Graficas para Leticia Loza

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Propósito: visualizar los promedios horario-mensuales de variable ambiental

Fuente de datos: archivo CSV con registros diarios de variable ambiental por hora (columnas HORA00 - HORA23)

1. Cargar las bibliotecas

```r
library(tidyr)
library(lattice)
library(latticeExtra)
library(lubridate)
```

```
##
## Attaching package: 'lubridate'
```

```
## The following objects are masked from 'package:base':
##
##     date, intersect, setdiff, union
```

2. Definir variables globales

```r
## variables globales (se usan in interior de funciones sin un paso a travez de parámetros de la función)
## colores
col.l <- colorRampPalette(c('blue', 'cyan', 'green', 'yellow', 'orange', 'red'))
col.divs <- 20

## códigos de mesees
meses <- c("E","F","M","A","M","J","J","A","S","O","N","D")

## nombres de las columnas de horas en la tabla
horas <- sprintf("HORA%02d", seq(0,23,1))
horas
```

```
##  [1] "HORA00" "HORA01" "HORA02" "HORA03" "HORA04" "HORA05" "HORA06" "HORA07"
##  [9] "HORA08" "HORA09" "HORA10" "HORA11" "HORA12" "HORA13" "HORA14" "HORA15"
## [17] "HORA16" "HORA17" "HORA18" "HORA19" "HORA20" "HORA21" "HORA22" "HORA23"
```

```r
nombre_variable = "T (°C)"
```

