Barro Colorado Island

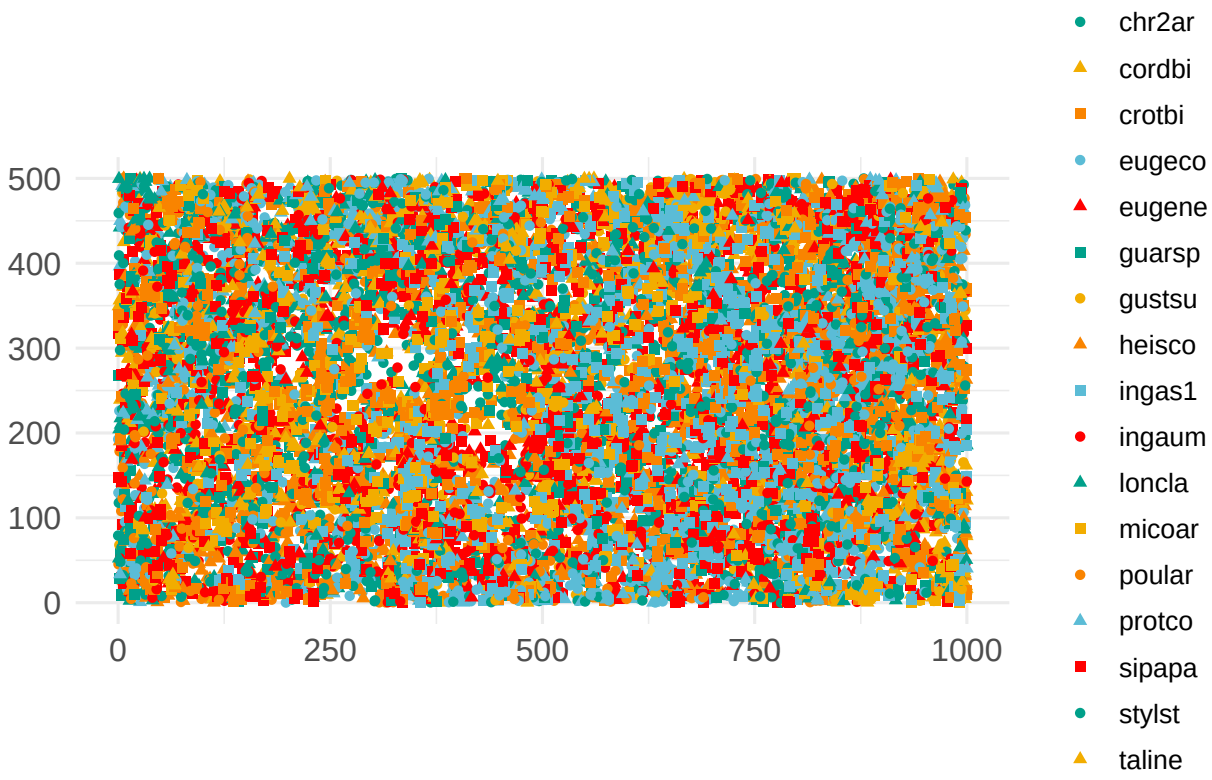
```
library(ppjsdm)
library(spatstat)
#> Loading required package: spatstat.data
#> Loading required package: spatstat.geom
#> spatstat.geom 2.4-0
#>
#> Attaching package: 'spatstat.geom'
#> The following object is masked from 'package:ppjsdm':
#>
#>     marks
#> Loading required package: spatstat.core
#> Loading required package: nlme
#> Loading required package: rpart
#> spatstat.core 2.3-2
#> Loading required package: spatstat.linnet
#> spatstat.linnet 2.3-1
#>
#> spatstat 2.3-0       (nickname: 'That's not important right now')
#> For an introduction to spatstat, type 'beginner'
library(plot.matrix)
remove(list = ls())

source("../R/get_bci.R")

set.seed(1)
```

This vignette explains how to use the `ppjsdm` package with the Barro Colorado Island (BCI) dataset. We begin by loading the data with only the most prevalent species.

```
number_of_species <- 20
bci <- get_bci(least_prevalent = 50, most_prevalent = 50 + number_of_species - 1)
configuration <- bci$configuration
window <- bci$window
```

The point configuration is plotted below.

