A novel velocity field correction method to reproduce wake effects in unresolved modeling of granular flows

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Abstract

It is known that in unresolved modeling of granular flows, a grid cell contains certain number of particles and it is not possible to consider the effects of wake flow of a particle on neighboring particles. Therefore unresolved modeling of granular flows is not able to reproduce wake-related phenomenon like Drafting-Kissing-Tumbling (DKT), which is physically existent and can be frequently observed in resolved simulations. This paper presents a novel velocity field correction in unresolved modeling of granular flows to enable the influence of the wake of a particle on its neighboring particles. The velocity field correction is originated from our previous work on the velocity similarity law obtained from resolved simulation on the detailed flow field for a single settling particle in moderate Reynolds numbers. Two numerical examples are provided including dual particle sedimentation and sedimentation with a number of particles. For both cases, it is found that if using the conventional unresolved modeling, relative position of particles do not change much during the evolution process, while DKT phenomenon seldom happen. In contrast, after the velocity field correction, the effect of wake flow of a particle on neighboring particles is considered, and relative position of particles change obviously while drafting and kissing are clearly observed. It is believed that the introduction of particle velocity field correction can help to improve the computational accuracy of unresolved modeling and to obtain comparable results with resolved modeling.

Keywords: Particle settling, Granular flow, Velocity field correction, Unresolved method, Resolved modeling