# Pacific sea level predicts global temperature changes

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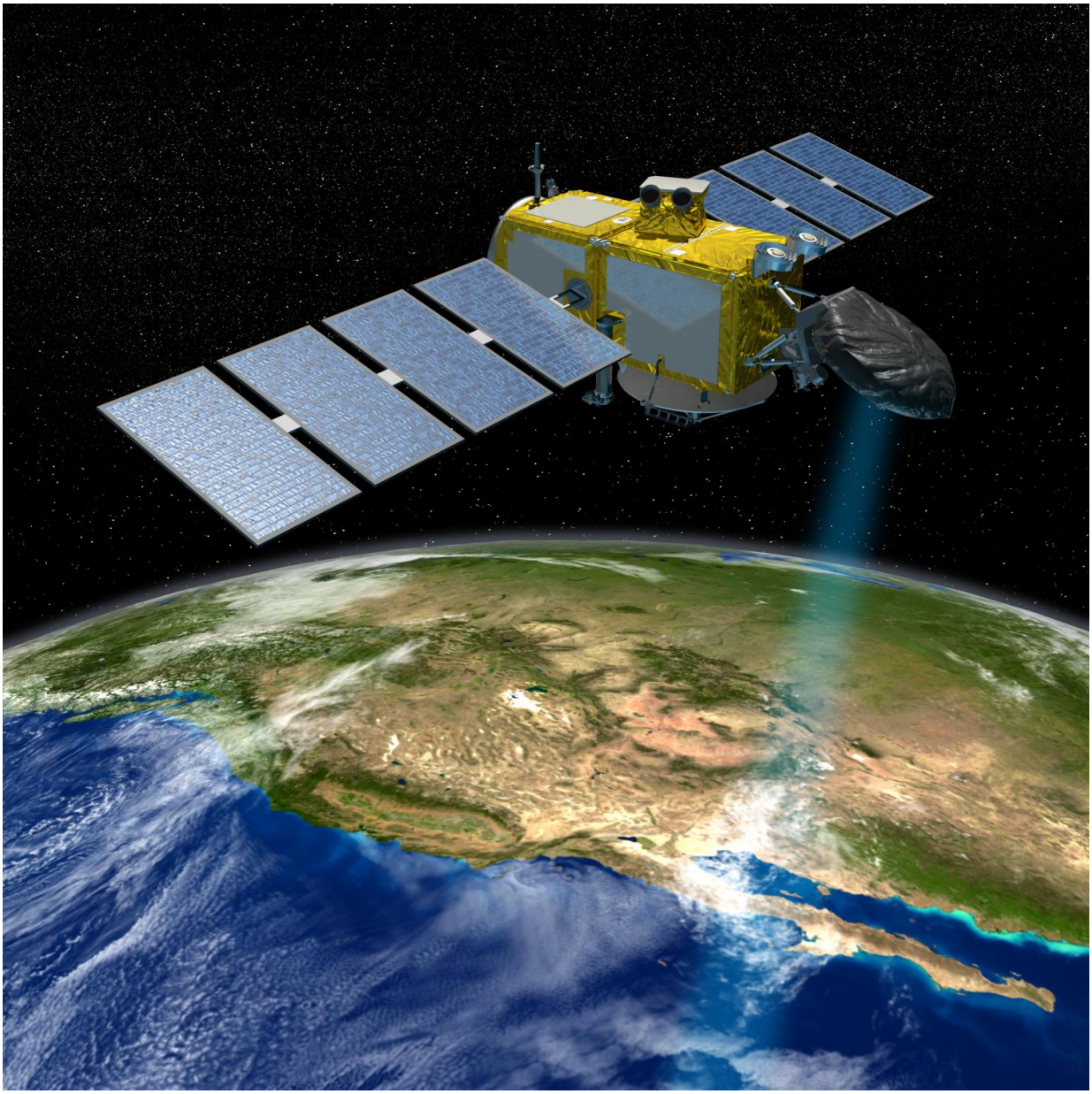

The Jason series of US/European satellites can measure the height of the ocean surface. Credit: NASA/JPL-Caltech

The amount of sea level rise in the Pacific Ocean can be used to estimate future global surface temperatures, according to a new report led by University of Arizona geoscientists.