3. Lectura de datos y su preparación

```r
datos <- read.csv("LDO_TMP_1996_2020.csv")

## renombrar columan AÑO para evitar us de simbolos especiales
names(datos)[names(datos) == "AÑO"] <- "AN"

datos$PARAMETRO <- as.factor(datos$PARAMETRO)
datos$CLAVE <- as.factor(datos$CLAVE)

for (i in 1:length(horas)) {
  datos[,horas[i]] <- as.numeric(datos[,horas[i]])
}
```

```
## Warning: NAs introduced by coercion

## Warning: NAs introduced by coercion

## Warning: NAs introduced by coercion

## Warning: NAs introduced by coercion

## Warning: NAs introduced by coercion

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## Warning: NAs introduced by coercion

## Warning: NAs introduced by coercion

## Warning: NAs introduced by coercion
## representación de meses como fracción del año (cada mes suma 1/12, excepto enero)
datos$AN_MES <- (datos$AN + (datos$MES - 1) / 12)

unique(datos$AN_MES)
```

```
##   [1] 1996.000 1996.083 1996.167 1996.250 1996.333 1996.417 1996.500 1996.583
##   [9] 1996.667 1996.750 1996.833 1996.917 1997.000 1997.083 1997.167 1997.250
##  [17] 1997.333 1997.417 1997.500 1997.583 1997.667 1997.750 1997.833 1997.917
##  [25] 1998.000 1998.083 1998.167 1998.250 1998.333 1998.417 1998.500 1998.583
##  [33] 1998.667 1998.750 1998.833 1998.917 1999.000 1999.083 1999.167 1999.250
##  [41] 1999.333 1999.417 1999.500 1999.583 1999.667 1999.750 1999.833 1999.917
##  [49] 2000.000 2000.083 2000.167 2000.250 2000.333 2000.417 2000.500 2000.583
##  [57] 2000.667 2000.750 2000.833 2000.917 2001.000 2001.083 2001.167 2001.250
##  [65] 2001.333 2001.417 2001.500 2001.583 2001.667 2001.750 2001.833 2001.917
##  [73] 2002.000 2002.083 2002.167 2002.250 2002.333 2002.417 2002.500 2002.583
##  [81] 2002.667 2002.750 2002.833 2002.917 2003.000 2003.083 2003.167 2003.250
##  [89] 2003.333 2003.417 2003.500 2003.583 2003.667 2003.750 2003.833 2003.917
##  [97] 2004.000 2004.083 2004.167 2004.250 2004.333 2004.417 2004.500 2004.583
## [105] 2004.667 2004.750 2004.833 2004.917       NA 2005.000 2005.083 2005.167
## [113] 2005.250 2005.333 2005.417 2005.500 2005.583 2005.667 2005.750 2005.833
## [121] 2005.917 2006.000 2006.083 2006.167 2006.250 2006.333 2006.417 2006.500
## [129] 2006.583 2006.667 2006.750 2006.833 2006.917 2007.000 2007.083 2007.167
## [137] 2007.250 2007.333 2007.417 2007.500 2007.583 2007.667 2007.750 2007.833
## [145] 2007.917 2008.000 2008.083 2008.167 2008.250 2008.333 2008.417 2008.500
## [153] 2008.583 2008.667 2008.750 2008.833 2008.917 2009.000 2009.083 2009.167
## [161] 2009.250 2009.333 2009.417 2009.500 2009.583 2009.667 2009.750 2009.833
## [169] 2009.917 2010.000 2010.083 2010.167 2010.250 2010.333 2010.417 2010.500
## [177] 2010.583 2010.667 2010.750 2010.833 2010.917 2011.000 2011.083 2011.167
## [185] 2011.250 2011.333 2011.417 2011.500 2011.583 2011.667 2011.750 2011.833
## [193] 2011.917 2012.000 2012.083 2012.167 2012.250 2012.333 2012.417 2012.500
## [201] 2012.583 2012.667 2012.750 2012.833 2012.917 2013.000 2013.083 2013.167
## [209] 2013.250 2013.333 2013.417 2013.500 2013.583 2013.667 2013.750 2013.833
## [217] 2013.917 2014.000 2014.083 2014.167 2014.250 2014.333 2014.417 2014.500
## [225] 2014.583 2014.667 2014.750 2014.833 2014.917 2015.000 2015.083 2015.167
## [233] 2015.250 2015.333 2015.417 2015.500 2015.583 2015.667 2015.750 2015.833
## [241] 2015.917 2016.000 2016.083 2016.167 2016.250 2016.333 2016.417 2016.500
## [249] 2016.583 2016.667 2016.750 2016.833 2016.917 2017.000 2017.083 2017.167
## [257] 2017.250 2017.333 2017.417 2017.500 2017.583 2017.667 2017.750 2017.833
## [265] 2017.917 2018.000 2018.083 2018.167 2018.250 2018.333 2018.417 2018.500
## [273] 2018.583 2018.667 2018.750 2018.833 2018.917 2019.000 2019.083 2019.167
## [281] 2019.250 2019.333 2019.417 2019.500 2019.583 2019.667 2019.750 2019.833
## [289] 2019.917 2020.000 2020.083 2020.167 2020.250 2020.333 2020.417 2020.500
## [297] 2020.583 2020.667 2020.750 2020.833 2020.917
```

```
str(datos)
```

```
