SMS-303: Integrative marine sciences III.

Solution to assignment #1

1. The effect of the sun on the tides in the Gulf of Maine (GOM).

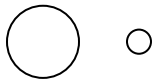
The sun and the moon both contribute to the tides in the GOM, with the moon being the major contributor. For simplicity we will consider only two tidal components (M2-lunar and S2-solar) which often have the largest amplitude of all tidal components and which will be the major contributor were the moon, sun and earth all on the same plane perpendicular to the axis of rotation of the earth.

The elevation (in m) near Rockport, ME for the two tidal wave components is given by:
M2: 1.5cos(28.984t)
S2: 0.23cos(30t)

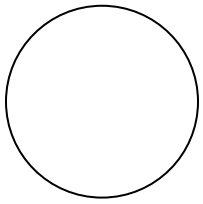
Where t is in hours and the frequency is given in degrees per hour. At time t=0 the sun and the moon are at the same side relative to the earth (new moon).

a) Add the two components together on a spread sheet and plot the resulting amplitude as function of time for a 28day lunar month (remember, t has to be in hours, 1 day = 24hours). Annotate on your plot the different arrangement of the planets every 3.5 days. For example:

t=0



Earth Moon



Sun

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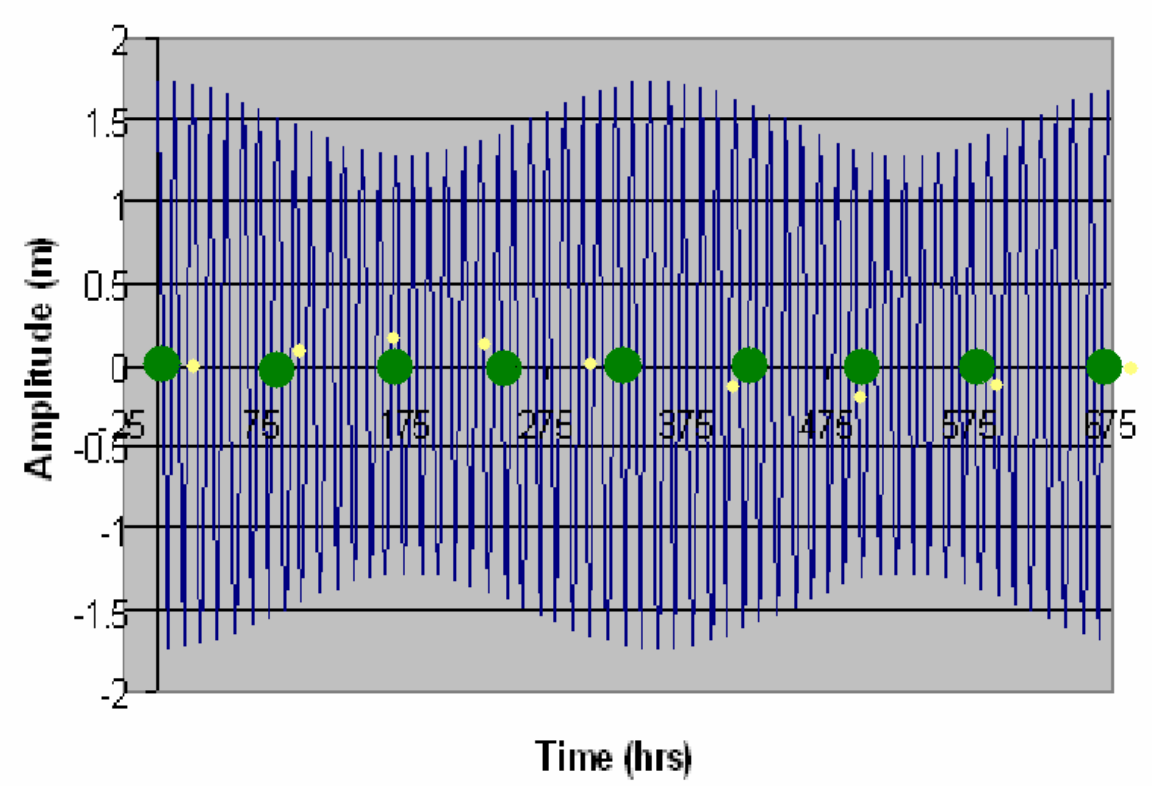
1)a. Done by one of your classmates:



b) Add the two tidal components using trigonometric relationship(s). Explain your results in light of the plot you got in question 1.

1.5cos(28.984t)+ 0.23cos(30t) = 1.27cos(28.984t)+0.23{cos(28.984t)+cos(30t)}= 1.27 cos(28.984t)+0.46cos(29.492t)cos(0.508t)

The primary oscillations have a period close to 12hrs {cos(28.984t) and cos(29.492t) components} and are modulated by a cos(0.508t) term. 0.508degree/hr represents a wave with a period: 360hr/0.508=29.5276days. Because the modulating wave multiply a higher frequency wave (that of 12hr) the magnitude of the modulation is what is important. The magnitude has twice the frequency of the modulating wave and thus the 14.76period observed. This is the period of the spring/neap cycle of the tides!

2. Seich: The 'natural' (resonant) frequency/period of a gravity wave in an enclosed (or semi-enclosed) basin depends on the depth of the water and the length of the basin (similar to the frequency emitted by a musical instrument). Calculate the seiche period for station I (the length of the tank is 30.5cm). How well does this formula compare with your results for station I of the lab?

Based on one of the groups:
When the depth of the water was 1.5cm, the sloshing period was 1.6s.
When the depth of the water was 6cm, the sloshing period was 0.75s.

The speed of the waves is expected to be equal to $(gH)^{0.5}$.
Since the length of the tank is fixed, the ratio of the priod should equal the ratio of the speeds.
Ratio of periods: 0.67
Ratio of speeds: $(H_1/H_2)^{0.5}=(1.5/6)^{0.5}=0.5$

Not very close, yet good enough. Differences may be due to: 1. uncertainty in depth. 2. Effect of drag and surface tension for the very shallow case.

This page was last edited on 11/3/2005