Based on the Pacific Ocean's sea level in 2015, the team estimates by the end of 2016 the world's average surface temperature will increase up to 0.5 F (0.28 C) more than in 2014.

In 2015 alone, the average global surface temperature increased by 0.32 F (0.18 C).

"Our prediction is through the end of 2016," said first author Cheryl Peyser. "The prediction is looking on target so far."

Scientists knew that both the rate at which global surface temperature is rising and sea level in the western Pacific varied, but had not connected the two phenomena, said Peyser, a UA doctoral candidate in geosciences.

"We're using sea level in a different way, by using the pattern of sea level changes in the Pacific to look at global surface temperatures - and this hasn't been done before," she said.

Peyser and her colleagues used measurements of sea level changes taken by NASA/NOAA/European satellites starting in 1993.

Using sea surface height rather than sea surface temperatures provides a more accurate reflection of the heat stored in the entire water column,

said co-author Jianjun Yin, a UA associate professor of geosciences.

"We are the first to use sea level observations to quantify the global surface temperature variability," Yin said.

The team found when sea level in the western Pacific rises more than average—as it did from 1998 to 2012—the rise in global surface temperatures slows.

In contrast, when sea level drops in the western Pacific but increases in the eastern Pacific as it did in 2015, global surface temperatures bump up because the heat stored in the ocean is released, Yin said.

The paper by Peyser, Yin, Felix Landerer of NASA's Jet Propulsion Laboratory, Pasadena, California, and Julia Cole, a UA professor of geosciences, titled, "Pacific Sea Level Rise Patterns and Global Surface Temperature Variability," is being published online in *Geophysical Research Letters*.

People already knew the tropical Pacific Ocean was relatively higher in the west—the trade winds blow from east to west, piling up water on the western side of the Pacific.

However, the degree of the tilt from west to east changes over time, much like a seesaw. Sometimes the western Pacific near Asia is much higher than the ocean's eastern coast with the Americas. At other times, Pacific sea level in the west is not much greater than sea level in the east.

Others had documented that two different climate cycles, the Pacific Decadal Oscillation and the El Niño/La Niña cycle, affected how much the surface of the Pacific Ocean tilted from west to east.

From 1998 to 2012, the rate at which the global surface temperature

increased slowed down—a phenomenon dubbed "the global warming hiatus." During the same time period, sea level in the western tropical Pacific Ocean increased four times faster than the average global sea level rise.

Yin wondered if the two phenomena - sea level and global surface temperature—were related and asked Peyser, his graduate student, to investigate.

To figure out whether there was a connection, Peyser used state-of-the-art climate models that show what the climate system would do in the absence of global warming.

The models showed that changes in sea level in the western Pacific were correlated with changes in global surface temperature.

Verifying the correlation allowed the researchers to calculate the numerical relationship between amount of tilt and global surface temperature.

Once the researchers had the correlation, they used actual Pacific sea level data from satellites to calculate the Pacific Ocean's contribution to global surface temperature.

"What I found was that during years when the tilt was steep in the western Pacific, global average temperature was cooler," she said. "And when the seesaw is tilted more toward the eastern Pacific, it's warmer."

"We could say that for a certain amount of change in the tilt, you could expect a certain change in the temperature," she said. "Natural variability is a really important part of the climate cycle."

Understanding the variability is crucial for understanding the

mechanisms underlying the warming hiatus, Yin said.

During the global warming hiatus, more heat was being stored in the deeper layers of the western Pacific Ocean, muting warming at the surface, the researchers said. Because warmer water expands, that stored heat contributed to the extreme sea level rise in the western Pacific during that time.

Starting in 2014 the ocean's tilt started to flatten out as the climate cycle changed to an El Niño pattern. The heat previously stored in the ocean was being released, warming the Earth's surface and reducing sea level in the western Pacific.

Yin was surprised to find the Pacific Ocean plays such an important role in the global surface temperature. He said, "Our research shows that the internal variability of the global climate system can conceal anthropogenic global warming, and at other times the internal variability of the system can enhance anthropogenic warming."

The next step, he said, is figuring out the mechanisms that allow the Pacific to change the global surface temperature so quickly.

**More information:** Cheryl E. Peyser et al, Pacific sea level rise patterns and global surface temperature variability, *Geophysical Research Letters* (2016). DOI: 10.1002/2016GL069401

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