## 'data.frame':    9132 obs. of  31 variables:
##  $ FECHA    : chr  "01/01/1996" "02/01/1996" "03/01/1996" "04/01/1996" ...
##  $ DIA      : int  1 2 3 4 5 6 7 8 9 10 ...
##  $ MES      : int  1 1 1 1 1 1 1 1 1 1 ...
##  $ AN       : int  1996 1996 1996 1996 1996 1996 1996 1996 1996 1996 ...
##  $ CLAVE    : Factor w/ 1 level "LDO": 1 1 1 1 1 1 1 1 1 1 ...
##  $ PARAMETRO: Factor w/ 2 levels "366","TMP": 2 2 2 2 2 2 2 2 2 2 ...
##  $ HORA00   : num  11.1 9.8 9.8 11.2 12.3 0 0 0 11.4 13.5 ...
##  $ HORA01   : num  10.3 9.2 8.6 10.6 12.1 0 0 0 11.1 13.6 ...
##  $ HORA02   : num  9.2 8.7 8 10.2 10.5 0 0 0 10.6 12.1 ...
##  $ HORA03   : num  8.6 7.6 8 9.6 9.8 0 0 0 10.6 11.3 ...
##  $ HORA04   : num  8.5 7.7 8 8.8 9.4 0 0 0 9.4 11.4 ...
##  $ HORA05   : num  8.1 6.5 7.7 7.8 8.9 0 0 0 8.8 10 ...
##  $ HORA06   : num  7.1 5.7 7 7.1 9.1 0 0 0 8.6 10.1 ...
##  $ HORA07   : num  6.5 5.6 6.9 6.8 7.8 0 0 0 8 9.7 ...
##  $ HORA08   : num  7.7 0 7.2 7.7 8.3 0 0 0 8.8 10.8 ...
##  $ HORA09   : num  10.7 9.4 8.5 10.7 11.5 0 0 0 10.9 13.3 ...
##  $ HORA10   : num  14.1 11 11.4 14.7 0 0 0 0 13.7 17 ...
##  $ HORA11   : num  16.4 12.7 13.9 18.1 0 0 0 14.2 17.1 20.2 ...
##  $ HORA12   : num  17.8 17.6 17.5 20.6 0 0 0 16.2 19.9 22.5 ...
##  $ HORA13   : num  19.1 18.7 18.9 21.9 0 0 0 18.8 23.7 24.4 ...
##  $ HORA14   : num  20 19.1 19.6 22.7 0 0 0 20.2 23.7 25.7 ...
##  $ HORA15   : num  20.4 19.3 20 23.7 0 0 0 20.4 24.1 26.3 ...
##  $ HORA16   : num  20 19.2 20.5 23.7 0 0 0 19.3 25.3 26.1 ...
##  $ HORA17   : num  19.4 18.5 18.7 23.1 0 0 0 18.5 24.7 25.3 ...
##  $ HORA18   : num  17.5 11 16.5 20.6 0 0 0 15.7 21.3 22.1 ...
##  $ HORA19   : num  15.5 12.7 14.7 17.6 0 0 0 13.8 18.1 19.5 ...
##  $ HORA20   : num  14.7 15.4 13.9 16.5 0 0 0 13.1 16.9 18.5 ...
##  $ HORA21   : num  13.3 13.3 13.6 15 0 0 0 12.5 16.4 17.7 ...
##  $ HORA22   : num  11.6 12.1 13.5 12.8 0 0 0 11.8 15.4 16.6 ...
##  $ HORA23   : num  10.7 10.9 12.7 12.7 0 0 0 11.1 14.3 16.4 ...
##  $ AN_MES   : num  1996 1996 1996 1996 1996 ...
```

```
head(datos)
```

```
##        FECHA DIA MES   AN CLAVE PARAMETRO HORA00 HORA01 HORA02 HORA03 HORA04
## 1 01/01/1996   1   1 1996   LDO       TMP   11.1   10.3    9.2    8.6    8.5
## 2 02/01/1996   2   1 1996   LDO       TMP    9.8    9.2    8.7    7.6    7.7
## 3 03/01/1996   3   1 1996   LDO       TMP    9.8    8.6    8.0    8.0    8.0
## 4 04/01/1996   4   1 1996   LDO       TMP   11.2   10.6   10.2    9.6    8.8
## 5 05/01/1996   5   1 1996   LDO       TMP   12.3   12.1   10.5    9.8    9.4
## 6 06/01/1996   6   1 1996   LDO       TMP    0.0    0.0    0.0    0.0    0.0
##   HORA05 HORA06 HORA07 HORA08 HORA09 HORA10 HORA11 HORA12 HORA13 HORA14 HORA15
## 1    8.1    7.1    6.5    7.7   10.7   14.1   16.4   17.8   19.1   20.0   20.4
## 2    6.5    5.7    5.6    0.0    9.4   11.0   12.7   17.6   18.7   19.1   19.3
## 3    7.7    7.0    6.9    7.2    8.5   11.4   13.9   17.5   18.9   19.6   20.0
## 4    7.8    7.1    6.8    7.7   10.7   14.7   18.1   20.6   21.9   22.7   23.7
## 5    8.9    9.1    7.8    8.3   11.5    0.0    0.0    0.0    0.0    0.0    0.0
## 6    0.0    0.0    0.0    0.0    0.0    0.0    0.0    0.0    0.0    0.0    0.0
##   HORA16 HORA17 HORA18 HORA19 HORA20 HORA21 HORA22 HORA23 AN_MES
## 1   20.0   19.4   17.5   15.5   14.7   13.3   11.6   10.7   1996
## 2   19.2   18.5   11.0   12.7   15.4   13.3   12.1   10.9   1996
## 3   20.5   18.7   16.5   14.7   13.9   13.6   13.5   12.7   1996
## 4   23.7   23.1   20.6   17.6   16.5   15.0   12.8   12.7   1996
## 5    0.0    0.0    0.0    0.0    0.0    0.0    0.0    0.0   1996
## 6    0.0    0.0    0.0    0.0    0.0    0.0    0.0    0.0   1996
```

```
tail(datos)
```

```
##           FECHA DIA MES   AN CLAVE PARAMETRO HORA00 HORA01 HORA02 HORA03 HORA04
## 9127 26/12/2020  26  12 2020   LDO       TMP   24.0   24.1   24.1   24.2   24.3
## 9128 27/12/2020  27  12 2020   LDO       TMP   24.3   24.3   24.4   24.5   24.6
## 9129 28/12/2020  28  12 2020   LDO       TMP   24.2   24.3   24.4   24.4   24.4
## 9130 29/12/2020  29  12 2020   LDO       TMP   24.0   24.1   24.2   24.3   24.4
## 9131 30/12/2020  30  12 2020   LDO       TMP   24.1   24.2   24.3   24.4   24.5
## 9132 31/12/2020  31  12 2020   LDO       TMP   24.3   24.5   24.5   24.5   24.6
##      HORA05 HORA06 HORA07 HORA08 HORA09 HORA10 HORA11 HORA12 HORA13 HORA14
## 9127   24.4   24.5   24.6   24.6   24.2   24.0   24.1   24.3   24.5   24.6
## 9128   24.8   24.8   24.9   24.9   24.4   24.1   24.2   24.5   24.7   24.7
## 9129   24.5   24.7   24.8   24.8   24.5   24.1   24.2   24.4   24.7   24.9
## 9130   24.4   24.5   24.6   24.5   24.2   24.1   24.2   24.4   24.6   24.6
## 9131   24.7   24.8   24.8     NA   24.4   24.1   24.2   24.3   24.5   24.7
## 9132   24.8   24.9   25.2   25.5   25.3   24.9   24.6   24.5   24.4   24.5
##      HORA15 HORA16 HORA17 HORA18 HORA19 HORA20 HORA21 HORA22 HORA23   AN_MES
## 9127   24.7   24.7   24.6   24.5   24.1   23.8   23.8   24.0   24.1 2020.917
## 9128   24.8   24.7   24.7   24.4   24.0   24.0   24.0   24.0   24.0 2020.917
## 9129   24.9   24.7   24.7   24.5   24.1   24.0   24.0   23.9   23.9 2020.917
## 9130   24.7   24.7   24.7   24.5   24.1   23.9   23.9   24.0   24.0 2020.917
## 9131   24.7   24.7   24.6   24.4   24.2   24.2   24.3   24.3   24.3 2020.917
## 9132   24.5   24.6   24.5   24.3   24.1   24.2   24.3   24.5   24.5 2020.917
```

