COVID-19-Spain-Analysis

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This notebook reports our initial analysis of COVID-19 incidence in Spain and the climatic correlates of incidence. The data have been organized in a package for ease of access and distribution. The name of the package is `covid19env` and if necessary can be installed from the GitHub repository.

Preliminaries

Load packages:

```
library(covid19env)
library(ggthemes)
library(gridExtra)
library(lubridate)
library(sf)
library(spdep)
library(spsur)
library(tidyverse)
library(units)
#library(spatialreg)
#library(systemfit)
#library(plm)
#library(splm)
```

Load data from package `covid19env`

```
data("covid19_spain")
```

Summarize the data:

```
covid19_spain %>%
  select(-geometry) %>%
  summary()
```

```
##              province                       CCAA         ID_INE
##  Albacete        :  30   Castilla y Leon     :270   Min.   : 1.0
##  Alicante/Alacant:  30   Andalucia           :240   1st Qu.:13.0
##  Almeria         :  30   Castilla - La Mancha:150   Median :25.5
##  Araba/alava     :  30   CataluÃ±a           :120   Mean   :25.5
##  Asturias        :  30   Galicia             :120   3rd Qu.:38.0
##  Avila           :  30   Aragon              : 90   Max.   :50.0
##  (Other)         :1320   (Other)             :510
##       Date                Cases           Incidence          Population
##  Min.   :2020-03-13   Min.   :    1.0   Min.   :   0.3832   Min.   :  88636
##  1st Qu.:2020-03-20   1st Qu.:  168.0   1st Qu.:  26.6722   1st Qu.: 331549
##  Median :2020-03-27   Median :  547.5   Median :  88.3491   Median : 684202
##  Mean   :2020-03-27   Mean   : 1485.7   Mean   : 153.6087   Mean   : 974257
```

```
##  3rd Qu.:2020-04-04   3rd Qu.: 1290.0   3rd Qu.: 209.6307   3rd Qu.:1149460
##  Max.   :2020-04-11   Max.   :45849.0   Max.   :1149.3577   Max.   :6663394
##
##      Older          Median_Age     Male2Female         GDPpc          Transit
##  Min.   :15.16   Min.   :40.19   Min.   : 91.59   Min.   :16666   Min.   :0.0
##  1st Qu.:18.02   1st Qu.:42.35   1st Qu.: 95.43   1st Qu.:18813   1st Qu.:0.0
##  Median :19.93   Median :43.70   Median : 98.06   Median :20870   Median :0.0
##  Mean   :21.03   Mean   :44.55   Mean   : 97.83   Mean   :22506   Mean   :0.1
##  3rd Qu.:23.07   3rd Qu.:46.01   3rd Qu.:100.08   3rd Qu.:25901   3rd Qu.:0.0
##  Max.   :31.36   Max.   :50.68   Max.   :103.01   Max.   :36001   Max.   :1.0
##
##       Area              Altitude          Coast      Meteo_Station
##  Min.   :1.979e+09   Min.   :   5.0   Min.   :0.00   0016A  :  30
##  1st Qu.:6.637e+09   1st Qu.:  24.0   1st Qu.:0.00   0076   :  30
##  Median :1.001e+10   Median : 215.5   Median :0.00   0367   :  30
##  Mean   :1.012e+10   Mean   : 369.0   Mean   :0.42   1024E  :  30
##  3rd Qu.:1.377e+10   3rd Qu.: 685.0   3rd Qu.:1.00   1082   :  30
##  Max.   :2.179e+10   Max.   :1131.0   Max.   :1.00   1111X  :  30
##                                                      (Other):1320
##     Max_Temp        Min_Temp        Mean_Temp     Mean_Temp_lag8
##  Min.   : 3.10   Min.   :-4.700   Min.   : 1.00   Min.   : 4.275
##  1st Qu.:14.68   1st Qu.: 4.400   1st Qu.: 9.80   1st Qu.: 9.637
##  Median :17.30   Median : 7.600   Median :12.40   Median :11.600
##  Mean   :17.07   Mean   : 7.289   Mean   :12.18   Mean   :11.779
##  3rd Qu.:19.80   3rd Qu.:10.200   3rd Qu.:14.60   3rd Qu.:13.713
##  Max.   :27.10   Max.   :20.600   Max.   :23.20   Max.   :20.200
##
##  Mean_Temp_lag11  Mean_Temp_lag11w Sunshine_Hours   Sunshine_Hours_lag8
##  Min.   : 5.118   Min.   : 4.201   Min.   : 0.000   Min.   : 0.000
##  1st Qu.: 9.770   1st Qu.: 9.803   1st Qu.: 1.800   1st Qu.: 4.938
##  Median :11.795   Median :11.781   Median : 6.100   Median : 6.275
##  Mean   :11.872   Mean   :11.903   Mean   : 5.738   Mean   : 6.221
##  3rd Qu.:13.598   3rd Qu.:13.941   3rd Qu.: 9.400   3rd Qu.: 7.781
##  Max.   :20.700   Max.   :21.167   Max.   :12.400   Max.   :10.938
##
##  Sunshine_Hours_lag11 Sunshine_Hours_lag11w Precipitation    Precipitation_lag8
##  Min.   : 0.000       Min.   : 0.000        Min.   :0.0000   Min.   :0.0000
##  1st Qu.: 5.164       1st Qu.: 4.771        1st Qu.:0.0000   1st Qu.:0.2500
##  Median : 6.273       Median : 6.313        Median :0.0000   Median :0.3750
##  Mean   : 6.188       Mean   : 6.212        Mean   :0.4447   Mean   :0.3762
##  3rd Qu.: 7.518       3rd Qu.: 7.862        3rd Qu.:1.0000   3rd Qu.:0.5000
##  Max.   :10.136       Max.   :11.041        Max.   :1.0000   Max.   :1.0000
##
##  Precipitation_lag11 Precipitation_lag11w    Humidity      Humidity_lag8
##  Min.   :0.0000      Min.   :0.0000       Min.   :  2.00   Min.   :40.24
##  1st Qu.:0.2727      1st Qu.:0.1845       1st Qu.: 71.00   1st Qu.:70.30
##  Median :0.3636      Median :0.3963       Median : 78.44   Median :75.98
##  Mean   :0.3834      Mean   :0.3831       Mean   : 77.82   Mean   :75.00
##  3rd Qu.:0.5455      3rd Qu.:0.5631       3rd Qu.: 85.00   3rd Qu.:80.38
##  Max.   :1.0000      Max.   :1.0000       Max.   :100.00   Max.   :94.61
##
##  Humidity_lag11  Humidity_lag11w          geometry
##  Min.   :42.20   Min.   :40.10   MULTIPOLYGON :1500
##  1st Qu.:71.19   1st Qu.:70.94   epsg:4326    :   0
```

```
##  Median :76.14   Median :76.99   +proj=long...:   0
##  Mean   :75.48   Mean   :75.84
##  3rd Qu.:80.32   3rd Qu.:81.08
##  Max.   :93.36   Max.   :94.04
##
```

The dataframe is a simple features object with information at the level of the province. The dataframe includes information about the province, including its Autonomous Community (a superior jurisdiction), an identifier, dates, COVID-19 cases and incidence. The period covered is from March 13, 2020 to April 11, 2020. In addition there are some demographic controls, and various climatic variables. Of interest are the lagged variables. The lagged variables are 8-day moving averages calculated using date-minus-12-days to date-minus-5-days, to account for the latency of the infection. More information about the dataset can be obtained by typing `?covid18_spain`.

There are 50 provinces in Spain:

```
nlevels(covid19_spain$province)
```

```
## [1] 50
```

The dataset covers 30 days:

```
T <- max(covid19_spain$Date) - min(covid19_spain$Date) + 1 # To include the starting day
T
```

```
## Time difference of 30 days
```

The order to shelter in place in Spain went into effect on March 16, 2020. March 13 is the first day that every province had at least one reported case of COVID-19.

Calculate population density and convert GDP per capita to thousands of euros:

```
covid19_spain <- covid19_spain %>%
  mutate(GDPpc = GDPpc/1000,
         Density = Population/units::set_units(st_area(covid19_spain), km^2))
```

Data exploration

Correlation analysis with Incidence:

```
covid19_spain %>%
  st_drop_geometry() %>%
  group_by(Date) %>%
  summarize(correlation_age = cor(Median_Age, Incidence),
            correlation_older = cor(Older, Incidence),
            correlation_m2f = cor(Male2Female, Incidence),
            correlation_density = cor(Density, Incidence),
            correlation_gdppc = cor(GDPpc, Incidence),
            correlation_humidity = cor(Humidity_lag11, Incidence),
            correlation_temp = cor(Mean_Temp_lag11, Incidence),
            correlation_sunshine = cor(Sunshine_Hours_lag11, Incidence)) %>%
  summary()
```

```
##       Date            correlation_age    correlation_older correlation_m2f
##  Min.   :2020-03-13   Min.   :-0.07549   Min.   :-0.2646   Min.   :-0.088806
##  1st Qu.:2020-03-20   1st Qu.: 0.06498   1st Qu.:-0.2298   1st Qu.:-0.037567
##  Median :2020-03-27   Median : 0.23377   Median :-0.2160   Median : 0.009642
##  Mean   :2020-03-27   Mean   : 0.15994   Mean   :-0.2083   Mean   : 0.013288
##  3rd Qu.:2020-04-03   3rd Qu.: 0.26632   3rd Qu.:-0.1807   3rd Qu.: 0.066967
```

```
##  Max.   :2020-04-11   Max.   : 0.27278   Max.   :-0.1204   Max.   : 0.106345
##  correlation_density correlation_gdppc correlation_humidity correlation_temp
##  Min.   :-0.08832    Min.   :0.2745    Min.   :-0.03195     Min.   :-0.6211
##  1st Qu.:-0.04832    1st Qu.:0.3354    1st Qu.: 0.04558     1st Qu.:-0.5997
##  Median : 0.03670    Median :0.4257    Median : 0.14829     Median :-0.5504
##  Mean   : 0.03221    Mean   :0.4035    Mean   : 0.13657     Mean   :-0.5160
##  3rd Qu.: 0.10103    3rd Qu.:0.4672    3rd Qu.: 0.20276     3rd Qu.:-0.4505
##  Max.   : 0.16734    Max.   :0.5052    Max.   : 0.31221     Max.   :-0.2780
##  correlation_sunshine
##  Min.   :-0.25196
##  1st Qu.:-0.12233
##  Median : 0.07528
##  Mean   : 0.02127
##  3rd Qu.: 0.13996
##  Max.   : 0.24925
```

Correlation analysis with Incidence (log-transformed variables):

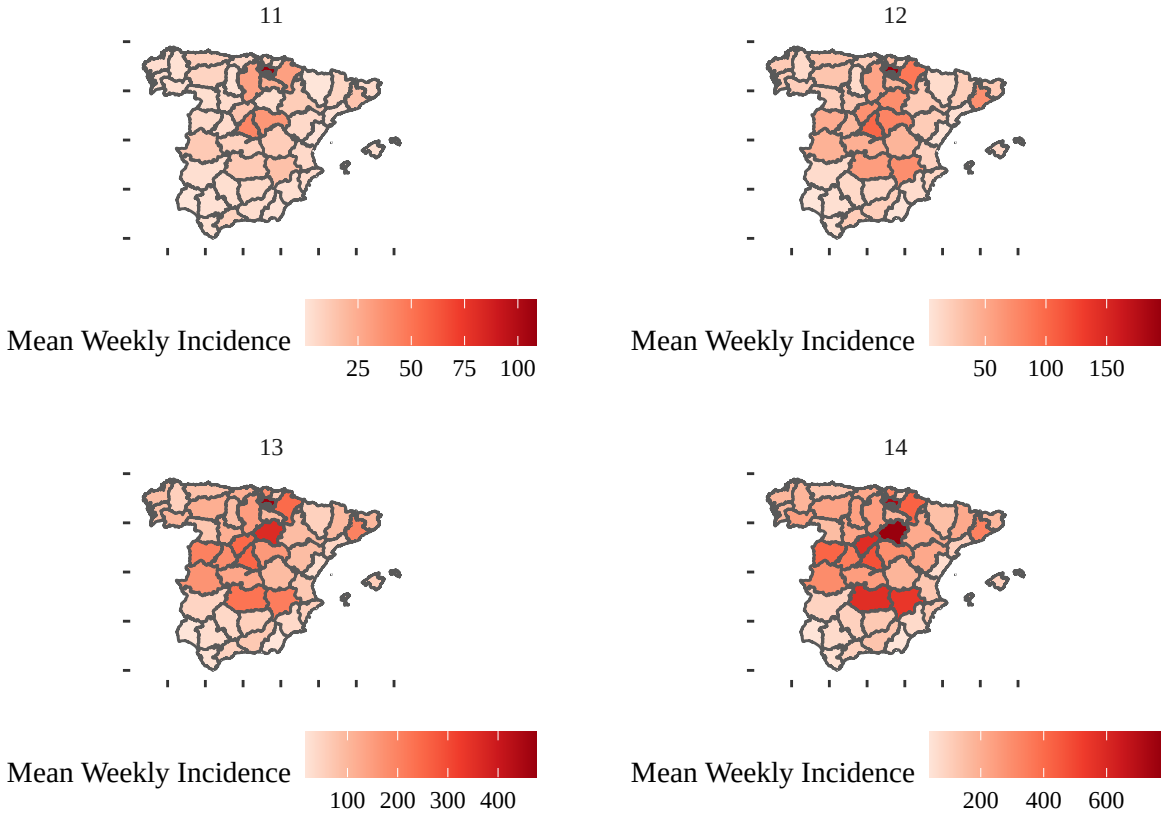
```
covid19_spain %>%
  st_drop_geometry() %>%
  group_by(Date) %>%
  summarize(correlation_age = cor(log(Median_Age), log(Incidence)),
            correlation_older = cor(log(Older), log(Incidence)),
            correlation_m2f = cor(log(Male2Female), log(Incidence)),
            correlation_density = cor(log(Density), log(Incidence)),
            correlation_gdppc = cor(log(GDPpc), log(Incidence)),
            correlation_humidity = cor(log(Humidity_lag11), log(Incidence)),
            correlation_temp = cor(log(Mean_Temp_lag11), log(Incidence)),
            correlation_sunshine = cor(log(Sunshine_Hours_lag11 + 0.1), log(Incidence))) %>%
  summary()
```

```
##       Date            correlation_age    correlation_older
##  Min.   :2020-03-13   Min.   :-0.05954   Min.   :-0.218157
##  1st Qu.:2020-03-20   1st Qu.: 0.25912   1st Qu.:-0.176906
##  Median :2020-03-27   Median : 0.40458   Median :-0.153385
##  Mean   :2020-03-27   Mean   : 0.32729   Mean   :-0.148579
##  3rd Qu.:2020-04-03   3rd Qu.: 0.44522   3rd Qu.:-0.137772
##  Max.   :2020-04-11   Max.   : 0.45304   Max.   :-0.006352
##  correlation_m2f     correlation_density correlation_gdppc correlation_humidity
##  Min.   :-0.127937   Min.   :-0.37372    Min.   :0.2595    Min.   :-0.056810
##  1st Qu.:-0.072667   1st Qu.:-0.34259    1st Qu.:0.3314    1st Qu.: 0.004894
##  Median :-0.049076   Median :-0.24061    Median :0.3547    Median : 0.128513
##  Mean   :-0.047487   Mean   :-0.21770    Mean   :0.3541    Mean   : 0.133877
##  3rd Qu.:-0.023532   3rd Qu.:-0.14173    3rd Qu.:0.3800    3rd Qu.: 0.267209
##  Max.   : 0.004793   Max.   : 0.09139    Max.   :0.4123    Max.   : 0.324925
##  correlation_temp  correlation_sunshine
##  Min.   :-0.7454   Min.   :-0.01165
##  1st Qu.:-0.7230   1st Qu.: 0.17008
##  Median :-0.6716   Median : 0.23303
##  Mean   :-0.6133   Mean   : 0.21897
##  3rd Qu.:-0.5388   3rd Qu.: 0.29667
##  Max.   :-0.2716   Max.   : 0.35854
```

There are 30 days in the dataset. We can summarize the incidence by week (excluding Canarias):

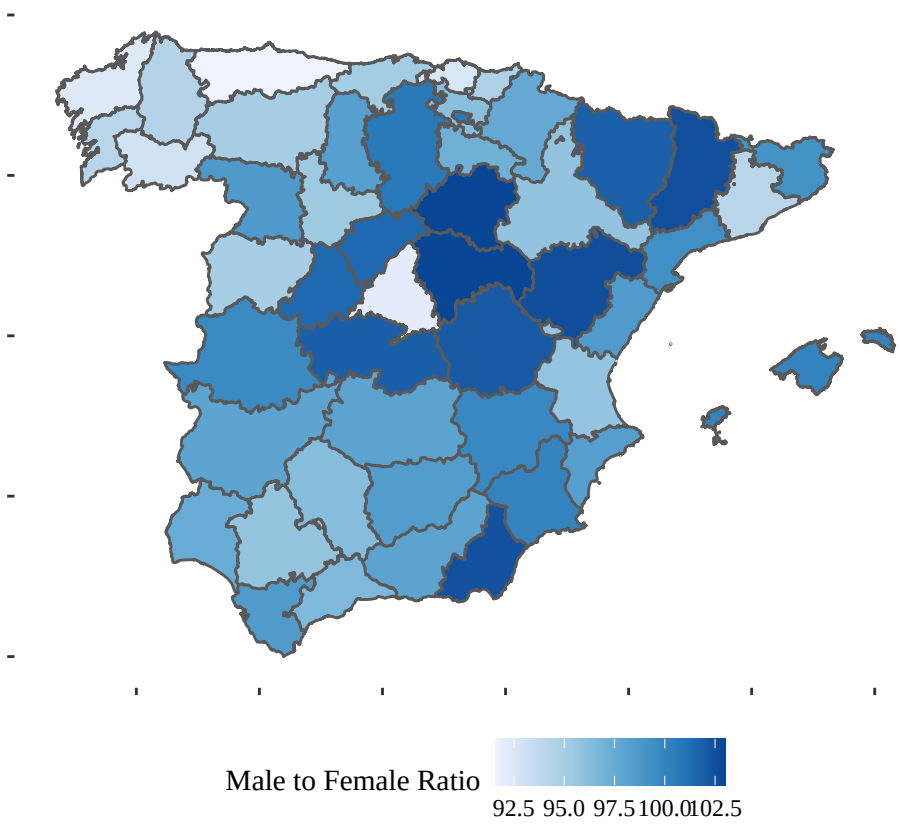
```r
week11.plot <- covid19_spain %>%
  filter(CCAA != "Canarias") %>%
  group_by(province, week = isoweek(Date)) %>%
  summarise(mean_weekly_incidence = mean(Incidence)) %>%
  filter(week == 11) %>%
  ggplot() +
  geom_sf(aes(fill = mean_weekly_incidence)) +
  scale_fill_distiller(name = "Mean Weekly Incidence",
                       palette = "Reds",
                       direction = 1) +
  theme_tufte() +
  theme(axis.text = element_blank(),
        legend.position = "bottom") +
  facet_wrap(~week)

week12.plot <- covid19_spain %>%
  filter(CCAA != "Canarias") %>%
  group_by(province, week = isoweek(Date)) %>%
  summarise(mean_weekly_incidence = mean(Incidence)) %>%
  filter(week == 12) %>%
  ggplot() +
  geom_sf(aes(fill = mean_weekly_incidence)) +
  scale_fill_distiller(name = "Mean Weekly Incidence",
                       palette = "Reds",
                       direction = 1) +
  theme_tufte() +
  theme(axis.text = element_blank(),
        legend.position = "bottom") +
  facet_wrap(~week)

week13.plot <- covid19_spain %>%
  filter(CCAA != "Canarias") %>%
  group_by(province, week = isoweek(Date)) %>%
  summarise(mean_weekly_incidence = mean(Incidence)) %>%
  filter(week == 13) %>%
  ggplot() +
  geom_sf(aes(fill = mean_weekly_incidence)) +
  scale_fill_distiller(name = "Mean Weekly Incidence",
                       palette = "Reds",
                       direction = 1) +
  theme_tufte() +
  theme(axis.text = element_blank(),
        legend.position = "bottom") +
  facet_wrap(~week)

week14.plot <- covid19_spain %>%
  filter(CCAA != "Canarias") %>%
  group_by(province, week = isoweek(Date)) %>%
  summarise(mean_weekly_incidence = mean(Incidence)) %>%
  filter(week == 14) %>%
  ggplot() +
  geom_sf(aes(fill = mean_weekly_incidence)) +
  scale_fill_distiller(name = "Mean Weekly Incidence",
```

```
                        palette = "Reds",
                        direction = 1) +
  theme_tufte() +
  theme(axis.text = element_blank(),
        legend.position = "bottom") +
  facet_wrap(~week)

grid.arrange(week11.plot, week12.plot, week13.plot, week14.plot, nrow = 2)
```



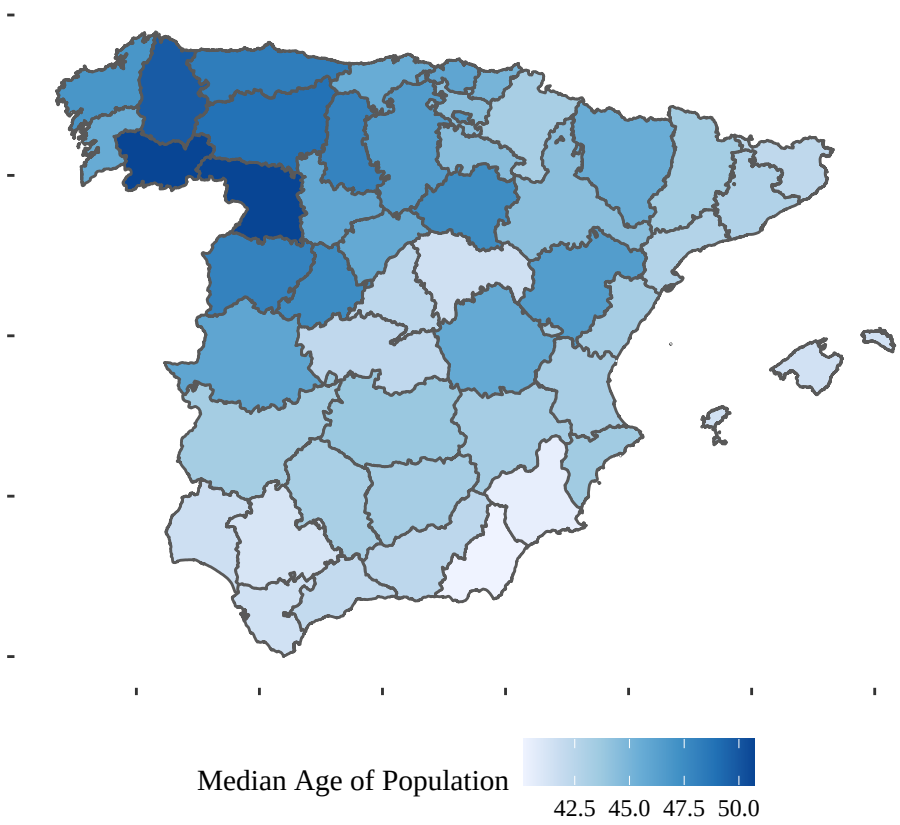
We consider some control variables: ratio of male to female in the province, median age of the population, population density:

```
covid19_spain %>%
  filter(CCAA != "Canarias", Date == "2020-03-13") %>%
  ggplot() +
  geom_sf(aes(fill = Male2Female)) +
  scale_fill_distiller(name = "Male to Female Ratio",
                       palette = "Blues",
                       direction = 1) +
  theme_tufte() +
  theme(axis.text = element_blank(),
        legend.position = "bottom")
```



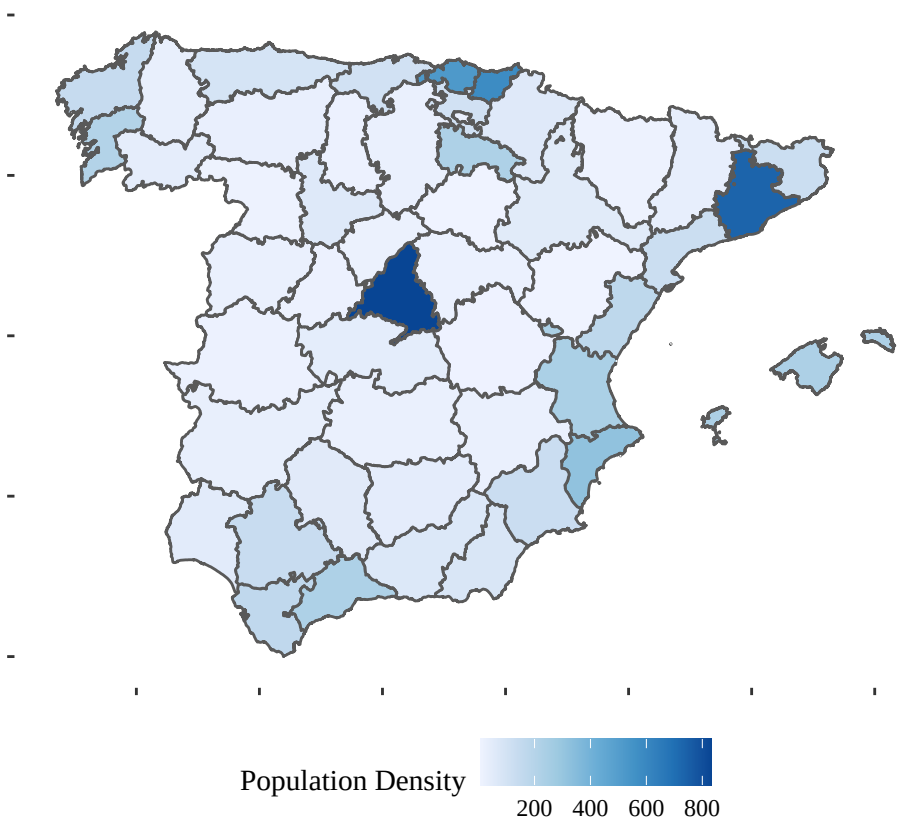
Median age of the population:

```
covid19_spain %>%
  filter(CCAA != "Canarias", Date == "2020-03-13") %>%
  ggplot() +
  geom_sf(aes(fill = Median_Age)) +
  scale_fill_distiller(name = "Median Age of Population",
                       palette = "Blues",
                       direction = 1) +
  theme_tufte() +
  theme(axis.text = element_blank(),
        legend.position = "bottom")
```



