Scalar dispersion in strongly curved open-channel flows

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Abstract

Large-eddy simulations (LES) and Reynolds-averaged numerical simulations (RANS) are performed for the flow and scalar dispersion through a strongly curved open-channel bend. The aim of the study is to investigate the performance of both LES and RANS as regards the reproduction of the key bend flow features and the associated prediction of scalar spreading along the flume. In this respect, three different issues are addressed. Firstly, the influence of the water depth on the flow behavior as computed by LES and RANS is considered. Secondly, the plume statistics of the case with a continuous vertical line source is investigated. And thirdly, the dispersion behavior of a scalar tracer is studied by means of the case in which a blob of the scalar tracer is instantaneously injected. It is found that the LES computations fairly well reproduce the main flow features, whereas RANS computations experience severe difficulties in predicting the flow field. Moreover, it was found that the gradient-hypothesis of diffusion is only limitedly valid; even counter-gradient diffusion is observed. In addition, the residence time characteristics of the instantaneously injected blob of the scalar tracer in the bend are addressed as well.

Keywords: large-eddy simulation, scalar spreading, curved open-channel flows.

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