A Simulation Platform for Detailed Particle Entrainment

Hezekiah Grayer, Aerospace Engineering
Mentor: Yulia Peet, Assistant Professor
School for Engineering of Matter, Transport and Energy

Motivation
Small scale events (dust devils) are efficient lifters of dust into the atmosphere for both Earth and Mars [1], posing hazards to desert populations and Martian rovers. In practice, particle entrainment schemes noticeably under-predict dust emission from small scale events such as dust devils.

Approach
The schema of entrainment described in [1] is pictured in Fig.2b and describes the lifting of particles from large eddies. The details of this process are important but not well studied—notably with experimental difficulties [2].

The flow structure of interest is readily generated by convection (eg. [3]). Thus, a simulation platform is developed on convection with a bed of small particles that interact with the flow. The code development integrated a new coupled particle dynamics solver ppiclF [4] with the research code nek5000.

Results
A fully debugged simulation platform that qualitatively agrees with the theory of is produce. The setup: a periodic, two-dimensional Rayleigh-Bénard convection (RBC) with a bed of particles with height initially at $y = 0.2$.

The literature of RBC is rich to provide good control of the flow strength. As the particle-drag solver is back-coupled to the flow, detailed momentum flux can be meaningfully studied. In the future, numerical studies based on this platform will hopefully yield quantitative relationships missing from literature.

Works Cited