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Particle Entrainment under Turbulent Flow Conditions[1]

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Erosion, transportation and deposition of sediments and pollutants influence the hydrosphere, pedosphere, biosphere and atmosphere in profound ways. The global amount of sediment eroded annually over the continental surface of the earth via the action of water and wind is estimated to be around 80 billion metric tons, with 20 of them delivered by rivers to the oceans. This redistribution of material over the surface of the earth affects most of its physical, chemical and biological processes in ways that are exceedingly difficult to comprehend. The criterion currently in use for predicting particle entrainment, originally proposed by Shields in 1936, emphasizes the time-averaged boundary shear stress and therefore is incapable of accounting for the fluctuating forces encountered in turbulent flows. A new criterion that was developed recently in an effort to overcome the limitations of the previous approach will be presented. It is hypothesized that not only the magnitude, but also the duration of energetic near bed turbulent events is relevant in predicting grain removal from the bed surface. It is therefore proposed that the product of force and its duration, or impulse, is a more appropriate and universal criterion for identifying conditions suitable for particle dislodgement. Analytical formulation of the problem and experimental data are used to examine the validity of the new criterion.

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