Supplemental material of analysis accompanying Schedler J C, Ensor K B . *A spatiotemporal case-crossover model of asthma exacerbation in the City of Houston.* Stat. 2021; https://doi.org/10.1002/sta4.357

# Spatial Case-crossover

## Raw data

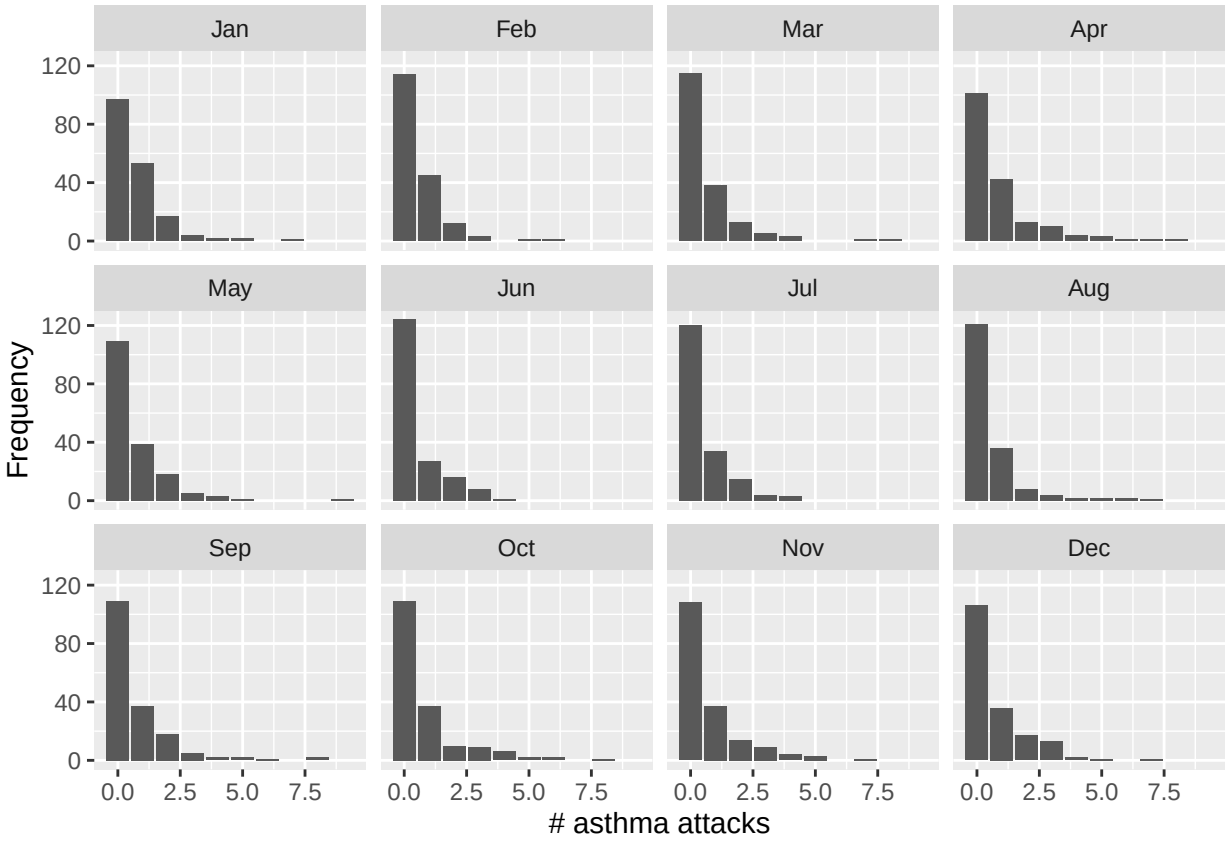
```
kable(head(asthma.15), digits = 3)
```

| Date | Year | HourofDay | hr | time_of_day | nbhd | count | month_num | month | dow | weekd |
|---|---|---|---|---|---|---|---|---|---|---|
| 01/1/2015 | 2015 | 0:00:00 | 0 | night | ACRES HOME | 0 | 1 | Jan | Thursday | |
| 01/1/2015 | 2015 | 1:00:00 | 1 | night | ACRES HOME | 0 | 1 | Jan | Thursday | |
| 01/1/2015 | 2015 | 2:00:00 | 2 | night | ACRES HOME | 0 | 1 | Jan | Thursday | |
| 01/1/2015 | 2015 | 3:00:00 | 3 | night | ACRES HOME | 0 | 1 | Jan | Thursday | |
| 01/1/2015 | 2015 | 4:00:00 | 4 | night | ACRES HOME | 0 | 1 | Jan | Thursday | |
| 01/1/2015 | 2015 | 5:00:00 | 5 | night | ACRES HOME | 0 | 1 | Jan | Thursday | |

## Distribution of daily # asthma attacks by month and weekday

One observation per unique combo of snbr/month/weekday indicator (n = 2112).

```
ggplot(asthma.ag.month, aes(x=ct, fill = weekday_ind)) +
  geom_bar()+ facet_wrap(month~.) + xlab("# asthma attacks") + ylab("Frequency")
```



## Distribution of daily # asthma attacks by month and time of day

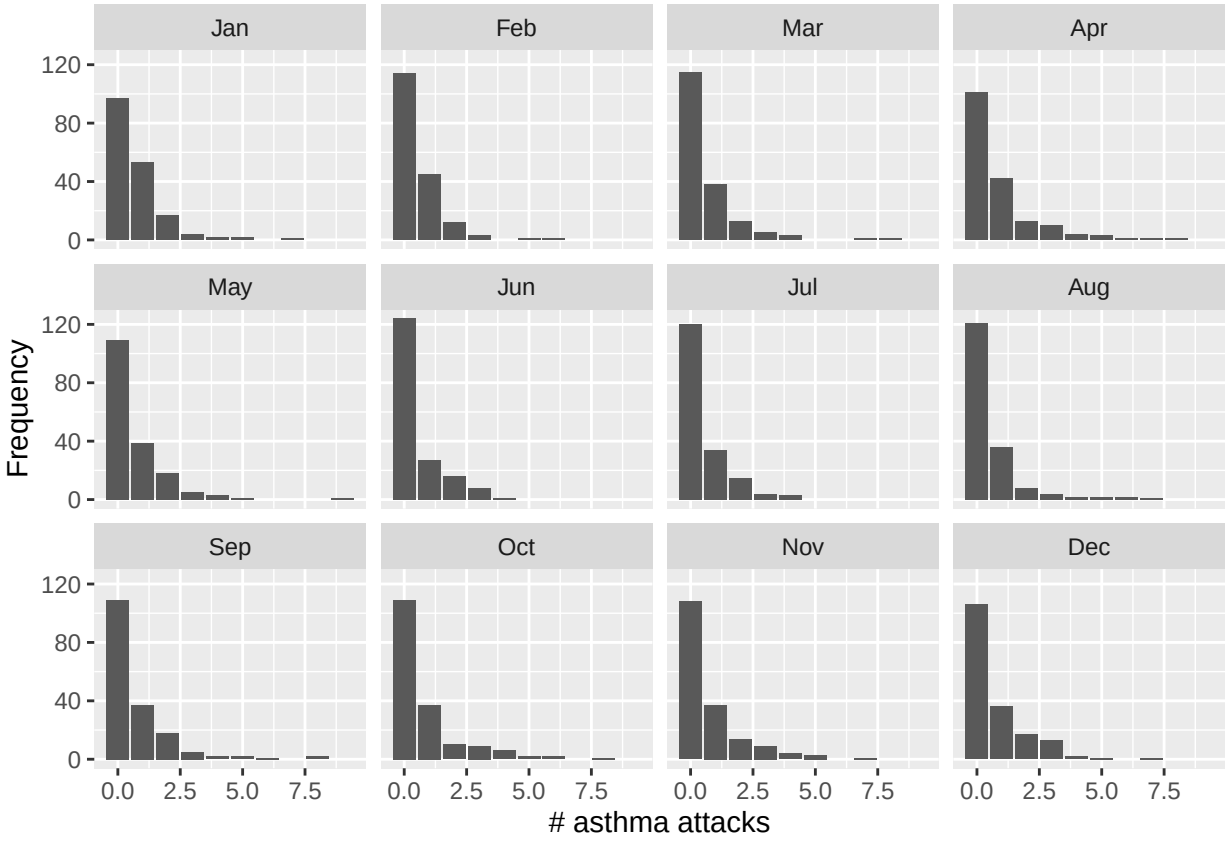
One observation per unique combo of snbr/month/time of day (n = 4224).

```
# ggplot(asthma.ag.tod, aes(x=ct, fill = time_of_day)) +
#   geom_bar()+ facet_wrap(month~.) + xlab("# asthma attacks") + ylab("Frequency")
```

## Distribution of daily # asthma attacks by month

One observation per unique combo of snbr/month (n = 1056).

