Assignment 1: Scripps Pier Temperature and Marine Heatwaves, Due 10 October 2024

Figure 2. (a) The original 1,000-ft) (305 m) Scripps Pier (right) built in 1916, alongside the new 1,084-ft (330 m) pier during construction, 1988. (b) Pier sampling well, Claude W. Palmer, 1949. (Photographs from SIO Photographic Laboratory, UC San Diego Digital Collections).

Figure from Rasmussen et al. (2019)

Daily measurements of near surface temperature have been collected from the SIO Pier since 1916, resulting in one the longest continuous ocean temperature time series in the Pacific. The pier time series has been used to illustrate how marine heatwaves have become more prevalent due to anthropogenic warming (Oliver et al. 2018, Fugo et al. 2019). We will perform a similar analysis, focused on the hottest summer months, to examine how extreme ocean temperatures off the pier have changed over the century.

Assignment:

Load the mat file SIO_TEMP_1917_2023_fill.mat. The time series from 1917 through 2023 are from the site https://shorestations.ucsd.edu/data-sio/. The file variables are:

T: daily near surface temperature (°C) at ~ 0.5-m depth
time: time in Matlab datetime format

1) Plot T and indicate extreme high values on the plot, i.e., values that exceed the 99th percentile of the entire record, and are less than the 1st percentile (**Figure 1**). Create histograms showing the counts of extreme values (high and low) as a function of year (**Figure 2**) and month of the year (**Figure 3**).

   Q1: When do extreme high and low temperatures tend to occur over the total record, and during the year?

2) Let's focus on the 3 months of the year with the greatest number of extreme high daily temperatures, which from Figure 3 should be July, August, and September

(JAS). Plot a histogram of JAS temperature (normalized to a pdf) over the first 30 years of the record, and overplot the same histogram computed over the last 30 years (**Figure 4**).

Q2: How do the two histograms differ?

3) Compute the 10^{th}, 50^{th}, and 90^{th} percentiles for each JAS day using all years. Plot the percentiles vs day of the summer (**Figure 5**). Overplot temperature for the summer of 2022.

4) Compute the number of days each summer when temperature exceeds the 95^{th} percentile. Plot this as an indicator of the number of summer heatwave days (**Figure 6**).

Q3: How has the number of heatwave days changed over the record?

5) Compute the mean JAS temperature for each year and plot this as a time series. Use *plotyy* (**Figure 7**) and scatter (**Figure 8**) to compare number of heatwave days and the mean JAS temperature.

Q4: How do changes in the number of summer heat wave days compare to changes in the mean JAS temperature?