```
par(mar = c(5, 4, 4, 13) + 0.1)
plot(configuration, window = window)
```

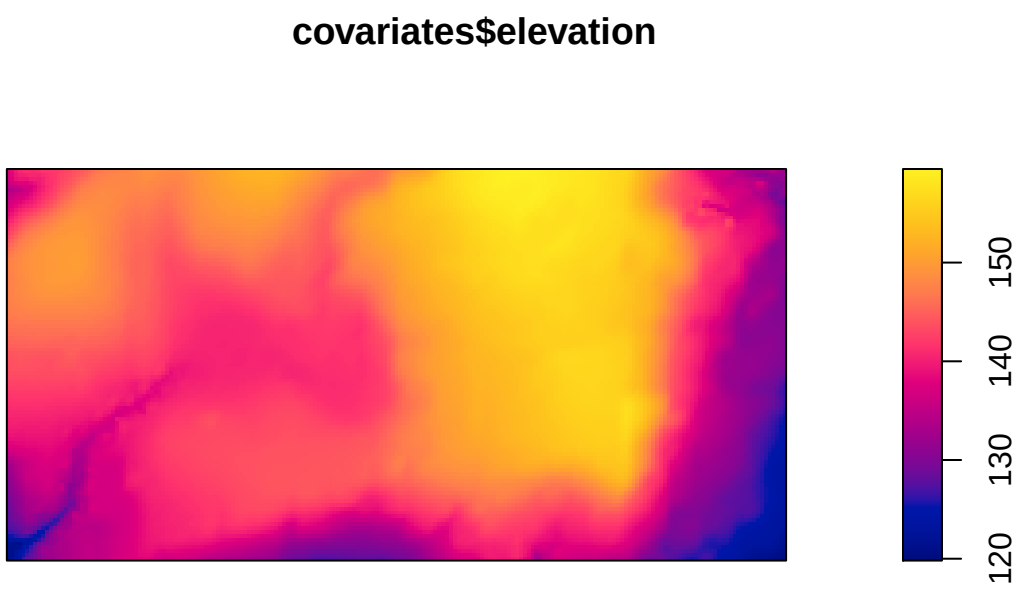


The BCI dataset also contains a series of environmental covariates. The easiest to obtain are the elevation level and the elevation gradient, since they are included in `spatstat`.

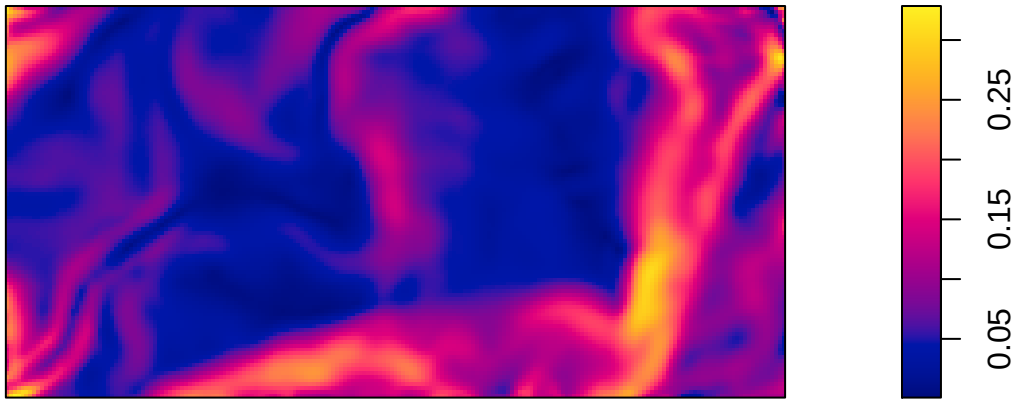
```
covariates <- list(elevation = spatstat.data::bei.extra$elev,
                   gradient = spatstat.data::bei.extra$grad)
```

Plotting covariates maps is easy in `spatstat`.

```
plot(covariates$elevation)
```




```
plot(covariates$gradient)
```



The matrix `short_range` defined below models short range interaction radii within a species (on the diagonal), and between species (outside the diagonal). One could play around with different interaction radii, but any homogeneous interaction radius of less than 10 m tends to work well.

```
short_range <- matrix(5, number_of_species, number_of_species)
medium_range <- matrix(10, number_of_species, number_of_species)
long_range <- matrix(30, number_of_species, number_of_species)
```

Fitting the model to the dataset is then quite easy.

```
tm <- Sys.time()
fit <- ppjsdm::gibbsm(configuration,
                      window = window,
                      covariates = covariates,
                      model = "square_exponential",
                      medium_range_model = "square_exponential",
                      short_range = short_range,
                      medium_range = medium_range,
                      long_range = long_range,
                      use_glmnet = FALSE)
print(Sys.time() - tm)
#> Time difference of 2.947552 mins
print(fit$coefficients)
#> $beta0
#>     brosal     chr2ar     cordbi     crotbi     eugeco     eugene     guarsp
#>  -7.342702  -6.504349  -7.121378  -7.265096  -8.748231  -7.909041  -8.692874
#>     gustsu     heisco     ingas1     ingaum     loncla     micoar     poular
```

```
#> -10.798090  -5.117772  -7.807359  -6.870018  -7.627231  -7.041943  -6.224500
#>     protco     sipapa     stylst     taline     talipr     unonpi
#>  -6.837755  -9.304144  -6.762653  -6.368888  -9.209363  -7.241139
#>
#> $alpha
#>                brosal       chr2ar       cordbi       crotbi       eugeco
#> brosal  0.3059338724  0.037909152 -0.151497888 -0.073984738  0.17515059
#> chr2ar  0.0379091524  0.218493697  0.201358183  0.068472500  0.12666210
#> cordbi -0.1514978879  0.201358183  0.679536683  0.176622795  0.02264623
#> crotbi -0.0739847381  0.068472500  0.176622795  1.674660678 -0.02862084
#> eugeco  0.1751505927  0.126662101  0.022646229 -0.028620844  0.39980499
#> eugene  0.0528252416  0.042225765  0.179343730 -0.001667551  0.13342230
#> guarsp  0.1385302180  0.198640948  0.210529466  0.013237899  0.01858508
#> gustsu -0.0009851543 -0.009272318 -0.197467367  0.027159777  0.08822781
#> heisco  0.2330071173 -0.080657285  0.054015582 -0.096580015  0.06556111
#> ingas1 -0.0081890843  0.073552713  0.117301844  0.014815174 -0.01512370
#> ingaum  0.0530891378  0.017427628  0.018635230  0.007890718  0.05664194
#> loncla -0.0278886643  0.127773992  0.215101429  0.016087456  0.13912473
#> micoar -0.0801365218  0.135683299  0.361529895  0.187456191 -0.06375046
#> poular  0.0839078446  0.024330907  0.071386843 -0.079756439  0.12506259
#> protco  0.0151191980  0.080071274  0.286040168  0.063836469  0.03365240
#> sipapa -0.1579552956  0.025536215  0.039677211  0.093573748 -0.08694160
#> stylst  0.0340709755  0.093893810  0.001625581  0.145891898  0.12344879
#> taline -0.0046492879  0.073170548 -0.021264729 -0.003228942  0.04753385
#> talipr -0.1205498751  0.155951874 -0.122069540 -0.012829891  0.06273192
#> unonpi -0.2309679806  0.050893168 -0.026234446  0.051659744  0.10185496
