Abstract Submitted
for the DFD10 Meeting of
The American Physical Society

Settling of finite-size colliding particles in unbounded domains

JULIAN SIMEONOV, Marine Geosciences Division, Naval Research Laboratory, JOSEPH CALANTONI — A numerical model for Direct Numerical Simulations of particle-laden flows is developed to investigate the bulk behavior of particle suspensions. The particle hydrodynamic forces are determined by solving the incompressible Navier-Stokes equations for the finite Reynolds number flow around individual particles. At grid resolutions permitting large-scale simulations, the pressure and viscous stress are resolved everywhere except in the gap of colliding particles where micro-scale lubrication effects become important just before contact. An analytical expression for the unresolved lubrication pressure force is added as a correction to the numerically resolved hydrodynamic force. The mechanical-contact interaction between particles is modeled with Hookean elasticity and friction. The model predicted dissipation of particle momentum during collisions is compared to experimental data for the coefficient of restitution of immersed binary collisions. We then consider the gravitational settling of particle suspensions in triply periodic domains and determine the dependence of the settling rate on the concentration and the domain size. The numerical results are compared to well-known empirical data for settling in pipes, which is often used in continuum models for particle-laden flow.

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Date submitted: 04 Aug 2010 Electronic form version 1.4