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Bottom shear stress and SSC control on the morphological evolution of estuarine intertidal mudflats

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The supply and fate of fine-grained suspended sediment is of primary importance to the functioning and evolution of estuaries. Intertidal mudflats are habitats of high ecological value: feeding ground for birds, fish species and other biota. Estuarine intertidal mudflats can also contain buried contaminants that can be potentially released in the estuarine system. Thus physical processes such as erosion and sedimentation are fundamental from both applied and environmental viewpoint.
Sedimentation and erosion rates/fluxes are mainly driven by hydrodynamics, particles/sediment properties, bedforms and sediment supply. Few high-frequency field-investigation studies compared tidal scale processes simultaneously in the water column and on the mudflat surface. The aim of this paper is to determine the thresholds values (bottom shear stress and SSC) that control the morphological evolution of estuarine intertidal mudflats (< 10% of sand) on semi-diurnal tidal scale. This field-based study combines high-resolution and high-frequency measurements of turbulence and SSC in the water column (using ADV) and bed height (using altimeter) on intertidal mudflat surface in three macrotidal estuaries. Such approach on semi-diurnal scale permitted to accurately understand relationships between hydrodynamics in the boundary layer and sedimentary processes above intertidal mudflats.
Results emphasize the role of waves, sediment supply and consolidation state of surface sediments on sedimentary processes over intertidal mudflats. Bottom shear stresses on studied intertidal mudflats were recorded always sufficiently low (<1N.m-2) to permit settling of fine particles during flood tide and/or high-water slack. Sedimentation occurrence and rate on studied intertidal mudflat was found to be driven by (i) the SSC near the bed (if > 0.1g.l-1) and (ii) the absence of significant waves. Wind-generated waves can prevent sedimentation or induce erosion if the bottom shear stress exceeds 1N.m-2. Further inspections demonstrate that the occurrence and the amplitude of erosion are also governed by consolidation state of the surface sediment and water level on the mudflat.