Abstract Submitted
for the DFD12 Meeting of
The American Physical Society

Entrainment and mixing dynamics of surface-stress-driven linearly stratified flow in a cylinder GEORGY MANUCHARYAN, Yale University, C.P. CAULFIELD, BP Institute & DAMTP, University of Cambridge — We consider experimentally a linearly stratified fluid (with constant buoyancy frequency N) in a cylinder of depth H subject to surface stress forcing from a disk spinning at constant angular velocity Ω. A turbulent mixed layer develops bounded by a sharp interface of constant thickness. Its depth $h/H \sim (N/\Omega)^{-2/3}(\Omega t)^{2/9}$. We argue this is a consequence of: the kinetic energy of the mixed layer staying constant with time (as previously observed in a two layer flow by Shravat et al. 2012) the entrainment at the interface being governed entirely by local processes; and the rate of increase of the total potential energy of the fluid being dependent only on the global dissipation rate and the ratio N^2/Ω^2. Below the moving primary interface, we also observe in some circumstances the formation of another partially mixed layer, separated by a secondary interface from the linearly stratified fluid below. Depending on the local flow properties, the secondary interfaces can exhibit rich time-dependent dynamics including drift towards or away from the primary interface, merger and/or decay. The secondary interfaces appear to develop due to the non-monotonic dependence of buoyancy flux on stratification as originally argued by Phillips (1972).

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Date submitted: 25 Jul 2012 Electronic form version 1.4