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Experimental quantification of a granular crater induced by a liquid-to-granular impact using a 3D scanner

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Granular impacts have been extensively studied but much remains to be investigated regarding the complex topic of liquid-to-granular impact. Its applications to Geosciences are of interest regarding recent advances in the investigation of the raindrop erosion or the sediment flux. In our study, we focus on the quantification of both the excavated and deposited volumes resulting from a water-droplet impact onto a fine granular. The quantification of the existing relationships between the impact energy, the packing fraction and the excavated volume is also of interest.

Indeed, the relationship between the packing fraction and the excavated volume has still to be investigated for constant impact energy (fixed height of fall and droplet size). Moreover, the volume distribution of the granular matter around the impact target has still to be achieved regarding the previous studies. Much of the previous work was focused on the ejected particles distribution but less is known about the volume distribution of the ejected mass. In this study, we have developed a specific methodology in order to investigate these two topics, as follows:

a) First of all, we carried out experimental investigations in laboratory on a setup inspired by the previous works of Long et al. (2014) and Furbish et al. (2007). Granular samples were prepared using a compaction device in order to produce various packing fractions. Pre- and post-impact surface geometries were recorded using a high precision 3D scanner (KONICA MINOLTA VIVID 9i). This provided an accurate point cloud of the impact crater and ejecta deposits.

b) Afterwards, we processed each point cloud pairs using different softwares (PolyWorks & MATLAB). We used an accurate change detection method by computing orthogonal distance from points (post-geometry) to reference meshed surface (pre-geometry) to extract the points belonging to deposits (positive distance) or crater (negative distance). Then, we used the computational geometry toolbox provided by MATLAB to compute the excavated and deposited volumes.

Results show that both excavated and deposited volumes seem to be dependent on the packing fraction (e.g the higher the packing the lower the volume) for a constant impact energy. The radial volume distribution is more likely to be a Burr XII distribution rather than an exponential distribution.

Following our experimental results, numerical modeling for the cratering process has yet to be established coupling different numerical methods (Computational Fluid Dynamic and Discrete Element Method) in order to reproduce similar volume distribution. Such numerical methods are promising techniques for further simulations of liquid-to-granular impact.