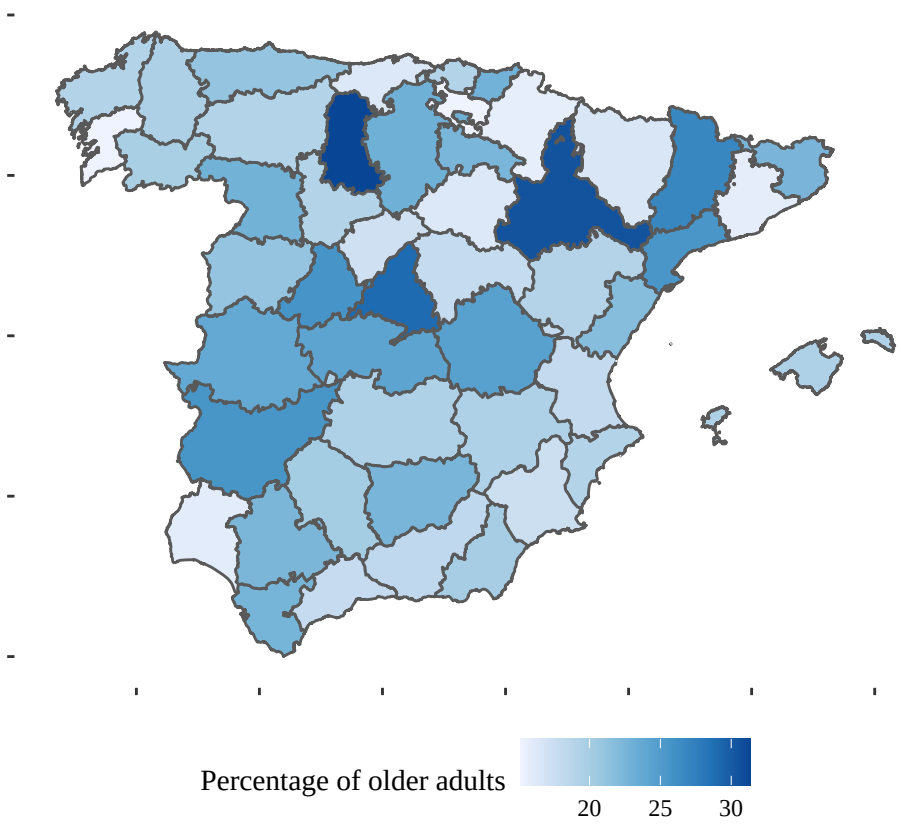
Population density:

```
covid19_spain %>%
  filter(CCAA != "Canarias", Date == "2020-03-13") %>%
  ggplot() +
  geom_sf(aes(fill = as.numeric(Density))) +
  scale_fill_distiller(name = "Population Density",
                       palette = "Blues",
                       direction = 1) +
  theme_tufte() +
  theme(axis.text = element_blank(),
        legend.position = "bottom")
```



Older people:

```
covid19_spain %>%
  filter(CCAA != "Canarias", Date == "2020-03-13") %>%
  ggplot() +
  geom_sf(aes(fill = as.numeric(Older))) +
  scale_fill_distiller(name = "Percentage of older adults",
                       palette = "Blues",
                       direction = 1) +
  theme_tufte() +
  theme(axis.text = element_blank(),
        legend.position = "bottom")
```



We are also interested in the climatic variables. To visualize the distribution of temperature by CCAA, we want to sort the communities by latitude, from north to south:

```
# Autonomous communities
ccaa.sf <- covid19_spain %>%
  filter(Date == "2020-03-13") %>%
  group_by(CCAA) %>%
  summarize(provinces = n())

# Extract coordinates of autonomous communities
ccaa.coords <- ccaa.sf %>%
  st_centroid() %>%
  st_coordinates() %>%
  as.data.frame()
```

```
## Warning in st_centroid.sf(.): st_centroid assumes attributes are constant over
## geometries of x
```

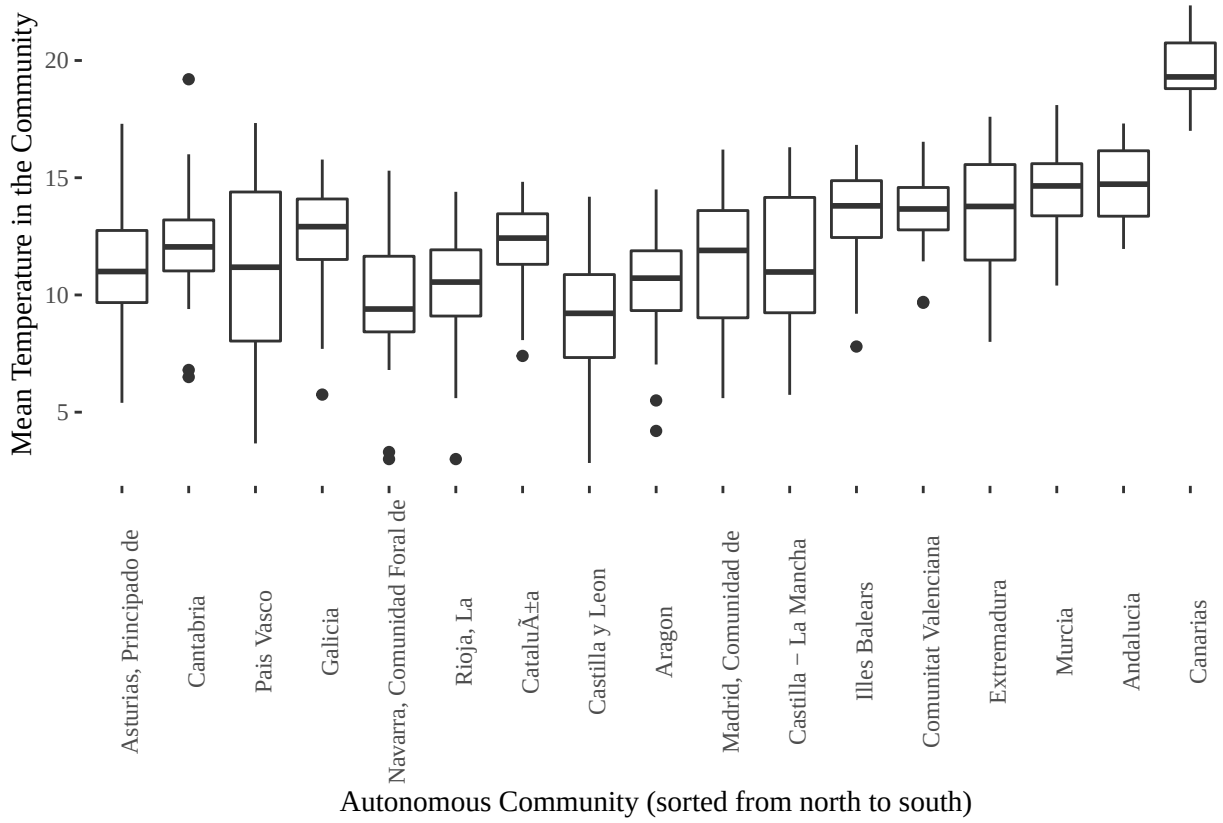
```
## Warning in st_centroid.sfc(st_geometry(x), of_largest_polygon =
## of_largest_polygon): st_centroid does not give correct centroids for longitude/
## latitude data
```

```
# Join Y coordinate to ccaa.sf
ccaa.sf <- ccaa.sf %>%
  mutate(long = ccaa.coords$Y)

# Sort autonomous communities from north to south
ccaa.levels <- ccaa.sf %>%
```

```
  arrange(desc(long)) %>% select(CCAA)

ccaa.levels <- as.character(ccaa.levels$CCAA)

# Relevel autonomous communities
covid19_spain <- covid19_spain %>%
  mutate(CCAA = factor(CCAA, levels = ccaa.levels, ordered = TRUE))
```

The following plot is the distribution of temperature by CCAA, sorted by latitude:

```
# Boxplots of temperatures
covid19_spain %>%
  st_drop_geometry() %>%
  group_by(CCAA, Date) %>%
  summarize(Mean_Temp = mean(Mean_Temp)) %>%
  ggplot(aes(x = CCAA, y = Mean_Temp)) +
  geom_boxplot() +
  theme_tufte() +
  theme(axis.text.x = element_text(angle = 90)) +
  xlab("Autonomous Community (sorted from north to south)") +
  ylab("Mean Temperature in the Community")
```



Multivariate analysis: comparison of approaches

Panel

1) Panel clásico

2) Panel Clásico o Dinámico

- Debe ser un modelo de efectos fijos para recoger la hetereogeneidad entre las distintas provincias (efectos)
- Debería incluir estructura dinámica ya que la serie tiene una fuerte estrutura temporal
- INCONVENIENTE: considera que la incluencia del dato del día anterior es constante (se estima un coeficiente constante)
- INCONVENIENTE: No se pueden incluir varaibles constantes en T. La hetereogeneidad entre provincias queda en el efecto fijo. No podemos por tanto incluir datos sobre estructura de la poblacion.
- INCONVENIENTE: No podemos incorporar efectos espaciales. El paquete **splm** no incluye estimación de paneles dinámicos con efectos espaciales. Tendriamos que hacerlo en matlab con los códigos de P.Elhorst.

Spatial SUR

2) SUR espacial

- Hay un coeficente para cada variable y cada instante de tiempo. Aunque es posible considerar coeficientes constantes para los periodos temporales que consideremos.
- La hetereoeneidad espacial debemos incorporarla mediante variables explicativas. –> Estructura de la población relacionada con COVID-19.
- Permite incluir varaibles constantes en T.
- la dinámica temporar quedará recogida mediante el término independiente y la estructura de correlaciones en los residuos. EN TODO CASO, ENTIENDO QUE NUESTRO OBJETIVO NO ES EXPLICAR ESA TENEDENCIA TEMPORAL (solo modelizarla para no incurrir en errores)

Prepare data for SUR analysis

*El modelo debe considerar efectos del 'individuo' y del 'tiempo' (para incorporar tendencia temporal)**

```
# Definicion del panel para plm
GPanel <- plm::pdata.frame(covid19_spain %>%
                             st_drop_geometry() %>%
                             select(province,
                                    Date,
                                    Incidence,
                                    Median_Age,
                                    Male2Female,
                                    Older,
                                    GDPpc,
                                    Density,
                                    Transit,
                                    Mean_Temp_lag8,
                                    Humidity_lag8,
                                    Sunshine_Hours_lag8,
                                    Mean_Temp_lag11,
                                    Humidity_lag11,
                                    Sunshine_Hours_lag11,
                                    Mean_Temp_lag11w,
                                    Humidity_lag11w,
                                    Sunshine_Hours_lag11w),
                           c("province","Date"))
```

Spatial SUR model

Create connectivity matrix:

```r
# Extract provinces
provinces <- covid19_spain %>%
  filter(Date == "2020-03-13") %>%
  select(province, CCAA, ID_INE)

# Spatial weights matrix:
Wmat <- provinces %>%
  as("Spatial") %>%
  poly2nb(queen = FALSE) %>%
  nb2mat(zero.policy = TRUE)

Wmat <- (Wmat > 0) * 1

# Join the two provinces in Canarias
Wmat[which(provinces$province == "Palmas(Las)"), which(provinces$province == "Santa Cruz de Tenerife")]
Wmat[which(provinces$province == "Santa Cruz de Tenerife"), which(provinces$province == "Palmas(Las)")]

# 'Paises Catalans'
#n = 8
Wmat[which(provinces$province == "Barcelona"), which(provinces$province == "Baleares")] <- 1
Wmat[which(provinces$province == "Baleares"), which(provinces$province == "Barcelona")] <- 1
Wmat[which(provinces$province == "Baleares"), which(provinces$province == "Castellon/Castello")] <- 1
Wmat[which(provinces$province == "Castellon/Castello"), which(provinces$province == "Baleares")] <- 1
Wmat[which(provinces$province == "Baleares"), which(provinces$province == "Tarragona")] <- 1
Wmat[which(provinces$province == "Tarragona"), which(provinces$province == "Baleares")] <- 1
miW <- Wmat/rowSums(Wmat)

# Convert to listw
listw <- mat2listw(Wmat,style = "W")
```

Define formulas with three different lagged variables:

```r
formula_lag8 <- log(Incidence) ~ log(Male2Female) +
  log(Median_Age) +
  #log(Older) +
  log(Density) +
  Transit +
  log(Humidity_lag8) +
  log(Mean_Temp_lag8)

formula_lag11 <- log(Incidence) ~ log(Male2Female) +
  log(Median_Age) +
  #log(Older) +
  log(Density) +
  Transit +
  log(Humidity_lag11) +
  log(Mean_Temp_lag11)

formula_lag11w <- log(Incidence) ~ log(Male2Female) +
  log(Median_Age) +
  #log(Older) +
  log(Density) +
  Transit +
  log(Humidity_lag11w) +
```

```
  log(Mean_Temp_lag11w)
```

Create the terms needed to impose restrictions to the parameters for estimation. In this case we will restrict the two demographic variables and let Density, Transit, and the climatic variables to vary across equations. The rationale is that age and ratio of male to female do not change in the short period of time examined; on the other hand, while density and the presence of transit systems are also constants over the period examined, the behavior changed as a consequence of the lockdown: we expect these variables to be significant early on in the evolution of the pandemic, and become non-significant as the lockdown reduces their importance for the transmission of the virus.

```
# Recall that T is the number of days, i.e., time periods, i.e., equations
k <- 7 # Number of independent variables, including the constant
coef_rest <- 2 # Number of restrictions

# nrow is number of equations (time periods) minus 1, times the number of restrictions
# ncol is number of variables times number of equations
R2 <- matrix(0, nrow = (T - 1) * coef_rest, ncol = k * T)

for (i in 1:(T-1)){
  R2[i, 2] <- 1
  R2[i, (2 + i * k)] <- -1
  R2[(i + T - 1), 3] <- 1
  R2[(i + T - 1), (3 + i * k)] <- -1
  # Use if more restrictions are needed
  #R2[(i + T - 1) * 2, 4] <- 1
  #R2[(i + T - 1) * 2, (4 + i * k)] <- -1
}
b2 <- matrix(0, ncol = 21*coef_rest)
```

