Abstract Submitted
for the DFD13 Meeting of
The American Physical Society

Influence of heterogeneity on second-kind self-similar solutions for gravity currents ZHONG ZHENG, IVAN CHRISTOV, HOWARD STONE, Department of Mechanical & Aerospace Engineering, Princeton University, COMPLEX FLUID GROUP TEAM — We report experimental, theoretical and numerical results on the effects of horizontal heterogeneity on the propagation of viscous gravity currents. We use two geometries to highlight these effects: (a) a horizontal channel (or crack) whose gap thickness varies as a power-law function of the streamwise coordinate; (b) a heterogeneous porous medium whose permeability and porosity have power-law variations. We demonstrate that two types of self-similar behaviors emerge as a result of horizontal heterogeneity: (a) a first-kind self-similar solution is found using dimensional analysis (scaling) for viscous gravity currents that propagate away from the origin (point of zero permeability); (b) a second-kind self-similar solution is found using a phase-plane analysis for gravity currents that propagate toward the origin. These theoretical predictions, obtained using the ideas of self-similar intermediate asymptotics, are compared to experimental results and numerical solutions of the governing partial differential equations developed under the lubrication approximation. All three results are found to be in good agreement.

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Date submitted: 18 Jul 2013 Electronic form version 1.4