Assignment 1 - Tide Gauge Data Analysis Introduction

Due: 26 January 2022

Tide gauges provide a rich record of water levels at a single location over a wide range of time scales. In this assignment, you will get an introduction to the analysis of tide gauge data . You can do this assignment using any data analysis tool that you feel most comfortable with, though MATLAB or Python are recommended (some relevant functions are suggested).

1. Choose a tide gauge in the United States from the NOAA Tides & Currents database with at least 40 years of continuous data (be careful that certain gauges have large gaps in their record). Download the monthly water level data for the entire record. To download data, navigate to "Tide/Water levels", select a time period, monthly interval, the NAVD or STND datum, metric units, and "export to CSV". CSV are comma-separated text tables that can be imported to just about all data analysis software tools (see `csv` module in python or the `readmatrix` function or the data import GUI in MATLAB accessed by right clicking on the file name from within MATLAB). You can choose the MHHW data column for the monthly data.

   (a) (10 pts) Plot the entire monthly time series of water level measurements. Make sure to label your axes with discernable units and a datum.

   (b) (5 pts) Calculate a linear trend line for the entire time series and make another figure with the trend line plotted on top of the data. Give the trend in mm/yr in the title of the figure.

   (c) (5 pts) Calculate the running 10-year trend for the entire tide gauge record (i.e., the trend over a 10 year period centered on a particular date). This should be a monthly time series of sea level trends starting 5 years into the record and ending 5 years before the end of the record. Then make a plot with the running 10-year trend rate (again in mm/yr) on the y-axis and the midpoint of the time period over which the trend is calculated on the x-axis.

   (d) (5 pts) Calculate the power spectrum of the time series and plot the power spectral density (PSD) as a function of time period (i.e. a "periodogram"). See `periodogram` function in MATLAB or `scipy.signal.periodogram` function in the Python scipy toolbox.

2. Now download hourly water level data for the same tide gauge for last available year of the record.

   (a) (5 pts) Plot the hourly time series of water level measurements over the last week of the record. Make sure to label your axes with discernable units and a datum.

   (b) (5 pts) Calculate the power spectrum of the hourly time series and plot the power spectral density (PSD) as a function of time period (i.e. a "periodogram"). What is the primary tidal constituent (i.e., the frequency with the most power) at this location?

   (c) (10 pts) Find the high tide levels from this hourly water level times series over the entire year of the dataset. You may code your own solution or use built-in data analysis functions to do so. MATLAB has a helpful function `findpeaks` and Python's scipy package has a similar function `scipy.signal.find_peaks`. The parameter inputs to these functions require some calibration, so be careful to check that your solution is producing reasonable results. Plot the resulting high tide time series for the one year of data.

   (d) (5 pts) Calculate and plot (on a separate figure) the linear trend line for the high tides from this 1-year dataset on top of the high tide data. Comment on how the trend rate differs either from the long-term trend rate or the 10-year trend rates calculated in part 1.