Geophysical Research Abstracts
Vol. 14, EGU2012-11390, 2012
EGU General Assembly 2012

Gas transport processes in sea ice: How convection and diffusion processes might affect biological imprints, a challenge for modellers

J.-L. Tison (1), J. Zhou (1,2), D.N. Thomas (3), S. Rysgaard (4,5), H. Eicken (6), O. Crabeck (2,1), F. Deleu (1), and B. Delille (2)

(1) Université Libre de Bruxelles, DSTE - Glaciology, Bruxelles, Belgium (jtison@ulb.ac.be, +32(0)26502226), (2) Université de Liège, COU, Liège, Belgium (Bruno.Delille@ulb.ac.be), (3) University of Bangor, School of Ocean Sciences, Bangor, Wales, UK (d.thomas@bangor.ac.uk), (4) University of Manitoba, CEOS, Winnipeg, Canada (Rysgaard@natur.gl), (5) Greenland Institute for Natural Ressources, Greenland Climate Research Center, Nuuk, Greenland (Rysgaard@natur.gl), (6) University of Alaska Fairbanks, Department of Geology and Geophysics, Fairbanks, Alaska, USA (hajo.eicken@gi.alaska.edu)

Recent data from a year-round survey of landfast sea ice growth in Barrow (Alaska) have shown how O_2/N2 and O_2/Ar ratios could be used to pinpoint primary production in sea ice and derive net productivity rates from the temporal evolution of the oxygen concentration at a given depth within the sea ice cover. These rates were however obtained surmising that neither convection, nor diffusion had affected the gas concentration profiles in the ice between discrete ice core collections. This paper discusses examples from three different field surveys (the above-mentioned Barrow experiment, the INTERICE IV tank experiment in Hamburg and a short field survey close to the Kapisilit locality in the South-East Greenland fjords) where convection or diffusion processes have clearly affected the temporal evolution of the gas profiles in the ice, therefore potentially affecting biological signatures. The INTERICE IV and Barrow experiment show that the initial equilibrium dissolved gas entrapment within the skeletal layer basically governs most of the profiles higher up in the sea ice cover during the active sea ice growth. However, as the ice layers age and cool down under the temperature gradient, bubble nucleation occurs while the concentration in the ice goes well above the theoretical one, calculated from brine equilibrium under temperature and salinity changes and observed brine volumes. This phase change locks the gases within the sea ice structure, preventing "degassing" of the ice, as is observed for salts under the mushy layer brine convection process. In some cases, mainly in the early stages of the freezing process (first 10-20 cm) where temperature gradients are strong and the ice still permeable on its whole thickness, repeated convection and bubble nucleation can actually increase the gas concentration in the ice above the one initially acquired within the skeletal layer. Convective processes will also occur on ice decay, when ice permeability is restored and the Rayleigh number reaches a critical value. The Barrow data set shows that these events, can be strong enough to redistribute the gases within the sea ice cover, including in the gaseous form. Diffusive processes will become dominant once internal melting is strong enough to stratify the brine network within the ice. In the Kapisilit case, the regular decrease of an internal gas peak intensity due to external forcing during ice growth (change of water type) has allowed us to deduce gas diffusivities from the temporal evolution of the peak. The values fit to the few previous estimates from experimental work, and lie close to diffusivity values in water. Finally, at the end of the decay phase, when the temperature profile is isothermal, the whole ice cover returns to ice concentrations equivalent to those calculated using gas solubility in water and observed brine volumes, to the exception of the very surface layer, generally for textural reasons.