Earth Surf. Dynam. Discuss.,
https://doi.org/10.5194/esurf-2020-101-RC1, 2021

Interactive comment on "Rarefied particle motions on hillslopes: 4. Philosophy" *by* David Jon Furbish and Tyler H. Doane

Joris Heyman (Referee)

joris.heyman@univ-rennes1.fr

Received and published: 1 February 2021

4) Philosophy :

The fourth paper present a general discussion on probabilistic approach to rarefied particle motions. It correctly points the generality of such approach, and shows how continuum equation of motion extend (within some subtle extra terms) to ensemble average quantities or probability distributions, even when the instantaneous particle flux is strongly intermittent.

While I completely agree with this viewpoint, and I believe the paper has its importance for the community, I am not sure how this relates specifically to the hillslope motions. Indeed, the use of ensemble averaging/probabilistic description to describe

rarefied gas, bedload, or avalanches, and the scale dependence of fluctuations, is a much more general discussion that could fit in a standalone study, with dedicated title. Indeed, the 4th papers format dilutes in my sense the distinct messages the authors convey. Nevertheless, if the editors and reviewers think the inclusion of this paper as a companion paper is justified I will not argue against this.

One minor comment is the following. The authors point 2 equivalent probabilistic viewpoints, the Fokker-Planck equation (the linearization of the master equation) and the maximum entropy approach, originating from statistical physics (they discussed in the 1st and 3rd companion paper). In the discussion, I would include a third way, the Poisson representation [1], which has the attracting characteristic of being exactly equivalent to the Master Equation, while leading to continuous, analytically tractable PDEs. This approach, developed by Gardiner, can be used [1,2] to compute the exact particle number pdf and correlations from basic entrainment/disentraiment rules, without requiring a "small" noise or Kramer-Moyal expansion that assume a large number of particles. As pointed by Gardiner, it has the potential to describe "low density-high fluctuations" states of granular gases, for which large deviations play an important role. A mention of such alternative could be relevant.

1 Gardiner, C. W. (1985). Handbook of stochastic methods (Vol. 3, pp. 2-20). Berlin: springer. 2 Ancey, C., & Heyman, J. (2014). A microstructural approach to bed load transport: mean behaviour and fluctuations of particle transport rates. Journal of Fluid Mechanics, 744, 129-168. 3 Heyman, J., Ma, H. B., Mettra, F., & Ancey, C. (2014). Spatial correlations in bed load transport: Evidence, importance, and modeling. Journal of Geophysical Research: Earth Surface, 119(8), 1751-1767.

Please also note the supplement to this comment:
https://esurf.copernicus.org/preprints/esurf-2020-101/esurf-2020-101-RC1-supplement.pdf

Interactive comment on Earth Surf. Dynam. Discuss., https://doi.org/10.5194/esurf-2020-101, 2020.