Earth Science

Chapter 21

Section 3 - Tides

E.Q.: *How does the gravitational pull of the moon cause tides and what are tidal characteristics?*

STANDARDS:

SES5. Students will investigate the interaction of insolation and Earth systems to produce weather and climate.

a. Explain how latitudinal variations in solar heating create atmospheric and ocean currents that redistribute heat globally.

Objectives

- **Describe how the gravitational pull of the moon causes tides.**
- **Compare spring tides and neap tides.**
- **Describe how tidal oscillations affect tidal patterns.**
- **Explain how the coastline affects tidal currents.**

TIDES

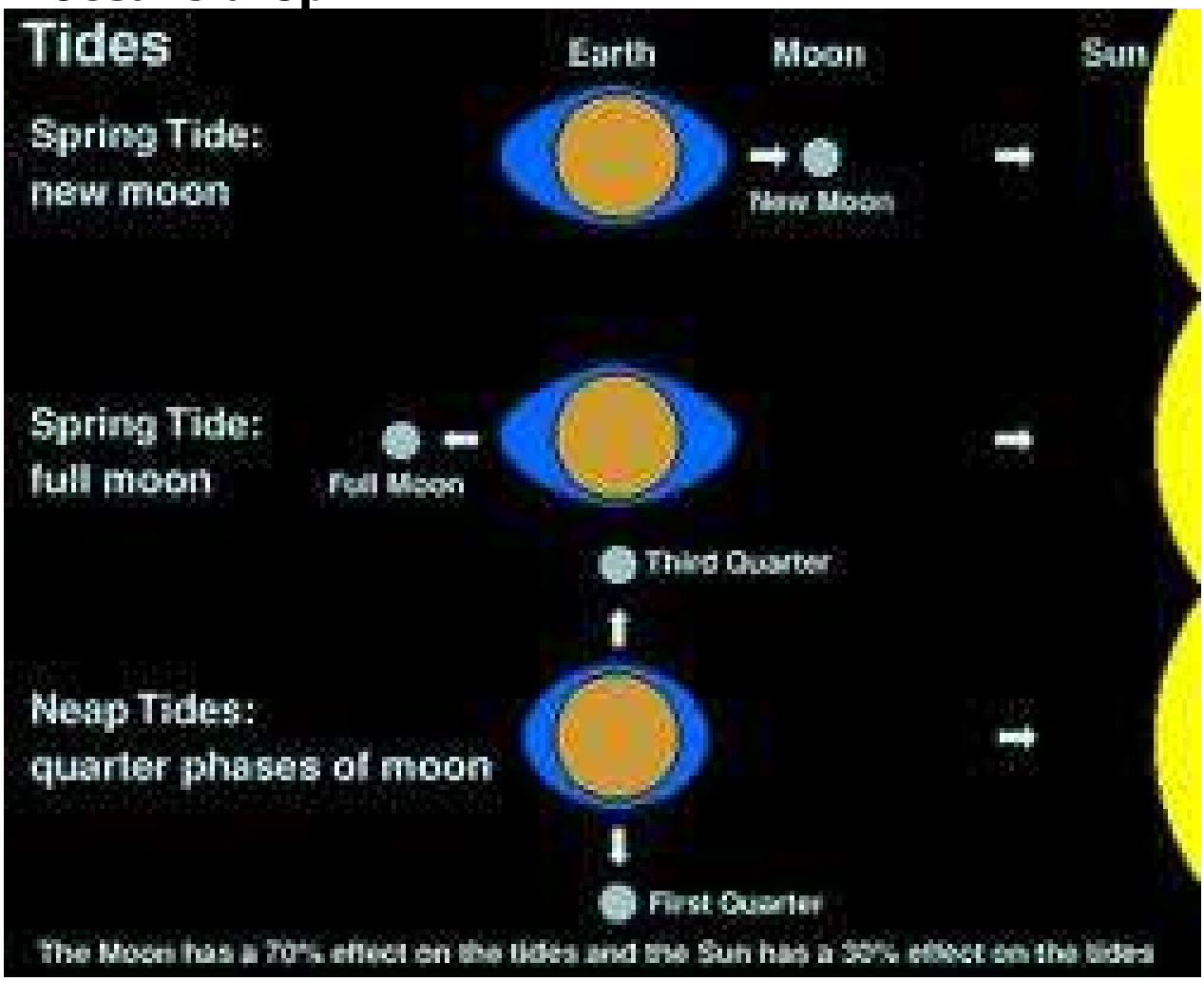
tides **the periodic rise and fall of the water level in the oceans and other large bodies of water**

