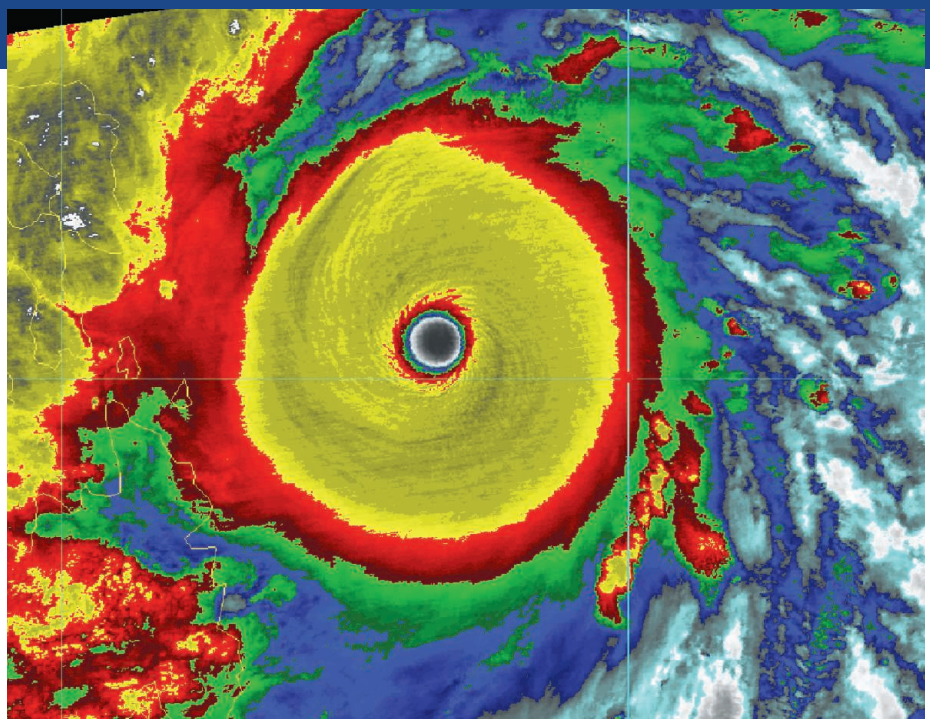


Feeding the monster. Unusually warm Pacific waters supercharged Haiyan.

CLIMATOLOGY

Clues to Supertyphoon's Ferocity Found in the Western Pacific

Tropical storm watchers agree that Haiyan was probably the strongest typhoon to make landfall when it slammed into the Philippines on 8 November, packing winds of up to 314 kilometers per hour. What gave Haiyan, which killed thousands and displaced millions, its deadly wallop?

Researchers think they have at least a partial answer to that question: unusually warm subsurface Pacific waters east of the Philippines. A related phenomenon—rising sea levels in the western Pacific—likely abetted Haiyan's devastating storm surge, which caused more deaths than the winds themselves.

Typhoons draw heat from the ocean for the energy that generates their winds. Typically, as a storm's winds increase, they stir up deeper, cooler ocean waters that temper its strength. This cooling effect "is nature's brake to stop typhoons from intensifying," says I-I Lin, a specialist in typhoon-ocean interactions at National Taiwan University in Taipei.

Drawing on data from satellite observations and Argo floats—thousands of instrumented, subsurface probes that measure ocean temperature, salinity, and current speeds—Lin and others have documented a steady 2-decade rise in subsurface temperatures in the western North Pacific and a bulging warm water layer. The warmer and thicker that subsurface layer, the more heat is available to feed a storm. Oceanographers use a measure called the Tropical Cyclone Heat Potential (TCHP) to quantify the heat reservoir. Lin and colleague Iam-Fei Pun reported online on 3 September in *Geophysical Research Letters* that the TCHP where most cyclones develop in the western North Pacific has increased 10% since the early 1990s (see graph). While surface waters along Haiyan's path were only slightly warmer than normal, waters down to 100 meters were 3° warmer than the historical average. So as Haiyan churned up western Pacific waters, it drew more wind-intensifying heat, Lin says.

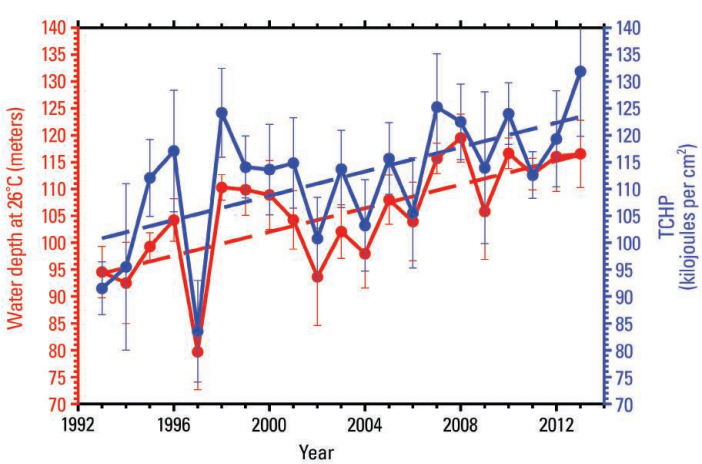
Other factors contributed to Haiyan's intensity. "The genesis location was very important," says Il-Ju Moon, a marine meteorologist at Jeju National University in South Korea who studies how ocean heat influences typhoons. Haiyan originated around 5° latitude north of the equator and was at about 10° when it hit land. "The ocean heat content is very high in that region," Moon says. And starting more than 3000 kilometers east of the Philippines gave Haiyan plenty of open water over which to strengthen.

Haiyan was a speed demon as well. "It was flying over the water" at 32 kilometers per hour, Lin says, nearly twice as fast as most typhoons travel. "Why it moved so fast is unknown," she adds. Researchers speculate that a fast-moving storm passes by before its churn pulls energy-sapping deeper, cooler water to the surface. In any case, "the warmer the subsurface layer, the faster the moving speed, the smaller the cooling effect," Lin says. "It's like a car without a brake, only an accelerator."

The warm bulge in the western North Pacific is the result of stronger easterly trade winds. This phenomenon also aggravated Haiyan's storm surge. In addition to blowing heat westward, the winds are literally piling up water in the western Pacific, where the cumulative sea-level rise over the past 20 years exceeds 20 centimeters, says Bo Qiu, an oceanographer at the University of Hawaii, Manoa. "It is likely that the elevated sea level contributed to the flood and inundation problems" in the Philippines, he says.

While many observers blame Haiyan's destructive power on climate change, tropical storm experts say there is little hard evidence of a link. "It is possibly natural variability," Lin says. Nor is it certain that the western Pacific has become a supertyphoon breeding ground. Although warmer subsurface waters might raise the risk, Lin says, atmospheric conditions may not always cooperate.

–DENNIS NORMILE



Heated situation. Over 2 decades, a thickening layer of warm water (red) increased the storm-driving heat potential (blue) at the latitudes Haiyan traversed.

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Published by AAAS