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Abstract

The recently developed eddy-correlation method for oxygen in stratified natural waters allows monitoring vertical oxygen fluxes to an accuracy of ∼20% over times scales of one hour. Such short-term variability is relevant in inland waters, as basin-scale deep-water flows usually define the forcing of oxygen fluxes into the sediment. These bottom boundary currents typically have oscillatory components of time scales of hours to days - depending on the horizontal extent of the water body - and subsequently currents regularly cease when flows change direction. Rapid profiling with oxygen microsensors reveals, indeed, that the diffusive boundary layer loses its oxygen within minutes, if currents fall below turbulence levels. Because the oxygen content of the uppermost sediment (< few mm) is usually only in the range of a few 0.01 mmol m–2 in meso- to eutrophic lakes, the sediment also becomes anoxic within some 10 minutes. Subsequently, reduced substances (main components are methane and ammonium) diffuse into the overlaying water and deplete oxygen from lake water in the bottom boundary layer. As a result, the oxygen depletion rate is larger than actually estimated from oxygen fluxes into the sediment. For meso-to eutrophic lakes on the Swiss Plateau, we showed that these reduced substances typically contribute about 30% of the oxygen consumption. In order to quantify deep-water oxygen consumption, we conclude that measurements by eddy correlation or by microprofiling need to be complemented by fine-scale profiles of reduced substances.