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Biogeochemical controls on nitrogen fixers in the global ocean

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We explore the biogeochemical controls on the nitrogen fixers (or diazotrophs) in a global ocean model. Diazotrophs are essential organisms in the ocean, as they provide most of the new nitrogen to the global ocean. We employ a three-dimensional global ocean model with a self-organizing phytoplanktonic community, which successfully accounts for diverse marine autotrophic diazotrophs (Trichodesmium, unicellular cyanobacteria and diatom-diazotroph associations). We examine in the model how temperature, nitrogen, iron and phosphate limitations influence the global distribution of marine diazotrophs. In the observations and model, total diazotroph population is distributed over most of the oligotrophic warm sub-and-tropical waters. We find that this global diazotroph distribution is restricted to the low fixed-nitrogen regions which have sufficient supplies in dissolved iron and phosphate. We use resource competition theory to illustrate the intertwined response of marine nutrients, dust input and ecosystem, and map out regions of iron and phosphate regulations of marine diazotroph distribution. The theory suggests that diazotroph distribution is largely regulated by iron availability, in particular in the South Atlantic, Pacific and Indian Oceans. This result demonstrates how important it is to understand the iron dust sources to the marine biological community in relation to the oceanic nitrogen cycle.