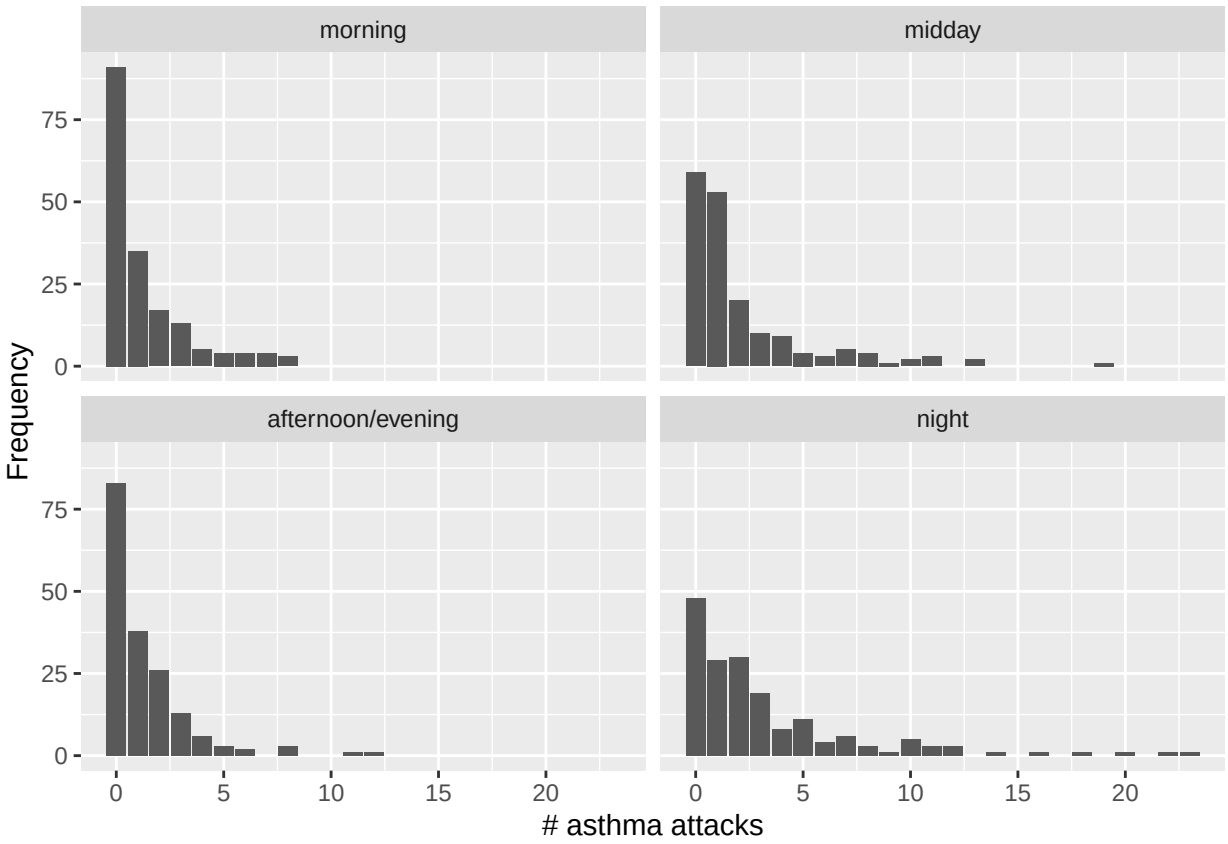
```
ggplot(asthma.ag.month, aes(x=ct)) +
  geom_bar()+ facet_wrap(month~.) + xlab("# asthma attacks") + ylab("Frequency")
```




## Distribution of daily # asthma attacks by weekday indicator and time of day (snbr level)

One observation per unique combo of snbr/weekday indicator/time of day (n = 704).

```
ggplot(asthma.ag.tod.wk, aes(x=ct, fill = weekday_ind)) +
  geom_bar()+ facet_wrap(time_of_day~.) + xlab("# asthma attacks") + ylab("Frequency")
```




## Strata: Month, weekday indicator

### Model with ozone

$$Y|X,Z,\beta \sim quasipoisson(\mu)\mu = E(Y|X,Z,\beta) = X\beta + ZZ \sim CAR()$$

## Non spatial model

```
asthma.ag.month$strata = factor(paste(asthma.ag.month$weekday_ind,
                                      asthma.ag.month$month))
#asthma.ag$strata <- factor(asthma.ag$strata, levels(asthma.ag.tod.wk$strata)[c(1,2,3,4,5,6,8,7)])
X <-  model.matrix(ct ~ 1 + ozone + strata, data = asthma.ag.month)
#dimnames(X)[[2]][3:13] <- as.character(levels(asthma.ag$month))[1:11]
#dimnames(X)[[2]][14] <- "weekday=T"
Z <- model.matrix(~ 1 + factor(nbhd), data = asthma.ag.month)
asthmaCAR_month<- hglm(y = asthma.ag.month$ct, X = X, Z = Z,family = quasipoisson(link = "log"),
                       rand.family = gaussian())

out = summary(asthmaCAR_month)
kable(out$FixCoefMat, digits = 3)
```

| | Estimate | Std. Error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | 0.090 | 1.308 | 0.069 | 0.945 |
| ozone | -0.052 | 0.041 | -1.288 | 0.198 |
| strata0 Aug | -0.080 | 0.504 | -0.158 | 0.875 |
| strata0 Dec | 0.313 | 0.388 | 0.808 | 0.419 |

| | Estimate | Std. Error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| strata0 Feb | 0.078 | 0.546 | 0.143 | 0.886 |
| strata0 Jan | 0.013 | 0.222 | 0.058 | 0.954 |
| strata0 Jul | -0.166 | 0.481 | -0.345 | 0.730 |
| strata0 Jun | -0.042 | 0.357 | -0.117 | 0.907 |
| strata0 Mar | 0.030 | 0.401 | 0.075 | 0.940 |
| strata0 May | 0.186 | 0.454 | 0.410 | 0.682 |
| strata0 Nov | 0.612 | 0.596 | 1.028 | 0.304 |
| strata0 Oct | -0.054 | 0.255 | -0.212 | 0.833 |
| strata0 Sep | 0.411 | 0.473 | 0.868 | 0.385 |
| strata1 Apr | 1.069 | 0.176 | 6.060 | 0.000 |
| strata1 Aug | 1.172 | 0.413 | 2.841 | 0.005 |
| strata1 Dec | 1.174 | 0.310 | 3.784 | 0.000 |
| strata1 Feb | 1.076 | 0.484 | 2.225 | 0.026 |
| strata1 Jan | 0.759 | 0.177 | 4.283 | 0.000 |
| strata1 Jul | 1.020 | 0.423 | 2.415 | 0.016 |
| strata1 Jun | 0.566 | 0.226 | 2.503 | 0.012 |
| strata1 Mar | 0.767 | 0.192 | 4.005 | 0.000 |
| strata1 May | 0.899 | 0.200 | 4.487 | 0.000 |
| strata1 Nov | 1.465 | 0.505 | 2.902 | 0.004 |
| strata1 Oct | 0.948 | 0.173 | 5.481 | 0.000 |
| strata1 Sep | 1.146 | 0.293 | 3.916 | 0.000 |

```
asthma.ag.month$strata = factor(paste(asthma.ag.month$weekday_ind,
                                      asthma.ag.month$month))
#asthma.ag$strata <- factor(asthma.ag$strata, levels(asthma.ag.tod.wk$strata)[c(1,2,3,4,5,6,8,7)])
X <-  model.matrix(ct ~ 1 + ozone + strata, data = asthma.ag.month)
#dimnames(X)[[2]][3:13] <- as.character(levels(asthma.ag$month))[1:11]
#dimnames(X)[[2]][14] <- "weekday=T"
Z <- model.matrix(~ 1 + factor(nbhd), data = asthma.ag.month)
asthmaCAR_month<- hglm(y = asthma.ag.month$ct, X = X, Z = Z, family = quasipoisson(link = "log"),
                       rand.family = CAR(D = hausMat))

out = summary(asthmaCAR_month)
kable(out$FixCoefMat, digits = 3)
```

| | Estimate | Std. Error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | 2.207 | 1.281 | 1.723 | 0.085 |
| ozone | -0.053 | 0.040 | -1.312 | 0.190 |
| strata0 Aug | -0.074 | 0.500 | -0.148 | 0.883 |
| strata0 Dec | 0.317 | 0.384 | 0.826 | 0.409 |
| strata0 Feb | 0.084 | 0.541 | 0.155 | 0.876 |
| strata0 Jan | 0.014 | 0.220 | 0.062 | 0.950 |
| strata0 Jul | -0.161 | 0.477 | -0.337 | 0.736 |
| strata0 Jun | -0.038 | 0.354 | -0.107 | 0.914 |
| strata0 Mar | 0.034 | 0.397 | 0.085 | 0.932 |
| strata0 May | 0.191 | 0.450 | 0.425 | 0.671 |
| strata0 Nov | 0.620 | 0.591 | 1.049 | 0.294 |
| strata0 Oct | -0.052 | 0.253 | -0.204 | 0.838 |
| strata0 Sep | 0.416 | 0.469 | 0.887 | 0.375 |
| strata1 Apr | 1.070 | 0.175 | 6.124 | 0.000 |
| strata1 Aug | 1.177 | 0.409 | 2.878 | 0.004 |

| | Estimate | Std. Error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| strata1 Dec | 1.177 | 0.307 | 3.830 | 0.000 |
| strata1 Feb | 1.082 | 0.480 | 2.257 | 0.024 |
| strata1 Jan | 0.759 | 0.175 | 4.325 | 0.000 |
| strata1 Jul | 1.025 | 0.419 | 2.448 | 0.014 |
| strata1 Jun | 0.568 | 0.224 | 2.534 | 0.011 |
| strata1 Mar | 0.768 | 0.190 | 4.049 | 0.000 |
| strata1 May | 0.901 | 0.198 | 4.537 | 0.000 |
| strata1 Nov | 1.472 | 0.501 | 2.939 | 0.003 |
| strata1 Oct | 0.948 | 0.171 | 5.542 | 0.000 |
| strata1 Sep | 1.150 | 0.290 | 3.960 | 0.000 |

