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A hybrid system for the near real-time modeling and visualization of extreme magnitude earthquakes

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Among other natural hazards, the occurrence and impact of extreme magnitude earthquakes are of great interest both from the scientific and societal points of view. The scarcity of observational instrumental data for these type of events, as well as the urgent need to take mitigation measures to minimize their effects on human life and critical infrastructure have required the development of computational codes for the modeling of the propagation of these events.

Examples of the realistic modeling of the propagation of extreme magnitude earthquakes that can be achieved by the use of powerful HPC facilities and 3D finite difference Fortran codes have been presented by Cabrera et al. 2007 and Chavez et al. 2016. These large-scale scientific simulations generate vast amount of data, writing such data out to storage step-by-step is very slow and requires expensive I/O post-processing procedures for their analyses. However, the current and foreseen major advances occurring in Exascale HPC systems offer a transformational approach to the research community, as well as the possibility for the latter of contributing to the solution of urgent and complex problems that society is or will be facing in the years to come.

Taking into account the future exascale developments and in order to speed-up in situ analysis, i.e., analyze data at the same time simulations are running, in this ongoing research we present the main computational characteristics of the hybrid system we are developing for the near real-time simulation and visualization of the propagation of the realistic modeling of the 3D wave propagation of extreme magnitude earthquakes. The system is based on the updated version the staggered finite difference Fortran code 3DWPFD, coupled with an efficient visualization C++ code. The system is being developed in the hybrid HPC Miztli of UNAM, Mexico, made up of CPUs (8344 cores) + GPUs (16 NVIDIA m2090 and 8 V100). We expect to fully adapt the code for emerging hybrid Exascale architectures in the near future. Examples of the results obtained by using the hybrid system for the modeling of the propagation of the extreme magnitude Mw 8.2 earthquake occurred the 7 September 2017 in southern Mexico will be presented.