NORTHERN CALIFORNIA WEATHER

5/15/2017

Temperature and precipitation in the San Francisco Bay Area and California Delta

Temperature and precipitation data for the San Francisco Bay Area and California Delta are visualized, analyzed and interpreted

Northern California weather

TEMPERATURE AND PRECIPITATION IN THE SAN FRANCISCO BAY AREA AND CALIFORNIA DELTA

INTRODUCTION

This report analyzes temperature and precipitation data for a rectangular area of Northern California that is bounded by the latitudes 37.4833 and 38.2103, and the longitudes -123.0000 and -120.8667. The left half of the rectangle encloses San Francisco and most of the Bay Area. The right half of the rectangle extends into the San Joaquin valley and encloses the cities of Stockton and Modesto. The upper half of the rectangle encloses the Sacramento-San Joaquin River Delta. According to Wikipedia, "The Sacramento–San Joaquin River Delta, or California Delta, is an expansive inland river delta and estuary in Northern California. The Delta is formed at the western edge of the Central Valley by the confluence of the Sacramento and San Joaquin rivers and lies just east of where the rivers enter Suisun Bay." Figure 1 shows the location of this area on a map.

The data come from the National Oceanic and Atmospheric Administration (NOAA: https://www.ncdc.noaa.gov/) and were downloaded from this FTP site: ftp://ftp.ncdc.noaa.gov/pub/data/ghcn/daily/.

Five measurements are analyzed:

- PRCP = Precipitation (mm)
- SNOW = Snowfall (mm)
- SNWD = Snow depth (mm)
- TMAX = Maximum temperature (tenths of degrees C)
- TMIN = Minimum temperature (tenths of degrees C)

Temperature at the time of observation (TOBS) is a measurement that was initially analyzed but was later discarded owing to the inconsistency in its collection methodology. Snow is extremely rare is this region so snowfall and snow depth data were also subsequently discarded.

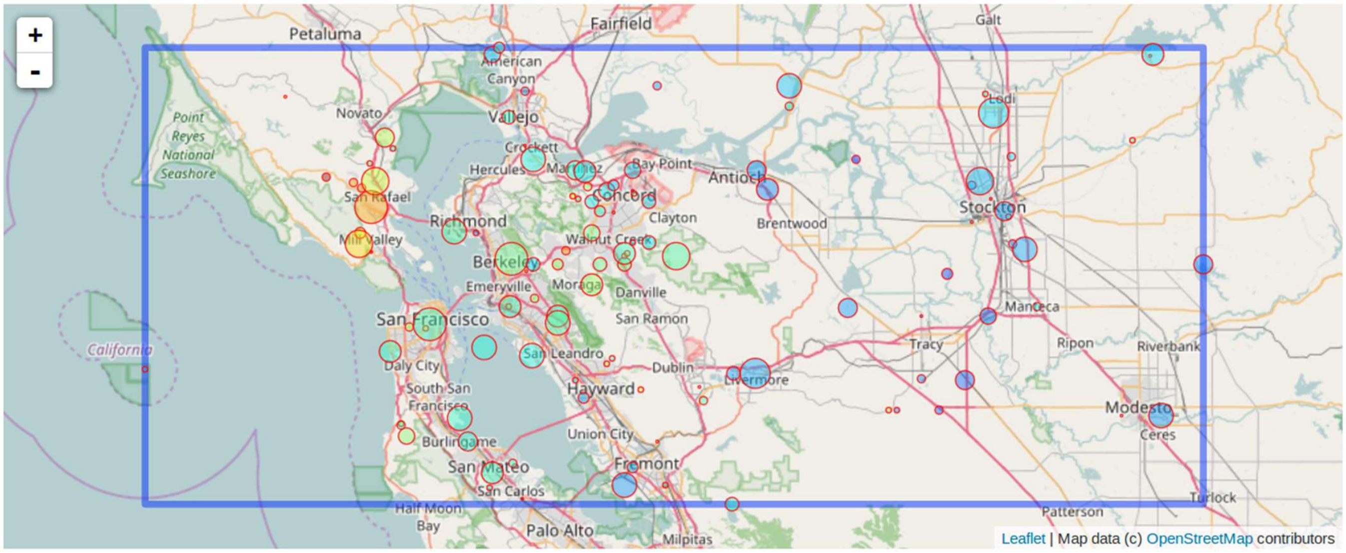

FIGURE 1: WEATHER DATA ARE FROM THE AREA OF NORTHERN CALIFORNIA OUTLINED BY THE BLUE RECTANGLE. CIRCLES INDICATE WEATHER STATIONS, WITH CIRCLE SIZE PROPORTIONATE TO YEARS OF DATA.

