

## Possible Belgian contributions to the International BioGeoSCAPES Program (October 16, 2023)

Since no national marine research programs have been funded in Belgium for a number of years, national workshops are also no longer organized. Therefore, the Belgian research groups active in marine research were directly contacted and asked how they could contribute to the BioGeoSCAPES program. A summary of that information round is shown below.

1. The preliminary BioGeoSCAPES Mission Statement is “To improve our understanding of the functioning and regulation of ocean metabolism and its interaction with nutrient cycling within the context of a hierarchical seascape perspective”

We prefer the revised BioGeoSCAPES Mission statement:

V1 - To develop mechanistic and quantitative knowledge of ocean metabolism and elemental cycling on a changing planet.

2. How would Belgium best contribute to BioGeoSCAPES efforts?

Pre-existing strengths of the Belgian marine science community relate to the start of marine research in the early 70ies when the National R&D program “Mathematical Models of the North Sea” was launched. A strong emphasis was placed on modelling, ecosystem dynamics, pollution, etc. Fifteen years later the “Antarctic Research Program” opened a new window on Belgian marine research but unfortunately those research programs no longer exist. Several Belgian marine research groups continue to contribute to major oceanography and climate change challenges, but now through international collaboration and dedicated funding. Belgian expertise in marine research includes:

- A) Modelling: mathematical modelling of the North Sea ecosystems (G. Lacroix, Royal Belgian Institute of Natural Sciences-RBINS); biogeochemical modelling (P. Regnier, S. Arndt, N. Gypens, University of Brussels-ULB); merging of statistical data analysis and modeling into assimilation approaches, including nested coastal models (J-M Beckers, University of Liege-ULg).
- B) Time series of marine data: in the Belgian coastal zone (Flemish Institute of Sea Research-VLIZ and Royal Belgian Institute of Natural Sciences-RBINS); in Calvi (Corsica-Mediterranean Sea) (S. Gobert, University of Liege-ULg).
- C) Organic carbon cycling (production, degradation, export): trace metal cycling in HNLC areas and their limiting role on phytoplankton growth as well as establishing sediment-water fluxes by high resolution porewater profiles (Y. Gao & W. Baeyens, University of Brussels-ULB-VUB); the role of the biological carbon pump in controlling greenhouse gas fluxes of the global coast ocean and its anthropogenic perturbation (P. Regnier, University of Brussels-ULB); linking microbial dynamics/traits, as well as energetics with OC degradation dynamics (in coastal and open ocean sediments and subsea permafrost) with the objective of understanding how these interactions control OC reactivity and thus degradation/burial (S. Arndt, University of Brussels-ULB); assessing the biological capacity for marine ecosystem resilience: acclimation and adaptation in a rapidly changing environment (A. Vanreusel, University of Ghent-UGent).
- D) Marine observatory technology: use of SeaExplorer (unmanned robot) for collecting high resolution data (H. Pirlet, Flemish Institute of Sea Research-VLIZ).

### 3. What scientific questions are important to Belgian research groups within the scope of BioGeoSCAPES?

Belgian research groups will continue to use their expertise that was build-up in the past and try, together with the international community, to better understand the biogeochemical processes in the ocean and the impact of global change on these processes. Specific themes/questions of interest are:

- Combining machine-learning and global ocean biogeochemical models to understand the role of the biological carbon pump in controlling greenhouse gas fluxes of the global coast ocean and its anthropogenic perturbation.
- Developing new tools for a better understanding of the bioavailability of trace metals (micronutrient and/or a contaminant) and their role in HNLC areas.
- To study organic matter-microbe interactions with early diagenetic models (local to global scale) and novel, mechanistic model formulations for these interactions.
- To answer fundamental questions on deep-sea ecology such as understanding trophic interactions, the relationship between biodiversity and ecosystem functioning and the connectivity between isolated and remote deep-sea habitats using ROV technology in combination with high resolution measurements.
- To study the ice sheet and ocean interactions near Greenland (ice-sheet, sea-ice, ocean, and biogeochemistry).
- To study fluxes across the sediment-water interface (nutrients and contaminants).
- To continue the existing marine data time-series in the Belgian coastal area and in the Mediterranean Sea (Calvi, Corsica).
- To develop the COHERENS model (COupled Hydrodynamical Ecological model for REgionAl Shelf seas) into a more dynamic ecosystem direction.

We hope that with our expertise and via international collaborations, we can contribute to the BioGeoSCAPES program and to help in achieving its goals. On the one hand, there are few resources available in Belgium for conducting oceanographic research but, on the other hand, most marine research groups have a long experience in that field.

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