Model with a lagged 8-day moving average of climatic variables:

```
sur.slm_lag8 <- spsur::spsurtime(formula = formula_lag8,
                                 data=GPanel,
                                 time = GPanel$Date,
                                 type = "slm",
                                 fit_method = "3sls",
                                 listw=  listw,
                                 R = R2,
                                 b = b2)
```

```
## Time to fit the model:  0.89  seconds
```

```
summary(sur.slm_lag8)
```

```
## Call:
## spsur::spsurtime(formula = formula_lag8, data = GPanel, time = GPanel$Date,
##     listw = listw, type = "slm", fit_method = "3sls", R = R2,
##     b = b2)
##
##
## Spatial SUR model type:  slm
##
## Equation  1
##                       Estimate Std. Error t value Pr(>|t|)
## (Intercept)_1         13.44984   15.11312  0.8899 0.373747
## log(Male2Female)_1    -1.64613    2.39352 -0.6877 0.491800
```

```
## log(Median_Age)_1      1.18476    1.28365  0.9230 0.356290
## log(Density)_1         0.17688    0.17088  1.0351 0.300918
## Transit_1              0.27409    0.57808  0.4741 0.635524
## log(Humidity_lag8)_1  -1.58699    0.50959 -3.1143 0.001906 **
## log(Mean_Temp_lag8)_1 -1.44960    0.49337 -2.9382 0.003390 **
## rho_1                  0.28975    0.12495  2.3189 0.020636 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.08196
##   Equation  2
##                       Estimate Std. Error t value Pr(>|t|)
## (Intercept)_2          9.90840   15.05917  0.6580  0.51074
## log(Density)_2         0.12647    0.14855  0.8514  0.39479
## Transit_2              0.40609    0.50295  0.8074  0.41964
## log(Humidity_lag8)_2  -0.75235    0.38217 -1.9686  0.04932 *
## log(Mean_Temp_lag8)_2 -1.17165    0.38012 -3.0823  0.00212 **
## rho_2                  0.18464    0.12882  1.4333  0.15214
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.1062
##   Equation  3
##                        Estimate Std. Error t value  Pr(>|t|)
## (Intercept)_3         11.315709  15.029593  0.7529 0.4517206
## log(Density)_3         0.070084   0.132380  0.5294 0.5966581
## Transit_3              0.440808   0.448411  0.9830 0.3258638
## log(Humidity_lag8)_3  -0.943037   0.341707 -2.7598 0.0059080 **
## log(Mean_Temp_lag8)_3 -1.222653   0.330814 -3.6959 0.0002331 ***
## rho_3                  0.235246   0.119393  1.9703 0.0491224 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.1334
##   Equation  4
##                         Estimate Std. Error t value  Pr(>|t|)
## (Intercept)_4         10.9636059 15.0384801  0.7290  0.466179
## log(Density)_4         0.0067185  0.1175162  0.0572  0.954422
## Transit_4              0.5353207  0.3968522  1.3489  0.177722
## log(Humidity_lag8)_4  -0.7691966  0.2787003 -2.7599  0.005905 **
## log(Mean_Temp_lag8)_4 -1.0781542  0.2730226 -3.9490 8.497e-05 ***
## rho_4                  0.1506806  0.1174745  1.2827  0.199957
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.134
##   Equation  5
##                        Estimate Std. Error t value  Pr(>|t|)
## (Intercept)_5         12.404953  15.018945  0.8260 0.4090613
## log(Density)_5        -0.030689   0.116477 -0.2635 0.7922445
## Transit_5              0.558137   0.395825  1.4101 0.1588868
## log(Humidity_lag8)_5  -0.974416   0.250970 -3.8826 0.0001113 ***
## log(Mean_Temp_lag8)_5 -1.222242   0.254942 -4.7942 1.927e-06 ***
## rho_5                  0.187947   0.100177  1.8761 0.0609765 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.1609
##   Equation  6
```

```
##                         Estimate Std. Error t value  Pr(>|t|)
## (Intercept)_6          10.83049   15.03632  0.7203 0.4715444
## log(Density)_6         -0.10441    0.11948 -0.8739 0.3824357
## Transit_6               0.62866    0.41146  1.5279 0.1269159
## log(Humidity_lag8)_6   -0.68658    0.26991 -2.5438 0.0111423 *
## log(Mean_Temp_lag8)_6 -0.93650    0.24869 -3.7657 0.0001775 ***
## rho_6                   0.25533    0.11077  2.3051 0.0214000 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.1304
##   Equation  7
##                          Estimate Std. Error t value  Pr(>|t|)
## (Intercept)_7          11.651636  15.026137  0.7754  0.438304
## log(Density)_7         -0.118801   0.114560 -1.0370  0.300020
## Transit_7               0.665989   0.391825  1.6997  0.089550 .
## log(Humidity_lag8)_7   -0.689727   0.239975 -2.8742  0.004152 **
## log(Mean_Temp_lag8)_7 -1.024375   0.217865 -4.7019 3.005e-06 ***
## rho_7                   0.158391   0.094053  1.6841  0.092533 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.1886
##   Equation  8
##                          Estimate Std. Error t value  Pr(>|t|)
## (Intercept)_8          10.893160  15.030576  0.7247   0.46881
## log(Density)_8         -0.156578   0.109145 -1.4346   0.15177
## Transit_8               0.682642   0.369031  1.8498   0.06468 .
## log(Humidity_lag8)_8   -0.478301   0.214664 -2.2281   0.02613 *
## log(Mean_Temp_lag8)_8 -0.921982   0.184342 -5.0015 6.908e-07 ***
## rho_8                   0.162020   0.081989  1.9761   0.04846 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.2021
##   Equation  9
##                          Estimate Std. Error t value  Pr(>|t|)
## (Intercept)_9          11.623896  15.014431  0.7742   0.43904
## log(Density)_9         -0.176662   0.110867 -1.5935   0.11143
## Transit_9               0.712788   0.376483  1.8933   0.05866 .
## log(Humidity_lag8)_9   -0.489376   0.198374 -2.4669   0.01382 *
## log(Mean_Temp_lag8)_9 -1.024812   0.179182 -5.7194 1.479e-08 ***
## rho_9                   0.109777   0.068468  1.6033   0.10923
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.2419
##   Equation  10
##                           Estimate Std. Error t value  Pr(>|t|)
## (Intercept)_10          9.986345  15.016763  0.6650   0.50622
## log(Density)_10        -0.134631   0.109370 -1.2310   0.21867
## Transit_10              0.650723   0.369541  1.7609   0.07861 .
## log(Humidity_lag8)_10  -0.170465   0.216446 -0.7876   0.43117
## log(Mean_Temp_lag8)_10 -0.955550   0.186729 -5.1173 3.831e-07 ***
## rho_10                  0.113468   0.074239  1.5284   0.12678
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.2302
```

```
##   Equation  11
##                          Estimate Std. Error t value  Pr(>|t|)
## (Intercept)_11          9.080799  15.041676  0.6037   0.54620
## log(Density)_11        -0.092801   0.099979 -0.9282   0.35357
## Transit_11              0.592621   0.327659  1.8087   0.07086 .
## log(Humidity_lag8)_11   0.178389   0.214850  0.8303   0.40660
## log(Mean_Temp_lag8)_11 -1.140343   0.172870 -6.5965 7.378e-11 ***
## rho_11                  0.083585   0.070316  1.1887   0.23489
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.3347
##   Equation  12
##                          Estimate Std. Error t value  Pr(>|t|)
## (Intercept)_12         11.202061  15.022693  0.7457 0.4560686
## log(Density)_12        -0.102112   0.097964 -1.0423 0.2975502
## Transit_12              0.673300   0.317681  2.1194 0.0343435 *
## log(Humidity_lag8)_12  -0.311162   0.192144 -1.6194 0.1057267
## log(Mean_Temp_lag8)_12 -1.282355   0.154621 -8.2936  4.26e-16 ***
## rho_12                  0.220517   0.060935  3.6189 0.0003133 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.3523
##   Equation  13
##                          Estimate Std. Error t value  Pr(>|t|)
## (Intercept)_13         12.155418  15.019873  0.8093  0.418575
## log(Density)_13        -0.084688   0.094181 -0.8992  0.368796
## Transit_13              0.666850   0.299118  2.2294  0.026048 *
## log(Humidity_lag8)_13  -0.456232   0.196078 -2.3268  0.020210 *
## log(Mean_Temp_lag8)_13 -1.367879   0.137606 -9.9405 < 2.2e-16 ***
## rho_13                  0.203890   0.063754  3.1981  0.001435 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.4079
##   Equation  14
##                          Estimate Std. Error  t value Pr(>|t|)
## (Intercept)_14         12.895542  15.024485   0.8583  0.39097
## log(Density)_14        -0.049838   0.091133  -0.5469  0.58461
## Transit_14              0.626989   0.283113   2.2146  0.02705 *
## log(Humidity_lag8)_14  -0.491212   0.203993  -2.4080  0.01625 *
## log(Mean_Temp_lag8)_14 -1.530018   0.142998 -10.6995  < 2e-16 ***
## rho_14                  0.154160   0.067569   2.2815  0.02276 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.4605
##   Equation  15
##                          Estimate Std. Error  t value  Pr(>|t|)
## (Intercept)_15         14.026862  15.050704   0.9320  0.351614
## log(Density)_15        -0.035078   0.090952  -0.3857  0.699830
## Transit_15              0.586001   0.280933   2.0859  0.037283 *
## log(Humidity_lag8)_15  -0.637999   0.195857  -3.2575  0.001168 **
## log(Mean_Temp_lag8)_15 -1.732752   0.152369 -11.3721 < 2.2e-16 ***
## rho_15                  0.167322   0.067711   2.4711  0.013664 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
## R-squared: 0.5013
##   Equation  16
##                          Estimate Std. Error  t value  Pr(>|t|)
## (Intercept)_16         13.934761  15.057281   0.9255  0.354994
## log(Density)_16        -0.039661   0.091139  -0.4352  0.663547
## Transit_16              0.578650   0.282035   2.0517  0.040504 *
## log(Humidity_lag8)_16  -0.510355   0.169504  -3.0109  0.002682 **
## log(Mean_Temp_lag8)_16 -1.734221   0.150574 -11.5174 < 2.2e-16 ***
## rho_16                  0.096357   0.074489   1.2936  0.196159
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.5253
##   Equation  17
##                          Estimate Std. Error  t value  Pr(>|t|)
## (Intercept)_17         15.446165  15.072955   1.0248   0.30577
## log(Density)_17        -0.053942   0.091087  -0.5922   0.55387
## Transit_17              0.564386   0.282279   1.9994   0.04588 *
## log(Humidity_lag8)_17  -0.666153   0.169635  -3.9270 9.296e-05 ***
## log(Mean_Temp_lag8)_17 -1.906077   0.162300 -11.7442 < 2.2e-16 ***
## rho_17                  0.059027   0.070555   0.8366   0.40305
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.5265
##   Equation  18
##                          Estimate Std. Error  t value  Pr(>|t|)
## (Intercept)_18         15.011625  15.078440   0.9956 0.3197420
## log(Density)_18        -0.082739   0.089698  -0.9224 0.3565743
## Transit_18              0.544969   0.275978   1.9747 0.0486262 *
## log(Humidity_lag8)_18  -0.611894   0.157452  -3.8862 0.0001097 ***
## log(Mean_Temp_lag8)_18 -1.734835   0.153588 -11.2954 < 2.2e-16 ***
## rho_18                  0.055856   0.069590   0.8026 0.4224054
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.5295
##   Equation  19
##                          Estimate Std. Error  t value  Pr(>|t|)
## (Intercept)_19         14.613467  15.015228   0.9732    0.3307
## log(Density)_19        -0.106579   0.090375  -1.1793    0.2386
## Transit_19              0.577372   0.277696   2.0792    0.0379 *
## log(Humidity_lag8)_19  -0.680824   0.147173  -4.6260 4.306e-06 ***
## log(Mean_Temp_lag8)_19 -1.457869   0.131353 -11.0989 < 2.2e-16 ***
## rho_19                  0.079397   0.065463   1.2128    0.2255
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.5129
##   Equation  20
##                          Estimate Std. Error  t value  Pr(>|t|)
## (Intercept)_20         14.452286  15.008409   0.9629   0.33585
## log(Density)_20        -0.118009   0.088806  -1.3288   0.18426
## Transit_20              0.581016   0.270686   2.1465   0.03212 *
## log(Humidity_lag8)_20  -0.677635   0.130707  -5.1844 2.708e-07 ***
## log(Mean_Temp_lag8)_20 -1.351665   0.111138 -12.1620 < 2.2e-16 ***
## rho_20                  0.066946   0.059594   1.1234   0.26160
## ---
```

```
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.5363
##   Equation  21
##                          Estimate Std. Error  t value  Pr(>|t|)
## (Intercept)_21         14.645791  15.026485   0.9747    0.3300
## log(Density)_21        -0.120054   0.086631  -1.3858    0.1662
## Transit_21              0.598982   0.261444   2.2910    0.0222 *
## log(Humidity_lag8)_21  -0.720607   0.130180  -5.5355 4.132e-08 ***
## log(Mean_Temp_lag8)_21 -1.330940   0.103620 -12.8445 < 2.2e-16 ***
## rho_21                  0.060944   0.060018   1.0154    0.3102
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.5444
##   Equation  22
##                          Estimate Std. Error  t value  Pr(>|t|)
## (Intercept)_22         14.362926  15.035956   0.9552   0.33973
## log(Density)_22        -0.136579   0.084839  -1.6099   0.10780
## Transit_22              0.631086   0.254599   2.4787   0.01338 *
## log(Humidity_lag8)_22  -0.641103   0.129807  -4.9389 9.453e-07 ***
## log(Mean_Temp_lag8)_22 -1.331418   0.094760 -14.0505 < 2.2e-16 ***
## rho_22                  0.071593   0.058724   1.2191   0.22313
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.5623
##   Equation  23
##                          Estimate Std. Error  t value  Pr(>|t|)
## (Intercept)_23         12.704871  15.021699   0.8458 0.3979194
## log(Density)_23        -0.156511   0.084842  -1.8447 0.0654226 .
## Transit_23              0.638285   0.255450   2.4987 0.0126531 *
## log(Humidity_lag8)_23  -0.372171   0.105597  -3.5245 0.0004469 ***
## log(Mean_Temp_lag8)_23 -1.109823   0.074116 -14.9740 < 2.2e-16 ***
## rho_23                  0.082617   0.058387   1.4150 0.1574346
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.5538
##   Equation  24
##                          Estimate Std. Error  t value Pr(>|t|)
## (Intercept)_24         11.571789  15.011703   0.7709  0.44101
## log(Density)_24        -0.170206   0.085769  -1.9845  0.04752 *
## Transit_24              0.625484   0.259957   2.4061  0.01634 *
## log(Humidity_lag8)_24  -0.149682   0.108526  -1.3792  0.16819
## log(Mean_Temp_lag8)_24 -0.948109   0.062931 -15.0658  < 2e-16 ***
## rho_24                  0.054686   0.059617   0.9173  0.35925
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.5477
##   Equation  25
##                          Estimate Std. Error  t value Pr(>|t|)
## (Intercept)_25         11.436057  15.015283   0.7616  0.44649
## log(Density)_25        -0.172359   0.085584  -2.0139  0.04433 *
## Transit_25              0.614354   0.260000   2.3629  0.01836 *
## log(Humidity_lag8)_25  -0.100055   0.104985  -0.9530  0.34084
## log(Mean_Temp_lag8)_25 -0.925930   0.060577 -15.2853  < 2e-16 ***
## rho_25                  0.036809   0.059081   0.6230  0.53343
```

```
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.5481
##   Equation  26
##                          Estimate Std. Error  t value Pr(>|t|)
## (Intercept)_26         11.050804  15.010081   0.7362  0.46180
## log(Density)_26        -0.166193   0.086393  -1.9237  0.05473 .
## Transit_26              0.613206   0.264079   2.3221  0.02046 *
## log(Humidity_lag8)_26  -0.048087   0.106885  -0.4499  0.65290
## log(Mean_Temp_lag8)_26 -0.915772   0.059732 -15.3314  < 2e-16 ***
## rho_26                  0.061878   0.061026   1.0139  0.31090
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.5477
##   Equation  27
##                          Estimate Std. Error  t value Pr(>|t|)
## (Intercept)_27         10.796678  15.012907   0.7192  0.47224
## log(Density)_27        -0.161802   0.086764  -1.8649  0.06254 .
## Transit_27              0.600227   0.265952   2.2569  0.02427 *
## log(Humidity_lag8)_27   0.027613   0.123835   0.2230  0.82360
## log(Mean_Temp_lag8)_27 -0.974149   0.066514 -14.6458  < 2e-16 ***
## rho_27                  0.078597   0.062158   1.2645  0.20640
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.5503
##   Equation  28
##                          Estimate Std. Error  t value Pr(>|t|)
## (Intercept)_28         11.358787  15.002356   0.7571  0.44918
## log(Density)_28        -0.179155   0.088430  -2.0260  0.04308 *
## Transit_28              0.637865   0.273633   2.3311  0.01998 *
## log(Humidity_lag8)_28  -0.086201   0.134724  -0.6398  0.52245
## log(Mean_Temp_lag8)_28 -1.011799   0.073558 -13.7550  < 2e-16 ***
## rho_28                  0.109569   0.061852   1.7715  0.07684 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.5377
##   Equation  29
##                          Estimate Std. Error  t value Pr(>|t|)
## (Intercept)_29         11.229688  14.990840   0.7491  0.45400
## log(Density)_29        -0.191128   0.089164  -2.1435  0.03235 *
## Transit_29              0.654982   0.276520   2.3687  0.01807 *
## log(Humidity_lag8)_29   0.023359   0.163680   0.1427  0.88655
## log(Mean_Temp_lag8)_29 -1.088102   0.082927 -13.1212  < 2e-16 ***
## rho_29                  0.103976   0.062366   1.6672  0.09585 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.5373
##   Equation  30
##                          Estimate Std. Error  t value Pr(>|t|)
## (Intercept)_30         11.799601  14.985307   0.7874  0.43126
## log(Density)_30        -0.203147   0.090973  -2.2330  0.02580 *
## Transit_30              0.708676   0.284437   2.4915  0.01291 *
## log(Humidity_lag8)_30  -0.090559   0.192976  -0.4693  0.63899
## log(Mean_Temp_lag8)_30 -1.135063   0.094097 -12.0627  < 2e-16 ***
```

```
## rho_30                  0.131120   0.066634   1.9678  0.04942 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.5224
##
## Variance-Covariance Matrix of inter-equation residuals:
##  1.1182563 0.9098830 0.7975777 0.6764132 0.6573438 0.6205371 0.5629458
##  0.9098830 0.8489919 0.7087750 0.6044651 0.5715793 0.5567053 0.5205337
##  0.7975777 0.7087750 0.6778503 0.5658804 0.5506614 0.5367463 0.4943378
##  0.6764132 0.6044651 0.5658804 0.5318687 0.5172578 0.5109135 0.4738031
##  0.6573438 0.5715793 0.5506614 0.5172578 0.5299510 0.5303869 0.4931065
##  0.6205371 0.5567053 0.5367463 0.5109135 0.5303869 0.5739233 0.5385649
##  0.5629458 0.5205337 0.4943378 0.4738031 0.4931065 0.5385649 0.5201109
##  0.5080998 0.4685015 0.4540600 0.4345078 0.4543341 0.4914405 0.4790405
##  0.5080792 0.4762366 0.4516895 0.4342009 0.4560982 0.4931051 0.4819448
##  0.4888787 0.4579890 0.4273290 0.4154211 0.4387660 0.4752772 0.4665190
##  0.4064836 0.3808485 0.3588320 0.3390001 0.3667017 0.4083891 0.4025867
##  0.3886870 0.3523288 0.3331740 0.3307107 0.3580395 0.3913384 0.3852520
##  0.3635691 0.3253283 0.3105545 0.3106044 0.3346028 0.3585879 0.3519485
##  0.3102844 0.2690953 0.2657039 0.2648937 0.2857021 0.3011191 0.2981952
##  0.2832341 0.2257763 0.2324307 0.2267824 0.2485109 0.2577685 0.2553555
##  0.2577883 0.2025333 0.2164185 0.2070461 0.2256172 0.2314749 0.2301749
##  0.2512318 0.1960556 0.2171990 0.2034817 0.2206736 0.2303925 0.2296815
##  0.2411016 0.2048401 0.2231717 0.2039157 0.2133636 0.2300124 0.2302032
##  0.2462636 0.2128767 0.2342385 0.2199733 0.2285836 0.2461629 0.2451034
##  0.2348479 0.2038085 0.2268670 0.2176839 0.2276584 0.2446452 0.2430821
##  0.2373443 0.2068991 0.2203575 0.2163976 0.2262305 0.2410271 0.2392672
##  0.2309067 0.2058150 0.2176650 0.2144721 0.2275759 0.2417591 0.2409240
##  0.2434555 0.2250270 0.2281998 0.2275158 0.2396575 0.2567190 0.2560850
##  0.2459870 0.2308055 0.2306944 0.2302194 0.2445972 0.2667857 0.2668520
##  0.2375664 0.2242284 0.2267040 0.2280443 0.2432602 0.2642168 0.2646949
##  0.2329468 0.2160497 0.2231339 0.2271739 0.2447450 0.2622730 0.2631072
##  0.2378358 0.2194221 0.2262530 0.2281592 0.2479629 0.2648656 0.2663098
##  0.2463596 0.2268734 0.2351032 0.2374519 0.2565107 0.2743179 0.2759697
##  0.2657724 0.2413598 0.2502876 0.2466617 0.2634294 0.2819760 0.2829029
##  0.2844912 0.2589161 0.2677859 0.2601064 0.2755990 0.2950404 0.2958718
##
##  0.5080998 0.5080792 0.4888787 0.4064836 0.3886870 0.3635691 0.3102844
##  0.4685015 0.4762366 0.4579890 0.3808485 0.3523288 0.3253283 0.2690953
##  0.4540600 0.4516895 0.4273290 0.3588320 0.3331740 0.3105545 0.2657039
##  0.4345078 0.4342009 0.4154211 0.3390001 0.3307107 0.3106044 0.2648937
##  0.4543341 0.4560982 0.4387660 0.3667017 0.3580395 0.3346028 0.2857021
##  0.4914405 0.4931051 0.4752772 0.4083891 0.3913384 0.3585879 0.3011191
##  0.4790405 0.4819448 0.4665190 0.4025867 0.3852520 0.3519485 0.2981952
##  0.4609818 0.4636371 0.4460184 0.3881292 0.3721895 0.3394506 0.2912645
##  0.4636371 0.4799172 0.4643012 0.4002880 0.3839802 0.3485212 0.2974496
##  0.4460184 0.4643012 0.4615898 0.3951360 0.3831288 0.3501339 0.3033439
##  0.3881292 0.4002880 0.3951360 0.3610488 0.3421241 0.3098382 0.2686876
##  0.3721895 0.3839802 0.3831288 0.3421241 0.3392774 0.3139455 0.2784981
##  0.3394506 0.3485212 0.3501339 0.3098382 0.3139455 0.2998876 0.2730688
##  0.2912645 0.2974496 0.3033439 0.2686876 0.2784981 0.2730688 0.2673035
##  0.2495380 0.2548824 0.2648024 0.2347936 0.2475743 0.2482378 0.2552850
##  0.2266161 0.2309677 0.2410772 0.2120717 0.2246656 0.2272649 0.2410773
##  0.2284788 0.2320303 0.2392739 0.2109035 0.2223194 0.2228242 0.2375652
```

```
##  0.2253434 0.2280957 0.2365653 0.2046085 0.2128612 0.2136131 0.2259514
##  0.2399977 0.2429692 0.2493331 0.2146787 0.2227406 0.2223622 0.2294533
##  0.2370444 0.2405428 0.2467085 0.2125932 0.2216113 0.2214191 0.2255987
##  0.2345275 0.2390049 0.2440450 0.2109345 0.2208199 0.2196407 0.2209132
##  0.2366663 0.2423519 0.2460292 0.2137252 0.2224521 0.2194128 0.2162320
##  0.2512650 0.2577597 0.2607560 0.2268153 0.2330974 0.2266185 0.2157006
##  0.2624037 0.2690936 0.2710753 0.2399336 0.2426413 0.2332263 0.2179459
##  0.2629026 0.2693367 0.2693623 0.2397556 0.2414201 0.2319320 0.2150718
##  0.2633565 0.2695508 0.2694714 0.2393372 0.2427601 0.2338846 0.2176473
##  0.2654196 0.2706231 0.2701444 0.2421062 0.2447460 0.2359340 0.2184462
##  0.2759477 0.2810033 0.2788040 0.2490042 0.2517742 0.2424033 0.2239736
##  0.2826218 0.2878577 0.2847598 0.2543157 0.2558090 0.2458586 0.2282654
##  0.2955134 0.3009646 0.2960788 0.2630423 0.2629472 0.2521501 0.2347855
##
##  0.2832341 0.2577883 0.2512318 0.2411016 0.2462636 0.2348479 0.2373443
##  0.2257763 0.2025333 0.1960556 0.2048401 0.2128767 0.2038085 0.2068991
##  0.2324307 0.2164185 0.2171990 0.2231717 0.2342385 0.2268670 0.2203575
##  0.2267824 0.2070461 0.2034817 0.2039157 0.2199733 0.2176839 0.2163976
##  0.2485109 0.2256172 0.2206736 0.2133636 0.2285836 0.2276584 0.2262305
##  0.2577685 0.2314749 0.2303925 0.2300124 0.2461629 0.2446452 0.2410271
##  0.2553555 0.2301749 0.2296815 0.2302032 0.2451034 0.2430821 0.2392672
##  0.2495380 0.2266161 0.2284788 0.2253434 0.2399977 0.2370444 0.2345275
##  0.2548824 0.2309677 0.2320303 0.2280957 0.2429692 0.2405428 0.2390049
##  0.2648024 0.2410772 0.2392739 0.2365653 0.2493331 0.2467085 0.2440450
##  0.2347936 0.2120717 0.2109035 0.2046085 0.2146787 0.2125932 0.2109345
##  0.2475743 0.2246656 0.2223194 0.2128612 0.2227406 0.2216113 0.2208199
##  0.2482378 0.2272649 0.2228242 0.2136131 0.2223622 0.2214191 0.2196407
##  0.2552850 0.2410773 0.2375652 0.2259514 0.2294533 0.2255987 0.2209132
##  0.2624821 0.2566046 0.2517908 0.2376993 0.2356831 0.2296993 0.2221658
##  0.2566046 0.2640318 0.2606083 0.2455221 0.2407362 0.2321358 0.2217893
##  0.2517908 0.2606083 0.2652298 0.2518928 0.2472647 0.2369299 0.2254833
##  0.2376993 0.2455221 0.2518928 0.2534618 0.2515873 0.2404095 0.2254803
##  0.2356831 0.2407362 0.2472647 0.2515873 0.2572028 0.2483143 0.2347442
##  0.2296993 0.2321358 0.2369299 0.2404095 0.2483143 0.2440474 0.2327884
##  0.2221658 0.2217893 0.2254833 0.2254803 0.2347442 0.2327884 0.2271684
##  0.2132450 0.2103830 0.2130556 0.2117976 0.2218485 0.2224014 0.2190310
##  0.2054870 0.2000081 0.2008179 0.2015290 0.2150022 0.2165845 0.2144128
##  0.2028056 0.1943581 0.1945849 0.1964925 0.2120108 0.2135439 0.2107637
##  0.1972612 0.1887374 0.1882220 0.1889529 0.2058000 0.2074861 0.2049809
##  0.2011878 0.1948343 0.1935556 0.1906264 0.2076221 0.2092928 0.2069818
##  0.2018652 0.1951470 0.1930729 0.1884839 0.2046535 0.2066972 0.2047792
##  0.2059062 0.1987343 0.1975735 0.1934682 0.2106335 0.2115829 0.2091759
##  0.2104721 0.2035866 0.2034142 0.2010676 0.2168705 0.2158188 0.2111561
##  0.2169451 0.2106802 0.2108704 0.2096812 0.2245050 0.2224997 0.2163060
##
##  0.2309067 0.2434555 0.2459870 0.2375664 0.2329468 0.2378358 0.2463596
##  0.2058150 0.2250270 0.2308055 0.2242284 0.2160497 0.2194221 0.2268734
##  0.2176650 0.2281998 0.2306944 0.2267040 0.2231339 0.2262530 0.2351032
##  0.2144721 0.2275158 0.2302194 0.2280443 0.2271739 0.2281592 0.2374519
##  0.2275759 0.2396575 0.2445972 0.2432602 0.2447450 0.2479629 0.2565107
##  0.2417591 0.2567190 0.2667857 0.2642168 0.2622730 0.2648656 0.2743179
##  0.2409240 0.2560850 0.2668520 0.2646949 0.2631072 0.2663098 0.2759697
##  0.2366663 0.2512650 0.2624037 0.2629026 0.2633565 0.2654196 0.2759477
##  0.2423519 0.2577597 0.2690936 0.2693367 0.2695508 0.2706231 0.2810033
```

```
##  0.2460292 0.2607560 0.2710753 0.2693623 0.2694714 0.2701444 0.2788040
##  0.2137252 0.2268153 0.2399336 0.2397556 0.2393372 0.2421062 0.2490042
##  0.2224521 0.2330974 0.2426413 0.2414201 0.2427601 0.2447460 0.2517742
##  0.2194128 0.2266185 0.2332263 0.2319320 0.2338846 0.2359340 0.2424033
##  0.2162320 0.2157006 0.2179459 0.2150718 0.2176473 0.2184462 0.2239736
##  0.2132450 0.2054870 0.2028056 0.1972612 0.2011878 0.2018652 0.2059062
##  0.2103830 0.2000081 0.1943581 0.1887374 0.1948343 0.1951470 0.1987343
##  0.2130556 0.2008179 0.1945849 0.1882220 0.1935556 0.1930729 0.1975735
##  0.2117976 0.2015290 0.1964925 0.1889529 0.1906264 0.1884839 0.1934682
##  0.2218485 0.2150022 0.2120108 0.2058000 0.2076221 0.2046535 0.2106335
##  0.2224014 0.2165845 0.2135439 0.2074861 0.2092928 0.2066972 0.2115829
##  0.2190310 0.2144128 0.2107637 0.2049809 0.2069818 0.2047792 0.2091759
##  0.2155609 0.2131507 0.2105506 0.2059294 0.2082041 0.2073625 0.2114568
##  0.2131507 0.2173215 0.2185256 0.2157320 0.2178583 0.2169750 0.2215207
##  0.2105506 0.2185256 0.2252666 0.2238428 0.2252476 0.2243633 0.2292011
##  0.2059294 0.2157320 0.2238428 0.2253841 0.2276629 0.2275096 0.2333216
##  0.2082041 0.2178583 0.2252476 0.2276629 0.2325492 0.2330875 0.2391740
##  0.2073625 0.2169750 0.2243633 0.2275096 0.2330875 0.2357819 0.2418572
##  0.2114568 0.2215207 0.2292011 0.2333216 0.2391740 0.2418572 0.2500889
##  0.2123163 0.2221423 0.2301153 0.2340278 0.2387875 0.2411770 0.2507076
##  0.2166782 0.2265436 0.2345692 0.2385635 0.2424450 0.2445660 0.2546775
##
##  0.2657724 0.2844912
##  0.2413598 0.2589161
##  0.2502876 0.2677859
##  0.2466617 0.2601064
##  0.2634294 0.2755990
##  0.2819760 0.2950404
##  0.2829029 0.2958718
##  0.2826218 0.2955134
##  0.2878577 0.3009646
##  0.2847598 0.2960788
##  0.2543157 0.2630423
##  0.2558090 0.2629472
##  0.2458586 0.2521501
##  0.2282654 0.2347855
##  0.2104721 0.2169451
##  0.2035866 0.2106802
##  0.2034142 0.2108704
##  0.2010676 0.2096812
##  0.2168705 0.2245050
##  0.2158188 0.2224997
##  0.2111561 0.2163060
##  0.2123163 0.2166782
##  0.2221423 0.2265436
##  0.2301153 0.2345692
##  0.2340278 0.2385635
##  0.2387875 0.2424450
##  0.2411770 0.2445660
##  0.2507076 0.2546775
##  0.2554745 0.2615465
##  0.2615465 0.2704584
## Correlation Matrix of inter-equation residuals:
##  1.0000000 0.9395027 0.9327644 0.9094724 0.8917049 0.8317093 0.8062810
```

```
##  0.9395027 1.0000000 0.9469363 0.9179331 0.8810722 0.8387579 0.8356912
##  0.9327644 0.9469363 1.0000000 0.9628235 0.9492536 0.9026160 0.8849747
##  0.9094724 0.9179331 0.9628235 1.0000000 0.9818689 0.9393822 0.9230122
##  0.8917049 0.8810722 0.9492536 0.9818689 1.0000000 0.9666258 0.9502732
##  0.8317093 0.8387579 0.9026160 0.9393822 0.9666258 1.0000000 0.9863324
##  0.8062810 0.8356912 0.8849747 0.9230122 0.9502732 0.9863324 1.0000000
##  0.7802418 0.8082898 0.8695466 0.9086021 0.9370476 0.9638972 0.9837897
##  0.7640322 0.8026225 0.8510437 0.8913394 0.9221923 0.9483977 0.9714496
##  0.7664403 0.8039683 0.8424087 0.8817270 0.9124242 0.9380080 0.9629372
##  0.7208953 0.7596372 0.7996409 0.8203149 0.8628262 0.9096441 0.9424088
##  0.7353983 0.7527048 0.7973631 0.8418122 0.8833505 0.9184453 0.9469511
##  0.7272438 0.7409775 0.7941053 0.8439265 0.8851922 0.9100965 0.9382179
##  0.6788623 0.6882012 0.7577612 0.7990155 0.8405829 0.8562044 0.8916840
##  0.6648600 0.6474126 0.7302037 0.7625425 0.8096666 0.8187746 0.8509940
##  0.6454822 0.6300627 0.7173193 0.7413823 0.7837422 0.7875529 0.8198045
##  0.6408993 0.6264440 0.7172991 0.7353279 0.7762583 0.7860381 0.8185581
##  0.6348248 0.6469200 0.7293641 0.7386143 0.7685933 0.7879704 0.8232600
##  0.6304260 0.6451214 0.7300443 0.7466505 0.7750649 0.7935537 0.8299260
##  0.6078913 0.6208222 0.7099523 0.7379364 0.7688228 0.7885963 0.8261308
##  0.6174739 0.6286410 0.7058095 0.7417513 0.7718430 0.7903930 0.8281807
##  0.6075916 0.6263525 0.7026072 0.7411249 0.7751893 0.7931763 0.8335094
##  0.6110813 0.6402525 0.7065761 0.7485466 0.7788432 0.8006672 0.8426748
##  0.6012068 0.6354145 0.6966112 0.7386988 0.7705922 0.7994248 0.8434175
##  0.5857780 0.6232889 0.6841388 0.7294873 0.7625026 0.7895644 0.8352333
##  0.5767611 0.6096751 0.6751568 0.7235008 0.7588857 0.7817300 0.8277837
##  0.5798275 0.6112650 0.6769316 0.7234152 0.7618892 0.7843567 0.8317006
##  0.5760556 0.6090332 0.6751830 0.7234587 0.7595617 0.7821496 0.8300400
##  0.5865288 0.6159921 0.6861155 0.7302561 0.7637597 0.7859728 0.8335224
##  0.5922902 0.6235134 0.6969794 0.7378387 0.7701497 0.7922736 0.8396815
##
##  0.7802418 0.7640322 0.7664403 0.7208953 0.7353983 0.7272438 0.6788623
##  0.8082898 0.8026225 0.8039683 0.7596372 0.7527048 0.7409775 0.6882012
##  0.8695466 0.8510437 0.8424087 0.7996409 0.7973631 0.7941053 0.7577612
##  0.9086021 0.8913394 0.8817270 0.8203149 0.8418122 0.8439265 0.7990155
##  0.9370476 0.9221923 0.9124242 0.8628262 0.8833505 0.8851922 0.8405829
##  0.9638972 0.9483977 0.9380080 0.9096441 0.9184453 0.9100965 0.8562044
##  0.9837897 0.9714496 0.9629372 0.9424088 0.9469511 0.9382179 0.8916840
##  1.0000000 0.9883266 0.9748732 0.9614730 0.9688993 0.9600488 0.9225595
##  0.9883266 1.0000000 0.9905286 0.9715006 0.9770898 0.9664239 0.9288267
##  0.9748732 0.9905286 1.0000000 0.9732596 0.9802361 0.9716284 0.9392402
##  0.9614730 0.9715006 0.9732596 1.0000000 0.9840528 0.9666545 0.9372570
##  0.9688993 0.9770898 0.9802361 0.9840528 1.0000000 0.9918345 0.9664762
##  0.9600488 0.9664239 0.9716284 0.9666545 0.9918345 1.0000000 0.9830598
##  0.9225595 0.9288267 0.9392402 0.9372570 0.9664762 0.9830598 1.0000000
##  0.8795254 0.8876485 0.9019387 0.8998626 0.9309714 0.9546228 0.9846056
##  0.8505835 0.8588943 0.8719169 0.8665346 0.8943760 0.9192006 0.9570526
##  0.8524389 0.8606125 0.8675610 0.8657234 0.8928664 0.9150909 0.9524498
##  0.8503687 0.8587925 0.8702536 0.8629411 0.8820316 0.9045842 0.9392147
##  0.8574846 0.8650991 0.8745184 0.8663197 0.8864351 0.9105920 0.9398567
##  0.8526263 0.8601422 0.8697341 0.8607284 0.8842414 0.9123496 0.9387097
##  0.8582924 0.8659064 0.8737271 0.8673975 0.8947868 0.9214666 0.9434736
##  0.8672115 0.8760538 0.8808157 0.8753457 0.9025147 0.9272687 0.9433094
##  0.8783801 0.8868807 0.8917530 0.8857702 0.9108205 0.9305232 0.9366862
##  0.8806239 0.8883587 0.8929700 0.8956245 0.9149755 0.9308735 0.9331822
```

```
##  0.8768472 0.8843743 0.8863506 0.8920968 0.9101465 0.9254029 0.9255843
##  0.8725690 0.8790513 0.8803533 0.8841675 0.9055789 0.9217833 0.9226056
##  0.8749532 0.8797090 0.8797228 0.8864620 0.9062280 0.9219001 0.9196489
##  0.8753568 0.8800738 0.8781320 0.8841006 0.9043508 0.9190438 0.9160918
##  0.8799410 0.8851563 0.8821685 0.8898794 0.9084582 0.9211335 0.9196569
##  0.8866000 0.8917948 0.8871679 0.8923803 0.9092806 0.9207068 0.9211770
##
##  0.6648600 0.6454822 0.6408993 0.6348248 0.6304260 0.6078913 0.6174739
##  0.6474126 0.6300627 0.6264440 0.6469200 0.6451214 0.6208222 0.6286410
##  0.7302037 0.7173193 0.7172991 0.7293641 0.7300443 0.7099523 0.7058095
##  0.7625425 0.7413823 0.7353279 0.7386143 0.7466505 0.7379364 0.7417513
##  0.8096666 0.7837422 0.7762583 0.7685933 0.7750649 0.7688228 0.7718430
##  0.8187746 0.7875529 0.7860381 0.7879704 0.7935537 0.7885963 0.7903930
##  0.8509940 0.8198045 0.8185581 0.8232600 0.8299260 0.8261308 0.8281807
##  0.8795254 0.8505835 0.8524389 0.8503687 0.8574846 0.8526263 0.8582924
##  0.8876485 0.8588943 0.8606125 0.8587925 0.8650991 0.8601422 0.8659064
##  0.9019387 0.8719169 0.8675610 0.8702536 0.8745184 0.8697341 0.8737271
##  0.8998626 0.8665346 0.8657234 0.8629411 0.8663197 0.8607284 0.8673975
##  0.9309714 0.8943760 0.8928664 0.8820316 0.8864351 0.8842414 0.8947868
##  0.9546228 0.9192006 0.9150909 0.9045842 0.9105920 0.9123496 0.9214666
##  0.9846056 0.9570526 0.9524498 0.9392147 0.9398567 0.9387097 0.9434736
##  1.0000000 0.9835270 0.9745940 0.9621515 0.9591709 0.9579210 0.9590388
##  0.9835270 1.0000000 0.9944443 0.9826281 0.9753675 0.9686863 0.9650295
##  0.9745940 0.9944443 1.0000000 0.9866377 0.9784295 0.9698561 0.9665505
##  0.9621515 0.9826281 0.9866377 1.0000000 0.9951449 0.9861821 0.9771171
##  0.9591709 0.9753675 0.9784295 0.9951449 1.0000000 0.9947676 0.9875375
##  0.9579210 0.9686863 0.9698561 0.9861821 0.9947676 1.0000000 0.9952038
##  0.9590388 0.9650295 0.9665505 0.9771171 0.9875375 0.9952038 1.0000000
##  0.9522336 0.9543732 0.9557707 0.9651320 0.9780236 0.9888400 0.9962210
##  0.9356944 0.9344477 0.9349513 0.9487098 0.9666954 0.9770207 0.9862938
##  0.9246170 0.9185492 0.9178463 0.9339705 0.9551507 0.9646836 0.9727741
##  0.9129562 0.9077744 0.9067633 0.9206876 0.9435361 0.9527336 0.9611004
##  0.9117168 0.9094989 0.9080059 0.9174796 0.9405607 0.9496166 0.9578649
##  0.9085418 0.9056585 0.9038818 0.9115256 0.9341835 0.9435104 0.9517015
##  0.9029433 0.9004463 0.8996510 0.9069937 0.9298150 0.9366860 0.9442594
##  0.9060328 0.9039426 0.9049590 0.9129075 0.9341304 0.9376010 0.9429922
##  0.9076897 0.9075098 0.9093358 0.9182569 0.9376407 0.9394191 0.9426586
##
##  0.6075916 0.6110813 0.6012068 0.5857780 0.5767611 0.5798275 0.5760556
##  0.6263525 0.6402525 0.6354145 0.6232889 0.6096751 0.6112650 0.6090332
##  0.7026072 0.7065761 0.6966112 0.6841388 0.6751568 0.6769316 0.6751830
##  0.7411249 0.7485466 0.7386988 0.7294873 0.7235008 0.7234152 0.7234587
##  0.7751893 0.7788432 0.7705922 0.7625026 0.7588857 0.7618892 0.7595617
##  0.7931763 0.8006672 0.7994248 0.7895644 0.7817300 0.7843567 0.7821496
##  0.8335094 0.8426748 0.8434175 0.8352333 0.8277837 0.8317006 0.8300400
##  0.8672115 0.8783801 0.8806239 0.8768472 0.8725690 0.8749532 0.8753568
##  0.8760538 0.8868807 0.8883587 0.8843743 0.8790513 0.8797090 0.8800738
##  0.8808157 0.8917530 0.8929700 0.8863506 0.8803533 0.8797228 0.8781320
##  0.8753457 0.8857702 0.8956245 0.8920968 0.8841675 0.8864620 0.8841006
##  0.9025147 0.9108205 0.9149755 0.9101465 0.9055789 0.9062280 0.9043508
##  0.9272687 0.9305232 0.9308735 0.9254029 0.9217833 0.9219001 0.9190438
##  0.9433094 0.9366862 0.9331822 0.9255843 0.9226056 0.9196489 0.9160918
##  0.9522336 0.9356944 0.9246170 0.9129562 0.9117168 0.9085418 0.9029433
##  0.9543732 0.9344477 0.9185492 0.9077744 0.9094989 0.9056585 0.9004463
```

```
##  0.9557707 0.9349513 0.9178463 0.9067633 0.9080059 0.9038818 0.8996510
##  0.9651320 0.9487098 0.9339705 0.9206876 0.9174796 0.9115256 0.9069937
##  0.9780236 0.9666954 0.9551507 0.9435361 0.9405607 0.9341835 0.9298150
##  0.9888400 0.9770207 0.9646836 0.9527336 0.9496166 0.9435104 0.9366860
##  0.9962210 0.9862938 0.9727741 0.9611004 0.9578649 0.9517015 0.9442594
##  1.0000000 0.9945309 0.9833104 0.9749365 0.9726801 0.9684356 0.9615898
##  0.9945309 1.0000000 0.9945642 0.9897989 0.9876032 0.9834079 0.9779959
##  0.9833104 0.9945642 1.0000000 0.9974381 0.9943443 0.9903946 0.9852962
##  0.9749365 0.9897989 0.9974381 1.0000000 0.9983473 0.9959015 0.9926243
##  0.9726801 0.9876032 0.9943443 0.9983473 1.0000000 0.9984008 0.9962314
##  0.9684356 0.9834079 0.9903946 0.9959015 0.9984008 1.0000000 0.9983921
##  0.9615898 0.9779959 0.9852962 0.9926243 0.9962314 0.9983921 1.0000000
##  0.9586247 0.9746107 0.9822450 0.9889078 0.9917670 0.9938476 0.9973189
##  0.9574329 0.9728912 0.9796161 0.9861065 0.9883909 0.9902297 0.9938142
##
##  0.5865288 0.5922902
##  0.6159921 0.6235134
##  0.6861155 0.6969794
##  0.7302561 0.7378387
##  0.7637597 0.7701497
##  0.7859728 0.7922736
##  0.8335224 0.8396815
##  0.8799410 0.8866000
##  0.8851563 0.8917948
##  0.8821685 0.8871679
##  0.8898794 0.8923803
##  0.9084582 0.9092806
##  0.9211335 0.9207068
##  0.9196569 0.9211770
##  0.9060328 0.9076897
##  0.9039426 0.9075098
##  0.9049590 0.9093358
##  0.9129075 0.9182569
##  0.9341304 0.9376407
##  0.9376010 0.9394191
##  0.9429922 0.9426586
##  0.9586247 0.9574329
##  0.9746107 0.9728912
##  0.9822450 0.9796161
##  0.9889078 0.9861065
##  0.9917670 0.9883909
##  0.9938476 0.9902297
##  0.9973189 0.9938142
##  1.0000000 0.9982288
##  0.9982288 1.0000000
##
##  R-sq. pooled: 0.809
##  Breusch-Pagan: 1.391e+04  p-value: (   0)
```

