Fire Project

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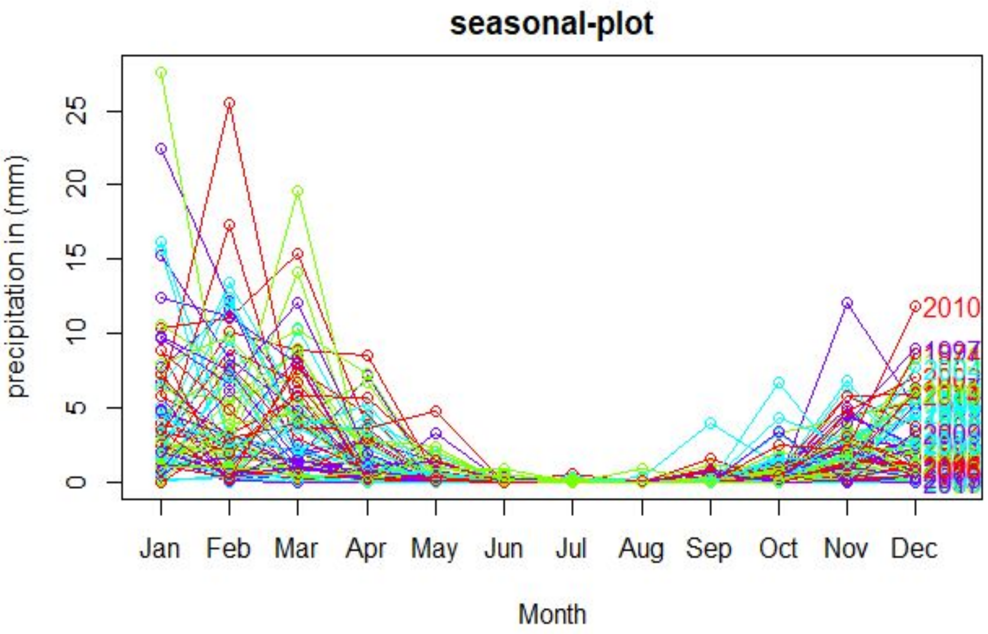
Introduction

The recent tragic examples of the Thomas and Camp fires underscore the importance of understanding the relationships among climate, extreme fire-weather, fire ignitions by electric power lines and vegetation management.

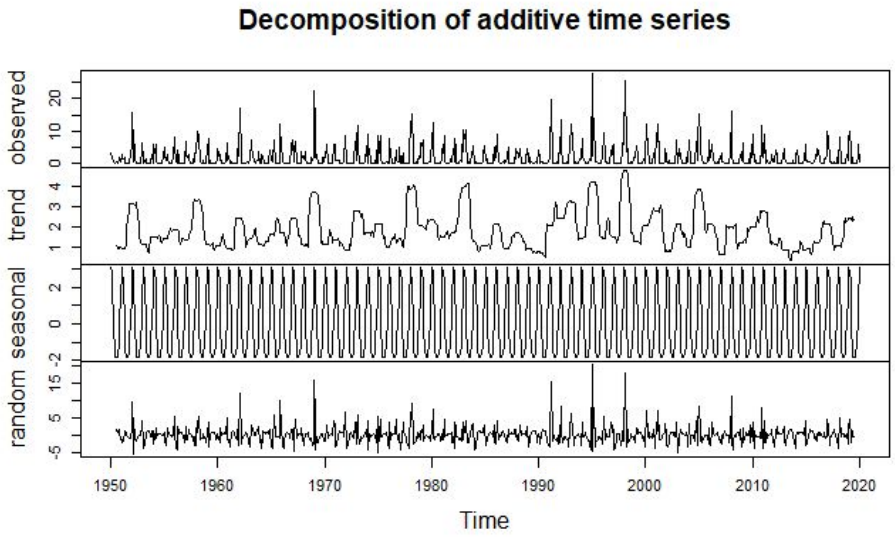
We will test whether trends in fire-weather can be attributed to climate change by quantifying whether observed recent historical trends are statistically different from similar trends that can arise from natural variability in the climate system.

