Shear flows of shallow water

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We derive a mathematical model of shear flows of shallow water down an inclined plane. The non-dissipative part of the model is obtained by averaging the incompressible Euler equations over the fluid depth. The averaged equations are simplified in the case of weakly sheared flows. They are reminiscent of the compressible non-isentropic Euler equations where the flow enstrophy plays the role of entropy. Two types of enstrophies are distinguished : a small-scale enstrophy generated near the wall, and a large-scale enstrophy corresponding to the flow in the roller region near the free surface. The dissipation is then added in accordance with basic physical principles. The model is hyperbolic, the corresponding `sound velocity' depends on the flow enstrophies. Periodic stationary solutions to this model describing roll waves were obtained. While classical Dressler's roll wave solution to the Saint Venant equations largely overestimates the wave amplitude, the solutions to our model are in good agreement with the experimental profiles of roll waves. In particular, the height of the vertical front of the waves, the shock thickness and the wave amplitude are well captured by the model. (joint work with G. Richard)