Modeling Tides

This worksheet will guide you through modeling tidal water levels outside Point Reyes, California, using a spreadsheet program like Excel or Google Drive. Every spreadsheet program is a little different, depending on brand, version, and operating system, but you can use almost any spreadsheet program to carry out these operations!

Tides are complicated and depend on many factors including the moon's gravitational pull. Tides can be roughly modeled by sine and cosine waves, though: functions of the form $f(t) = A\cos(Bt) + C$. We use t to represent time and $f(t)$ represents water level.

1. Understanding check: what is the *input* to the function for water height and what is the *output*? Use units!

2. Label the first column "Time" and the second column "Water height."

3. To model the tide over *24 hours*, start by filling the rest of the left-most column of your spreadsheet with the numbers zero through twenty-four (0,1,2,3,...). (Is this column full of inputs or outputs? On a graph, will these numbers be along the horizontal or the vertical axis?)

4. The next column will give your predictions of water height, but we must do some math first to come up with the model.

   (a) Data about the tides in Point Reyes tell us that the water height ranges between 1.4 feet and 6 feet. What is the *average water height*? This number is C.

   (b) Since you know the lowest water height is 1.4 feet and the highest is 6 feet, what is the *amplitude* of the cosine wave?

   (c) On October 4, 2013, the water was at high tide at 6 am and 6 pm. The water was at low tide at noon and at midnight. What is the *period* of the water height function?

   (d) Using the previous two parts, figure out A and B.

Modeling Tides

5. Write the equation for the model you have created:

$$f(t) = \text{\hspace{8cm}} .$$

6. Go back to the spreadsheet and now fill in the second column. In the first free cell, you will enter your formula by typing the $=$ sign first and then the rest of the formula.

   - Use $*$ for multiplication.
   - Click on the appropriate cell in the first column to get an input from that cell. The program will probably add a symbol like A2 to the cell you were typing in – this means that it will automatically use the value from cell A2 in the calculation.
   - To get the cosine function, you'll probably need to type COS(and then use autocomplete.
   - You'll get something that looks like $= -2 * COS(3 * A2) + 4$ (these numbers are wrong of course!)
   - Troubleshoot with a neighbor if you need to! Typos are easy to make.

7. Once you've pressed enter on that formula cell, you should get a number. That is your predicted water height! Now copy and paste to the rest of the cells in that second column. You may need to "paste special."

8. Highlight the first two columns and make a chart out of the information. Graph your prediction and check that it meets all the conditions from the first page.

9. When is the water level increasing? When is the water level decreasing?

10. You want to go on a two-hour hike to a secluded beach, but the path is underwater during high tide. When is the best time of day to start the hike? Discuss.

Modeling Tides

11. Now take a look at the actual data from Point Reyes. How good is your model? List two accurate parts and two inaccurate parts:

12. Can you mess with A, B, and C to get a better model?

13. Extra: find more data on the tides at Point Reyes from the National Oceanic Administration's Tides and Currents website and build a better model!