



Air-ice CO₂ fluxes and pCO₂ dynamics in the Arctic coastal area (Amundsen Gulf, Canada)

Nicolas-Xavier Geilfus (1,2), Jean Louis Tison (2), Gauthier Carnat (3), Brent Else (3), Alberto V. Borges (1), Helmuth Thomas (4), Elizabeth Shadwick (4), and Bruno Delille (1)

(1) Université de Liège (ULg), Unité d'Océanographie Chimique, Liège, Belgium (nxgeilfus@ulg.ac.be), (2) Université Libre de Bruxelles (ULB), Unité de Glaciologie, Bruxelles, Belgium, (3) University of Manitoba, Centre for Earth Observation Science, Canada, (4) University of Dalhousie, Department of Oceanography, Canada

Sea ice covers about 7% of the Earth surface at its maximum seasonal extent. For decades sea ice was assumed to be an impermeable and inert barrier for air – sea exchange of CO₂ so that global climate models do not include CO₂ exchange between the oceans and the atmosphere in the polar regions. However, uptake of atmospheric CO₂ by sea ice cover was recently reported raising the need to further investigate pCO₂ dynamics in the marine cryosphere realm and related air-ice CO₂ fluxes. In addition, budget of CO₂ fluxes are poorly constrained in high latitudes continental shelves [Borges et al., 2006]. We report measurements of air-ice CO₂ fluxes above the Canadian continental shelf and compare them to previous measurements carried out in Antarctica.

We carried out measurements of pCO₂ within brines and bulk ice, and related air-ice CO₂ fluxes (chamber method) in Antarctic first year pack ice (“Sea Ice Mass Balance in Antarctica –SIMBA” drifting station experiment September – October 2007) and in Arctic first year land fast ice (“Circumpolar Flaw Lead” – CFL, April – June 2008). These 2 experiments were carried out in contrasted sites. SIMBA was carried out on sea ice in early spring while CFL was carried out in from the middle of the winter to the late spring while sea ice was melting.

Both in Arctic and Antarctic, no air-ice CO₂ fluxes were detected when sea ice interface was below -10°C. Slightly above -10°C, fluxes toward the atmosphere were observed. In contrast, at -7°C fluxes from the atmosphere to the ice were significant. The pCO₂ of the brine exhibits a same trend in both hemispheres with a strong decrease of the pCO₂ anti-correlated with the increase of sea ice temperature. The pCO₂ shifted from a large over-saturation at low temperature to a marked under-saturation at high temperature. These air-ice CO₂ fluxes are partly controlled by the permeability of the air-ice interface, which depends of the temperature of this one. Moreover, air-ice CO₂ fluxes are driven by the air-ice pCO₂ gradient. Hence, while the temperature is a leading factor in controlling magnitude of air-ice CO₂ fluxes, pCO₂ of the ice controls both magnitude and direction of fluxes. However, pCO₂ in Arctic is significantly higher than in Antarctica. This difference could be due to a higher level of organic matter in Arctic. The degradation of this organic matter fuel CO₂ efflux from the ice to the atmosphere in early spring. We observed evidence of CaCO₃ precipitation, but only at the top of the ice. Implications in term of air-ice CO₂ transfer of such CaCO₃ precipitation will be discussed. In addition, salt-rich snow appears to strongly affect air-ice CO₂ fluxes in the arctic.

Borges, A. V., et al. (2006), Carbon dioxide in European coastal waters, *Estuar. Coast. Shelf Sci.*, 70(3), 375-387.