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Slow Relaxations in Fluid-Driven Granular Flows CARLOS ORTIZ, DOUGLAS DURIAN, DOUGLAS JEROLMACK, Univ of Pennsylvania — Particles in a pack may appear frozen, but exhibit very slow dynamics (creep). To probe long-time dynamics, we construct an annular chamber that mimics an infinitely-long river channel. We drive the packs with a laminar flow and record dynamics by laser scanned particle tracking. The dynamics of "bed load" grains near the surface exhibit relatively fast shear and their velocity profile as a function of depth can be well-described by a local $\mu(I)$-rheology. However, grains deep in the pack, which appear frozen by eye, exhibit slow creep dynamics that are not captured by the local model. This transition between bed load and creep occurs at a critical value of the local relaxation time. We find that the timescale for heterogeneous dynamics increases monotonically as a function of depth, but the length scale characterized by the domain size of the heterogeneities achieves a maximum at the transition to creeping. We explore the relation between the important length and time scales of the flow in the creep phase using nonlocal rheology.

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