3. Calcuar subtotales por mes-hora

```
## formato ancho
datos_wide <- aggregate(x = datos[horas], by = list(datos$AN_MES), FUN = "mean", na.action = na.omit)
names(datos_wide)[names(datos_wide) == "Group.1"] <- "AN_MES"
head(datos_wide)
```

```
##     AN_MES   HORA00   HORA01   HORA02   HORA03    HORA04    HORA05    HORA06
## 1 1996.000 12.72258 11.87097 11.20645 10.17419  9.690323  8.945161  8.703226
## 2 1996.083 15.43103 14.30690 13.56897 13.01724 12.031034 11.413793 10.879310
## 3 1996.167 15.55161 14.56774 13.67742 11.99032 12.219355 11.648387 10.235484
## 4 1996.250 18.96333 17.90000 16.88333 16.08667 15.276667 14.616667 14.160000
## 5 1996.333 21.85806 20.97742 20.27419 18.99355 18.532258 17.329032 17.432258
## 6 1996.417 18.82667 18.16667 17.50667 16.48667 15.553333 15.933333 15.620000
##      HORA07    HORA08   HORA09   HORA10   HORA11   HORA12   HORA13   HORA14
## 1  7.874194  8.745161 12.19677 14.39677 17.50645 19.72581 21.39032 20.78710
## 2 10.413793 12.596552 16.28966 18.50690 20.88276 23.97931 25.58966 26.75862
## 3 11.041935 13.948387 16.26129 19.10968 21.14194 23.09032 24.57097 24.65484
## 4 13.943333 15.433333 18.68000 21.32000 21.86000 25.54333 27.26000 28.62000
## 5 16.990323 18.635484 20.68065 23.94194 24.41935 27.16774 26.94516 30.36452
## 6 14.310000 17.423333 19.17667 20.89333 23.27333 24.98000 25.52667 27.67333
##     HORA15   HORA16   HORA17   HORA18   HORA19   HORA20   HORA21   HORA22
## 1 22.16129 23.19032 21.69677 19.31935 17.61935 16.51613 15.56452 14.61613
## 2 27.46552 27.65517 26.00345 24.67241 21.98966 20.26552 19.03448 18.00000
## 3 24.43226 24.34194 24.96452 23.03226 20.79032 19.69032 18.35161 17.20968
## 4 29.35000 30.42000 30.22667 29.30333 27.60333 25.26333 23.42667 22.06333
## 5 31.22581 31.35161 30.93871 29.24516 27.90968 25.91935 24.82581 23.51290
## 6 28.51333 28.86333 27.91667 26.76000 25.58667 23.14000 21.02333 20.80000
##     HORA23
## 1 13.75806
## 2 17.03103
## 3 16.16452
## 4 20.23667
## 5 22.06774
## 6 19.22333
```

```
str(datos_wide)
```

```
## 'data.frame':    300 obs. of  25 variables:
##  $ AN_MES: num  1996 1996 1996 1996 1996 ...
##  $ HORA00: num  12.7 15.4 15.6 19 21.9 ...
##  $ HORA01: num  11.9 14.3 14.6 17.9 21 ...
##  $ HORA02: num  11.2 13.6 13.7 16.9 20.3 ...
##  $ HORA03: num  10.2 13 12 16.1 19 ...
##  $ HORA04: num  9.69 12.03 12.22 15.28 18.53 ...
##  $ HORA05: num  8.95 11.41 11.65 14.62 17.33 ...
##  $ HORA06: num  8.7 10.9 10.2 14.2 17.4 ...
##  $ HORA07: num  7.87 10.41 11.04 13.94 16.99 ...
##  $ HORA08: num  8.75 12.6 13.95 15.43 18.64 ...
##  $ HORA09: num  12.2 16.3 16.3 18.7 20.7 ...
##  $ HORA10: num  14.4 18.5 19.1 21.3 23.9 ...
##  $ HORA11: num  17.5 20.9 21.1 21.9 24.4 ...
##  $ HORA12: num  19.7 24 23.1 25.5 27.2 ...
##  $ HORA13: num  21.4 25.6 24.6 27.3 26.9 ...
##  $ HORA14: num  20.8 26.8 24.7 28.6 30.4 ...
##  $ HORA15: num  22.2 27.5 24.4 29.4 31.2 ...
##  $ HORA16: num  23.2 27.7 24.3 30.4 31.4 ...
##  $ HORA17: num  21.7 26 25 30.2 30.9 ...
##  $ HORA18: num  19.3 24.7 23 29.3 29.2 ...
##  $ HORA19: num  17.6 22 20.8 27.6 27.9 ...
##  $ HORA20: num  16.5 20.3 19.7 25.3 25.9 ...
##  $ HORA21: num  15.6 19 18.4 23.4 24.8 ...
##  $ HORA22: num  14.6 18 17.2 22.1 23.5 ...
##  $ HORA23: num  13.8 17 16.2 20.2 22.1 ...
```

```
## formato Largo
datos_long <- gather(datos_wide, key = "Hora", "T", horas, factor_key=TRUE)
```

```
## Note: Using an external vector in selections is ambiguous.
## i Use `all_of(horas)` instead of `horas` to silence this message.
## i See <https://tidyselect.r-lib.org/reference/faq-external-vector.html>.
## This message is displayed once per session.
```

```
names(datos_long)[names(datos_long) == "Group.1"] <- "AN_MES"
datos_long$Hora_num <- as.integer(factor(datos_long$Hora, levels = horas, ordered = TRUE))
head(datos_long)
```

```
##     AN_MES   Hora        T Hora_num
## 1 1996.000 HORA00 12.72258        1
## 2 1996.083 HORA00 15.43103        1
## 3 1996.167 HORA00 15.55161        1
## 4 1996.250 HORA00 18.96333        1
## 5 1996.333 HORA00 21.85806        1
## 6 1996.417 HORA00 18.82667        1
```

```
str(datos_long)
```

```
## 'data.frame':    7200 obs. of  4 variables:
##  $ AN_MES  : num  1996 1996 1996 1996 1996 ...
##  $ Hora    : Factor w/ 24 levels "HORA00","HORA01",..: 1 1 1 1 1 1 1 1 1 1 ...
##  $ T       : num  12.7 15.4 15.6 19 21.9 ...
##  $ Hora_num: int  1 1 1 1 1 1 1 1 1 1 ...
```

