Abstract Submitted
for the DFD14 Meeting of
The American Physical Society

Effects of Hydrodynamic Interaction in Aerosol Particle Settling: Mesoscopic Particle-level Full Dynamics Simulations[1] SHUIQING LI, MENGMENG YANG, Tsinghua University, JEFFREY MARSHALL, University of Vermont — A new mesoscopic particle-level approach is developed for the full dynamics simulation (FDS) of the settling of systems of aerosol micro-particles. The approach efficiently combines an adhesive discrete-element method for particle motions and an Oseen dynamics method for hydrodynamic interactions. Compared to conventional Stokeslet and Oseenlet simulations, the FDS not only accounts for the cloud-scale fluid inertia effect and the particle inertia effect, but also overcomes the singularity problem using a soft-sphere model of adhesive contact. The effect of hydrodynamic interactions is investigated based on FDS results. The particle inertia is found to reduce the mobility of particle clouds and to elongate the cloud on vertical direction. Meanwhile, the fluid inertia decreases the settling velocity by weakening the hydrodynamic interaction and tends to flatten the cloud, leading to breakup. Expressions for the settling velocity of particle cloud are proposed with consideration of fluid inertia effect and the cloud shape. Finally, the transformation in settling behavior from a finite particle cloud to an unbounded uniform suspension is explained.

[1]This work has been funded by the National Natural Science Funds of China (No. 50976058), and by the National Key Basic Research and Development Program (2013CB228506).

Shuiqing Li
Tsinghua University

Date submitted: 26 Jul 2014 Electronic form version 1.4