

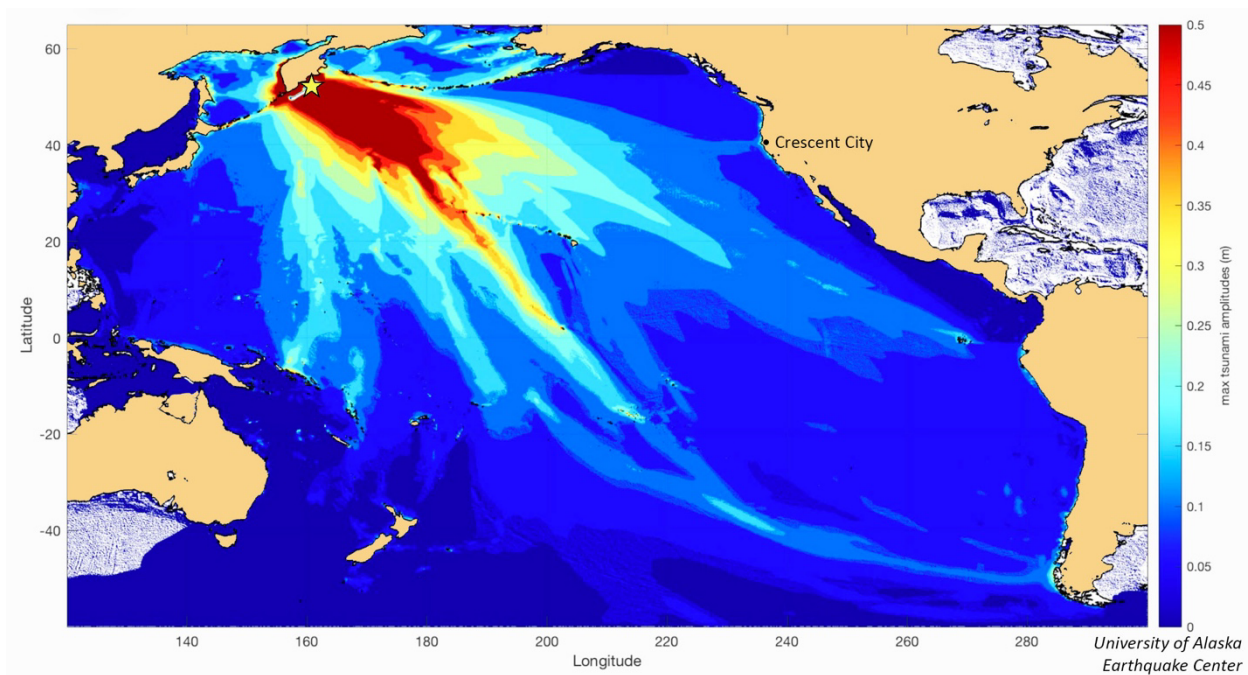
Times Standard

Not My Fault: Largest earthquake in 14 years triggers tsunami alerts throughout the Pacific

Lori Dengler for the Times-Standard

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Modeled tsunami amplitudes in the deep ocean for the July 29, 2025 M8.8 earthquake near Kamchatka (epicenter shown by star). Note the finger of higher amplitudes that heads to California's North Coast (model from the University of Alaska Earthquake Center).

Like many of you last Tuesday evening (7/29/25), I was jarred by the blare of my cell phone announcing a tsunami WARNING. The alert was in response to a magnitude 8.8 earthquake that had occurred roughly four hours earlier 3,500 miles away off the coast of Russia's Kamchatka Peninsula.

The scope of tsunami impact is like no other hazard on the planet. Great earthquakes can trigger tsunami surges that attack nearby coastlines within minutes but still pack a large enough punch to damage distant shores more than a day later. The surges always last for hours, and in some locations, for days. Unlike hurricanes and other storms, we can't observe the source area directly and must infer their behavior on the basis of modeling and few direct data points.