Visualización de datos

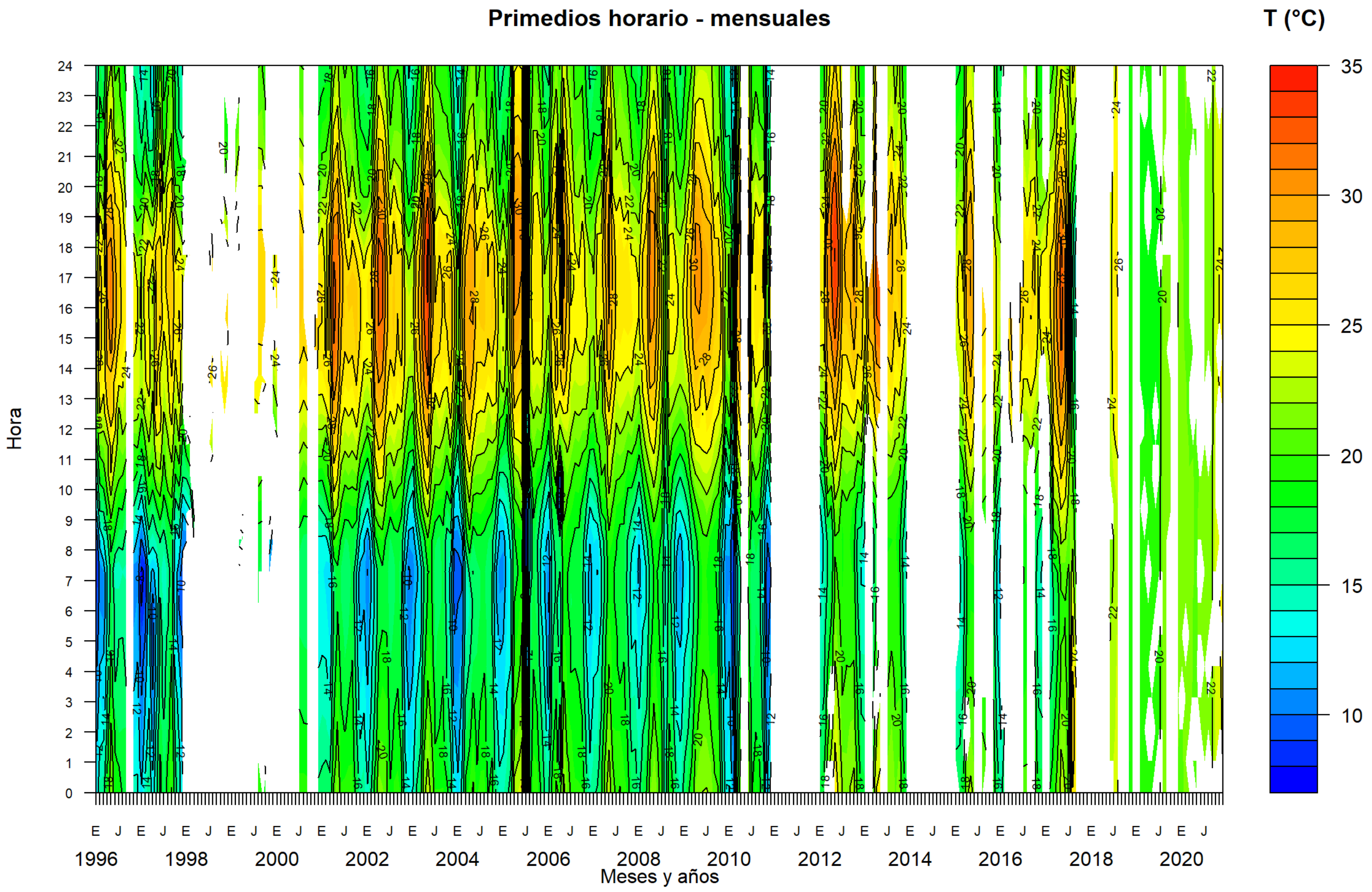
En las zonas sin cobertura de datos apareceré el espacio en blanco

