AMERICAN METEOROLOGICAL SOCIETY

The Maury Project

OCEAN TIDES ON THE WEB

AN ACTIVITY

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Activity: Ocean Tides On the Web

Introduction

Ocean tides are the periodic rise and fall of sea level observed along coasts. Although tides are most often viewed from their local impact, their origins are literally astronomical. They are a result of the complex interaction of the gravitational attraction of the Moon and the Sun on the Earth's water surface. Many other influences build on these astronomical foundations to produce the tides actually observed. These include such factors as the shape of the ocean bottom, coastline irregularities, and weather.

This activity investigates the tides by generating and comparing tidal predictions and observations of changes in sea level over time. The objective is to build an understanding of the factors that influence the water levels in bays and harbors and along beaches, and are used to predict the tide.

Materials

Photocopies of ***Tide Table Predictions Page, Partial Tides Page, Galveston Tide Observations Page.*** For today's tidal predictions, internet access to the World Wide Web is required.

Objectives

After completing this investigation, you should be able to:

- Describe some of the factors that determine local tides.
- Describe partial tides and their use in making tide predictions.
- Demonstrate use of tide data acquired via the World Wide Web.

Investigations

A. Plotting Tides:

1. Local tides result from a complex interplay of astronomical and non-astronomical factors. However, they can be predicted with a high degree of accuracy through a detailed analysis of the long-term tide record. Examine the ***Tide Table Predictions*** provided on the ***Tide Prediction Page*** in this activity for Humboldt Bay, CA for four days in February 1999 or, for the current predictions available on the World Wide Web go to:

http://www.opsd.nos.noaa.gov/tideframe.html

(At this address, scroll down and "click" on Tide Predictions or Predictions, continue scrolling and making selections with your mouse until the current tide data for Humbolt Bay, CA appears. Print the data. If your web browser uses frames, be sure to place your cursor on the frame containing the data and click your mouse before proceeding to printing. If preferred, another location on the Atlantic or Pacific coast, such as Charleston, SC or San Diego, CA could be used in this activity.)

2. The tidal heights shown in the tide table you are using are given above or below a reference height based on low-tide water levels observed over a number of years. Select the current date and three subsequent days if you downloaded data. Otherwise, use the Humbolt Bay data provided. Indicate dates: _____, _____, _____, _____. During this four-day period for which data are given in the table, the maximum predicted high tide is _____ feet and the minimum low tide is _____ feet. In order to graphically display the tide prediction data, use these maximum and minimum values to determine what you think is the most appropriate vertical scale for the blank graph which appears on the ***Tide Prediction Page*** included in this activity. Add the vertical scale to the graph. The horizontal axis is already labeled with two-hour increments.

3. Plot the tidal predictions from the tide table for the first two complete days only. Do NOT plot the tidal data beyond the second day. Draw smooth lines to connect the adjacent points you have plotted. You have drawn a **tidal curve**. It depicts expected local changes in water level over time. This tidal curve shows that during a one-day period, this location appears typically to experience (***0***) (***1***) (***2***) high tide(s) and (***0***) (***1***) (***2***) low tide(s).

4. Tides are often distinguished by their cyclical patterns. One tidal cycle is the sequence from one high tide to the next high tide. Tides that go through one cycle during a single day are described as **diurnal** or daily tides. Those that go through two cycles are described as **semi-diurnal**, or semi-day tides. A third common category is **mixed** tides. Mixed tides have characteristics intermediate between the other two. They usually show two unequal high waters and two unequal low waters each tidal day. As plotted on your diagram, the predicted tide is a (***diurnal***) (***semi-diurnal***) (***mixed***) tide.

5. The time between successive high tides is called the **tidal period**. The average tidal period for your tidal curve is about (***one quarter***) (***one half***) (***one***) day.

6. From the tidal curve you drew, determine the **tidal range** over the two-day period. It is the vertical distance between the highest high tide and the lowest low tide predicted to occur during the two days. The predicted tidal range is about ____ feet.

7. Notice that the high tides are not of the same height, nor are the low tides at the same height. This is due ultimately to the variations in the combined gravitational effects of the Sun and Moon, as their positions relative to Earth are changing continuously. Using the shape of the tidal curve you drew, continue the curve to predict the height and time of the next high and low tides. Place x's on the graph showing your predictions. Read from the graph your predictions of the heights and times of the next high and low tides, and record them in order of their occurrence in the spaces provided immediately below the graph.

   Next, plot the third day's data from the tide table. Compare your predictions and the tide table prediction. Your predictions were (***exactly the same as***) (***very close to***) (***way off from***) the tide table prediction. Your predictions may or may not have been accurate. Success could depend a great deal on your luck. Predicting tides from only two days of data cannot fully account for the increase or decrease in tidal height, or changes in times of high and low tides, due to the changing alignments of the celestial bodies involved and numerous other local factors.

