Earth Surf. Dynam. Discuss.,
https://doi.org/10.5194/esurf-2020-20-RC3, 2020

Interactive comment on "Inertial drag and lift forces for coarse grains on rough alluvial beds" *by* Georgios Maniatis et al.

Anonymous Referee #3

Received and published: 21 May 2020

This manuscript is intended to quantify the dynamics of entrained sediment particles by using advanced inertial force monitoring systems. I believe this work has good contributions to this long-standing problem and it is worth being published. Overall, the materials are properly organized and relevant concepts explained concisely. I see no significant problems for its publication, but there are several minor suggestions for the authors to consider in their revision. Below, I listed my comments and suggestions as I read through the manuscript.

L50-54: Regarding the Lagrangian approach, Ballio et al. (2018, "Lagrangian and Eulerian description of bed load transport") provide a unified framework to describe sediment particle motion under different frames of reference and quantification methods. The authors may want to refer to this work and highlight their particular contributions to

the topic.

L58: The issue of over-prediction of transport rates was also extendedly discussed by Bunte et al. (2004, "Measurement of coarse gravel and cobble transport using portable bedload traps") and Singh et al. (2009, "Experimental evidence for statistical scaling and intermittency in sediment transport rates"), and other related papers. The reference can be updated with these contributions.

Sec. 2 (Frames of reference, rotations and IMU measurements) provides details of mathematical expressions for the conversion/transformation among different frames of reference. But Fig. 1 needs some more clarity on the specifics of these frames, e.g. (x,y,z) (rx,ry,rz),(ix,iy,iz).

Based on their formulation, Eq. (9) only concerns the threshold condition in the tractive mode towards downstream, and Eq. (10) the upward movement. Yet, when approaching the strictly critical condition, particle rolling, which has even lower resistance, can be the most predominant entrainment mode. The authors can consider adding an extra formula describing the rolling threshold for providing a more complete framework.

L234. Has the 1.5 mm uniform sand glued to surface or also movable?

Fig.2 (b) describes the change of drag forces during the noted five entrainment events. The pattern shown here, however, somewhat contradicts the impulse model mentioned later in the manuscript (e.g. L278-279). If all these five events follow exactly the impulse criterion, the events of higher magnitude should persist for a shorter duration, and vice versa, to maintain at the same impulse level. In other words, these events, very likely, represent different degrees of particle mobility and not the most extreme cases of entrainment (minimal critical impulse). I think this aspect is worth mentioning in the discussion.

Sec. 5.0.2. The calculation of entrainment probability is not clear to me. Is it described as the ratio of entrainment duration to the total observation time, or the ratio of entrainment events to the total exceedance events observed? I assume it is the latter definition. Adding an equation will help to clarify this point.

L300. The scaling effects are usually attributed to the intermittency of particle motion dictated by turbulent flow structures. Yet, this sentence seems to suggest the role of physical scale between the laboratory flume and field stream. A clarification will be helpful (see discussion in Singh et al., 2009).

Fig. 4(a) can be improved by using different shading colors for FD and FL, respectively.

L310-317. The differences in magnitude of critical drag and lift forces between this work and literature data are attributed to the particle sizes, or corresponding mass, used differently. To resolve this issue, a dimensionless quantity, e.g. FD/particle weight, FL/particle weight, can be considered for both the present work and previous reports.

L325-332. The description of the negative lift forces can be more precise in relating to the threshold of motion conditions. Specifically, when the negative lift force appears, the probability of particle lifting reduces, and also, the resistance to the tractive movement increases via the enhanced inter-surface friction.

L353-357. The description of the entrainment mode of rolling can be placed in the earlier section (see the previous comment) to avoid confusion.

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