Método 1: función *filled.contour*

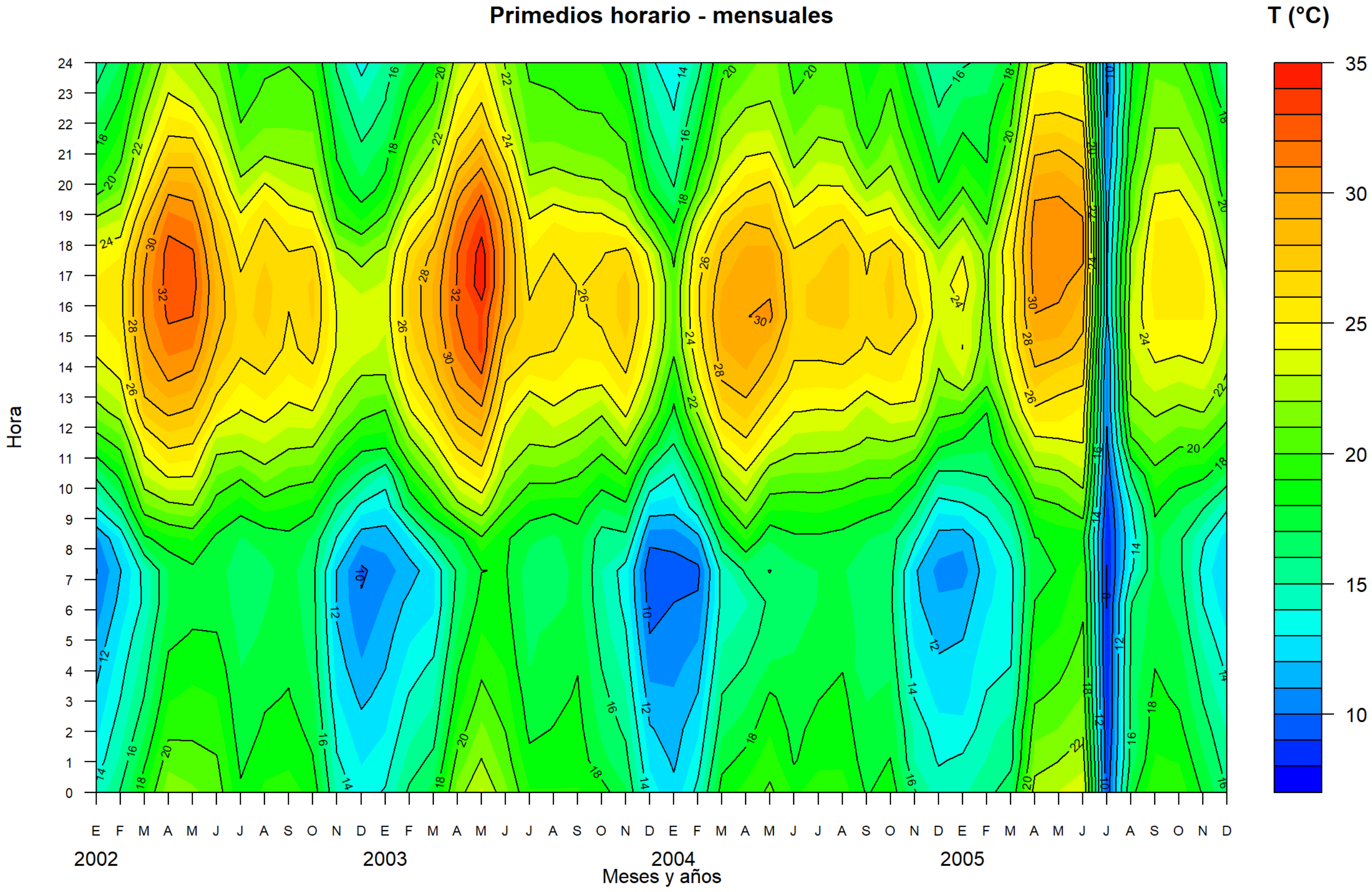
Tres ejemplos:

