Problems Week 3

Due Thursday, October 19, 2017

We've talked about least-squares fitting, and we've talked about the χ^2 distribution, so it's time to explore both more closely. 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,

1. **Visual evaluation.** Plot the time series of pressure data from 2015, and examine the time increments between adjacent measurements. (You can do this in Matlab using the "diff" command, for example.) Are the data always uniformly spaced? What is the increment between measurements? Choose a time period with consistent spacing: roughly the first month of 2015. How long is your record?

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 amplitudes.)

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

3. **Stationarity of the tide.** If you repeat the fit for a period in the summer, how different are your tidal amplitudes? Which tidal component changes most? Can you speculate why this might be?

4. χ^2 **and the misfit.** What is the squared misfit of your least-squares fit? You can compute this as

$$\chi^2 = \sum_{i=1}^{N} \frac{(y_i - \sum_{j=1}^{M} a_{ij} x_j)^2}{\sigma_i^2} \sim N - M. \tag{1}$$

In other words, the misfit for each point should be roughly equal to the uncertainty. We lose a degree of freedom for each function that we use to fit. How much does the misfit change if you fit with 5 frequencies instead of 3? For example, see the table below. How could you decide if the reduced misfit was sufficient to justify fitting additional frequencies?

Symbol	Name	period (hours)
O1	Principal lunar diurnal	25.82
K1	Luni-solar diurnal	23.93
M2	Principal lunar	12.42
S2	Principal solar semidiurnal	12.00
N2	Larger lunar elliptic semidiurnal	12.66