



Numerical study of grain size segregation and its control on the flow properties

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While our understanding of the behavior of mono-disperse granular flows has benefited from significant advances in the last decade, mono-sized systems, if common in industrial handling, are rarely encountered in natural contexts. Geophysical granular flows typically exhibit a wide range of grain sizes, causing segregation patterns to form and resulting in modified flow properties. Segregation mechanisms add considerable difficulty to the modeling of geophysical granular flows; the formulation of meaningful segregation criteria, as well as the understanding of the control of segregation patterns on the flow properties, remain challenging issues. In this contribution, we analyze the behavior of model granular chute flows of bi-disperse spherical particles in two dimensions using discrete numerical techniques. Our interest focuses on the characteristic time scale for segregation and its feedback control on the flow velocity, as a function of the grain size ratio and the relative volume of grain species. The chute flow configuration is convenient because different slope angles can simply constrain the stress state and friction mobilization, and we investigate how the mean flow velocity adjusts to different volumetric ratio of particles in bi-disperse mixtures. Segregation rates, partial stress tensors and resultant forces are analyzed to derive the effective drag force applied to the larger grains. Our results allow the quantification of how the volume ratio of grains species controls the rheological properties of the flow, explored in the framework of the dependence on the inertial number.