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Sea ice pCO_2dynamics and related air-ice CO_2 fluxes during a flood-freeze cycle (Bellinghausen Sea, Antarctica)

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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 CO_2 so that global climate models do not include CO_2 exchange between the oceans and the atmosphere in the polar region. However, uptake of atmospheric CO_2 over sea ice cover has been recently reported raising the need to further investigate pCO_2 dynamics in the marine cryosphere realm and related air-ice CO_2 fluxes.

We carried out direct measurements of pCO_2 within brines and related air-ice CO_2 fluxes (chamber method) of Antarctic first year pack ice during the "Sea Ice Mass Balance in Antarctica –SIMBA" drifting station experiment. This experiment was carried out on board the N.B. Palmer in September and October 2008 in the Bellingshausen Sea (Antarctica, 69 – 71˚S; 90 – 95˚E). In this area, significant snow loading promotes flooding of sea ice floes. In the course of the experiment we experienced a full cycle of cooling and warming of the air temperature with large changes in the snow cover thickness. Temperature and snow cover changes affected brine salinities, drastically increasing the instability of the brine column in the initial isothermal and porous sea ice. Cooling of the surface layer has significantly increased the surface layer brine salinity, triggering a downwards transfer of brines into the underlying porous ice. This

downward transfer was likely counterbalanced by upwards (or lateral) transfer of sea water into the ice, a flooding-like process. While the sea-ice cover was undersaturated in CO_2 with respect to the atmosphere, convective processes significantly affected the partial pressure of CO_2 (pCO_2) of the brines, promoting the increase of pCO_2 and reducing the magnitude of related air-ice CO_2 transfer.