Abstract Submitted
for the DFD14 Meeting of
The American Physical Society

Inertial particle clustering, relative velocity, and collision statistics in the presence of gravity PETER J. IRELAND, ANDREW D. BRAGG, LANCE R. COLLINS, Cornell University — We use direct numerical simulations to investigate the dynamics of inertial particles in the presence of gravitational forces over a large range of Taylor-scale Reynolds numbers ($90 \leq R_\lambda \leq 597$). The particle inertial and gravitational forces are parameterized to provide insight into the motion and growth of water droplets in warm, cumulus clouds. We perform a detailed analysis of the effect of the periodic boundary conditions in the simulations and find that extended domain lengths are needed for accurate particle statistics, especially at low Reynolds numbers. While gravity reduces the relative velocities of all particle classes, it has a bifurcated effect on particle clustering, suppressing (enhancing) clustering for weakly (strongly) inertial particles. We provide a physical explanation of these trends by extending the model of Zaichik & Alipchenkov (New J. Phys., 11:103018, 2009) to account for gravitational effects. The particle statistics are strongly anisotropic, and we use spherical harmonic decomposition to quantify this anisotropy. Finally, we compare collision statistics of inertial particles with gravity to those without gravity and suggest practical implications for the onset of precipitation in cumulus clouds.

Peter Ireland
Cornell University

Date submitted: 14 Jul 2014 Electronic form version 1.4