map1

ANKWASA DOREEN

2025-12-14

```
library(terra)
```

```
## Warning: package 'terra' was built under R version 4.4.3
```

```
## terra 1.8.80
```

```
library(sf)
```

```
## Warning: package 'sf' was built under R version 4.4.3
```

```
## Linking to GEOS 3.13.0, GDAL 3.10.1, PROJ 9.5.1; sf_use_s2() is TRUE
```

```
library(ggplot2)
```

```
## Warning: package 'ggplot2' was built under R version 4.4.3
```

```
library(rnaturalearth)
```

```
## Warning: package 'rnaturalearth' was built under R version 4.4.3
```

```
library(dplyr)
```

```
## Warning: package 'dplyr' was built under R version 4.4.3
```

```
##
## Attaching package: 'dplyr'
```

```
## The following objects are masked from 'package:terra':
##
##     intersect, union
```

```
## The following objects are masked from 'package:stats':
##
##     filter, lag
```

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

```
climgrid <- rast("C:/Users/magara cliff/Downloads/nclimgrid_tavg.nc")
climgrid
```

```
## class       : SpatRaster
## size        : 596, 1385, 1571  (nrow, ncol, nlyr)
## resolution  : 0.04166666, 0.04166667  (x, y)
## extent      : -124.7083, -67, 24.5417, 49.37503  (xmin, xmax, ymin, ymax)
## coord. ref. : lon/lat WGS 84 (CRS84) (OGC:CRS84)
## source      : nclimgrid_tavg.nc
## varname     : tavg (Temperature, monthly average of daily averages)
## names       :      tavg_1,      tavg_2,      tavg_3,      tavg_4,      tavg_5,
## tavg_6,          ...
## unit        : degree_Celsius
## time (days) : 1895-01-01 to 2025-11-01 (1571 steps)
```

```
climgrid
```

```
## class       : SpatRaster
## size        : 596, 1385, 1571  (nrow, ncol, nlyr)
## resolution  : 0.04166666, 0.04166667  (x, y)
## extent      : -124.7083, -67, 24.5417, 49.37503  (xmin, xmax, ymin, ymax)
## coord. ref. : lon/lat WGS 84 (CRS84) (OGC:CRS84)
## source      : nclimgrid_tavg.nc
## varname     : tavg (Temperature, monthly average of daily averages)
## names       :      tavg_1,      tavg_2,      tavg_3,      tavg_4,      tavg_5,
## tavg_6,          ...
## unit        : degree_Celsius
## time (days) : 1895-01-01 to 2025-11-01 (1571 steps)
```

```
names(climgrid)[1:12]
```

```
##  [1] "tavg_1"  "tavg_2"  "tavg_3"  "tavg_4"  "tavg_5"  "tavg_6"  "tavg_7"
##  [8] "tavg_8"  "tavg_9"  "tavg_10" "tavg_11" "tavg_12"
```

Select the 30-Year Climatology Period (1991–2020)

```
time_vals <- time(climgrid)

years <- as.numeric(format(time_vals, "%Y"))

idx <- which(years >= 1991 & years <= 2020)

length(idx)
```

