

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

F. Meysman (Referee)

f.meysman@nioo.knaw.nl

Received and published: 19 January 2012

General assessment

This paper presents a novel application of the recently developed Eddy Correlation Technique (ECT) for flux measurements in aquatic systems. In this study, the technique is applied in a quite challenge setting, namely under sea ice in Greenland. The study is innovative, because it combines a geochemical application ECT, where one looks at O₂ fluxes (typically towards sediments), with a physical application, where one looks at heat fluxes (as under sea ice). As the authors mention, both applications have been done before, but never combined.

The manuscript is well written, reads fluently, has carefully prepared figures and is of

C5408

the right length. In fact, I have only a few (mostly minor) comments, and so, after adapting these, the manuscript is ready for publication.

General comments

One problem with the ECT is that datasets are cleaned up and trimmed by visual inspection before fluxes are reported. In the present study, it is reported that only during 34% of the measurement period, there was enough turbulence under the sea ice to allow flux estimates. However, even if there is enough turbulence, EC flux calculations can be compromised because of other reasons (here called “anomalous variations due to sensor malfunction” like shifts in the O₂ signal because detritus attachment etc). These data are typically removed based on judgment and expertise of the data collector. In my view, an important challenge for the ECT community is to make this data processing and data cleaning step more quantitative and objective. At least to start with, it would be great if ECT studies would report how many of the total data bursts were removed, because of being judged as “bad data sectors”. Would it be possible to specify to report the percentage of data bursts that was rejected even when there was enough turbulence?

Statistical reporting of results. This study systematically reports the Standard Error (SE) rather than the Standard Deviation (SD). The SD is an index of the variability of the measurements, while the SE is a quality estimate for the mean (how certain are we that the reported sample mean is the true population mean). The ECT induces inherently a large burst-to-burst variation in the fluxes, and hence in the derived estimated of Respiration and NPP. Therefore, in my view, it is more appropriate to report the SD rather than the SE.

Equation (3). Given that this study explicitly constrains the for the contribution of ice melt to the O₂ flux, why not explicitly taking this into account in the mass balance (3), i.e., add an extra term for this? This mass balance also assumes that no major respiration and production occurs in the 22 cm between the sensor and the ice (better

C5409

explain where you assume that respiration and primary production takes place).

Explain the sign convention of the flux: negative flux means O₂ transport towards the ice

Discussion of spectra analysis (P11263). The turbulent cascade stretches from frequency range 0.1 Hz to 1 Hz (Fig 3a). However, all contributions to the O₂ flux however occur in the range below 0.1 Hz (i.e. from 0.01 Hz to 0.1 Hz or time scales of 10 to 100 seconds). Are these really turbulent eddies below 0.1 HZ doing the O₂ transport, or something else (eg waves)? Typically, the velocity spectrum should be closed on the left hand side (showing the band gap between turbulence and advection). This is not the case here.

There is no discussion of what causes the clear trend in heat flux (ice melt) rates over the study period. Correlation with irradiance, water temperature or flow direction? Make a figure similar to fig 5, but now for the heat flux?

The calculation of u^* and z_0 is based on a single point measurement (here at 22 cm beneath the ice boundary) and therefore subject to considerable uncertainty. It would be better to measure a velocity profile in the boundary layer with the ADV.

Figure 2. The stratification should also induce O₂ depletion in the boundary layer. Given 2 mmol m⁻² d⁻¹ of respiration in the ice, and a 0.2 boundary layer, one would expect to observed a decrease of 10 mmol m⁻³ d⁻¹. Was this observed by the accompanying Hatch optode?

I'm not a photosynthesis expert, but I'm amazed that as an algae, you can make a living on 4 μ mol photons per m⁻² d⁻¹.

Specific comments

Abstract. Avoid the phrase avoid "amounting to...". Some sentences can be shortened. Remove SE's from the abstract. 11256 L5 This study was... 11256 L7 revealed low rates of ice melt with a maximum of.. 11256 L8 The O₂ flux associated with...

C5410

11256 L12during 66% of total 11257 L15 O₂ flux contributions due to... 11257 L28 time consuming 11258 L11 rephrase sentence – difficult to read

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