003 -0.087  0.105  0.067  0.330
## scl(__2020)  0.012 -0.077  0.256  0.172  0.161 -0.136
## scal(mdn_g) -0.004  0.211 -0.020  0.294  0.239  0.119  -0.171
## fctr(prty)R -0.020  0.020 -0.104  0.004 -0.026 -0.078  -0.667 -0.073
## mean_pm25   -0.036  0.119 -0.236  0.016 -0.015 -0.020   0.079  0.140   0.080
## optimizer (Nelder_Mead) convergence code: 0 (OK)
## Model is nearly unidentifiable: very large eigenvalue
##  - Rescale variables?
```

```r
# Model deaths
model.indicator.deaths.nohumidity = glmer(deaths ~ (1 | state) + factor(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)
```

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, : Model is nearly unider
##  - Rescale variables?
```

```r
summary(model.indicator.deaths.nohumidity)
```

```
## Generalized linear mixed model fit by maximum likelihood (Laplace
##   Approximation) [glmerMod]
##  Family: poisson  ( log )
## Formula:
## deaths ~ (1 | state) + factor(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
##    Data: coastal.new
## 
##      AIC      BIC   logLik deviance df.resid
##  60295.8  60362.1 -30136.9  60273.8     3077
## 
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -30.6176 -1.8819 -0.1612  1.9077 30.2565
## 
## Random effects:
##  Groups Name        Variance Std.Dev.
##  state  (Intercept) 0.1421   0.377
## Number of obs: 3088, groups:  state, 49
## 
## Fixed effects:
##                                 Estimate Std. Error  z value Pr(>|z|)
## (Intercept)                    -6.9678367  0.0551329 -126.383  < 2e-16 ***
```

```
## factor(indicatorcoast)NonCoastal  0.0031276  0.0039742   0.787    0.431
## scale(popdensity)                 -0.0002864  0.0007564  -0.379    0.705
## scale(poverty)                     0.1438658  0.0045751  31.445  < 2e-16 ***
## scale(log(median_income))         -0.0969172  0.0040564 -23.893  < 2e-16 ***
## scale(pct_obesity)                -0.0001422  0.0025259  -0.056    0.955
## scale(voter_margin_2020)           0.1005832  0.0030384  33.104  < 2e-16 ***
## scale(median_age)                  0.0999162  0.0024367  41.005  < 2e-16 ***
## factor(party)Republican           -0.0299615  0.0054325  -5.515 3.48e-08 ***
## mean_pm25                          0.0776299  0.0010857  71.501  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##            (Intr) fc()NC scl(pp) scl(pv) s((_)) scl(p_) s(__20 scl(m_) fct()R
## fctr(ndc)NC -0.084
## scl(ppdnst)  0.038  0.196
## scal(pvrty)  0.000  0.011 -0.181
## scl(lg(m_))  0.004  0.004 -0.093   0.865
## scl(pct_bs)  0.018 -0.080  0.150   0.046   0.325
## scl(__2020)  0.059 -0.082  0.268   0.169   0.147 -0.119
## scal(mdn_g) -0.023  0.197  0.022   0.281   0.248  0.144  -0.166
## fctr(prty)R -0.098  0.022 -0.135   0.011  -0.011 -0.086  -0.669 -0.093
## mean_pm25   -0.177  0.131 -0.216   0.008  -0.038 -0.030   0.090  0.153   0.074
## optimizer (Nelder_Mead) convergence code: 0 (OK)
## Model is nearly unidentifiable: very large eigenvalue
##  - Rescale variables?
```

Summary of output

```
## [1] "0.992 (0.99, 0.993)"
```

```
## [1] "1.003 (1.001, 1.005)"
```

```
## [1] "1.043 (1.031, 1.055)"
```

```
## [1] "1.024 (1.009, 1.039)"
```

```
## [1] "1.013 (1.011, 1.014)"
```

```
## [1] "1.022 (1.02, 1.024)"
```

```
## [1] "1.059 (1.048, 1.071)"
```

```
## [1] "1.037 (1.022, 1.052)"
```

```
## [1] "0.993 (0.992, 0.994)"
```

```
## [1] "0.988 (0.981, 0.996)"
```

```
## [1] "1.011 (1.01, 1.012)"
```

```
## [1] "1.003 (0.995, 1.011)"
```

Humidity Included

Coastal Distance	Case Model Coefficients (CI)	Death Model Coefficients (CI)
1 (Reference)	0	0
2	0.992 (0.99, 0.993)	1.043 (1.031, 1.055)
3	1.003 (1.001, 1.005)	1.024 (1.009, 1.039)

Humidity Excluded

Coastal Distance	Case Model Coefficients (CI)	Death Model Coefficients (CI)
1 (Reference)	0	0
2	1.013 (1.011, 1.014)	1.059 (1.048, 1.071)
3	1.022 (1.02, 1.024)	1.037 (1.022, 1.052)

Humidity Included

Binary Variable	Case Model Coefficients (CI)	Death Model Coefficients (CI)
Coastal (Reference)	0	0
Noncoastal	0.993 (0.992, 0.994)	0.988 (0.981, 0.996)

Humidity Excluded

Binary Variable	Case Model Coefficients (CI)	Death Model Coefficients (CI)
Coastal (Reference)	0	0
Noncoastal	1.011 (1.01, 1.012)	1.003 (0.995, 1.011)