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Experimental study of sheet flow regime of sediment transport in a laboratory flume.

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The sheet flow regime of sediment transport occurs when the shear stress exerted by the fluid flow on the sediment bed is high enough to set in motion a thick layer of particles. This phenomenon is very important for river and coastal morphodynamical evolution. However, the key mechanisms controlling this regime such as intergranular interactions or turbulent processes in dense fluid-sediment mixture are not well understood yet. For this purpose, an original laboratory experiment has been set up at LEGI in a tilted flume (10 meters long, 35 centimeters wide). 3mm plastic (PMMA) particles are stored in a 3m long tank located close to the channel outlet. The channel is tilted at 0.5 per cent slope and the fluid flow rate is 35 l/s. The instrumentation is composed of an acoustic profiler, ACVP, a high speed camera and a water level sensor. The acoustic profiler allows to get streamwise and vertical velocities profiles from the clear water flow down to the fixed bed with great spatial and temporal resolution (3mm and 0,013s respectively) permitting a good characterization of turbulence. The high speed camera together with a videotrajectography method allow to get sediment velocity profiles and qualitative concentration profiles close to the wall. To compensate the lack of sediment recirculation and the short duration of the experiment, it is repeated to carry out ensemble averaging. The statistical protocol for the treatment of the turbulent signal is presented. This initial treatment allows the estimation of the mean velocity, the turbulent shear and the normal stresses profiles. From these profiles, reproducibility and steadiness of the flow are verified and the main mechanisms of momentum transfer acting from the fixed bed to the dilute suspension are analyzed. The mean velocity profile close to the bed shows three different regions, from bottom to top, an exponential tail, a linear layer and a logarithmic layer. The exponential tail is characteristic of a Coulomb yield criterion. In the linear layer, the scaling of the equivalent mixing length with the particles diameter is the signature of the dominance of the grain inertia for momentum transfer. The logarithmic layer is dominated by turbulent processes. Our measurements show a reduction of the Von Karman coefficient by a factor of two, illustrating the strong influence of the sheet layer on the boundary layer processes.