Biological- and physical-induced oxygen dynamics in melting sea ice of the Fram Strait

Ronnie N. Glud, Søren Rysgaard, Gavin Turner, Daniel F. McGinnis and Raymond J. G. Leakey

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ABSTRACT: We investigated the production, consumption, and exchange of O_2 in melting sea ice to assess the biological- and physical-induced O_2 turnover. The underside of the ice was covered with 5 – 20 cm^3 large, buoyant algal aggregates. Their gross primary production amounted to 0.49 mmol C m^{-2} d^{-1}, which was 4.5 times higher than the primary production of sea ice – encrusted microalgae (0.11 mmol C m^{-2} d^{-1}). The phototrophic biomass of the aggregates (2.94 mg chlorophyll *a* m^{-2}) was six times higher than that encountered in the sea ice itself. Taxono-specific investigations strongly suggest that the aggregates were formed from agglutinated algae released from the melting ice. At the prevailing light conditions, the sea ice – encrusted communities were almost at metabolic balance, while the aggregates were net heterotrophic. Together, the two communities were responsible for an overall O_2 consumption of 0.32 mmol m^{-2} d^{-1}. The sea ice – associated communities thereby represent a southward-drifting carbon source that is being exhausted by sea ice – affiliated food webs. The sea ice volume decreased rapidly, releasing meltwater at a rate 25 L m^{-2} d^{-1}, but no surface melt ponds were formed. Aquatic eddy correlation (EC) measurements on the underside of the ice revealed a light-dependent O_2 exchange rate. However, the integrated signal resolved a net O_2 uptake of 7.70 mmol m^{-2} d^{-1}. The net O_2 exchange was therefore dominated by the production of O_2-depleted meltwater rather than biological activity. The EC technique represents a new non-invasive tool for O_2 studies in sea ice communities.

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