The authors would like to sincerely thank Dr. Stéphane Lambert for his comments and suggestions on the submitted research paper. Each comment and its corresponding reply are addressed in the following text.

This paper addresses an interesting topic, and rather hot topic as studied by different research laboratories worldwide. This contribution is original and of real scientific value as it provides interesting insights into the DEM modeling of debris flow.

The authors thank the referee for confirming the importance and relevance of the topic.

To the referee's knowledge this is the very first publication proposing a DEM model of debris flow accounting for a tensile force between particles. Undeniably this is an interesting point. However, this topic is not really addressed in the article. The motivations for using such a contact law are not detailed nor argued, in particular with respect to other contact laws used for modeling debris flows. It is not explicitly stated what this law is supposed to allow accounting for. Besides, the consequences of using such a model on the granular flow behavior is not addressed in the results presentation neither than in the discussion. For sure, it has an influence on the flowing material velocity and height. It may also have a consequence on the interaction with the sensor (and thus on the impact force). Basically, the adhesive force may favor longer duration contacts between the particles and the wall (considering that contacting particles are pushed downward by other flowing particles). Considering the importance given to the type of contact law in the article title one could have expected more consideration to this crucial and innovative point.

The introductory part of the article included references to previous DEM contact laws that were developed to simulate granular flows down inclined planes. Some of these models considered dry granular flows while others included the effect of water by coupling the classical visco-elastic DEM model with a fluid-solver such as LBM or CFD. However, the latter was found to be computationally very expensive and its application for practical granular flows is limited.
In order to further clarify our motivation for using this adhesive elasto-plastic model, a paragraph will be added at the end of the introduction section which states:
"This paper presents a new computationally-efficient DEM model that would partially account for the presence of the fluid composed of water and find material, based on the work of (Luding, 2008). This is achieved through the adhesive aspect of the contact law which would indirectly take the presence of such fluid into account, as this fluid would increase the cohesion of the flowing mass. The advantage of this new approach is that it accounts for the interaction between solid grains of the flowing mass as well as the effect of fluid between them, all in the same modeling frame (DEM). As a result, modeling 3D real scale experiments or back-calculating historical events of granular flows would be computationally possible.

Furthermore, in the revised version, a clear difference will be highlighted between the particle-particle interaction and the particle-wall interaction, with the "wall" object being either the sensor or the channel base. The authors will clearly state that the particle-particle interaction is governed by the new proposed contact law of Luding (2008). On the other side, the particle-wall interaction is governed by the classical visco-elastic contact law (Schwager and Pöschel, 2007) for which previous studies of Albaba et al. (2015) has been used as reference for calibrating its parameter values concerning the impact between a flowing mass and a rigid wall.

In addition, in the revised version, the effect of the possible formation of adhesive bonds and their effect on the results concerning height, velocity and pressure will be discussed by selecting a virtual sampling box at a fixed distance away from the sensor where such bonds will be characterized and compared for different model parameter combinations.

Experimental data from Bugnion et al. (2012) are used for developing the proposed model. More precisely, couples of parameters (basal friction angle, restitution coefficient) are calibrated against different flowing materials. In the end, the main conclusions drawn concern the ability of the modeling approach in satisfactorily fitting the experimental data, focusing on 3 measurements (flow height and velocity and pressure on the obstacle). So, contrary to what is suggested in the title, what is cross compared with field experiments is not the model itself, but the modeling approach. This comment is motivated by the fact that the calibration of the model parameters is conducted using these experimental data.

In the revised version, the title will be changed to in order to better reflect the content of the article.

Concerning the area considered for measuring the pressure it seems the simulations do not perfectly meet the experimental conditions. For instance, the dimensions given in Bugnion et al. are the wedged dimensions and not the sensor dimensions. Differences thus seem to exist between the effective experimental measurements conditions and that in the simulations, with possible influence on results validity and discussion. The implication is that, for example, the sensor gives no value for thin flows and that the height of flow concerned by the measurement is not 295 mm, but much less. As dealing with a debris flow, a velocity gradient may be observed from the flow bottom to top, implying a variable impact force on the obstacle. The position and dimensions of the measuring surface should thus be identical between the experiments and the simulations. This point should be clarified.

