THE EFFECT OF WAVE-CURRENT INTERACTIONS ON THE SEDIMENT DYNAMICS IN THE ÓBIDOS LAGOON

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1. Introduction

The combined effect of waves and currents plays a major role on the sediment dynamics of wave-dominated inlets. When waves are propagating toward the lagoon, the ebb-currents can partially or totally block the wave motion. Besides analysing the wave blocking phenomenon in the Albufeira lagoon, Dodet *et al.* (2013) showed that the interaction between waves and currents will increase the sediment transport towards the lagoon during the flood. This study aims at verifying these phenomena in a different scenario through an idealized test case with a constant in space and time wave spectrum.

2. Case study – the Óbidos lagoon

The Óbidos Lagoon, located at the Portuguese western coast, has an average depth of 4,5 m below the mean sea level. The freshwater input is generally small as it represents less than 5% of the average tidal prism scaled by the M_2 period (Oliveira *et al.*, 2006). Morphologically, the Óbidos Lagoon is divided in two zones: the upper zone and the lower zone. The upper zone is constituted by cohesive sediments, while in the lower zone, the vast majority of sediments are sands with d_{50} ranging 0,4 to 0,8 mm (Fortunato *et al.*, 2011).

According to Bertin *et al.* (2009), the wave regime can be briefly characterized by a significant wave height (Hs) larger than 1 m during 88% of the time, reaching 6 m in the maritime winter. The most frequent wave direction is 315º N and the wave peak period varies between 5 and 20 s. The tidal regime is semidiurnal with amplitudes ranging between 2 to 4 m at the coast and 1 to 2 m inside the lagoon after the damping caused by the inlet (Oliveira *et al*., 2006).

3. Numerical model – SELFE and WWM-II

The numerical model used in this study simulates the water circulation in estuaries or coastal environments taking into account the full interaction between waves and currents. This model comprehends the coupling between a hydrodynamic model – SELFE (Zhang and Baptista, 2008) and a wave model – WWM-II (Roland, 2009). These models share the same unstructured grid and make computations in parallel. There are two coupling options: fully coupled (1) and partially coupled (2). In option (1), SELFE is forced with the radiation stresses from WWM-II, and the currents obtained by SELFE are considered by the WWM-II in order to reproduce the wave shoaling induced by currents. In the option (2), only the radiation stresses of WWM-II are considered by SELFE.

The grid used in this study was obtained from previous studies (Bruneau *et al.*, 2011). This grid has 29398 elements with a spatial resolution of 1,6 km at the ocean boundary and 6 m at the inlet. The hydrodynamic model was forced by 20 tidal constituents on the ocean boundary where the amplitudes and phases were computed with the regional tidal model of Fortunato *et al.* (2014). The wave model was forced by a JONSWAP spectrum with a constant Hs, Tp and Dir of 2 m, 9 s and 315º N, respectively. The wave blocking phenomenon will be addressed with two simulations of thirty days, each one with a different coupling option. The sediment discharge was computed with the sediment transport formulation of Van Rijn (2007a,b), which considers the wave-current interaction for the sediment transport.

4. Wave blocking phenomenon

Figure 1 shows the time series of the simulated parameters in a grid node located inside the lagoon at the end of the transitional channel. The results show the wave blocking phenomenon with the Hs going to zero during the ebb and the increase of 12% on the sediment transport during the flood towards the lagoon whenever the numerical model considers the full interaction between waves and currents (coupling option (1)).

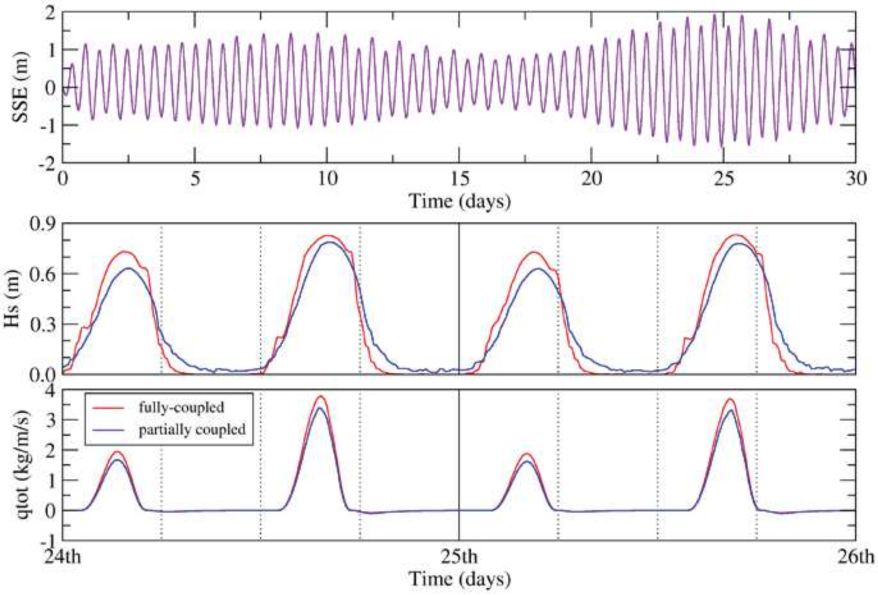

Figure 1 – Top: Sea surface elevations for the thirty days; Middle and bottom: Comparison between a simulation with the coupling option (1) (red lines) and with the coupling option (2) (blue lines) for the Hs (first box) and sediment fluxes (qtot) (third box) between the 24th and 26th days of simulation

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