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Measurement and analysis methods of large scale horizontal coherent structures in a wide shallow channel

by
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ABSTRACT

Rivers can be characterized as wide, very shallow flows. Where contiguous flows of different velocity are present, shallow mixing layers develop. Examples are the mixing layer at the confluence of two rivers and the mixing layer between the flow in the main channel of the river and the slower flow over the flood plain. The lateral exchanges of momentum, sediments and pollutants through the mixing layers are important processes. A major contribution to these lateral exchanges stems from the large scale horizontal coherent structures present in shallow mixing layers.

Experimental investigation of the development of two kinds of shallow mixing layers was executed in very shallow flumes. One, the mixing layer at the confluence, was investigated in a flat glass-bottomed flume; second, the mixing layer between river and flood plain in a concrete compound channel. A main objective of this study was the detection and characterization of large scale horizontal structures. The investigation was executed with particle tracking velocimetry (PTV) and laser-Doppler velocimetry (LDV).

The experiments showed clearly the presence of the mixing layer and the large scale horizontal structures therein (see figure 1). The shallowness has a marked influence on the development of the mixing layer and on the large scale structures. PTV measurements were analysed in different ways in order to characterize the large scale structures. In particular ensemble averaged vorticity distributions and the enstrophy distribution appear useful for the evaluation of numerical modelling of shallow mixing layers.

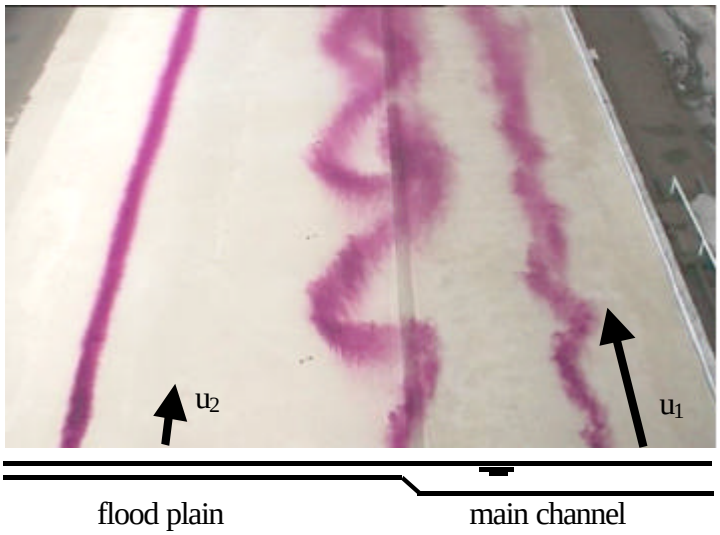

Figure 1: Top view of the compound channel experiment. The large coherent structures in the mixing layer are made visible by injecting dye.