### Model with temp

#### non spatial

```
X <-  model.matrix(ct ~ 1 + temp + strata , data = asthma.ag.month)
dimnames(X)[[2]][3:13] <- as.character(levels(asthma.ag.month$month))[1:11]
dimnames(X)[[2]][14] <- "weekday=T"
Z <- model.matrix(~ 1 + factor(nbhd), data = asthma.ag.month)
asthmaCAR_month<- hglm(y = asthma.ag.month$ct, X = X, Z = Z, family = quasipoisson(link = "log"),
                       rand.family = gaussian())
out = summary(asthmaCAR_month);round(out$FixCoefMat,3)
```

```
##             Estimate Std. Error t-value Pr(>|t|)
## (Intercept)   11.554      9.787   1.181    0.238
## temp          -0.197      0.156  -1.269    0.205
## Jan            2.270      2.310   0.983    0.326
## Feb            3.283      2.679   1.226    0.220
## Mar            1.991      2.019   0.986    0.324
## Apr           -2.335      1.791  -1.304    0.192
## May            1.173      1.492   0.786    0.432
## Jun           -0.788      0.387  -2.036    0.042
## Jul            1.064      1.171   0.909    0.364
## Aug           -0.646      0.341  -1.895    0.058
## Sep            4.044      3.276   1.234    0.217
## Oct            4.471      3.706   1.207    0.228
## Nov            3.729      3.051   1.222    0.222
## weekday=T      0.681      0.311   2.189    0.029
## strata1 Aug    3.522      2.236   1.575    0.115
## strata1 Dec    4.308      2.736   1.575    0.115
## strata1 Feb    2.548      1.624   1.570    0.117
## strata1 Jan   -1.633      1.907  -0.856    0.392
## strata1 Jul    2.334      1.433   1.629    0.104
## strata1 Jun    0.628      0.258   2.437    0.015
## strata1 Mar    1.117      0.388   2.880    0.004
## strata1 May   -1.448      1.763  -0.822    0.411
## strata1 Nov    5.095      3.346   1.523    0.128
## strata1 Oct    5.355      3.456   1.550    0.121
## strata1 Sep    4.681      3.028   1.546    0.122
```

```
kable(out$FixCoefMat, digits = 3)
```

| | Estimate | Std. Error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | 11.554 | 9.787 | 1.181 | 0.238 |
| temp | -0.197 | 0.156 | -1.269 | 0.205 |
| Jan | 2.270 | 2.310 | 0.983 | 0.326 |
| Feb | 3.283 | 2.679 | 1.226 | 0.220 |
| Mar | 1.991 | 2.019 | 0.986 | 0.324 |
| Apr | -2.335 | 1.791 | -1.304 | 0.192 |
| May | 1.173 | 1.492 | 0.786 | 0.432 |
| Jun | -0.788 | 0.387 | -2.036 | 0.042 |
| Jul | 1.064 | 1.171 | 0.909 | 0.364 |
| Aug | -0.646 | 0.341 | -1.895 | 0.058 |
| Sep | 4.044 | 3.276 | 1.234 | 0.217 |
| Oct | 4.471 | 3.706 | 1.207 | 0.228 |
| Nov | 3.729 | 3.051 | 1.222 | 0.222 |
| weekday=T | 0.681 | 0.311 | 2.189 | 0.029 |
| strata1 Aug | 3.522 | 2.236 | 1.575 | 0.115 |
| strata1 Dec | 4.308 | 2.736 | 1.575 | 0.115 |
| strata1 Feb | 2.548 | 1.624 | 1.570 | 0.117 |
| strata1 Jan | -1.633 | 1.907 | -0.856 | 0.392 |
| strata1 Jul | 2.334 | 1.433 | 1.629 | 0.104 |
| strata1 Jun | 0.628 | 0.258 | 2.437 | 0.015 |
| strata1 Mar | 1.117 | 0.388 | 2.880 | 0.004 |
| strata1 May | -1.448 | 1.763 | -0.822 | 0.411 |
| strata1 Nov | 5.095 | 3.346 | 1.523 | 0.128 |
| strata1 Oct | 5.355 | 3.456 | 1.550 | 0.121 |
| strata1 Sep | 4.681 | 3.028 | 1.546 | 0.122 |
| #### spatial | | | | |

```
X <-  model.matrix(ct ~ 1 + temp + strata , data = asthma.ag.month)
dimnames(X)[[2]][3:13] <- as.character(levels(asthma.ag.month$month))[1:11]
dimnames(X)[[2]][14] <- "weekday=T"
Z <- model.matrix(~ 1 + factor(nbhd), data = asthma.ag.month)
asthmaCAR_month<- hglm(y = asthma.ag.month$ct, X = X, Z = Z, family = quasipoisson(link = "log"),
                       rand.family = CAR(D = hausMat))
out = summary(asthmaCAR_month);round(out$FixCoefMat,3)
```

```
##             Estimate Std. Error t-value Pr(>|t|)
## (Intercept)    9.901      9.650   1.026    0.305
## temp          -0.137      0.154  -0.894    0.371
## Jan            1.385      2.283   0.606    0.544
## Feb            2.254      2.647   0.851    0.395
## Mar            1.218      1.995   0.610    0.542
## Apr           -1.649      1.770  -0.932    0.352
## May            0.606      1.475   0.411    0.681
## Jun           -0.668      0.383  -1.744    0.081
## Jul            0.621      1.157   0.537    0.591
## Aug           -0.547      0.337  -1.624    0.105
## Sep            2.783      3.239   0.859    0.390
## Oct            3.045      3.663   0.831    0.406
## Nov            2.556      3.016   0.847    0.397
## weekday=T      0.782      0.308   2.538    0.011
## strata1 Aug    2.662      2.210   1.205    0.228
## strata1 Dec    3.256      2.704   1.204    0.229
```

```
## strata1 Feb    1.926      1.605   1.200    0.230
## strata1 Jan   -0.901      1.885  -0.478    0.633
## strata1 Jul    1.787      1.417   1.261    0.207
## strata1 Jun    0.561      0.255   2.197    0.028
## strata1 Mar    0.984      0.383   2.567    0.010
## strata1 May   -0.772      1.743  -0.443    0.658
## strata1 Nov    3.807      3.308   1.151    0.250
## strata1 Oct    4.025      3.416   1.178    0.239
## strata1 Sep    3.515      2.994   1.174    0.240
```

```
kable(out$FixCoefMat, digits = 3)
```

| | Estimate | Std. Error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | 9.901 | 9.650 | 1.026 | 0.305 |
| temp | -0.137 | 0.154 | -0.894 | 0.371 |
| Jan | 1.385 | 2.283 | 0.606 | 0.544 |
| Feb | 2.254 | 2.647 | 0.851 | 0.395 |
| Mar | 1.218 | 1.995 | 0.610 | 0.542 |
| Apr | -1.649 | 1.770 | -0.932 | 0.352 |
| May | 0.606 | 1.475 | 0.411 | 0.681 |
| Jun | -0.668 | 0.383 | -1.744 | 0.081 |
| Jul | 0.621 | 1.157 | 0.537 | 0.591 |
| Aug | -0.547 | 0.337 | -1.624 | 0.105 |
| Sep | 2.783 | 3.239 | 0.859 | 0.390 |
| Oct | 3.045 | 3.663 | 0.831 | 0.406 |
| Nov | 2.556 | 3.016 | 0.847 | 0.397 |
| weekday=T | 0.782 | 0.308 | 2.538 | 0.011 |
| strata1 Aug | 2.662 | 2.210 | 1.205 | 0.228 |
| strata1 Dec | 3.256 | 2.704 | 1.204 | 0.229 |
| strata1 Feb | 1.926 | 1.605 | 1.200 | 0.230 |
| strata1 Jan | -0.901 | 1.885 | -0.478 | 0.633 |
| strata1 Jul | 1.787 | 1.417 | 1.261 | 0.207 |
| strata1 Jun | 0.561 | 0.255 | 2.197 | 0.028 |
| strata1 Mar | 0.984 | 0.383 | 2.567 | 0.010 |
| strata1 May | -0.772 | 1.743 | -0.443 | 0.658 |
| strata1 Nov | 3.807 | 3.308 | 1.151 | 0.250 |
| strata1 Oct | 4.025 | 3.416 | 1.178 | 0.239 |
| strata1 Sep | 3.515 | 2.994 | 1.174 | 0.240 |

