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Interactive comment on "The mechanical origin of snow avalanche dynamics and flow regime transitions" *by* Xingyue Li et al.

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The paper by X. Li, B. Sovilla, C. Jiang and J. Gaume entitled The mechanical origin of snow avalanche dynamics and flow regime transitions is well organised and written with a short introduction, three sections presenting the different steps of the work and some conclusions and perspectives to finish with.

In the introduction, the applicative context is first depicted regarding the necessity of investigating the snow avalanche dynamics for a better understanding and protection of people and human goods. The originality of this study is justified by the need of having a numerical tool to model the dynamics of snow avalanches with snow of different types and different slope geometries.

In section 2, the MPM is briefly described, as well as the constitutive model mainly referring to former contributions by some of the authors but not solely.

Section 3 presents a complete parametric study of five snow types flowing along an ideal slopes and arresting on an horizontal plane. The inclination and length of the slope are also part of the parametric study. All simulations falls into four typical snow avalanche groups denoted cold dense, warm shear, warm plug and sliding slab. The front velocity, the velocity profile across the flow, the arresting distance and the free surface shape are part of the output parameters analysed. The results are qualitatively in agreement with the physics and discussed as such. The influence of the snow type is systematically explained. Unfortunately, only macroscopic quantities (see above) as output are studied to distinguish flow types. I would suggest, as in Gracia et al. (2019) [F. Gracia, P. Villard, V. Richefeu (2019) Comparison of two numerical approaches (DEM and MPM) applied to unsteady flow, Computational Particle Mechanics, 6(4), pp. 591-609] which deals with the same topic applied to granular flows, in order to understand the internal physics of the flow that you extract, show and discuss some quantities such as energies (potential, kinetic, dissipated by friction or fracture) to understand their transfers during the flow and to provide an insight to understand which material parameters, including the basal friction coefficient, are the key ones. Some master curves or should I say master clouds are proposed with dimensionless parameters. Proposition of analytical solutions fitting the simulated results would be an interesting point for further uses towards a quantitative step.

In section 4, the model strategy is applied to real cases with field measurements. It should be more clearly stated in each case what are the parameters that are set a priori and the one used for the calibration process. I suggest to set some stars in table 3 to distinguish calibrated parameters. The results are impressive with a very good agreement in general with field measures. The discrepancies are explained by the fact that MPM cannot entrain further material during the flow, that the turbulence dynamics in powder cloud is not modelled in MPM (some perspectives are set along this line although the frictional dissipation with air is not mentioned), that the measurement acquisition frequencies are not comparable between field and numerical data (in order to be more precise on this point, data could be presented with points instead of lines, for instance in Fig 14 where the velocity peak is much discussed.)

The conclusion summarises the main qualitative results. A very interesting discussion is proposed at the end for the future work towards real geometry in 3D (MPM tools already exist in 3D, thus it is mainly a matter of computational time), to introduce in the MPM tool a constitutive law dedicated to powder cloud and its interaction with the dense part (the air friction is not mentioned here).

Overall the contribution is very well written, clear and well organised. The results and analysis are well documented, except the few points mentioned in bold in this review which need to be addressed for the final version. The work is original and provides an interesting step towards the prediction of snow avalanche propagation conditions.

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