#>               eugene       guarsp       gustsu       heisco       ingas1
#> brosal  0.052825242  0.138530218 -0.0009851543  0.233007117 -0.008189084
#> chr2ar  0.042225765  0.198640948 -0.0092723183 -0.080657285  0.073552713
#> cordbi  0.179343730  0.210529466 -0.1974673675  0.054015582  0.117301844
#> crotbi -0.001667551  0.013237899  0.0271597768 -0.096580015  0.014815174
#> eugeco  0.133422300  0.018585080  0.0882278066  0.065561106 -0.015123701
#> eugene  0.455328579 -0.039637050  0.0522711835 -0.103153128  0.068694021
#> guarsp -0.039637050  0.206246093  0.0259228114 -0.050894002 -0.142675882
#> gustsu  0.052271183  0.025922811  0.9349092997 -0.101551181  0.030262881
#> heisco -0.103153128 -0.050894002 -0.1015511805  0.280370722  0.007513693
#> ingas1  0.068694021 -0.142675882  0.0302628814  0.007513693  0.460224283
#> ingaum -0.025491774  0.174660166 -0.0989264394  0.127012437  0.085431845
#> loncla -0.176615258  0.101172431 -0.0339344253 -0.121120797 -0.064503121
#> micoar  0.001900017  0.009202066  0.1010656365 -0.089624103  0.131835055
#> poular -0.100322456  0.115661310 -0.0263604585  0.114519241  0.002071563
#> protco -0.103226616  0.088010949  0.0253658583 -0.122965034 -0.182375734
#> sipapa -0.172997794  0.019179247  0.0935090104 -0.018721882  0.068834306
#> stylst  0.047643621  0.083971447  0.1096188297  0.053235280  0.114768143
#> taline -0.048908925 -0.105467131  0.0055719223  0.114095540 -0.035476039
#> talipr  0.187175060  0.037126141  0.0909632789 -0.071315347  0.139883480
#> unonpi -0.063278030  0.225016461 -0.0774588083  0.025948705  0.062016019
#>               ingaum       loncla       micoar       poular       protco
#> brosal  0.053089138 -0.027888664 -0.080136522  0.083907845  0.0151191980
#> chr2ar  0.017427628  0.127773992  0.135683299  0.024330907  0.0800712743
#> cordbi  0.018635230  0.215101429  0.361529895  0.071386843  0.2860401681
#> crotbi  0.007890718  0.016087456  0.187456191 -0.079756439  0.0638364687
#> eugeco  0.056641943  0.139124727 -0.063750462  0.125062591  0.0336523992
```

```
#> eugene -0.025491774 -0.176615258  0.001900017 -0.100322456 -0.1032266156
#> guarsp  0.174660166  0.101172431  0.009202066  0.115661310  0.0880109494
#> gustsu -0.098926439 -0.033934425  0.101065637 -0.026360458  0.0253658583
#> heisco  0.127012437 -0.121120797 -0.089624103  0.114519241 -0.1229650343
#> ingas1  0.085431845 -0.064503121  0.131835055  0.002071563 -0.1823757339
#> ingaum  0.361532212  0.052823902 -0.003677878 -0.089207257  0.1129270221
#> loncla  0.052823902  0.327014837  0.029988675 -0.028921460  0.0624943390
#> micoar -0.003677878  0.029988675  1.233119963 -0.107649023 -0.0024170779
#> poular -0.089207257 -0.028921460 -0.107649023  0.635850250  0.0699826413
#> protco  0.112927022  0.062494339 -0.002417078  0.069982641  0.3563376706
#> sipapa -0.008788858  0.089627267  0.314141510  0.107247353  0.1364251229
#> stylst  0.028923025  0.083444161  0.062157446  0.028427661 -0.0005148491
#> taline  0.060476496  0.137956782  0.061491411 -0.046967649  0.1271035818
#> talipr  0.046736779  0.049361608 -0.022488185 -0.045186808 -0.0422058409
#> unonpi -0.075212424  0.009360649  0.064641888  0.178938364  0.2671556947
#>              sipapa       stylst       taline      talipr       unonpi
#> brosal -0.157955296  0.0340709755 -0.004649288 -0.12054988 -0.230967981
#> chr2ar  0.025536215  0.0938938105  0.073170548  0.15595187  0.050893168
#> cordbi  0.039677211  0.0016255815 -0.021264729 -0.12206954 -0.026234446
#> crotbi  0.093573748  0.1458918977 -0.003228942 -0.01282989  0.051659744
#> eugeco -0.086941603  0.1234487944  0.047533851  0.06273192  0.101854962
#> eugene -0.172997794  0.0476436207 -0.048908925  0.18717506 -0.063278030
