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Refractive index matched suspensions as a tool for investigating entrainment by avalanches and debris flows

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Geophysical gravity flows such as avalanches and debris flows are complicated mixtures of fluid and solids, often containing particle sizes of many orders of magnitude. In a debris flow, for example, the composition varies from head to tail, and from bottom to top due to particle size segregation and recirculation. In addition the solid components may have different masses and mechanical properties. For this reason, a complete understanding of substrate entrainment by this type of flow is still out of reach.

A common strategy for advancing our understanding of the physics of processes like entrainment is to use a greatly simplified laboratory model of a debris flow, and take internal and bulk measurements. This idealized technique forms the basis of this study, in which a two-phase, monodisperse suspension of PMMA beads in a refractive-index matched suspending fluid flowed down a flume, encountering an entrainable region of the same suspension on the way. This study represents the first attempt of taking continuous internal velocity measurements inside a flowing, entraining model avalanche or debris flow in the laboratory.

Interior PIV measurements of flow velocity were taken in the entrainable region, along with surface height measurements, to shed some light on the entrainment mechanisms and to see how the bulk flow responded. Further, some differential pressure measurements were made in the entrainable bed to see if pore-pressure peaks had any correlation with significant events during entrainment. We present our preliminary findings and discuss the suitability of the method to entrainment investigations.