Universal scaling of dissolved oxygen distribution at the sediment-water interface: A power law

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ABSTRACT: Dissolved oxygen (DO) distribution at the sediment-water interface of a flow over a smooth bed is investigated for Reynolds numbers >360 and <4,090. These conditions are commonly encountered in streams, wetlands, and lakes. A power-law scaling of DO distribution is derived and compared with experimental data. The scaling analysis is based on DO flux at the sediment-water interface in a turbulent flow. The power-law model with diffusive sublayer thickness (DSLT) as a fitting parameter agrees well with the data over the investigated range of Reynolds numbers. Using the proposed power-law model with a limited number of DO and flow properties away from the sediment-water interface provides the distribution of DO concentrations and corresponding DSLT at a submillimeter resolution. The estimate of DSLT is, on average, 30% lower than the traditional estimate, defined as a thin fluid layer bounded at the lower boundary by a sediment bed and extended upward in the main water column to where a bulk DO concentration intersects with a linear DO gradient at the bed.