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Laboratory experiment on the 3D tide-induced Lagrangian residual current using the PIV technique

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The three-dimensional structure of the tide-induced Lagrangian residual current is studied using the Particle Image Velocimetry (PIV) technique in a long shallow narrow model tank in the laboratory. A periodic wave is generated at the mouth of the tank to simulate tide, and at the head of the tank a lateral slopping topography with the length of one-fifth of the water tank is installed, above which the tide-induced Lagrangian residual current is studied. The results demonstrate a three-layer structure of the Lagrangian residual velocity (LRV) field, that the water flows into the head in the bottom layer and flows outwards in the middle layer, while in the surface layer it flows inwards at the shallow side and outwards at the deep side. The depth-averaged LRV flows out at the shallow side and flows towards the head at the deep side. The breadth-averaged LRV flows outwards at the upper part and inwards at the lower part. Moreover, the volume fluxes of the Lagrangian and Eulerian residual current are compared, indicating that the Eulerian residual velocity violates the mass conservation law and it is appropriate to use the LRV to represent the inter-tidal water transport.