B. Predicting Tides

8. From the predicted tide curve you drew, it should be apparent that the tide has wave characteristics with periodic fluctuations. The Sun and the Moon produce what can be interpreted as waves at the Earth's water surface with different wave heights, periods and lengths. The tidal fluctuation observed along the shore is the product of these numerous waves, in addition to local conditions. Scientists study the tidal records in one location to determine the variations in the fluctuations. They use records of at least 19 years to include all the dominant cycles of the Sun and Moon positions in the sky relative to Earth. The observed local tide can be separated into various components called **partial tides**. Partial tides are individually calculated for the future and then recombined to produce the predicted tide.

9. On the ***Partial Tides Page*** that appears in this activity, there are two curves plotted on the graph which represent two partial tides or components of the observed tides. For the 24-hour period covered, the tidal range of the solid curve is _____ feet and the tidal range of the dashed curve is _____ feet.

10. At every two hours (0, 2, 4, etc.), combine the two partial tide heights to determine their net effect on sea-surface height. Plot each result on the graph with a small "x". Make sure to note the correct sign, either positive or negative for addition or subtraction. Draw lines or a smooth curve to connect the points. The curve you have drawn is the net effect or combined wave of the two partial tides, which would be the tide if they were the only two partial tides. The 24-hour tidal range of the tide is _____ feet. The height of the tide is the sum of the partial tides.

11. You have combined the two different waves into one wave. There are mathematical techniques which can do the reverse of what you have done. With these techniques, a complex combined wave be can separated into individual waves. Treated as a wave, the local observed tide is separated into over 100 waves or partial tide components. Some 60 components are commonly used to predict tides by combining their effects.

C. Observing Tides

12. The observed tides are often different from the predicted tides, due to changing meteorological conditions such as storms, winds, and atmospheric pressure. This can be seen on the ***Galveston Tide Observations Page***, or may be seen in today's observations at Galveston available at:

http://www.opsd.nos.noaa.gov/hgports/NOS.html
(Note: "NOS" must be in capital letters.)

The observed sea-level measurements are plotted on the graphs by series of "x" symbols. These data are from National Ocean Service water level gages located on two different piers in the Galveston area. Also shown are solid-line curves which represent the tide predicted from partial tides. The horizontal axis represents time; where 0 hours is the present, negative time is the past and positive time is the future. The observed tide in the graphs you are examining is (***higher than***) (***lower than***) (***the same as***) the predicted tide.

Questions

Now use what you have learned from this activity to answer the following questions about tides.

1. Continue looking at the ***Galveston Tide Observations Page***. The tidal curves show that during one day, Galveston would experience (***0***) (***1***) (***2***) high tide(s) and (***0***) (***1***) (***2***) low tide(s).

2. Examine the heights of the high and low tides. The tide height is measured in feet above MLLW. MLLW (Mean Lower Low Water) is the standard datum level used in the US. The heights of the high tides at each location are (***equal***) (***unequal***) and the heights of the low tides at each location are (***equal***) (***unequal***).

3. The average tidal period for Galveston tidal curves is about (***one quarter***) (one half) (***one***) day.

4. For the 18-hour period during which observed tidal data are reported, the observed tidal range at Galveston's Pleasure Pier is about _____ feet and the predicted tidal range is about _____ feet. Is it possible the observed and predicted ranges could be the same even though the observed and predicted tide heights are quite different? Explain your answer:

_____
_____

5. Based on information given in this tides investigation, list some factors which may modify the tides once they are generated by the gravitational interaction of the Earth-Moon-Sun system.

_____
_____

Tide Table Predictions Page

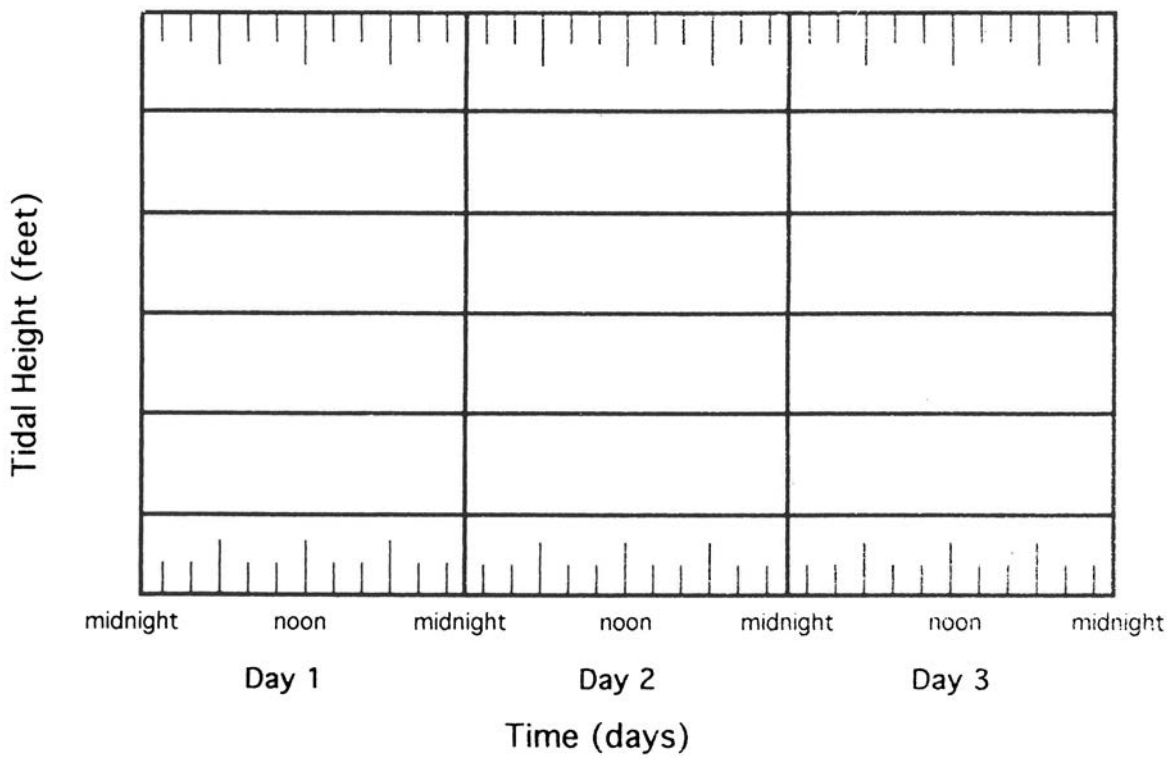
http://www.opsd.nos.noaa.gov/tides/westHB.html