Comparison of data with other sources

To help validate the data, its statistics are compared with graphs obtained from a site called US Climate Data, which is produced by Your Weather Service (https://www.yourweatherservice.com). In Figure 2, the graph on the left is for Berkeley, a city in the rectangular area. The two graphs on the right are for all the stations in the rectangular area averaged together.

The first comparison involves temperature. The middle graph in Figure 2 shows the minimum temperature. The mean minimum temperature line (gold) is very similar to the blue, low temperature line for Berkeley. The right graph shows the maximum temperature. The mean maximum temperature line (gold) is similar to the red, high temperature line for Berkeley, except that it is higher in summer. This is because the mean maximum temperature includes data from inland stations where it is hotter than Berkeley.

The second comparison involves precipitation. In **Error! Reference source not found.**, the right graph shows the mean amount of precipitation for all the stations in the rectangular area. The mean precipitation line (gold) is very similar to the height of the blue, precipitation bars for Berkeley, except that it is lower in winter. This is because the mean precipitation includes data from inland stations where it rains less than in Berkeley.

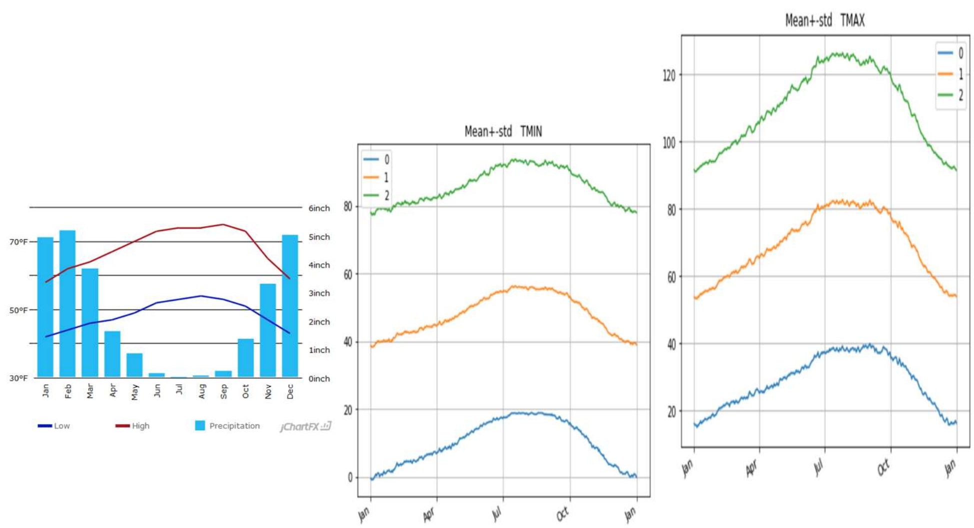

FIGURE 2: COMPARISON OF BERKELEY TEMPERATURE METRICS WITH STATISTICS CALCULATED USING NOAA DATA

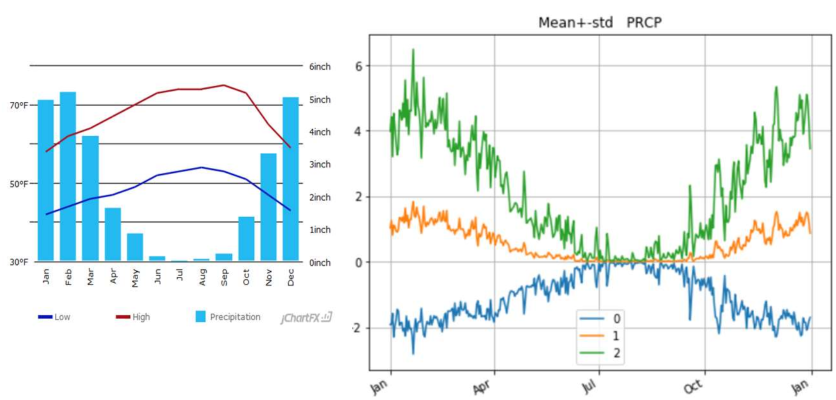

FIGURE 3: COMPARISON OF BERKELEY PRECIPITATION METRICS WITH STATISTICS CALCULATED USING NOAA DATA

PRINCIPAL COMPONENT ANALYSIS (PCA)

For each of the three measurements, maximum temperature (TMAX), minimum temperature (TMIN) and precipitation (PRCP), the percentage of variance explained was calculated as a function of the number of eigenvectors used. The top three eigenvectors explain 43% of variance for TMAX, 33% of the variance for TMIN, and 10% of the variance for PRCP. Of these measurements, TMAX is best explained by the top three eigenvectors. This is especially true for the first eigenvector, which, by itself, explains 36% of the variance. Based on that, the PCA analysis for TMAX is further explored below.