The authors have obtained internal reports of the tests where the precise measurements of the sensors are written. The large sensor has a size of 20x20 cm while the small one has a size of 12x12 cm. These new details concerning the sensors sizes will be taken into account when carrying simulations for the revised version. The sizes of plates representing the sensors in DEM will be modified accordingly.

On the other hand, this raised point by the referee explains the phenomenon seen when comparing the evolution of pressure with time for the experiments and the model. The model is found to register pressure values earlier than the experiment. This now can be explained further by the fact that the experiments do not register pressure values for thin flows or for flows with heights lower than the height of the bottom edge of the sensor. On the other hand, the DEM model starts registering values for all types of interaction even for single particles at the beginning. This point will be further discussed in the revised manuscript of the article.

Table 1 shows a rather large panel of experiments, varying three parameters related to the flowing material (wet density, water mass fraction and fine mass content). Due to these differences, very variable values where measured in relation to the flowing material and impact pressure. But in such a context, it doesn't seem relevant to refer to mean values when comparing the results of all the tests, as done section 3. The initial conditions are extremely variable and consequently the velocities, flow thickness and pressure differ significantly from one test to the other: a comparison based on an average value seems to be of very limited interest and relevance.

The main purpose of presenting the results in mean values in Figure 8 was to show how do flow velocity, flow height and pressure fluctuate around the mean for different experiments and different initial conditions. The mean value of different experiments was not used for any comparison with numerical data, since that one of the objectives of the article is to relate the model parameters with the initial conditions of the flowing mass.

However, to avoid confusion, Figure 8 will be deleted in the revised version.

*In addition, and due to these differences in initial material characteristics, tests 9, 14 and 16 seem to pose a problem to the authors, either when comparing the maximum pressure of the different tests or when comparing the experimental data with DEM results. A basic way to compare these results, is to compute the hydrodynamic pressure which is proportional to (unit mass * v^2) and to compare this pressure with that measured (as done by Bugnion et al.). When plotting this term versus Pmax, it appears that most of the test results are aligned, with a ratio of 0.76+/-0.1 between the two parameters. The exceptions are tests 9 (ratio of 0.35) and, to a lesser extent, test 11 (ratio of 0.57). This suggests that the pressure measured for test 14 is in line with other experiments, when considering the unit mass and the velocity, and may not be justified by the presence of large boulders in the flow. The difficulty for the DEM model to well reproduce results of tests 9, 14 and 16 certainly finds an explanation in Figure 16. This figure shows that these tests are far from the domain where the modeling approach gives good results. In other words, Figure 16 reveals the domain where the proposed DEM modeling approach is valid, in terms of restitution coefficient and basal friction angle and after having calibrated the model parameters. Cases 9, 14 and 16 are out of this validity domain.*

Tests 9, 14 and 16 are of special interest for the authors since they have considerably different values of pressures in comparison with other tests. However, those values of pressures were well reproduced by the corresponding DEM simulations as seen in Figure 11.
Bugnion et al. (2012) carried detailed analysis of the pressure measured by both sensors and related it to the hydrodynamic pressure measured as the product of mass and squared front velocity. This however is not in the core interest of the comparison for the authors since such calculated pressure is only proportional to the measured ones. The calibration process has an objective of reproducing real pressure values by DEM simulation. However, in the revised version, a new column will be added to Table 1 representing the hydrodynamic pressure of each test as presented by Bugnion et al. (2012). In addition, a paragraph will be added to stress the fact that the difference in pressure of tests 9, 14 and 16 is best explained by a change in the hydrodynamic pressure. However, the explanation of the pressure difference between tests 14 and 9 is also possible by assuming the impact of large particles on the sensor in case of test 14 when compared with test 9. This is because the gravel percentage of the mixture in test 14 is 3 times higher than that of test 9 (see Table 3 in Bugnion et al. 2012).
Concerning Figure 16, it is meant to illustrate the sets of model parameters that are used to reproduce the different experimental tests, depending on the chosen calibration process. This figure shows by no means the domain where the proposed DEM model is valid. In contrast, it shows for each experimental test the right values of φ and ε to be used to reproduce that test. A reader can be misled by the red dashed-line drawn in Figure 16 which purpose was to limit a zone where several experimental tests are reproduced with very similar set of parameters of DEM model. Such confusion will be avoided when preparing the revised manuscript by eliminating that line and by better introducing the figure in the text.