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

```
# 30-year mean temperature climatology
temp_clim <- mean(climgrid[[idx]], na.rm = TRUE)
```

```
## |---------|---------|---------|---------|=========================================
```

```
temp_clim
```

```
## class       : SpatRaster
## size        : 596, 1385, 1  (nrow, ncol, nlyr)
## resolution  : 0.04166666, 0.04166667  (x, y)
## extent      : -124.7083, -67, 24.5417, 49.37503  (xmin, xmax, ymin, ymax)
## coord. ref. : lon/lat WGS 84 (CRS84) (OGC:CRS84)
## source      : spat_71a473045c16_29092_o8up7yuDdJ6XHBX.tif
## name        :      mean
## min value   : -5.928448
## max value   : 25.881323
```

```
download.file(
  url = "https://www2.census.gov/geo/tiger/GENZ2020/shp/cb_2020_us_state_20m.zip",
  destfile = "cb_2020_us_state_20m.zip",
  mode = "wb"
)

unzip("cb_2020_us_state_20m.zip", exdir = "cb_2020_us_state_20m")
library(sf)

states <- st_read("cb_2020_us_state_20m/cb_2020_us_state_20m.shp")
```

```
## Reading layer `cb_2020_us_state_20m' from data source
##    `C:\Users\magara cliff\Documents\cb_2020_us_state_20m\cb_2020_us_state_20m.shp'
##    using driver `ESRI Shapefile'
## Simple feature collection with 52 features and 9 fields
## Geometry type: MULTIPOLYGON
## Dimension:     XY
## Bounding box:  xmin: -179.1743 ymin: 17.91377 xmax: 179.7739 ymax: 71.35256
## Geodetic CRS:  NAD83
```

```
california <- states[states$NAME == "California", ]

california
```

```
## Simple feature collection with 1 feature and 9 fields
## Geometry type: MULTIPOLYGON
## Dimension:     XY
## Bounding box:  xmin: -124.4096 ymin: 32.53416 xmax: -114.1391 ymax: 42.00925
## Geodetic CRS:  NAD83
##   STATEFP  STATENS    AFFGEOID GEOID STUSPS       NAME LSAD        ALAND
## 1      06 01779778 0400000US06    06     CA California   00 403671196038
##        AWATER                       geometry
## 1 20294133830 MULTIPOLYGON (((-118.594 33...
```

```
time_vals <- time(climgrid)
years <- as.numeric(format(time_vals, "%Y"))

idx <- which(years >= 1991 & years <= 2020)

temp_clim <- mean(climgrid[[idx]], na.rm = TRUE)
```

```
## |---------|---------|---------|---------|=======================================
```

```
states <- st_read("cb_2020_us_state_20m/cb_2020_us_state_20m.shp")
```

```
## Reading layer `cb_2020_us_state_20m' from data source
##   `C:\Users\magara cliff\Documents\cb_2020_us_state_20m\cb_2020_us_state_20m.shp'
##   using driver `ESRI Shapefile'
## Simple feature collection with 52 features and 9 fields
## Geometry type: MULTIPOLYGON
## Dimension:     XY
## Bounding box:  xmin: -179.1743 ymin: 17.91377 xmax: 179.7739 ymax: 71.35256
## Geodetic CRS:  NAD83
```

```
california <- states[states$NAME == "California", ]

temp_ca <- crop(temp_clim, vect(california))
temp_ca <- mask(temp_ca, vect(california))
```

```
## Warning: [mask] CRS do not match
```

```
temp_df <- as.data.frame(temp_ca, xy = TRUE, na.rm = TRUE)
```

```
names(temp_ca) <- "MeanTemp"
temp_df <- as.data.frame(temp_ca, xy = TRUE, na.rm = TRUE)

ggplot() +
  geom_raster(data = temp_df, aes(x = x, y = y, fill = MeanTemp)) +
  geom_sf(data = california, fill = NA, color = "black", linewidth = 0.6) +
  coord_sf() +
  scale_fill_viridis_c(name = "Mean Temperature (°C)", option = "C") +
  labs(
    title = "California Mean Temperature Climatology (1991–2020)",
    subtitle = "ClimGrid Monthly Average Temperature",
    x = "Longitude",
    y = "Latitude"
  ) +
  theme_minimal()
```

California Mean Temperature Climatology (1991–2020)
ClimGrid Monthly Average Temperature
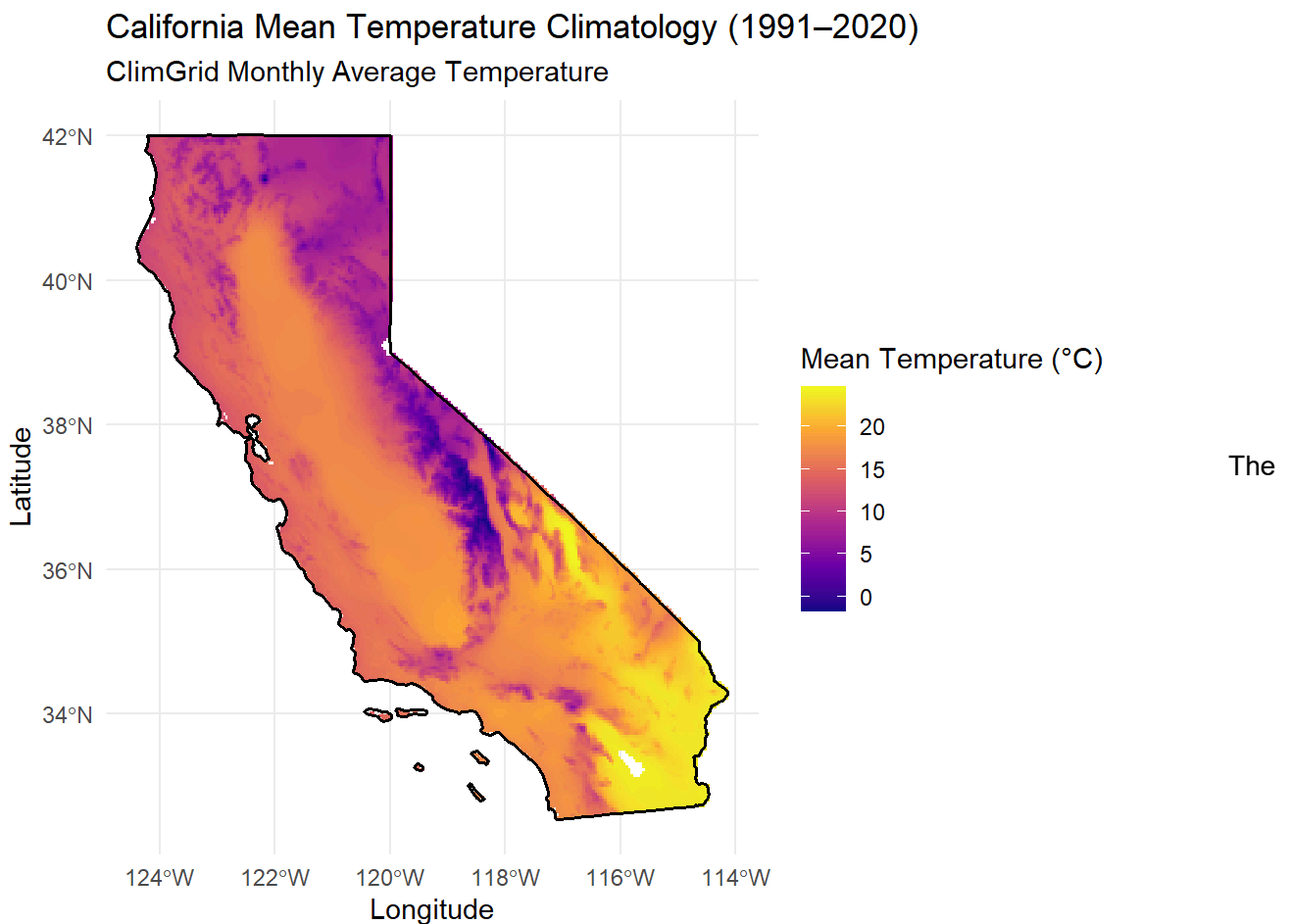
The color scale on the map shows the mean (average) temperature in degrees Celsius, calculated over 30 years (1991–2020).

