Nitrogen regeneration under extreme oxygen conditions

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Nitrogen (N) is a key element of life and limits primary production in large parts of the ocean. Still, the factors controlling the oceanic N-budget are largely unclear, particularly in the context of changing climate. Dinitrogen fixation is the biological reduction of dinitrogen gas (N_2) to ammonium. It is quantitatively the most important source of 'new' N to the ocean and is thought to be limited by the availability of phosphorous and iron (Fe). Global change is predicted to result in the expansion of anoxic waters in the ocean, which in extreme cases can turn sulfidic. While O_2 depletion favors N_2-fixation, the presence of hydrogen sulfide (H_2S) has a direct toxic effect on N_2-fixing organisms and also influences the availability of Fe. To explore the sensitivity of N_2-fixation to changes in O_2 and H_2S in different oceanic regions, an interdisciplinary approach was applied, combining chemical profiling, direct rate measurements and meta-omics including metabolomics. This approach allowed an incomparably detailed monitoring of the response of N_2-fixation to naturally occurring extreme changes in redox conditions. Complementary to the field studies, we explored the potential of N_2-fixing microbes to adapt to manipulated rapidly changing redox conditions in incubation experiments using pure cultures. Our results illuminate the potential of the microbial community involved in N_2-fixation to respond to ocean deoxygenation and sulphidic anoxia, both of which are considered key challenges of the future ocean.