Problems Week 4

Due Monday, October 25, 2021

We've talked about least-squares fitting, and we've talked about the Fourier transform, so it's time for us to test both strategies out using the same data set. Here we'll use the automated pressure data from the Scripps Pier. (As a reminder, you can download it here:)

http://sccoos.org/thredds/catalog/autoss/catalog.html,

For 2021, we will use data records 70521 through 88190, since these are nearly evenly spaced in time. There are 4 gaps, that we will need to fill. You can download the data directly into matlab using

```
filename='http://sccoos.org/thredds/dodsC/autoss/scripps_pier-2021.nc';
pressure=ncread(filename,'pressure');
time=ncread(filename,'time');
```

Here is one Matlab strategy for filling gaps:

```
startline=70521;
endline=88190;
xx=startline:endline;
N=(time(endline)-time(startline))/240;
time2=double(time(startline))+240*(0:N);
% gaps at 2420, 4952, 7496, 15042
pressure2(1:2420)=pressure(xx(1:2420));
pressure2(2421)=0.5*sum(pressure(xx(2420:2421)));
pressure2(2422:4953)=pressure(xx(2421:4952));
pressure2(4954)=0.5*sum(pressure(xx(4952:4953)));
pressure2(4955:7498)=pressure(xx(4953:7496));
pressure2(7499)=0.5*sum(pressure(xx(7496:7497)));
pressure2(7500:15045)=pressure(xx(7497:15042));
pressure2(15046)=0.5*sum(pressure(xx(15042:15043)));
pressure2(15047:length(xx)+4)=pressure(xx(15043:end));
```

1. **Visual evaluation.** Plot the time series of pressure data from 2021, and examine the time increments between adjacent measurements. (You can do this in Matlab using the "diff" command or in python using "numpy.diff", for example.) Are the data always uniformly spaced? What is the increment between measurements? How long is the time record? Are there other portions of the 2021 record that also have reliable uniform spacing?

2. **Least-squares fit.** Least-squares fit a mean and 3 major tidal constituents to your data. What is the mean, and what are the total amplitudes of the tidal constituents? (Total amplitude should be determined from the square root of the sum of the squares of the sine and cosine amplitutes.)

Symbol	Name	period (hours)
O1	Principal lunar diurnal	25.82
K1	Luni-solar diurnal	23.93
M2	Principal lunar	12.42

3. **Fourier transform.** Now Fourier transform your data. (Don't worry about any of the details of computing a spectrum for this exercise—just Fourier transform.)

   a Plot the real and imaginary parts of the Fourier transform. Find the peaks. What frequencies correspond to these peaks? Are they what you'd expect based on the known tidal frequencies?

   b Now use the Fourier coefficients to identify the mean pressure and the amplitudes of the major peaks. (Hint: to determine the amplitudes of the oscillatory modes, you'll need to multiply by a factor of 2 to account for both the positive and negative frequencies.)

   c Do these spectral peaks align with the results from the least-squares fit? Is there anything you could do to further check your results?

   d Now plot the spectral energy (based on the squared magnitude of the Fourier coefficients) as a function of frequency. Is the spectrum red, white, or blue?