1. datos completos
2. recorte de 2002 hasts 2006
3. recorte de 2006 hasts 2010

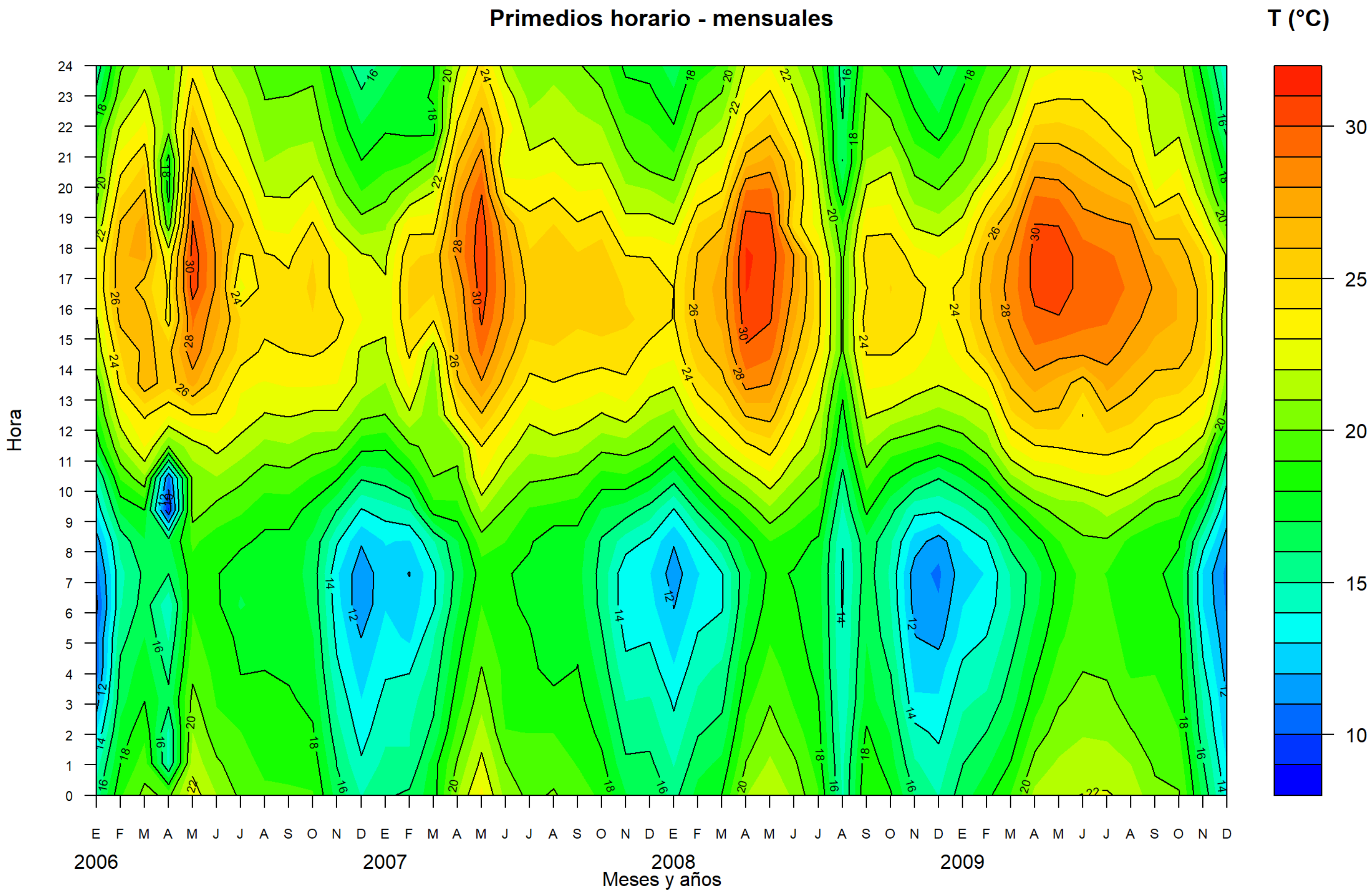
```
datos_wide1 <- datos_wide[datos_wide$AN_MES >= 2002 & datos_wide$AN_MES < 2006,]
datos_wide2 <- datos_wide[datos_wide$AN_MES >= 2006 & datos_wide$AN_MES < 2010,]

dibujar1 <- function (dw) {
  ## función para visualizar datos
  ## dw - dataframe en formato ancho
  df.x <- seq(min(dw$AN_MES, na.rm = TRUE),
            max(dw$AN_MES, na.rm = TRUE),
            length.out = nrow(dw[,horas]))

  numero_mes <- round(12 * (df.x - floor(df.x)) + 1)
  an_inicio_selector <- (df.x - floor(df.x)) == 0
  #print(meses[numero_mes])
  #print(an_inicio_selector)

  df.y <- seq(0, 24, length.out = ncol(dw[,horas]))
  df.z <- as.matrix(dw[,horas])

  ## calcular rango de colores a partir de datos
  rango_z <- c(min(df.z, na.rm = TRUE),max(df.z, na.rm = TRUE))
  ## opcionalmente se puede utilizar un rango fijo
  # rango_z <- c(5,45)

  divisiones <- pretty(rango_z, col.divs)
  colores <- col.l(length(divisiones))

  filled.contour(df.x, df.y, df.z,
                levels = divisiones,
                #nlevels = col.divs,
                col = colores,
                key.title = title(main = nombre_variable),
                plot.axes = {
                  axis(1, pos = -1, lwd = 0, at = df.x[an_inicio_selector])
                  axis(1, at = df.x, labels = meses[numero_mes], cex.axis = 0.7)
                  axis(2, at = 0:24, cex.axis = 0.7)
                  contour(df.x, df.y, df.z, add = T)},
                ylab = "Hora", xlab = "Meses y años",
                main = "Primedios horario - mensuales"
                )

}

dibujar1(datos_wide)
```



```
dibujar1(datos_wide1)
```



