Antarctic sea ice trophic status

Van der Linden F.[1,2], W. Champenois[1], B. Heinesch[3], S. Moreau[4], M. Kotovitch, G. Carnat[2], F. Fripiat[5], J. Zhou[2], T. Haskell[5], J.-L. Tison[2] and B. Delille[1]

[1] Unité d'Océanographie Chimique, Université de Liège, Belgium
[2] Laboratoire de Glaciologie, Université libre de Bruxelles, Belgium
[3] Unit of Biosystems Physics, Université de Liège, Belgium
[4] Georges Lemaître Centre for Earth and Climate Research, Université catholique de Louvain, Belgium
[5] Max Planck Institute for Chemistry, Mainz, Germany
[6] Callaghan Innovation, New Zealand

The sea ice ecosystem is characterized by steep gradients in temperature, salinity, light and nutrient availability. Despite these challenging environmental conditions, sea ice provides a dynamic habitat for diverse communities of microorganisms. These communities include a wide variety of organisms from different taxonomic groups such as algae, bacteria, heterotrophic protists, fungi as well as viruses. In the frame of the YROSIAE project (Year-Round survey of Ocean-Sea-Ice-Atmosphere Exchanges), carried out at Cape Evans in McMurdo Sound (Antarctica) from Nov. 2011 to Dec. 2012, ice cores, seawater, and brine material were collected at regular time intervals. Physical properties (salinity, temperature, texture) and biogeochemical parameters (pCO2, dissolved inorganic carbon, total alkalinity, chlorophyll-a, macro-nutrients) were analysed. We used dissolved inorganic carbon (DIC) and chlorophyll-a (chl-a) as proxies of net community production and autotrophic biomass, respectively. A high spatial and temporal variability in ice algal biomass and DIC were observed. From spring, very high chl-a concentrations ($>2400 \mu g.L^{-1}$) were observed at the bottom of the ice, a common feature of land fast ice in the McMurdo Sound. This suggests high primary production. Strikingly, at the same time, nutrients at the bottom of the ice increased significantly suggesting high remineralisation. In the middle of the ice column, evolution of DIC was marked by a succession of autotrophic and heterotrophic phases. The overall increase of DIC suggests that the ice interior was rather heterotroph. Such sea ice system should expel CO2. Yet, strong under-saturation in CO2 and DIC depletion appeared at the ice surface, suggesting that sea ice was taking up CO2 from the atmosphere. On the whole, land fast sea ice in McMurdo Sound appears as a puzzling ecosystem. It is able to support elevated growth of autotrophic organisms at the bottom, in parallel to high remineralization, while the top of the ice appears to be rather heterotrophic but still able to pump CO2 from the atmosphere.