- ***High tide*** **is when the water level is highest.**
- ***Low tide*** **is when the water level is lowest.**

The Causes of Tides

- **The gravitational effects of the moon and, to a lesser extent, the sun causes tides.**
- **Because the force of the moon's gravity decreases with distance from the moon, the gravitational pull of the moon is strongest on the side of Earth that is nearest to the moon.**
- **As a result, the ocean on Earth's near side bulges slightly, which causes a high tide within the area of the bulge.**
- **Low tides form halfway between two high tides. Low tides form because as ocean water flows toward areas**

of high tide, the water level in other areas of the oceans drop.



BEHAVIOR OF TIDES

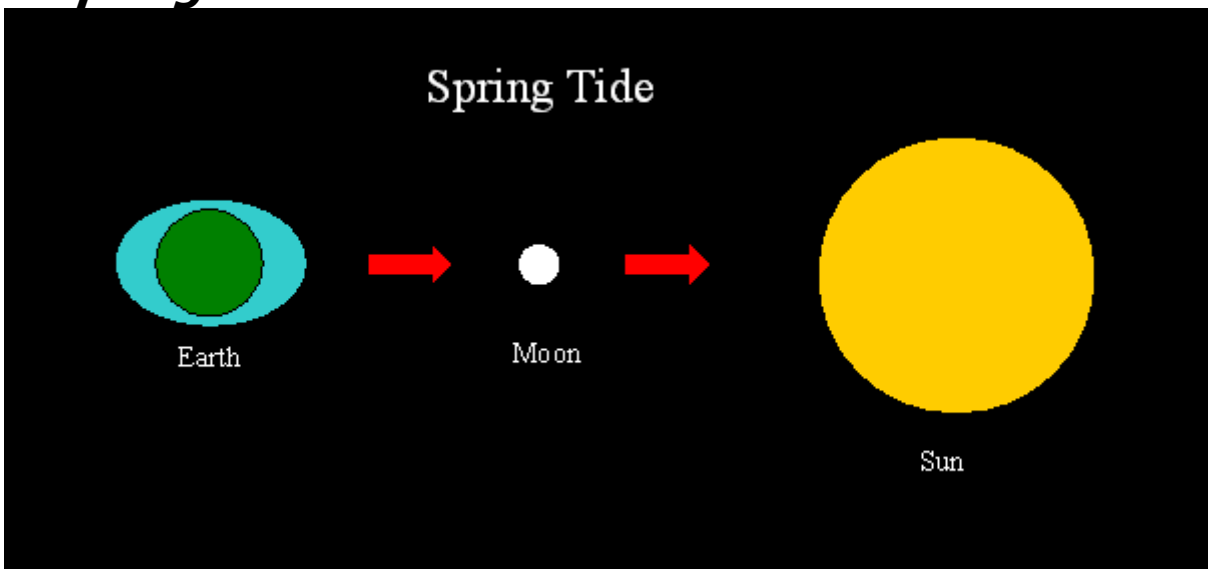
tidal range **- the difference in levels of ocean water at high tide and low tide**

- **Because there are two tidal bulges, most locations in the ocean have two high tides and two low tides daily.**
- **The tidal range can vary widely from place to place.**
- **Because the moon rises about 50 minutes later each day, the times of high and low tides are about 50 minutes later each day.**

