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Impact of Particle Resuspension on Oxygen Consumption and Nutrient Cycling in a Turbid Estuary: Insights from the Loire Estuary

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A characteristic feature of macrotidal estuaries is the presence of a Maximum Turbidity Zone (TMZ), defined by a high concentration of suspended particles (>0.5 $g.L^{-1}$). It is maintained by frequent resuspension and deposition events, mainly influenced by waves, tidal currents, and river discharge. These cycles often result in enhanced organic matter degradation, generating a local dissolved oxygen (DO) demand, which can lead to drastic declines in DO and even hypoxic conditions (DO<2 $mg.L^{-1}$). In the Loire estuary (France), a macrotidal and turbid environment prone to summer hypoxia, the TMZ is a focal point of interest as it is the site of a persistent oxygen deficit in the inner estuary. To investigate the effects of particle reactivity on DO consumption within the inner estuary, we conducted 14 sampling campaigns between summer 2022 and summer 2023, covering a wide range of river discharge and temperature conditions. We selected two sampling stations: one subjected to freshwater influence and almost continuous presence of TMZ, and the second exposed to coastal ocean conditions. Suspended particles were collected at mid-tide and incubated in the laboratory under controlled conditions at 20°C with continuous stirring to maintain resuspension. DO concentrations were measured using optic sensors and incubations were stopped when 30% of the oxygen concentration was consumed. Nutrient and organic matter composition were investigated by pre- and post-incubation filtration to analyse ammonium, nitrate, phosphate, particulate organic carbon, and nitrogen (POC, PON). DO consumption rates reached maximum values in spring (52.2±0.1 $\mu mol.g^{-1}.d^{-1}$,42.6±0.4 $\mu mol.g^{-1}.d^{-1}$) at the upstream and downstream stations, respectively. Overall, the most downstream station had higher oxygen consumption rates due to the marine influence contributing to the input of fresher organic material compared to the upstream station where the presence of TMZ is associated with degraded material. These results emphasize the importance of the material source on oxygen consumption rates. Our discussion will focus on the degradation processes occurring within the TMZ and consider how the reactivity and source of suspended particles may play a role in influencing oxygen consumption patterns, potentially contributing to the development of hypoxic conditions within the estuary.