### Model with ozone and temp

#### non-spatial

```
X <-  model.matrix(ct ~ 1 + temp + ozone + strata , data = asthma.ag.month)
#dimnames(X)[[2]][4:14] <- as.character(levels(asthma.ag$month))[1:11]
#dimnames(X)[[2]][15] <- "weekday=T"
Z <- model.matrix(~ 1 + factor(nbhd), data = asthma.ag.month)
asthmaCAR_month<- hglm(y = asthma.ag.month$ct, X = X, Z = Z, family = quasipoisson(link = "log"),
                       rand.family = gaussian())

out = summary(asthmaCAR_month);round(out$FixCoefMat,3)
```

```
##             Estimate Std. Error t-value Pr(>|t|)
```

```
## (Intercept)   10.419      9.841   1.059    0.290
## temp          -0.167      0.158  -1.059    0.290
## ozone         -0.045      0.041  -1.082    0.279
## strata0 Aug    2.308      2.310   0.999    0.318
## strata0 Dec    3.124      2.682   1.165    0.244
## strata0 Feb    2.141      2.022   1.059    0.290
## strata0 Jan   -1.914      1.832  -1.045    0.296
## strata0 Jul    1.338      1.499   0.892    0.372
## strata0 Jun   -0.428      0.510  -0.839    0.401
## strata0 Mar    1.203      1.178   1.021    0.307
## strata0 May   -0.163      0.561  -0.291    0.771
## strata0 Nov    4.024      3.276   1.228    0.219
## strata0 Oct    3.900      3.742   1.042    0.297
## strata0 Sep    3.605      3.053   1.181    0.238
## strata1 Apr    0.781      0.325   2.405    0.016
## strata1 Aug    3.499      2.235   1.565    0.118
## strata1 Dec    4.062      2.745   1.480    0.139
## strata1 Feb    2.727      1.632   1.671    0.095
## strata1 Jan   -1.281      1.934  -0.662    0.508
## strata1 Jul    2.477      1.439   1.722    0.085
## strata1 Jun    0.731      0.275   2.663    0.008
## strata1 Mar    1.124      0.388   2.900    0.004
## strata1 May   -1.005      1.809  -0.556    0.579
## strata1 Nov    4.970      3.347   1.485    0.138
## strata1 Oct    4.664      3.513   1.328    0.184
## strata1 Sep    4.354      3.042   1.431    0.153
```

```
kable(out$FixCoefMat, digits = 3)
```

| | Estimate | Std. Error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | 10.419 | 9.841 | 1.059 | 0.290 |
| temp | -0.167 | 0.158 | -1.059 | 0.290 |
| ozone | -0.045 | 0.041 | -1.082 | 0.279 |
| strata0 Aug | 2.308 | 2.310 | 0.999 | 0.318 |
| strata0 Dec | 3.124 | 2.682 | 1.165 | 0.244 |
| strata0 Feb | 2.141 | 2.022 | 1.059 | 0.290 |
| strata0 Jan | -1.914 | 1.832 | -1.045 | 0.296 |
| strata0 Jul | 1.338 | 1.499 | 0.892 | 0.372 |
| strata0 Jun | -0.428 | 0.510 | -0.839 | 0.401 |
| strata0 Mar | 1.203 | 1.178 | 1.021 | 0.307 |
| strata0 May | -0.163 | 0.561 | -0.291 | 0.771 |
| strata0 Nov | 4.024 | 3.276 | 1.228 | 0.219 |
| strata0 Oct | 3.900 | 3.742 | 1.042 | 0.297 |
| strata0 Sep | 3.605 | 3.053 | 1.181 | 0.238 |
| strata1 Apr | 0.781 | 0.325 | 2.405 | 0.016 |
| strata1 Aug | 3.499 | 2.235 | 1.565 | 0.118 |
| strata1 Dec | 4.062 | 2.745 | 1.480 | 0.139 |
| strata1 Feb | 2.727 | 1.632 | 1.671 | 0.095 |
| strata1 Jan | -1.281 | 1.934 | -0.662 | 0.508 |
| strata1 Jul | 2.477 | 1.439 | 1.722 | 0.085 |
| strata1 Jun | 0.731 | 0.275 | 2.663 | 0.008 |
| strata1 Mar | 1.124 | 0.388 | 2.900 | 0.004 |
| strata1 May | -1.005 | 1.809 | -0.556 | 0.579 |
| strata1 Nov | 4.970 | 3.347 | 1.485 | 0.138 |

| | Estimate | Std. Error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| strata1 Oct | 4.664 | 3.513 | 1.328 | 0.184 |
| strata1 Sep | 4.354 | 3.042 | 1.431 | 0.153 |
| #### spatial | | | | |

```
X <-  model.matrix(ct ~ 1 + temp + ozone + strata , data = asthma.ag.month)
#dimnames(X)[[2]][4:14] <- as.character(levels(asthma.ag$month))[1:11]
#dimnames(X)[[2]][15] <- "weekday=T"
Z <- model.matrix(~ 1 + factor(nbhd), data = asthma.ag.month)
asthmaCAR_month<- hglm(y = asthma.ag.month$ct, X = X, Z = Z, family = quasipoisson(link = "log"),
                       rand.family = CAR(D = hausMat))

out = summary(asthmaCAR_month);round(out$FixCoefMat,3)
```

```
##              Estimate Std. Error t-value Pr(>|t|)
## (Intercept)     8.648      9.705   0.891    0.373
## temp           -0.105      0.156  -0.670    0.503
## ozone          -0.048      0.041  -1.172    0.241
## strata0 Aug     1.418      2.283   0.621    0.534
## strata0 Dec     2.074      2.650   0.783    0.434
## strata0 Feb     1.373      1.998   0.687    0.492
## strata0 Jan    -1.191      1.812  -0.657    0.511
## strata0 Jul     0.779      1.482   0.526    0.599
## strata0 Jun    -0.280      0.506  -0.554    0.579
## strata0 Mar     0.767      1.164   0.659    0.510
## strata0 May    -0.028      0.556  -0.051    0.959
## strata0 Nov     2.752      3.238   0.850    0.395
## strata0 Oct     2.420      3.699   0.654    0.513
## strata0 Sep     2.413      3.018   0.800    0.424
## strata1 Apr     0.889      0.321   2.768    0.006
## strata1 Aug     2.631      2.209   1.191    0.234
## strata1 Dec     2.983      2.713   1.099    0.272
## strata1 Feb     2.113      1.612   1.311    0.190
## strata1 Jan    -0.517      1.912  -0.270    0.787
## strata1 Jul     1.936      1.422   1.361    0.174
## strata1 Jun     0.671      0.272   2.469    0.014
## strata1 Mar     0.991      0.383   2.586    0.010
## strata1 May    -0.291      1.789  -0.162    0.871
## strata1 Nov     3.662      3.309   1.107    0.268
## strata1 Oct     3.272      3.473   0.942    0.346
## strata1 Sep     3.155      3.008   1.049    0.294
```

```
kable(out$FixCoefMat, digits = 3)
```

| | Estimate | Std. Error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | 8.648 | 9.705 | 0.891 | 0.373 |
| temp | -0.105 | 0.156 | -0.670 | 0.503 |
| ozone | -0.048 | 0.041 | -1.172 | 0.241 |
| strata0 Aug | 1.418 | 2.283 | 0.621 | 0.534 |
| strata0 Dec | 2.074 | 2.650 | 0.783 | 0.434 |
| strata0 Feb | 1.373 | 1.998 | 0.687 | 0.492 |
| strata0 Jan | -1.191 | 1.812 | -0.657 | 0.511 |
| strata0 Jul | 0.779 | 1.482 | 0.526 | 0.599 |