Grid point analysis

I picked up a grid point from Prism climate data to process with time series analysis. The decomposed seasonal data indicates that the precipitation value drops to near zero during summer time. And it peaks during first three months.

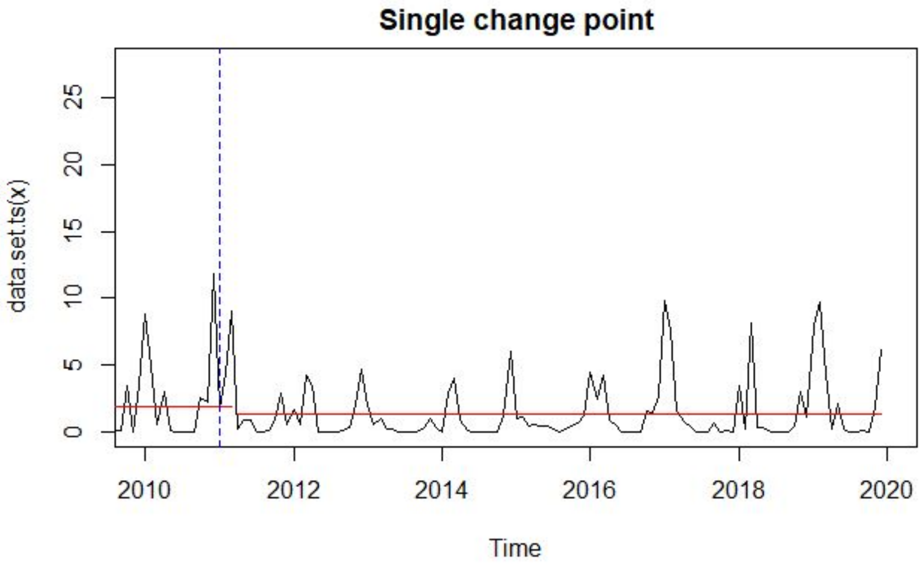


The decomposition plot provides a clear seasonality here. However, the trend does not have monotonic or seasonal pattern.



Change of points analysis

By applying a single change point analysis, From the R output, the most important change occurs between 2011 and 2012.

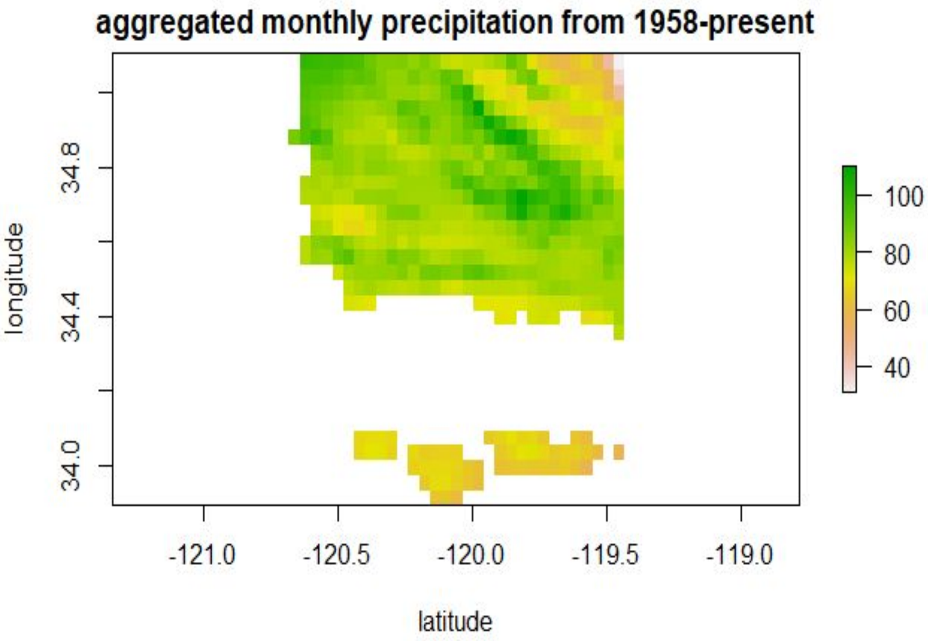


Realizing a single grid cannot be representative, we then work on terra climate which provides the precipitation data across the county. I Retrieve Santa Barbara county geographical information with rspatial package. Graph the raster plot on California state map.

