What causes the tides in the ocean?

By NASA and NOAA on 02.09.17
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Flying gulls on Morro Strand State Beach, California, at low tide. Morro Rock is seen in the background. Photo taken January 21, 2012, by Mike Baird. Originally posted to Flickr, licensed under Creative Commons. MIDDLE: Graphic showing the moon's gravitational pull. BOTTOM: The tidal range.

High tides and low tides come and go, as the level of the sea goes up and down. This cycle of two high tides and two low tides occurs most days on most of the coastlines of the world.

Why Is That?

Tides are really all about gravity, and when we're talking about the daily tides, it's the moon's gravity that's causing them.

As Earth rotates, the moon's gravity pulls on different parts of our planet. Even though the moon only has about 1/100th the mass of Earth, since it's so close to us, it has enough gravity to move things around. The moon's gravity even pulls on the land, but not enough for anyone to really tell.

When the moon's gravity pulls on the water in the oceans, however, someone's bound to notice. Water, being a liquid and all, has a much easier time moving around. It bulges toward the moon, and that bulge follows the moon as Earth turns beneath it.

That explains the first high tide each day, but what about the second high tide?

The ocean also bulges out on the side of Earth opposite the moon.

Wait, What?

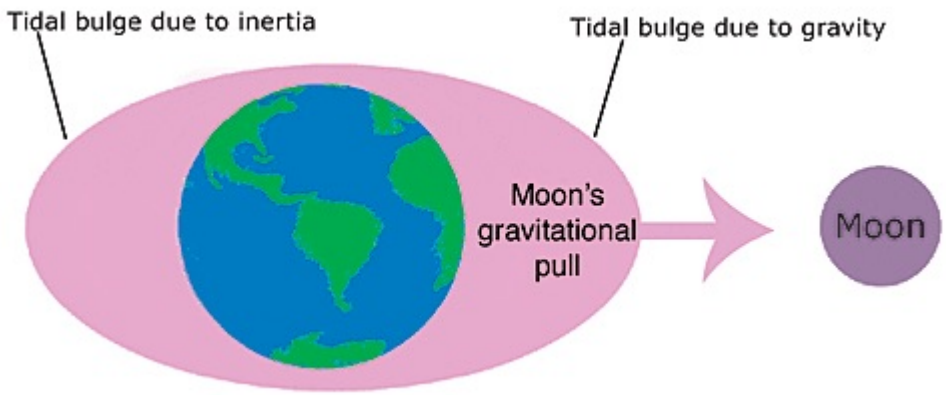
If the moon's gravity is pulling the oceans toward it, how can the ocean also bulge on the side of Earth away from the moon? It does seem a little weird.

Gravity is the major force causing tides, but inertia is playing a part too. Inertia is matter's resistance to change. Inertia acts to counterbalance gravity. It is the tendency of moving objects to continue moving in a straight line. It wants to keep doing whatever it's doing, whether that's moving in a straight line or staying still, until another force acts on it.

While the water closest to the moon is getting pulled, the water farthest from the moon is staying right where it is. Both sides are experiencing gravity and inertia, but one always overpowers the other.

On the side by the moon, gravity wins. On the side away from the moon, inertia wins.

These two bulges explain why in one day, there are two high tides and two low tides.



Are Tides The Same Height Everywhere On The Planet?

