Geophysical Research Abstracts
Vol. 19, EGU2017-2238, 2017
EGU General Assembly 2017
© Author(s) 2016. CC Attribution 3.0 License.

Settling velocity in a turbulence column and its effect on the suspension profile

Thibaud Revil-Baudard (1,2), Yulia Akutina (1), and Olivier Eiff (1)

(1) Institute for Hydromechanics, Karlsruhe Institute of Technology, 76131 Karlsruhe, Germany, (2) LEGI, Grenoble University, Domaine Universitaire, BP 53, 38041 Grenoble Cedex 9, France

The settling velocity of sediment particles is one of the key parameters used to predict sediment transport in natural streams. Commonly, the still-water settling velocity is used to predict the suspension profile, for example in the Rouse model. The implicit assumption is that the effect of the turbulent fluctuations on the particle velocity vanishes on average. Even though the settling velocity has been shown to be altered by the turbulent motion of the fluid, it is common to use a non-unity Schmidt number rather than a modified settling velocity to match the measured suspension profiles. The purpose of this study is to verify whether the turbulence-induced modification of the settling velocity is significant enough to explain the low values of the experimental Schmidt number. The settling velocity is known to be altered by different particle-turbulence interaction mechanisms, such as (i) the "loitering" effect, when a particle experiences upward fluctuations for longer periods of time than downward ones and thus is decelerated, (ii) the non-linear drag effect and (iii) the vortex trapping that both decelerate the particle settling velocity, and (iv) the downward preferential path effect that can accelerate it. In this work, the settling velocities of different sediment particles are measured in a turbulence column with varying background turbulence kinetic energy and are compared with those measured in still water. The background turbulence produced by oscillating grids. A Particle Tracking Velocimetry technique was applied to obtain the particle settling velocities while the background turbulence was measured by 2-D Particle Image Velocimetry. Thus, the cumulative effect of the particle-turbulence interaction mechanisms was evaluated. In the regime of large and "massive" sediment particles considered here (particles are larger than the Kolmogorov viscous scale and have high particulate Reynolds number), it was found that the background turbulence significantly decelerated the particle settling compared to that in still water in all the cases investigated. The deceleration appears to increase linearly with the increasing turbulence intensity. Moreover, when normalized by the still-water value, the settling velocities of all different types of sediment particles follow a unique linear trend as a function of the normalized turbulence intensity. It is argued that this effect should be accounted for in the Rouse model exponent by modifying the settling velocity.