On continuum dilute and dense granular-air flow modeling with GRAIN - Current state and challenges

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We present a hydrodynamic granular flow modeling approach for both dilute and densely packed regimes. A continuous transition between the dilute phase, based on granular gas kinetics and the dense phase based on a granular-temperature-independent pressure is assured. This initially single-phase modeling approach is extended to a two- or multiphase method via friction-based coupling to a compressible air phase and incompressible fluid phases. The potential of the method is exemplified via a three phase suspension flow granular bead mill scenario.
Furthermore we discuss the limits of the continuum modeling approach regarding the parameter setup for actual granular materials from powders to granulates. The continuum and hence macroscopic approach requires macroscopic, material-dependent constituting relations, from volume-fraction dependent pressure, through granular viscosity to fluid permeability of the granular bed, which are non-trivial to obtain. Here we present our view on future extensions of the method, both experimentally as well as through upscaling ideas.