| | Estimate | Std. Error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| strata0 Jun | -0.280 | 0.506 | -0.554 | 0.579 |
| strata0 Mar | 0.767 | 1.164 | 0.659 | 0.510 |
| strata0 May | -0.028 | 0.556 | -0.051 | 0.959 |
| strata0 Nov | 2.752 | 3.238 | 0.850 | 0.395 |
| strata0 Oct | 2.420 | 3.699 | 0.654 | 0.513 |
| strata0 Sep | 2.413 | 3.018 | 0.800 | 0.424 |
| strata1 Apr | 0.889 | 0.321 | 2.768 | 0.006 |
| strata1 Aug | 2.631 | 2.209 | 1.191 | 0.234 |
| strata1 Dec | 2.983 | 2.713 | 1.099 | 0.272 |
| strata1 Feb | 2.113 | 1.612 | 1.311 | 0.190 |
| strata1 Jan | -0.517 | 1.912 | -0.270 | 0.787 |
| strata1 Jul | 1.936 | 1.422 | 1.361 | 0.174 |
| strata1 Jun | 0.671 | 0.272 | 2.469 | 0.014 |
| strata1 Mar | 0.991 | 0.383 | 2.586 | 0.010 |
| strata1 May | -0.291 | 1.789 | -0.162 | 0.871 |
| strata1 Nov | 3.662 | 3.309 | 1.107 | 0.268 |
| strata1 Oct | 3.272 | 3.473 | 0.942 | 0.346 |
| strata1 Sep | 3.155 | 3.008 | 1.049 | 0.294 |

```
## non wpq5iql
asthmaCAR_month<- hglm(y = asthma.ag.month$ct, X = X, Z = Z, family = quasipoisson(link = "log"),
                       rand.family = gaussian())

out = summary(asthmaCAR_month);#round(out$FixCoefMat,3)
kable(out$FixCoefMat, digits = 3)
```

| | Estimate | Std. Error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | 10.419 | 9.841 | 1.059 | 0.290 |
| temp | -0.167 | 0.158 | -1.059 | 0.290 |
| ozone | -0.045 | 0.041 | -1.082 | 0.279 |
| strata0 Aug | 2.308 | 2.310 | 0.999 | 0.318 |
| strata0 Dec | 3.124 | 2.682 | 1.165 | 0.244 |
| strata0 Feb | 2.141 | 2.022 | 1.059 | 0.290 |
| strata0 Jan | -1.914 | 1.832 | -1.045 | 0.296 |
| strata0 Jul | 1.338 | 1.499 | 0.892 | 0.372 |
| strata0 Jun | -0.428 | 0.510 | -0.839 | 0.401 |
| strata0 Mar | 1.203 | 1.178 | 1.021 | 0.307 |
| strata0 May | -0.163 | 0.561 | -0.291 | 0.771 |
| strata0 Nov | 4.024 | 3.276 | 1.228 | 0.219 |
| strata0 Oct | 3.900 | 3.742 | 1.042 | 0.297 |
| strata0 Sep | 3.605 | 3.053 | 1.181 | 0.238 |
| strata1 Apr | 0.781 | 0.325 | 2.405 | 0.016 |
| strata1 Aug | 3.499 | 2.235 | 1.565 | 0.118 |
| strata1 Dec | 4.062 | 2.745 | 1.480 | 0.139 |
| strata1 Feb | 2.727 | 1.632 | 1.671 | 0.095 |
| strata1 Jan | -1.281 | 1.934 | -0.662 | 0.508 |
| strata1 Jul | 2.477 | 1.439 | 1.722 | 0.085 |
| strata1 Jun | 0.731 | 0.275 | 2.663 | 0.008 |
| strata1 Mar | 1.124 | 0.388 | 2.900 | 0.004 |
| strata1 May | -1.005 | 1.809 | -0.556 | 0.579 |
| strata1 Nov | 4.970 | 3.347 | 1.485 | 0.138 |

| | Estimate | Std. Error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| strata1 Oct | 4.664 | 3.513 | 1.328 | 0.184 |
| strata1 Sep | 4.354 | 3.042 | 1.431 | 0.153 |

## Strata: month, time of day

### Model with ozone

```
asthma.ag.tod$strata = factor(paste(asthma.ag.tod$time_of_day,
                                    asthma.ag.tod$month))
X <-  model.matrix(ct ~ 1 + ozone +strata , data = asthma.ag.tod)
#dimnames(X)[[2]][3:13] <- as.character(levels(asthma.ag.tod$month))[1:11]
#dimnames(X)[[2]][14:16] <- c("morning", "midday", "afternoon/evening")
Z <- model.matrix(~ 1 + factor(nbhd), data = asthma.ag.tod)
asthmaCAR_month<- hglm(y = asthma.ag.tod$ct, X = X, Z = Z, family = quasipoisson(link = "log"),
                       rand.family = CAR(D = hausMat))

out = summary(asthmaCAR_month);round(out$FixCoefMat, 3)
```

```
##                Estimate Std. Error t-value Pr(>|t|)
## (Intercept)       1.437      1.384   1.038    0.300
## ozone             0.110      0.067   1.642    0.102
## stratamidday     -0.216      0.441  -0.490    0.625
## stratamorning    -2.317      1.408  -1.646    0.101
## stratanight      -0.077      0.607  -0.127    0.899
```

```
kable(out$FixCoefMat, digits = 3)
```

| | Estimate | Std. Error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | 1.437 | 1.384 | 1.038 | 0.300 |
| ozone | 0.110 | 0.067 | 1.642 | 0.102 |
| stratamidday | -0.216 | 0.441 | -0.490 | 0.625 |
| stratamorning | -2.317 | 1.408 | -1.646 | 0.101 |
| stratanight | -0.077 | 0.607 | -0.127 | 0.899 |

```
asthmaCAR_month<- hglm(y = asthma.ag.tod$ct, X = X, Z = Z, family = quasipoisson(link = "log"),
                       rand.family = gaussian())

out = summary(asthmaCAR_month);round(out$FixCoefMat, 3)
```

```
##                Estimate Std. Error t-value Pr(>|t|)
## (Intercept)      -0.569      1.359  -0.418    0.676
## ozone             0.100      0.069   1.440    0.151
## stratamidday     -0.150      0.457  -0.329    0.743
## stratamorning    -2.101      1.454  -1.444    0.150
## stratanight       0.016      0.628   0.025    0.980
```

```
kable(out$FixCoefMat, digits = 3)
```

| | Estimate | Std. Error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | -0.569 | 1.359 | -0.418 | 0.676 |

| | Estimate | Std. Error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| ozone | 0.100 | 0.069 | 1.440 | 0.151 |
| stratamidday | -0.150 | 0.457 | -0.329 | 0.743 |
| stratamorning | -2.101 | 1.454 | -1.444 | 0.150 |
| strata night | 0.016 | 0.628 | 0.025 | 0.980 |

### Model with temp

```
X <-  model.matrix(ct ~ 1 + temp + strata, data = asthma.ag.tod)
# dimnames(X)[[2]][3:13] <- as.character(levels(asthma.ag.tod$month))[1:11]
# dimnames(X)[[2]][14:16] <- c("morning", "midday", "afternoon/evening")
Z <- model.matrix(~ 1 + factor(nbhd), data = asthma.ag.tod)
asthmaCAR_month<- hglm(y = asthma.ag.tod$ct, X = X, Z = Z, family = quasipoisson(link = "log"),
                       rand.family = CAR(D = hausMat))

out = summary(asthmaCAR_month);round(out$FixCoefMat,3)
```

```
##                Estimate Std. Error t-value Pr(>|t|)
## (Intercept)     -11.572     11.741  -0.986    0.325
## temp              0.219      0.176   1.239    0.216
## stratamidday     -0.273      0.624  -0.438    0.662
## stratamorning    -2.131      1.713  -1.244    0.214
## strata night      0.001      0.738   0.002    0.998
```

```
asthmaCAR_month<- hglm(y = asthma.ag.tod$ct, X = X, Z = Z, family = quasipoisson(link = "log"),
                       rand.family = gaussian())

out = summary(asthmaCAR_month);round(out$FixCoefMat,3)
```

```
##                Estimate Std. Error t-value Pr(>|t|)
## (Intercept)     -10.146     12.384  -0.819    0.413
## temp              0.165      0.186   0.886    0.376
## stratamidday     -0.085      0.657  -0.129    0.898
## stratamorning    -1.608      1.804  -0.892    0.373
## strata night      0.226      0.777   0.290    0.772
```

```
#kable(out$FixCoefMat, digits = 3)
```

