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Vorticity distribution in a periodically driving flow

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In the last decades some investigations about tidal induced flow between a channel and an open domain (e.g. an estuary and the sea) have been conducted. According to them, during each tidal period two counter rotating vortices form in front of the channel output. This structure is known as a dipole. More recently, some experimental and numerical data have revealed the existence of a third vortex, which appears due to the boundary layer detachment at the bottom. This vortex travels in front of the dipole. The existence of the three vortices occurs provided the depth of the liquid layer is constant. However, in a channel flushing into the sea it is possible to have mass accumulation near the channel mouth. On the other side, according to some observational data the depth increases at the open domain in front of the channel. In this work we present the results of a numerical simulation of a periodic driving flow occurring in a channel and an open domain. To this end we use the finite volume method (OpenFOAM) to solve the Navier-Stokes and continuity equations in three cases a) a domain of constant depth, b) a domain in which there is a step in front of the channel output and c) a domain with variable depth. In the first case, the three vortices are detected, however in the second case a single vortex emerges in front of the channel. That is, the two counter-rotating vortices connect at the bottom forming a single horseshoe vortex. In this work we discuss the transition from three vortices in a constant depth layer to a single vortex when there is a step in at the channel output. The results for the case c) are intended to give an insight on this transition. Finally, we discuss briefly the implications of these results on the particle transport in this kind of flow.
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