Last Tuesday's great earthquake and ensuing tsunami was not catastrophic. No deaths have been attributed to either ground shaking or directly linked to tsunami impacts. Tsunami surges in excess of 20 feet swept away structures in Kamchatka and the Kuril Islands and damages to

piers and docks in Crescent City's harbor are estimated at near a million dollars. But the casualty numbers are nothing like 2011 Japan or 2004 in the Indian Ocean.

I didn't realize when I was writing my column last week, that it was an inadvertent introduction to this one. I briefly mentioned the Kamchatka July 20th M7.4 and how it triggered tsunami threat messages for Russia and a tsunami watch for Hawaii. It was never of significant concern to us. I had no idea that the 7.4 would end up being a foreshock of this week's M8.8, an hors d'oeuvres so to speak, and that the main course would be more impactful.

Lesson 1 – Whenever an earthquake occurs there is always a chance that a larger one will follow. The current Kamchatka sequence began with earthquakes on July 20th, including a 6.6 that triggered a “no tsunami threat” message. Twenty-one minutes after the 6.6, the 7.4 occurred and was followed by many aftershocks including five in the M6 range. There was nothing about these earthquakes that suggested something bigger was about to occur but always a statistical chance that it could. Tuesday's M8.8 rupture encompassed the earlier earthquakes and extended roughly 300 miles further to the southwest. There may have been suggestions of what was to come almost a year ago. Last August, a 7.0 occurred in the same area as the recent earthquakes, perhaps setting the stage for this week's activity.

My first alert on Tuesday was at 5:35 PM local time when a National tsunami Warning Center (NTWC) message alerted me to a magnitude 8.0 offshore of Kamchatka. That first bulletin triggered an ADVISORY for the western Aleutian Islands and stated other areas of Alaska and the North American West Coast were being analyzed. The Pacific Tsunami Warning Center (PTWC) also issued alerts – a THREAT message to foreign countries stating a tsunami hazard to Japan and Russia, and a WATCH for Hawaii and Pacific territories.

That got my attention, and I went to NOAA's Global Tsunami Database to look up information on the 1952 tsunami. Everyone in the tsunami science world knows about the November 1952 M9.0 earthquake that was the first big test for the U.S. tsunami warning system that had only become operational three years before. It caused 12-foot surges in Hilo and a million (1952 \$\$) in property damages to Hawaii, and a three-foot high tsunami in Crescent City. A 9.0 is much larger than an 8.0 so my first hunch was this is probably not a big issue for the U.S. West Coast. But there was one important difference in 1952. That was before Crescent City's small boat basin was built and I had published papers on how the basin shape exacerbated tsunamis.

The second NTWC bulletin arrived 44 minutes after the first and completely changed the tsunami hazard landscape. The USGS analysis had upped the magnitude to 8.7. The protocols for an earthquake of this size are different than for an 8.0 and put the W Aleutians into a WARNING, an ADVISORY for the central Aleutians, and a WATCH for the U.S. West Coast. Watch means the first tsunami waves are still hours away and there is time for further study before deciding on the alert status.

Lesson 2 – Great earthquakes are hard to pin down. Earthquakes in the upper 8 to 9 range involve faults with dimensions of hundreds of miles. It takes minutes for the entire rupture to finish. The amplitude of the seismic waves and the overprinting of different phases makes it difficult to quickly determine the size. The Kamchatka quake would be further upgraded to M8.8 later that day and more detailed analyses in the coming weeks could tweak it further.

Always be wary if an 8.0 pops up as an initial magnitude – it could actually be much bigger. As the magnitude is reassessed, the warning levels may change.

It was a long afternoon and evening. Once the revised magnitude came in and the hazard area expanded, California's response agencies kicked into gear, and the media calls arrived. I've been working with State and County Office of Emergency Services (OES) folks since my first tsunami experience in 1992 and over the years a tight organizational structure has evolved with hourly conference calls to keep everyone abreast of the NTWC forecasts and likely response.

