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Coupling physical and biogeochemical processes in sea ice

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In the last decades the scientific community has been making lot of efforts to understand the physics of sea ice. We currently have a good knowledge of the sea ice dynamics and thermodynamics and of their temporal and spatial variability. Sea ice biogeochemistry is instead largely unknown. There are only sparse localized observations and little knowledge of the functioning of sea ice biogeochemistry at larger scales. Modelling becomes then a necessary tool to qualify and quantify the role of sea ice biogeochemistry in the ocean dynamics.
We used a different approach with respect to the previous attempts of modelling the sea ice biogeochemistry and in particular of its primary production. The central concept is the definition of the Biologically-Active-Layer (BAL), which is the time-varying fraction of sea ice that is continuously connected to the ocean via brines pockets and channels. A 1-D Enhanced Sea Ice halo-thermodynamic Model (ESIM2) is able to simulate the key physical properties of the BAL (thickness, temperature, brines salinity and volume, sea ice bulk salinity and irradiance), which are passed to the new implementation of the Biogeochemical Flux Model in sea ice (BFM-SI). The new BFM-SI uses those information to simulate the physiological and ecological response of the biological community in sea ice. The new model is also coupled to the pelagic BFM through the exchange of organic and inorganic matter at the boundaries between the two systems . This is done by computing the entrapment of matter and gases when sea ice grows and release to the ocean when sea ice melts and it is thus totally mass-conserving.
The implementation of the BFM-SI model and coupling structure in General Circulation Models will add a new component to GCMs (and in general to Earth System Models), which will be finally able to estimate globally the role and importance of sea ice biogeochemistry in the global carbon cycle.