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Characteristics of wind waves in shallow tidal basins and how they affect bed shear stress, bottom erosion, and the morphodynamic evolution of coupled marsh and mudflat landforms

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Wind-wave induced erosion is one of the main processes controlling the morphodynamic evolution of shallow tidal basins, because wind waves promote the erosion of subtidal platforms, tidal flats and salt marshes. Our study considered zero-, one-and two-dimensional wave models. First, we analyzed the relations between wave parameters, depth and bed shear stress with constant and variable wave period considering two zero-dimensional models based on the Young and Verhagen (1996), and Carniello et al. (2005, 2011) approaches. The first one is an empirical method that computes wave height and the variable wave period from wind velocity, fetch and water depth. The second one is based on the solution of wave action conservation equation, we use this second approach for computing the bottom shear stress and wave height, considering variable and constant (t=2s) wave period. Second, we compared the wave spectral model SWAN with a fully coupled Wind-Wave Tidal Model applied to a 1D rectangular domain. These models describe both the growth and propagation of wind waves. Finally, we applied the two-dimensional Wind Wave Tidal Model (WWTM) to six different configurations of the Venice lagoon considering the same boundary conditions and we evaluated the spatial variation of mean wave power density.
The analysis with zero-dimensional models show that the effects of the different model assumptions on the wave period and on the wave height computation cannot be neglected. In particular, the relationships between bottom shear stress and water depth have different shapes. Two results emerge: first, the differences are higher for small depths, and then the maximum values reached with the Young and Verhagen (1996) approach are greater than the maximum values obtained with WWTM approach. The results obtained with two-dimensional models suggest that the wave height is different in particular for small fetch, this could be due to the different formulation of the wave period. Finally, the application of WWTM for the entire Lagoon basin underlines an increase of the mean power density in the last four centuries, in particular in the central-southern part of the lagoon between Chioggia and Malamocco inlets.