Almond Model

Almond Group F

4/10/2022

Packages

```
# Load packages
library(tidyverse)
```

```
## Warning: package 'tidyverse' was built under R version 4.1.2

## -- Attaching packages --------------------------------------- tidyverse 1.3.1 --

## v ggplot2 3.3.5     v purrr   0.3.4
## v tibble  3.1.6     v dplyr   1.0.7
## v tidyr   1.1.4     v stringr 1.4.0
## v readr   2.0.0     v forcats 0.5.1

## Warning: package 'tibble' was built under R version 4.1.2

## Warning: package 'tidyr' was built under R version 4.1.2

## -- Conflicts ------------------------------------------ tidyverse_conflicts() --
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()    masks stats::lag()
```

```
library(here)
```

```
## here() starts at C:/Users/rmunn/OneDrive/MEDS/EDS_241/Assignment_2/eds230_almond_yield_model
```

```
# Read in climate data (data hosted here: https://github.com/naomitague/ESM232_Examples/tree/main/Data)
data <- read.table(file = here("data", "clim.txt"), sep = "")

# Calculate total precipitation and minimum temperature per month per year (1988 to 2010)
data_annual <- data %>%
  group_by(month, year) %>%
  summarize(total_precip = sum(precip), min_temp = mean(tmin_c))
```

```
## `summarise()` has grouped output by 'month'. You can override using the `.groups` argument.
```

```r
#Filter for February and January months, consistent with Lobell paper.
data_feb <- data_annual %>% filter(month == 2)
data_jan <- data_annual %>% filter(month == 1)
```

Code your function in R; save it as a separate file called "the name of your function".R; Make sure you include documentation Store your R function in a git repository - you will need it again for future assignment

```r
# Model parameters representing yield anomalies (ton acre^-1)
# temp_param_1 & temp_param_2 denoting February minimum temperature from the year prior to harvest
# precip_param_1 & precip_param_2 denoting January precipitation variables
almond_model <- function(monthly_temp, monthly_precip, temp_param_1 = -0.015, temp_param_2 = -0.0046, p

# Model function to find yield anomalies per month per year
yield_anomaly <- (temp_param_1*monthly_temp + temp_param_2*monthly_temp^2 + precip_param_1*monthly_prec

return(yield_anomaly)
}
```

```r
# Creates a new dataframe of each year from 1988 to 2010
year_anom <- data.frame("year" = unique(data_annual$year)) %>% mutate(anomaly = NA)

# For loop appending year_anom with yearly anomalies calculated using "yield anomaly" function
for (i in 1:length(year_anom$year)) {
  # Calculates an anomaly variable using minimum February temps and total January precipitation rates p
  anom <- almond_model(monthly_temp = data_feb$min_temp[i], monthly_precip = data_jan$total_precip[i])
  #Appends results to dataframe.
  year_anom$anomaly[i] <- anom
}

yield_anom <- year_anom %>% drop_na()
```

```r
check <- yield_anom %>% filter(year >= 2000 & year <= 2002)
check
```

```
##   year     anomaly
## 1 2000   9.5999883
## 2 2001 159.5119587
## 3 2002   0.2450914
```

```r
ggplot(data = yield_anom, aes(x = year, y = anomaly, fill = anomaly)) +
  geom_col() +
  theme_minimal() +
  labs(title = "Figure 1. Historical California Almond Yield Anomalies (1988-2010)",
       x = "Year",
       y = "Yield Anomaly (tons/acre)",
       caption = "Figure 1. depicts historical anomalies (tons/acre) of almond production in California
  theme(legend.position="none")
```

