Title: Numerical simulation of the three-dimensional river antidunes

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Abstract:

This study presents numerical simulations of the formation and development of the three-dimensional river antidunes. We use a Boussinesq type depth-integrated hydrodynamic model to account for the non-hydrostatic pressure effects on the flow field, dissipative feature of the free surface and the bed shear stress distribution. In addition, a non-equilibrium bedload transport model is incorporated into the model to consider the lag effect of the bedload transport on the bedform dynamics. The model is applied to idealized laboratory-scale conditions, i.e., steady water and sediment supplies, uniform sediment and a straight channel with constant slope and channel width, to understand the model performance and applicability. The results shows that the model is able to reproduce an upstream-migrating antidunes and associated free surface dynamics. The model also captures the formation of the two dimensional and the three-dimensional antidunes. The antidunes reproduced by the model are somewhat unstable, i.e., the repeated cycle of dissipation and regeneration of antidunes is observed. In addition, as the calculation progresses, the modelled three-dimensional antidunes generally tend to lose their three-dimensionality, i.e., the reduction of the spanwise wavenumber. In the early stage of the calculation, the antidune mode is dominant, whereas, the free bars also develop when the formative condition of bars is satisfied. The numerical results show the coexisting of free bars and antidunes, which are a common evident in flume experiments and field observations.