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A new implementation of the Biogeochemical Flux Model in sea ice

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The Biogeochemical Flux Model (BFM) is a direct descendent of the European Regional Seas Ecosystem Model (ERSEM) and it has been widely used and validated among the scientific community. The BFM view of the of the marine ecosystem is based upon the recognition that the major ecological functions of producers, decomposers and consumers and their specific trophic interactions can be expressed in terms of material flows of basic elements. The concentration and characteristics of organic and inorganic compounds are thus seen under a stoichiometrical perspective. This functional approach brings to the definition of Chemical Functional Families (CFF) and Living Functional Groups (LFG). The BFM is thus a set of biogeochemical equations describing the cycling of carbon, the macro-nutrients and oxygen through the lower trophic levels of marine ecosystems.

A Sea-Ice system has now been implemented in the BFM and the new BFM-SI consists of three new LFG (sea ice algae, heterotrophic zooplankton, bacterioplankton), one new non-living organic functional group (sea ice DOM and POM) and two new inorganic functional groups: dissolved gases (sea ice CO_2 and O_2) and four nutrients (sea ice PO_4, NH_3, NO_3 and SiO_4). The innovative approach consists in simulating the biogeochemistry of the sea ice Biologically-Active-Layer (BAL), where the majority of the biomass (bottom communities) concentrates. The BFM-SI requires the physical properties of the BAL in order to be able to simulate the physiological and ecological response of the biological community to the physical environment. This is currently done by using an Enhanced 1-D thermo-halodynamic Sea Ice Model (ESIM2), developed to be suitable for biogeochemical studies.

Since the biogeochemistry of sea ice is largely unknown, the BFM-SI is a useful tool that allow us to test hypotheses on the functioning of the sea ice ecosystem. By initially setting the sea ice community as having the same characteristics than the pelagic community, it is possible to change many parametrizations of the model, such as the adaptation to the different environmental conditions (light, temperature and salinity) but also nutrient utilization and carbon-chlorophyll ratio. Elected experiments will be shown to elucidate some dynamics of sea ice ecosystems. Once biogeochemical dynamics have been studied in local process studies, it will be possible to apply the new implementation of the model both regionally and globally in order to give a wider picture of the role and importance of the sea ice biogeochemistry in the global carbon cycle, also in view of climate change scenarios.