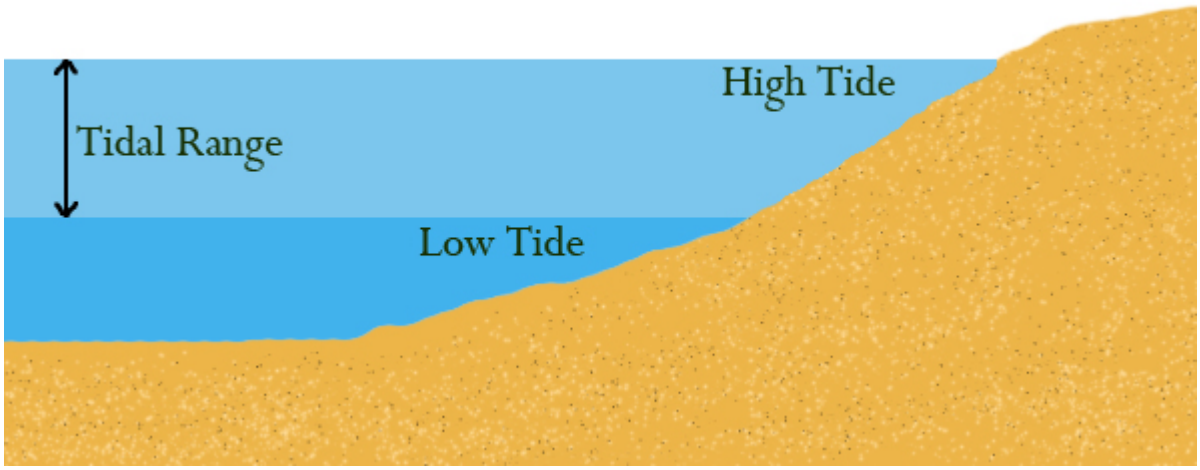
Nope.

If Earth were perfectly round and completely covered in water, then high and low tides would be equally proportioned everywhere. But Earth is not a perfect sphere, and there are big continents getting in the way of water flowing and bulging in the direction of the moon. That's why in some places, the difference between high and low tide isn't very big, and in other places, the difference is drastic.

High And Low Tides

Tides start in the oceans as waves and move toward the coastlines where they appear as the regular rise and fall of the sea surface. When the highest part, or crest of the wave, reaches a particular location, high tide occurs; low tide corresponds to the lowest part of the wave, or its trough.

Most coastal areas experience two high tides and two low tides every day. But, they are affected by the lunar day, not the solar day. Everyone knows the 24-hour solar day, which is the time it takes for the Earth to rotate about its axis so that the sun appears in the same position in the sky. But a lunar day is the time it takes the moon to make one complete orbit around the Earth and come back to the same phase. A lunar day is longer than a solar day, and it takes 24 hours and 50 minutes. The lunar day is 50 minutes longer than a solar day because the moon revolves around the Earth in the same direction that the Earth rotates around its axis. So, it takes the Earth an extra 50 minutes to “catch up” to the moon. Because the Earth rotates through two tidal “bulges” every lunar day, coastal areas experience two high and two low tides every 24 hours and 50 minutes. High tides occur 12 hours and 25 minutes apart. It takes six hours and 12.5 minutes for the water at the shore to go from high to low, or from low to high.



Does Anything Else Affect Tides?

The sun has a part to play in tides as well. For instance, when the sun’s gravitational pull lines up with the moon’s gravitational pull, the tides are more extreme.

Wind and weather patterns also can affect tides. Strong offshore winds can move water away from coastlines, exaggerating low tides. Onshore winds can push water onto the shore, making low tides much less noticeable.

High-pressure weather systems can push down sea levels, leading to nice sunny days with particularly low tides. Low-pressure systems that lead to cloudy, rainy days often cause tides that are much higher than predicted, so watch out!

Quiz

1 According to the article, each of the following contributes to the variation in tides EXCEPT:

(A) the formation of weather systems

(B) the presence of land masses

(C) the mass of the moon

(D) the shape of the Earth

2 Which sentence BEST summarizes how the sun affects the ocean tides?

(A) The length of the solar day dictates the length of time between high and low tides.

(B) Solar winds have the capacity to magnify the effects that low tides have on coastlines.

(C) Sunny days are linked to high-pressure weather systems that create low tides.

(D) Tides can intensify when the sun's gravitational pull aligns with the moon's gravitational pull.

3 Which of the following topics is discussed in the article, but is NOT represented in any of the graphics?

(A) the effect of the continents on high and low ocean tides

(B) the variations that can exist between high and low tides

(C) the interaction between inertia and the gravity pulling Earth

(D) the sun's gravitational role in generating tides on Earth

4 Read the caption below the photo at the top of the article. Based on the information in the caption and article, which of the following conclusions is MOST reasonable?

(A) At the time the picture was taken, the difference between high and low tide was very drastic.

(B) At the time the picture was taken, California was experiencing inertia counterbalancing gravity.

(C) At the time the picture was taken, California was about 12 hours away from the next tidal bulge.

(D) At the time the picture was taken, California was about six hours away from the next tidal bulge.

Answer Key

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