Analyzing Temperature and Precipitation in Europe: January vs July

Thursday, November 2, 2017

Background:

Client needs a temperature and precipitation map of Europe for January and July. It must be based on the most recent NOAA long term means data from NOAA webpage, the v401 format.

Solution:

About the data:

- Monthly climatology of precipitation (monthly total in cm) and air temperature (monthly mean in degrees C)
- Taken at the surface
- Time series spanning 1900 to 2014
- .nc is a NetCDF file that's a format for creating and distributing arrays of gridded data (often used for climate data)

Load temperature data:

```
# install.packages("ncdf4")
library(ncdf4)
nc <- nc_open("air.mon.mean.v401.nc")

  # Using https://www.r-bloggers.com/a-netcdf-4-in-r-cheatsheet/
airtemp_alltime <- ncvar_get(nc, attributes(nc$var)$names[1])

dim(airtemp_alltime) # 720, 360, 1380
```

```
## [1]  720  360 1380
```

```
  # 1380 / 12 (months) = 115 (years of data)

# Use ncatt_get(nc, attributes(nc$var)$names[1]) to learn data attributes
```

Notes:

- Data is monthly mean of surface temperature
- Missing values will be -9.96921e+36
- Units are degC
- Valid range: -90 50
- Actual range: -79.3 43.9

Tidy temperature data:

```
library(tidyverse)
```

```
## Warning: package 'dplyr' was built under R version 3.4.2
```

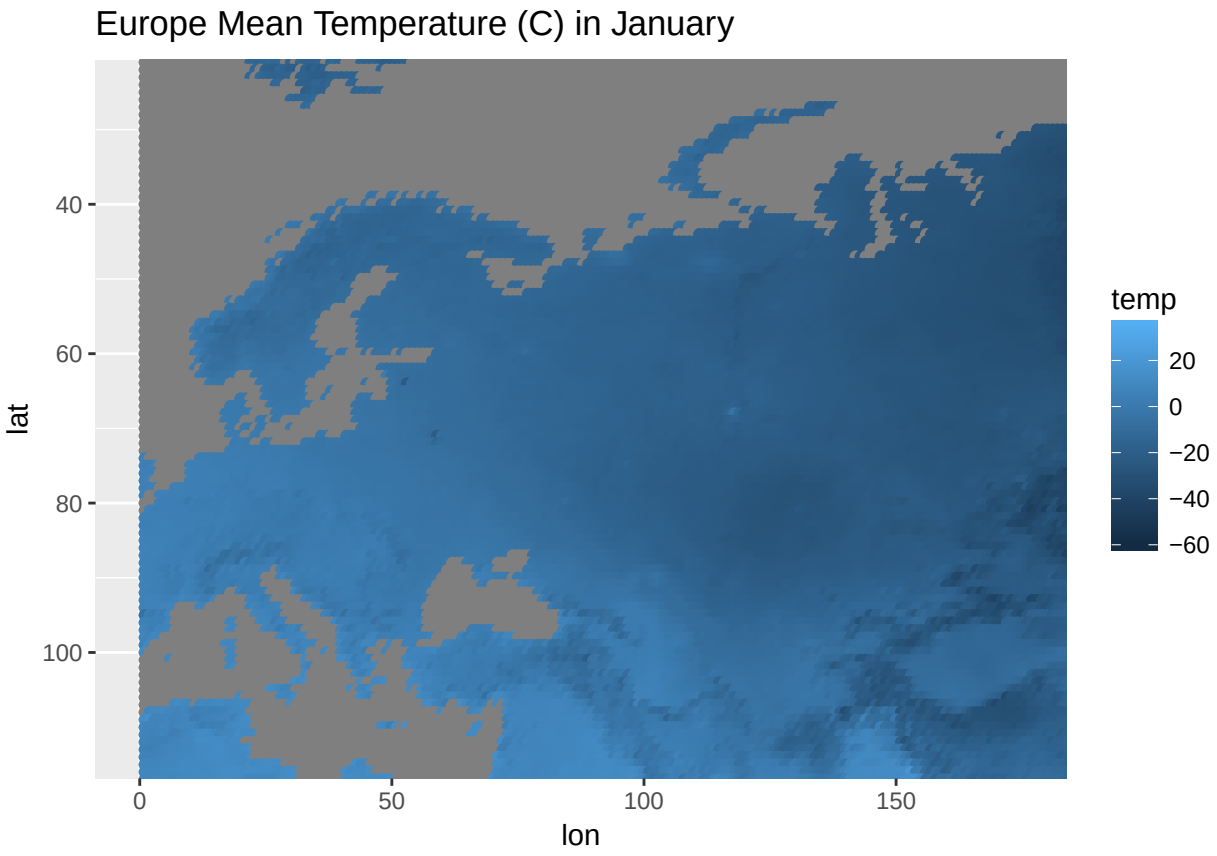
```r
# grabbed one year's air temperature data
airtemp_Jan <- (airtemp_alltime[,,1]) # January will be month 1
dim(airtemp_Jan)
```

```
## [1] 720 360
```

```r
  # 720, 360 which confirms this is one layer of data (January 1900)

# turns matrix into a df we can tidy
airtemp_df_Jan <- data.frame(airtemp_Jan)
colnames(airtemp_df_Jan) <- c(1:360)
lon_vals <- c(1:720)
airtemp_df_Jan$lon <- lon_vals

# tidy up data
airtemp_df_Jan <- gather(airtemp_df_Jan,"lat","temp",1:360)
airtemp_df_Jan$lat <- as.integer(airtemp_df_Jan$lat)
```