### Model with ozone and temp

```
X <-  model.matrix(ct ~ 1 + temp + ozone + strata, data = asthma.ag.tod)
# dimnames(X)[[2]][4:14] <- as.character(levels(asthma.ag.tod$month))[1:11]
# dimnames(X)[[2]][15:17] <- c("morning", "midday", "afternoon/evening")
Z <- model.matrix(~ 1 + factor(nbhd), data = asthma.ag.tod)
asthmaCAR_month<- hglm(y = asthma.ag.tod$ct, X = X, Z = Z, family = quasipoisson(link = "log"),
                       rand.family = CAR(D = hausMat))

out = summary(asthmaCAR_month);round(out$FixCoefMat,3)
```

```
##                Estimate Std. Error t-value Pr(>|t|)
## (Intercept)      -5.668     12.684  -0.447    0.655
## temp              0.111      0.197   0.563    0.574
```

```
## ozone             0.091      0.075   1.220    0.223
## stratamidday     -0.485      0.646  -0.751    0.453
## stratamorning    -3.005      1.853  -1.622    0.106
## stratanight      -0.372      0.797  -0.467    0.641
```

```
kable(out$FixCoefMat, digits = 3)
```

| | Estimate | Std. Error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | -5.668 | 12.684 | -0.447 | 0.655 |
| temp | 0.111 | 0.197 | 0.563 | 0.574 |
| ozone | 0.091 | 0.075 | 1.220 | 0.223 |
| stratamidday | -0.485 | 0.646 | -0.751 | 0.453 |
| stratamorning | -3.005 | 1.853 | -1.622 | 0.106 |
| stratanight | -0.372 | 0.797 | -0.467 | 0.641 |

```
asthmaCAR_month<- hglm(y = asthma.ag.tod$ct, X = X, Z = Z, family = quasipoisson(link = "log"),
                       rand.family = gaussian())

out = summary(asthmaCAR_month);round(out$FixCoefMat,3)
```

```
##                Estimate Std. Error t-value Pr(>|t|)
## (Intercept)      -4.685     13.219  -0.354    0.723
## temp              0.064      0.205   0.313    0.755
## ozone             0.090      0.077   1.172    0.242
## stratamidday     -0.310      0.682  -0.454    0.650
## stratamorning    -2.511      1.953  -1.286    0.200
## stratanight      -0.160      0.841  -0.191    0.849
```

```
kable(out$FixCoefMat, digits = 3)
```

| | Estimate | Std. Error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | -4.685 | 13.219 | -0.354 | 0.723 |
| temp | 0.064 | 0.205 | 0.313 | 0.755 |
| ozone | 0.090 | 0.077 | 1.172 | 0.242 |
| stratamidday | -0.310 | 0.682 | -0.454 | 0.650 |
| stratamorning | -2.511 | 1.953 | -1.286 | 0.200 |
| stratanight | -0.160 | 0.841 | -0.191 | 0.849 |

### Strata: month

### Model with Temp

```
X <-  model.matrix(ct ~ 1 + temp + factor(month), data = asthma.ag.month)
#dimnames(X)[[2]][3:13] <- as.character(levels(asthma.ag.month$month))[1:11]
Z <- model.matrix(~ 1 + factor(nbhd), data = asthma.ag.month)
asthmaCAR_month<- hglm(y = asthma.ag.month$ct, X = X, Z = Z, family = quasipoisson(link = "log"),
                       rand.family = CAR(D = hausMat))

out = summary(asthmaCAR_month)
kable(out$FixCoefMat, digits = 3)
```

| | Estimate | Std. Error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | 12.706 | 1.683 | 7.550 | 0.000 |
| temp | -0.157 | 0.019 | -8.466 | 0.000 |
| factor(month).L | 4.901 | 0.571 | 8.587 | 0.000 |
| factor(month).Q | 0.706 | 0.113 | 6.227 | 0.000 |
| factor(month).C | -1.006 | 0.158 | -6.385 | 0.000 |
| factor(month)^4 | -2.835 | 0.329 | -8.627 | 0.000 |
| factor(month)^5 | 1.953 | 0.288 | 6.790 | 0.000 |
| factor(month)^6 | -0.385 | 0.133 | -2.896 | 0.004 |
| factor(month)^7 | -0.064 | 0.095 | -0.671 | 0.502 |
| factor(month)^8 | 0.015 | 0.095 | 0.161 | 0.872 |
| factor(month)^9 | 0.595 | 0.112 | 5.321 | 0.000 |
| factor(month)^10 | -0.504 | 0.113 | -4.466 | 0.000 |
| factor(month)^11 | 0.072 | 0.102 | 0.712 | 0.476 |

```
asthmaCAR_month<- hglm(y = asthma.ag.month$ct, X = X, Z = Z, family = quasipoisson(link = "log"),
                       rand.family = gaussian())

out = summary(asthmaCAR_month)
kable(out$FixCoefMat, digits = 3)
```

| | Estimate | Std. Error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | 10.656 | 1.691 | 6.301 | 0.000 |
| temp | -0.158 | 0.019 | -8.415 | 0.000 |
| factor(month).L | 4.924 | 0.577 | 8.534 | 0.000 |
| factor(month).Q | 0.709 | 0.115 | 6.189 | 0.000 |
| factor(month).C | -1.011 | 0.159 | -6.350 | 0.000 |
| factor(month)^4 | -2.848 | 0.332 | -8.574 | 0.000 |
| factor(month)^5 | 1.964 | 0.291 | 6.755 | 0.000 |
| factor(month)^6 | -0.389 | 0.134 | -2.897 | 0.004 |
| factor(month)^7 | -0.064 | 0.095 | -0.669 | 0.503 |
| factor(month)^8 | 0.016 | 0.095 | 0.167 | 0.867 |
| factor(month)^9 | 0.598 | 0.113 | 5.291 | 0.000 |
| factor(month)^10 | -0.506 | 0.114 | -4.443 | 0.000 |
| factor(month)^11 | 0.073 | 0.103 | 0.713 | 0.476 |

## Model with ozone

```
X <-  model.matrix(ct ~ 1 + ozone + factor(month), data = asthma.ag.month)
#dimnames(X)[[2]][3:13] <- as.character(levels(asthma.ag.month$month))[1:11]
Z <- model.matrix(~ 1 + factor(nbhd), data = asthma.ag.month)
asthmaCAR_month<- hglm(y = asthma.ag.month$ct, X = X, Z = Z, family = quasipoisson(link = "log"),
                       rand.family = CAR(D = hausMat))

out = summary(asthmaCAR_month);round(out$FixCoefMat, 3)
```

```
##                  Estimate Std. Error t-value Pr(>|t|)
## (Intercept)         6.238      1.140   5.471    0.000
## ozone              -0.202      0.015 -13.253    0.000
## factor(month).L     1.173      0.116  10.088    0.000
```

```
## factor(month).Q     0.150      0.090   1.668    0.095
## factor(month).C    -0.092      0.087  -1.059    0.290
## factor(month)^4    -0.366      0.091  -4.016    0.000
## factor(month)^5     0.910      0.131   6.966    0.000
## factor(month)^6    -1.506      0.174  -8.634    0.000
## factor(month)^7    -0.603      0.103  -5.841    0.000
## factor(month)^8    -1.240      0.125  -9.921    0.000
## factor(month)^9    -0.275      0.090  -3.045    0.002
## factor(month)^10    0.023      0.089   0.255    0.799
## factor(month)^11   -0.499      0.102  -4.889    0.000
```

```
kable(out$FixCoefMat, digits = 3)
```

| | Estimate | Std. Error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | 6.238 | 1.140 | 5.471 | 0.000 |
| ozone | -0.202 | 0.015 | -13.253 | 0.000 |
| factor(month).L | 1.173 | 0.116 | 10.088 | 0.000 |
| factor(month).Q | 0.150 | 0.090 | 1.668 | 0.095 |
| factor(month).C | -0.092 | 0.087 | -1.059 | 0.290 |
| factor(month)^4 | -0.366 | 0.091 | -4.016 | 0.000 |
| factor(month)^5 | 0.910 | 0.131 | 6.966 | 0.000 |
| factor(month)^6 | -1.506 | 0.174 | -8.634 | 0.000 |
| factor(month)^7 | -0.603 | 0.103 | -5.841 | 0.000 |
| factor(month)^8 | -1.240 | 0.125 | -9.921 | 0.000 |
| factor(month)^9 | -0.275 | 0.090 | -3.045 | 0.002 |
| factor(month)^10 | 0.023 | 0.089 | 0.255 | 0.799 |
| factor(month)^11 | -0.499 | 0.102 | -4.889 | 0.000 |

```
asthmaCAR_month<- hglm(y = asthma.ag.month$ct, X = X, Z = Z, family = quasipoisson(link = "log"),
                       rand.family = gaussian())

out = summary(asthmaCAR_month);round(out$FixCoefMat, 3)
```

```
##                   Estimate Std. Error t-value Pr(>|t|)
## (Intercept)          4.138      1.146   3.612    0.000
## ozone               -0.202      0.015 -13.120    0.000
## factor(month).L      1.170      0.117   9.974    0.000
## factor(month).Q      0.151      0.091   1.661    0.097
## factor(month).C     -0.089      0.087  -1.023    0.306
## factor(month)^4     -0.365      0.092  -3.970    0.000
## factor(month)^5      0.910      0.132   6.896    0.000
## factor(month)^6     -1.503      0.176  -8.542    0.000
## factor(month)^7     -0.603      0.104  -5.785    0.000
## factor(month)^8     -1.239      0.126  -9.821    0.000
## factor(month)^9     -0.274      0.091  -3.013    0.003
## factor(month)^10     0.023      0.090   0.258    0.797
## factor(month)^11    -0.499      0.103  -4.841    0.000
```

```
kable(out$FixCoefMat, digits = 3)
```

| | Estimate | Std. Error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | 4.138 | 1.146 | 3.612 | 0.000 |
| ozone | -0.202 | 0.015 | -13.120 | 0.000 |

| | Estimate | Std. Error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| factor(month).L | 1.170 | 0.117 | 9.974 | 0.000 |
| factor(month).Q | 0.151 | 0.091 | 1.661 | 0.097 |
| factor(month).C | -0.089 | 0.087 | -1.023 | 0.306 |
| factor(month)^4 | -0.365 | 0.092 | -3.970 | 0.000 |
| factor(month)^5 | 0.910 | 0.132 | 6.896 | 0.000 |
| factor(month)^6 | -1.503 | 0.176 | -8.542 | 0.000 |
| factor(month)^7 | -0.603 | 0.104 | -5.785 | 0.000 |
| factor(month)^8 | -1.239 | 0.126 | -9.821 | 0.000 |
| factor(month)^9 | -0.274 | 0.091 | -3.013 | 0.003 |
| factor(month)^10 | 0.023 | 0.090 | 0.258 | 0.797 |
| factor(month)^11 | -0.499 | 0.103 | -4.841 | 0.000 |

