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The marine diatom and diazotroph under future climate: Role of Iron

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Diatoms constitute a major group of phytoplankton, accounting for one quarter of the world's net primary productivity. Diazotrophs provide the largest input of new nitrogen (N) to the ocean and control the marine N budgets. It has been shown that iron (Fe) can be the limiting factor for diatom growth, in particular, in the HNLC (High Nutrient Low Chlorophyll) regions. This trace element can also govern the development of marine diazotrophs due to the high Fe demand necessary for biological N2 fixation. Iron plays thus an essential role in governing the marine primary productivity and the efficiency of biological carbon pump.

Ocean systems are undergoing continuous modifications at varying rates and magnitudes as a result of changing climate. The objectives of our research is to evaluate 1) how climate change (dust deposition, ocean warming and acidification) can affect Fe biogeochemistry and the growth of diatoms and diazotrophs, and 2) the role of Fe in the control of biological N2 fixation under future climate scenarios.

Laboratory culture experiments using Chaetoceros socialis were examined at two temperatures (13°C and 18°C) and two CO_2 conditions (400 μatm and 800 μatm). The present study demonstrates clearly the influence of ocean acidification on the release of Fe upon dust deposition. It also shows that dust particles could provide a readily utilizable source of Fe and other macronutrients (dissolved phosphate and silicate) for phytoplankton growth. Elevated pCO_2 concentrations may have adverse impact on the diatom growth; seawater warming may cause poleward shifts in the biogeographic distribution of diatoms.

The impact of Fe on the natural N2 fixation was tested via field incubation experiments using natureal phytoplankton assemblage in the Bay of Biscay and along the Iberian Margin. N2 fixation rates in oligotrophic waters were greatly stimulated through the addition of dissolved Fe compared to the control, demonstrating the limitation of N2 fixation by Fe. Numerous factors can affect the extent of N2 fixation, but a better understanding of the major controlling factors is highly required. Semi-continuous dilution culture experiments were conducted on Trichodesmium IMS-101 under future high pCO_2 and warming seawater conditions. Additionally, special attention has been given to studying the effects of mineral dust deposition which is believed to promote N2 fixation through increasing Fe availability.