Geophysical Research Abstracts
Vol. 19, EGU2017-1246, 2017
EGU General Assembly 2017

Assessment of Efficiency and Performance in Tsunami Numerical Modeling with GPU

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Non-linear shallow water equations (NSWE) are used to solve the propagation and coastal amplification of long waves and tsunamis. Leap Frog scheme of finite difference technique is one of the satisfactory numerical methods which is widely used in these problems. Tsunami numerical models are necessary for not only academic but also operational purposes which need faster and accurate solutions. Recent developments in information technology provide considerably faster numerical solutions in this respect and are becoming one of the crucial requirements. Tsunami numerical code NAMI DANCE uses finite difference numerical method to solve linear and non-linear forms of shallow water equations for long wave problems, specifically for tsunamis. In this study, the new code is structured for Graphical Processing Unit (GPU) using CUDA API. The new code is applied to different (analytical, experimental and field) benchmark problems of tsunamis for tests. One of those applications is 2011 Great East Japan tsunami which was instrumentally recorded on various types of gauges including tide and wave gauges and offshore GPS buoys cabled Ocean Bottom Pressure (OBP) gauges and DART buoys. The accuracy of the results are compared with the measurements and fairly well agreements are obtained. The efficiency and performance of the code is also compared with the version using multi-core Central Processing Unit (CPU). Dependence of simulation speed with GPU on linear or non-linear solutions is also investigated. One of the results is that the simulation speed is increased up to $\sim$75 times comparing to the process time in the computer using single 4/8 thread multi-core CPU. The results are presented with comparisons and discussions. Furthermore how multi-dimensional finite difference problems fits towards GPU architecture is also discussed.

The research leading to this study has received funding from the European Union's Seventh Framework Programme (FP7/2007-2013) under grant agreement No: 603839 (Project ASTARTE-Assessment, Strategy and Risk Reduction for Tsunamis in Europe). PARI, Japan and NOAA, USA are acknowledged for the data of the measurements. Prof. Ahmet C. Yalciner is also acknowledged for his long term and sustained support to the authors.