Resuspension of particles in an oscillating grid turbulent flow

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The incipient motion condition for particulate material exposed to a moving fluid constitutes the central problem for sediment transport in river, coastal areas and atmospheric flows [1]. Furthermore, it is an important mechanism in a variety of engineering applications, such as: silicon wafer cleaning and pneumatic conveying [3]. Despite a significant progress in the field of sediment transport during the past decades, description of the mechanisms responsible for the initiation of particle motion from a surface and re-entrainment into suspension remains a challenge. This is partially due to the technical difficulties to quantify the forces applied on the particles and the collection of high resolution data of particle displacement simultaneously.

In this study we continue the previous research [2] and investigate the necessary conditions for initial entrainment of spherical particles from smooth bed into zero-mean-shear turbulent flow in an oscillating grid chamber. The experiments are not designed to fully mimic the real problem of sediment transport but rather identify key mechanisms, utilizing direct observation and quantification of particle motion at the beginning, during and after lift-off. Particle image velocimetry (PIV) was used to determine the properties of turbulent flow and three-dimensional particle tracking velocimetry (3D-PTV) is used to examine long duration data that synchronously measure local flow conditions, and track the entrainment of individual test particles through the various phases of the resuspension. The combination of the experimental methods and different types of particles (tracers and test particles) allow to identify the dominant scales within the turbulence spectrum which cause resuspension and to explore the role hydrodynamic forces (lift and drag) play in this process. The results will provide further insight into the resuspension process of spherical particles in the transitional range of particle size Reynolds numbers $2 \leq Re_p \leq 500$. Future work will cover the extended range of the Stokes number, in which particles of different sizes and different density will be resuspended in the turbulent flow under an oscillating grid. The preliminary results show that the resuspension modes are similar.

References


Figure 1: (a) three orthogonal views and an isometric sketch of the lagrangian trajectory of the resuspended particle. (b) position, velocity and acceleration of the resuspended particle during the incipient motion and pick-up phases.