Similarly as for the experiments, a 50ms filtering interval was used to smooth the pressure curves. This temporal window aims at smoothing sensor plate vibrations resulting from the impact of solid grains (Bugnion et al.). It was observed that after an impact by a single solid ball the sensor plates vibrates for up to 30 ms. This period of time is much longer than the impact duration: it takes a few milliseconds for having a momentum transfer from the solid ball to the plate. In the case of debris flows, these peaks come in addition to pressure transmitted by the matrix surrounding large particles (this matrix consists in a mixture of water and fine grains). Bugnion et al. stated that this technique was efficient in smoothing peaks due to solid grains contained in the debris flows, without altering the information. Nevertheless, it doesn't seem really justified to consider the same filtering interval for treating the DEM results because there is no plate vibration but just short duration peaks (2ms) related to the plate-

particle contacts. Such peaks do not justify having a 50ms filtering interval. This comment is also motivated by the point addressed below.

The DEM model considers an assembly of large grains, with mean diameters ranging from 75 to 150 mm. For the main case, the diameter ranges from 50 to 100mm, which represent only a fraction of the grain-size distribution of the debris flows considered by Bugnion et al (less than 30% in mass). Considering the size of the sensor it appears that the maximum number of d50-particles in contact with the plate goes from about 12 for d50 = 75 mm down to less than 4 for d50 = 150 mm. Such a small number of contacts has a strong influence on the pressure deduced from the DEM simulations. In the absence of matrix, the force exerted by the flow on the sensor is then the sum of a small number of short duration contacts. As the interaction with the sensor is a key issue in this work, a more in-depth investigation of the particle-plate interaction could have been conducted, for instance addressing items such as pressure representativeness (variability in results repeating the test varying the initial particles packing), peak force amplitude, impact duration, number of contacts, … This is particularly critical for d50 = 150 mm, and results presented in Fig. 17 may be explained by the fact that the variability in force exerted on the plate and resulting from the small number of contact points has not been accounted for. The influence of the small number of contact points should also be checked for cases down to d50=75mm.

The authors thank the referee for raising this important point concerning the filtering of DEM signal which has a direct effect on the way the maximum impact pressure is calculated and also relates to the calibration process which is partially based on the comparison between maximum pressures of DEM and Exp, in addition to the flowing height and velocity.

The strong oscillations of DEM signals are usually linked to many factors including the number of particles, the area that is being impacted, the frequency of recording data, the mean particle diameter and the number of contacts.

One difficulty in the current study however is the fact that the experiment represents a full-scale hill slope debris flow with a volume of 50 m^3. Such a large volume requires running simulation with particle sizes that are relatively large (d_{50} = 75 mm) in comparison with the range of sizes, in order to keep the total number of particles within feasible range as to the computation capabilities of the super computers (the average total number of particles is around 160,000). In addition, the sensor size is indeed small (200x200 mm) in comparison to the mean particle size considered for the simulations, which leads to having few contacts per impacting step and thus a discrete fluctuating signal in DEM.

Furthermore, the possible variation of the particles' initial spatial distribution in the released material might also have a small effect on the force signal, as reported in some DEM studies (e.g. Albaba et al 2015).

Because of all aforementioned reasons, there is a need to define a filtering interval based solely on an investigation of the DEM signal and independent of the experiment's filtering interval.

