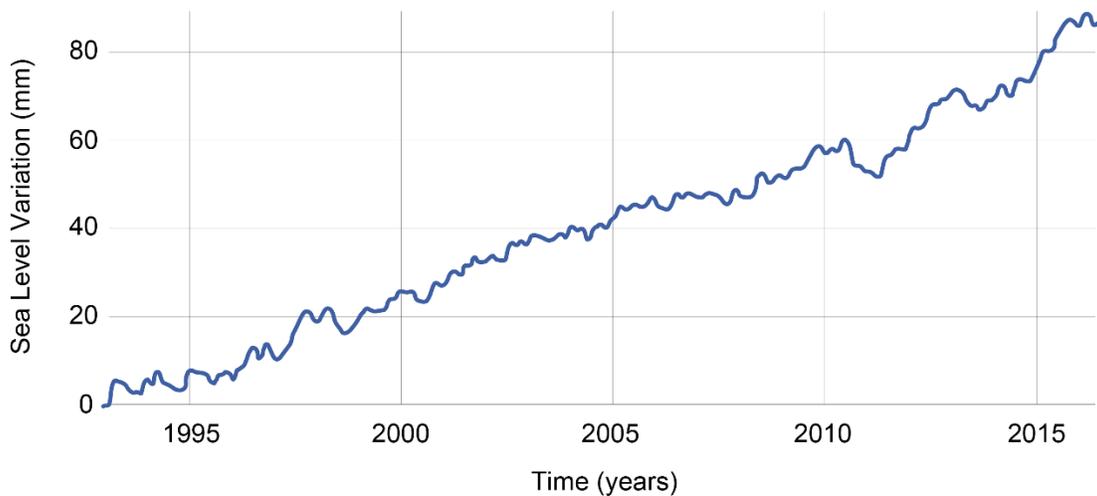


Our Ocean Backyard — *Santa Cruz Sentinel* columns by Gary Griggs, Director, Institute of Marine Sciences, UC Santa Cruz.

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Measuring a Rising Ocean**



Source: climate.nasa.gov

Sea level rise from satellite altimetry.

While we get to vote on a lot of things, we don't get to vote on climate change and sea-level rise. The climate is warming and sea level is rising in response. We can measure sea-level rise, and we've been keeping track at hundreds of water level recorders around the world for over a century.

The closest recording gages to Santa Cruz are in Monterey and San Francisco and you can check their records at:

<http://tidesandcurrents.noaa.gov/sltrends/sltrends.shtml> You can also look at sea-level rise for any of the other tide gages scattered around the world's coastlines.

The gage at the Golden Gate is the oldest in the nation has been keeping track of sea level since 1855, or for 160 years. The station in Monterey is newer and its record goes back about 40 years.

What do these gages actually measure and what do they tell us? A tide gage is essentially a large pipe, extending vertically down into the water, and anchored on some solid structure such as a breakwater, a wharf or even a solid rock outcrop. Using a float, the gage faithfully records the level of the water surface, day after day, year after year. These were originally emplaced to provide warnings to ship captains of what kind of water depths they had to be concerned with at different tidal stages as they entered ports and harbors.

Over time, however, it became clear that the water levels were rising at most stations around the planet at pretty regular rates. At the Golden Gate, the average historic rate has been about 2 mm/year or 7.6 inches every century. Monterey is a little lower, about 5.5 inches every 100 years.

If you look at the NOAA tide gage website listed above (and you can move around on the map to check different coastal locations around the planet), you will see that the rate of sea-level rise isn't the same at all stations. This might initially seem confusing. Shouldn't global sea level be rising at the same rate everywhere?

The explanation for these differences is that gages are mounted on land or a stable structure attached to the land, like a wharf. Many coastlines around the world, however, are rising or sinking so what the gages are actually recording is how sea level is changing relative to the adjacent land.

For some extremes, we can look at two areas 3000 miles apart, Skagway, Alaska, and Eugene Island, Louisiana, not far from New Orleans. At Skagway, sea level is actually dropping relative to the land at 5.8 feet/century, or almost $\frac{3}{4}$ of an inch per year! At Eugene Island, sea level is rising at 3.2 feet/century ($\frac{3}{8}$ of an inch/year), over five times the global average.

Why? Well, Skagway was covered with thousands of feet of ice during the last ice age, which depressed the land surface, much like sitting down on your mattress. When the last ice age ended about 18,000 years ago, the glaciers began to melt and retreat. In response, the land began to rebound, like your mattress when you stand up, only slower - much slower- it's taken thousands of years.

So while sea level is rising in Alaska, the land is rising much faster than sea level. So sea level is actually dropping relative to the land. Alaska isn't worried about sea-level rise.

At the other extreme, Eugene Island and New Orleans on the Mississippi River Delta are subsiding. This is from a combination of ground water and petroleum extraction, and also from the extra weight placed on the seafloor by many thousands of feet of Mississippi River sediment that have been deposited over millions of years.

Much like the glacial ice in Alaska, this thick pile of sediments also has depressed the coastline; think about more people sitting on the bed. So while sea level is rising at Eugene Island, the land is also sinking, making the sea-level rise rate even greater, 3.2 feet per century. This is why New Orleans has levees surrounding it, and why anyone living there should be very concerned about the future of sea-level rise and the next hurricane.

Our global sea-level rise rate historically has been determined by averaging out all of the global tide gages, which produced an average rate of about 1.7 mm/year or seven inches per 100 years for most of the last century.

In 1993, some extremely smart and very clever scientists solved the problem of the uncertainty of averaging tide gage records from around the planet. Two satellites were launched that use radar to measure the elevation of the sea surface from space, very precisely, to give an absolute global value for sea level over time.

What this requires is that the global positioning system on those satellites has to know down to a fraction of an inch, exactly where those satellites are. And what these measurements indicate is that since 1993, global sea level has risen at a rate of 3.34 mm/year, or just over 13 inches per century, nearly twice as rapidly as it did throughout most of the 20th century.