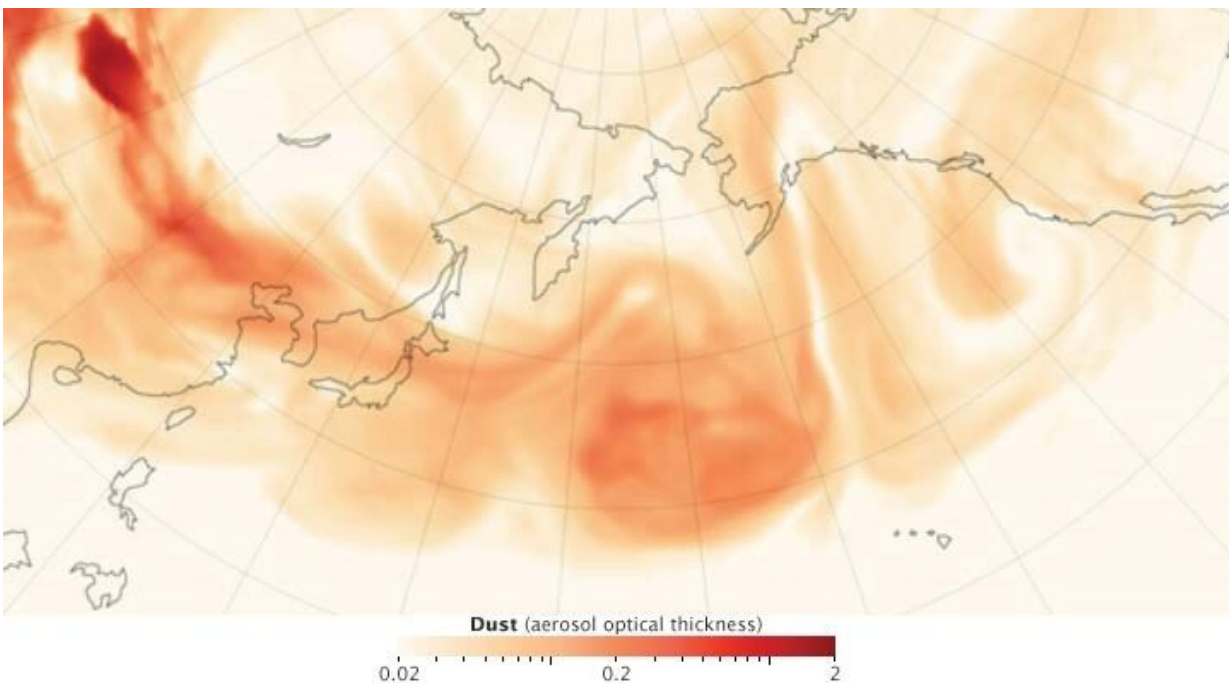


# Scientists discover unlikely culprit for fertilizing North Pacific Ocean: Asian dust

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NASA image of Asian dust transport over the North Pacific. Credit: Robert Simmon

The vast subtropical "gyres"—large systems of rotating currents in the middle of the oceans—cover 40 percent of the Earth's surface and have long been considered biological deserts with stratified waters that contain very little nutrients to sustain life.

These regions also are thought to be remarkably stable, yet scientists have documented one anomaly in the North Pacific Subtropical Gyre ecosystem that has puzzled oceanographers for years: The region's chemistry changes periodically, especially levels of phosphorous and iron, affecting the overall nutrient composition and ultimately its biological productivity.

In a new study published this week in *Proceedings of the National Academy of Sciences*, researchers document what induces these variations: changes in the amount of iron that is deposited into the [ocean](#) via dust from Asia.

"We now know that these areas that were thought to be barren and stable are actually quite dynamic," said Ricardo Letelier, an Oregon State University biogeochemist and ecologist, who in collaboration with David Karl at the University of Hawaii led this study. "Since these areas cover so much of the Earth's surface, we need to know more about how they work in order to better predict how the system will respond to climate variations in the future."

The study focused on the North Pacific Subtropical Gyre, and used three decades of observation data from Station ALOHA by the Hawaii Ocean Time-series program, which is funded by the National Science Foundation.

The surface layer of the North Pacific gyre is characterized by very clear waters with hardly any nutrients. The extraordinary optical clarity of these waters allows sunlight to penetrate deep into the [water column](#) and support photosynthetic activity below 100 meters (or 328 feet).

Typically, the ocean's upper water column is fertilized by [nutrient](#)-rich water mixing from the deep, but these waters are very stratified and little mixing takes place. Deeper water (hundreds to thousands of meters

below the surface) is enriched in nutrients through the decomposition of the remains of small organisms that grew and harvested the scarce nutrients in the surface layers before sinking toward the seafloor.

Both phosphorous and iron are key components for life and the researchers noticed that the levels of those nutrients in North Pacific gyre surface waters changed significantly during the three decades of the study.

Letelier said the team was able to relate these changes to the iron input from Asian dust—a combination of the desertification of that continent, with combustion, especially wildfires and factory output and the wind patterns across the North Pacific ocean—that accounted for the variance and provided varying amounts of nutrients to sustain life.

And a key to that variance is the Pacific Decadal Oscillation, an ocean-atmosphere relationship that varies between weak and strong phases of atmospheric pressure in the northeast Pacific. In years when the low pressure weakens, winds from Asia become stronger, move more southward, and bring more dust, fertilizing the ocean surrounding Station ALOHA. When the pressure strengthens, the opposite takes place.

Strong winds can bring significant amounts of iron, allowing organisms to grow and utilize all the phosphorus in the upper layers of the ocean. However, because most of the iron is not soluble, [deep waters](#) are enriched in phosphorus relative to iron. Hence, when winds are weaker, there is little iron input to fertilize and remove any excess phosphorus in the upper layers that may be introduced through deep [water](#) mixing.

"Sometimes there are periods of 5-6 years of phosphorus enrichment, and then there are periods when it switches over," Letelier said. "From 2000 to 2007, there was almost no phosphorus. We have seen some changes in the function of the ecosystem, but we haven't yet seen

significant changes in the biological composition. They may be coming; it's too early to tell."

As the Arctic warms, the scientists say they expect to see long-term changes in [wind patterns](#) across the North Pacific. In addition, the evolution of land use and pollution driven by anthropogenic activity in Asia will affect the sources and magnitude of iron and other nutrients carried by wind across the ocean.

How these changes will affect the transport of [iron](#)-rich dust into the eastern Pacific and affect the productivity in this vast oceanic region remains an open question.

**More information:** Ricardo M. Letelier et al., "Climate-driven oscillation of phosphorus and iron limitation in the North Pacific Subtropical Gyre," *PNAS* (2019).

[www.pnas.org/cgi/doi/10.1073/pnas.1900789116](http://www.pnas.org/cgi/doi/10.1073/pnas.1900789116)

Provided by Oregon State University

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