#> guarsp  0.019179247  0.0839714465 -0.105467131  0.03712614  0.225016461
#> gustsu  0.093509010  0.1096188297  0.005571922  0.09096328 -0.077458808
#> heisco -0.018721882  0.0532352798  0.114095540 -0.07131535  0.025948705
#> ingas1  0.068834306  0.1147681428 -0.035476039  0.13988348  0.062016019
#> ingaum -0.008788858  0.0289230253  0.060476496  0.04673678 -0.075212424
#> loncla  0.089627267  0.0834441611  0.137956782  0.04936161  0.009360649
#> micoar  0.314141510  0.0621574463  0.061491411 -0.02248819  0.064641888
#> poular  0.107247353  0.0284276605 -0.046967649 -0.04518681  0.178938364
#> protco  0.136425123 -0.0005148491  0.127103582 -0.04220584  0.267155695
#> sipapa  0.765475103  0.1741223511 -0.209416186 -0.05904695  0.108198387
#> stylst  0.174122351  0.2823590540 -0.062883034  0.09641924  0.099626487
#> taline -0.209416186 -0.0628830341  1.054295223  0.06777511  0.156370419
#> talipr -0.059046951  0.0964192402  0.067775108  0.37326544  0.049535519
#> unonpi  0.108198387  0.0996264868  0.156370419  0.04953552  0.381716330
#>
#> $gamma
#>              brosal       chr2ar       cordbi       crotbi       eugeco
#> brosal -0.059333868 -0.070891043 -0.053971914 -0.015067698 -0.027162789
#> chr2ar -0.070891043 -0.032417808  0.100295747 -0.008339600 -0.078728951
#> cordbi -0.053971914  0.100295747 -0.070129704 -0.049985779  0.024632604
#> crotbi -0.015067698 -0.008339600 -0.049985779  0.231288562 -0.050060523
#> eugeco -0.027162789 -0.078728951  0.024632604 -0.050060523 -0.071744989
#> eugene  0.016155048 -0.027698137  0.088527993  0.007708640  0.009942066
#> guarsp  0.036707360 -0.075905488  0.005372702 -0.064130148 -0.021143773
#> gustsu -0.025624196 -0.035491219  0.036197349 -0.025174770 -0.058986593
#> heisco -0.039758587 -0.025899363 -0.078568850 -0.059753147  0.033772583
#> ingas1  0.006270729 -0.060180475 -0.032133590 -0.023579674  0.035607385
#> ingaum  0.073300328 -0.056339758  0.081686317  0.005963304 -0.090442306
#> loncla  0.034170426  0.027575055 -0.008055284 -0.020670184 -0.008660903
#> micoar -0.002384248 -0.030055596  0.025937533 -0.033618830  0.038828688
#> poular -0.005058838 -0.004859556  0.008083344 -0.003568737 -0.084179490
```

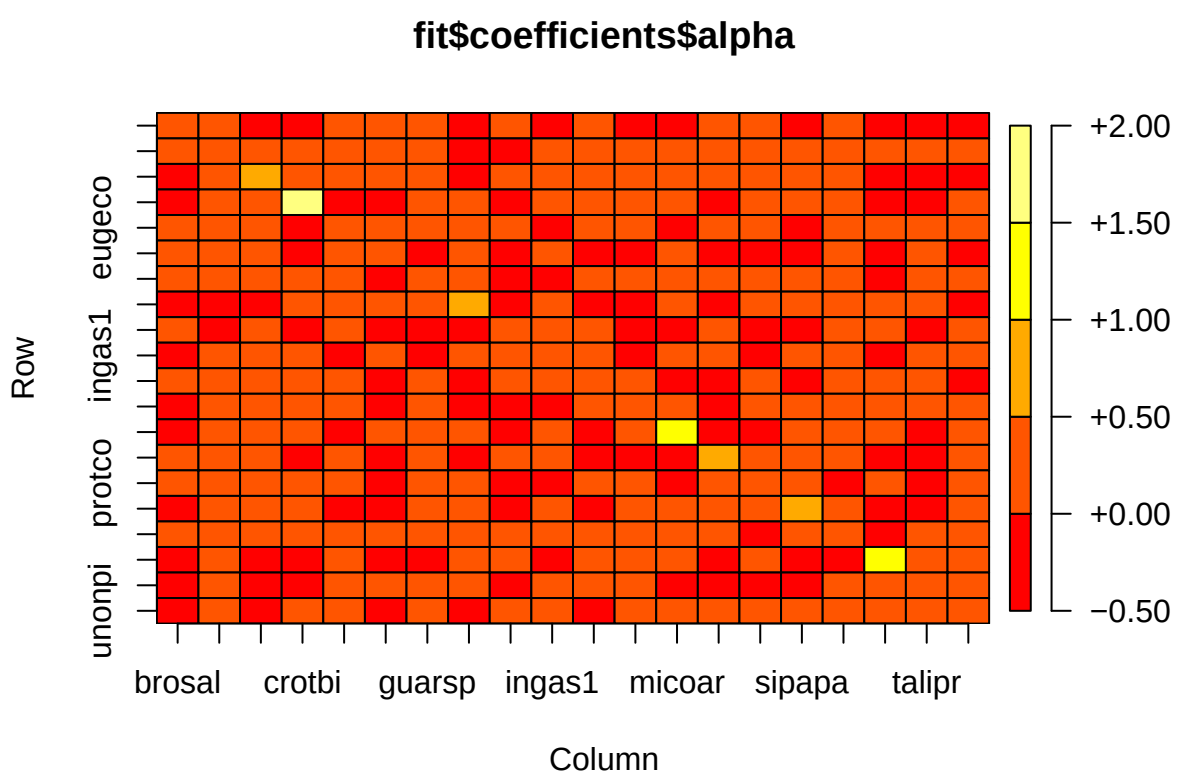
```
#> protco -0.020763269  0.026016977 -0.061168112 -0.064914974 -0.138365478
#> sipapa -0.021301061 -0.009224500 -0.047627120 -0.031675944 -0.043516375
#> stylst -0.071381711  0.060759562 -0.053651998  0.055912923  0.041466097
#> taline -0.084835389 -0.024409228 -0.065183369 -0.013152252  0.047432120
#> talipr  0.019459160  0.055013595 -0.103022948 -0.024065812 -0.014202429
#> unonpi -0.077163824 -0.040765249  0.013033213 -0.011732645  0.075916418
#>              eugene        guarsp        gustsu       heisco        ingas1
#> brosal  0.016155048  3.670736e-02 -0.0256241958 -0.039758587  0.0062707294
#> chr2ar -0.027698137 -7.590549e-02 -0.0354912191 -0.025899363 -0.0601804748
#> cordbi  0.088527993  5.372702e-03  0.0361973492 -0.078568850 -0.0321335900
#> crotbi  0.007708640 -6.413015e-02 -0.0251747695 -0.059753147 -0.0235796739
#> eugeco  0.009942066 -2.114377e-02 -0.0589865930  0.033772583  0.0356073849
#> eugene  0.057542807  9.803876e-03 -0.0067695637  0.010257262 -0.0690865705
#> guarsp  0.009803876  2.126880e-01 -0.0341073457 -0.025999802 -0.0003912737
#> gustsu -0.006769564 -3.410735e-02  0.1361074809 -0.022454965 -0.0072920224
#> heisco  0.010257262 -2.599980e-02 -0.0224549651 -0.024507434 -0.0622904013
#> ingas1 -0.069086571 -3.912737e-04 -0.0072920224 -0.062290401  0.0977923464
#> ingaum -0.071792390  2.958740e-02 -0.0095774553  0.024644924  0.0048043111
#> loncla -0.021792452 -1.116845e-01 -0.0041082035  0.027914166 -0.0466640609
#> micoar -0.066535351  3.462002e-02 -0.0306810801 -0.066685886 -0.0208588878
