Almond Yield Anomaly: Function & Analysis

Pat Byrne, Hannah Garcia, and Yani Pohl

4/7/2021

```
# Install packages
library(tidyverse)
library(lubridate)
library(patchwork)
library(kableExtra)
library(tinytex)
```

Read in climate data and run yield_anomaly function

```
# Read in data frame & convert date column (D) to a date
clim.df <- read.table('clim_edited.txt',header = TRUE) %>%
  mutate(
    D = as.Date(D)
  )

# Read in yield_anomaly.R function
source("yield_anomaly.R")

# Run the function with clim.df using years 2000-2002
test.func <- yield_anomaly(input.dataframe = clim.df, years.calc = c(2000,2001,2002))
test.func[1,]
```

```
## [1] 2000.000000    9.599988
```

```
test.func[2,]
```

```
## [1] 2001.000  159.512
```

```
test.func[3,]
```

```
## [1] 2002.0000000    0.2450914
```

Summarize the results

```r
# Calculate almond yield anomaly for 1988-2010

almond.func <- yield_anomaly(input.dataframe = clim.df, years.calc = c(1989:2010))

# make a df of the almond yield anomaly for each year
almond.df = tibble(year = almond.func[,1], anomaly= almond.func[,2])

# Create data frames to summarize mean temp for January and mean precip for February for each year

temp.df <- clim.df %>%
  filter(month == 1) %>%
  group_by(year) %>%
  summarise(temp = mean(tmin_c))

precip.df <- clim.df %>%
  filter(month == 2) %>%
  group_by(year) %>%
  summarise(precip = sum(precip))

# Graph anomaly, temp, and precip using 'patchwork'

anomaly.plot <- ggplot(almond.df, aes(x = year, y = anomaly)) +
  geom_line(color = "darkgreen") +
  geom_point(color = "darkgreen") +
  labs(title = "Almond Yield Anomaly (ton/acre)")

temp.plot <- ggplot(data = temp.df, aes(x = year, y = temp)) +
  geom_line(color = "red") +
  geom_point(color = "red") +
  labs(title = "Average January Temperature (C)")

precip.plot <- ggplot(precip.df, aes(x = year, y = precip)) +
  geom_line(color = "blue") +
  geom_point(color = "blue") +
  labs(title = "Total February Precipitation (mm)")

(temp.plot|precip.plot)/anomaly.plot
```

```r
# Merge dataframes

almond_temp <- inner_join(almond.df, temp.df, by="year")
total <- inner_join(almond_temp, precip.df, by="year")

# create table
table  <- total %>%
  kable(col.names = c("Year",
                "Yield Anomaly (ton/acre)",
                "Average Minimum Temperature (C)",
                "Total Precipitation (mm)")) %>%
  kable_styling(bootstrap_options = "bordered",
                full_width = F,
                position = "left")
```