Time is the big advantage when an earthquake occurs far away. There is time to revise magnitudes and the source parameters. There is time to run models to forecast the likely water heights. There is time for the tsunami to pass over ocean bottom instruments and coastal tide gauges from sites closer to the epicenter. This data refines forecasts. December 5 was a different story. The M7 was only 40 miles offshore and first tsunami arrivals less than a half hour away. Decisions had to be made quickly and be conservative to allow room for error.

NTWC's third bulletin came out at 6:30 PM. It placed the entire U.S. West Coast into an ADVISORY. That doesn't trigger cell phone warnings or the Emergency Alert System (EAS), but it puts emergency response personnel on high alert. Advisory means little threat of flooding – the highest water won't exceed the highest king tides – but low areas like beaches and harbors are likely to experience extremely strong currents that can be both damaging and deadly.

The bulletins kept coming in every hour. As time passed, the model refinement improved. Most of the California coast was looking at peak amplitudes of one to two feet above or below ambient tide levels. But there was one notable exception. Crescent City estimates were consistently falling into the four-to-six-foot range, certainly capable of causing modest inundation and very hazardous currents in the harbor. Crescent City Harbor officials had begun notifying boat owners and organizing an orderly evacuation of boats from the harbor while still in the Watch phase.





At 8:30 PM Tuesday evening, NTWC blew the whistle and placed the North Coast from Cape Mendocino to the Oregon border in a WARNING category. As soon as a warning is issued, a Wireless Emergency Alert (WEA) is issued, and EAS is activated. Unlike December 5th following our M7.0, this time we knew that the tsunami was going to be modest. None of the models forecast anything above 6 feet so we were able to temper the alert message on air and in the media that the only folks who needed to evacuate were people at low elevations very close to the coast.

Lesson 3 – Terminology is confusing. For most people there is little difference between the words threat, advisory, watch, and warning. These are qualitative terms and applied over a wide area (from breakpoint to breakpoint), but tsunami heights and impacts will vary considerably from place to place. We need a better system.

The warning was downgraded back to an advisory at 4:20 AM on Wednesday for Humboldt County but the warning remained for another four hours along the Del Norte coast. Messages continued to be issued – by message #19 the advisory had shrunk to central California and Del Norte. Central California was deemed clear a few hours later but it took until Thursday morning before the surges in Crescent Harbor to consistently fall below two feet and for NTWC to feel

confident about cancelling the advisory. As I write, the tsunami continues, and the currents are still too strong for divers to assess the full scope of damage in Crescent City.

Lesson 4 – Way too many messages. By the time the last cancellation was issued, NTWC had issued 35 bulletins, PTWC had issued 24 threat messages to foreign countries, 20 messages to Hawaii and 13 to Samoa. Most of these messages contained differing alert levels for different regions. The tsunami hazard can last a very long time but it's time for brilliant minds to come up with a clearer and less complicated way to convey hazard information.

U.S. Tsunami Alert Messages		
Alert Name	Actions	Potential Hazards
 WARNING	Get to high ground or inland IMMEDIATELY Follow tsunami evacuation signage	DANGER! TSUNAMI IMMINENT! Flooding/powerful currents Wave heights > 3 ft. or unknown
 ADVISORY	Stay out of the water and away from the shore	STRONG CURRENTS AND DANGEROUS WAVES in or very near coastal water Wave heights of 1 - 3 ft.
 WATCH	Be prepared to take action Stay tuned to local radio/TV/ NOAA "alert" weather radios	TSUNAMI IS POSSIBLE Alert level may change once more information is known
 INFORMATION STATEMENT	No action needed	NO TSUNAMI IMPACT EXPECTED Alert level may change once more information is known
THREAT Message: Intended to alert international partners only. Not applicable to U.S. coasts		

U.S. tsunami message definitions. There is no distinction for local or distant tsunamis and no gradational levels for moderate or large tsunamis. In large tsunamis like Kamchatka, the alert levels are likely to change as the event progresses.

Next week a deeper dive into why Crescent Harbor is one of the world's foremost tsunami magnets and why this tsunami was not as bad as it could have been.

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