Spring Tides

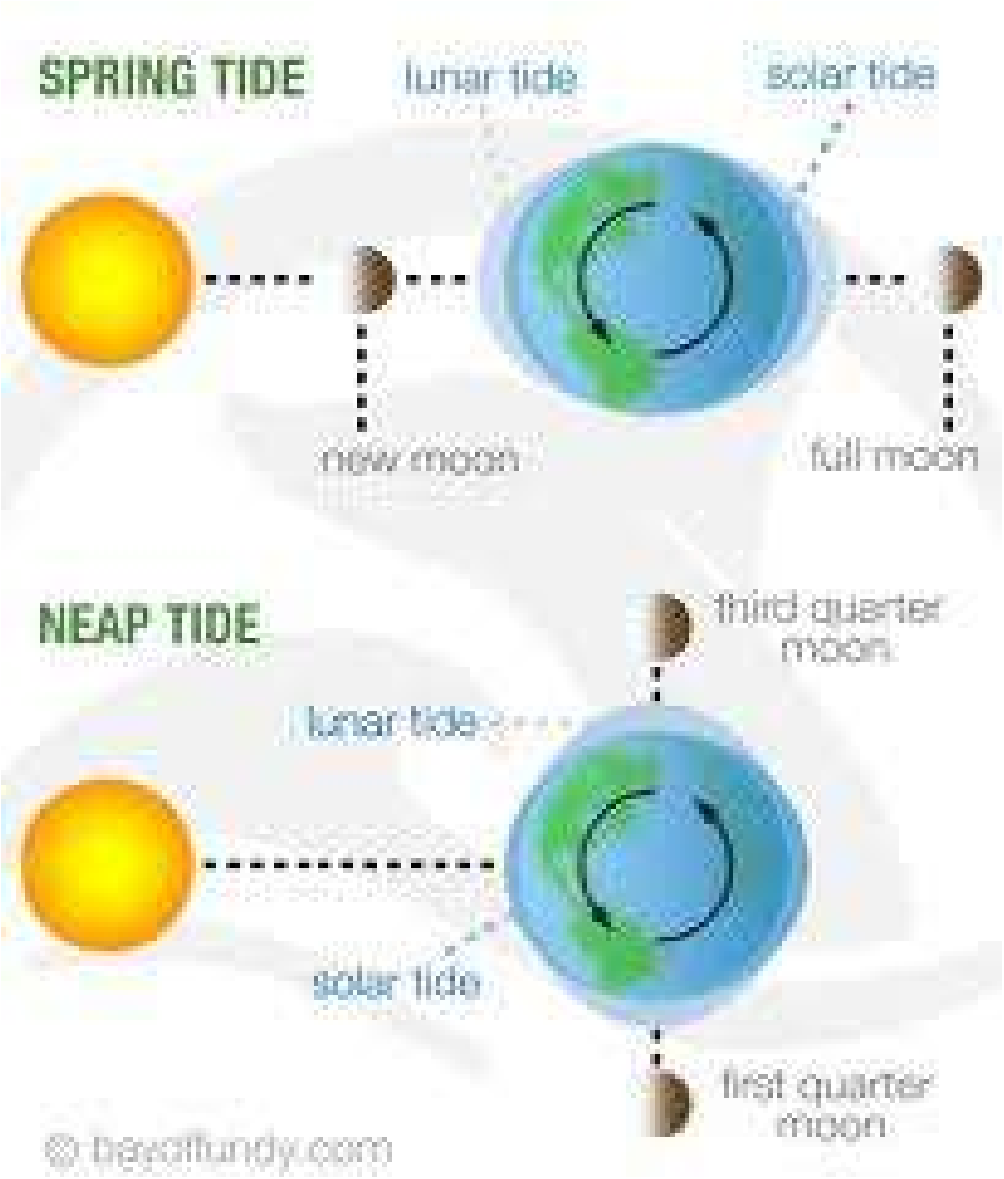
- **The sun's gravitational pull can strengthen or weaken the moon's influence on the tides.**

- **During the new moon and the full moon, Earth, the sun, and the moon are aligned. The combined gravitational pull of the sun and the moon results in higher high tides and lower low tides.**
- **During these two monthly periods, tides are called *spring tides.***