In the revised version, the authors propose an analysis of the DEM signal based on two points:

I. The repeatability of the same tests to account for initial spatial variation.
II. The signal of different simulations with different parameter values.

First, the same DEM simulation would be run 10 times with different initial spatial distribution and then the maximum pressure will be plotted against different filtering intervals (0.025 s up to 0.5 s). In addition, the relative error defined as the normalized difference between two successive values of maximum impact pressure would be plotted. An optimum filtering interval would be defined as that with a relative error of 5% or lower. The same would then be carried out for the different DEM simulations with different parameters of φ and ε.

The filtering interval to be used for filtering the DEM and deducing the maximum impact pressure would be the optimal one while considering the two points above. An example of the proposed analysis is presented below in Fig R1 for a simulation with φ = 30° and ε = 0.3

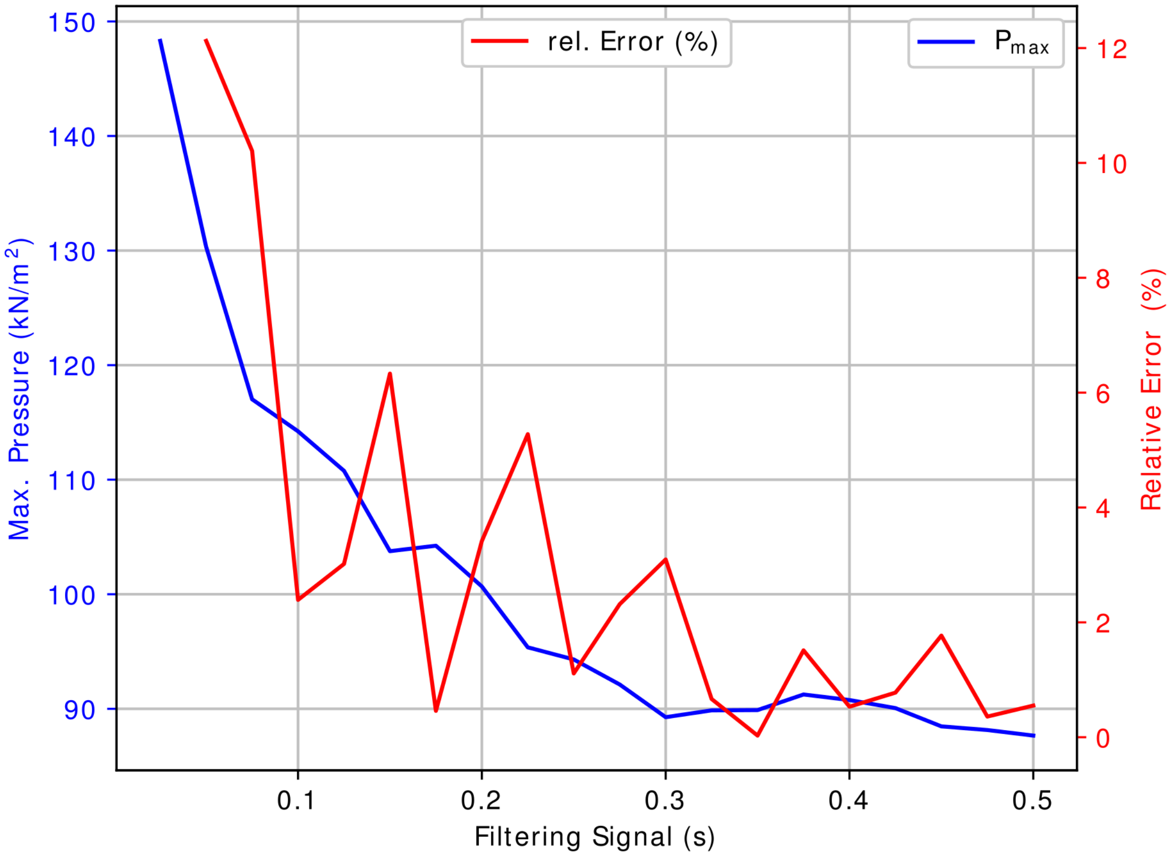

Figure R1 The maximum pressure and relative error for different filtering intervals for DEM simulation with φ = 30° and k_1/k_2 = 0.3.

