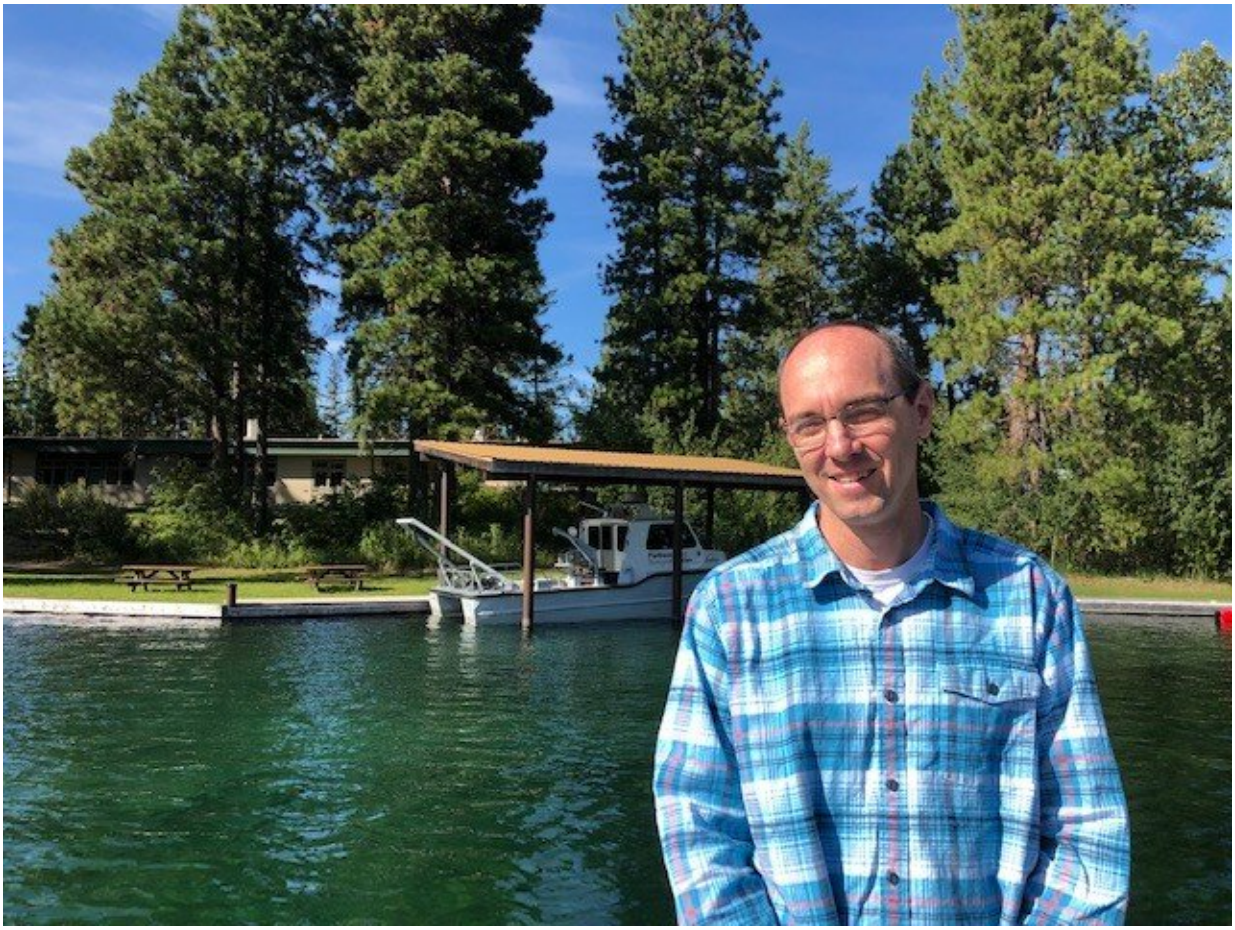
Researchers uncover ocean iron level mystery

August 30 2019



Matthew Church, a researcher with the University of Montana's Flathead Lake Biological Station, helped discover why phosphorus and iron levels fluctuate in part of the Pacific Ocean. Credit: UM

The middle of the Earth's oceans are filled with vast systems of rotating

currents known as subtropical gyres. These regions occupy 40% of the Earth's surface and have long been considered remarkably stable biological deserts, with little variation in chemical makeup or the nutrients needed to sustain life.

However, there exists a strange anomaly in the North Pacific Subtropical Gyre ecosystem that has puzzled scientists for years. In this region that occupies the Pacific Ocean between China and the United States, the chemistry changes periodically. There's a particularly notable fluctuation in the levels of phosphorus and iron, which affects the overall nutrient composition and ultimately impacts biological productivity.

In a new study published in the *Proceedings of the National Academy of Sciences*, a group of researchers uncovered the reason behind these variations in the North Pacific Subtropical Gyre ecosystem. The group includes Matthew Church, a microbial ecologist with the University of Montana's Flathead Lake Biological Station, as well as Oregon State University's Ricardo Letelier and the University of Hawaii's David Karl, among others.

"Variations in ocean climate appear to regulate iron supply, altering the types of plankton growing in these waters, which ultimately controls ocean nutrient concentrations," Church said. "My laboratory has worked on questions related to the role of plankton in controlling ocean nutrient availability for many years, and this study places much of that work in context. As a result of sustained, long-term observations, our work confirms how tightly coupled plankton biology is to the supply of nutrients, specifically iron, delivered from the atmosphere."

Using three decades of observational data from Station ALOHA, a six-mile area in the Pacific Ocean north of Hawaii dedicated to oceanographic research, the team discovered that the periodic shift in iron levels result from iron input from Asian dust, accounting for the

chemical variances and providing varying amounts of nutrients to sustain life.

The key to the variance is the Pacific Decadal Oscillation, an ocean-atmosphere relationship that varies between weak and strong phases of atmospheric pressure in the northeast Pacific Ocean.

In years when the low pressure weakens in the northeast Pacific, winds from Asia become stronger and move in a more southern direction. This brings more dust from the Asian continent, "fertilizing" the ocean surrounding Station ALOHA. When the pressure strengthens, the opposite occurs.

The supply of nutrients is a fundamental regulator of ocean productivity, and phosphorous and iron are key components for life. Typically, the ocean's upper water column is fertilized by nutrient-rich water mixing up from the deep. This is a difficult process in the North Pacific Subtropical Gyre ecosystem because the waters are very stratified and little mixing actually takes place.

When strong Asian winds bring in significant amounts of iron, organisms are allowed to grow and use phosphorus in the upper layers of the ocean. When Asian winds weaken and iron input is reduced, organisms are forced to return to a deep-water-mixing nutrient delivery system. This creates the periodic ebb and flow of iron and phosphorus levels in the North Pacific Gyre.

Church said the findings from this study emphasize the critical need to include both atmospheric and ocean circulation variability when forecasting how climate change might impact ocean ecosystems.

"It reaffirms the need to think about how tightly connected plankton biology is to changes in climate and ultimately also to changes in land

use, which can directly impact dust supply to the sea," he said.

As Earth's temperature continues to warm, researchers expect to see long-term changes in wind patterns across the North Pacific. The evolution of land use and pollution driven by human activity in Asia also will affect the sources and magnitude of iron and other nutrients carried by wind across the ocean.

Further research is needed to better understand how these changes ultimately will impact ecosystems in this ocean region, as well as others around the world.

More information: Ricardo M. Letelier et al, Climate-driven oscillation of phosphorus and iron limitation in the North Pacific Subtropical Gyre, *Proceedings of the National Academy of Sciences* (2019). DOI: 10.1073/pnas.1900789116

Provided by University of Montana