Explore monthly precipitation data of NCDF data from Terraclimate (1958-2020). The data was obtained on Lat/lon subset Coordinate subset Bounding box, in decimal degrees (33.89571,35.11464, -119.4404,-120.6708).

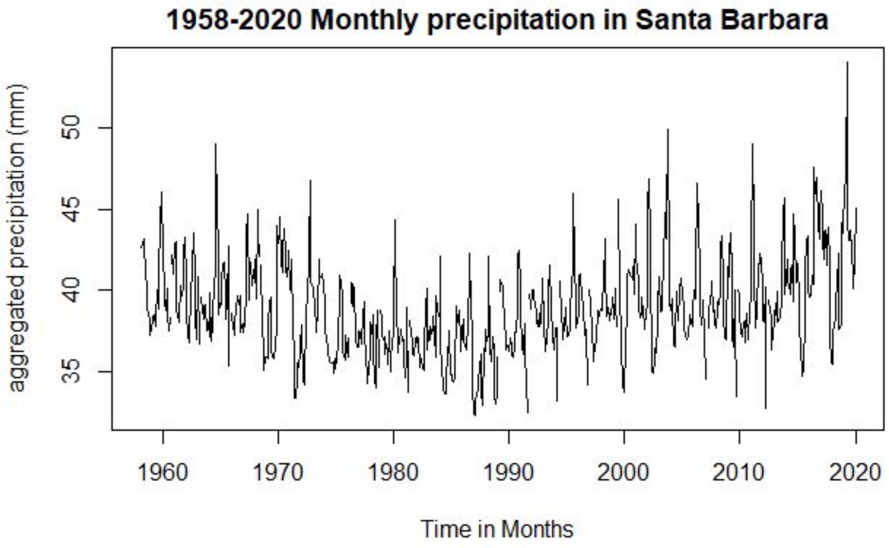
The 3-D dimensional data contains 30 latitudes, 31 longitudes and 744 time points.

Plot the aggregated monthly precipitation (mm) across Santa Barbara on a raster map.



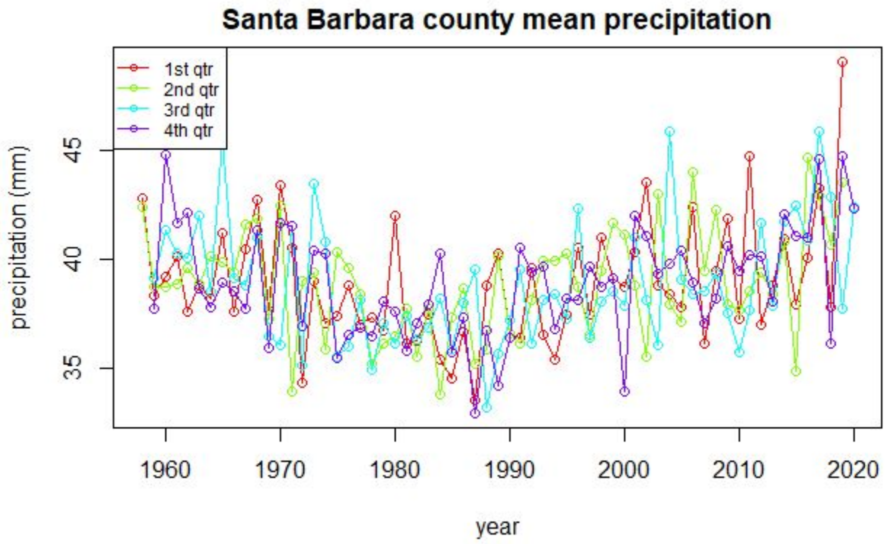
To make a visible 2-D dataframe, I combined the precipitation values across the coordinates by time, and then took the average precipitation values as monthly mean over 62 years.