All times listed are in Local Time, all heights (Ht.) are in Feet, **H** means high tide and **L** means low tide.

Humboldt Bay, North Spit, California
Tide Predictions (High and Low Waters) February, 1999
NOAA, National Ocean Service

Standard Time

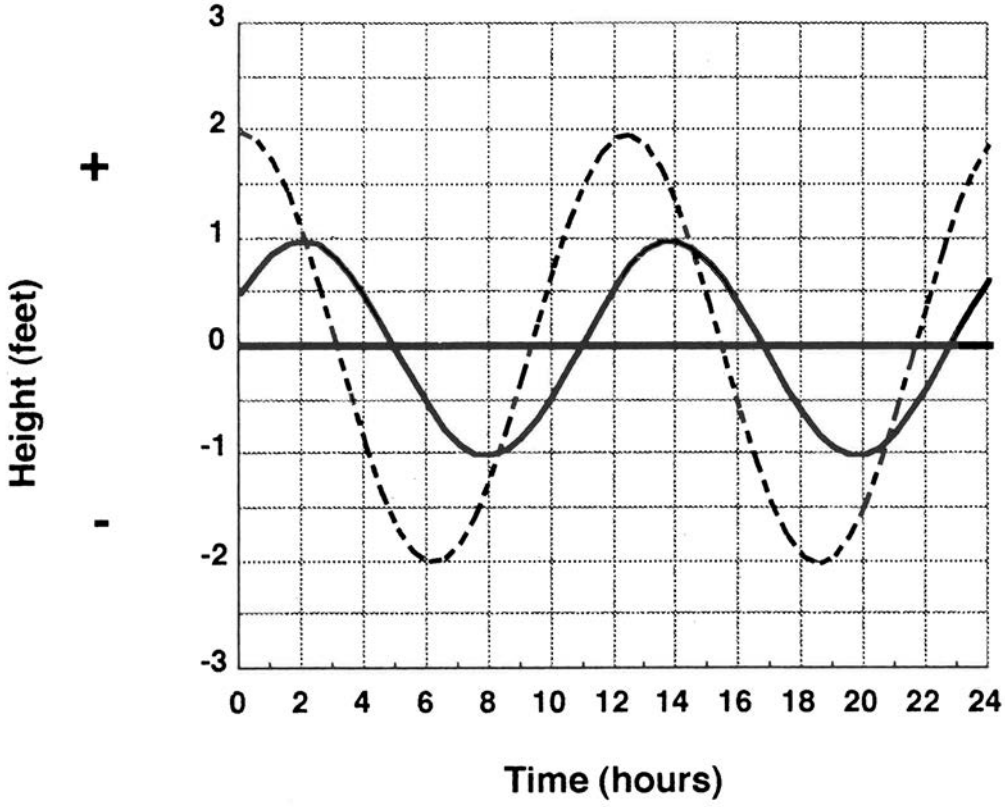
Day	Time	Ht.	Time	Ht.	Time	Ht.	Time	Ht.
1 M	1247am H	6.2	557am L	2.4	1156am H	7.6	644pm L	-1.0
2 Tu	125am H	6.3	644am L	2.3	1239pm H	7.2	722pm L	-.6
3 W	201am H	6.3	730am L	2.2	122pm H	6.7	758pm L	-.1
4 Th	237am H	6.3	817am L	2.1	206pm H	6.2	833pm L	.4



_____ tide at _____ (am) (pm) _____ feet

_____ tide at _____ (am) (pm) _____ feet

Partial Tides Page



Galveston Tide Observation Page