#> poular  0.040688852  2.593349e-02  0.0017025451 -0.038381445 -0.0553854871
#> protco  0.020324488 -1.234650e-03 -0.0053328941 -0.069309619 -0.0138738559
#> sipapa  0.004667151  1.039610e-01 -0.0250126372  0.014349946  0.0012417615
#> stylst -0.058877053  1.010599e-01 -0.0714459561 -0.046363244 -0.1142971859
#> taline -0.042057071  8.253960e-03 -0.0007554069 -0.036640773  0.0023836032
#> talipr -0.029886948 -2.024386e-02  0.0057757765 -0.004256677  0.0912908821
#> unonpi -0.022631858 -1.021265e-05 -0.0153015957 -0.035994251 -0.0502557913
#>              ingaum       loncla       micoar       poular       protco
#> brosal  0.073300328  0.034170426 -0.002384248 -0.005058838 -0.020763269
#> chr2ar -0.056339758  0.027575055 -0.030055596 -0.004859556  0.026016977
#> cordbi  0.081686317 -0.008055284  0.025937533  0.008083344 -0.061168112
#> crotbi  0.005963304 -0.020670184 -0.033618830 -0.003568737 -0.064914974
#> eugeco -0.090442306 -0.008660903  0.038828688 -0.084179490 -0.138365478
#> eugene -0.071792390 -0.021792452 -0.066535351  0.040688852  0.020324488
#> guarsp  0.029587402 -0.111684534  0.034620022  0.025933489 -0.001234650
#> gustsu -0.009577455 -0.004108204 -0.030681080  0.001702545 -0.005332894
#> heisco  0.024644924  0.027914166 -0.066685886 -0.038381445 -0.069309619
#> ingas1  0.004804311 -0.046664061 -0.020858888 -0.055385487 -0.013873856
#> ingaum  0.206083876  0.007935021  0.062201295 -0.060388455 -0.004980375
#> loncla  0.007935021  0.209561018 -0.043354862  0.014632548 -0.001677943
#> micoar  0.062201295 -0.043354862 -0.057236925 -0.037256346 -0.019568143
#> poular -0.060388455  0.014632548 -0.037256346  0.098147274 -0.038807481
#> protco -0.004980375 -0.001677943 -0.019568143 -0.038807481  0.131395601
#> sipapa  0.027353661 -0.026845457 -0.060732698 -0.001336156  0.075766819
#> stylst -0.029491061 -0.050424232 -0.003998418 -0.089225101  0.019611282
#> taline -0.011569385 -0.083955838 -0.048055988 -0.032384426  0.013199266
#> talipr -0.075080626 -0.047691581 -0.018157592 -0.014384620 -0.022749868
#> unonpi  0.020188359 -0.055090954 -0.066941774  0.007481196  0.109231898
#>              sipapa       stylst        taline       talipr        unonpi
#> brosal -0.021301061 -0.071381711 -0.0848353894  0.019459160 -7.716382e-02
#> chr2ar -0.009224500  0.060759562 -0.0244092276  0.055013595 -4.076525e-02
#> cordbi -0.047627120 -0.053651998 -0.0651833688 -0.103022948  1.303321e-02
#> crotbi -0.031675944  0.055912923 -0.0131522516 -0.024065812 -1.173264e-02
```

```
#> eugeco -0.043516375  0.041466097  0.0474321199 -0.014202429  7.591642e-02
#> eugene  0.004667151 -0.058877053 -0.0420570710 -0.029886948 -2.263186e-02
#> guarsp  0.103961029  0.101059943  0.0082539602 -0.020243858 -1.021265e-05
#> gustsu -0.025012637 -0.071445956 -0.0007554069  0.005775776 -1.530160e-02
#> heisco  0.014349946 -0.046363244 -0.0366407730 -0.004256677 -3.599425e-02
#> ingas1  0.001241762 -0.114297186  0.0023836032  0.091290882 -5.025579e-02
#> ingaum  0.027353661 -0.029491061 -0.0115693848 -0.075080626  2.018836e-02
#> loncla -0.026845457 -0.050424232 -0.0839558376 -0.047691581 -5.509095e-02
#> micoar -0.060732698 -0.003998418 -0.0480559876 -0.018157592 -6.694177e-02
#> poular -0.001336156 -0.089225101 -0.0323844259 -0.014384620  7.481196e-03
#> protco  0.075766819  0.019611282  0.0131992658 -0.022749868  1.092319e-01
#> sipapa  0.197648820 -0.040019715 -0.0219956071 -0.010610233 -7.470972e-03
#> stylst -0.040019715 -0.034614941 -0.0370179602  0.105803145 -3.552959e-02
#> taline -0.021995607 -0.037017960  0.0831369564 -0.078594104 -7.933251e-02
#> talipr -0.010610233  0.105803145 -0.0785941037  0.061089563 -5.215591e-02
#> unonpi -0.007470972 -0.035529587 -0.0793325081 -0.052155914  2.098334e-01