Model with 11-day moving average of climatic variables:

```
sur.slm_lag11 <- spsur::spsurtime(formula = formula_lag11,
                                  data=GPanel,
                                  time = GPanel$Date,
                                  type = "slm",
```

```
                                  fit_method = "3sls",
                                  listw=  listw,
                                 R = R2,
                                 b = b2)
```

```
## Time to fit the model:  1.47  seconds
```

```
summary(sur.slm_lag11)
```

```
## Call:
## spsur::spsurtime(formula = formula_lag11, data = GPanel, time = GPanel$Date,
##     listw = listw, type = "slm", fit_method = "3sls", R = R2,
##     b = b2)
##
##
## Spatial SUR model type:  slm
##
## Equation  1
##                           Estimate Std. Error t value Pr(>|t|)
## (Intercept)_1           14.629030  16.470894  0.8882 0.374697
## log(Male2Female)_1      -0.904527   2.585106 -0.3499 0.726501
## log(Median_Age)_1       -0.017897   1.392574 -0.0129 0.989749
## log(Density)_1           0.136550   0.170853  0.7992 0.424383
## Transit_1                0.360881   0.584452  0.6175 0.537090
## log(Humidity_lag11)_1  -1.516207   0.538466 -2.8158 0.004978 **
## log(Mean_Temp_lag11)_1 -1.472902   0.543854 -2.7083 0.006899 **
## rho_1                    0.251350   0.124413  2.0203 0.043666 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.08817
##   Equation  2
##                           Estimate Std. Error t value Pr(>|t|)
## (Intercept)_2           12.193542  16.443626  0.7415 0.458573
## log(Density)_2           0.069136   0.150049  0.4608 0.645091
## Transit_2                0.494745   0.513068  0.9643 0.335175
## log(Humidity_lag11)_2  -0.866759   0.452838 -1.9141 0.055947 .
## log(Mean_Temp_lag11)_2 -1.255424   0.469681 -2.6729 0.007663 **
## rho_2                    0.130364   0.134642  0.9682 0.333206
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.1216
##   Equation  3
##                           Estimate Std. Error t value  Pr(>|t|)
## (Intercept)_3           13.731007  16.370585  0.8388 0.4018385
## log(Density)_3           0.030904   0.133802  0.2310 0.8173920
## Transit_3                0.532367   0.455176  1.1696 0.2424951
## log(Humidity_lag11)_3  -1.051189   0.404198 -2.6007 0.0094650 **
## log(Mean_Temp_lag11)_3 -1.372328   0.376460 -3.6453 0.0002832 ***
## rho_3                    0.159108   0.109729  1.4500 0.1474229
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.1558
##   Equation  4
##                           Estimate Std. Error t value  Pr(>|t|)
## (Intercept)_4           12.501692  16.322466  0.7659 0.4439362
```

```
## log(Density)_4         -0.025680   0.120706 -0.2127 0.8315772
## Transit_4               0.612406   0.404324  1.5146 0.1302341
## log(Humidity_lag11)_4  -0.721221   0.338721 -2.1292 0.0335197 *
## log(Mean_Temp_lag11)_4 -1.073654   0.285975 -3.7544 0.0001856 ***
## rho_4                  -0.015448   0.114066 -0.1354 0.8923008
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.1983
##   Equation  5
##                          Estimate Std. Error t value  Pr(>|t|)
## (Intercept)_5          14.142764  16.289745  0.8682  0.385529
## log(Density)_5         -0.055377   0.120579 -0.4593  0.646167
## Transit_5               0.627950   0.404600  1.5520  0.121027
## log(Humidity_lag11)_5  -1.025600   0.323097 -3.1743  0.001556 **
## log(Mean_Temp_lag11)_5 -1.214396   0.264019 -4.5996 4.873e-06 ***
## rho_5                   0.096786   0.100526  0.9628  0.335922
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.1949
##   Equation  6
##                          Estimate Std. Error t value  Pr(>|t|)
## (Intercept)_6          11.735140  16.296581  0.7201  0.471662
## log(Density)_6         -0.099212   0.121711 -0.8151  0.415216
## Transit_6               0.654297   0.409765  1.5968  0.110690
## log(Humidity_lag11)_6  -0.539603   0.301328 -1.7907  0.073688 .
## log(Mean_Temp_lag11)_6 -1.113703   0.249873 -4.4571 9.417e-06 ***
## rho_6                   0.271843   0.093961  2.8931  0.003911 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.1548
##   Equation  7
##                          Estimate Std. Error t value  Pr(>|t|)
## (Intercept)_7          11.932745  16.296770  0.7322   0.46424
## log(Density)_7         -0.104978   0.115272 -0.9107   0.36271
## Transit_7               0.675328   0.381943  1.7681   0.07740 .
## log(Humidity_lag11)_7  -0.389970   0.291831 -1.3363   0.18181
## log(Mean_Temp_lag11)_7 -1.245946   0.235530 -5.2900 1.556e-07 ***
## rho_7                   0.181812   0.088046  2.0650   0.03923 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.2324
##   Equation  8
##                          Estimate Std. Error t value  Pr(>|t|)
## (Intercept)_8          10.676475  16.296563  0.6551  0.512556
## log(Density)_8         -0.138786   0.108299 -1.2815  0.200365
## Transit_8               0.669846   0.352228  1.9017  0.057542 .
## log(Humidity_lag11)_8  -0.057655   0.259165 -0.2225  0.824006
## log(Mean_Temp_lag11)_8 -1.183232   0.208072 -5.6866 1.779e-08 ***
## rho_8                   0.201888   0.076957  2.6234  0.008861 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.2642
##   Equation  9
##                         Estimate Std. Error t value  Pr(>|t|)
```

```
## (Intercept)_9          13.50679   16.29780  0.8287   0.40748
## log(Density)_9         -0.15332    0.10988 -1.3953   0.16329
## Transit_9               0.70830    0.35883  1.9739   0.04872 *
## log(Humidity_lag11)_9  -0.43529    0.26379 -1.6501   0.09928 .
## log(Mean_Temp_lag11)_9 -1.50867    0.21546 -7.0020 5.113e-12 ***
## rho_9                   0.16232    0.07286  2.2278   0.02615 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.3066
##   Equation  10
##                          Estimate Std. Error t value  Pr(>|t|)
## (Intercept)_10          12.969008  16.327996  0.7943   0.42725
## log(Density)_10         -0.110080   0.108645 -1.0132   0.31125
## Transit_10               0.649647   0.352497  1.8430   0.06568 .
## log(Humidity_lag11)_10  -0.367708   0.278671 -1.3195   0.18735
## log(Mean_Temp_lag11)_10 -1.462839   0.219079 -6.6772 4.385e-11 ***
## rho_10                   0.176127   0.082495  2.1350   0.03305 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.2938
##   Equation  11
##                          Estimate Std. Error t value Pr(>|t|)
## (Intercept)_11          11.769604  16.333387  0.7206  0.47136
## log(Density)_11         -0.052600   0.098948 -0.5316  0.59515
## Transit_11               0.578678   0.308295  1.8770  0.06086 .
## log(Humidity_lag11)_11   0.017457   0.246537  0.0708  0.94357
## log(Mean_Temp_lag11)_11 -1.687958   0.186964 -9.0282  < 2e-16 ***
## rho_11                   0.180616   0.072046  2.5070  0.01236 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.4127
##   Equation  12
##                          Estimate Std. Error  t value  Pr(>|t|)
## (Intercept)_12          12.658288  16.302283   0.7765   0.43768
## log(Density)_12         -0.057667   0.097644  -0.5906   0.55496
## Transit_12               0.618549   0.301196   2.0536   0.04031 *
## log(Humidity_lag11)_12  -0.219238   0.221715  -0.9888   0.32303
## log(Mean_Temp_lag11)_12 -1.736247   0.166494 -10.4283 < 2.2e-16 ***
## rho_12                   0.279737   0.066705   4.1937 3.032e-05 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.427
##   Equation  13
##                          Estimate Std. Error  t value Pr(>|t|)
## (Intercept)_13          12.513851  16.279019   0.7687  0.44228
## log(Density)_13         -0.039997   0.096066  -0.4163  0.67726
## Transit_13               0.602197   0.292599   2.0581  0.03988 *
## log(Humidity_lag11)_13  -0.127564   0.216479  -0.5893  0.55584
## log(Mean_Temp_lag11)_13 -1.759523   0.157667 -11.1597  < 2e-16 ***
## rho_13                   0.238324   0.073003   3.2646  0.00114 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.4612
##   Equation  14
```

```
##                            Estimate Std. Error  t value  Pr(>|t|)
## (Intercept)_14          12.3940094 16.2958838   0.7606  0.447130
## log(Density)_14         -0.0091049  0.0945154  -0.0963  0.923279
## Transit_14               0.5808808  0.2846887   2.0404  0.041617 *
## log(Humidity_lag11)_14  -0.0103824  0.2304013  -0.0451  0.964068
## log(Mean_Temp_lag11)_14 -1.9040191  0.1669811 -11.4026 < 2.2e-16 ***
## rho_14                   0.2266333  0.0832808   2.7213  0.006635 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.4876
##   Equation  15
##                            Estimate Std. Error  t value Pr(>|t|)
## (Intercept)_15          14.198401  16.294419   0.8714  0.38380
## log(Density)_15         -0.010121   0.094642  -0.1069  0.91486
## Transit_15               0.562876   0.285864   1.9690  0.04927 *
## log(Humidity_lag11)_15  -0.304009   0.210829  -1.4420  0.14968
## log(Mean_Temp_lag11)_15 -2.067982   0.168936 -12.2412  < 2e-16 ***
## rho_15                   0.221668   0.084582   2.6208  0.00893 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.5022
##   Equation  16
##                            Estimate Std. Error  t value  Pr(>|t|)
## (Intercept)_16          15.389135  16.255615   0.9467  0.344062
## log(Density)_16         -0.039820   0.093012  -0.4281  0.668677
## Transit_16               0.583757   0.280552   2.0807  0.037755 *
## log(Humidity_lag11)_16  -0.512681   0.187811  -2.7298  0.006468 **
## log(Mean_Temp_lag11)_16 -1.917253   0.144258 -13.2905 < 2.2e-16 ***
## rho_16                   0.123229   0.080208   1.5364  0.124821
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.5181
##   Equation  17
##                            Estimate Std. Error  t value  Pr(>|t|)
## (Intercept)_17          16.583592  16.283676   1.0184   0.30877
## log(Density)_17         -0.054357   0.090620  -0.5998   0.54878
## Transit_17               0.568251   0.271472   2.0932   0.03662 *
## log(Humidity_lag11)_17  -0.704847   0.176550  -3.9923 7.106e-05 ***
## log(Mean_Temp_lag11)_17 -1.972727   0.134174 -14.7027 < 2.2e-16 ***
## rho_17                   0.106902   0.072402   1.4765   0.14018
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.5361
##   Equation  18
##                            Estimate Std. Error  t value  Pr(>|t|)
## (Intercept)_18          16.399448  16.310391   1.0055   0.31496
## log(Density)_18         -0.072837   0.088860  -0.8197   0.41262
## Transit_18               0.543271   0.264227   2.0561   0.04008 *
## log(Humidity_lag11)_18  -0.726772   0.164532  -4.4172 1.128e-05 ***
## log(Mean_Temp_lag11)_18 -1.793886   0.126960 -14.1295 < 2.2e-16 ***
## rho_18                   0.105993   0.074863   1.4158   0.15719
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.5363
```

```
##   Equation  19
##                            Estimate Std. Error  t value  Pr(>|t|)
## (Intercept)_19           16.076853  16.278873   0.9876    0.3236
## log(Density)_19          -0.082281   0.088634  -0.9283    0.3535
## Transit_19                0.564585   0.262698   2.1492    0.0319 *
## log(Humidity_lag11)_19   -0.694444   0.149719  -4.6383 4.063e-06 ***
## log(Mean_Temp_lag11)_19 -1.695501   0.116367 -14.5703 < 2.2e-16 ***
## rho_19                    0.109702   0.069122   1.5871    0.1129
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared:  0.54
##   Equation  20
##                            Estimate Std. Error  t value  Pr(>|t|)
## (Intercept)_20           15.160852  16.238739   0.9336   0.35076
## log(Density)_20          -0.103747   0.087976  -1.1793   0.23863
## Transit_20                0.580146   0.259345   2.2370   0.02555 *
## log(Humidity_lag11)_20   -0.561856   0.125979  -4.4599 9.295e-06 ***
## log(Mean_Temp_lag11)_20 -1.473536   0.094878 -15.5308 < 2.2e-16 ***
## rho_20                    0.091279   0.063698   1.4330   0.15222
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.556
##   Equation  21
##                            Estimate Std. Error  t value Pr(>|t|)
## (Intercept)_21           13.460221  16.220717   0.8298  0.40687
## log(Density)_21          -0.122404   0.087124  -1.4049  0.16040
## Transit_21                0.609860   0.255052   2.3911  0.01701 *
## log(Humidity_lag11)_21   -0.249241   0.121356  -2.0538  0.04030 *
## log(Mean_Temp_lag11)_21 -1.290527   0.082272 -15.6861  < 2e-16 ***
## rho_21                    0.092022   0.060692   1.5162  0.12984
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.5565
##   Equation  22
##                            Estimate Std. Error  t value Pr(>|t|)
## (Intercept)_22           13.060770  16.228353   0.8048  0.42115
## log(Density)_22          -0.134818   0.086664  -1.5556  0.12016
## Transit_22                0.619686   0.253088   2.4485  0.01455 *
## log(Humidity_lag11)_22   -0.120788   0.114264  -1.0571  0.29077
## log(Mean_Temp_lag11)_22 -1.270509   0.076472 -16.6141  < 2e-16 ***
## rho_22                    0.073698   0.055067   1.3383  0.18114
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.5678
##   Equation  23
##                            Estimate Std. Error  t value Pr(>|t|)
## (Intercept)_23           12.615553  16.226275   0.7775  0.43709
## log(Density)_23          -0.153641   0.087418  -1.7575  0.07918 .
## Transit_23                0.627057   0.256737   2.4424  0.01479 *
## log(Humidity_lag11)_23   -0.053045   0.111983  -0.4737  0.63584
## log(Mean_Temp_lag11)_23 -1.173851   0.072147 -16.2702  < 2e-16 ***
## rho_23                    0.084021   0.054908   1.5302  0.12634
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
## R-squared: 0.5557
##   Equation  24
##                            Estimate Std. Error  t value Pr(>|t|)
## (Intercept)_24          12.692323  16.225954   0.7822  0.43430
## log(Density)_24         -0.170841   0.088230  -1.9363  0.05316 .
## Transit_24               0.633496   0.260352   2.4332  0.01517 *
## log(Humidity_lag11)_24  -0.092738   0.121198  -0.7652  0.44438
## log(Mean_Temp_lag11)_24 -1.101979   0.070252 -15.6861  < 2e-16 ***
## rho_24                   0.089132   0.056186   1.5864  0.11303
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.5519
##   Equation  25
##                            Estimate Std. Error  t value Pr(>|t|)
## (Intercept)_25          12.580587  16.218016   0.7757  0.43813
## log(Density)_25         -0.183709   0.089018  -2.0637  0.03934 *
## Transit_25               0.642159   0.264171   2.4308  0.01527 *
## log(Humidity_lag11)_25  -0.110232   0.113168  -0.9741  0.33030
## log(Mean_Temp_lag11)_25 -1.059127   0.068533 -15.4543  < 2e-16 ***
## rho_25                   0.121523   0.054240   2.2405  0.02532 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.5429
##   Equation  26
##                            Estimate Std. Error  t value  Pr(>|t|)
## (Intercept)_26          12.466653  16.207376   0.7692  0.441990
## log(Density)_26         -0.180917   0.089877  -2.0130  0.044433 *
## Transit_26               0.654779   0.268053   2.4427  0.014779 *
## log(Humidity_lag11)_26  -0.073808   0.120675  -0.6116  0.540948
## log(Mean_Temp_lag11)_26 -1.126717   0.071736 -15.7064 < 2.2e-16 ***
## rho_26                   0.150934   0.053573   2.8173  0.004954 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.5408
##   Equation  27
##                             Estimate Std. Error  t value  Pr(>|t|)
## (Intercept)_27          12.4101232 16.2038461   0.7659  0.443962
## log(Density)_27         -0.1845649  0.0906946  -2.0350  0.042158 *
## Transit_27               0.6598972  0.2716998   2.4288  0.015356 *
## log(Humidity_lag11)_27   0.0014789  0.1338886   0.0110  0.991190
## log(Mean_Temp_lag11)_27 -1.2522642  0.0822244 -15.2298 < 2.2e-16 ***
## rho_27                   0.1732159  0.0525717   3.2949  0.001025 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.5367
##   Equation  28
##                            Estimate Std. Error  t value  Pr(>|t|)
## (Intercept)_28          12.731725  16.201815   0.7858 0.4321906
## log(Density)_28         -0.206392   0.092131  -2.2402 0.0253353 *
## Transit_28               0.713556   0.278322   2.5638 0.0105243 *
## log(Humidity_lag11)_28  -0.029016   0.168926  -0.1718 0.8636629
## log(Mean_Temp_lag11)_28 -1.348480   0.096810 -13.9292 < 2.2e-16 ***
## rho_28                   0.215247   0.055315   3.8913 0.0001075 ***
## ---
```

```
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.5217
##   Equation  29
##                            Estimate Std. Error  t value  Pr(>|t|)
## (Intercept)_29           11.656206  16.205890   0.7193  0.472179
## log(Density)_29          -0.222011   0.093049  -2.3860  0.017252 *
## Transit_29                0.732949   0.282543   2.5941  0.009646 **
## log(Humidity_lag11)_29    0.285970   0.194118   1.4732  0.141073
## log(Mean_Temp_lag11)_29 -1.436209   0.111171 -12.9189 < 2.2e-16 ***
## rho_29                    0.227926   0.056760   4.0156 6.452e-05 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.5152
##   Equation  30
##                            Estimate Std. Error  t value  Pr(>|t|)
## (Intercept)_30           10.958075  16.214950   0.6758  0.499350
## log(Density)_30          -0.218312   0.094057  -2.3210  0.020519 *
## Transit_30                0.757977   0.286789   2.6430  0.008369 **
## log(Humidity_lag11)_30    0.454933   0.220223   2.0658  0.039150 *
## log(Mean_Temp_lag11)_30 -1.514856   0.128118 -11.8239 < 2.2e-16 ***
## rho_30                    0.263450   0.061766   4.2653  2.22e-05 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.5065
##
## Variance-Covariance Matrix of inter-equation residuals:
##  1.1475027 0.9459712 0.8243680 0.6948210 0.6728978 0.6400175 0.5759468
##  0.9459712 0.8860899 0.7360241 0.6265219 0.5936623 0.5827500 0.5384173
##  0.8243680 0.7360241 0.7006135 0.5872736 0.5742111 0.5589726 0.5072724
##  0.6948210 0.6265219 0.5872736 0.5530088 0.5417624 0.5291263 0.4827084
##  0.6728978 0.5936623 0.5742111 0.5417624 0.5540291 0.5430458 0.4959700
##  0.6400175 0.5827500 0.5589726 0.5291263 0.5430458 0.5684697 0.5220800
##  0.5759468 0.5384173 0.5072724 0.4827084 0.4959700 0.5220800 0.4927868
##  0.5128247 0.4813818 0.4618477 0.4371444 0.4498740 0.4690896 0.4462030
##  0.5108911 0.4840856 0.4587561 0.4372861 0.4503483 0.4679342 0.4465727
##  0.4892742 0.4628458 0.4360678 0.4192760 0.4309626 0.4451870 0.4258752
##  0.4068385 0.3792696 0.3639900 0.3384858 0.3537734 0.3742436 0.3607091
##  0.3820028 0.3467427 0.3371239 0.3270007 0.3440396 0.3551543 0.3429197
##  0.3610552 0.3243389 0.3178255 0.3111558 0.3279178 0.3322594 0.3211072
##  0.3104420 0.2760005 0.2774586 0.2691149 0.2841795 0.2843551 0.2783177
##  0.2958734 0.2536809 0.2619170 0.2477010 0.2611792 0.2591141 0.2533047
##  0.2730140 0.2392187 0.2518871 0.2368611 0.2451342 0.2447980 0.2387910
##  0.2619395 0.2322888 0.2489106 0.2321524 0.2386337 0.2411153 0.2341037
##  0.2406643 0.2245810 0.2392124 0.2230869 0.2258198 0.2305345 0.2238939
##  0.2369700 0.2197099 0.2363675 0.2222735 0.2263488 0.2294163 0.2235737
##  0.2335770 0.2183249 0.2331378 0.2257410 0.2310651 0.2346070 0.2294921
##  0.2484429 0.2300240 0.2358040 0.2297301 0.2366515 0.2426036 0.2384358
##  0.2448976 0.2280734 0.2367420 0.2298930 0.2387514 0.2442734 0.2407845
##  0.2493662 0.2343319 0.2440871 0.2379978 0.2463663 0.2525203 0.2481086
##  0.2516294 0.2402526 0.2493924 0.2432851 0.2515291 0.2601659 0.2546535
##  0.2498250 0.2407759 0.2507416 0.2463869 0.2553367 0.2643221 0.2583252
##  0.2584591 0.2477427 0.2575171 0.2517860 0.2599017 0.2677151 0.2615859
##  0.2721754 0.2586502 0.2667379 0.2572619 0.2661811 0.2735846 0.2683381
##  0.2803200 0.2675011 0.2756217 0.2646072 0.2741860 0.2815285 0.2763416
```

```
##  0.2875195 0.2730222 0.2818457 0.2663922 0.2771042 0.2857223 0.2805806
##  0.2913124 0.2774117 0.2853335 0.2672276 0.2779975 0.2869075 0.2814104
##
##  0.5128247 0.5108911 0.4892742 0.4068385 0.3820028 0.3610552 0.3104420
##  0.4813818 0.4840856 0.4628458 0.3792696 0.3467427 0.3243389 0.2760005
##  0.4618477 0.4587561 0.4360678 0.3639900 0.3371239 0.3178255 0.2774586
##  0.4371444 0.4372861 0.4192760 0.3384858 0.3270007 0.3111558 0.2691149
##  0.4498740 0.4503483 0.4309626 0.3537734 0.3440396 0.3279178 0.2841795
##  0.4690896 0.4679342 0.4451870 0.3742436 0.3551543 0.3322594 0.2843551
##  0.4462030 0.4465727 0.4258752 0.3607091 0.3429197 0.3211072 0.2783177
##  0.4182448 0.4196378 0.4001358 0.3425189 0.3263609 0.3048556 0.2678666
##  0.4196378 0.4342935 0.4193143 0.3556265 0.3419202 0.3193643 0.2831647
##  0.4001358 0.4193143 0.4187837 0.3528690 0.3433008 0.3235122 0.2921174
##  0.3425189 0.3556265 0.3528690 0.3183843 0.3041288 0.2846643 0.2592516
##  0.3263609 0.3419202 0.3433008 0.3041288 0.3034095 0.2898443 0.2688822
##  0.3048556 0.3193643 0.3235122 0.2846643 0.2898443 0.2854931 0.2690942
##  0.2678666 0.2831647 0.2921174 0.2592516 0.2688822 0.2690942 0.2691632
##  0.2446956 0.2624041 0.2751465 0.2465272 0.2565476 0.2590334 0.2650294
##  0.2330293 0.2493540 0.2601606 0.2320603 0.2406949 0.2429427 0.2509523
##  0.2297425 0.2459110 0.2534737 0.2257712 0.2321726 0.2316526 0.2381654
##  0.2184833 0.2336505 0.2430515 0.2141635 0.2196505 0.2201652 0.2253949
##  0.2176910 0.2321592 0.2414723 0.2138265 0.2195286 0.2206283 0.2242573
##  0.2224978 0.2364287 0.2447759 0.2161557 0.2219129 0.2227341 0.2214339
##  0.2319958 0.2449481 0.2499614 0.2230349 0.2264610 0.2243139 0.2191466
##  0.2356864 0.2482304 0.2515800 0.2244662 0.2266311 0.2234789 0.2155269
##  0.2431835 0.2548093 0.2576311 0.2281045 0.2295075 0.2250930 0.2146972
##  0.2488495 0.2597065 0.2615561 0.2318144 0.2317359 0.2260882 0.2135880
##  0.2526218 0.2635656 0.2645384 0.2340595 0.2335153 0.2273472 0.2136795
##  0.2566180 0.2677904 0.2687130 0.2373949 0.2370689 0.2311064 0.2177959
##  0.2625434 0.2742090 0.2741232 0.2436770 0.2423278 0.2357414 0.2216917
##  0.2706230 0.2822640 0.2808846 0.2500857 0.2476493 0.2401628 0.2250635
##  0.2745297 0.2868504 0.2848970 0.2555623 0.2513907 0.2430641 0.2282895
##  0.2749170 0.2872001 0.2864592 0.2560468 0.2515311 0.2449467 0.2317085
##
##  0.2958734 0.2730140 0.2619395 0.2406643 0.2369700 0.2335770 0.2484429
##  0.2536809 0.2392187 0.2322888 0.2245810 0.2197099 0.2183249 0.2300240
##  0.2619170 0.2518871 0.2489106 0.2392124 0.2363675 0.2331378 0.2358040
##  0.2477010 0.2368611 0.2321524 0.2230869 0.2222735 0.2257410 0.2297301
##  0.2611792 0.2451342 0.2386337 0.2258198 0.2263488 0.2310651 0.2366515
##  0.2591141 0.2447980 0.2411153 0.2305345 0.2294163 0.2346070 0.2426036
##  0.2533047 0.2387910 0.2341037 0.2238939 0.2235737 0.2294921 0.2384358
##  0.2446956 0.2330293 0.2297425 0.2184833 0.2176910 0.2224978 0.2319958
##  0.2624041 0.2493540 0.2459110 0.2336505 0.2321592 0.2364287 0.2449481
##  0.2751465 0.2601606 0.2534737 0.2430515 0.2414723 0.2447759 0.2499614
##  0.2465272 0.2320603 0.2257712 0.2141635 0.2138265 0.2161557 0.2230349
##  0.2565476 0.2406949 0.2321726 0.2196505 0.2195286 0.2219129 0.2264610
##  0.2590334 0.2429427 0.2316526 0.2201652 0.2206283 0.2227341 0.2243139
##  0.2650294 0.2509523 0.2381654 0.2253949 0.2242573 0.2214339 0.2191466
##  0.2710479 0.2598500 0.2456399 0.2341927 0.2323771 0.2265610 0.2209247
##  0.2598500 0.2606895 0.2492836 0.2390028 0.2358391 0.2281910 0.2211776
##  0.2456399 0.2492836 0.2440073 0.2337979 0.2303254 0.2224138 0.2157905
##  0.2341927 0.2390028 0.2337979 0.2304804 0.2279573 0.2203221 0.2114859
##  0.2323771 0.2358391 0.2303254 0.2279573 0.2280863 0.2224502 0.2140226
##  0.2265610 0.2281910 0.2224138 0.2203221 0.2224502 0.2222377 0.2161171
```

```
##  0.2209247 0.2211776 0.2157905 0.2114859 0.2140226 0.2161171 0.2148697
##  0.2148773 0.2150988 0.2102286 0.2056243 0.2086567 0.2120742 0.2121143
##  0.2129880 0.2145732 0.2097517 0.2061550 0.2093440 0.2128476 0.2132971
##  0.2104343 0.2120625 0.2075443 0.2052320 0.2090461 0.2133279 0.2139479
##  0.2094623 0.2113090 0.2070865 0.2055051 0.2099095 0.2143108 0.2150719
##  0.2132965 0.2149719 0.2103216 0.2082996 0.2126210 0.2165347 0.2171167
##  0.2167503 0.2165919 0.2117837 0.2088306 0.2135222 0.2173711 0.2183475
##  0.2191634 0.2186296 0.2145043 0.2111816 0.2155300 0.2184963 0.2196417
##  0.2232819 0.2222517 0.2178078 0.2134851 0.2171252 0.2190789 0.2204945
##  0.2281807 0.2272163 0.2210291 0.2170160 0.2201267 0.2214398 0.2219839
##
##  0.2448976 0.2493662 0.2516294 0.2498250 0.2584591 0.2721754 0.2803200
##  0.2280734 0.2343319 0.2402526 0.2407759 0.2477427 0.2586502 0.2675011
##  0.2367420 0.2440871 0.2493924 0.2507416 0.2575171 0.2667379 0.2756217
##  0.2298930 0.2379978 0.2432851 0.2463869 0.2517860 0.2572619 0.2646072
##  0.2387514 0.2463663 0.2515291 0.2553367 0.2599017 0.2661811 0.2741860
##  0.2442734 0.2525203 0.2601659 0.2643221 0.2677151 0.2735846 0.2815285
##  0.2407845 0.2481086 0.2546535 0.2583252 0.2615859 0.2683381 0.2763416
##  0.2356864 0.2431835 0.2488495 0.2526218 0.2566180 0.2625434 0.2706230
##  0.2482304 0.2548093 0.2597065 0.2635656 0.2677904 0.2742090 0.2822640
##  0.2515800 0.2576311 0.2615561 0.2645384 0.2687130 0.2741232 0.2808846
##  0.2244662 0.2281045 0.2318144 0.2340595 0.2373949 0.2436770 0.2500857
##  0.2266311 0.2295075 0.2317359 0.2335153 0.2370689 0.2423278 0.2476493
##  0.2234789 0.2250930 0.2260882 0.2273472 0.2311064 0.2357414 0.2401628
##  0.2155269 0.2146972 0.2135880 0.2136795 0.2177959 0.2216917 0.2250635
##  0.2148773 0.2129880 0.2104343 0.2094623 0.2132965 0.2167503 0.2191634
##  0.2150988 0.2145732 0.2120625 0.2113090 0.2149719 0.2165919 0.2186296
##  0.2102286 0.2097517 0.2075443 0.2070865 0.2103216 0.2117837 0.2145043
##  0.2056243 0.2061550 0.2052320 0.2055051 0.2082996 0.2088306 0.2111816
##  0.2086567 0.2093440 0.2090461 0.2099095 0.2126210 0.2135222 0.2155300
##  0.2120742 0.2128476 0.2133279 0.2143108 0.2165347 0.2173711 0.2184963
##  0.2121143 0.2132971 0.2139479 0.2150719 0.2171167 0.2183475 0.2196417
##  0.2119384 0.2141041 0.2154239 0.2172554 0.2194934 0.2213949 0.2235749
##  0.2141041 0.2184210 0.2204346 0.2229741 0.2254068 0.2267991 0.2297029
##  0.2154239 0.2204346 0.2247718 0.2275977 0.2299114 0.2309842 0.2341061
##  0.2172554 0.2229741 0.2275977 0.2317723 0.2346932 0.2360949 0.2399164
##  0.2194934 0.2254068 0.2299114 0.2346932 0.2389015 0.2411029 0.2454165
##  0.2213949 0.2267991 0.2309842 0.2360949 0.2411029 0.2456608 0.2508164
##  0.2235749 0.2297029 0.2341061 0.2399164 0.2454165 0.2508164 0.2581789
##  0.2246203 0.2306970 0.2348802 0.2406313 0.2466415 0.2528513 0.2611061
##  0.2258415 0.2316181 0.2349563 0.2408898 0.2477457 0.2544744 0.2624436
##
##  0.2875195 0.2913124
##  0.2730222 0.2774117
##  0.2818457 0.2853335
##  0.2663922 0.2672276
##  0.2771042 0.2779975
##  0.2857223 0.2869075
##  0.2805806 0.2814104
##  0.2745297 0.2749170
##  0.2868504 0.2872001
##  0.2848970 0.2864592
##  0.2555623 0.2560468
##  0.2513907 0.2515311
```

```
##  0.2430641 0.2449467
##  0.2282895 0.2317085
##  0.2232819 0.2281807
##  0.2222517 0.2272163
##  0.2178078 0.2210291
##  0.2134851 0.2170160
##  0.2171252 0.2201267
##  0.2190789 0.2214398
##  0.2204945 0.2219839
##  0.2246203 0.2258415
##  0.2306970 0.2316181
##  0.2348802 0.2349563
##  0.2406313 0.2408898
##  0.2466415 0.2477457
##  0.2528513 0.2544744
##  0.2611061 0.2624436
##  0.2662557 0.2686619
##  0.2686619 0.2742734
## Correlation Matrix of inter-equation residuals:
##  1.0000000 0.9403010 0.9300692 0.8994038 0.8809872 0.8333785 0.8145938
##  0.9403010 1.0000000 0.9451230 0.9147053 0.8763196 0.8445479 0.8459102
##  0.9300692 0.9451230 1.0000000 0.9596311 0.9456877 0.9074748 0.8945869
##  0.8994038 0.9147053 0.9596311 1.0000000 0.9821768 0.9417065 0.9308477
##  0.8809872 0.8763196 0.9456877 0.9821768 1.0000000 0.9661035 0.9542280
##  0.8333785 0.8445479 0.9074748 0.9417065 0.9661035 1.0000000 0.9864272
##  0.8145938 0.8459102 0.8945869 0.9308477 0.9542280 0.9864272 1.0000000
##  0.7934302 0.8248667 0.8845278 0.9179161 0.9410246 0.9645645 0.9848652
##  0.7784676 0.8199063 0.8676255 0.9018742 0.9259476 0.9482240 0.9714893
##  0.7768570 0.8171291 0.8561703 0.8888107 0.9119296 0.9321095 0.9571347
##  0.7442848 0.7804647 0.8254550 0.8366467 0.8684592 0.9071430 0.9395139
##  0.7486120 0.7636887 0.8148951 0.8461793 0.8817138 0.9086258 0.9380386
##  0.7382592 0.7494037 0.8080259 0.8437762 0.8803482 0.8948261 0.9252693
##  0.6913470 0.6990705 0.7685144 0.7892678 0.8259644 0.8324980 0.8702481
##  0.6783171 0.6683127 0.7456640 0.7543868 0.7919356 0.7953947 0.8312949
##  0.6508286 0.6521413 0.7327843 0.7388498 0.7675616 0.7709440 0.8067292
##  0.6472435 0.6506657 0.7368371 0.7379762 0.7659256 0.7752359 0.8097351
##  0.6231599 0.6472691 0.7278812 0.7290237 0.7501687 0.7636441 0.8000013
##  0.6152894 0.6369406 0.7211861 0.7275795 0.7509058 0.7607418 0.8000051
##  0.5964357 0.6183150 0.7040750 0.7276278 0.7531975 0.7634093 0.8057884
##  0.6144370 0.6327279 0.7071019 0.7344624 0.7615646 0.7756209 0.8203135
##  0.6033917 0.6267515 0.7046451 0.7334138 0.7635871 0.7758999 0.8230020
##  0.6008857 0.6288704 0.7069977 0.7373985 0.7655680 0.7796859 0.8256890
##  0.5954301 0.6290401 0.7062838 0.7382661 0.7656977 0.7844582 0.8284094
##  0.5874905 0.6252978 0.7013041 0.7354738 0.7628092 0.7830552 0.8269958
##  0.5907469 0.6279703 0.7044789 0.7376866 0.7631169 0.7817386 0.8261677
##  0.6005468 0.6360412 0.7114096 0.7406446 0.7673918 0.7862403 0.8327796
##  0.5994880 0.6381143 0.7117454 0.7381428 0.7643387 0.7836068 0.8313935
##  0.6019600 0.6374596 0.7126425 0.7334271 0.7609772 0.7814173 0.8292102
##  0.6043601 0.6399938 0.7159946 0.7327023 0.7603369 0.7802919 0.8270075
##
##  0.7934302 0.7784676 0.7768570 0.7442848 0.7486120 0.7382592 0.6913470
##  0.8248667 0.8199063 0.8171291 0.7804647 0.7636887 0.7494037 0.6990705
##  0.8845278 0.8676255 0.8561703 0.8254550 0.8148951 0.8080259 0.7685144
##  0.9179161 0.9018742 0.8888107 0.8366467 0.8461793 0.8437762 0.7892678
```

```
##  0.9410246 0.9259476 0.9119296 0.8684592 0.8817138 0.8803482 0.8259644
##  0.9645645 0.9482240 0.9321095 0.9071430 0.9086258 0.8948261 0.8324980
##  0.9848652 0.9714893 0.9571347 0.9395139 0.9380386 0.9252693 0.8702481
##  1.0000000 0.9872524 0.9698269 0.9586370 0.9585732 0.9445491 0.8980001
##  0.9872524 1.0000000 0.9886963 0.9692134 0.9704066 0.9554069 0.9118761
##  0.9698269 0.9886963 1.0000000 0.9728683 0.9774846 0.9654889 0.9292461
##  0.9586370 0.9692134 0.9728683 1.0000000 0.9849998 0.9662449 0.9346489
##  0.9585732 0.9704066 0.9774846 0.9849998 1.0000000 0.9905761 0.9647086
##  0.9445491 0.9554069 0.9654889 0.9662449 0.9905761 1.0000000 0.9815494
##  0.8980001 0.9118761 0.9292461 0.9346489 0.9647086 0.9815494 1.0000000
##  0.8573815 0.8765953 0.8991661 0.9077675 0.9377387 0.9590072 0.9870291
##  0.8388685 0.8592064 0.8785570 0.8853611 0.9113854 0.9320214 0.9628294
##  0.8454775 0.8659450 0.8779090 0.8868969 0.9109953 0.9284724 0.9566630
##  0.8336359 0.8531912 0.8696614 0.8750224 0.8963188 0.9164392 0.9421908
##  0.8318174 0.8491759 0.8651720 0.8726399 0.8948032 0.9175166 0.9397118
##  0.8353232 0.8512616 0.8657979 0.8720359 0.8960068 0.9217442 0.9344497
##  0.8535422 0.8678062 0.8772469 0.8910691 0.9122731 0.9320508 0.9385535
##  0.8598676 0.8741539 0.8810623 0.8951990 0.9139824 0.9324138 0.9337565
##  0.8646987 0.8772721 0.8845425 0.8953844 0.9136215 0.9287571 0.9254115
##  0.8664632 0.8772281 0.8839242 0.8962547 0.9124277 0.9255454 0.9187940
##  0.8660732 0.8767575 0.8814021 0.8930071 0.9086975 0.9203510 0.9117737
##  0.8674406 0.8780567 0.8823780 0.8919222 0.9085133 0.9195739 0.9117338
##  0.8729647 0.8830841 0.8851710 0.8969786 0.9116972 0.9209636 0.9114479
##  0.8730731 0.8826834 0.8829803 0.8961935 0.9091018 0.9168390 0.9068177
##  0.8711062 0.8813340 0.8810701 0.8992524 0.9093640 0.9150989 0.9064993
##  0.8696960 0.8792078 0.8804990 0.8953200 0.9051776 0.9124054 0.9071579
##
##  0.6783171 0.6508286 0.6472435 0.6231599 0.6152894 0.5964357 0.6144370
##  0.6683127 0.6521413 0.6506657 0.6472691 0.6369406 0.6183150 0.6327279
##  0.7456640 0.7327843 0.7368371 0.7278812 0.7211861 0.7040750 0.7071019
##  0.7543868 0.7388498 0.7379762 0.7290237 0.7275795 0.7276278 0.7344624
##  0.7919356 0.7675616 0.7659256 0.7501687 0.7509058 0.7531975 0.7615646
##  0.7953947 0.7709440 0.7752359 0.7636441 0.7607418 0.7634093 0.7756209
##  0.8312949 0.8067292 0.8097351 0.8000013 0.8000051 0.8057884 0.8203135
##  0.8573815 0.8388685 0.8454775 0.8336359 0.8318174 0.8353232 0.8535422
##  0.8765953 0.8592064 0.8659450 0.8531912 0.8491759 0.8512616 0.8678062
##  0.8991661 0.8785570 0.8779090 0.8696614 0.8651720 0.8657979 0.8772469
##  0.9077675 0.8853611 0.8868969 0.8750224 0.8726399 0.8720359 0.8910691
##  0.9377387 0.9113854 0.9109953 0.8963188 0.8948032 0.8960068 0.9122731
##  0.9590072 0.9320214 0.9284724 0.9164392 0.9175166 0.9217442 0.9320508
##  0.9870291 0.9628294 0.9566630 0.9421908 0.9397118 0.9344497 0.9385535
##  1.0000000 0.9831822 0.9730299 0.9647761 0.9624896 0.9535798 0.9520438
##  0.9831822 1.0000000 0.9945324 0.9887488 0.9823899 0.9693117 0.9654675
##  0.9730299 0.9945324 1.0000000 0.9910801 0.9839744 0.9706058 0.9686729
##  0.9647761 0.9887488 0.9910801 1.0000000 0.9962581 0.9844877 0.9774150
##  0.9624896 0.9823899 0.9839744 0.9962581 1.0000000 0.9933010 0.9863315
##  0.9535798 0.9693117 0.9706058 0.9844877 0.9933010 1.0000000 0.9949392
##  0.9520438 0.9654675 0.9686729 0.9774150 0.9863315 0.9949392 1.0000000
##  0.9422873 0.9561528 0.9600389 0.9687203 0.9791169 0.9904169 0.9970436
##  0.9311285 0.9465699 0.9500653 0.9615714 0.9729957 0.9837985 0.9914724
##  0.9205113 0.9342096 0.9367633 0.9511323 0.9642509 0.9764346 0.9842044
##  0.9109656 0.9250422 0.9284473 0.9437987 0.9580890 0.9698316 0.9782565
##  0.9097753 0.9239400 0.9277684 0.9417168 0.9556816 0.9660950 0.9742616
##  0.9084550 0.9204068 0.9251137 0.9370175 0.9514985 0.9613106 0.9701545
```

```
##  0.9018086 0.9138225 0.9190250 0.9299441 0.9435707 0.9510063 0.9604634
##  0.9030676 0.9142500 0.9196211 0.9283673 0.9409258 0.9461307 0.9564910
##  0.9051302 0.9168510 0.9211610 0.9300013 0.9413200 0.9446817 0.9536752
##
##  0.6033917 0.6008857 0.5954301 0.5874905 0.5907469 0.6005468 0.5994880
##  0.6267515 0.6288704 0.6290401 0.6252978 0.6279703 0.6360412 0.6381143
##  0.7046451 0.7069977 0.7062838 0.7013041 0.7044789 0.7114096 0.7117454
##  0.7334138 0.7373985 0.7382661 0.7354738 0.7376866 0.7406446 0.7381428
##  0.7635871 0.7655680 0.7656977 0.7628092 0.7631169 0.7673918 0.7643387
##  0.7758999 0.7796859 0.7844582 0.7830552 0.7817386 0.7862403 0.7836068
##  0.8230020 0.8256890 0.8284094 0.8269958 0.8261677 0.8327796 0.8313935
##  0.8598676 0.8646987 0.8664632 0.8660732 0.8674406 0.8729647 0.8730731
##  0.8741539 0.8772721 0.8772281 0.8767575 0.8780567 0.8830841 0.8826834
##  0.8810623 0.8845425 0.8839242 0.8814021 0.8823780 0.8851710 0.8829803
##  0.8951990 0.8953844 0.8962547 0.8930071 0.8919222 0.8969786 0.8961935
##  0.9139824 0.9136215 0.9124277 0.9086975 0.9085133 0.9116972 0.9091018
##  0.9324138 0.9287571 0.9255454 0.9203510 0.9195739 0.9209636 0.9168390
##  0.9337565 0.9254115 0.9187940 0.9117737 0.9117338 0.9114479 0.9068177
##  0.9422873 0.9311285 0.9205113 0.9109656 0.9097753 0.9084550 0.9018086
##  0.9561528 0.9465699 0.9342096 0.9250422 0.9239400 0.9204068 0.9138225
##  0.9600389 0.9500653 0.9367633 0.9284473 0.9277684 0.9251137 0.9190250
##  0.9687203 0.9615714 0.9511323 0.9437987 0.9417168 0.9370175 0.9299441
##  0.9791169 0.9729957 0.9642509 0.9580890 0.9556816 0.9514985 0.9435707
##  0.9904169 0.9837985 0.9764346 0.9698316 0.9660950 0.9613106 0.9510063
##  0.9970436 0.9914724 0.9842044 0.9782565 0.9742616 0.9701545 0.9604634
##  1.0000000 0.9971966 0.9919266 0.9878367 0.9844833 0.9816080 0.9737340
##  0.9971966 1.0000000 0.9966828 0.9946901 0.9921365 0.9887548 0.9825852
##  0.9919266 0.9966828 1.0000000 0.9983613 0.9957869 0.9917328 0.9858061
##  0.9878367 0.9946901 0.9983613 1.0000000 0.9987823 0.9956763 0.9912650
##  0.9844833 0.9921365 0.9957869 0.9987823 1.0000000 0.9982000 0.9952003
##  0.9816080 0.9887548 0.9917328 0.9956763 0.9982000 1.0000000 0.9984662
##  0.9737340 0.9825852 0.9858061 0.9912650 0.9952003 0.9984662 1.0000000
##  0.9697746 0.9783780 0.9810291 0.9862877 0.9910472 0.9955369 0.9984607
##  0.9664299 0.9747081 0.9759380 0.9816672 0.9876462 0.9927364 0.9957063
##
##  0.6019600 0.6043601
##  0.6374596 0.6399938
##  0.7126425 0.7159946
##  0.7334271 0.7327023
##  0.7609772 0.7603369
##  0.7814173 0.7802919
##  0.8292102 0.8270075
##  0.8711062 0.8696960
##  0.8813340 0.8792078
##  0.8810701 0.8804990
##  0.8992524 0.8953200
##  0.9093640 0.9051776
##  0.9150989 0.9124054
##  0.9064993 0.9071579
##  0.9030676 0.9051302
##  0.9142500 0.9168510
##  0.9196211 0.9211610
##  0.9283673 0.9300013
##  0.9409258 0.9413200
```

```
##  0.9461307 0.9446817
##  0.9564910 0.9536752
##  0.9697746 0.9664299
##  0.9783780 0.9747081
##  0.9810291 0.9759380
##  0.9862877 0.9816672
##  0.9910472 0.9876462
##  0.9955369 0.9927364
##  0.9984607 0.9957063
##  1.0000000 0.9977870
##  0.9977870 1.0000000
##
##  R-sq. pooled: 0.8143
##  Breusch-Pagan: 1.485e+04  p-value: (   0)
```

