axis 2

“Complexity and efficiency of the biological pump”

Keywords

- Export
- Carbon
- Silicium
- Nitrogen
- Traces elements
- Mixotrophy
- Diversity

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SCIENTIFIC CONTEXT

The set of processes that transports particulate organic carbon (POC) to the deep sea and ultimately to sediments is collectively known as the «biological pump» and includes the primary production of POC and its packaging via coagulation or other processes, into large, rapidly sinking particles versus its recycling or entrainment into marine food webs. This biological carbon pump in the ocean is a significant term in the global carbon cycle as it transports ~10 Gt C per year from the surface waters to the ocean interior.

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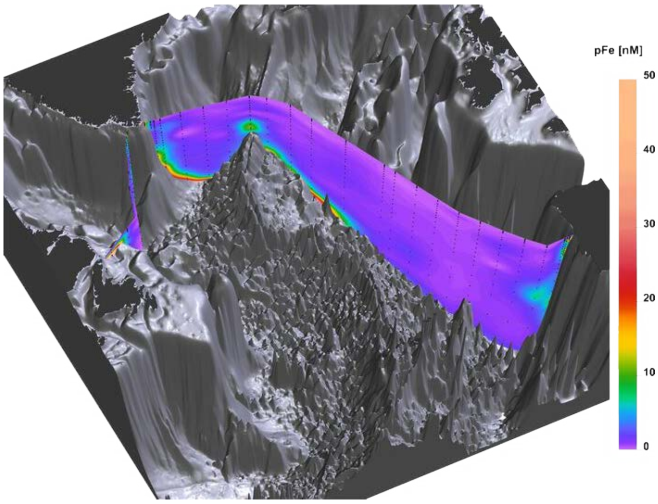
ROADMAP

Despite decades of research, there is still no detailed understanding of the mechanisms that control the efficiency of the biological pump, which is known to vary dramatically, both spatially and temporally, at different scales. This is due to the fact that these mechanisms reside at the intersection of ocean dynamics, biogeochemistry and ecology. Therefore, we seek to study the efficiency and the complexity involved in the production, export and fate of biogenic materials. These objectives bring together a group of 40 researchers from different labs within the Brest area. Novel and complementary approaches are implemented through field studies, experimental and modeling approaches that are adapted to different scales, from individual particles and organisms up to ecosystems, in order to address the following questions:



Particulate iron distribution in the North Atlantic (GEOVIDE cruise)
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• How do marine microorganisms and ecosystem functioning diversity impact the efficiency of production?
The generic term of "diversity" concerns many facets that influence organic matter production such as the species and / or size class diversity and the functional mode trophic diversity including mixotrophy or nitrogen fixation. These aspects are studied by axis 2 researchers (in collaboration with axes 1 & 6 of LabexMER) thanks to a variety of approaches using taxonomy, metabarcoding or modelling studies up to fine spatial scales.

• How do trace metals control the operation and structure of these ecosystems? Phytoplankton growth requires macro and micronutrients. In particular, some trace elements are essential for living organisms (e.g. Fe, Mn, Cu, Ni, Zn, Co), while others are toxic (eg Pb and Hg). Several members of our axis are often involved in major oceanographic cruises (e.g. GEOTRACES) in order to better understand the distribution and the biogeochemical cycles of the trace elements in key areas of the world ocean. Meanwhile, laboratory cultures that consider the potential impact of co-limitation (eg Mn / Fe, light) and acidification are performed. Modeling studies reveal to also be very useful, with in particular the first realistic modeling exercise documenting global impacts of the sedimentary particulate iron (this source being arguably overlooked by most studies).

• What are the controls on the Carbon export efficiency? Actions linked to this question will help to determine the fate of biogenic materials sinking as aggregates and fecal pellets by studying degradation processes inside sinking particles and the interaction between these particles and organisms. Aggregation and incorporation to fecal pellets processes, can impact the biogeochemical cycles of carbon and silicium. Therefore, specific laboratory or mesocosm studies are designed to explore these processes, under different stress conditions (e.g. grazers). Dissolution of biogenic silica and aggregation processes will be assessed under different micro-environment conditions (e.g. iron limitation, presence of microplastics). Other processes affecting the efficiency of carbon export from the ocean surface also include the behavior of zooplankton on the transfer of organic matter from surface to the deep ocean during their nycthemeral migration. This will be assessed by different modeling exercises.

EXPECTED RESULTS

The different research actions will provide an insight on the different controls of the biological pump, especially in targeted areas of high productivity such as the North Atlantic or the Arctic. Field work, novel experiments and modelling studies will contribute to a better understanding of processes controlling the fate of particles and to better evaluate the influence of ecosystem structure and trace metals on carbon export. These data could also be implemented in coupled (physics-biogeochemistry) models such as NEMOPISCES.