#>
#> $beta
#>            elevation    gradient
#> brosal  0.0095054966  1.51503732
#> chr2ar  0.0002464323  0.99709821
#> cordbi  0.0022200625 -0.26333214
#> crotbi  0.0003771026 -1.06803703
#> eugeco  0.0146682767  3.04024733
#> eugene  0.0103468781 -0.98465096
#> guarsp  0.0071966783  0.88214763
#> gustsu  0.0295086212 -0.43484007
#> heisco -0.0030265336  0.35681603
#> ingas1  0.0116918043 -0.05930479
#> ingaum -0.0010242181 -0.26342140
#> loncla  0.0076246112  0.29092619
#> micoar  0.0020272867  0.06916027
#> poular -0.0032138904  4.46604635
#> protco -0.0007321658  1.74614365
#> sipapa  0.0118423811  2.23850966
#> stylst  0.0034053027  0.27578845
#> taline  0.0014443327  1.44706894
#> talipr  0.0187334581  0.87466645
#> unonpi  0.0016944829  2.84310964
#>
#> $short_range
#>        brosal chr2ar cordbi crotbi eugeco eugene guarsp gustsu heisco ingas1
#> brosal      5      5      5      5      5      5      5      5      5      5
#> chr2ar      5      5      5      5      5      5      5      5      5      5
#> cordbi      5      5      5      5      5      5      5      5      5      5
#> crotbi      5      5      5      5      5      5      5      5      5      5
#> eugeco      5      5      5      5      5      5      5      5      5      5
#> eugene      5      5      5      5      5      5      5      5      5      5
#> guarsp      5      5      5      5      5      5      5      5      5      5
#> gustsu      5      5      5      5      5      5      5      5      5      5
#> heisco      5      5      5      5      5      5      5      5      5      5
#> ingas1      5      5      5      5      5      5      5      5      5      5
#> ingaum      5      5      5      5      5      5      5      5      5      5
```

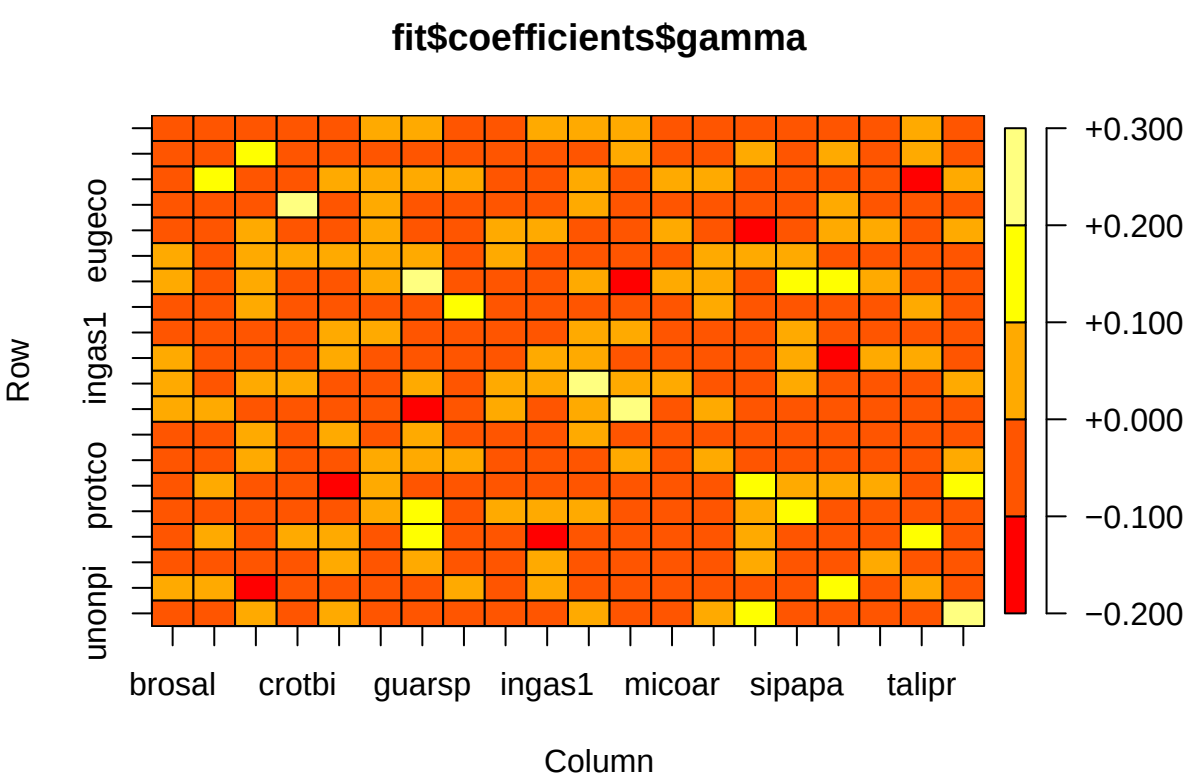
```
#> loncla      5      5      5      5      5      5      5      5      5      5
#> micoar      5      5      5      5      5      5      5      5      5      5
#> poular      5      5      5      5      5      5      5      5      5      5
#> protco      5      5      5      5      5      5      5      5      5      5
#> sipapa      5      5      5      5      5      5      5      5      5      5
#> stylst      5      5      5      5      5      5      5      5      5      5
#> taline      5      5      5      5      5      5      5      5      5      5
#> talipr      5      5      5      5      5      5      5      5      5      5
#> unonpi      5      5      5      5      5      5      5      5      5      5
#>        ingaum loncla micoar poular protco sipapa stylst taline talipr unonpi
#> brosal      5      5      5      5      5      5      5      5      5      5
#> chr2ar      5      5      5      5      5      5      5      5      5      5
#> cordbi      5      5      5      5      5      5      5      5      5      5
#> crotbi      5      5      5      5      5      5      5      5      5      5
#> eugeco      5      5      5      5      5      5      5      5      5      5
#> eugene      5      5      5      5      5      5      5      5      5      5
#> guarsp      5      5      5      5      5      5      5      5      5      5
#> gustsu      5      5      5      5      5      5      5      5      5      5
#> heisco      5      5      5      5      5      5      5      5      5      5
#> ingas1      5      5      5      5      5      5      5      5      5      5
#> ingaum      5      5      5      5      5      5      5      5      5      5
#> loncla      5      5      5      5      5      5      5      5      5      5
#> micoar      5      5      5      5      5      5      5      5      5      5
#> poular      5      5      5      5      5      5      5      5      5      5
