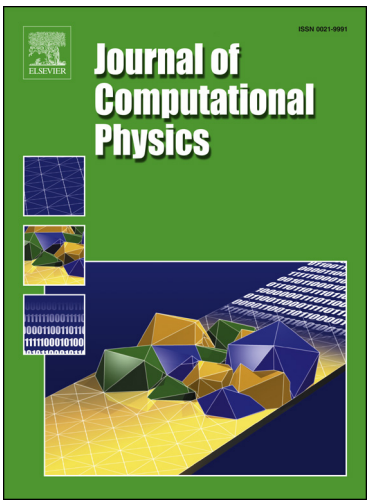
Accepted Manuscript



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PII: S0021-9991(17)30230-9
DOI: http://dx.doi.org/10.1016/j.jcp.2017.03.035
Reference: YJCPH 7239

To appear in: *Journal of Computational Physics*

Received date: 9 August 2016
Revised date: 26 February 2017
Accepted date: 16 March 2017

Please cite this article in press as: E. Biegert et al., A collision model for grain-resolving simulations of flows over dense, mobile, polydisperse granular sediment beds, *J. Comput. Phys.* (2017), http://dx.doi.org/10.1016/j.jcp.2017.03.035

A collision model for grain-resolving simulations of flows over dense, mobile, polydisperse granular sediment beds

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Abstract

We present a collision model for phase-resolved Direct Numerical Simulations of sediment transport that couple the fluid and particles by the Immersed Boundary Method. Typically, a contact model for these types of simulations comprises a lubrication force for particles in close proximity to another solid object, a normal contact force to prevent particles from overlapping, and a tangential contact force to account for friction. Our model extends the work of previous authors to improve upon the time integration scheme to obtain consistent results for particle-wall collisions. Furthermore, we account for polydisperse spherical particles and introduce new criteria to account for enduring contact, which occurs in many sediment transport situations. This is done without using arbitrary values for physically-defined parameters and by maintaining the full momentum balance of a particle in enduring contact. We validate our model against several test cases for binary particle-wall collisions as well as the collective motion of a sediment bed sheared by a viscous flow, yielding satisfactory agreement with experimental data by various authors.

Keywords: Direct Numerical Simulations, Immersed Boundary Method, contact modeling, particle-laden flow, sediment transport

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