CARBON DIOXIDE TRANSFER AT THE ICE-SEA AND AIR-ICE INTERFACES: A STEP TOWARDS THE END OF A LONG-LIVED PARADIGM?

Delille Bruno[1], Anne J. Trevena[2], Delphine Lannuzel[3], Marie-Line Sauvée[3], Bronte Tilbrook[4], Michel Frankignoulle[1], Alberto V. Borges[1] and Jean-Louis Tison[2]

[1] Unité d'Océanographie Chimique, Université de Liège
Allée du 6 Août, 17, B-4000 Liège, Belgium
E-mail: Bruno.Delille@ulg.ac.be

[2] Glaciology Unit, Department of Earth and Environmental Science, Université Libre de Bruxelles, CP 160/03, 50, av. F.D. Roosevelt, B-1050 Brussels, Belgium

[3] Océanographie Chimique et Géochimie des Eaux, Université Libre de Bruxelles
Campus de la Plaine, CP 208, Boulevard du Triomphe, B-1050 Brussels, Belgium

[4] CSIRO Marine Research, PO Box 1538, Hobart, Tasmania 7001, Australia

Spring dynamics of partial pressure of CO_2 (pCO_2) within and below fast sea ice and associated exchanges of CO_2 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).

Preliminary results exhibit fast CO_2 dynamics in sea-ice, mainly driven by internal physical and biogeochemical processes. pCO_2 in brines ranged from marked undersaturation down to 210 ppmV to oversaturation up to 915 ppmV while DIC reached values up to 5975 µmol.kg-1. p CO_2 from crushed sea-ice evidenced strong vertical gradient of p CO_2 with p CO_2 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 p CO_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 p CO_2 of the water column while the following development of primary production leads to a shallow decrease of p CO_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.