New findings blow a decade of assumptions out of the water

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The Atlantic Ocean doesn't receive the mother lode of fixed nitrogen, the building block of life, after all. Instead, comparing fathom for fathom, the Pacific and Indian oceans experience twice the amount of nitrogen fixing as the Atlantic, say researchers in the Jan. 11 issue of *Nature*.

The title of an accompanying News and Views piece says it all, "Looking for N_2 Fixation in all the Wrong Places."

It's important to have a global picture of where nitrogen fixation is occurring – that is where nitrogen gas is being converted into substances like nitrate that are usable by life – in order to understand the environmental controls on nitrogen fixation and its likely response to climate change in the past and in the future, says Curtis Deutsch, a University of Washington research assistant and lead author of a paper in the Jan. 11 issue of *Nature*. The new research, for example, indicates that the inventory of nitrogen in the oceans is likely to be less subject to major fluctuations than had been assumed.

Because it has been thought that nitrogen fixation is limited without enough iron, the conventional wisdom for the past decade dictated that the Atlantic Ocean would be the prime site for fixing nitrogen. That's because compared to the other low-latitude oceans, the Atlantic is peppered with iron-laden dust blowing off the African continent.

Winds can't carry such dust all the way across the Pacific Ocean because

it is so vast. Iron may still be a limiting factor in nitrogen fixation, but if it is, then the Pacific and Indian oceans are getting iron from some source other than atmospheric dust, Deutsch says.

The new research also means places where nitrogen is being fixed by certain microorganisms are in close proximity to where it is being pulled back apart into its gaseous state by a different kind of micoorganism, he says.

Nitrogen gas, N_2, is unusable by life. It has to be fixed, that is, latched onto other chemicals to form compounds such as nitrate, NO_3. Only then can it be used to build amino acids and proteins essential to all life.

Eventually the fixed nitrogen is returned to its gaseous state, a process called denitrification. Scientists have known for several decades that denitrification occurs in the deep, low-oxygen waters of the Pacific and Indian oceans.

If the Atlantic was the site of a lot of nitrogen fixation, that would have put the two processes half a world away from each other. Scientists had estimated that, at those distances, it could take 1,000 years to re-balance the ocean's nitrogen cycle if large-scale changes were to occur in either nitrogen fixation or denitrification – if climate change altered ocean temperatures and the rates of the two processes, for instance.

The new findings show the processes are happening within a few hundred miles of each other so the balance could be reached within a decade, the authors estimate. Deutsch compares the old assumption to a house where the thermostat is many rooms away from a window that has swung open, letting in cold air. The house could get quite chilly before the draft reaches the thermostat and the furnace turns on. But if the thermostat is in the same room as the window, the furnace will turn on and even out the temperature much faster.

In his research Deutsch used a novel analysis of surface nutrients in the world's oceans that relied on several decades of existing large-scale data on nitrogen-to-phosphorous ratios, phosphorous also playing a major role in primary production. His work has been supported by a NASA Earth System Science Fellowship and the UW Program on Climate Change.

"There has been a great deal of controversy in the literature as to whether fixed nitrogen in the ocean remains constant with time or fluctuates widely," says Jorge Sarmiento, professor of geosciences at Princeton University and one of the co-authors. "This study is a major advance for those of us who have been arguing that it is relatively stable."

Source: University of Washington