Application of the Lattice Boltzmann Method to Oscillatory Boundary Layers Over the Sea Bed

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Recently we have successfully applied the Lattice Boltzmann Method (LBM) simulation technique to the study of oscillatory boundary layers over a flat bed at relatively low Reynold's numbers. The results shed light on a number of poorly-understood phenomena relating to the stability of oscillatory shear flows.

The figure shows vorticity calculated from a three-dimensional simulations of a purely oscillatory flow over a smooth bed at the oscillatory phase for which the fluid velocity is a maximum. LBM simulations have shown that in two-dimensional flow the phase at which there is a transition to turbulence is in good agreement with the results of two-dimensional linear stability analyses, while the results of three-dimensional simulations are in agreement with experimental observations.

This work is now being extended to high Reynolds numbers in order that it can be applied more specifically to flow over the sea bed. A LBM code has been implemented which incorporates the Smagorinsky sub-grid turbulent model. This code also allows sediment particles to be added to the flow using a development of the technique recently described by A. Masselot (2000) and A. Dupuis (2002). This will enable us to study sediment transport, deposition and pick-up in oscillatory flows over both smooth and rough beds. The flow field will respond to changes in bed morphology as sediment is deposited or eroded or both, this technique, therefore, will enable us to study important phenomena such as scouring due to wave motion.

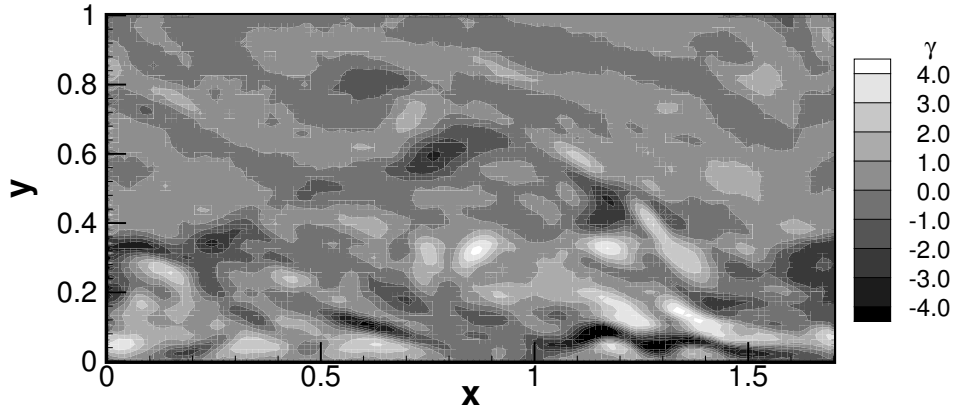

Figure: Vorticity calculated from a three-dimensional LBM simulation of a purely oscillatory flow over a smooth bed. The image corresponds to the oscillatory phase for which the fluid velocity is a maximum.