Model with 11-day weighted moving average of climatic variables:

```
sur.slm_lag11w <- spsur::spsurtime(formula = formula_lag11w,
                                   data=GPanel,
                                   time = GPanel$Date,
                                   type = "slm",
                                   fit_method = "3sls",
                                   listw=  listw,
                                  R = R2,
                                  b = b2)
```

```
## Time to fit the model:  1.64  seconds
```

```
summary(sur.slm_lag11w)
```

```
## Call:
## spsur::spsurtime(formula = formula_lag11w, data = GPanel, time = GPanel$Date,
##     listw = listw, type = "slm", fit_method = "3sls", R = R2,
##     b = b2)
##
##
## Spatial SUR model type:  slm
##
## Equation  1
##                           Estimate Std. Error t value  Pr(>|t|)
## (Intercept)_1           14.554168  16.324921  0.8915 0.3728960
## log(Male2Female)_1      -2.638713   2.587019 -1.0200 0.3080262
## log(Median_Age)_1        0.660383   1.387171  0.4761 0.6341505
## log(Density)_1           0.140058   0.165892  0.8443 0.3987521
## Transit_1                0.415219   0.587334  0.7070 0.4797876
## log(Humidity_lag11w)_1  -0.325417   0.350619 -0.9281 0.3536073
## log(Mean_Temp_lag11w)_1 -1.261928   0.374942 -3.3657 0.0007977 ***
## rho_1                    0.082886   0.094143  0.8804 0.3788775
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.1175
##   Equation  2
##                           Estimate Std. Error t value  Pr(>|t|)
## (Intercept)_2           15.838472  16.327362  0.9701 0.3322930
## log(Density)_2           0.043362   0.147671  0.2936 0.7691050
## Transit_2                0.520514   0.521163  0.9988 0.3181970
```

```
## log(Humidity_lag11w)_2  -0.453234   0.312544 -1.4501 0.1473867
## log(Mean_Temp_lag11w)_2 -1.143469   0.344582 -3.3184 0.0009436 ***
## rho_2                    0.012987   0.112679  0.1153 0.9082689
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.1156
##   Equation  3
##                           Estimate Std. Error t value  Pr(>|t|)
## (Intercept)_3           17.6407798 16.3059558  1.0819  0.279620
## log(Density)_3          -0.0066955  0.1340647 -0.0499  0.960180
## Transit_3                0.5294317  0.4671280  1.1334  0.257375
## log(Humidity_lag11w)_3  -0.6901422  0.3096880 -2.2285  0.026107 *
## log(Mean_Temp_lag11w)_3 -1.3894258  0.3142432 -4.4215 1.107e-05 ***
## rho_3                    0.2486656  0.0957495  2.5970  0.009565 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.1141
##   Equation  4
##                           Estimate Std. Error t value Pr(>|t|)
## (Intercept)_4           18.339056  16.274836  1.1268 0.260129
## log(Density)_4          -0.064726   0.122408 -0.5288 0.597100
## Transit_4                0.617087   0.418361  1.4750 0.140578
## log(Humidity_lag11w)_4  -0.814269   0.289950 -2.8083 0.005094 **
## log(Mean_Temp_lag11w)_4 -1.115189   0.263133 -4.2381  2.5e-05 ***
## rho_4                    0.099650   0.114594  0.8696 0.384767
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.119
##   Equation  5
##                          Estimate Std. Error t value  Pr(>|t|)
## (Intercept)_5           21.09681   16.25543  1.2978 0.1946960
## log(Density)_5          -0.09712    0.12218 -0.7949 0.4269077
## Transit_5                0.66260    0.41738  1.5875 0.1127654
## log(Humidity_lag11w)_5  -1.43811    0.31764 -4.5275 6.817e-06 ***
## log(Mean_Temp_lag11w)_5 -1.28435    0.24312 -5.2828 1.616e-07 ***
## rho_5                    0.34809    0.10404  3.3456 0.0008571 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.1057
##   Equation  6
##                           Estimate Std. Error t value  Pr(>|t|)
## (Intercept)_6           20.437214  16.274612  1.2558   0.20954
## log(Density)_6          -0.147072   0.124447 -1.1818   0.23761
## Transit_6                0.706096   0.427619  1.6512   0.09906 .
## log(Humidity_lag11w)_6  -1.453751   0.317217 -4.5828 5.272e-06 ***
## log(Mean_Temp_lag11w)_6 -1.087508   0.225546 -4.8217 1.685e-06 ***
## rho_6                    0.559112   0.093426  5.9845 3.193e-09 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.06339
##   Equation  7
##                           Estimate Std. Error t value  Pr(>|t|)
## (Intercept)_7           17.699173  16.258438  1.0886   0.27663
## log(Density)_7          -0.145179   0.118039 -1.2299   0.21907
```

```
## Transit_7                0.701220   0.398153  1.7612   0.07857 .
## log(Humidity_lag11w)_7  -0.669352   0.281104 -2.3812   0.01748 *
## log(Mean_Temp_lag11w)_7 -1.079390   0.191500 -5.6365 2.358e-08 ***
## rho_7                    0.369272   0.088447  4.1751 3.285e-05 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.1353
##   Equation  8
##                          Estimate Std. Error t value  Pr(>|t|)
## (Intercept)_8           14.852652  16.267021  0.9131  0.361473
## log(Density)_8          -0.131410   0.108462 -1.2116  0.226009
## Transit_8                0.620235   0.353692  1.7536  0.079858 .
## log(Humidity_lag11w)_8   0.070772   0.230742  0.3067  0.759136
## log(Mean_Temp_lag11w)_8 -1.083051   0.157674 -6.8689 1.247e-11 ***
## rho_8                    0.291451   0.080148  3.6364  0.000293 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.2265
##   Equation  9
##                          Estimate Std. Error t value Pr(>|t|)
## (Intercept)_9           17.007533  16.266369  1.0456  0.29606
## log(Density)_9          -0.118055   0.107395 -1.0993  0.27196
## Transit_9                0.611517   0.346796  1.7633  0.07820 .
## log(Humidity_lag11w)_9  -0.108443   0.212138 -0.5112  0.60935
## log(Mean_Temp_lag11w)_9 -1.395297   0.163975 -8.5092  < 2e-16 ***
## rho_9                    0.145260   0.078277  1.8557  0.06384 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.3292
##   Equation  10
##                            Estimate Std. Error t value Pr(>|t|)
## (Intercept)_10           17.7939316 16.2921078  1.0922   0.2751
## log(Density)_10          -0.0557625  0.1044033 -0.5341   0.5934
## Transit_10                0.5349894  0.3314853  1.6139   0.1069
## log(Humidity_lag11w)_10  -0.1648338  0.2073770 -0.7949   0.4269
## log(Mean_Temp_lag11w)_10 -1.4467523  0.1828892 -7.9105 7.93e-15 ***
## rho_10                   -0.0047427  0.0863958 -0.0549   0.9562
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.369
##   Equation  11
##                           Estimate Std. Error  t value Pr(>|t|)
## (Intercept)_11           19.413174  16.375649   1.1855  0.23615
## log(Density)_11           0.015690   0.092900   0.1689  0.86593
## Transit_11                0.468960   0.279075   1.6804  0.09324 .
## log(Humidity_lag11w)_11  -0.284816   0.217909  -1.3070  0.19155
## log(Mean_Temp_lag11w)_11 -1.888650   0.183074 -10.3163  < 2e-16 ***
## rho_11                   -0.020214   0.075568  -0.2675  0.78916
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.5022
##   Equation  12
##                            Estimate Std. Error  t value Pr(>|t|)
## (Intercept)_12           20.2410843 16.3520827   1.2378  0.21612
```

```
## log(Density)_12          -0.0032294  0.0936825  -0.0345  0.97251
## Transit_12                0.4990389  0.2812001   1.7747  0.07631 .
## log(Humidity_lag11w)_12  -0.4751547  0.2108093  -2.2540  0.02445 *
## log(Mean_Temp_lag11w)_12 -1.8985167  0.1815122 -10.4594  < 2e-16 ***
## rho_12                    0.0554432  0.0673400   0.8233  0.41055
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.5095
##   Equation  13
##                             Estimate Std. Error t value Pr(>|t|)
## (Intercept)_13           20.8592957 16.3667231  1.2745  0.20284
## log(Density)_13          -0.0045116  0.0948780 -0.0476  0.96209
## Transit_13                0.4767877  0.2843001  1.6771  0.09390 .
## log(Humidity_lag11w)_13  -0.5374704  0.2305463 -2.3313  0.01997 *
## log(Mean_Temp_lag11w)_13 -1.9128271  0.1938183 -9.8692  < 2e-16 ***
## rho_13                    0.0216867  0.0699628  0.3100  0.75666
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.5166
##   Equation  14
##                              Estimate  Std. Error t value Pr(>|t|)
## (Intercept)_14           21.94198665 16.36701075  1.3406  0.18040
## log(Density)_14          -0.01078203  0.09735226 -0.1108  0.91184
## Transit_14                0.49786043  0.29376193  1.6948  0.09048 .
## log(Humidity_lag11w)_14  -0.71739727  0.25242353 -2.8420  0.00459 **
## log(Mean_Temp_lag11w)_14 -1.91970553  0.21110073 -9.0938  < 2e-16 ***
## rho_14                   -0.00045764  0.07823028 -0.0058  0.99533
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.4945
##   Equation  15
##                             Estimate Std. Error t value  Pr(>|t|)
## (Intercept)_15           23.1089564 16.3481938  1.4135 0.1578595
## log(Density)_15          -0.0383552  0.0983285 -0.3901 0.6965807
## Transit_15                0.5179698  0.2995309  1.7293 0.0841226 .
## log(Humidity_lag11w)_15  -0.9451594  0.2508369 -3.7680 0.0001759 ***
## log(Mean_Temp_lag11w)_15 -1.9026082  0.2111780 -9.0095 < 2.2e-16 ***
## rho_15                    0.0099609  0.0823096  0.1210 0.9037061
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.4882
##   Equation  16
##                             Estimate Std. Error  t value  Pr(>|t|)
## (Intercept)_16           23.970667  16.337681   1.4672   0.14269
## log(Density)_16          -0.083044   0.095217  -0.8722   0.38336
## Transit_16                0.559813   0.289309   1.9350   0.05332 .
## log(Humidity_lag11w)_16  -1.103027   0.228374  -4.8299 1.619e-06 ***
## log(Mean_Temp_lag11w)_16 -1.763160   0.175321 -10.0568 < 2.2e-16 ***
## rho_16                   -0.040169   0.077602  -0.5176   0.60485
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.5099
##   Equation  17
##                              Estimate Std. Error  t value  Pr(>|t|)
```

```
## (Intercept)_17           22.6654739 16.3166950   1.3891   0.16517
## log(Density)_17          -0.1156848  0.0928365  -1.2461   0.21307
## Transit_17                0.5628069  0.2805805   2.0059   0.04519 *
## log(Humidity_lag11w)_17  -0.9367978  0.2023967  -4.6285 4.255e-06 ***
## log(Mean_Temp_lag11w)_17 -1.5297431  0.1328611 -11.5139 < 2.2e-16 ***
## rho_17                   -0.0048497  0.0727149  -0.0667   0.94684
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.5165
##   Equation  18
##                            Estimate Std. Error  t value  Pr(>|t|)
## (Intercept)_18           21.356014  16.314577   1.3090   0.19088
## log(Density)_18          -0.139862   0.090413  -1.5469   0.12225
## Transit_18                0.545033   0.270675   2.0136   0.04436 *
## log(Humidity_lag11w)_18  -0.753449   0.174971  -4.3061 1.854e-05 ***
## log(Mean_Temp_lag11w)_18 -1.196928   0.103749 -11.5368 < 2.2e-16 ***
## rho_18                   -0.038613   0.074894  -0.5156   0.60629
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.5214
##   Equation  19
##                            Estimate Std. Error  t value  Pr(>|t|)
## (Intercept)_19           20.497837  16.300320   1.2575   0.20891
## log(Density)_19          -0.140014   0.089070  -1.5720   0.11633
## Transit_19                0.547951   0.263743   2.0776   0.03805 *
## log(Humidity_lag11w)_19  -0.618105   0.153665  -4.0224 6.271e-05 ***
## log(Mean_Temp_lag11w)_19 -1.112577   0.091164 -12.2042 < 2.2e-16 ***
## rho_19                   -0.017861   0.069100  -0.2585   0.79610
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.5337
##   Equation  20
##                             Estimate Std. Error  t value  Pr(>|t|)
## (Intercept)_20           19.5711026 16.3005211   1.2006  0.230223
## log(Density)_20          -0.1519017  0.0878278  -1.7295  0.084074 .
## Transit_20                0.5649567  0.2577719   2.1917  0.028671 *
## log(Humidity_lag11w)_20  -0.4201087  0.1483704  -2.8315  0.004742 **
## log(Mean_Temp_lag11w)_20 -1.0901877  0.0886478 -12.2980 < 2.2e-16 ***
## rho_20                    0.0092675  0.0691670   0.1340  0.893444
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.5522
##   Equation  21
##                            Estimate Std. Error  t value Pr(>|t|)
## (Intercept)_21           18.259536  16.287484   1.1211  0.26257
## log(Density)_21          -0.167682   0.087135  -1.9244  0.05464 .
## Transit_21                0.604456   0.254512   2.3750  0.01777 *
## log(Humidity_lag11w)_21  -0.195621   0.138549  -1.4119  0.15834
## log(Mean_Temp_lag11w)_21 -0.966236   0.076808 -12.5799  < 2e-16 ***
## rho_21                    0.039914   0.068171   0.5855  0.55837
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.5499
##   Equation  22
```

```
##                            Estimate Std. Error  t value Pr(>|t|)
## (Intercept)_22           16.869082  16.266026   1.0371  0.30000
## log(Density)_22          -0.178473   0.088163  -2.0244  0.04324 *
## Transit_22                0.603872   0.259168   2.3300  0.02004 *
## log(Humidity_lag11w)_22   0.072958   0.128259   0.5688  0.56962
## log(Mean_Temp_lag11w)_22 -0.871544   0.065566 -13.2926  < 2e-16 ***
## rho_22                    0.057434   0.063560   0.9036  0.36645
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.5434
##   Equation  23
##                            Estimate Std. Error  t value Pr(>|t|)
## (Intercept)_23           16.148130  16.265878   0.9928  0.32111
## log(Density)_23          -0.181474   0.088520  -2.0501  0.04066 *
## Transit_23                0.587911   0.260625   2.2558  0.02434 *
## log(Humidity_lag11w)_23   0.243833   0.129613   1.8812  0.06028 .
## log(Mean_Temp_lag11w)_23 -0.850227   0.063858 -13.3144  < 2e-16 ***
## rho_23                    0.056880   0.061156   0.9301  0.35259
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.5423
##   Equation  24
##                            Estimate Std. Error  t value Pr(>|t|)
## (Intercept)_24           16.640007  16.266485   1.0230  0.30662
## log(Density)_24          -0.186740   0.089759  -2.0805  0.03778 *
## Transit_24                0.586159   0.265838   2.2050  0.02772 *
## log(Humidity_lag11w)_24   0.172649   0.149311   1.1563  0.24788
## log(Mean_Temp_lag11w)_24 -0.878014   0.071821 -12.2251  < 2e-16 ***
## rho_24                    0.049989   0.064605   0.7738  0.43928
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.5368
##   Equation  25
##                            Estimate Std. Error  t value Pr(>|t|)
## (Intercept)_25           17.084677  16.266180   1.0503  0.29387
## log(Density)_25          -0.197042   0.090330  -2.1814  0.02943 *
## Transit_25                0.593680   0.268399   2.2119  0.02724 *
## log(Humidity_lag11w)_25   0.084888   0.156208   0.5434  0.58698
## log(Mean_Temp_lag11w)_25 -0.907508   0.078228 -11.6008  < 2e-16 ***
## rho_25                    0.072096   0.061739   1.1678  0.24323
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.5287
##   Equation  26
##                            Estimate Std. Error  t value Pr(>|t|)
## (Intercept)_26           16.841472  16.260364   1.0357  0.30062
## log(Density)_26          -0.201571   0.091190  -2.2104  0.02734 *
## Transit_26                0.607563   0.272368   2.2307  0.02596 *
## log(Humidity_lag11w)_26   0.165489   0.161248   1.0263  0.30504
## log(Mean_Temp_lag11w)_26 -0.999674   0.085272 -11.7234  < 2e-16 ***
## rho_26                    0.110867   0.052886   2.0963  0.03635 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.525
```

```
##   Equation  27
##                            Estimate Std. Error  t value  Pr(>|t|)
## (Intercept)_27           16.683862  16.260128   1.0261 0.3051543
## log(Density)_27          -0.220943   0.093114  -2.3728 0.0178741 *
## Transit_27                0.643343   0.281246   2.2875 0.0224125 *
## log(Humidity_lag11w)_27   0.231966   0.182662   1.2699 0.2044579
## log(Mean_Temp_lag11w)_27 -1.096832   0.103008 -10.6481 < 2.2e-16 ***
## rho_27                    0.164174   0.042986   3.8193 0.0001435 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.4981
##   Equation  28
##                            Estimate Std. Error t value  Pr(>|t|)
## (Intercept)_28           17.129982  16.283996  1.0520  0.293119
## log(Density)_28          -0.256975   0.094750 -2.7122  0.006819 **
## Transit_28                0.720997   0.289387  2.4915  0.012911 *
## log(Humidity_lag11w)_28   0.139481   0.230881  0.6041  0.545921
## log(Mean_Temp_lag11w)_28 -1.173339   0.134399 -8.7303 < 2.2e-16 ***
## rho_28                    0.236713   0.040387  5.8611 6.568e-09 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.4656
##   Equation  29
##                            Estimate Std. Error t value  Pr(>|t|)
## (Intercept)_29           16.570156  16.288578  1.0173  0.309305
## log(Density)_29          -0.285900   0.097174 -2.9422  0.003348 **
## Transit_29                0.765738   0.301134  2.5428  0.011171 *
## log(Humidity_lag11w)_29   0.337152   0.271545  1.2416  0.214724
## log(Mean_Temp_lag11w)_29 -1.239547   0.163297 -7.5907 8.338e-14 ***
## rho_29                    0.252609   0.049652  5.0876 4.462e-07 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.4444
##   Equation  30
##                            Estimate Std. Error t value  Pr(>|t|)
## (Intercept)_30           16.347737  16.303933  1.0027 0.3162964
## log(Density)_30          -0.295862   0.099639 -2.9693 0.0030679 **
## Transit_30                0.821104   0.312726  2.6256 0.0088037 **
## log(Humidity_lag11w)_30   0.463575   0.298047  1.5554 0.1202278
## log(Mean_Temp_lag11w)_30 -1.358432   0.196783 -6.9032 9.924e-12 ***
## rho_30                    0.270852   0.069505  3.8968 0.0001051 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## R-squared: 0.4332
##
## Variance-Covariance Matrix of inter-equation residuals:
##  1.1658557 0.9650778 0.8476086 0.7105957 0.6695102 0.6365497 0.5898090
##  0.9650778 0.9195150 0.7746701 0.6558030 0.6062035 0.5984088 0.5653791
##  0.8476086 0.7746701 0.7401383 0.6264374 0.6023540 0.5952629 0.5468568
##  0.7105957 0.6558030 0.6264374 0.5932867 0.5780217 0.5752731 0.5253834
##  0.6695102 0.6062035 0.6023540 0.5780217 0.5903899 0.5886485 0.5360149
##  0.6365497 0.5984088 0.5952629 0.5752731 0.5886485 0.6196436 0.5648513
##  0.5898090 0.5653791 0.5468568 0.5253834 0.5360149 0.5648513 0.5354713
##  0.5113602 0.4874862 0.4726316 0.4517030 0.4599658 0.4789616 0.4622666
```

```
##  0.4861883 0.4656264 0.4431063 0.4306049 0.4390358 0.4547091 0.4391971
##  0.4504845 0.4278343 0.4044065 0.3969411 0.4035254 0.4150270 0.3972478
##  0.3464279 0.3204449 0.3131653 0.2951366 0.3035501 0.3178943 0.3021311
##  0.3246477 0.2948814 0.2938953 0.2868812 0.2939871 0.3021368 0.2834305
##  0.2985114 0.2675825 0.2754642 0.2711228 0.2813287 0.2851937 0.2659593
##  0.2623961 0.2346907 0.2567166 0.2503579 0.2653174 0.2663450 0.2505222
##  0.2659796 0.2352305 0.2626596 0.2516844 0.2662170 0.2679567 0.2507507
##  0.2715708 0.2549109 0.2764217 0.2599740 0.2652223 0.2701056 0.2534396
##  0.2866774 0.2773128 0.2933992 0.2751753 0.2766015 0.2860181 0.2696955
##  0.2680827 0.2714947 0.2843566 0.2682339 0.2678642 0.2813169 0.2645360
##  0.2618019 0.2642261 0.2745104 0.2626920 0.2639971 0.2752518 0.2596503
##  0.2389386 0.2398939 0.2515531 0.2482208 0.2535289 0.2646990 0.2514831
##  0.2436624 0.2392489 0.2453671 0.2458074 0.2535655 0.2653890 0.2555230
##  0.2447828 0.2394128 0.2480183 0.2484885 0.2598386 0.2722268 0.2658232
##  0.2447508 0.2369619 0.2493884 0.2486010 0.2606525 0.2729879 0.2675498
##  0.2496046 0.2386465 0.2545838 0.2527569 0.2655260 0.2775720 0.2713503
##  0.2530125 0.2431683 0.2599155 0.2575593 0.2701249 0.2818114 0.2744950
##  0.2621731 0.2541286 0.2712009 0.2652812 0.2756978 0.2879822 0.2785601
##  0.2936206 0.2837030 0.2979327 0.2845108 0.2904209 0.3038353 0.2905776
##  0.3080710 0.2998455 0.3128251 0.2936566 0.2968592 0.3114152 0.2972443
##  0.3026432 0.3051248 0.3198693 0.2982096 0.3025901 0.3184799 0.3048624
##  0.3016147 0.3129377 0.3269219 0.3031143 0.3085978 0.3252758 0.3122194
##
##  0.5113602 0.4861883 0.4504845 0.3464279 0.3246477 0.2985114 0.2623961
##  0.4874862 0.4656264 0.4278343 0.3204449 0.2948814 0.2675825 0.2346907
##  0.4726316 0.4431063 0.4044065 0.3131653 0.2938953 0.2754642 0.2567166
##  0.4517030 0.4306049 0.3969411 0.2951366 0.2868812 0.2711228 0.2503579
##  0.4599658 0.4390358 0.4035254 0.3035501 0.2939871 0.2813287 0.2653174
##  0.4789616 0.4547091 0.4150270 0.3178943 0.3021368 0.2851937 0.2663450
##  0.4622666 0.4391971 0.3972478 0.3021311 0.2834305 0.2659593 0.2505222
##  0.4203179 0.4035254 0.3651773 0.2825622 0.2671460 0.2490486 0.2365419
##  0.4035254 0.4034697 0.3740425 0.2898697 0.2767466 0.2591257 0.2459986
##  0.3651773 0.3740425 0.3684464 0.2923025 0.2861095 0.2723694 0.2600248
##  0.2825622 0.2898697 0.2923025 0.2591913 0.2529576 0.2418311 0.2334924
##  0.2671460 0.2767466 0.2861095 0.2529576 0.2631162 0.2596347 0.2545007
##  0.2490486 0.2591257 0.2723694 0.2418311 0.2596347 0.2682500 0.2696019
##  0.2365419 0.2459986 0.2600248 0.2334924 0.2545007 0.2696019 0.2859864
##  0.2341409 0.2440245 0.2574200 0.2312320 0.2530509 0.2689828 0.2884168
##  0.2377377 0.2470303 0.2539845 0.2231479 0.2421594 0.2524120 0.2682478
##  0.2530095 0.2601167 0.2575175 0.2200611 0.2321246 0.2353678 0.2455090
##  0.2462069 0.2515412 0.2476725 0.2092907 0.2185956 0.2200554 0.2256372
##  0.2410053 0.2465488 0.2433776 0.2051998 0.2128872 0.2146695 0.2180616
##  0.2327012 0.2383116 0.2356232 0.1976463 0.2041417 0.2071394 0.2094708
##  0.2374652 0.2415896 0.2351191 0.1967544 0.1993202 0.1994446 0.1999434
##  0.2485610 0.2508259 0.2406272 0.2014079 0.2003984 0.1981560 0.1970845
##  0.2517688 0.2525988 0.2409951 0.2019093 0.1999776 0.1959599 0.1935959
##  0.2553240 0.2548452 0.2427362 0.2028593 0.2024027 0.1993708 0.1976421
##  0.2574943 0.2565109 0.2438463 0.2024474 0.2031877 0.2012699 0.2008005
##  0.2606688 0.2600698 0.2480938 0.2063207 0.2090848 0.2081057 0.2082774
##  0.2696447 0.2685940 0.2558337 0.2139085 0.2186255 0.2177884 0.2175997
##  0.2735122 0.2705425 0.2551998 0.2138599 0.2192767 0.2189430 0.2199613
##  0.2805271 0.2770759 0.2609663 0.2206316 0.2264762 0.2269573 0.2302204
##  0.2878848 0.2838923 0.2679297 0.2272181 0.2326053 0.2338776 0.2393223
##
```

```
##  0.2659796 0.2715708 0.2866774 0.2680827 0.2618019 0.2389386 0.2436624
##  0.2352305 0.2549109 0.2773128 0.2714947 0.2642261 0.2398939 0.2392489
##  0.2626596 0.2764217 0.2933992 0.2843566 0.2745104 0.2515531 0.2453671
##  0.2516844 0.2599740 0.2751753 0.2682339 0.2626920 0.2482208 0.2458074
##  0.2662170 0.2652223 0.2766015 0.2678642 0.2639971 0.2535289 0.2535655
##  0.2679567 0.2701056 0.2860181 0.2813169 0.2752518 0.2646990 0.2653890
##  0.2507507 0.2534396 0.2696955 0.2645360 0.2596503 0.2514831 0.2555230
##  0.2341409 0.2377377 0.2530095 0.2462069 0.2410053 0.2327012 0.2374652
##  0.2440245 0.2470303 0.2601167 0.2515412 0.2465488 0.2383116 0.2415896
##  0.2574200 0.2539845 0.2575175 0.2476725 0.2433776 0.2356232 0.2351191
##  0.2312320 0.2231479 0.2200611 0.2092907 0.2051998 0.1976463 0.1967544
##  0.2530509 0.2421594 0.2321246 0.2185956 0.2128872 0.2041417 0.1993202
##  0.2689828 0.2524120 0.2353678 0.2200554 0.2146695 0.2071394 0.1994446
##  0.2884168 0.2682478 0.2455090 0.2256372 0.2180616 0.2094708 0.1999434
##  0.2977772 0.2797854 0.2556395 0.2362617 0.2275378 0.2179310 0.2065019
##  0.2797854 0.2780645 0.2633922 0.2461683 0.2340312 0.2199813 0.2074181
##  0.2556395 0.2633922 0.2617928 0.2483829 0.2366350 0.2220048 0.2118224
##  0.2362617 0.2461683 0.2483829 0.2430083 0.2343771 0.2218024 0.2118269
##  0.2275378 0.2340312 0.2366350 0.2343771 0.2305286 0.2218777 0.2136522
##  0.2179310 0.2199813 0.2220048 0.2218024 0.2218777 0.2196698 0.2141287
##  0.2065019 0.2074181 0.2118224 0.2118269 0.2136522 0.2141287 0.2141061
##  0.2018712 0.2028700 0.2088572 0.2089401 0.2112810 0.2124535 0.2157441
##  0.1974713 0.1995112 0.2062763 0.2062580 0.2080573 0.2077590 0.2120776
##  0.2014006 0.2040158 0.2102987 0.2097512 0.2105031 0.2088153 0.2126221
##  0.2058782 0.2091225 0.2143770 0.2137552 0.2141435 0.2116780 0.2141843
##  0.2148118 0.2189323 0.2228655 0.2218568 0.2213271 0.2172878 0.2174116
##  0.2250567 0.2304693 0.2333589 0.2306911 0.2285366 0.2218388 0.2193143
##  0.2281125 0.2344635 0.2367336 0.2321201 0.2278654 0.2191560 0.2152865
##  0.2392193 0.2446287 0.2448791 0.2386176 0.2325000 0.2229218 0.2185365
##  0.2489985 0.2520975 0.2491997 0.2421437 0.2353761 0.2260044 0.2213650
##
##  0.2447828 0.2447508 0.2496046 0.2530125 0.2621731 0.2936206 0.3080710
##  0.2394128 0.2369619 0.2386465 0.2431683 0.2541286 0.2837030 0.2998455
##  0.2480183 0.2493884 0.2545838 0.2599155 0.2712009 0.2979327 0.3128251
##  0.2484885 0.2486010 0.2527569 0.2575593 0.2652812 0.2845108 0.2936566
##  0.2598386 0.2606525 0.2655260 0.2701249 0.2756978 0.2904209 0.2968592
##  0.2722268 0.2729879 0.2775720 0.2818114 0.2879822 0.3038353 0.3114152
##  0.2658232 0.2675498 0.2713503 0.2744950 0.2785601 0.2905776 0.2972443
##  0.2485610 0.2517688 0.2553240 0.2574943 0.2606688 0.2696447 0.2735122
##  0.2508259 0.2525988 0.2548452 0.2565109 0.2600698 0.2685940 0.2705425
##  0.2406272 0.2409951 0.2427362 0.2438463 0.2480938 0.2558337 0.2551998
##  0.2014079 0.2019093 0.2028593 0.2024474 0.2063207 0.2139085 0.2138599
##  0.2003984 0.1999776 0.2024027 0.2031877 0.2090848 0.2186255 0.2192767
##  0.1981560 0.1959599 0.1993708 0.2012699 0.2081057 0.2177884 0.2189430
##  0.1970845 0.1935959 0.1976421 0.2008005 0.2082774 0.2175997 0.2199613
##  0.2018712 0.1974713 0.2014006 0.2058782 0.2148118 0.2250567 0.2281125
##  0.2028700 0.1995112 0.2040158 0.2091225 0.2189323 0.2304693 0.2344635
##  0.2088572 0.2062763 0.2102987 0.2143770 0.2228655 0.2333589 0.2367336
##  0.2089401 0.2062580 0.2097512 0.2137552 0.2218568 0.2306911 0.2321201
##  0.2112810 0.2080573 0.2105031 0.2141435 0.2213271 0.2285366 0.2278654
##  0.2124535 0.2077590 0.2088153 0.2116780 0.2172878 0.2218388 0.2191560
##  0.2157441 0.2120776 0.2126221 0.2141843 0.2174116 0.2193143 0.2152865
##  0.2224840 0.2219367 0.2235657 0.2245256 0.2262038 0.2263714 0.2218214
##  0.2219367 0.2251523 0.2284751 0.2295040 0.2306587 0.2307898 0.2268269
```

```
##  0.2235657 0.2284751 0.2342087 0.2357276 0.2368986 0.2369383 0.2329162
##  0.2245256 0.2295040 0.2357276 0.2389926 0.2414025 0.2425121 0.2390910
##  0.2262038 0.2306587 0.2368986 0.2414025 0.2466567 0.2515006 0.2503314
##  0.2263714 0.2307898 0.2369383 0.2425121 0.2515006 0.2637628 0.2683264
##  0.2218214 0.2268269 0.2329162 0.2390910 0.2503314 0.2683264 0.2798254
##  0.2254596 0.2299048 0.2350577 0.2411252 0.2533819 0.2732671 0.2882404
##  0.2289120 0.2327751 0.2369475 0.2431522 0.2559232 0.2761284 0.2919861
##
##  0.3026432 0.3016147
##  0.3051248 0.3129377
##  0.3198693 0.3269219
##  0.2982096 0.3031143
##  0.3025901 0.3085978
##  0.3184799 0.3252758
##  0.3048624 0.3122194
##  0.2805271 0.2878848
##  0.2770759 0.2838923
##  0.2609663 0.2679297
##  0.2206316 0.2272181
##  0.2264762 0.2326053
##  0.2269573 0.2338776
##  0.2302204 0.2393223
##  0.2392193 0.2489985
##  0.2446287 0.2520975
##  0.2448791 0.2491997
##  0.2386176 0.2421437
##  0.2325000 0.2353761
##  0.2229218 0.2260044
##  0.2185365 0.2213650
##  0.2254596 0.2289120
##  0.2299048 0.2327751
##  0.2350577 0.2369475
##  0.2411252 0.2431522
##  0.2533819 0.2559232
##  0.2732671 0.2761284
##  0.2882404 0.2919861
##  0.3035398 0.3121056
##  0.3121056 0.3275075
## Correlation Matrix of inter-equation residuals:
##  1.0000000 0.9379874 0.9250031 0.8845597 0.8531787 0.7828166 0.7890523
##  0.9379874 1.0000000 0.9432042 0.9069482 0.8536291 0.8000407 0.8258215
##  0.9250031 0.9432042 1.0000000 0.9595607 0.9398395 0.8906193 0.8932614
##  0.8845597 0.9069482 0.9595607 1.0000000 0.9797316 0.9341942 0.9367146
##  0.8531787 0.8536291 0.9398395 0.9797316 1.0000000 0.9687127 0.9623908
##  0.7828166 0.8000407 0.8906193 0.9341942 0.9687127 1.0000000 0.9821123
##  0.7890523 0.8258215 0.8932614 0.9367146 0.9623908 0.9821123 1.0000000
##  0.7801616 0.8139427 0.8847691 0.9268585 0.9480139 0.9522867 0.9824530
##  0.7611642 0.8085095 0.8619259 0.9096055 0.9281004 0.9260288 0.9626918
##  0.7404934 0.7983448 0.8359161 0.8849565 0.8955982 0.8874270 0.9275732
##  0.7031373 0.7529635 0.7949013 0.8210927 0.8374520 0.8453767 0.8891337
##  0.6938157 0.7323244 0.7823044 0.8267551 0.8427253 0.8431846 0.8809173
##  0.6625307 0.6985391 0.7584090 0.8068223 0.8253343 0.8193015 0.8568976
##  0.5865399 0.6227271 0.7051897 0.7459415 0.7739575 0.7644061 0.8048498
##  0.5805870 0.6082337 0.6966195 0.7311009 0.7600425 0.7502895 0.7882571
```

