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Bar migration in tidal channels

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The problem of formation of tidal bars has been recently investigated by Seminara and Tubino (2001) in the context of a fully 3-D linear model. The authors showed that in the absence of mean currents tidal bars are non migrating features (in the mean). In order to ascertain the conditions required for bar migration, we have first formulated a depth-averaged model. The suspended sediment flux has been modelled by means of the analytical relationship derived by Bolla Pittaluga and Seminara (2003) for slowly varying flows, which retains the relevant information arising from the three-dimensional nature of the convection-diffusion equation. The results of the model proposed herein show a fairly satisfactory agreement with those of the three-dimensional model of Seminara and Tubino. Hence, the suggestion that the problem of the non-linear development of tidal bars can be formulated in the context of a depth-averaged analysis, which definitely requires a lower computational effort than a 3-D model. In agreement with the analysis of Seminara and Tubino, a basic flow consisting of a purely semidiurnal tide with constant depth, gives rise to bed forms characterized by no net migration over a tidal cycle. We have then investigated the case of forcing oscillations consisting of a combination of a lunar semidiurnal tide (M2), a solar-lunar diurnal tide (K1) and an M4 overtide, a situation that is tipically encountered in Venice Lagoon. Under these conditions, the flood asymmetry, namely the fact that the flood peak velocity is higher than its ebb value, induces an asymmetric forward-backward movement, hence a net migration of the order of the order of meters per day. Bar migration turns out to be maximum when both the overtides investigated are in phase with the dominant harmonic, and may be enhanced by the finite amplitude character of tidal waves.