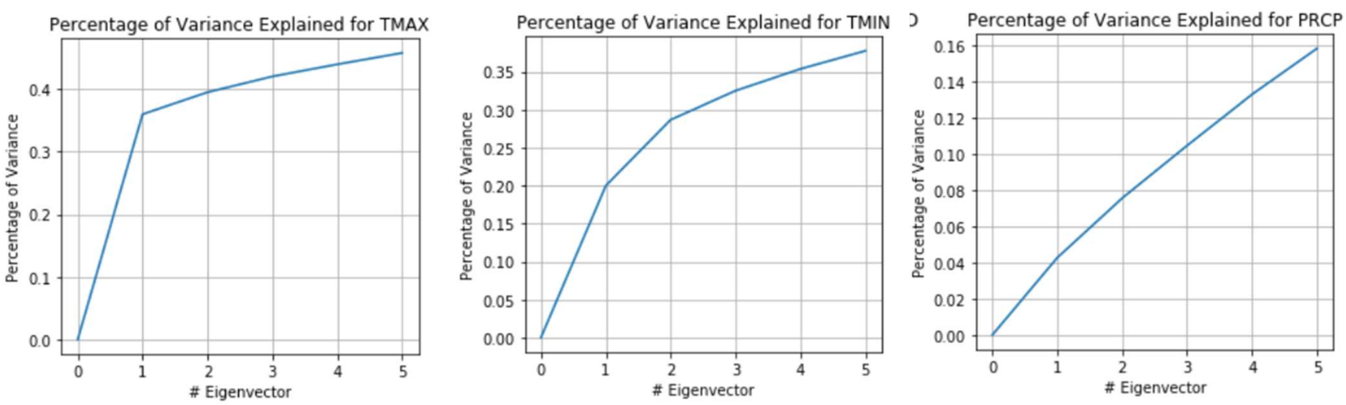

FIGURE 4: PERCENTAGE OF VARIANCE EXPLAINED AS A FUNCTION OF THE NUMBER OF EIGENVECTORS USED FOR TMAX, TMIN AND PRCP

Analysis of maximum temperature, TMAX

Figure 5 shows the mean of TMAX in tenths of degrees Celsius and the top three eigenvectors, which explain 43% of the variance. The top graph shows that the mean TMAX increases almost linearly from January to July, where it peaks through the end of the summer. Mean TMAX drops off from September to year-end more precipitously than it climbed.

The bottom graph in Figure 5 shows the eigen-functions. The first eigen-function (eig1) has a shape nearly opposite that of the mean function and is mostly below zero. The interpretation of this shape is that eig1 represents locations that have less extreme maximum temperatures than the mean. This is the case of Berkeley that was presented in the comparison of data with other sources section. Eig1 allows these locations to have a flatter TMAX profile.

Eig2 peaks when the mean temperature peaks, is close to zero on either side of the peak, and is below zero before and after the peak. The interpretation of eig2 is that it represents a more concave ascent of TMAX to its peak and a more concave descent of TMAX to its minimum, compared with the nearly linear ascent and decent of the mean.

Eig 3 is shaped like a cosine function. The interpretation of eig3 is that it shifts the timing of TMAX to the right so that it peaks later in the year.

Following are the summarized eigen-function interpretations:

- Eig1: flatter, more even TMAX over the year than the mean
- Eig2: more steeple-shaped TMAX than the mean
- Eig3: TMAX shifted about one month later in time than the mean

The eigen-function effects are well illustrated by reconstructing the TMAX curve from the mean plus one, two and three eigenvectors for a sample of locations and years. This is shown in Figure 6.

