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Three-dimensional structures in quasi-two-dimensional shallow flows R.A.D. AKKERMANS, A.R. CIESLIK, L.P.J. KAMP, H.J.H. CLERCX, G.J.F. VAN HEIJST, Physics Department, Eindhoven University of Technology, Eindhoven, The Netherlands — The extent to which an evolving dipole in a non-rotating shallow fluid layer can be considered as (quasi-) two-dimensional is addressed. We present Stereo-PIV measurements at several horizontal fluid levels as well as 3D numerical simulations of this dipole evolution. The experimental setup consists of a 52x52cm^2 square tank with a magnet below the bottom and two electrodes on opposite sides of the tank. A salt solution serves as the conducting fluid enabling electromagnetic forcing. The fluid layer is thin (up to 10 mm), thus 3D motions are suppressed by geometrical confinement. Due to the no-slip condition the flow is subjected to a vertical shear resulting in secondary circulations. Experimental results reveal significant vertical velocity in the frontal region of the dipole, as well as vertical motion inside the vortex cores. The dipole-wall collision shows the influence of the lateral side-wall on the flow, viz. vorticity production at the no-slip boundaries and subsequent advection of these vorticity filaments into the interior. The numerical simulations show good quantitative agreement with the experiments, and provide the full 3D velocity and vorticity field over the entire flow domain.

R.A.D. Akkermans
Phys. Dept., Eindhoven University of Technology, The Netherlands

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