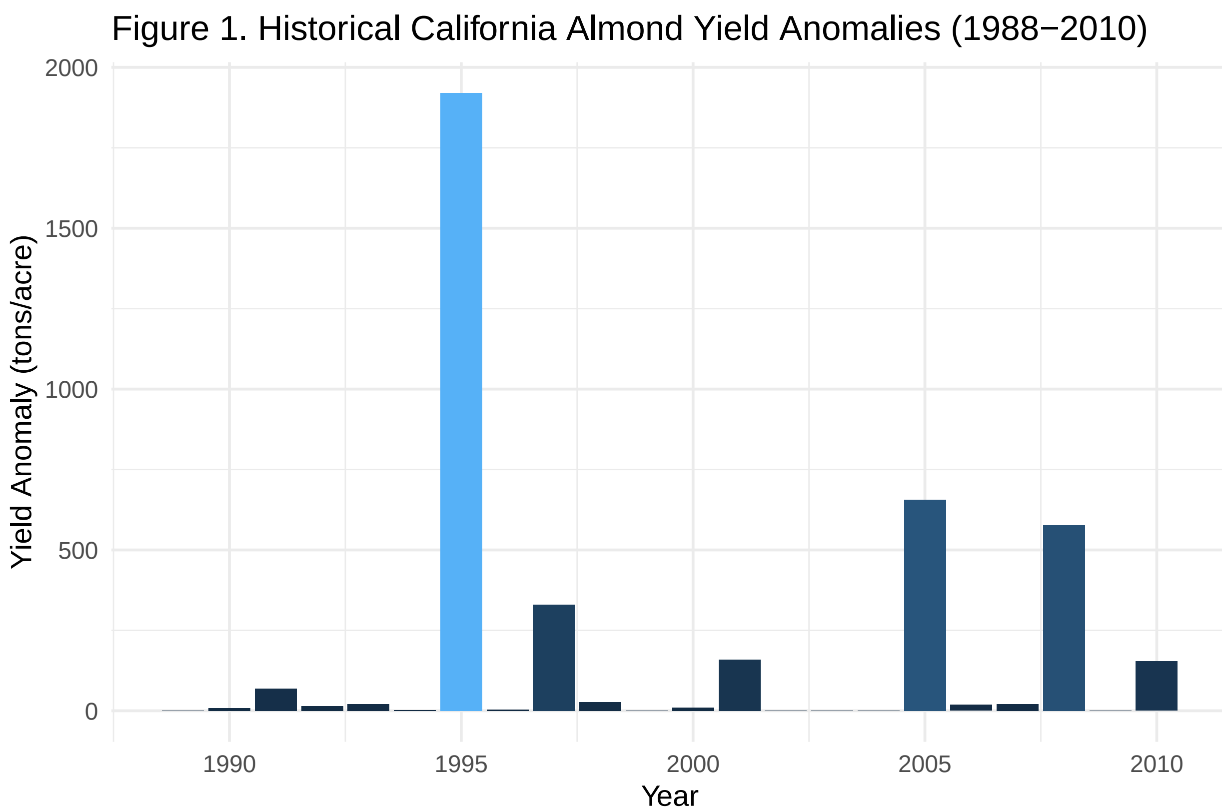


Figure 1. depicts historical anomalies (tons/acre) of almond production in California from 1988 to 2010.

```
ggplot(data = data_jan, aes(x = year, y = total_precip, fill = total_precip)) +
  geom_col() +
  scale_fill_continuous(low="red", high="blue") +
  theme_minimal() +
  labs(title = "Figure 2. Historical California January Precipitation Rates (1988-2010)",
       x = "Year",
       y = "Total Janurary Rain (mm)",
       caption = "Figure 2. depicts historical January precipitation rates (mm) in California from 1988
  theme(legend.position="none")
```

Figure 2. Historical California January Precipitation Rates (1988−2010)

