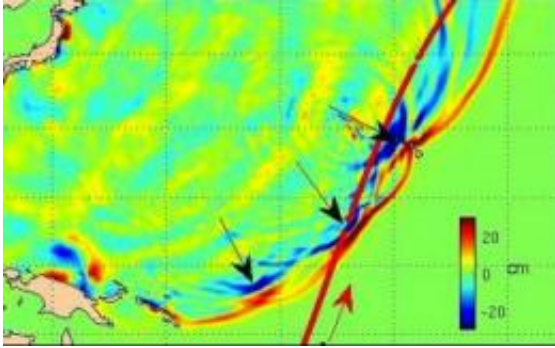


# 'Double tsunami' doubled Japan destruction

December 5 2011, by Pam Frost Gorder

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A 3-D ocean model created by Y. Tony Song of NASA's Jet Propulsion Laboratory and colleagues replicates the March 11, 2011 tsunami. The red line shows the path of the Jason-1 satellite, which crossed the wave front at the site of a double-high wave. Credit: Image courtesy of NASA

Researchers have discovered that the destructive tsunami generated by the March 2011 Tōhoku earthquake was a long-hypothesized "merging tsunami" that doubled in intensity over rugged ocean ridges, amplifying its destructive power before reaching shore.

Satellites captured not just one wave front that day, but at least two, which merged to form a single double-high wave far out at sea – one capable of traveling long distances without losing its power. Ocean ridges and undersea mountain chains pushed the waves together, but only along certain directions from the tsunami's origin.

The discovery helps explain how tsunamis can cross ocean basins to

cause massive destruction at some locations while leaving others unscathed, and raises hope that scientists may be able to improve [tsunami](#) forecasts.

At a news conference Monday at the American Geophysical Union meeting in San Francisco, Y. Tony Song, a research scientist at NASA's Jet Propulsion Laboratory (JPL); and C.K. Shum, professor and Distinguished University Scholar in the Division of Geodetic Science, School of Earth Sciences at Ohio State University, discussed the satellite data and simulations that enabled them to piece the story together.

"It was a one-in-ten-million chance that we were able to observe this double wave with satellites," said Song, the study's principal investigator. "Researchers have suspected for decades that such 'merging tsunamis' might have been responsible for the 1960 Chilean tsunami that killed many in Japan and Hawaii, but nobody had definitively observed a merging tsunami until now."

"It was like looking for a ghost," he continued. "A NASA/French Space Agency satellite altimeter happened to be in the right place at the right time to capture the double wave and verify its existence."

Shum agreed. "We were very lucky, not only in the timing of the satellite, but also to have access to such detailed GPS-observed ground motion data from Japan to initiate Tony's tsunami model, and to validate the model results using the satellite data. Now we can use what we learned to make better forecasts of tsunami danger in specific coastal regions anywhere in the world, depending on the location and the mechanism of an undersea quake."

The NASA/Centre National d'Etudes Spaciales Jason-1 satellite passed over the tsunami on March 11, as did two other satellites: the NASA/European Jason-2 and the European Space Agency's EnviSAT.

All three carry a radar altimeter, which measures sea level changes to an accuracy of a few centimeters.

Each satellite crossed the tsunami at a different location. Jason-2 and EnviSAT measured wave heights of 20 cm (8 inches) and 30 cm (12 inches), respectively. But as Jason-1 passed over the undersea Mid-Pacific Mountains to the east, it captured a wave front measuring 70 cm (28 inches).

The researchers conjectured ridges and undersea mountain chains on the ocean floor deflected parts of the initial tsunami wave away from each other to form independent jets shooting off in different directions, each with its own wave front.

The sea floor topography nudges tsunami waves in varying directions and can make a tsunami's destruction appear random. For that reason, hazard maps that try to predict where tsunamis will strike rely on sub-sea topography. Previously, these maps only considered topography near a particular shoreline. This study suggests scientists may be able to create maps that take into account all undersea topography, even sub-sea ridges and mountains far from shore.

Song and his team were able to verify the satellite data through model simulations based on independent data, including the GPS data from [Japan](#) and buoy data from the National Oceanic and Atmospheric Administration's Deep-ocean Assessment and Reporting of Tsunamis program.

"Tools based on this research could help officials forecast the potential for tsunami jets to merge," said Song. "This, in turn, could lead to more accurate coastal tsunami hazard maps to protect communities and critical infrastructure."

Song and Shum's collaborators include Ichiro Fukumori, an oceanographer and supervisor in JPL's Ocean Circulation Group; and Yuchan Yi, a research scientist in the Division of Geodetic Science, School of Earth Sciences at Ohio State.

Provided by The Ohio State University

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