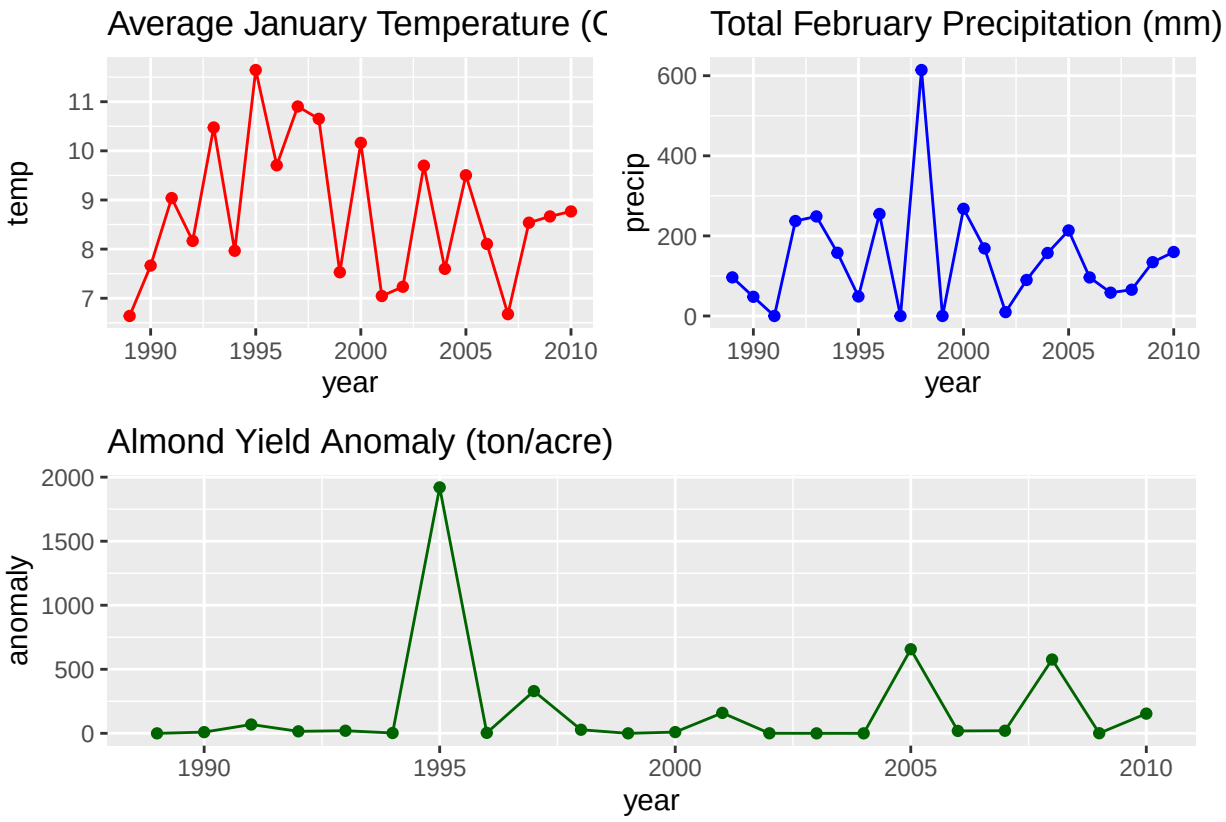

Figure 1: Almond yield anomaly (ton/acre), average minimum January temperature (C), and total February precipitation (mm) for years 1989 to 2010. The almond yield anomaly is the difference from the 1983-2003 average yield.

```
table
```

Year	Yield Anomaly (ton/acre)	Average Minimum Temperature (C)	Total Precipitation (mm)
1989	-0.3552237	6.639247	96.370
1990	9.2906757	7.664803	47.891
1991	68.9130633	9.038996	0.000
1992	15.4280698	8.167401	237.164
1993	20.2083803	10.475538	248.615
1994	2.4820009	7.966362	157.845
1995	1919.9811511	11.644875	48.716
1996	3.5818399	9.705735	254.764
1997	329.6938750	10.903064	0.000
1998	27.8636956	10.651129	614.250
1999	-0.1436364	7.528656	0.000
2000	9.5999883	10.162527	267.701
2001	159.5119587	7.045143	168.755
2002	0.2450914	7.233459	9.631
2003	-0.2585997	9.698100	89.916
2004	-0.2367722	7.598638	157.226
2005	656.3724121	9.503423	213.614
2006	18.6324135	8.105054	96.266
2007	20.2007396	6.676147	58.166
2008	576.2821943	8.538037	65.532
2009	0.7367438	8.665278	134.366
2010	153.7655092	8.767070	159.766

Table 1. Almond yield anomaly (ton/acre), average minimum January temperature (C), and total February precipitation (mm) for years 1989 to 2010. The almond yield anomaly is the difference from the 1983-2003 average yield.

```
# calculate average temperature & precip of all years
# mean(total$temp) = 8.7
# mean(total$precip) = 142.1161
```

Write one paragraph summarizing your findings

There were 3 years that had noticeably higher almond years than the 1983-2003 average: 1995, 2005, and 2008. The average minimum January temperature for these years were 11.6 C, 9.5 C, and 8.5 C, respectively. The average minimum January temperature for all years was approximately 8.7 C; years 1995 and 2005 had higher than average temperatures, which could potentially be contributing to their higher almond yields. Regarding precipitation, years 1995 and 2008 had fairly low totals. In 2005, precipitation totals were 213 mm, greater than the average total precipitation of years 1989-2010, which averaged approximately 142 mm.

On the other hand, the years with the lowest almond yield anomalies were: 1989, 1999, 2003, and 2004. These years had yields that were lower than the 1983-2008 average. From these low yield years, all years except 2003 had average temperatures that were lower than the 8.7 average. Interestingly, years with low almond yields did not have significantly less precipitation than years with high yields, besides 1999, which had 0 mm of February precipitation.

Overall, there is not a clear trend of how the average January minimum temperature and total February precipitation affects almond yield anomalies. There may be more information that is needed to draw definite conclusions. For example, there could have been agricultural pests that decimated crops or issues with pollinator activity. However, our function, 'yield_anomaly.R' can be used by almond farmers to predict their almond yield based on minimum temperature and total rainfall parameters.