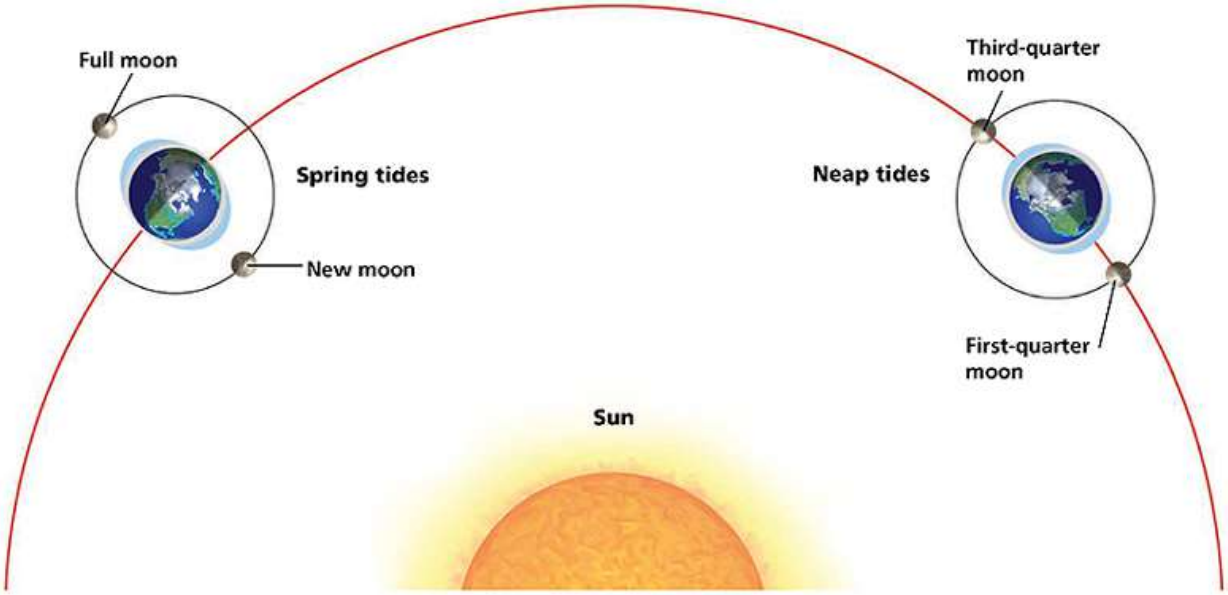


<u>Neap Tides</u>

- **During the first- and third-quarter phases of the moon, the moon and the sun are at right angles to each other in relation to Earth.**
- **The gravitational forces of the sun and moon work against each other.**
- **As a result, the daily tidal range is small. Tides that occur during this time are called *neap tides.***



The diagram below shows spring tides and neap tides.



