

Our Ocean Backyard — *Santa Cruz Sentinel* columns by Gary Griggs, Distinguished Professor of Earth and Planetary Sciences, UC Santa Cruz.

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Antarctica's Ice and California's Shoreline

In January of this year I wrote about an iceberg the size of Delaware that had come close to breaking off of Antarctica. For me the size of Delaware is a little abstract as I've never been there.

Coming close to home for an analogy, combining Santa Cruz, San Mateo, San Francisco and Santa Clara counties gives us that same 2200 square mile area of that iceberg. That's a big chunk of frozen water. That iceberg, named Larsen C, did crack off a month ago and is now breaking up into Santa Cruz County sized pieces, which are drifting into the Southern ocean to become potential hazards to ship traffic.

While this was an extraordinarily large ice cube, it didn't raise sea level, simply because it was already floating. It's a little hard to imagine, but when floating icebergs melt, they don't raise sea level. If you don't believe this, fill up a glass half full of water and then add ice cubes. Mark the level of the water and see if it changes as the ice cubes melt.

The floating ice-shelves like this one, however, do play an important role around the edges of Antarctica in holding back a number of massive glaciers, much like a cork in a champagne bottle. As long as the cork stays in the bottle, the champagne

stays put. Recent work in Antarctica, however, is giving us cause for concern as we begin to better understand the processes that are starting to destabilize these floating corks.

The most recent analysis indicates that a warming ocean is eating away at the undersides of these ice shelves, and rising air temperatures are melting them from above. The meltwater drains downward and forms cracks that can cause an ice shelf to break off.

While we don't know with any certainty when any of these Antarctic shelves or corks are likely to break off, we believe the process is accelerating. When this happens the rate at which the land-based glaciers will move into the ocean will accelerate and we will likely see a significant increase in the rate of sea-level rise from the additional meltwater.

A 2016 study improved our understanding of this Antarctic ice break up process. The potential for a rapid future rise in sea level came to Governor Brown's attention. He wanted to know what this might mean for coastal California and requested that a working group be appointed to produce a summary report on sea-level rise within two months.

Whether power plants, sewage treatment facilities, airports, highways, railroads, bridges, homes, businesses, or public infrastructure, there is a lot at stake with a rising sea for California's shoreline, and the governor wanted to know what the risks were so the state could better plan for projected future sea levels.

This is not a question of whether or not this will happen; it's going to happen. The question is how high sea level is likely to be by some future date, specifically 2030, 2050 or 2100. And there is a lot of ice in Antarctica to be concerned about; roughly 190 feet of sea-level rise were it all to melt.

This isn't going to happen any time soon; not in this century or the next, but then it doesn't all need to melt to create serious problems for coastal cities and communities around the planet, including California. Just two or three percent would create a disaster for California's coast, not to mention the rest of the world.

The working group released their report in April of this year, *Rising Seas in California: An Update on Sea-Level Rise Science*, which is available on-line at: <http://www.opc.ca.gov/webmaster/ftp/pdf/docs/rising-seas-in-california-an-update-on-sea-level-rise-science.pdf>

The report concludes that 1] the direction of sea level change is clear; 2] the rate of ice loss from both Antarctica and Greenland is increasing; 3] the potential exists for extreme sea-level rise in this century; 4] probabilities for specific sea levels can inform land-use decisions and help us plan for the future.

For central California, the most likely range of sea level rise for 2030 is between 4 and 6 inches higher than 2000, and for 2050 between 7 and 13 inches higher. If the nations of the world stick to the Paris climate agreement on greenhouse gas emission reductions, we could hold sea-level rise to an additional 12 inches by 2100. But if we continue with business as usual, sea level could be 40 inches higher or more. This would not be good news for coastal California.