We would like to thank Chan Young Yune for this thorough review and the interest granted to our preprint. You will find in this comment the complete reply with our answers in italic type. I am also attaching a pdf of the same answers, this time in blue, if it makes it easier to read.

The manuscript deals with interesting simulations of viscous flows and mixtures with grains using DualSPHysics. I have a couple of comments as follows.

1. "Introduction" includes comprehensive explanations of the related works but is also too lengthy. It needs to be deliberately and concisely reorganized. For example, modelling with CFD-DEM appeared two times in lines 77 to 85 and 103 to 104.

OK thank you for this comment, we will shorten the introduction to make it more concise.

1. What is the advantage of the analysis technique used in the study over CFD-DEM? If the advantages using DualSPHysics incorporating with collision algorithm is stated in the manuscript, it will be helpful for other researchers to employ similar approach.

The advantages of using the method shown here are :

- *classic Eulerian CFD struggles to represent steep free surfaces as at surge front, leading to a need to re-mesh the domain very frequently, thus having very high computational time compared to Lagrangian methods for debris flow studies*
- *SPH is fast when parallelized and well documented among Lagrangian methods. Overall, the advantage of using SPH compared to LBM is mainly the computational time, and accessibility of the SPH methods and softwares*
- *Using CHRONO is also faster than DEM when there are many collisions. In our case, DEM and CHRONO have comparable computational time because our number of collisions remain relatively low (compared to, for example, pure DEM with big size ratios between elements). The choice of using CHRONO in the software was mainly motivated by practical reasons of compatibility between the versions of the software, however, there is a DEM implementation present in version 5.2 (although not compatible with mDBC),*
- *DualSPHysics is an open software that has made a lot of efforts to have accessible and easily understandable documentation as well as a very active community of users and developers. It also has the advantage to have a lot of different features that can be useful when setting up cases (motion of boundaries, damping zones, etc..). Overall, we think these practical aspects are a huge advantage of this method when dealing with numerical studies. This helps bridging the gap between pure numerical research communities and field/experimental communities.*

In the end, since hybrid methods are relatively new, we think exploration of different methods is still needed to determine what would be best. However, DualSPHysics is a very strong contender because of its accessibility and its relatively low computational times. Now that *this method is validated, we hope to see it being applied to wider, more complex scenarii. We will add a few sentences on such advantages around line 125.*

1. Is this necessary to validate the simulation twice with viscous fluid without solid particles and again fluid with solid particles considering field conditions? I think it makes the manuscript too lengthy as well. Isn't it better to shorten the first validation and explain logically to have more relevance to the second validation?

The validation of the pure fluid simulation does bear the weight of validating the behaviour of creeping flows for SPH and DualSPHysics against experimental data. It is quite lengthy, but this is also of use for the SPH community because, to the best of our knowledge, it has not been done. In the method section, it's important to ensure that the numerical method for the fluid mechanics part actually renders results that are expected for such flow. We really believe it is necessary to validate each technical 'package' separately, and we want to encourage the community to do the same. We agree that the paper is long. We thought it better to present such a comprehensive study rather than do salami-slicing and publish several papers not showing the broad view of performing the type of modelling we intend to perform. We will try to reframe the way these two sections are articulated so that we can shorten the first section.

1. The study simplifies debris flow behavior by representing it as a combination of a viscous Newtonian fluid and poly-disperse solid particles. However, this neglects the complex non-Newtonian characteristics of real debris flows, such as yield stress behavior and inter-particle dynamics. Debris flow has inertia and frictional behavior between particles during the flow process. What is the authors' opinion on the limitations of this simulation considering this?

We agree that this complexity is lacking in the model, as pointed out in section 4.3. One of the reasons we named the paper 'Towards … ' was to highlight that these validation steps are crucial for a complete numerical model to be built but are not the final step. Any model is a simplified vision of reality, here we both simplify the fluid and the granular content, as pointed out in the discussion. Many authors also use a Newtonian fluid hypothesis in complex flow modelling but do not focus on validating the code on actual measurement of viscous Newtonian flows. By doing so, we attract the attention on this point, but we validate that the code is correctly behaving against experiments when using this assumption. Many codes are published and used without heavy, thorough validation. We believe doing so is good scientific practice even though it is a bit lengthy.

Our hope is that this validation will free further studies from these first arduous steps and will allow them to incorporate non-Newtonian rheology into the model, without having to worry about the feasibility of using this method in the context of slow creeping flows as in debris flow research. Our opinion is that these do still represent macroscopically the flow in a way that can be used for some studies, e.g. where the values of the shear stress gradient and the plug flow does not directly impact the object of interest (for example, entrainment) and are simplified enough to be usable by practitioners. Non-Newtonian rheologies are a crucial *next step, but they do require much higher complexity and computational time. We have started exploring non-Newtonian rheologies with the same method, for which preliminary results can be seen in Lapillonne (2024). Technical difficulties highlighted in the manuscript are hoped to be overcome in the future to then compare Newtonian and non-Newtonian models and answer : how much complexity is needed to accurately represent the motion of the flow ?*

Lapillonne S.. Modelling debris flow surges with a coupled solid-fluid model : a multi-scale investigation. Fluid mechanics [physics.class-ph]. Université Grenoble Alpes [2020-..], 2024. English. ⟨NNT : 2024GRALI034⟩. ⟨tel-04716855⟩, available here : https://theses.hal.science/tel-04716855/

There are minor comments on this manuscript as well.

1. In line 67, change “the estimation impact forces” as “the estimation of impact forces”

OK thank you, corrected

2. In line 81, change “Due to this technical inconvenient” as “Due to this technical inconvenience”

OK thank you, corrected

3. In line 88, change “Their study contributed to understanding” as “Their study contributed to understand”.

OK thank you, corrected

4. In line 91, change “both a pure fluid phase and a soil phase” as “both a pure fluid phase and a solid phase”

OK thank you, corrected

5. In line 167, change “work by (Einstein, 1906)” as “work by Einstein (1906)”

OK thank you, corrected

6. In line 170, change “was extended to any dimension D by (Brady, 1983)” as “was extended to any dimension D by Brady (1983)”

OK thank you, corrected

7. In line 177, change “at high volumetric fractions Guazzelli and Pouliquen (2018)” as “at high volumetric fractions (Guazzelli and Pouliquen, 2018)”

OK thank you, corrected

8. In line 201, change “to substitute the the value of” as “to substitute the value of”

OK thank you, corrected

9. In the legend of Figure 1, solid line should be changed as dashed line.

OK thank you, corrected

10. In line 301, what is kernel coefficients? Adding physical or mathematical meaning of this coefficient will be helpful for the understanding of readers.

They are defined line 224. We will add “Kernel coefficient are a measure of the ratio between smoothing length and particle spacing” and remind the reader of the mathematical definition.

11. In line 414, change “which average density is ≈ 1800−−2000kg/m^3” as change “with average density of about 1800 to 2000kg/m^3”

OK thank you, corrected

12. In Figure 7 (a), the Froude numbers are less than 1 and mostly lie between 0.5 to 0.8 even though, in lines 392 to 399, the value showed a distribution centred around 1. Is there a specific reason or didn’t you need to change simulation conditions to show the value similar to this?

In the field, the values are centered around 1 and span from 0.5 to 3. Here we want to be in the same order of magnitude so we start from 1 and the Froude number decreased with the progressive addition of boulders. We chose not to start from a supercritical regime for simplicity of the intercomparison between all the chosen setup, since it could have led to difficulties to compare between the sub- and supercritical cases.