Segregation-induced granular fingering

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It is well known that a mixture of grains of different sizes tends to segregate as they avalanche downslope, with large particles rising to the near surface regions, which move faster (Gray & Ancey 2009). As a result, large particles tend to be preferentially transported to flow front, where they can accumulate by being over-run and resegregated to the surface. If the large particles are also more frictional, the flow becomes unstable and breaks-up in a series of fingers: the so-called granular fingering instability (Pouliquen et al. 1997). This instability is observed in a wide variety of systems, from geophysical mass flows, such as pyroclastic flows, to small-scale experiments relevant to industry. Although key features of the fingering pattern are predicted by a particle-size segregation model, coupled with a standard depth-averaged avalanche model, stability analysis shows that the equations are ill-posed, leading to unphysical growth of short-wavelength perturbations (Woodhouse et al. 2012). Recently, a well-posed model was presented (Baker et al. 2016), in which a dissipative viscous-like term (Gray & Edwards 2014) derived from the $\mu(I)$-rheology is incorporated to the avalanche model. In this paper we use fully nonlinear simulations of this model to make a first assessment of the fastest growing mode of the frontal instability, which sets the finger wavelength.

References

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