CARBON DIOXIDE DYNAMICS IN ANTARCTIC PACK ICE AND TRANSFER AT THE ICE-SEA AND AIR-ICE INTERFACES.

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Spring dynamics of partial pressure of CO2 (pCO2) within and below fast sea ice and associated exchanges of CO2 at the ice-sea and air-ice interfaces were investigated in conjunction with the measurement of an extended and comprehensive set of physical, biological, and biogeochemical parameters in the framework of the SIBCLIM project (Sea Ice Biogeochemistry in a Climate Change Perspective). Dynamics of CO2 was investigated through measurement of Dissolved Inorganic Carbon (DIC), Total Alkalinity (TAlk) and in-situ pCO2 in sea ice brines and underlying water down to 30m depth at contrasted stations. Reliable in-situ pCO2 measurements were obtained using an apparatus derived from the classical method used for underway pCO2 measurement. Measurement of pCO2 in air extracted from crushed sea ice allowed us to evidence strong vertical gradient of CO2, even within the thin sea ice edge. Associated exchanges of CO2 at the air-ice interface were measured directly using a chamber method.

Preliminary results exhibit fast CO2 dynamics in sea-ice, mainly driven by internal physical and biogeochemical processes. pCO2 in brines ranged from marked under-saturation down to 210 ppmV to oversaturation up to 915 ppmV while DIC reached values up to 5975 μmol.kg-1. pCO2 from crushed sea-ice evidenced strong vertical gradients of pCO2 with pCO2 ranging in some cases from oversaturation at the air-ice interface to undersaturation at the ice-sea interface. Amongst the physical properties of the sea ice cover, the temperature profile appears to be the main controlling factor

on the CO_2 dynamics. Ice below the porosity threshold of about -5°C displays the higher pCO_2 values, whilst the warmer, more porous, ice favours the set up of primary production and hence, shows the lowest pCO_2 values. At the ice-sea interface, spring initial release of dense CO_2 rich brines tends to increase pCO_2 of the water column while the following development of primary production lead to a shallow decrease of pCO_2. Strong gradients of CO_2 have been observed at the air-ice interface either positive or negative, depending primarily on the temperature profile. These gradients can drive exchanges of CO_2 up to 1.8 mmol.m-2.d-1, depending of the snow cover and the ice temperature.

From this study, it appears that spring Antarctic pack ice can either act as a source or as a sink of CO_2 for both the atmosphere and the underlying water, in close connection with its thermal and biogeochemical seasonal history. For decades, sea ice was seen as a simple inert stopper for air-sea exchange of CO_2; this long-lived paradigm should be revisited in some part.