### Model with temp and ozone

```
X <-  model.matrix(ct ~ 1 + temp + ozone + factor(month), data = asthma.ag.month)
#dimnames(X)[[2]][4:14] <- as.character(levels(asthma.ag.month$month))[1:11]
Z <- model.matrix(~ 1 + factor(nbhd), data = asthma.ag.month)
asthmaCAR_month<- hglm(y = asthma.ag.month$ct, X = X, Z = Z, family = quasipoisson(link = "log"),
                       rand.family = CAR(D = hausMat))

out = summary(asthmaCAR_month);round(out$FixCoefMat,3)
```

```
##                   Estimate Std. Error t-value Pr(>|t|)
## (Intercept)          7.816      1.787   4.373    0.000
## temp                -0.026      0.023  -1.152    0.249
## ozone               -0.190      0.018 -10.330    0.000
## factor(month).L      1.912      0.653   2.925    0.003
## factor(month).Q      0.236      0.117   2.011    0.045
## factor(month).C     -0.264      0.174  -1.519    0.129
## factor(month)^4     -0.792      0.381  -2.077    0.038
## factor(month)^5      1.216      0.299   4.065    0.000
## factor(month)^6     -1.533      0.178  -8.597    0.000
## factor(month)^7     -0.576      0.106  -5.449    0.000
## factor(month)^8     -1.149      0.147  -7.798    0.000
## factor(month)^9     -0.169      0.129  -1.316    0.188
## factor(month)^10    -0.080      0.127  -0.636    0.525
## factor(month)^11    -0.433      0.116  -3.730    0.000
```

```
kable(out$FixCoefMat, digits = 3)
```

| | Estimate | Std. Error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | 7.816 | 1.787 | 4.373 | 0.000 |
| temp | -0.026 | 0.023 | -1.152 | 0.249 |
| ozone | -0.190 | 0.018 | -10.330 | 0.000 |
| factor(month).L | 1.912 | 0.653 | 2.925 | 0.003 |
| factor(month).Q | 0.236 | 0.117 | 2.011 | 0.045 |
| factor(month).C | -0.264 | 0.174 | -1.519 | 0.129 |
| factor(month)^4 | -0.792 | 0.381 | -2.077 | 0.038 |
| factor(month)^5 | 1.216 | 0.299 | 4.065 | 0.000 |
| factor(month)^6 | -1.533 | 0.178 | -8.597 | 0.000 |
| factor(month)^7 | -0.576 | 0.106 | -5.449 | 0.000 |

| | Estimate | Std. Error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| factor(month)^8 | -1.149 | 0.147 | -7.798 | 0.000 |
| factor(month)^9 | -0.169 | 0.129 | -1.316 | 0.188 |
| factor(month)^10 | -0.080 | 0.127 | -0.636 | 0.525 |
| factor(month)^11 | -0.433 | 0.116 | -3.730 | 0.000 |

```
asthmaCAR_month<- hglm(y = asthma.ag.month$ct, X = X, Z = Z, family = quasipoisson(link = "log"),
                       rand.family = gaussian())

out = summary(asthmaCAR_month);round(out$FixCoefMat,3)
```

```
##                   Estimate Std. Error t-value Pr(>|t|)
## (Intercept)          5.804      1.804   3.217    0.001
## temp                -0.028      0.023  -1.202    0.230
## ozone               -0.189      0.019 -10.197    0.000
## factor(month).L      1.948      0.661   2.949    0.003
## factor(month).Q      0.241      0.119   2.036    0.042
## factor(month).C     -0.271      0.176  -1.543    0.123
## factor(month)^4     -0.814      0.385  -2.113    0.035
## factor(month)^5      1.233      0.303   4.074    0.000
## factor(month)^6     -1.532      0.180  -8.507    0.000
## factor(month)^7     -0.575      0.107  -5.385    0.000
## factor(month)^8     -1.143      0.149  -7.691    0.000
## factor(month)^9     -0.163      0.130  -1.257    0.209
## factor(month)^10    -0.086      0.128  -0.669    0.504
## factor(month)^11    -0.429      0.117  -3.666    0.000
```

```
kable(out$FixCoefMat, digits = 3)
```

| | Estimate | Std. Error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | 5.804 | 1.804 | 3.217 | 0.001 |
| temp | -0.028 | 0.023 | -1.202 | 0.230 |
| ozone | -0.189 | 0.019 | -10.197 | 0.000 |
| factor(month).L | 1.948 | 0.661 | 2.949 | 0.003 |
| factor(month).Q | 0.241 | 0.119 | 2.036 | 0.042 |
| factor(month).C | -0.271 | 0.176 | -1.543 | 0.123 |
| factor(month)^4 | -0.814 | 0.385 | -2.113 | 0.035 |
| factor(month)^5 | 1.233 | 0.303 | 4.074 | 0.000 |
| factor(month)^6 | -1.532 | 0.180 | -8.507 | 0.000 |
| factor(month)^7 | -0.575 | 0.107 | -5.385 | 0.000 |
| factor(month)^8 | -1.143 | 0.149 | -7.691 | 0.000 |
| factor(month)^9 | -0.163 | 0.130 | -1.257 | 0.209 |
| factor(month)^10 | -0.086 | 0.128 | -0.669 | 0.504 |
| factor(month)^11 | -0.429 | 0.117 | -3.666 | 0.000 |

### Strata: time of day/weekday indicator

### Model with Temp

```
asthma.ag.tod.wk$strata = factor(paste(asthma.ag.tod.wk$weekday_ind,
                                       asthma.ag.tod.wk$time_of_day))
X <-  model.matrix(ct ~ 1 + temp + strata, data = asthma.ag.tod.wk)
#dimnames(X)[[2]][3:5] <-c("morning", "midday", "afternoon/evening")
#dimnames(X)[[2]][6] <- "weekday=T"
Z <- model.matrix(~ 1 + factor(nbhd), data = asthma.ag.tod.wk)
asthmaCAR_month<- hglm(y = asthma.ag.tod.wk$ct, X = X, Z = Z, family = quasipoisson(link = "log"),
                       rand.family = CAR(D = hausMat))

out = summary(asthmaCAR_month)
kable(out$FixCoefMat, digits = 3)
```

| | Estimate | Std. Error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | -16.094 | 10.771 | -1.494 | 0.136 |
| temp | 0.264 | 0.161 | 1.645 | 0.100 |
| strata0 midday | -0.624 | 0.727 | -0.859 | 0.391 |
| strata0 morning | -2.821 | 1.781 | -1.584 | 0.114 |
| strata0 night | -0.027 | 0.735 | -0.037 | 0.970 |
| strata1 afternoon/evening | 1.379 | 0.191 | 7.207 | 0.000 |
| strata1 midday | 1.027 | 0.431 | 2.384 | 0.017 |
| strata1 morning | -1.088 | 1.379 | -0.789 | 0.431 |
| strata1 night | 1.138 | 0.566 | 2.011 | 0.045 |

```
asthmaCAR_month<- hglm(y = asthma.ag.tod.wk$ct, X = X, Z = Z, family = quasipoisson(link = "log"),
                       rand.family = gaussian())

out = summary(asthmaCAR_month)
kable(out$FixCoefMat, digits = 3)
```

| | Estimate | Std. Error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | -14.505 | 11.086 | -1.308 | 0.191 |
| temp | 0.208 | 0.165 | 1.258 | 0.209 |
| strata0 midday | -0.376 | 0.748 | -0.502 | 0.616 |
| strata0 morning | -2.196 | 1.830 | -1.200 | 0.230 |
| strata0 night | 0.226 | 0.756 | 0.299 | 0.765 |
| strata1 afternoon/evening | 1.343 | 0.197 | 6.812 | 0.000 |
| strata1 midday | 1.169 | 0.443 | 2.636 | 0.009 |
| strata1 morning | -0.604 | 1.417 | -0.426 | 0.670 |
| strata1 night | 1.331 | 0.582 | 2.288 | 0.022 |

