BG-PART

BioGeochemical PARTicle interactions and feedback loops on the Belgian Continental Shelf

DURATION
15/12/2020 - 15/03/2025

BUDGET
906 418€

PROJECT DESCRIPTION

Suspended Particulate Matter (SPM) is a key parameter in biological processes, ecosystem functioning and biogeochemical fluxes in coastal ecosystems. While SPM dynamics is primarily controlled by hydrodynamic forcing and the physical and chemical properties of the particles, it is becoming increasingly clear that biological activity also affects the size and settling of particle aggregates. Mineral particles are continuously resuspended from the bottom sediment to the water column through tidal forcing, which increases turbidity and reduces the light availability for phytoplankton photosynthesis. In turn, phytoplankton exudes or releases precursors to marine gels, that is, Transparent Exopolymer Particles (TEP) having sticky properties, and Coomassie Stainable Particles (CSP) being less sticky than TEP. Marine gels enhance the aggregation of suspended particles into biomineral flocs that have higher settling velocities, thus causing a larger fraction of the SPM to deposit in the bottom layer. This enhances light penetration and fosters phytoplankton photosynthesis. Bacterial mineralisation and zooplankton grazing break down the flocs, increasing the resuspension of sediments in autumn and winter. Little is known about the relative importance of physical and biological processes for SPM dynamics in highly productive yet turbid shallow coastal areas. With BG-PART, we aim to assess the importance of interactions and feedback mechanisms between biological activity and sediment mineralogy for SPM dynamics and ecosystem functioning on the Belgian Continental Shelf.

We test several hypotheses:

- Biophysical flocculation is differently affected by the freshly-produced and the refractory organic matter as they show different sticky properties.
- The cohesive and non-cohesive mineral fractions of the SPM differently affect flocculation processes.
- Low light adapted species kickstart the early spring bloom under turbid winter conditions. Marine gel production then leads to the formation of faster sinking flocs, fostering the species with higher light requirements.
- Bacterial mineralisation and zooplankton grazing accelerate floc degradation and alter their dynamics.
  Phytoplankton production, marine gel production and flocculation are different along the coastal-offshore transect.

Our approach combines field measurements, experimental lab work and numerical modeling:

- Field samplings on board the RV Belgica and Simon Stevin allow observing the dynamics of particles in the natural system, including the concentration and size distribution of SPM, of organic matter and of marine gels, phytoplankton species, abundance and photosynthesis, bottom sediments, etc. The seasonality of processes is covered by monthly to bimonthly sampling. Each sampling occurs every hour during 12 hours to capture the tidal influence and derive consistent statistics. Sampling is performed at bottom and surface along the coastal-offshore transect (MOW1, W05, W08). A benthic lander at MOW1 and a buoy at W05 also continuously monitor parameters variability.
- Lab experiments focus on TEP/CSP production by phytoplankton, and on floc formation, sedimentation, and disaggregation. Ecophysiological experiments are conducted in incubators using monocultures of dominant phytoplankton species (non-axenic strains). The species producing precursors to marine gels are grown in a flocculation chamber (8.2 L), where TEP/CSP concentration and size distribution are measured. The stability and composition of flocs under variable turbulence is monitored, revealing how marine gels associate with mineral and biological particles. The action of bacteria and zooplankton on TEP/CSP and floc size is studied in dilution experiments using anaesthetics.
- Based on the results of our observations, a numerical model simulating phytoplankton, marine gels and SPM interactions will be set up to describe the flocs dynamics in the water column.

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BG-PART addresses fundamental questions related to the sediment-phytoplankton interactions that drive photosynthesis and lie at the basis of the habitability of coastal systems. The new data and information will contribute to the definition of a safe operating space for human activities (marine and coastal), in the scope of both increasing activities at sea, and sea surface warming or sea level rise, all of which affect phytoplankton or sediment dynamics.

The project delivers data sets reflecting the transdisciplinary approach of the study, a numerical model, reports, scientific papers, policy briefs, and conferences. These outputs are primarily intended to the scientific community and the private sector, and also to policy-makers at national and international levels. It will be disseminated to the general public to raise awareness on how microscopic processes shape our coastal zones.

CONTACT INFORMATION

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LINKS

https://www.marineatugent.be/bg-part-project-how-do-interactions-between-plankton-and-suspended-particulate-matter-affect