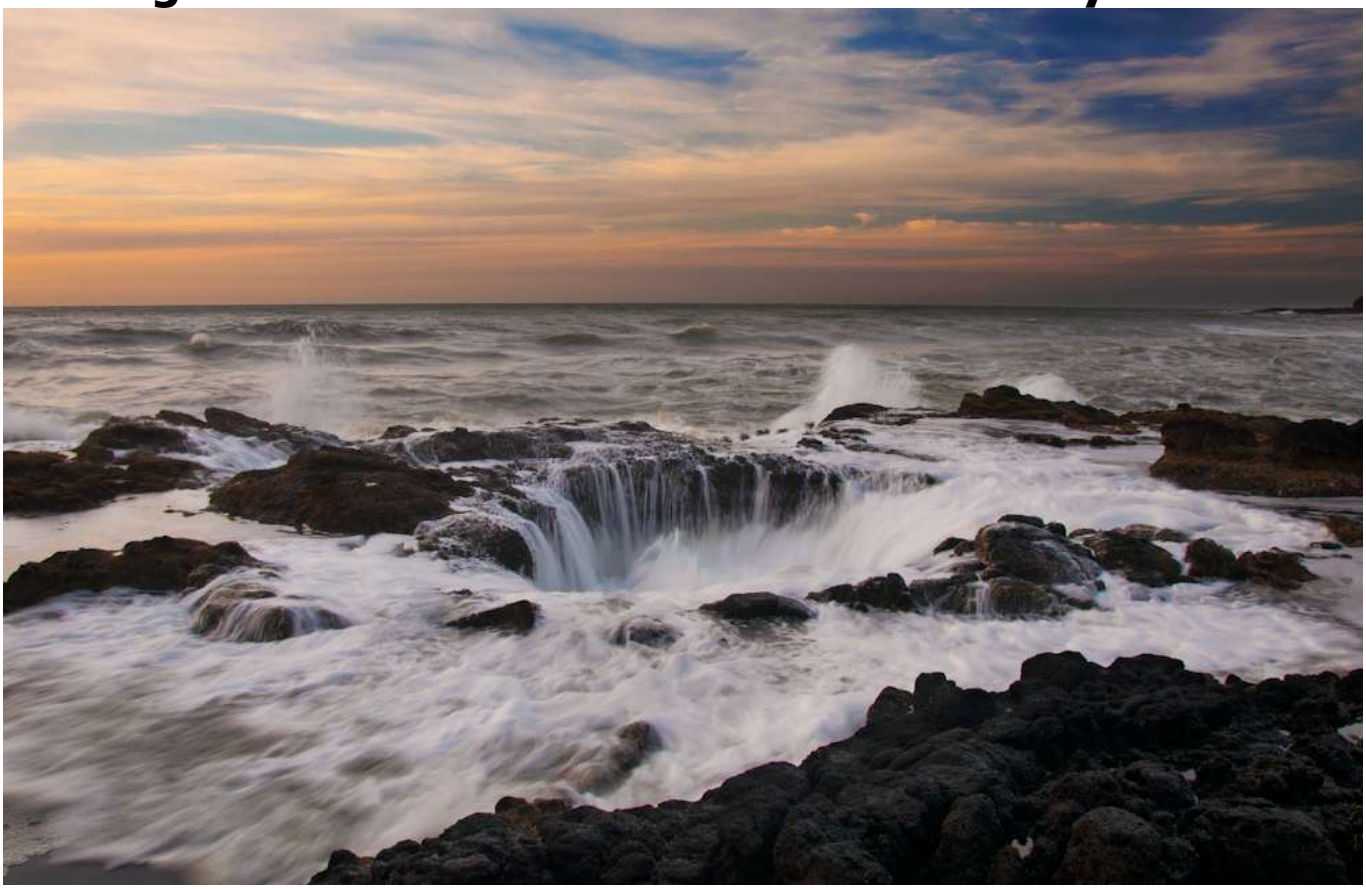
READING CHECK

Describe the location of the sun and moon in relation to Earth when the tidal range is small.

When the tidal range is small, the sun and the moon are at right angles to each other relative to Earth's orbit.

Tidal Variations

- **Tidal patterns are greatly influenced by the size, shape, depth, and location of the ocean basin in which the tides occur.**
- **Along the Atlantic Coast of the United States, two high tides and two low tides occur each day and have a fairly regular tidal range.**
- **Along the shore of the Gulf of Mexico, however, only one high tide and one low tide occur each day.**



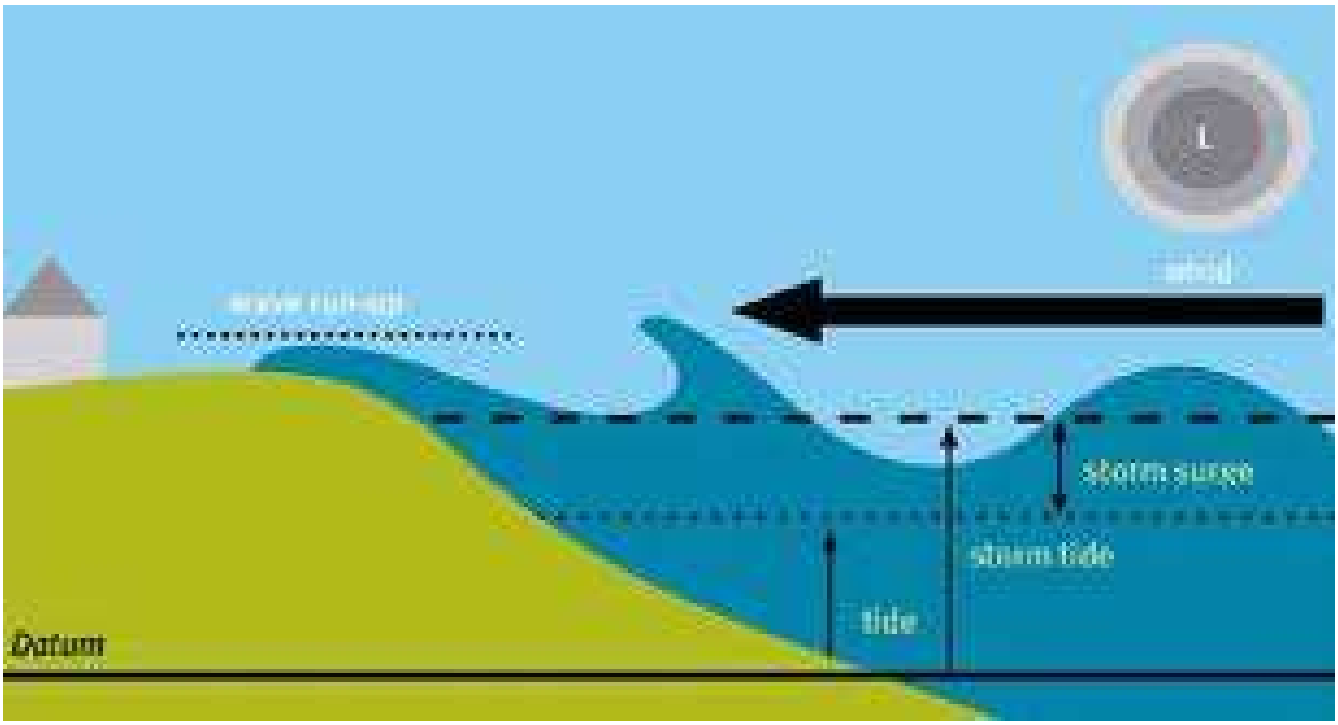
Siuslaw National Forest *'Thors wrath'* © Damon Edwards
Witness the awe and power of this natural phenomenon, known to the locals as Thors Well. This massive hole embedded in the porous volcanic rock near the coast of central Oregon swells with sea water during high tides and drains below with immense speed. Formed over hundreds of years, this dangerous yet beautiful spectacle shows off the Pacific Oceans never-ending ability carve and shape the land.

