HORIZON 2020

NITROX- Nitrogen regeneration under changing oxygen conditions

Rapports

Informations projet

NITROX

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Site Web du projet

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Coordonné par
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Ce projet apparaît dans...

Periodic Reporting for period 1 - NITROX (NITROX-Nitrogen regeneration under changing oxygen conditions)

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Résumé du contexte et des objectifs généraux du projet

Nitrogen (N) is a limiting nutrient for life in the ocean and the atmospheric pool of dinitrogen gas (N2) is only accessible to a limited group of microbes. Classically, those N2-fixers were supposed to be mainly present in nutrient depleted surface waters. But also in oxygen poor deep waters, such as e.g. present in the tropical Oceans or in the Baltic Sea, N2-fixers are present. Not much is known about these microbes and their potential to contribute to the N-budget of the ocean, but they may be of critical importance in the future, as human-made climate change leads to a loss of oxygen from the ocean. This phenomenon is called ocean deoxygenation and it is a result of global warming. Because a systematic investigation of N2-fixation in oxygen poor waters and its controls and feedbacks is missing; the exploration of this important but largely understudied topic was addressed by 'NITROX-Nitrogen Regeneration under changing oxygen conditions' project.
The specific goals of NITROX were to

1. identify which microbes are involved in N2 fixation in oxygen depleted waters using molecular genetic methods
2. measure how much N2 fixation takes place in those waters
3. understand how the N2 fixation in those waters is regulated, and how it will respond to further oxygen loss from the water.

Over the course of NITROX it has been found that a feedback regulation between N2 fixation, primary production by algae and cyanobacteria, and their degradation after they die and sink out of the surface water, exists. This means that oxygen poor conditions favor N2 fixation, through the higher availability of N algae can grow. As soon as those algae die and sink down to low oxygen waters, they are degraded, a process that consumes oxygen. Thus, oxygen is progressively being lost from those waters until they are completely anoxic and possibly a toxic substance, hydrogen sulfide can evolve. This development would in principle mean that oxygen poor waters would continuously expand, but as we found during NITROX, extreme anoxia with hydrogen sulfide being produced stops N2 fixation and with that primary production. In consequence, no more organic material is produced and exported, and oxygen consumption in deeper waters decreases. Thus, this is the first prove of a feedback cycle driven by bacteria, which can counteract one of the consequences of climate change, namely Ocean deoxygenation.

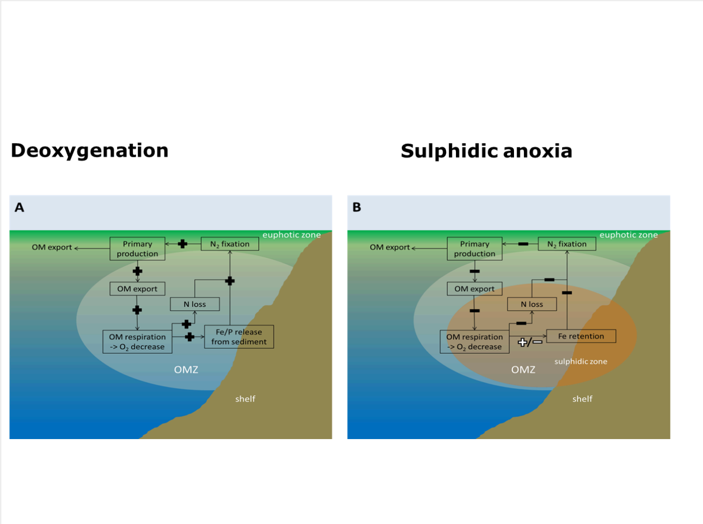
Travail effectué depuis le début du projet jusqu'à la fin de la période considérée dans le rapport et principaux résultats atteints jusqu'à présent

Samples for NITROX were collected in ocean areas with different oxygen conditions, such as the anoxic-sulfidic Mariager Fjord in Denmark, the oxygen minimum zone off Peru, the seasonally anoxic Eckernförde Bay in the Baltic Sea, Germany. Additional samples were analyzed from the Bay of Bengal in the Indian Ocean, and the tropical Atlantic.
The sampling approach combined collection of water samples for incubation experiments to measure rates using stable isotopes of nitrogen and carbon. We further collected samples for genetic analysis, cell counting and we performed oxygen and nutrient measurements in parallel to every sample collection.
Laboratory analysis included mass spectrometry to determine the rates of N2 fixation, N loss and C fixation. We used a metagenomic approach, which means we sequenced all genes present in our sample, to understand the diversity of N2 fixers. From additional incubation experiments with changing oxygen and hydrogen sulfide concentrations, we defined the conditions under which N2 fixers are most effective, and those conditions, which make it unable for them to function.

Our major result so far is indeed that we found a limit in terms of hydrogen sulfide concentrations allowing for N2 fixation. This speaks for our hypothesis of too extreme anoxia decreasing N2 fixation and thus primary production. In conclusion, export and respiration of organic material would decrease, and the waters could recover to a less severe anoxia.

Progrès au-delà de l'état des connaissances et impact potentiel prévu (y compris l'impact socio-économique et les conséquences sociétales plus larges du projet jusqu'à présent)

Currently we are collecting the generated data in a database which should ultimately be the basis for a global statistical evaluation. Further, we developed a mathematical box model, which will now be used to understand the influence of water mass dynamics on oxygen depletion and on N2 fixation. With this additional information, we hope to be able to predict the potential of the microbial community involved in N2 fixation to respond to and to possibly mitigate the ongoing ocean deoxygenation.



feedback reggulation as proposed by NITROX

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