Furthermore, an in-depth analysis will be carried out concerning the effect of the particle size (75, 100, 125 and 150 mm) on the impact pressure signal by relating mean particle diameter, evolution of number of contacts and the duration of the contact.

The model is calibrated focusing on 2 parameters: the basal friction angle and the ratio of k1 to k2. This later is referred to as restitution coefficient but this term seems improper. It doesn't correspond to the classical definition of the restitution coefficient (ratio of velocities between after and before contact) and thus may introduce ambiguity. This comment seems to be supported by the results plotted in Fig. 18, revealing the very limited influence of this coefficient on the flow velocity and height. For what concerns the basal friction angle, this parameter seems artificial. Figure 16 shows that for a same slope, the basal friction angle varies from 25 to 40_ depending on the flowing material. This range may hardly be justified by changes in the slope characteristics from one test to the other, neither than the 40_ value be justified. It seems on the contrary that this parameter is a way to account for the flowing material rheology. The debris flows being modeled as a collection of particles of large diameter with respect to the flow thickness, a good agreement of the DEM model with the experiments in terms of flow height and depth-averaged velocity requires adjusting the basal friction angle. This parameter is thus not intrinsic to the channel characteristics, but also accounts for the rheology of the debris flows. This would deserve specific comments and probably discussion.

The use of the term restitution coefficient confirms the choice of terms of Luding (2008). It is however true that it is also usually used to refer to the ratio of velocities before and after the impact for classical visco-elastic contact laws, such as that of Schwager and Pöschel (2007). It will be labelled as k_1/k_2 in the new version of paper to avoid ambiguity. Concerning the friction angle, it would be recalled "microscopic" friction angle since it defines the friction angle at the microscopic scale between each single particle and the base of the channel.
The effect of the ratio of k_1/k_2 on the flow height and velocity was found to be limited because the variation of this ratio only concerns the interaction between the particles themselves. The interaction between flowing particles and the base of the channel is governed by a visco-elastic contact law where the value of ε_n was fixed based on previous studies of Albaba et al (2015). In that study, it was shown that the flow height is affected by the value of restitution coefficient while the flow velocity is governed by the value of the microscopic friction angle.
All these details will be presented in detail in the new version and critically analyzed.

On a formal point of view the paper organization is sometimes confusing. The calibrated parameters are presented late, after plotting and discussing the results. Technical details concerning the experiments are presented in the discussion, while these pieces of information were discussed by Bugnion et al. and the figure was directly copied from their article. As such, this should be introduced together with the experiments, in section 2. Last, in section 3.3 dedicated to the parametric study, there is a mix between DEM model parameters and physical parameters describing the flowing material and conditions. Considering the former or the later does not fall within the same scope.

As stated in the previous authors' replies, the new version of the paper will be prepared in compliance with the proposition of the referee. After the introduction, a detailed sensitivity analysis of the model's parameters will be presented in addition to the analysis of the filtering interval. After optimizing the choice of filtering interval of DEM, a comparison between the model and experiment will be detailed. The discussion will then be based on the analysis of pressure signal in addition to further analysis of the comparison between DEM and Exp data. All pieces of information concerning the experiment will be introduced when introducing the experimental data.

Last, curves plotted Figures 13 to 15 do not correspond to the maximum values plotted in Figure 11.

Values concerning the maximum impact forces (after applying the 0.05 seconds filtering interval) of the experiments of Bugnion et al. (2012) are given in Figure 11 and table 1 in the paper. The temporal evolution of pressure of the different experimental tests (Fig 12 to Fig 15) were reproduced from non-published internal reports of the experiments. This will be cleared in the new version of the paper.