Harmonic pipes located in Zadar, Croatia. The Sea Organ was built by architect Nikola Basic as part of a project to renovate the city coast. It's a series of marble steps that descend into the sea, concealing 35 harmonic pipes. The wind and the tide oscillate directly into the pipes, acting as the bellows of a giant watery pipe organ.
http://www.rotatingcorpse.com/soundz/ocean-music/8081.html

Tidal Oscillations

tidal oscillation **- the slow, rocking motion of ocean water that occurs as the tidal bulges move around the ocean basins**

- **In some enclosed seas tidal oscillations reduce the effects of the tidal bulges.**
- **However, in small basins and narrow bays located off major ocean basins, tidal oscillations may amplify the effects of the tidal bulges.**



Tidal Currents

tidal current **- the movement of water toward and away from the coast as a result of the rise and fall of the tides**

Tidal currents at Boat Passage, Saturna Island, British Columbian a Canadian province
http://gulfislandsnationalpark.com/photos/boat-passage.htm

- **When the tidal current flows toward the coast, it is called *flood tide*.**
- **When the tidal current flows toward the ocean, it is called *ebb tide*.**
- **When there are no tidal currents, the time period between flood tide and ebb tide is called *slack water*.**
- **Tidal currents in the open ocean are much smaller than those at the coastlines.**
- **Tidal currents are strongest between two adjacent coastal regions that have large differences in the height of the tides.**
- **http://www.google.com/imgres?q=tidal+currents&um=1&hl=en&client=firefox-a&sa=N&rls=org.mozilla:en-US:official&biw=896&bih=429&tbm=isch&tbnid=4mHj_lsAgpbZCM:&imgrefurl=http://oceanservice.noaa.gov/education/tutorial_currents/02tidal1.html&docid=92y3aF5TjEqTHM&imgurl=http://oceanservice.noaa.gov/education/tutorial_currents/media/tide02_480.gif&w=480&h=360&ei=JJ-QT6HMEoiWtweJqOXEBA&zoom=1&iact=hc&vpx=189&vpy=79&dur=8543&hovh=194&hovw=259&tx=98&ty=145&sig=102009843697178923583&page=1&tbnh=90&tbnw=120&start=0&ndsp=12&ved=1t:429,r:1,s:0,i:109**

First Lunar Tides - the newborn moon looms close and large in the earth's sky, stirring huge tides; cover of The Deep Range by Arthur C. Clarke http://www.cosmographica.com/gallery/portfolio2007/content/067_FirstLunarTides_large.html