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The biggest tide of the century—again!

Every so often the newspapers announce the biggest tide of the century. The interval between such announcements seems to me to be just long enough for readers to have forgotten when they saw it last. The latest pronouncements concern the tide on December 22, which on Gabriola means December 24 because we're on island time. If you've been to the beach at night recently, you'll have noticed how low the spring tides are. Many a clam has gone the chowder-pot route to shellfish heaven, and if you have low bank waterfront, you'll have been anxiously watching the high tides come and go.

Tidewise, December 22, 1999 is (was) certainly an unusual date. Not since 1866 has the winter solstice, a full moon, and perigee—the moon's closest approach to earth—all occurred on the same day. These are important factors that go into determining tidal range, but as writers of articles know, they aren't the only ones. If you want a *really* big tide, you look for a spring tide, at perigee, at solar solstice, when the moon is the highest that it ever gets in the sky. It doesn't happen too often because the moon only reaches its height limit every 18.6 years and there's only a small chance the other three factors will be right when it does. December 27, 1818 was good; the low tide on Gabriola that day must have been several inches lower than it has been recently. But as for 1866—well I set my computer searching for a bigger tide and in no time at all it came up with 1991 when the local tides around the winter solstice were much the same as back then, even though there weren't the same-day coincidences.

So why do tides vary so much? Giving a short answer is a challenge—but I'll give it a go. **What causes tides?** The gravitational pull of extraterrestrial bodies, practically only the sun and moon, but in principle everything else in the Universe too. **Why?** Two reasons. Firstly, the pull from celestial objects changes direction as they move about in the sky; secondly, the strength of their pull varies. When an object is high in the sky, you're a tiny bit closer to it than when it's below the horizon, so it's pull for you is stronger.

Spring tides are? When lunar and solar tides coincide around the time of full and new moon. **The lunar tide is stronger than the solar tide, right?** In principle yes. The solar tide is only 46% as strong. However, this is altered by the shape of the ocean. Where we live, the lunar tide is relatively weaker than normal; tides tend to be always out during the day in the summer, something that wouldn't happen if the solar tides were less significant. It's because the water in the Juan de Fuca Strait and the Strait of Georgia seesaw in a resonant response to the rhythmic pull of the moon. We live fairly close to the pivot point of this seesaw, though not as close as Victoria. Near the pivot, the lunar tide is subdued and the solar tides appear stronger.

Why are there two tides a day? Take the sun first, it's easier. At noon, because you are closer to the sun than is the earth's centre, the pull of the sun is stronger than the pull needed to keep the earth in its chosen orbit around the sun. The water moves toward the sun in response to this extra pull creating a high tide. At midnight, because you are further away from the sun than is the earth's centre, the pull is a bit weaker than the pull needed to keep the earth in its chosen orbit. It's not so weak that everything not tied down flies off into space—but the water does move upward a bit, just as it did at noon, creating a second high tide. It's similar for the moon, but instead of considering the earth's orbiting of the sun, you have to consider the earth's orbiting of the common centre of gravity of the earth and moon.

So why are the two daily tides different heights? Imagine the two tidal bulges on opposite sides of the earth as an oval football with the long axis pointing at the sun let's say. Near the ends of the ball, the solar tides are high, and near the waist they're low. The ball rotates around the earth's axis tracking the apparent movement of the sun. As the ball spins around, the end in the northern hemisphere passes closer to us than the end in the southern hemisphere. The bulge passing closer creates a higher tide. Only at the solar equinoxes, when the two ends are on the equator, are the two daily solar tides the same. There are exactly equivalent effects for the moon with different timings.

Why aren't the tides at noon around midsummer's day high tides? Again, it's because of the shape of the ocean. The sea is slow to respond to tidal forces—it takes nearly five hours for the tides in the open Pacific to reach us. The tide is high on midsummer's day somewhere out there, but we don't see the effect till the early evening.

Anything else? A couple of things. The moon's position in the sky is constantly changing as it responds to the complex pattern of gravitational pulls of the sun, earth, and other planets. One day's tides are never exactly like any other's. Tidal forces are actually very small but their effects are amplified because the forces are rhythmic and they set up resonances involving both whole oceans and purely local waters. It's why tides vary from place to place. And finally there's the weather. When atmospheric pressure is low, the ocean rises, and vice versa. And then there's the wind. Coastal flooding is practically always due to a combination of astronomical and bad-weather effects.

So there you are. Remember you saw it here first; there's another biggest tide of the century coming soon!