

Calibration of sediment parameterizations to simulate the turbidity maximum in a highly turbid estuary: integration of model, field and satellite data

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Numerical modelling of turbidity maximum in macrotidal estuaries requires a robust hydrodynamical model coupled to a sediment transport model that accounts for the fundamental sediment processes. In theory, an exhaustive number of physical processes affecting cohesive sediment are needed. However, the deterministic simulation of turbidity patterns in large estuaries is often obtained through a limited number of simplified parameterization, which have been carefully calibrated.

The Gironde Estuary (Bay of Biscay, SW France) is a macrotidal estuary characterized by a high-concentrated turbidity maximum. A key issue during the last years was to grade the basic mechanisms inducing fine sediment trapping. This was achieved by a 3D numerical model which simulated turbidity in academic situations. In this work we apply the 3D model to reproduce realistic turbidity maximum and to explore sensitivity to sediment parameterization. Because of the lack of knowledge on physical properties of flocs in the Gironde, the parameterization of the settling velocity is based on comparisons with time series of surface suspended sediment concentration (SSC). A settling velocity ranging from 0.1 to 2mm.s⁻¹ is found to be the best adjustment to reproduce satisfactory the dynamics of measured turbidity, as well as to ensure the persistence of the turbidity maximum over time. The comparison with satellite imagery shows that the model reproduces well the geometry of the turbidity maximum at different seasons. In the lower estuary, the lateral suspended sediment flux from the main navigation channel to the eastern bank promotes the transfer of sediment towards the downstream part of the estuary and the escape of sediment through the mouth. One-year simulations allow the study of the mass budget in the estuary over seasonal cycles. These confirm the main role of tidal asymmetry on the turbidity maximum formation, and the secondary role of density gradients to maintain a stable mass of suspended sediment within the estuary. Moreover, the sensitivity of the turbidity maximum to sediment erodibility and to the process of consolidation is discussed.