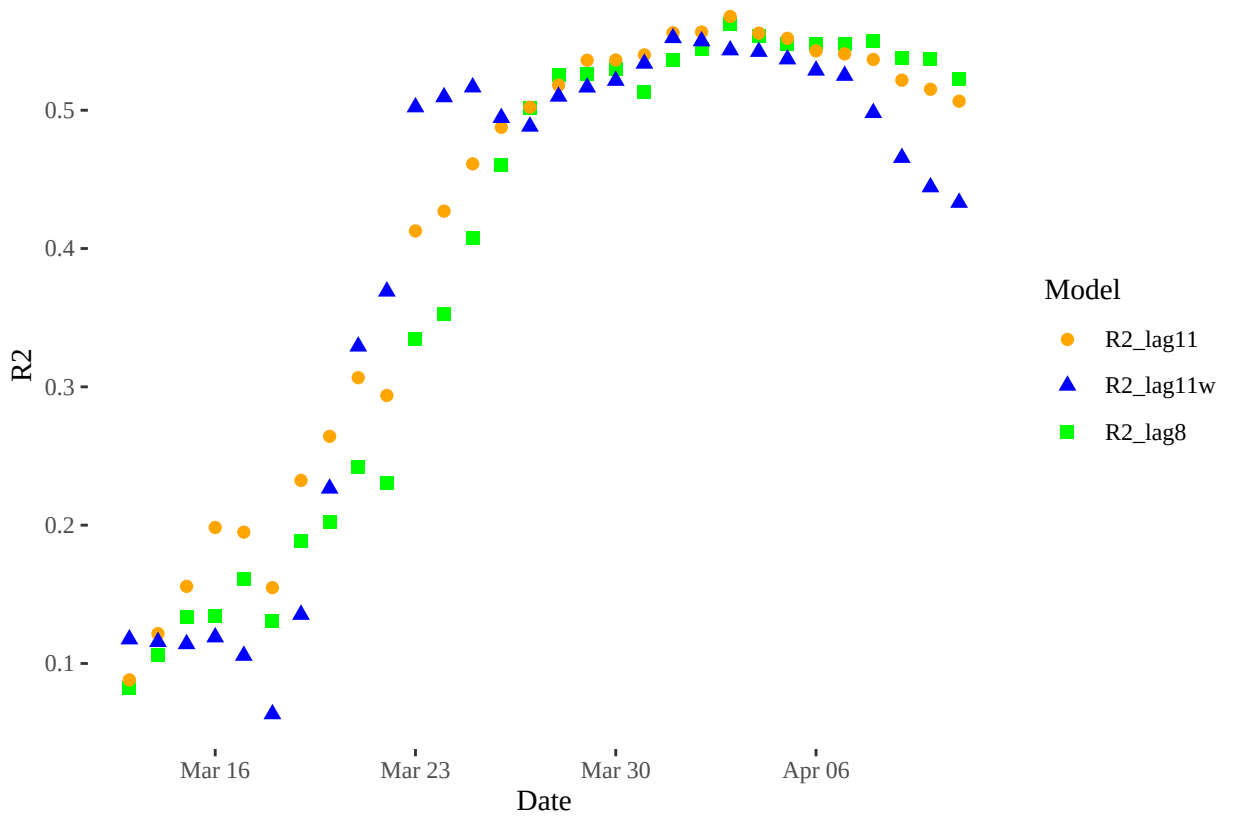
```
##  0.5875258 0.6324910 0.7172719 0.7470171 0.7635902 0.7537609 0.7932150
##  0.6133434 0.6613431 0.7472668 0.7740396 0.7891001 0.7846430 0.8245160
##  0.5891854 0.6589881 0.7354894 0.7655843 0.7735802 0.7745894 0.8167938
##  0.5871566 0.6570713 0.7298858 0.7664888 0.7744293 0.7725763 0.8184034
##  0.5605714 0.6246414 0.6992608 0.7483039 0.7615176 0.7627991 0.8119819
##  0.5738797 0.6273394 0.6951366 0.7475714 0.7639841 0.7679579 0.8205112
##  0.5666514 0.6185191 0.6885862 0.7407522 0.7609516 0.7644650 0.8228217
##  0.5628183 0.6140592 0.6868770 0.7377015 0.7578684 0.7621598 0.8218332
##  0.5621140 0.6119331 0.6886107 0.7392501 0.7599507 0.7649095 0.8218147
##  0.5619814 0.6158631 0.6930263 0.7438556 0.7645887 0.7701256 0.8250625
##  0.5614581 0.6214539 0.6981791 0.7448912 0.7635569 0.7700562 0.8238295
##  0.5770687 0.6403654 0.7146370 0.7558302 0.7717631 0.7807760 0.8309718
##  0.5831369 0.6500055 0.7221133 0.7582360 0.7719404 0.7830351 0.8314287
##  0.5800187 0.6476332 0.7185193 0.7504414 0.7641395 0.7757437 0.8241461
##  0.5731895 0.6432597 0.7142658 0.7429018 0.7580899 0.7695268 0.8182496
##
##  0.7801616 0.7611642 0.7404934 0.7031373 0.6938157 0.6625307 0.5865399
##  0.8139427 0.8085095 0.7983448 0.7529635 0.7323244 0.6985391 0.6227271
##  0.8847691 0.8619259 0.8359161 0.7949013 0.7823044 0.7584090 0.7051897
##  0.9268585 0.9096055 0.8849565 0.8210927 0.8267551 0.8068223 0.7459415
##  0.9480139 0.9281004 0.8955982 0.8374520 0.8427253 0.8253343 0.7739575
##  0.9522867 0.9260288 0.8874270 0.8453767 0.8431846 0.8193015 0.7644061
##  0.9824530 0.9626918 0.9275732 0.8891337 0.8809173 0.8568976 0.8048498
##  1.0000000 0.9854929 0.9508048 0.9204559 0.9144786 0.8881591 0.8416554
##  0.9854929 1.0000000 0.9790213 0.9434053 0.9378949 0.9133932 0.8683500
##  0.9508048 0.9790213 1.0000000 0.9661531 0.9670750 0.9478086 0.9046822
##  0.9204559 0.9434053 0.9661531 1.0000000 0.9826385 0.9593351 0.9254305
##  0.9144786 0.9378949 0.9670750 0.9826385 1.0000000 0.9880088 0.9585543
##  0.8881591 0.9133932 0.9478086 0.9593351 0.9880088 1.0000000 0.9817351
##  0.8416554 0.8683500 0.9046822 0.9254305 0.9585543 0.9817351 1.0000000
##  0.8213784 0.8513494 0.8880035 0.9099142 0.9436383 0.9689044 0.9915641
##  0.8305528 0.8629032 0.8915763 0.9043852 0.9353953 0.9529775 0.9712511
##  0.8646611 0.8929602 0.9020994 0.9084057 0.9329315 0.9417951 0.9514245
##  0.8562576 0.8841837 0.8981809 0.9037051 0.9244955 0.9335816 0.9375704
##  0.8567458 0.8824954 0.8968897 0.9028223 0.9229647 0.9351707 0.9351571
##  0.8487431 0.8719846 0.8851862 0.8895773 0.9117337 0.9294617 0.9283379
##  0.8607702 0.8799882 0.8844409 0.8925681 0.9115081 0.9235105 0.9179163
##  0.8665213 0.8836187 0.8830370 0.8923370 0.9061913 0.9148029 0.9058894
##  0.8686822 0.8837883 0.8823950 0.8910491 0.9032299 0.9072460 0.8946687
##  0.8674286 0.8800650 0.8782158 0.8847957 0.8994738 0.9045402 0.8929698
##  0.8687111 0.8798408 0.8753611 0.8785515 0.8946475 0.9004916 0.8907259
##  0.8671239 0.8791766 0.8767521 0.8788312 0.8968807 0.9029718 0.8945516
##  0.8712386 0.8823818 0.8795107 0.8814900 0.9012569 0.9059876 0.8960791
##  0.8700989 0.8793093 0.8727262 0.8751560 0.8952995 0.8986330 0.8894149
##  0.8622002 0.8714066 0.8652155 0.8741515 0.8934001 0.8963535 0.8885212
##  0.8570106 0.8657030 0.8605474 0.8706360 0.8882279 0.8913699 0.8852955
##
##  0.5805870 0.5875258 0.6133434 0.5891854 0.5871566 0.5605714 0.5738797
##  0.6082337 0.6324910 0.6613431 0.6589881 0.6570713 0.6246414 0.6273394
##  0.6966195 0.7172719 0.7472668 0.7354894 0.7298858 0.6992608 0.6951366
##  0.7311009 0.7470171 0.7740396 0.7655843 0.7664888 0.7483039 0.7475714
##  0.7600425 0.7635902 0.7891001 0.7735802 0.7744293 0.7615176 0.7639841
##  0.7502895 0.7537609 0.7846430 0.7745894 0.7725763 0.7627991 0.7679579
##  0.7882571 0.7932150 0.8245160 0.8167938 0.8184034 0.8119819 0.8205112
```

```
##  0.8213784 0.8305528 0.8646611 0.8562576 0.8567458 0.8487431 0.8607702
##  0.8513494 0.8629032 0.8929602 0.8841837 0.8824954 0.8719846 0.8799882
##  0.8880035 0.8915763 0.9020994 0.8981809 0.8968897 0.8851862 0.8844409
##  0.9099142 0.9043852 0.9084057 0.9037051 0.9028223 0.8895773 0.8925681
##  0.9436383 0.9353953 0.9329315 0.9244955 0.9229647 0.9117337 0.9115081
##  0.9689044 0.9529775 0.9417951 0.9335816 0.9351707 0.9294617 0.9235105
##  0.9915641 0.9712511 0.9514245 0.9375704 0.9351571 0.9283379 0.9179163
##  1.0000000 0.9839611 0.9607635 0.9511781 0.9483157 0.9419053 0.9289310
##  0.9839611 1.0000000 0.9891297 0.9811772 0.9715357 0.9571019 0.9433363
##  0.9607635 0.9891297 1.0000000 0.9909627 0.9809400 0.9656262 0.9582357
##  0.9511781 0.9811772 0.9909627 1.0000000 0.9954529 0.9831865 0.9734395
##  0.9483157 0.9715357 0.9809400 0.9954529 1.0000000 0.9935134 0.9854567
##  0.9419053 0.9571019 0.9656262 0.9831865 0.9935134 1.0000000 0.9947001
##  0.9289310 0.9433363 0.9582357 0.9734395 0.9854567 0.9947001 1.0000000
##  0.9136586 0.9293953 0.9477172 0.9628710 0.9763531 0.9863259 0.9957296
##  0.9005095 0.9181582 0.9383071 0.9540660 0.9681701 0.9753372 0.9863956
##  0.8972921 0.9151055 0.9342633 0.9497850 0.9631966 0.9684468 0.9785738
##  0.8962212 0.9156544 0.9343284 0.9499303 0.9631087 0.9669146 0.9756206
##  0.9020981 0.9232245 0.9396335 0.9548901 0.9663859 0.9678471 0.9736613
##  0.9038870 0.9266262 0.9421046 0.9545208 0.9640023 0.9622743 0.9657700
##  0.8965245 0.9209765 0.9368812 0.9457001 0.9527815 0.9477664 0.9502326
##  0.8957656 0.9184077 0.9325929 0.9390371 0.9450191 0.9391997 0.9419431
##  0.8928874 0.9139739 0.9261067 0.9329272 0.9388790 0.9340141 0.9362134
##
##  0.5666514 0.5628183 0.5621140 0.5619814 0.5614581 0.5770687 0.5831369
##  0.6185191 0.6140592 0.6119331 0.6158631 0.6214539 0.6403654 0.6500055
##  0.6885862 0.6868770 0.6886107 0.6930263 0.6981791 0.7146370 0.7221133
##  0.7407522 0.7377015 0.7392501 0.7438556 0.7448912 0.7558302 0.7582360
##  0.7609516 0.7578684 0.7599507 0.7645887 0.7635569 0.7717631 0.7719404
##  0.7644650 0.7621598 0.7649095 0.7701256 0.7700562 0.7807760 0.7830351
##  0.8228217 0.8218332 0.8218147 0.8250625 0.8238295 0.8309718 0.8314287
##  0.8665213 0.8686822 0.8674286 0.8687111 0.8671239 0.8712386 0.8700989
##  0.8836187 0.8837883 0.8800650 0.8798408 0.8791766 0.8823818 0.8793093
##  0.8830370 0.8823950 0.8782158 0.8753611 0.8767521 0.8795107 0.8727262
##  0.8923370 0.8910491 0.8847957 0.8785515 0.8788312 0.8814900 0.8751560
##  0.9061913 0.9032299 0.8994738 0.8946475 0.8968807 0.9012569 0.8952995
##  0.9148029 0.9072460 0.9045402 0.9004916 0.9029718 0.9059876 0.8986330
##  0.9058894 0.8946687 0.8929698 0.8907259 0.8945516 0.8960791 0.8894149
##  0.9136586 0.9005095 0.8972921 0.8962212 0.9020981 0.9038870 0.8965245
##  0.9293953 0.9181582 0.9151055 0.9156544 0.9232245 0.9266262 0.9209765
##  0.9477172 0.9383071 0.9342633 0.9343284 0.9396335 0.9421046 0.9368812
##  0.9628710 0.9540660 0.9497850 0.9499303 0.9548901 0.9545208 0.9457001
##  0.9763531 0.9681701 0.9631966 0.9631087 0.9663859 0.9640023 0.9527815
##  0.9863259 0.9753372 0.9684468 0.9669146 0.9678471 0.9622743 0.9477664
##  0.9957296 0.9863956 0.9785738 0.9756206 0.9736613 0.9657700 0.9502326
##  1.0000000 0.9963114 0.9907055 0.9876804 0.9842385 0.9746449 0.9589198
##  0.9963114 1.0000000 0.9971643 0.9950611 0.9913376 0.9815724 0.9668104
##  0.9907055 0.9971643 1.0000000 0.9981863 0.9943112 0.9843317 0.9697226
##  0.9876804 0.9950611 0.9981863 1.0000000 0.9979117 0.9897221 0.9771770
##  0.9842385 0.9913376 0.9943112 0.9979117 1.0000000 0.9962266 0.9871007
##  0.9746449 0.9815724 0.9843317 0.9897221 0.9962266 1.0000000 0.9967836
##  0.9589198 0.9668104 0.9697226 0.9771770 0.9871007 0.9967836 1.0000000
##  0.9503182 0.9575911 0.9592391 0.9665462 0.9783303 0.9912121 0.9977870
##  0.9447194 0.9516096 0.9521039 0.9598851 0.9728162 0.9864309 0.9939412
```

```
##
##  0.5800187 0.5731895
##  0.6476332 0.6432597
##  0.7185193 0.7142658
##  0.7504414 0.7429018
##  0.7641395 0.7580899
##  0.7757437 0.7695268
##  0.8241461 0.8182496
##  0.8622002 0.8570106
##  0.8714066 0.8657030
##  0.8652155 0.8605474
##  0.8741515 0.8706360
##  0.8934001 0.8882279
##  0.8963535 0.8913699
##  0.8885212 0.8852955
##  0.8957656 0.8928874
##  0.9184077 0.9139739
##  0.9325929 0.9261067
##  0.9390371 0.9329272
##  0.9450191 0.9388790
##  0.9391997 0.9340141
##  0.9419431 0.9362134
##  0.9503182 0.9447194
##  0.9575911 0.9516096
##  0.9592391 0.9521039
##  0.9665462 0.9598851
##  0.9783303 0.9728162
##  0.9912121 0.9864309
##  0.9977870 0.9939412
##  1.0000000 0.9980244
##  0.9980244 1.0000000
##
##  R-sq. pooled: 0.809
##  Breusch-Pagan: 1.405e+04  p-value: (   0)
```

