Phosphorus controls on marine N2 fixation

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Despite its essential role in maintaining the marine nitrogen inventory, the environmental controls and the rates of marine nitrogen fixation are not yet well understood. Geochemical estimates and global-scale numerical models usually assume that a deficit in ambient nitrate with respect to phosphate generates environmental niches for the success of diazotrophs. However, such assumptions cannot well explain observed patterns of marine N2 fixation and, moreover may lead to runaway-nitrogen loss once oxygen minimum zones and denitrification come into play. Here, we show first results of a novel concept of marine N2 fixation being controlled by low phosphate concentrations that promote the utilization of dissolved organic phosphorus. Diazotrophs may have a key advantage in producing nitrogen-rich exoenzymes, such as alkaline phosphatase, that mediate this process in oligotrophic regions where non-diazotrophic phytoplankton is limited by nitrogen availability. We present results of novel modeling concepts, both zero- and three-dimensional, and find a much better simulation of spatial patterns of marine N2 fixation than has been possible with current models.