Abstract Submitted
for the DFD15 Meeting of
The American Physical Society

Heat Transfer and Drag of a Sphere: Variable Density and Buoyancy Effects[1] SWETAVA GANGULI, SANJIVA LELE, Stanford University — How do forces acting on a particle change in the presence of significant heat transfer from the particle, a variable density fluid or gravity? We define unit problems isolating subsets of these phenomena and solve them via particle resolved simulations. Our investigations are agnostic to the Boussinesq regime and encompass both, the short time (acoustic) behavior and the subsequent nearly-incompressible flow field that is established. Defining λ as the ratio of the initial particle-fluid temperature difference to the far-field fluid temperature, we observe that the particle size affects the acoustic response whereas λ and Re affects the low-Mach response. The heating of the fluid near the particle affects the drag significantly which is studied in a parameter space where Re, λ and the Grashof number are varied. In the isothermal case, the drag computed numerically matches the drag correlation of Clift-Grace-Weber. For heated particles, using the density of the fluid at the particle surface in the correlation under-estimates the drag (e.g. by 30% when λ =1), using the dynamic viscosity of the fluid at the particle surface over-estimates the drag (e.g. by 17 % when λ =1) and using both still over-estimates the drag (e.g. by 13% when λ =1). The deviations increase as λ increases.

[1]This research is funded by the PSAAP II program at Stanford University

Swetava Ganguli
Stanford University

Date submitted: 31 Jul 2015 Electronic form version 1.4