Time <date>	a_mean <dbl>
1961-05-01	38.39247
1961-06-01	40.10394
1961-07-01	40.28674
1961-08-01	39.60753
1961-09-01	40.20789
1961-10-01	42.39785
1961-11-01	43.21505
1961-12-01	40.65233
1962-01-01	38.63262
1962-02-01	37.21102



Seasonal data

The seasonal group enables us to have a clear look at the precipitation change of each season. By applying dplyr in R, I made quarterly mean precipitation graphs. To deal with missing values, I tried linear interpolation. However, the precipitation values may be highly variable, and finally we just discarded missing values.



Spearman’s rho

A nonparametric test spearman's rho is used to check to see if the mean is changing over time for each time series point. The null hypothesis H0 indicates no trend over time; the alternate hypothesis Ha is that a trend exists and that data increase or decrease with time. A spearman rho value could indicate a positive relation, a negative relation and no relation. The precipitation values and time were unlisted first, the plugged in for spearman’s rho correlation test.

According to the test results, p-values are greater than 0.05 level, and therefore we fail to reject the null hypothesis. For all four seasons, the trend does not clearly exist.

```
        Spearman's rank correlation rho

data:  prep1 and time1
S = 35302, p-value = 0.3893
alternative hypothesis: true rho is not equal to 0
sample estimates:
      rho
0.1110272
        Spearman's rank correlation rho

data:  prep2 and time2
S = 35030, p-value = 0.3606
alternative hypothesis: true rho is not equal to 0
sample estimates:
      rho
0.1178767
        Spearman's rank correlation rho

data:  prep3 and time3
S = 35440, p-value = 0.4044
alternative hypothesis: true rho is not equal to 0
sample estimates:
      rho
0.1075521
        Spearman's rank correlation rho

data:  prep4 and time4
S = 31777, p-value = 0.1195
alternative hypothesis: true rho is not equal to 0
sample estimates:
      rho
0.1997985
```

Kolmogorov-Smirnov test

The Kolmogorov–Smirnov test is a nonparametric test of the equality of continuous one-dimensional probability distributions that can be used to compare a sample with a reference probability distribution. In this case, I compared precipitation with individual time. The null hypothesis H0 is sample is drawn from the reference distribution. The alternative hypothesis is that the sample is not drawn from the reference distribution.

According to R outputs, the p-value are all very small, therefore we reject the null hypothesis and conclude that the two distributions are different.

```
        Two-sample Kolmogorov-Smirnov test

data:  prep1 and time1
D = 0.79032, p-value = 2.22e-16
alternative hypothesis: two-sided
```

```
        Two-sample Kolmogorov-Smirnov test

data:  prep2 and time2
D = 0.80645, p-value = 2.22e-16
alternative hypothesis: two-sided
```

```
        Two-sample Kolmogorov-Smirnov test

data:  prep3 and time3
D = 0.80645, p-value = 2.22e-16
alternative hypothesis: two-sided
```

```
        Two-sample Kolmogorov-Smirnov test

data:  prep4 and time4
D = 0.80645, p-value < 2.2e-16
alternative hypothesis: two-sided
```

Mann-Whitney Test

To look into the data, I tried non-parametric test like Mann-Whitney test for location shifts. To explore a stream data, I used CPM package with Mann-Whitney Statistics.

According to the output, for all four quarters, the first potential change of mean precipitation occurred around 1971-1975 and the second potential change occurred 1993-1995. That means after 1971-01-01 the mean precipitation value might have declined and after 1995-01-01 it started to increase.