Values range roughly from 0 °C (dark purple/blue) to around 20+ °C (yellow) depending on the location.Areas colored near 0 °C have an average monthly temperature close to freezing, typical of higher elevation mountainous or northern coastal zones in California during cooler months.

Areas near 20 °C experience much warmer average monthly temperatures, typical of low-elevation inland and southern parts of California.

Spatial Temperature Gradient and Climate Zones

The 0–20 °C range reflects natural climatic variability across California's diverse geography:

Coastal and mountainous regions are cooler on average (close to 0–10 °C in many places).

The Central Valley and southern inland regions are warmer, averaging 15–20 °C.

This gradient is important because:

It influences vegetation, agriculture, and ecosystems differently across the state.

Local temperature behavior, including seasonal variation and trends, will differ by location within this range.

SARIMA Modeling.

The SARIMA model analyzes time series at specific locations or aggregates of this spatial data.Knowing the mean temperature range helps interpret model outputs,For example, a forecasted seasonal peak of 23 °C in summer makes sense in warmer regions (Central Valley).Cooler regions will have lower absolute values but similar seasonal patterns.

The SARIMA model captures seasonal cycles and trends on top of these baseline means.

Since these are average temperatures, any upward drift (warming trend) modeled by SARIMA will shift these baseline values gradually higher.

For instance, if a region averages 15 °C now, a positive trend means future mean temps could rise toward 16–17 °C or more, affecting climate impact assessments.

Decision-Making and Planning.

Understanding this baseline range helps stakeholders to know Where heat stress or cold risk is more likely.

How seasonal forecasting can help prepare for temperature extremes relative to these means.

Which regions might experience greater climate change impacts based on their current mean temperatures.

This temperature forecasting study using SARIMA models and ClimGrid data holds critical importance for a diverse range of stakeholders across California. State and local government agencies—including the California Air Resources Board, Department of Water Resources, and energy commissions—rely on accurate seasonal and long-term forecasts to inform climate policy, water resource management, and energy planning. The agricultural sector, especially farmers and specialty crop growers, uses these forecasts for crop scheduling and risk mitigation. Public health authorities employ temperature predictions to prepare for heat-related illnesses and other climate-sensitive health issues. Water management bodies and environmental organizations depend on temperature trends to protect ecosystems and manage water quality. Additionally, utility providers and emergency services incorporate climate forecasts into operational planning for energy demand and disaster response. Urban planners and infrastructure developers utilize these insights to design resilient communities amid changing climate conditions. Finally, researchers and academics benefit from improved modeling approaches to advance understanding of climate dynamics. Together,These stakeholders depend on accurate seasonal and long-term temperature forecasts to plan resource allocation, protect vulnerable populations, adapt infrastructure, and mitigate risks linked to climate variability and change in california.