Plot data, Mean Temp in January:

```r
# install.packages('mapproj')
library(mapproj)

  # http://www.milanor.net/blog/maps-in-r-plotting-data-points-on-a-map/

ggplot() +
  geom_point(data = airtemp_df_Jan, aes(x=lon, y = lat, color=temp)) +
  coord_cartesian(xlim=c(0,175),ylim=c(25,112.5)) +
  scale_y_reverse() +
  ggtitle("Europe Mean Temperature (C) in January")
```

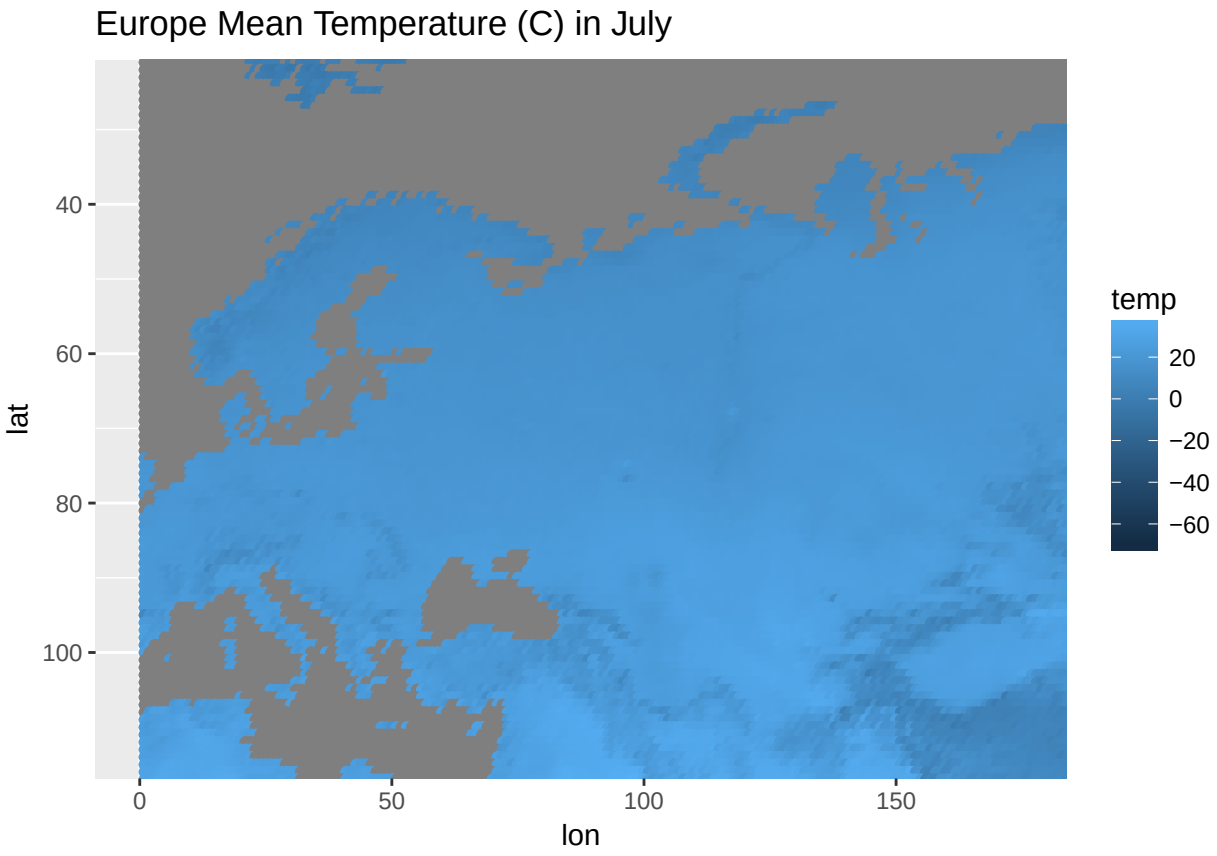


Repeat process, Temp for July:

```
airtemp_Jul <- (airtemp_alltime[,,7]) # July will be month 7
dim(airtemp_Jul)
```

```
## [1] 720 360
```

```
  # 720, 360 which confirms this is one layer of data (July 1900)

# turns matrix into a df we can tidy
airtemp_df_Jul <- data.frame(airtemp_Jul)
colnames(airtemp_df_Jul) <- c(1:360)
lon_vals <- c(1:720)
airtemp_df_Jul$lon <- lon_vals

# tidy up data
airtemp_df_Jul <- gather(airtemp_df_Jul,"lat","temp",1:360)
airtemp_df_Jul$lat <- as.integer(airtemp_df_Jul$lat)

ggplot() +
  geom_point(data = airtemp_df_Jul, aes(x=lon, y = lat, color=temp)) +
  coord_cartesian(xlim=c(0,175),ylim=c(25,112.5)) +
  scale_y_reverse() +
  ggtitle("Europe Mean Temperature (C) in July")
```



Repeat loading data, now for precipitation:

```
nc <- nc_open("precip.mon.total.v401.nc")
```

```
precip_alltime <- ncvar_get(nc, attributes(nc$var)$names[1])
```

```
dim(precip_alltime) # 720, 360, 1380 just like with air temperatures
```

```
## [1]  720  360 1380
```

```
  # 1380 / 12 (months) = 115 (years of data)
```

```
# Use ncatt_get(nc, attributes(nc$var)$names[1]) to learn data attributes
```

Notes:

- Data is monthly total of precipitation
- Missing values will be -9.96921e+36
- Units are cm
- Actual range: 0 776.75

Tidy precipitation data:

