Title:

Modeling changes in the tidal propagation and its implication for vessel navigation in Guadalquivir Estuary (Spain).

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Abstract:

The Port of Seville is an inland harbour located in the Guadalquivir Estuary some 80 km from the river mouth and is the unique Spanish inland port. Vessel traffic in the estuary is a relevant economic activity and a suitable trade-off between vessel draught and safety to prevent ship aground is required and to optimize the port operability. The Guadalquivir is a mesotidal estuary with tidal range of 2-3 m, an important fraction of the minimum depth of the navigation waterway (presently 6.5m). Upstream navigation is favoured around high water as the tide progresses at ~12 knots, which is comparable to the vessel speed, thus allowing greater vessel draughts. Oceanwards navigation of heavy vessels, on the contrary, is hampered by the tide because a low water is unavoidably met when heading downstream.

A 3D, high resolution hydrodynamic model has been implemented in the whole estuary to study the tidal propagation. The model is forced by the oceanic tide at the mouth and freshwater discharges controlled by an upstream dam at the head. It has been satisfactorily validated and predicts tidal oscillations with high accuracy (less than 4 cm in amplitude and 20 min in phase everywhere in the estuary). Based on the model outputs of tidal heights and currents and using present-day estuary bathymetry, a MATLAB application has been developed for shipping planning (Vessel Traffic Decision Support System, VTDSS). The application allows the final users to test different traffic scheduling scenarios in order to assess the effects on navigational patterns and explore possible management and policy scenarios under sea level rise and changes in tidal propagation. A description of the model and an overview of the VTDSS are presented here; the effectiveness as a decision support tool is demonstrated via the simulated navigation time of several vessels.