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Interactive comment on "Scales of collective entrainment and intermittent transport in collision-driven bed load" *by* Dylan B. Lee and Douglas Jerolmack

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One weakness of extant models of sediment transport is related to collective motion, including collective entrainment of particles from the bed. There is growing evidence that on many if not most occasions, particles move (or are entrained) not in isolation, but as clusters. To the best of my knowledge, most microstructural models (i.e., those inferring the bulk behavior from the local behavior on the particle scale) consider individual events. For instance, in the model developed by Ancey and coworkers (PRE 2006, JFM 2008, JFM 2014, JGR:ES 2015), a central assumption in their Markovian model is that only a single event (e.g., entrainment or deposition) can occur within

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Discussion paper

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a small time increment. Multiple events cannot be considered in jump Markov processes. Correlated motion is another complication, which is poorly accounted for by existing models.

The authors take a first stab at this problem by running experiments in which sediment is replaced with marbles. This allows the authors to reduce the degree of complexity of the problem and look at the mechanisms that drive collective entrainment. I know of no similar study. While there are studies on how particles form clusters when they come to a halt (e.g., Strom et al. JHE 2004), there is little information on collective entrainment. In this respect, the paper is topical. The authors do not present many results, they seem to be skeptical about the chances of ending up with clear ideas on collective entrainment, but the paper is a good starting point. If it does not solve the problem, it should spark interest and lead to further investigations.

I think the paper could be accepted after minor changes. As it stands it suffers from many inaccuracies, mostly of semantic order, which does not make it possible to understand unambiguously what the authors mean. I provide a list of some of the points that jump out at me when reading the paper. I also think that there is an imbalance between the length of the introduction and the subsequent developments. I suggest shortening the introduction and focusing on the key issues in our current understanding of bedload transport. I will take a keen interest in the future results.

Christophe Ancey

Detailed remarks: âĂć Title: it does not seem to reflect the contents of this paper. âĂć Abstract: it should be shortened. Part of the material is not related to what the authors found out. For instance, a sentence such as “A general statistical framework has been developed” led me to think that they developed a theoretical model. Some expressions like “stochastic fluctuations”, “probabilistic motion”, “relax” sound weird to me. âĂć On p. 2, L5-10: granular avalanches are mass movements (particles move en masse), whereas in many cases, bedload transport involve particles clusters that take the form

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of superficial sheets (carpet of moving particles). Therefore, in my opinion, the analogy is not obvious. I agree with the authors that some collective entrainment events may result from avalanches (e.g., on banks or lee slides of bedforms), but this does not seem the only scenario. âĂć P. 2, L14, the citation to Albert (2000) is not related to the statement in this sentence. âĂć P. 2, L27-35: there is a misconception with regards to the term “collective entrainment” used by Ancey et al. Please read [1] more carefully. In my model, I figured out that large fluctuations could be captured by assuming that the probability of entrainment depends on the number of moving particles. That is why the coefficient mu was referred to as the collective entrainment coefficient as it accounts for collective effects in the stream. This does not mean that many particles are entrained at the same time. âĂć P3 L3, I do not think that Einstein mentioned the analogy with Brownian motion. âĂć P4 L1: the sentence may be unclear to many readers. What do the authors mean with “continuously driven limits”? Define “particle activity” (the term was introduced by Furbish et al. recently and not all readers are familiar with this terminology). âĂć P4 L28: remove [] âĂć P8 L11: why do the authors mean with “intermittency”? Intermittent refers to a process that stops and starts. This is the definition used in studies of fluid turbulence, see the related chapter in [2]. Recently, within the bedload transport community, a number of authors have started to use “intermittent” as “fluctuating”, but this is not the common definition of this word. Note that for any stochastic process, the time-averaged value converges to a steady state value (if the mean exists, so some heavy tailed distributions are excluded), this is not the signature of a process that would be intermittent âĂć P9 L13: “confounds efforts” -> I understand that the authors failed (or partially managed) to obtain the characteristic time, but then they wrote that they were able to compute it. I am at a loss how to understand this sentence. âĂć P9 L26: a Poisson distribution is a discrete probability distribution whereas the waiting time is a continuous random variable. Did the authors mean “exponential distribution”? âĂć P15 L3: “analogous to avalanches”: did they mean that they observed particles moving en masse? âĂć P15 L9: what is D? âĂć Figure 10: “deposited” sounds strange. “imparted” would not be more correct? âĂć P18 L1: “the

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similarity of (. . .)" -> I do not understand what the authors mean exactly. Is "dependence" correct? âĂć P 19: there are two citations to Ancey et al. (2008). [1] Ancey, C., P. Bohorquez, and J. Heyman, Stochastic interpretation of the advection diffusion equation and its relevance to bed load transport, Journal of Geophysical Research: Earth Surface, 120, 2529-2551, 2015. [2] Frisch, U., Turbulence, Cambridge University Press, Cambridge, 1995.

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