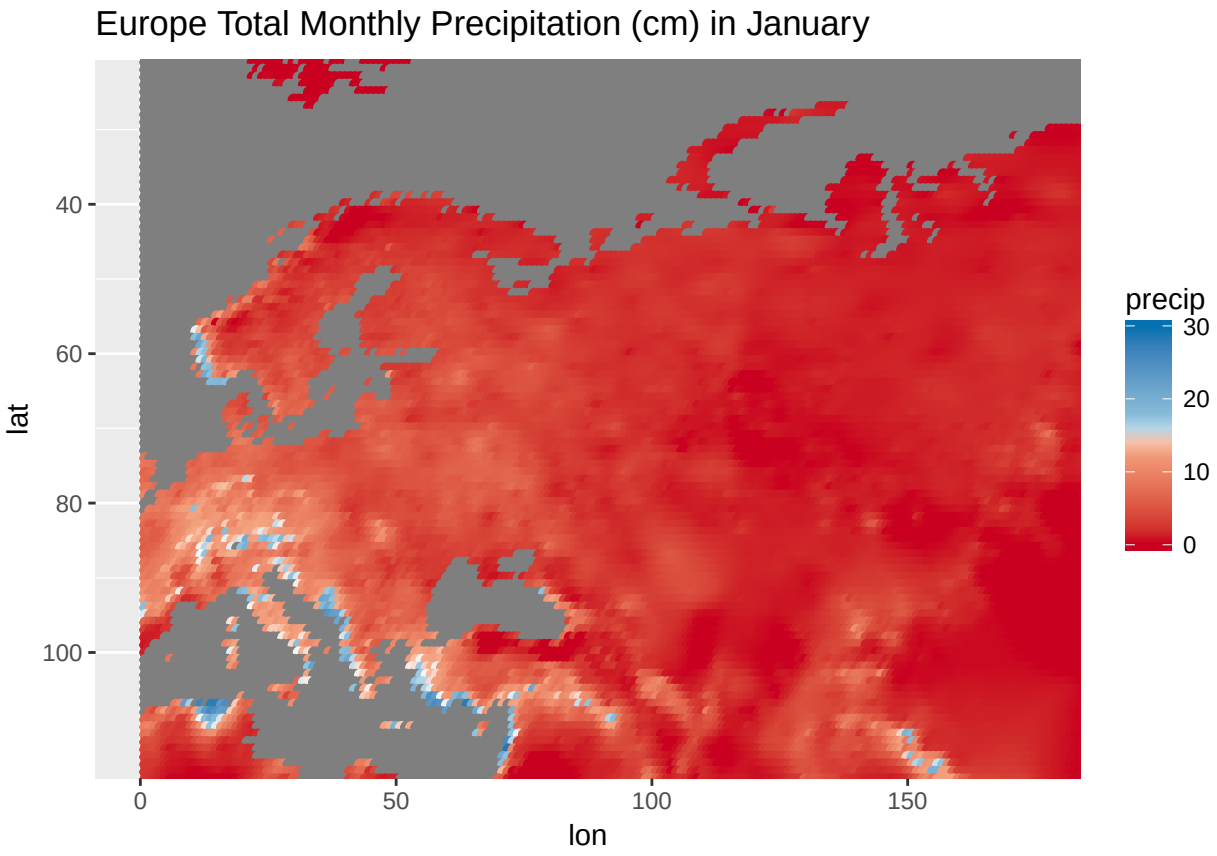
```
precip_Jan <- (precip_alltime[,,1]) # January will be month 1
dim(precip_Jan)
```

```
## [1] 720 360
```

```
  # 720, 360 which confirms this is one layer of data (January 1900)

# turns matrix into a df we can tidy
precip_df_Jan <- data.frame(precip_Jan)
colnames(precip_df_Jan) <- c(1:360)
lon_vals <- c(1:720)
precip_df_Jan$lon <- lon_vals

# tidy up data
precip_df_Jan <- gather(precip_df_Jan,"lat","precip",1:360)
precip_df_Jan$lat <- as.integer(precip_df_Jan$lat)
```

Plot data, Total Precip in January:

```
  # Download libraries to improve color options
library(RColorBrewer)
cols <- brewer.pal(n = 5, name = "RdBu")
library(scales)

ggplot() +
  geom_point(data = precip_df_Jan, aes(x=lon, y = lat, color=precip)) +
  coord_cartesian(xlim=c(0,175),ylim=c(25,112.5)) +
  scale_colour_gradientn(colours = cols,
                         values = rescale(c(-10, -1, 0, 1, 10)),
                         guide = "colorbar", limits=c(0, 30)) +
  scale_y_reverse() +
  ggtitle("Europe Total Monthly Precipitation (cm) in January")
```