Compare goodness of fit:

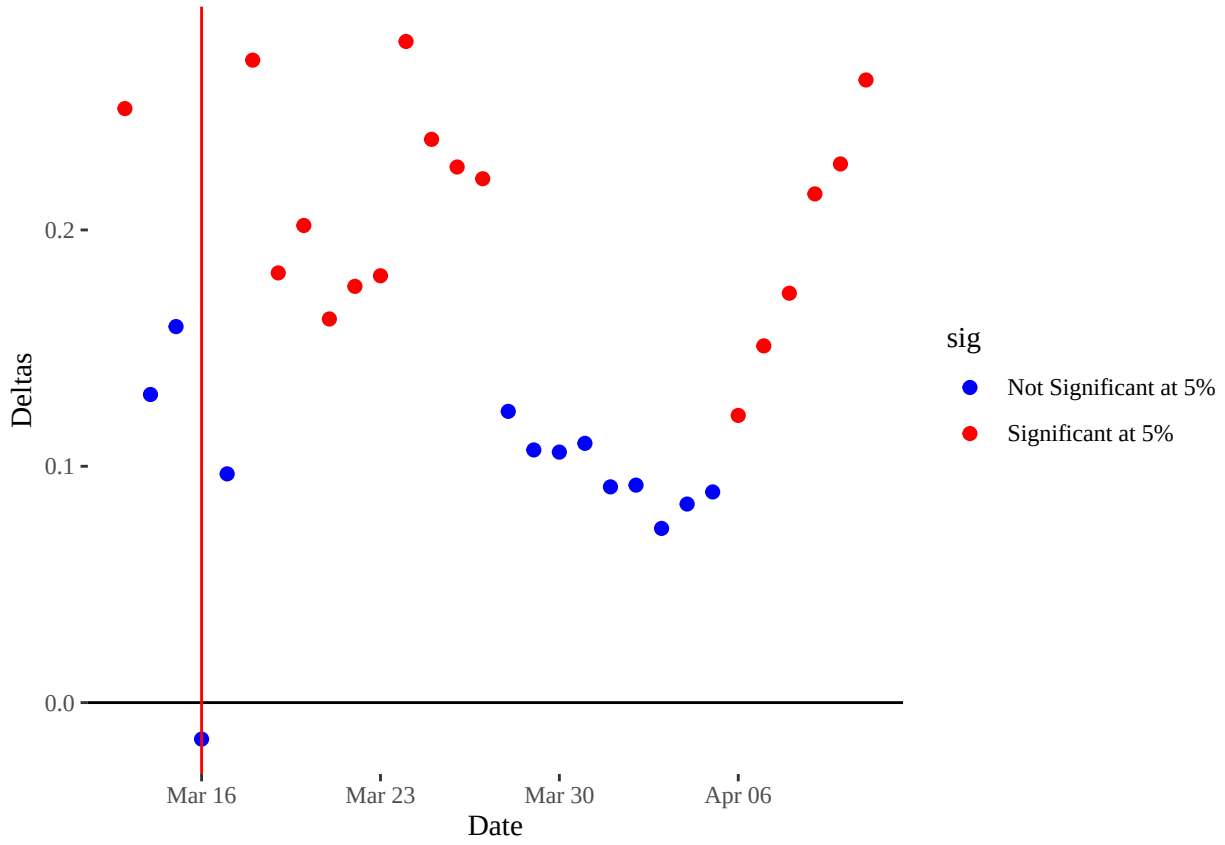
```
data.frame(R2_lag8 = sur.slm_lag8$R2,
           R2_lag11 = sur.slm_lag11$R2,
           R2_lag11w = sur.slm_lag11w$R2) %>%
  slice(2:n()) %>%
  rownames_to_column(var = "Equation") %>%
  mutate(Date = seq(ymd("2020-03-13"),
                    ymd("2020-04-11"),
                    by = "days")) %>%
  pivot_longer(cols = starts_with("R"), names_to = "Model", values_to = "R2") %>%
  ggplot(aes(x = Date, y = R2, color = Model, shape = Model)) +
  geom_point(size = 2) +
  scale_color_manual(values = c("R2_lag11w" = "blue", "R2_lag11" = "orange", "R2_lag8" = "green") ) +
  theme_tufte()
```



Spatial evolution of spatial residual autocorrelation

Plot the evolution of the spatial autocorrelation parameter:

```
data.frame(Date = seq(ymd("2020-03-13"),
                      ymd("2020-04-11"),
                      by = "days"),
           Deltas = sur.slm_lag11$deltas,
           tvalue = sur.slm_lag11$deltas/sur.slm_lag11$deltas.se) %>%
  mutate(sig = ifelse(abs(tvalue) > 1.64, "Significant at 5%", "Not Significant at 5%")) %>%
  ggplot(aes(x = Date, y = Deltas, color = sig)) +
  geom_point(size = 2) +
  scale_color_manual(values = c("Significant at 5%" = "red", "Not Significant at 5%" = "blue")) +
  geom_hline(yintercept = 0) +
  geom_vline(xintercept = as_date("2020-03-16"), color = "red") +
  theme_tufte()
```



Analisis of autocorrelated residuals

Identify all equations with significant autocorrelation parameters:

```
deltas.sig <- data.frame(Date = seq(ymd("2020-03-13"),
                         ymd("2020-04-11"),
                         by = "days"),
           Deltas = sur.slm_lag11$deltas,
           tvalue = sur.slm_lag11$deltas/sur.slm_lag11$deltas.se) %>%
  mutate(sig = abs(tvalue) > 1.64)
```

