Weak winds in the Pacific drove record-breaking 2019 summertime marine heat wave

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Giant kelp (Macrocystis pyrifera). California, Channel Islands NMS. Credit: Claire Fackler, CINMS, NOAA

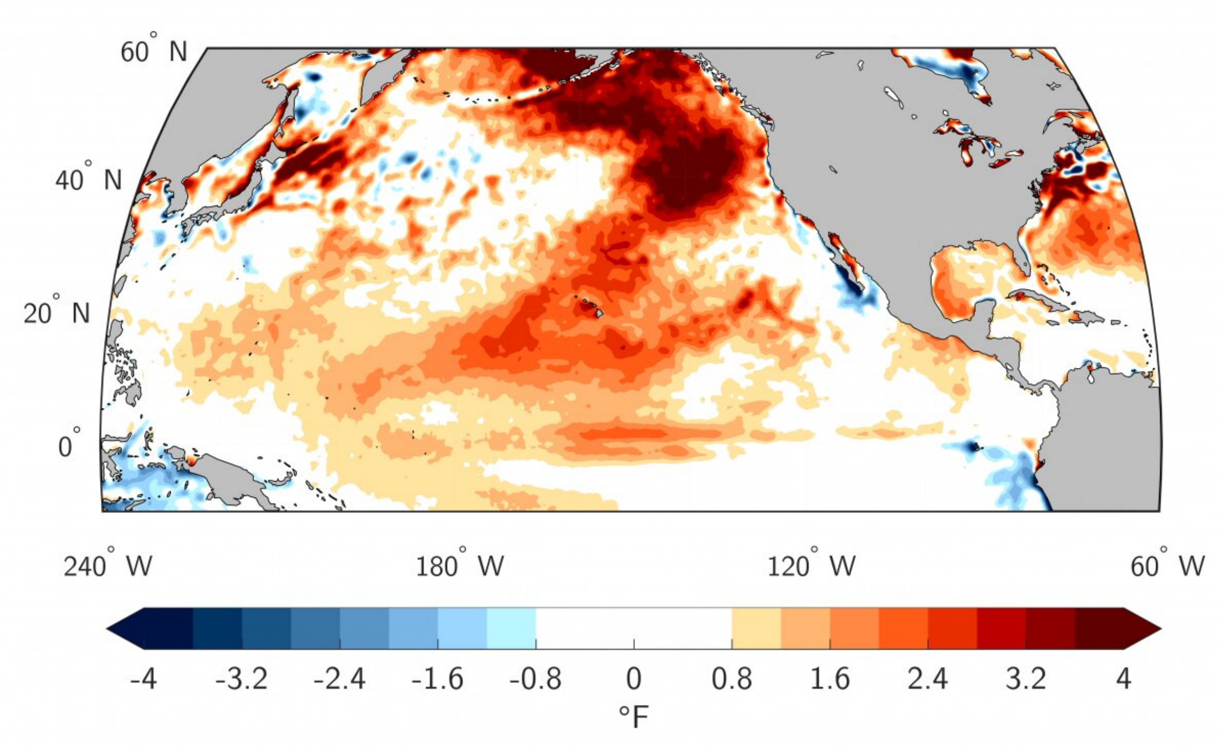
Weakened wind patterns likely spurred the wave of extreme ocean heat that swept the North Pacific last summer, according to new research led by the University of Colorado Boulder and the Scripps Institution of Oceanography at the University of California San Diego. The marine heat wave, named the "Blob 2.0" after 2013's "Blob," likely damaged marine ecosystems and hurt coastal fisheries. Waters off the U.S. West Coast were a record-breaking 4.5 degrees F (2.5 degrees C) above normal, the authors found.

"Most large marine heat waves have historically occurred in the winter," said Dillon Amaya, a postdoctoral Visiting Fellow at CIRES and lead author on the new study out this week in *Nature Communications*. "This was the first summertime marine heat wave in the last five years—and it's also the hottest: a record high ocean temperature for the last 40 years."

And that wasn't the only record: 2019 also saw the weakest North Pacific atmospheric circulation patterns in at least the last 40 years. "This was truly a 99th-percentile type of event, with impacts like slow winds felt around the North Pacific," Amaya said.

To search for physical processes that might have influenced the formation of Blob 2.0 in summertime, the team paired real world sea surface temperature data with an atmospheric model, and tested the impacts of various possible drivers.

The most likely culprit: weaker winds. In short, when circulation patterns weaken, so does the wind. With less wind blowing over the ocean's surface, there's less evaporation and less cooling: The process is similar to wind cooling off human skin by evaporating sweat. In 2019, it was as if the ocean was stuck outside on a hot summer day with no wind to cool it down.



Satellite measurements of sea surface temperatures, averaged during june-august of 2019. reds are warmer than normal, blue are colder than normal. Data is from the NOAA optimum interpolation daily sst analysis. Credit: Dillon Amaya, CIRES

A thinning of the ocean's mixed layer, the depth where surface ocean properties are evenly distributed, also fueled the Blob 2.0, the researchers found. The thinner the mixed layer, the faster it warms from incoming sunlight and weakened winds. And the impacts can keep accumulating in a vicious cycle: the lower atmosphere above the ocean responds to warmer water by burning off low clouds, which leaves the ocean more exposed to sunlight, which warms the ocean more, and burns off even more clouds.

Warm ocean temperatures have the potential to devastate marine ecosystems along the U.S. West Coast During warmer months, marine plants and animals with a low heat tolerance are at higher risk than during the winter—warm on top of warm can be more harmful than warm on top of cold.

And with our changing climate, we may see more harmful impacts like this in years to come, the authors reported. As global warming continues, heat extremes like last summer's Blob 2.0 are becoming increasingly likely.

"It's the same argument that can be made for heat waves on land," said Amaya. "Global warming shifts the entire range of possibilities towards warmer events. The Blob 2.0 is just the beginning. In fact, events like this may not even be considered 'extreme' in the future."

The researchers hope these results will help scientists and decision makers better predict and prepare for future marine heat waves. "If we understand the mechanisms that drove this summertime event and how it influenced marine systems," Amaya said, "we can better recognize the early warning signs in the future and better predict how heat waves interact with the coast, how long they last and how destructive they might be."

More information: Dillon J. Amaya et al, Physical drivers of the summer 2019 North Pacific marine heatwave, *Nature Communications* (2020). DOI: 10.1038/s41467-020-15820-w

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