

## ***Interactive comment on “Oxygen exchange and ice melt measured at the ice-water interface by eddy correlation” by M. H. Long et al.***

**M. H. Long et al.**

mhl4a@virginia.edu

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**Our response to referee A. McMinn:** The referee's comments are in *italics* and our responses are in normal font.

*This is a valuable manuscript that describes the application of a relatively novel method for estimating photosynthesis and primary production of sea ice algae. The author's use the 'eddy correlation' technique, developed by Berg et al. 2003 for use in aquatic systems. Berg and co-authors have produced a series of papers which have validated the method in a variety of marine ecosystems. This manuscript is the first application with sea ice. The results show great promise and while there is a need for better correlation and validation studies in sea ice, the method would seem to have a bright future. The manuscript is well written and the illustrations are well produced.*

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*Sea ice ecosystems are one of the most challenging environments to work in and most methods applied have always had some constraints and limitations. The advantages of this method include the large footprint of measurement, the quantification of oxygen fluxes from melting ice and the relatively high temporal resolution. Disadvantages include the number of assumptions that need to be made (p11261, 18-24), the need for moderate current velocities and the resultant small proportion of the time when measurements could be made. Consequently, site selection may be an important consideration in future applications of this method in sea ice. Although it has been shown that current strength significantly affects primary production in sea ice algal communities (McMinn et al. 2000).*

*Correlation of the eddy correlation method is not well constrained against other methods. The authors compare it with  $^{14}\text{C}$  measurements based on ice melted over two days and that have then been incubated for 5 hours (Sogaard et al. 2010). The vastly different treatment would suggest any similarity in results is just luck! A more appropriate comparison would have been with the oxygen flux across a diffusive boundary layer approach as this has similar temporal resolution, similar lack of invasiveness and measures oxygen rather than carbon.*

We agree with the reviewer that the results of this comparison should be interpreted cautiously and we have expanded our discussion to further emphasize the differences between the methods. The eddy correlation technique has been validated successfully a number of times in the benthic environment but since this application under the sea ice was new, we felt it was important to put our results in perspective. Unfortunately we do not have concurrent data allowing comparisons with the diffusive boundary layer approach.

*The authors overstate the problems of melting and brine exclusion in micro oxygen electrode measurements (11258, In 12-16: 11265 In 23-27). Brine exclusion is a problem when ice is newly forming and thin. It is a much less important when ice is thicker and growing either very slowly or not at all. In many polar areas sea ice is either grow-*

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*ing slowly or is static for much of the year. Once ice exceeds a thickness of 75 cm, growth is very slow and brine exclusion is minimal. Similarly melting only takes place for a relatively short period. Likewise, microsensor profiling problems associated with invasiveness are minor (Lorenzen et al. 1995) been used successfully many times.*

We agree with the referee that these processes are likely insignificant at this site during our sampling period. However, we felt it was appropriate to mention melting and brine exclusion as a potential problem in our brief method review. We have kept the information in the text, but have now been very specific with respect to when this can be a problem. We have also clarified our specific statements about microsensor invasiveness and their sensitivity to salinity and temperature gradients at the ice-water interface. Thus, the text should now be in line with the reviewer's comments.

*Biomass, i.e. chlorophyll, measurements should be added (if taken) so primary production estimates can be compared with other studies.*

This is an excellent point. In section 2.1 we have now included the chlorophyll A concentration in the bottom 12 cm of the ice ( $2.75 \pm 0.35 \mu\text{g L}^{-1}$ ) and the average concentration of the entire ice column ( $1.0 \pm 1.2 \mu\text{g L}^{-1}$ ).

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Interactive comment on Biogeosciences Discuss., 8, 11255, 2011.