Extract all residuals and calculate the spatially autocorrelated residuals:

```
all_residuals <- data.frame(matrix(unlist(residuals(sur.slm_lag11)),
                                   ncol = length(residuals(sur.slm_lag11)),
                                   byrow = FALSE))

# Spatially lagged residuals
for(i in 1:ncol(all_residuals)){
  all_residuals[,i] <- deltas.sig$Deltas[i] * lag.listw(listw, all_residuals[,i])
}

# Pivot table
all_residuals <- all_residuals %>%
  pivot_longer(everything(),
               names_to = "Date",
```

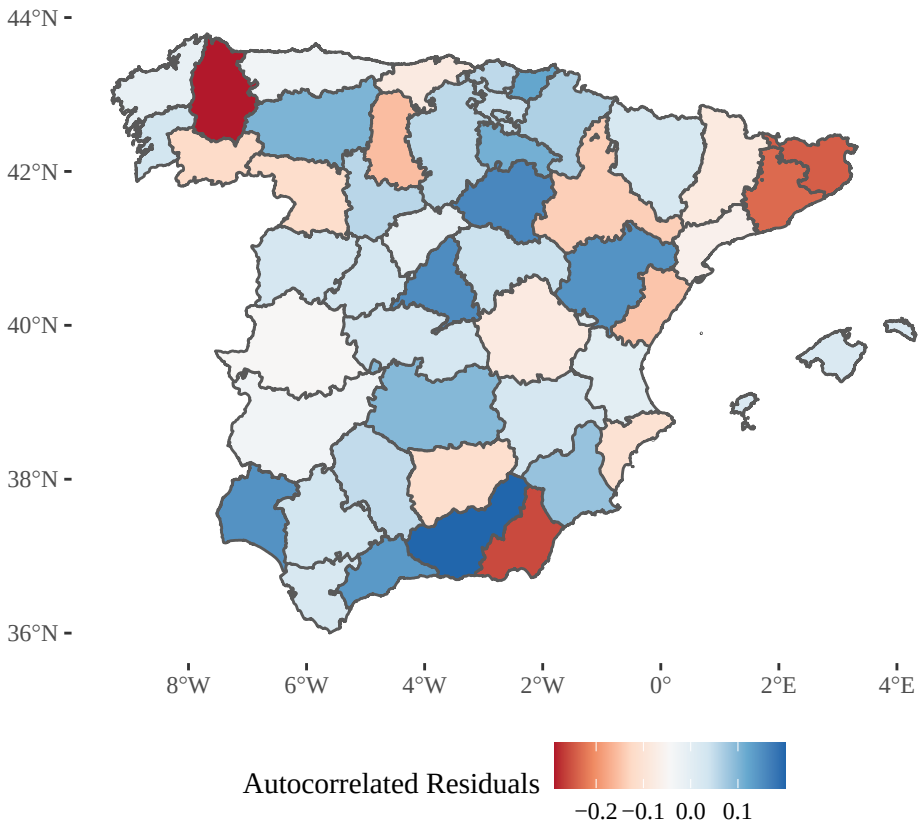
```
                values_to = "Spatially_Autocorrelated_Residuals")%>%
  mutate(Date = rep(seq(dmy("13-03-2020"),
                        dmy("11-04-2020"),
                        by = "days"),
                    50),
         ID_INE = rep(provinces$ID_INE,
                      each = 30))
```

Join to `covid19_spain`:

```
covid19_spain <- covid19_spain %>%
  left_join(all_residuals, by = c("Date", "ID_INE"))
```

Plot residuals on March 13 (positive autocorrelation):

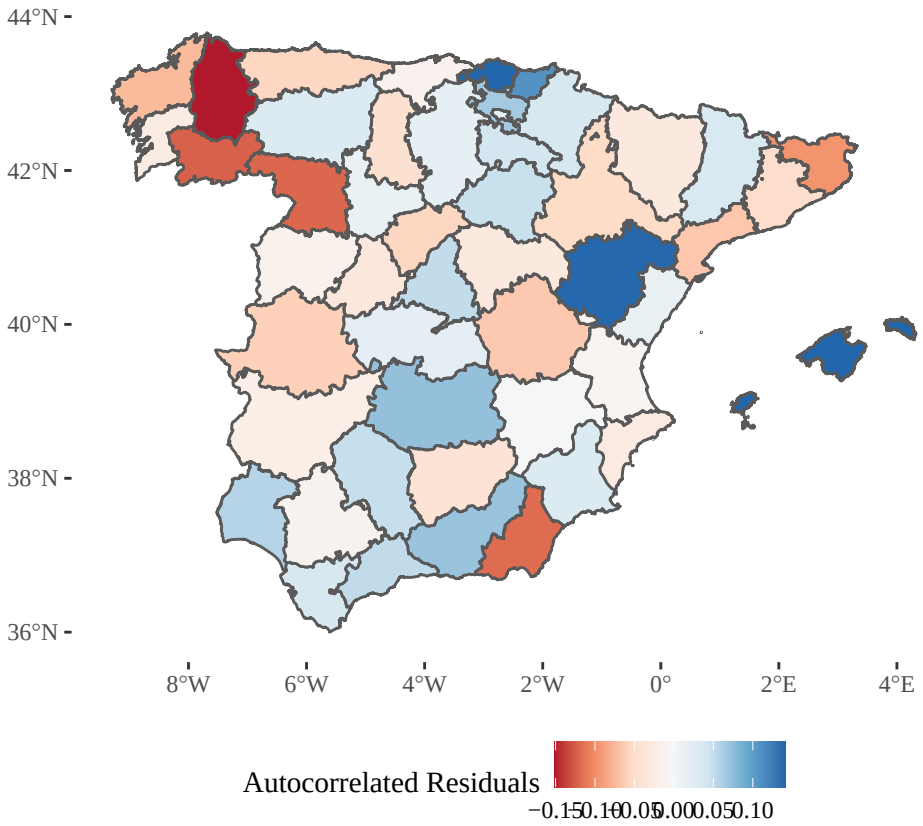
```
covid19_spain %>% filter(Date == "2020-03-13") %>%
  filter(CCAA != "Canarias") %>%
  ggplot() +
  geom_sf(aes(fill = Spatially_Autocorrelated_Residuals)) +
  scale_fill_distiller(name = "Autocorrelated Residuals", palette = "RdBu", direction = 1) +
  theme_tufte() +
  theme(legend.position = "bottom")
```



Plot residuals on March 24 (positive autocorrelation):

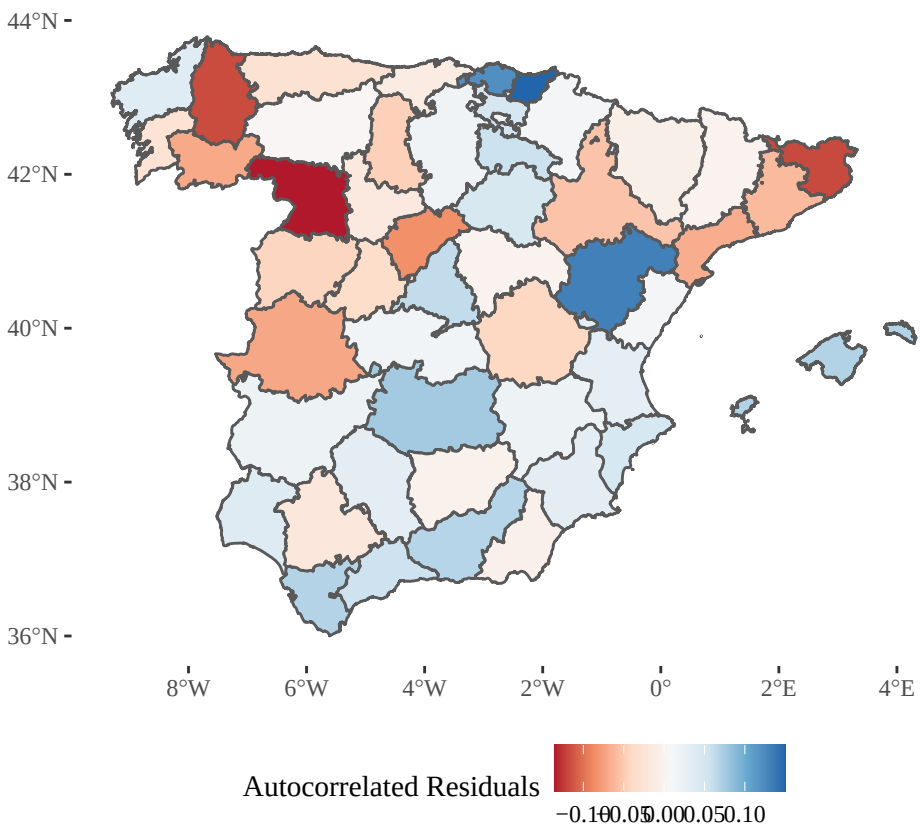
```
covid19_spain %>% filter(Date == "2020-03-24") %>%
  filter(CCAA != "Canarias") %>%
  ggplot() +
```

```
  geom_sf(aes(fill = Spatially_Autocorrelated_Residuals)) +
  scale_fill_distiller(name = "Autocorrelated Residuals", palette = "RdBu", direction = 1) +
  theme_tufte() +
  theme(legend.position = "bottom")
```



Plot residuals on April 11:

```
covid19_spain %>% filter(Date == "2020-04-11") %>%
  filter(CCAA != "Canarias") %>%
  ggplot() +
  geom_sf(aes(fill = Spatially_Autocorrelated_Residuals)) +
  scale_fill_distiller(name = "Autocorrelated Residuals", palette = "RdBu", direction = 1) +
  theme_tufte() +
  theme(legend.position = "bottom")
```



Are these spatially autocorrelated residuals correlated with any other potential control variables? Check the correlations:

```
covid19_spain %>%
  st_drop_geometry() %>%
  group_by(Date) %>%
  summarize(correlation_gdppc = cor(log(GDPpc), Spatially_Autocorrelated_Residuals),
            correlation_older = cor(log(Older), Spatially_Autocorrelated_Residuals),
            correlation_sunshine = cor(log(Sunshine_Hours_lag11 + 0.1), Spatially_Autocorrelated_Residua
  summary()
```

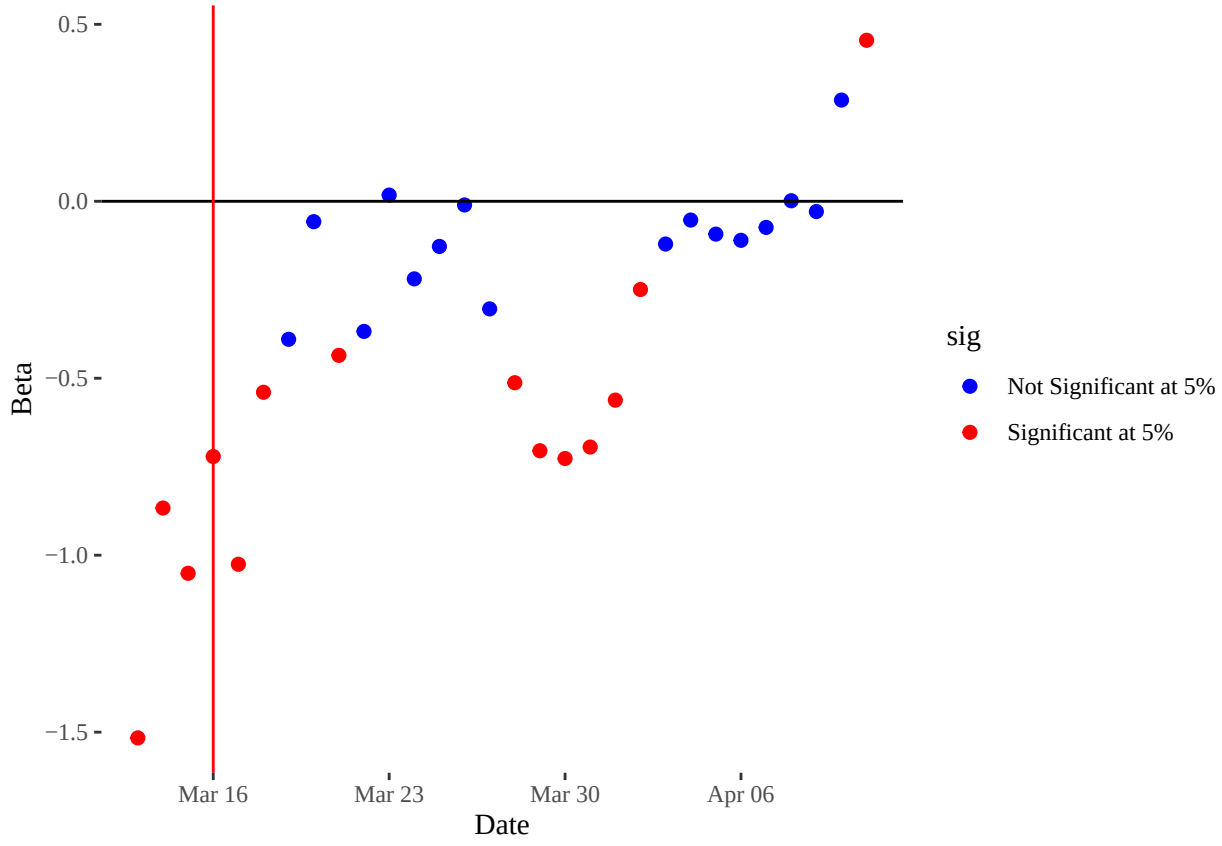
```
##       Date            correlation_gdppc  correlation_older
##  Min.   :2020-03-13   Min.   :-0.13571   Min.   :-0.30192
##  1st Qu.:2020-03-20   1st Qu.: 0.04029   1st Qu.:-0.18268
##  Median :2020-03-27   Median : 0.12926   Median :-0.10704
##  Mean   :2020-03-27   Mean   : 0.10492   Mean   :-0.12756
##  3rd Qu.:2020-04-03   3rd Qu.: 0.16818   3rd Qu.:-0.09424
##  Max.   :2020-04-11   Max.   : 0.26249   Max.   : 0.28224
##  correlation_sunshine
##  Min.   :-0.14541
##  1st Qu.:-0.03345
##  Median : 0.03646
##  Mean   : 0.04495
##  3rd Qu.: 0.12765
##  Max.   : 0.23903
```

These two variables are only weakly and inconsistently correlated with the residuals.

Temporal variation of coefficients of climatic variables

Humidity:

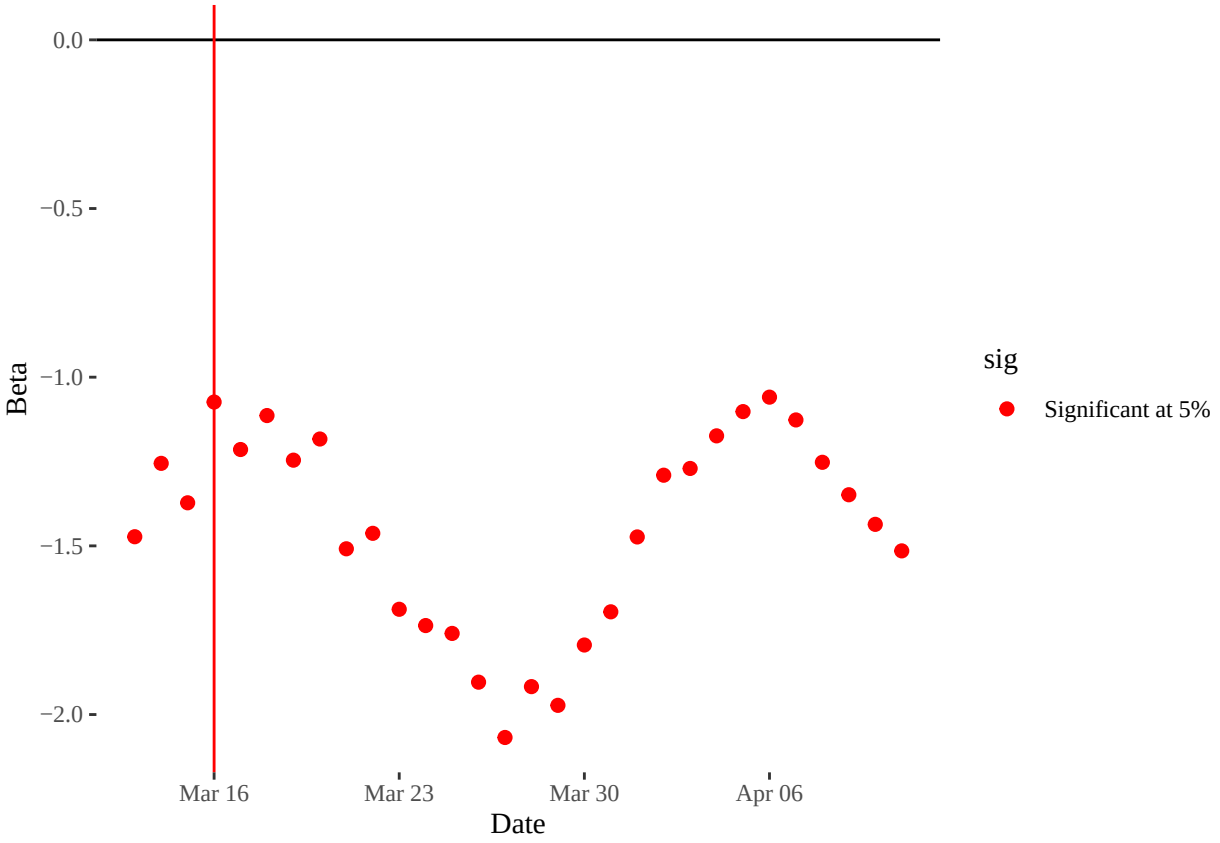
```
n = 4
data.frame(Date = seq(ymd("2020-03-13"),
                      ymd("2020-04-11"),
                      by = "days"),
           Beta = matrix(sur.slm_lag11$coefficients[-c(2,3)],ncol = T)[n,],
           tvalue = matrix(sur.slm_lag11$coefficients[-c(2,3)]/sur.slm_lag11$rest.se[-c(2,3)], ncol = T
  mutate(sig = ifelse(abs(tvalue) > 1.64, "Significant at 5%", "Not Significant at 5%")) %>%
  ggplot(aes(x = Date, y = Beta, color = sig)) +
  geom_point(size = 2) +
  scale_color_manual(values = c("Significant at 5%" = "red", "Not Significant at 5%" = "blue")) +
  geom_hline(yintercept = 0) +
  geom_vline(xintercept = as_date("2020-03-16"), color = "red") +
  theme_tufte()
```



Temperature:

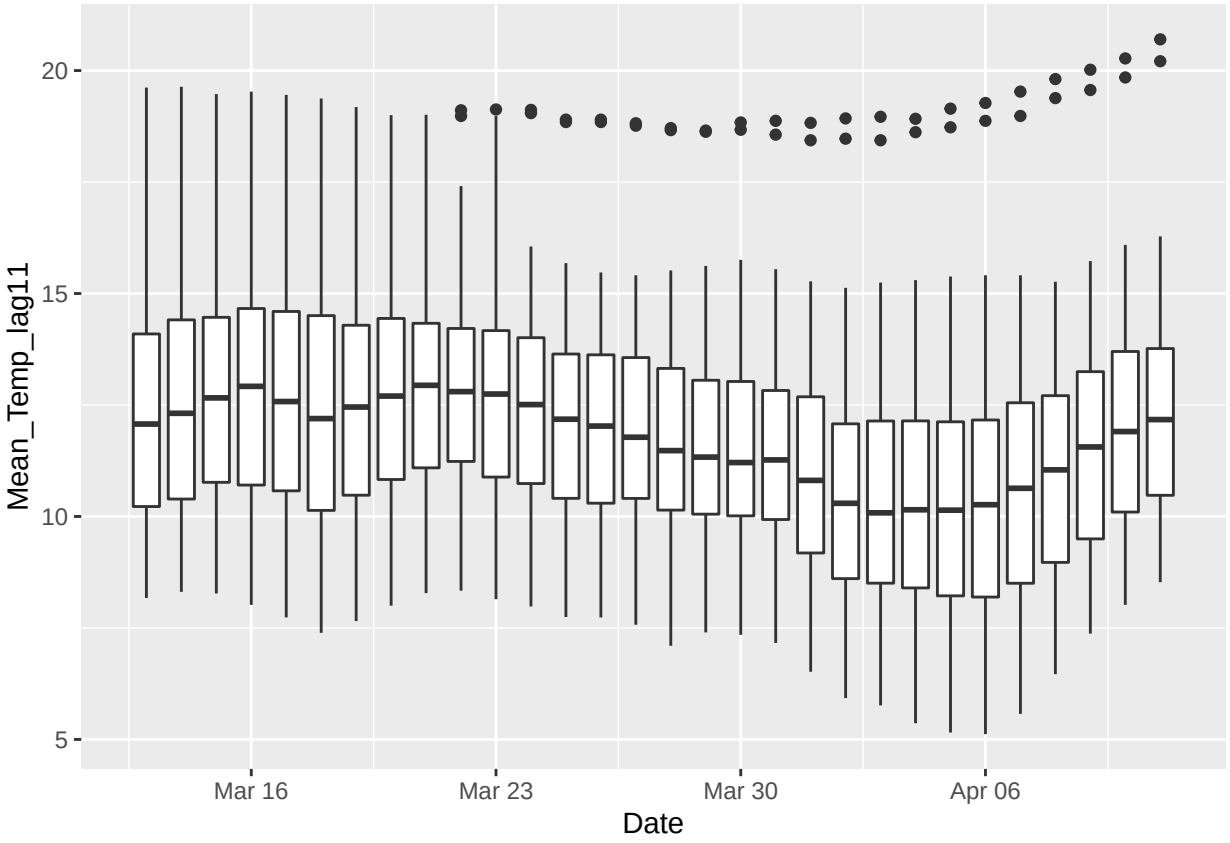
```
n = 5
data.frame(Date = seq(ymd("2020-03-13"),
                      ymd("2020-04-11"),
                      by = "days"),
           Beta = matrix(sur.slm_lag11$coefficients[-c(2,3)],ncol = T)[n,],
           tvalue = matrix(sur.slm_lag11$coefficients[-c(2,3)]/sur.slm_lag11$rest.se[-c(2,3)], ncol = T
  mutate(sig = ifelse(abs(tvalue) > 1.64, "Significant at 5%", "Not Significant at 5%")) %>%
  ggplot(aes(x = Date, y = Beta, color = sig)) +
```

```
  geom_point(size = 2) +
  scale_color_manual(values = c("Significant at 5%" = "red", "Not Significant at 5%" = "blue")) +
  geom_hline(yintercept = 0) +
  geom_vline(xintercept = as_date("2020-03-16"), color = "red") +
  theme_tufte()
```



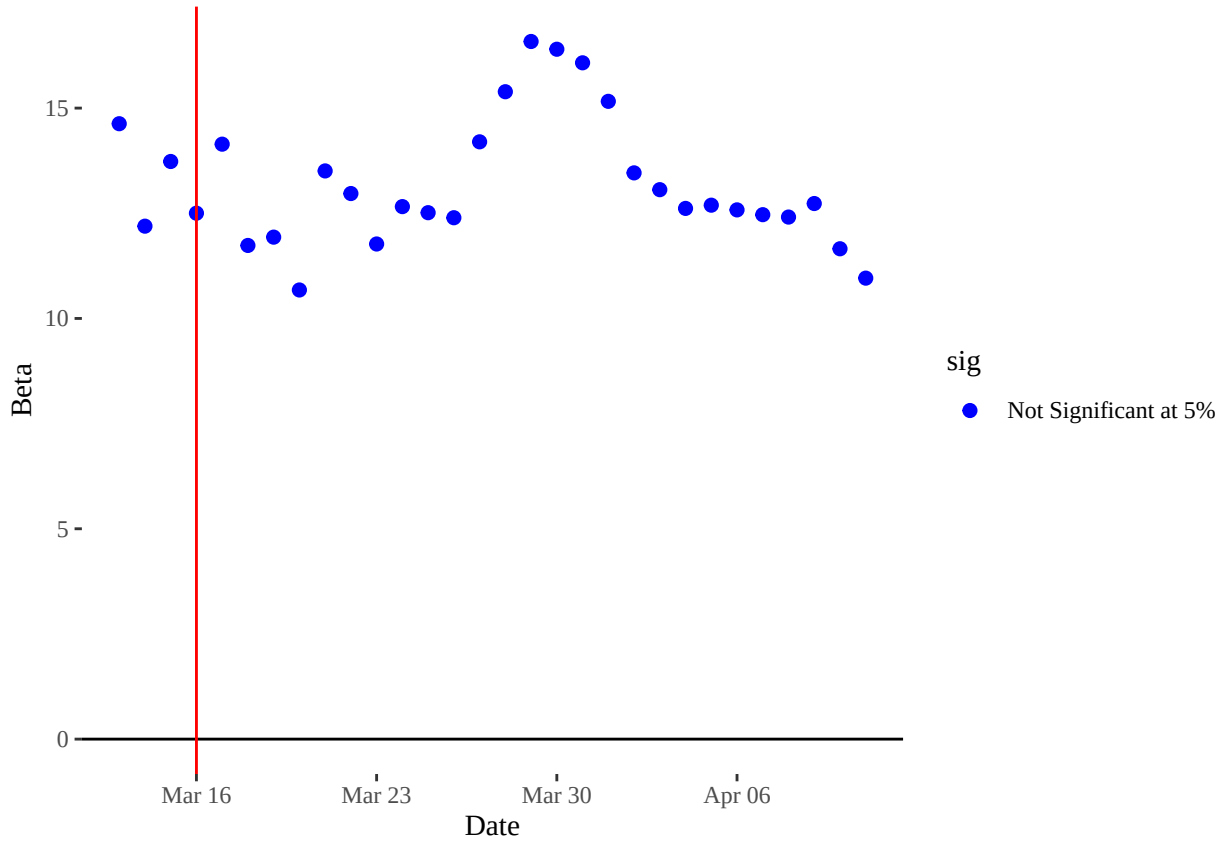
Boxplot of temperatures by date

```
ggplot(data = covid19_spain, aes(x = Date, y = Mean_Temp_lag11, group = Date)) +
  geom_boxplot()
```



Intercept

```
n = 1
data.frame(Date = seq(ymd("2020-03-13"),
                      ymd("2020-04-11"),
                      by = "days"),
           Beta = matrix(sur.slm_lag11$coefficients[-c(2,3)],ncol = T)[n,],
           tvalue = matrix(sur.slm_lag11$coefficients[-c(2,3)]/sur.slm_lag11$rest.se[-c(2,3)], ncol = T
  mutate(sig = ifelse(abs(tvalue) > 1.64, "Significant at 5%", "Not Significant at 5%")) %>%
  ggplot(aes(x = Date, y = Beta, color = sig)) +
  geom_point(size = 2) +
  scale_color_manual(values = c("Significant at 5%" = "red", "Not Significant at 5%" = "blue")) +
  geom_hline(yintercept = 0) +
  geom_vline(xintercept = as_date("2020-03-16"), color = "red") +
  theme_tufte()
```


15
10
5
0
Beta
Mar 16
Mar 23
Mar 30
Apr 06
Date
sig
Not Significant at 5%