

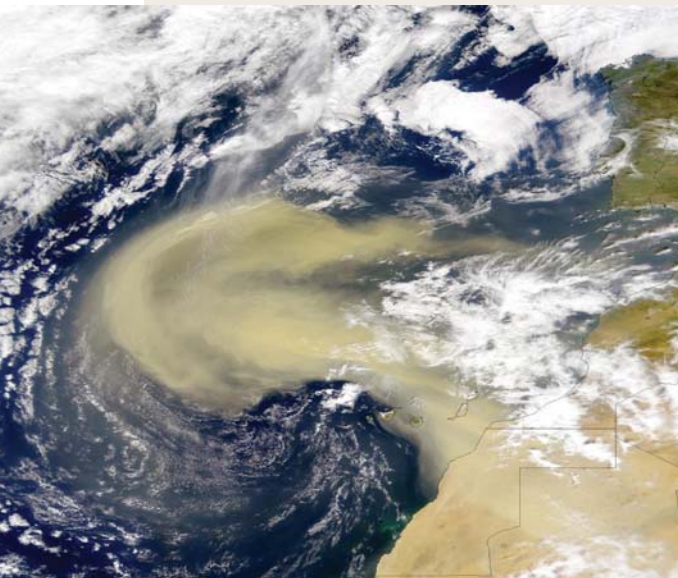
The most conspicuous planktonic  $N_2$  fixer, the cyanobacteria *Trichodesmium* spp., is ubiquitous throughout the nutrient-poor tropical oceans. Other microorganisms, including symbiotic cyanobacteria of diatoms and free-living planktonic bacteria and cyanobacteria, have recently been found to fix nitrogen in these systems as well. Colonies of *Trichodesmium* ~1 cm in length. Below: Micrograph of filaments.



## REINVENTING THE MARINE NITROGEN CYCLE

### $N_2$ FIXATION IN THE WORLD'S OCEANS

This dust storm off of NW Africa in February 2000 blanketed hundreds of thousands of square miles of the eastern Atlantic Ocean with a dense cloud of Saharan sand.



Provided by the SeaWiFS Project, NASA/Goddard Space Flight Center and ORBIMAGE

Like crops in a field, microscopic marine plants, or phytoplankton, that live near the ocean's surface need nitrogen to grow. Nitrogen fixation, the microbiological process through which nitrogen gas ( $N_2$ ) is converted to a form easily used by plants, provide both ocean and soil with naturally occurring nitrogen. In the oceans, the few well-studied species of phytoplankton that can "fix"  $N_2$  (diazotrophs; photos, top) all live within  $30^\circ$  to  $40^\circ$  of the equator where nutrients in the surface waters are not abundant. By "fertilizing" the oceans, these marine  $N_2$  fixers allow other phytoplankton to grow, increasing the draw down of carbon from the atmosphere. Because it is now recognized that  $N_2$  fixation by tropical marine organisms can affect oceanic inventories of fixed nitrogen and thus the ocean's capacity to sequester carbon, it is proposed as a key component in a suite of interactions among the oceans, atmospheric  $CO_2$ , and climate.

Diazotrophs have a greater demand for iron than do non-diazotrophs, and the delivery of iron to the upper ocean through wind-borne dust deposition (photo, bottom) is hypothesized to be a critical control on this process. Indeed, tropical areas of the ocean that receive the greatest dust fluxes have the densest populations of the  $N_2$ -fixing cyanobacteria, *Trichodesmium*. Phosphate availability may also limit  $N_2$  fixation in some ecosystems, for instance, where excess iron is available. Investigations are now focusing on the role of  $N_2$  fixers in ocean carbon sequestration and developing ecosystem and biogeochemical models for oceanic carbon dynamics that explicitly include  $N_2$  fixation.

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