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

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We would like to applaud the authors for an interesting paper describing a novel application of the aquatic eddy correlation technique. Having read the Discussion Paper we are left with a few questions/recommendations that we are hoping the authors would kindly address. These are the following:

1. On page 11263 (lines 4-8) the authors infer 'well-mixed conditions' under the ice from a -5/3 fit to the inertial subrange of the spectra for Vz. We would like to point out that whilst the -5/3 fit does suggest well-developed turbulence, it is not necessarily indicative of well-mixed conditions below the ice. Brand et al. (2008) found, for example, that even though turbulence was within the inertial subrange at low current velocities, this was not sufficient to transport O2 through the stratified top of the BBL. Being such a

crucial assumption, we feel that this statement should be at the least complemented by a hypothetical model of mixing height vs current velocity as in Brand et al. 2008, Fig. 8.

2. The footprint calculation (page 11264, line 27 onwards) as demonstrated by Berg et al. (2007) assumes law-of-the-wall (LOW). We feel that this assumption deserves some more attention in order to be justified, since this paper deals with a system that exhibits both low flow velocities as well as stratification. For example, Lorke et al (2003; Fig. 3) show that LOW does not always hold true during periods of low current velocity. Assuming LOW during periods where LOW is not valid may compromise the values obtained for u*, zo, dissipation and subsequently the footprint calculation. As a rough estimate, the timescale of establishing a well-mixed boundary layer can be estimated as t=Lˆ2/(2Kz) where L is the thickness of the boundary layer and Kz is the vertical diffusivity. The authors could also double-check that the LOW assumption by calculating the dissipation using the inertial dissipation method and then comparing the dissipation values obtained using both methods.

3. Looking at Figure 3, it is apparent to us that there is a mis-match between the periods defined as the inertial subrange of Vz and O2 and the turbulent transport of O2 as indicated by the cumulative cospectra. The inertial subrange for Vz (Fig. 3A) is defined for frequencies between around 0.06Hz to 0.7Hz. For O2 (Fig. 3B) this is defined between around 0.04Hz to 0.3Hz, however the cumulative cospectra (Fig. 3C) suggests that the contributing eddy range is between approximately 0.015Hz to 0.1Hz – a shift to the lower frequency range by a factor of $\sim$10. Looking at the cumulative co-spectrum you rightly note that eddies with a frequency of <0.1Hz contribute to most of the turbulence-driven O2-flux. However, this seems to be inconsistent with the turbulence range defined for Vz, especially since the cumulative co-spectrum suggests that around 80% of the turbulent O2 flux is driven by eddies with frequencies lower than the defined Vz inertial subrange.

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