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Spring CO2 dynamics within sea ice: abiotical versus biological control.

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High latitude oceans are major sinks for atmospheric carbon dioxide (CO_2) but so far the extensive sea ice cover has been considered inert with respect to gas exchange with the atmosphere. There are growing observations that sea ice exchanges CO_2 directly with the atmosphere, highlighting the need in understanding CO_2 dynamics within sea ice. In spring ice, at least 6 processes can affect CO_2 dynamics, namely: (1) temperature change and (2) related melting of ice crystal, (3) biological activity, (4) dissolution of carbonate minerals, (5) internal convection and (6) air-ice gases exchanges. Each process can significantly impact inorganic carbon dynamics with opposing and compensating effects. To explore the relationships between sea ice-specific biogeochemical processes and spring CO_2 dynamics, we carried out three surveys in Antarctic land fast sea ice, and first year and multiyear pack ice. We tried to assess the role played by none-transport processes and give some clues of the impact of the others.

In sea ice, intense growth of microalgae is commonly observed and acts to significantly decrease the partial pressure of CO_2 (pCO_2) and promote the uptake of atmospheric CO_2 by Antarctic sea ice. Biological mediated decrease of pCO_2 is significantly enhanced by superimposed none-transport abiotic processes (temperature change and related melting of ice crystals, dissolution of carbonate minerals) while transport processes (internal convection and air-ice gas exchange) counteract the observed decrease of pCO_2. Independent and indirect estimates of the potential CO_2 fluxes driven by these processes are consistent with measurements of air-ice CO_2 exchanges.