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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Tree-based mesh-refinement GPU accelerated tsunami simulator for real time operation" *by* Marlon Arce Acuña and Takayuki Aoki

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** General Comments **

The paper presents an operational model for the fast simulation of the generation, propagation and inundation of tsunamis in wide areas by exploiting modern multiGPU hardware. The model is tested and compared under a real tsunami scenario, obtaining a nice performance results from the operational point of view. The implementation of this operational model on a cluster of multiGPU computers involves the suitable integration of numerical schemes (MOC with dimensional splitting to solve spherical SWE for the Tsunami propagation, Surface Gradient Method to solve the cartesian SWE for inundation areas, ...) and computing techniques (quadtree-based mesh refinement to

save resources, Hilbert Space-filling curves to preserve locality in the parallel partitioning, CUDA for GPU programming and MPI for remote communication, overlapping the computation in GPU and the generation of output files and rendering in CPU, etc.) to obtain an efficient complete CPU-multi-GPU operational model for Tsunami forecasting.This model would make it possible a very fast simulation which can help in the early identification of the tsunami consequences.

In my opinion, the techniques which are presented and the scientific data which are included are coherent and relevant and can be useful to scientists working in this area because all the approaches and techniques are devised in conjunction to perform very quickly realistic simulations. Although the paper is well organized and written, the reading of several pieces of the sections which explain the multiGPU implementation is not easy to understand and several implementation decisions which are presented are not clear. Moreover, in Section 5, I think that the use of technical and english language should be checked (several corrections are included in the Section of Technical Corrections).

On the other hand, to intend the validation of the operational model with a real tsunami scenario when the input data are not sufficiently accurate is very ambitious.

** Specific Comments **

In Section 1, it would be interesting to include a comparison with previous works related with the multiGPU simulation of tsunamis to obtain faster-than-real-time results.

In Section 5.1., the description of the configuration of the main CUDA kernels (second paragraph of the section 5.1.) is not easy to understand. A graphical description of the configuration and a description of the calculations assigned to each CUDA thread (relating this section with section 3 and 4) would be very useful to understand it.

The specialized kernel types presented in section 5.1.2. could affect the load balancing between GPUs because the computational execution cost of each kernel type on

a mesh block would be possibly different. I do not know if this fact is taken into account for the considerations included in section 5.2. I think it would be interesting to report graphically execution times for each particular GPU in order to evaluate the effectiveness of the domain partitioning and even to rethink the approach by designing a dynamic load balancer.

In Section 5.3.2., the configuration for the network which interconnects the TeslaP100-based nodes and the Tesla K80 nodes should be included to analyze Fig. 15.

In Section 5.3.2. and in the Conclusions, authors underline evidences about the wall clock time and the speedup which are obtained with 3 GPUs. However, the particular performance results for 3 GPUs are not reported and they are not included in Figure 15.

In Section 5.3.2., absolute performance measures on one GPU for the main kernels (it can be obtained by using the Nvidia CUDA profiler) could be useful to evaluate the efficiency of the CUDA implementation.

In section 6.1.2., the figure 18 Top which presents the RIMES results for Hambantota Inundation is not introduced textually in page 31, line 18. On the other hand, it is difficult to compare visually the RIMES and TRITON G inundation maps if the colours are used in a completely different manner for each map.

** Technical corrections **

- Page 13, Section 4.1, line 7: "blocks close to the coast until reaching a target ..."

- Page 15, Line 7,8: The sentence is not clear.

- Page 17, Line 20; The sentence is not easy to understand.

- Page 17, Line 21: "organized in a grid of blocks of CUDA threads ..."

- Page 18, Line 8: "branch diversion" is not the usual term. "branch divergence" is more frequent in this context.

- Page 18, Line 12: A comma in the sentence after "speed up" would help in order for it to make sense.

- Page 18, Line 18: "... This way the kernels can be laubched ...".

- Page 19, Line 5: "... is illustrated in Fig. 7 ...".

- Page 23, Line 5: "... was introduced in order ..."

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