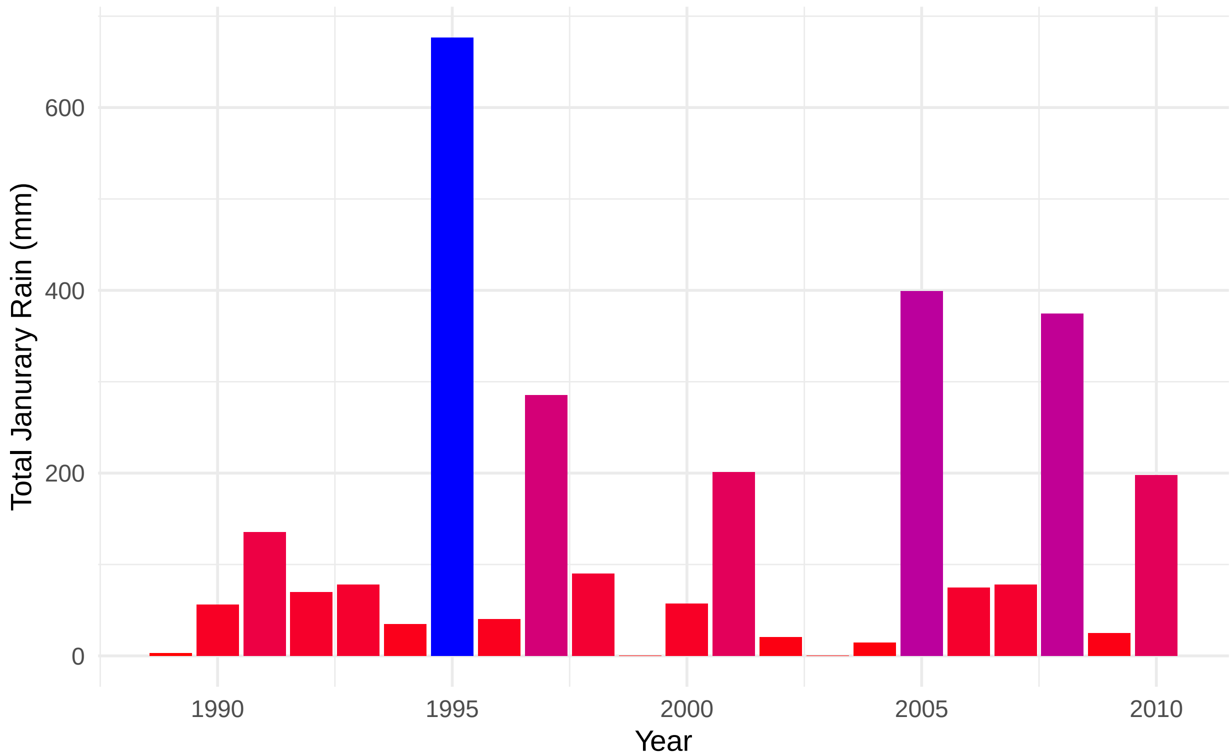
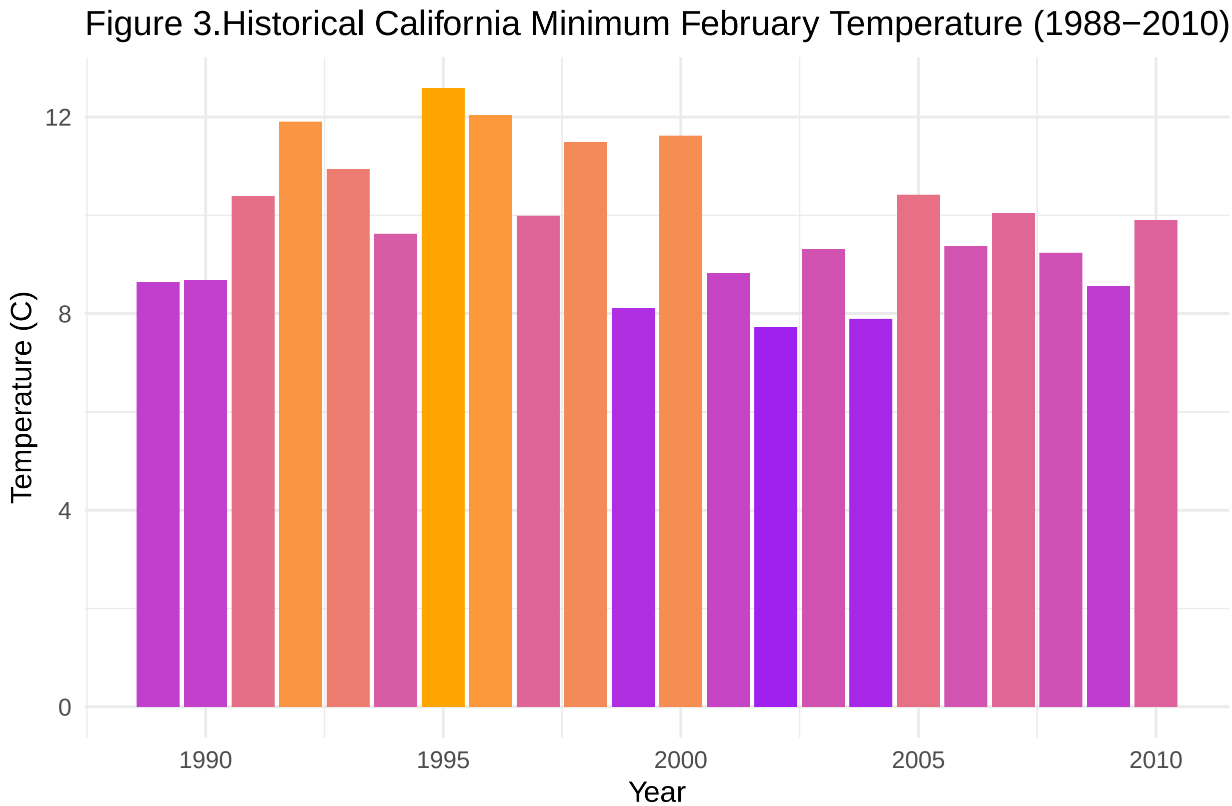


Figure 2. depicts historical January precipitation rates (mm) in California from 1988 to 2010.

```
ggplot(data = data_feb, aes(x = year, y = min_temp, fill = min_temp)) +
  geom_col() +
  scale_fill_continuous(low="purple", high="orange") +
  theme_minimal() +
  labs(title = "Figure 3.Historical California Minimum February Temperature (1988-2010)",
       x = "Year",
       y = "Temperature (C)",
      caption = "Figure 3. depicts historical minimum February temperatures (C) in California almond gr
  theme(legend.position="none")
```



ure 3. depicts historical minimum February temperatures (C) in California almond growing regions from 1988 to 2010.

Summary

Our group estimated yield anomalies were fairly consistent with the provided answers of 2000: 9.59, 2001: 159.51, and 2002: 0.24. Our calculated values for the same years were 2000: 9.60, 2001:159.51, and 2002:0.25, overestimating 2000 and 2002 by only 0.01. These overestimations were likely the product of rounding errors in our calculations.

When observing the almond yield anomalies in Figure 1, we see that 1995 had the largest anomaly for almond yields, followed by 2005 and 2008. These historic anomalies are consistent with January precipitation rates, as seen in Figure 2, with the highest rainfall amounts in 1995, 2005, and 2008. While 1995 also had the highest minimum February temperature, 2005 and 2008 were not the second and third highest minimum temperature (Figure 3). These trends suggest that almond yield production is more closely tied to the amount of precipitation rather than minimum temperature.