The propagation of high-Reynolds number gravity currents: what changes and what does not change when the cross-section area is changed from a rectangle to other realistic shapes?

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The propagation of a high-Reynolds-number gravity current in a horizontal channel along the horizontal coordinate x is considered. The bottom and top of the channel are at z = 0, H, and the cross-section is given by the quite general -- $f_1(z) \leq y \leq f_2(z)$ for $0 \leq z \leq H$. A thin-layer (shallow-water type) model is used; the dependent variables are the position of the interface, h(x,t), and the speed (averaged over the area of the current), u(x,t). The propagation of the nose, x_N (t), is an important by-product of the model, and a useful variable for comparisons between predictions and data (from experiments or Navier-Stokes simulations). The classical results and insights are for the rectangular (or laterally unbounded) 2D channel, i.e, f_1,f_2 = const. However, very different cross-section shapes (such as triangle, V-valley, circle/semi-circle, trapezoid) occur in nature (e.g., rivers) and constructed environment (tunnels, reservoirs, canals). We show that the non-rectangular cross-section enters the formulation via f(h) and integrals of f(z) and zf(z), where $f(z) = f_1(z) + f_2(z)$ is the width of the channel. We present a recent systematic extension/generalization of the classical analysis to a wide range of f(z) cases. We show that typical classical features (like Benjamin's nose Froude relationship, the types of dam-break interface shape, the transition to viscous regime, and more) remain valid for a variety of f(z) shapes, but the details depend strongly on f(z). For example, the initial speed of propagation of a lock-released bottom current is larger in a ∇ triangle than in a 2D channel. Some experimental support to the theoretical results is also discussed. The classical 2D system is just a particular case, f(z) = const., of the various cross-section geometries covered by the new model.

SPECIAL DATE, TIME, AND LOCATION

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Friday, 17 November 2017, 11:00 AM
Refreshments 10:45 AM
NCAR-Foothills Laboratory
3450 Mitchell Lane
Bldg. 2, **Seminar Room 1001**

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