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A new microcosm to investigate oxygen dynamics at the sea ice water interface

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Abstract:

A laboratory sea ice microcosm was developed to enable the cultivation of the ice diatom *Fragilariosis cylindrus* in the skeletal layer and bottom 10 cm of sea ice. Growth of diatoms was ensured by continuous flow of new medium beneath the ice. Light was provided from above by a metal halide lamp to simulate a typical natural daylight irradiance spectrum. Oxygen micro-optodes were deployed in the microcosm to measure micro-profiles through the ice water interface and between the ice lamellae of the skeletal layer. Net oxygen production at the ice water interface, at an irradiance of 40 µmol photons $m^{-2} s^{-1}$ and -1.9°C, ranged between 0.0064 and 0.0225 nmol O_2 cm^{-2} s^{-1}. Algal biomass increased from 0.03µg chlorophyll a (chl a) 1^{-1} in the column interior to 42 µg chl a 1^{-1} within 5 mm of the ice water interface. Oxygen micro-profiles revealed diffusive boundary layers (DBLs) which varied between ca. 460 and 1000 µm. DBLs were detected between ice lamellae, the periphery of the ice water interface and extending from the water below the ice through the ice water interface into the spaces between ice lamellae. An additional small-scale horizontal variability of DBLs was also reflected in the net photosynthetic activity. The small-scale patchiness of algae and the differences in DBL thickness were caused by physico-chemical processes (e.g. turbulence, water flow velocity), which in turn were influenced by ice lamellar structure at the ice water interface. These factors were the grounds of the observed variability in net-photosynthesis.

Key-words: Fragilariopsis cylindrus, methods, microcosm, micro-optodes, oxygen, photosynthesis, sea ice