#> protco      5      5      5      5      5      5      5      5      5      5
#> sipapa      5      5      5      5      5      5      5      5      5      5
#> stylst      5      5      5      5      5      5      5      5      5      5
#> taline      5      5      5      5      5      5      5      5      5      5
#> talipr      5      5      5      5      5      5      5      5      5      5
#> unonpi      5      5      5      5      5      5      5      5      5      5
#>
#> $medium_range
#>        brosal chr2ar cordbi crotbi eugeco eugene guarsp gustsu heisco ingas1
#> brosal     10     10     10     10     10     10     10     10     10     10
#> chr2ar     10     10     10     10     10     10     10     10     10     10
#> cordbi     10     10     10     10     10     10     10     10     10     10
#> crotbi     10     10     10     10     10     10     10     10     10     10
#> eugeco     10     10     10     10     10     10     10     10     10     10
#> eugene     10     10     10     10     10     10     10     10     10     10
#> guarsp     10     10     10     10     10     10     10     10     10     10
#> gustsu     10     10     10     10     10     10     10     10     10     10
#> heisco     10     10     10     10     10     10     10     10     10     10
#> ingas1     10     10     10     10     10     10     10     10     10     10
#> ingaum     10     10     10     10     10     10     10     10     10     10
#> loncla     10     10     10     10     10     10     10     10     10     10
#> micoar     10     10     10     10     10     10     10     10     10     10
#> poular     10     10     10     10     10     10     10     10     10     10
#> protco     10     10     10     10     10     10     10     10     10     10
#> sipapa     10     10     10     10     10     10     10     10     10     10
#> stylst     10     10     10     10     10     10     10     10     10     10
#> taline     10     10     10     10     10     10     10     10     10     10
#> talipr     10     10     10     10     10     10     10     10     10     10
#> unonpi     10     10     10     10     10     10     10     10     10     10
```

```
#>         ingaum loncla micoar poular protco sipapa stylst taline talipr unonpi
#> brosal     10     10     10     10     10     10     10     10     10     10
#> chr2ar     10     10     10     10     10     10     10     10     10     10
#> cordbi     10     10     10     10     10     10     10     10     10     10
#> crotbi     10     10     10     10     10     10     10     10     10     10
#> eugeco     10     10     10     10     10     10     10     10     10     10
#> eugene     10     10     10     10     10     10     10     10     10     10
#> guarsp     10     10     10     10     10     10     10     10     10     10
#> gustsu     10     10     10     10     10     10     10     10     10     10
#> heisco     10     10     10     10     10     10     10     10     10     10
#> ingas1     10     10     10     10     10     10     10     10     10     10
#> ingaum     10     10     10     10     10     10     10     10     10     10
#> loncla     10     10     10     10     10     10     10     10     10     10
#> micoar     10     10     10     10     10     10     10     10     10     10
#> poular     10     10     10     10     10     10     10     10     10     10
#> protco     10     10     10     10     10     10     10     10     10     10
#> sipapa     10     10     10     10     10     10     10     10     10     10
#> stylst     10     10     10     10     10     10     10     10     10     10
#> taline     10     10     10     10     10     10     10     10     10     10