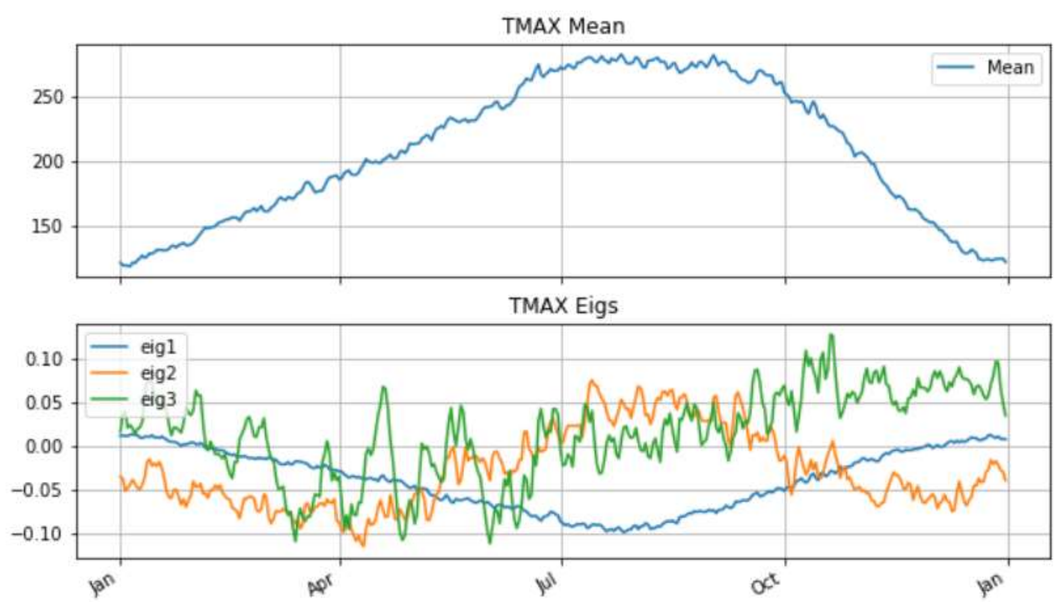

Figure 5: Mean of TMAX in tenths of degrees Celsius and the top three eigenvectors

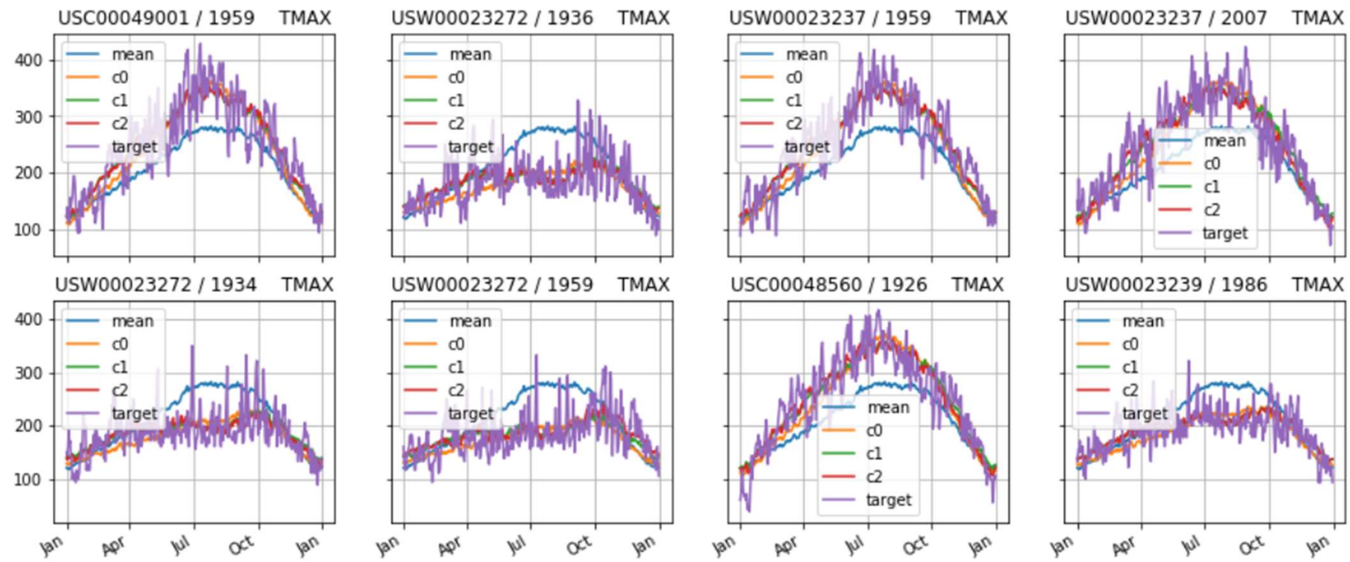

FIGURE 6: RECONSTRUCTION OF TMAX (TARGET) FROM THE MEAN PLUS ONE, TWO AND THREE EIGENVECTORS (C0, C1 AND C2) FOR A SAMPLE OF STATION LOCATIONS AND YEARS