Abstract Submitted
for the DFD12 Meeting of
The American Physical Society

Convective Shutdown in a Porous Medium JOHN LISTER, DUNCAN HEWITT, ITG, DAMTP, University of Cambridge, JEROME NEUFELD, ITG, DAMTP & Department of Earth Sciences & BP Institute, University of Cambridge — Convective flow in a porous medium, driven by a buoyancy source along one boundary, is found in many geophysical and industrial processes, and has recently been investigated in the context of CO_2 sequestration. If the domain is closed then the convective flux soon starts to decrease due to the slow evolution of the average interior density. We reveal a close link between such a "one-sided" shutdown system and the "two-sided" statistically steady Rayleigh–Bénard cell. We present high-resolution numerical simulations of convective shutdown at high Rayleigh number Ra in a two-dimensional porous medium. A simple analytic box model of the shutdown system is constructed, with time-dependent Rayleigh and Nusselt numbers, which is based on measurements of the convective flux from a Rayleigh–Bénard cell (Hewitt *et al.* Phys. Rev. Lett. 2012) and gives excellent quantitative agreement with numerical results. These ideas are generalised to model fluids with a power-law equation of state. The dynamical structure of high-Ra shutdown flow is dominated by vertical columnar flow in the interior, and the evolving horizontal wavenumber $k[Ra(t)]$ of the columns gives extremely good agreement with similar measurements of $k(Ra)$ from the columnar flow in a Rayleigh–Bénard cell.

Duncan Hewitt
ITG, DAMTP, University of Cambridge

Date submitted: 06 Aug 2012 Electronic form version 1.4