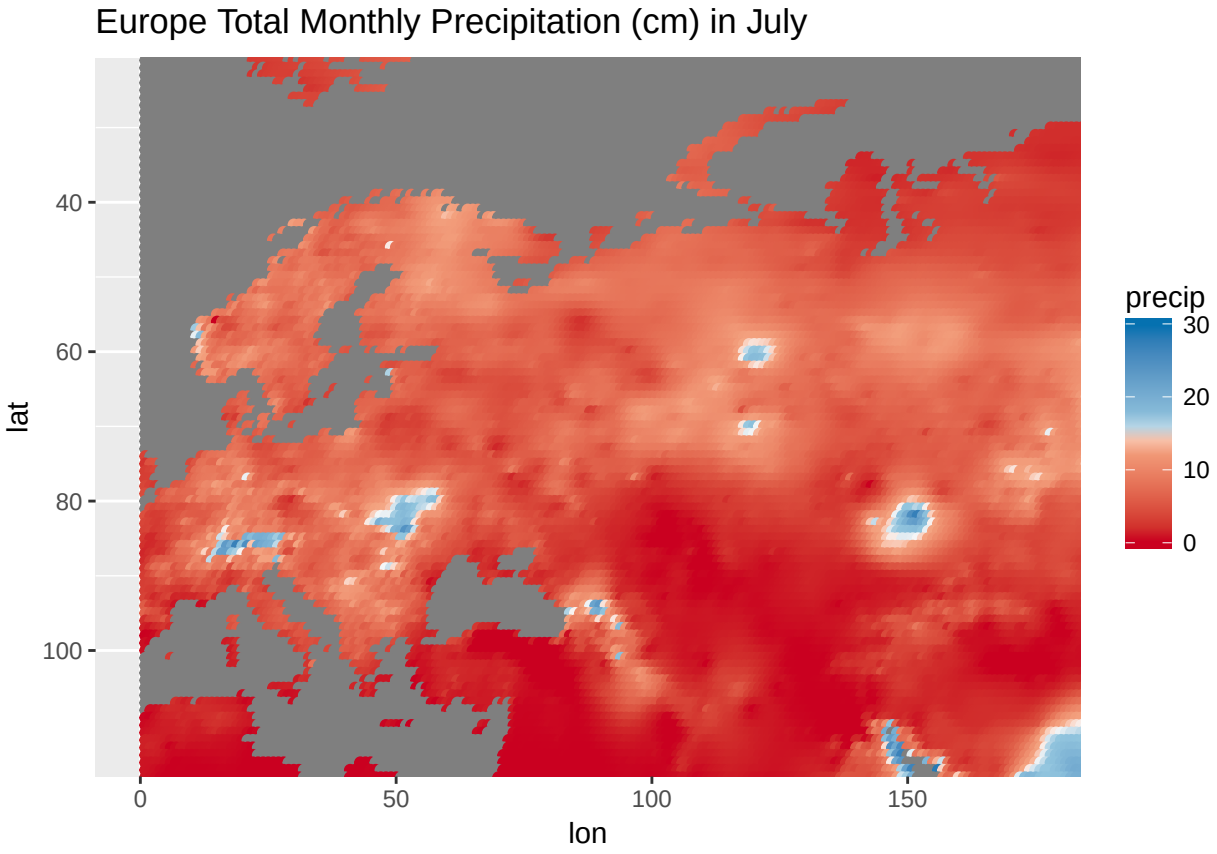


Repeat process, Precip for July:

```
precip_Jul <- (precip_alltime[,,7]) # July will be month 7
dim(precip_Jul)
```

```
## [1] 720 360
```

```
  # 720, 360 which confirms this is one layer of data (July 1900)

# turns matrix into a df we can tidy
precip_df_Jul <- data.frame(precip_Jul)
colnames(precip_df_Jul) <- c(1:360)
lon_vals <- c(1:720)
precip_df_Jul$lon <- lon_vals

# tidy up data
precip_df_Jul <- gather(precip_df_Jul,"lat","precip",1:360)
precip_df_Jul$lat <- as.integer(precip_df_Jul$lat)

ggplot() +
  geom_point(data = precip_df_Jul, aes(x=lon, y = lat, color=precip)) +
  coord_cartesian(xlim=c(0,175),ylim=c(25,112.5)) +
  scale_colour_gradientn(colours = cols,
                         values = rescale(c(-10, -1, 0, 1, 10)),
                         guide = "colorbar", limits=c(0, 30)) +
  scale_y_reverse() +
  ggtitle("Europe Total Monthly Precipitation (cm) in July")
```



Conclusion:

- Mean temperatures across Europe are generally higher (lighter in color) in July compared to January, which makes sense given the timing of the Northern Hemisphere summer
- Mountain regions are relatively cooler (darker) than their surroundings, which makes sense given temperature generally decreases with elevation
- Monthly total precipitation varies more than temperature across Europe: in some places it rains more in January/the winter time (e.g. Italy, Greek coasts, western edge of Norway) and in other places it rains more in July/the summer time (e.g. spots of Russia, Romania/Ukraine, most of Scandinavia)