

# Effect of the diffusive boundary layer on benthic mineralization and O2 distribution: A theoretical model analysis

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ABSTRACT: On the basis of a dynamic diagenetic model, we evaluate and discuss the effect of the diffusive boundary layer (DBL) on benthic $O_2$ exchange and $O_2$ consuming pathways. The analysis documents that the DBL has only minor importance for the annual $O_2$ uptake of coastal cohesive sediments. Imposing static DBL thicknesses of 300-900 mm decreased the annual $O_2$ uptake by only 2-10% in comparison to a situation without any DBL. Lower $O_2$ availability as imposed by a thicker DBL, however, markedly reduced the aerobic heterotrophic respiration but enhanced aerobic reoxidation of solutes released by the stimulated anaerobic respiration. The 2- 10% decrease in the annual $O_2$ uptake was caused mainly by higher benthic release rates of $NH_4^+$ and $Mn^{2+}$. The overall carbon degradation rate and thus the carbon preservation remained unaffected by the DBL thickness. Dynamic modeling revealed that abrupt changes in the DBL thickness caused an instantaneous change in the interstitial $O_2$ distribution and in the benthic $O_2$ uptake rate. However, conditions quickly reversed as the porewater profiles of reduced solutes and distribution of reduced solids readjusted even though full steady state was obtained only after several months. In nature the DBL is constantly changing, and thus in situ $O_2$ microprofiles are transient by nature. Dynamic modeling showed that the benthic $O_2$ concentration and the $O_2$ uptake in Aarhus Bay could vary by 30% or more on time scales of a few hours or days solely because of changes in the DBL thickness. The integrated annual $O_2$ uptake remained unaffected by these fluctuations.