#> talipr     10     10     10     10     10     10     10     10     10     10
#> unonpi     10     10     10     10     10     10     10     10     10     10
#>
#> $long_range
#>         brosal chr2ar cordbi crotbi eugeco eugene guarsp gustsu heisco ingas1
#> brosal     30     30     30     30     30     30     30     30     30     30
#> chr2ar     30     30     30     30     30     30     30     30     30     30
#> cordbi     30     30     30     30     30     30     30     30     30     30
#> crotbi     30     30     30     30     30     30     30     30     30     30
#> eugeco     30     30     30     30     30     30     30     30     30     30
#> eugene     30     30     30     30     30     30     30     30     30     30
#> guarsp     30     30     30     30     30     30     30     30     30     30
#> gustsu     30     30     30     30     30     30     30     30     30     30
#> heisco     30     30     30     30     30     30     30     30     30     30
#> ingas1     30     30     30     30     30     30     30     30     30     30
#> ingaum     30     30     30     30     30     30     30     30     30     30
#> loncla     30     30     30     30     30     30     30     30     30     30
#> micoar     30     30     30     30     30     30     30     30     30     30
#> poular     30     30     30     30     30     30     30     30     30     30
#> protco     30     30     30     30     30     30     30     30     30     30
#> sipapa     30     30     30     30     30     30     30     30     30     30
#> stylst     30     30     30     30     30     30     30     30     30     30
#> taline     30     30     30     30     30     30     30     30     30     30
#> talipr     30     30     30     30     30     30     30     30     30     30
#> unonpi     30     30     30     30     30     30     30     30     30     30
#>         ingaum loncla micoar poular protco sipapa stylst taline talipr unonpi
#> brosal     30     30     30     30     30     30     30     30     30     30
#> chr2ar     30     30     30     30     30     30     30     30     30     30
#> cordbi     30     30     30     30     30     30     30     30     30     30
#> crotbi     30     30     30     30     30     30     30     30     30     30
#> eugeco     30     30     30     30     30     30     30     30     30     30
#> eugene     30     30     30     30     30     30     30     30     30     30
#> guarsp     30     30     30     30     30     30     30     30     30     30
#> gustsu     30     30     30     30     30     30     30     30     30     30
```

```
#> heisco     30     30     30     30     30     30     30     30     30     30
#> ingas1     30     30     30     30     30     30     30     30     30     30
#> ingaum     30     30     30     30     30     30     30     30     30     30
#> loncla     30     30     30     30     30     30     30     30     30     30
#> micoar     30     30     30     30     30     30     30     30     30     30
#> poular     30     30     30     30     30     30     30     30     30     30
#> protco     30     30     30     30     30     30     30     30     30     30
#> sipapa     30     30     30     30     30     30     30     30     30     30
#> stylst     30     30     30     30     30     30     30     30     30     30
#> taline     30     30     30     30     30     30     30     30     30     30
#> talipr     30     30     30     30     30     30     30     30     30     30
#> unonpi     30     30     30     30     30     30     30     30     30     30
par(mar = c(5.1, 5.1, 4.1, 4.1))
plot(fit$coefficients$alpha)
```




```
plot(fit$coefficients$gamma)
```




```
print(fit$aic)
#> [1] -37203.77
print(fit$bic)
#> [1] -32777.37

Sys.time() - tm
#> Time difference of 2.948312 mins
```