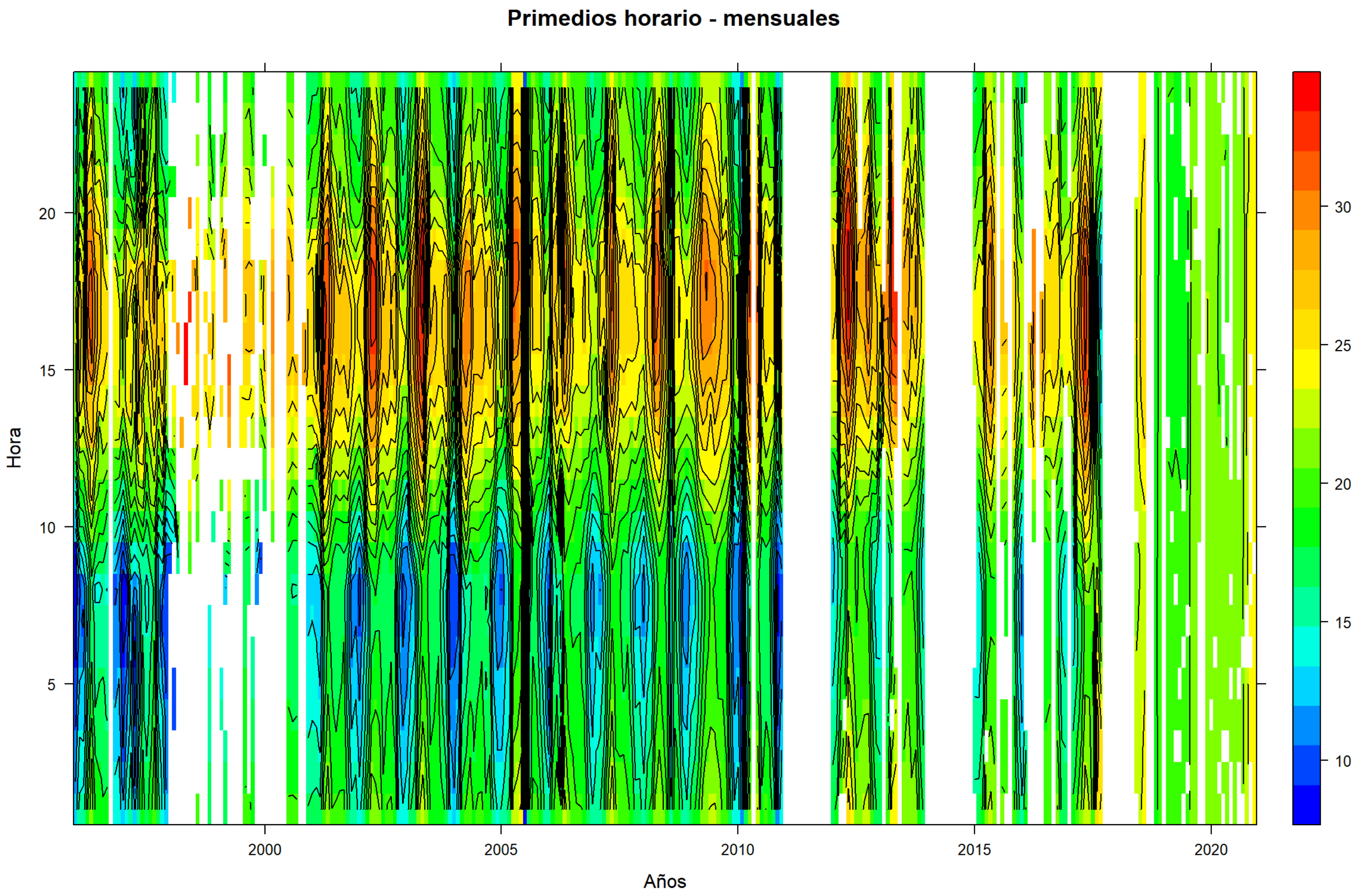
```
dibujar1(datos_wide2)
```



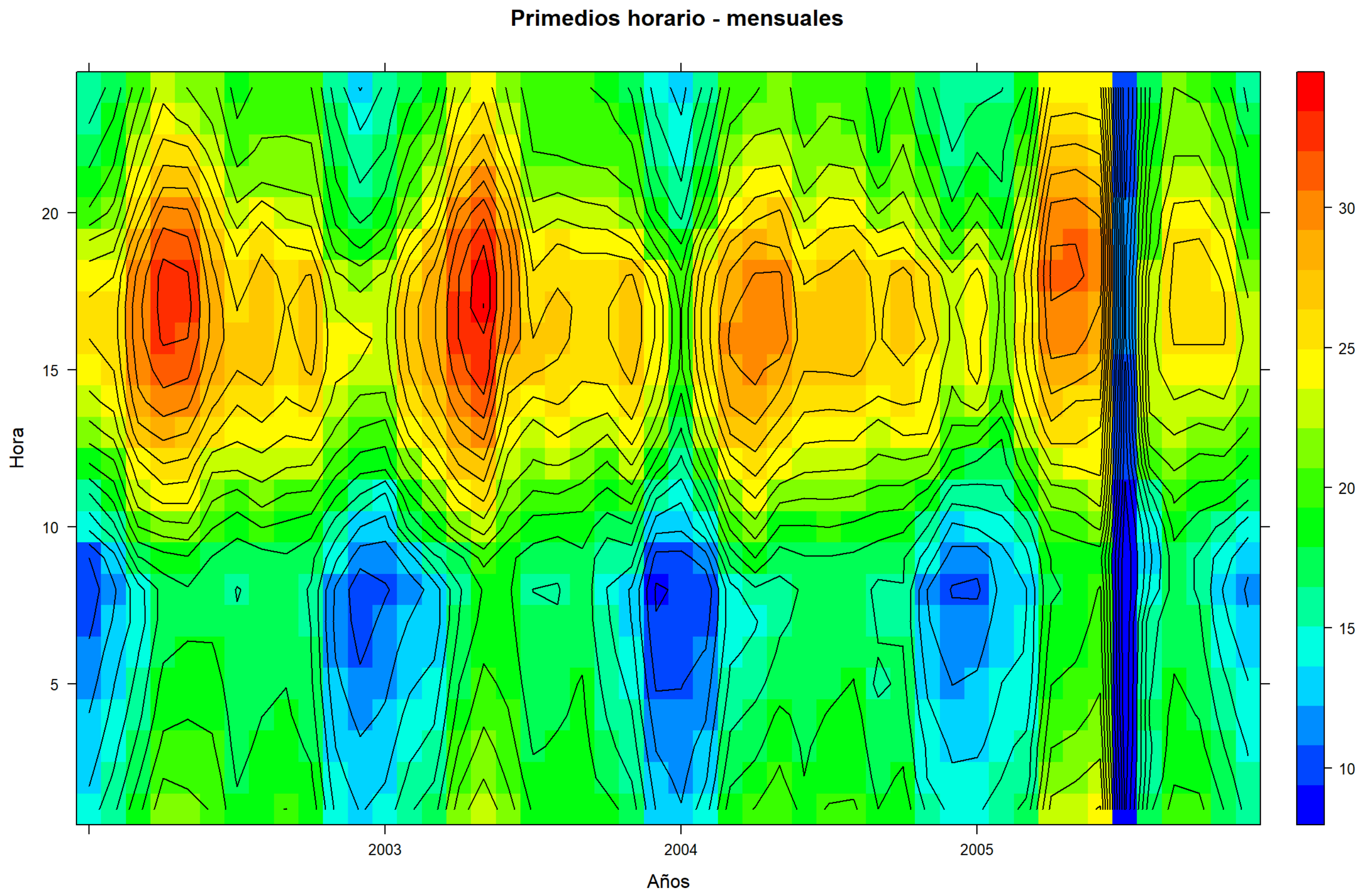
Método 2: funcion *levelplot*

Los mismos tres ejemplos que antes

```
datos_long1 <- datos_long[datos_long$AN_MES >= 2002 & datos_long$AN_MES < 2006,]
datos_long2 <- datos_long[datos_long$AN_MES >= 2006 & datos_long$AN_MES < 2010,]


dibujar2 <- function (dl) {
  ## función para visualizar datos
  ## dl - dataframe en formato largo

  ## calcular rango de colores a partir de datos
  rango_z <- c(min(dl$T, na.rm = TRUE),max(dl$T, na.rm = TRUE))
  ## opcionalmente se puede utilizar un rango fijo
  # rango_z <- c(5,45)

  levelplot(T ~  AN_MES * Hora_num, data = dl,
          cuts = 100, col.regions = col.l,
          region = TRUE, contour = TRUE,
          at = seq(from = rango_z[1], to = rango_z[2], length = col.divs),
          ylab = "Hora", xlab = "Años",
          main = "Primedios horario - mensuales")

}

dibujar2(datos_long)
```

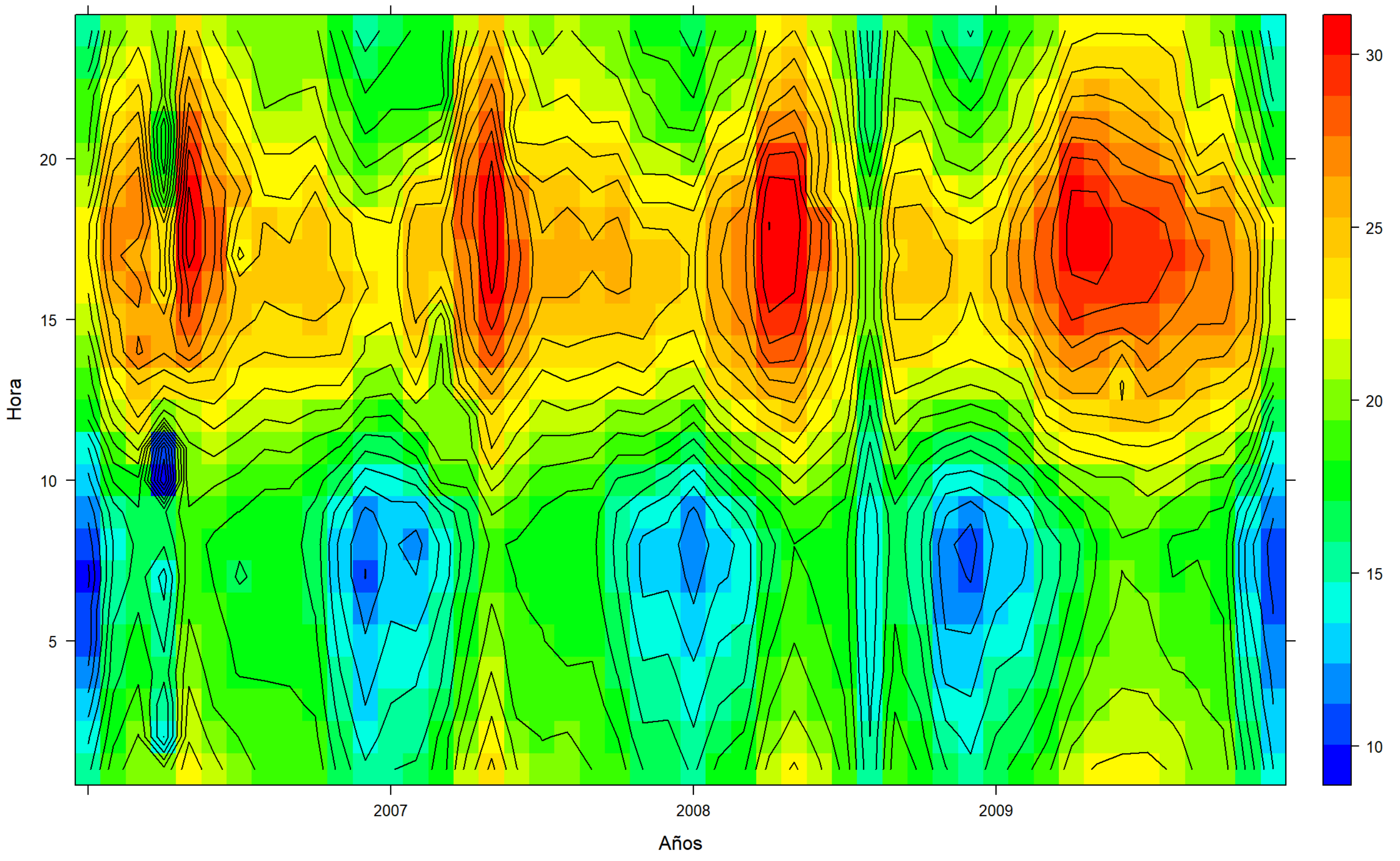


```
dibujar2(datos_long1)
```



```
dibujar2(datos_long2)
```

Primedios horario - mensuales


Hora
Años