## Model with ozone

```
asthma.ag.tod.wk$strata = factor(paste(asthma.ag.tod.wk$weekday_ind,
                                       asthma.ag.tod.wk$time_of_day))
asthma.ag.tod.wk$strata <- factor(asthma.ag.tod.wk$strata, levels(asthma.ag.tod.wk$strata)[c(7,1,2,3,4,5
X <-  model.matrix(ct ~ 1 + ozone +strata, data = asthma.ag.tod.wk)
# dimnames(X)[[2]][3:5] <-c("morning", "midday", "afternoon/evening")
# dimnames(X)[[2]][6] <- "weekday=T"
Z <- model.matrix(~ 1 + factor(nbhd), data = asthma.ag.tod.wk)
```

```
asthmaCAR_month<- hglm(y = asthma.ag.tod.wk$ct, X = X, Z = Z, family = quasipoisson(link = "log"),
                       rand.family = CAR(D = hausMat))

out = summary(asthmaCAR_month);round(out$FixCoefMat, 3)
```

```
##                            Estimate Std. Error t-value Pr(>|t|)
## (Intercept)                  -1.584      2.224  -0.712    0.476
## ozone                         0.130      0.059   2.201    0.028
## strata0 afternoon/evening     1.231      1.101   1.118    0.264
## strata0 midday                0.825      0.674   1.224    0.221
## strata0 morning              -1.703      0.325  -5.234    0.000
## strata0 night                 1.094      0.516   2.118    0.035
## strata1 afternoon/evening     2.640      1.185   2.229    0.026
## strata1 midday                2.327      0.826   2.816    0.005
## strata1 night                 2.352      0.681   3.455    0.001
```

```
kable(out$FixCoefMat, digits = 3)
```

| | Estimate | Std. Error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | -1.584 | 2.224 | -0.712 | 0.476 |
| ozone | 0.130 | 0.059 | 2.201 | 0.028 |
| strata0 afternoon/evening | 1.231 | 1.101 | 1.118 | 0.264 |
| strata0 midday | 0.825 | 0.674 | 1.224 | 0.221 |
| strata0 morning | -1.703 | 0.325 | -5.234 | 0.000 |
| strata0 night | 1.094 | 0.516 | 2.118 | 0.035 |
| strata1 afternoon/evening | 2.640 | 1.185 | 2.229 | 0.026 |
| strata1 midday | 2.327 | 0.826 | 2.816 | 0.005 |
| strata1 night | 2.352 | 0.681 | 3.455 | 0.001 |

```
asthmaCAR_month<- hglm(y = asthma.ag.tod.wk$ct, X = X, Z = Z, family = quasipoisson(link = "log"),
                       rand.family = gaussian())

out = summary(asthmaCAR_month);round(out$FixCoefMat, 3)
```

```
##                            Estimate Std. Error t-value Pr(>|t|)
## (Intercept)                  -3.590      2.252  -1.594    0.111
## ozone                         0.125      0.060   2.074    0.039
## strata0 afternoon/evening     1.135      1.122   1.012    0.312
## strata0 midday                0.766      0.686   1.116    0.265
## strata0 morning              -1.679      0.333  -5.043    0.000
## strata0 night                 1.050      0.526   1.994    0.047
## strata1 afternoon/evening     2.537      1.207   2.102    0.036
## strata1 midday                2.254      0.842   2.678    0.008
## strata1 night                 2.293      0.694   3.305    0.001
```

```
kable(out$FixCoefMat, digits = 3)
```

| | Estimate | Std. Error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | -3.590 | 2.252 | -1.594 | 0.111 |
| ozone | 0.125 | 0.060 | 2.074 | 0.039 |
| strata0 afternoon/evening | 1.135 | 1.122 | 1.012 | 0.312 |
| strata0 midday | 0.766 | 0.686 | 1.116 | 0.265 |
| strata0 morning | -1.679 | 0.333 | -5.043 | 0.000 |

| | Estimate | Std. Error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| strata0 night | 1.050 | 0.526 | 1.994 | 0.047 |
| strata1 afternoon/evening | 2.537 | 1.207 | 2.102 | 0.036 |
| strata1 midday | 2.254 | 0.842 | 2.678 | 0.008 |
| strata1 night | 2.293 | 0.694 | 3.305 | 0.001 |

### Model with temp and ozone

```
asthma.ag.tod.wk$strata = factor(paste(asthma.ag.tod.wk$weekday_ind,
                                       asthma.ag.tod.wk$time_of_day))
asthma.ag.tod.wk$strata <- factor(asthma.ag.tod.wk$strata, levels(asthma.ag.tod.wk$strata)[c(7,1,2,3,4,5
X <-  model.matrix(ct ~ 1 + temp + ozone + strata, data = asthma.ag.tod.wk)
dimnames(X)[[2]][4:6] <-c("morning", "midday", "afternoon/evening")
dimnames(X)[[2]][7] <- "weekday=T"
Z <- model.matrix(~ 1 + factor(nbhd), data = asthma.ag.tod.wk)
asthmaCAR_month<- hglm(y = asthma.ag.tod.wk$ct, X = X, Z = Z, family = quasipoisson(link = "log"),
                       rand.family = CAR(D = hausMat))

out = summary(asthmaCAR_month)
kable(out$FixCoefMat, digits = 3)
```

| | Estimate | Std. Error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | -10.546 | 12.762 | -0.826 | 0.409 |
| temp | 0.129 | 0.180 | 0.713 | 0.476 |
| ozone | 0.108 | 0.066 | 1.633 | 0.103 |
| morning | 1.932 | 1.469 | 1.315 | 0.189 |
| midday | 1.117 | 0.786 | 1.421 | 0.156 |
| afternoon/evening | -1.920 | 0.444 | -4.328 | 0.000 |
| weekday=T | 1.434 | 0.700 | 2.048 | 0.041 |
| strata1 afternoon/evening | 3.390 | 1.577 | 2.149 | 0.032 |
| strata1 midday | 2.804 | 1.059 | 2.648 | 0.008 |
| strata1 night | 2.767 | 0.892 | 3.101 | 0.002 |

```
asthmaCAR_month<- hglm(y = asthma.ag.tod.wk$ct, X = X, Z = Z, family = quasipoisson(link = "log"),
                       rand.family = gaussian())

out = summary(asthmaCAR_month)
kable(out$FixCoefMat, digits = 3)
```

| | Estimate | Std. Error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | -8.383 | 13.076 | -0.641 | 0.522 |
| temp | 0.068 | 0.184 | 0.372 | 0.710 |
| ozone | 0.113 | 0.067 | 1.685 | 0.092 |
| morning | 1.513 | 1.509 | 1.002 | 0.317 |
| midday | 0.924 | 0.806 | 1.147 | 0.252 |
| afternoon/evening | -1.796 | 0.456 | -3.937 | 0.000 |
| weekday=T | 1.233 | 0.719 | 1.714 | 0.087 |
| strata1 afternoon/evening | 2.941 | 1.620 | 1.816 | 0.070 |
| strata1 midday | 2.512 | 1.087 | 2.311 | 0.021 |

| | Estimate | Std. Error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| strata1 night | 2.517 | 0.916 | 2.747 | 0.006 |

```
asthma.ag.tod.wk$strata = factor(paste(asthma.ag.tod.wk$weekday_ind,
                                       asthma.ag.tod.wk$time_of_day))
asthma.ag.tod.wk$strata <- factor(asthma.ag.tod.wk$strata, levels(asthma.ag.tod.wk$strata)[c(7,1,2,3,4,5
X <-  model.matrix(ct ~ 1+ temp + ozone + strata, data = asthma.ag.tod.wk)
#dimnames(X)[[2]][4:6] <-c("morning", "midday", "afternoon/evening")
#dimnames(X)[[2]][7] <- "weekday=T"
Z <- model.matrix(~ 1 + factor(nbhd), data = asthma.ag.tod.wk)
asthmaCAR_tod.wk<- hglm(y = asthma.ag.tod.wk$ct, X = X, Z = Z, family = quasipoisson(link = "log"),
                        rand.family = CAR(D = hausMat))
asthma.ag.tod.wk$resid = asthmaCAR_tod.wk$resid
p = rep(NA, times = 8)
strata_cats = levels(asthma.ag.tod.wk$strata)
i = 1
for(j in strata_cats){
    p[i] = moran.test(filter(asthma.ag.tod.wk, strata== j)$resid,
                W_haus_5_sym)$p
    i = i +1
}
data.frame(strata = strata_cats, pval =round(p, 3))
out = summary(asthmaCAR_tod.wk); round(out$FixCoefMat,3)
kable(out$FixCoefMat, digits = 3)
```