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Simulation of sediment settling in reduced gravity

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Gravity has a non-linear effect on the settling velocity of sediment particles in liquids and gases due to the interdependence of settling velocity, drag and friction. However, Stokes′ Law or similar empirical models, the common way of estimating the terminal velocity of a particle settling in a gas or liquid, carry the notion of a drag as a property of a particle, rather than a force generated by the flow around the particle. For terrestrial applications, this simplifying assumption is not relevant, but it may strongly influence the terminal velocity achieved by settling particles on other planetary bodies. False estimates of these settling velocities will, in turn, affect the interpretation of particle sizes observed in sedimentary rocks, e.g. on Mars and the search for traces of life.

Simulating sediment settling velocities on other planets based on a numeric simulation using Navier-Stokes equations and Computational Fluid Dynamics requires a prohibitive amount of time and lacks measurements to test the quality of the results. The aim of the experiments presented in this study was therefore to quantify the error incurred by using settling velocity models calibrated on Earth at reduced gravities, such as those on the Moon and Mars. In principle, the effect of lower gravity on settling velocity can be achieved by reducing the difference in density between particle and liquid. However, the use of such analogues creates other problems because the properties (i.e. viscosity) and interaction of the liquids and sediment (i.e. flow around the boundary layer between liquid and particle) differ from those of water and mineral particles. An alternative for measuring the actual settling velocities of particles under reduced gravity, on Earth, is offered by placing a settling tube on a reduced gravity flight and conduct settling velocity measurements within the 20 to 25 seconds of Martian gravity that can be simulated during such a flight. In this presentation, the results of the during the MarsSedEx I and II reduced gravity flights are reported, focusing both on the feasibility of experiments in reduced gravity as well as the error incurred when using terrestrial drag coefficients to calculate sediment settling on another planet.