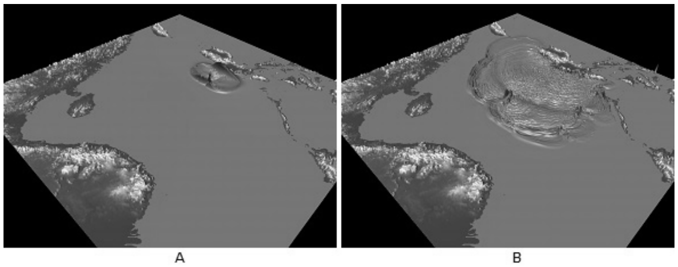
Tsunami Modeling



RBF Implementation

Although MATLAB provides an API to interface with C code, and in essence with CUDA through MEX files, Jacket software by AccelerEyes was used to run the RBF simulation in conjunction with a GPU given that it provides an ease of use and time to solution not available with the alternative. By using Jacket, the authors were able to access the GPU without leaving the MATLAB environment. Jacket is a software platform that masks the complexity of programming a GPU, eliminating the need for the user to know any GPU programming languages or architectures. Instead of writing CUDA kernels, one just needs to tell the MATLAB environment when and what should be transferred to the GPU and then when to copy it back to the CPU. The following is an example of how to implement MATLAB code on the GPU using Jacket.

```
A = eye(5);         % creates a 5x5 identity matrix
A = gsingle (A);    % casts A from the CPU to the GPU
A = A * 5;          % multiplies matrix A by a scalar on the GPU
A = double (A);     % casts A from the GPU back to the CPU
```

The radial basis function simulation was executed on an NVIDIA 8600 GPU using Jacket. Comparing the simulation that ran strictly on the CPU of a MacBook Pro to the simulation that implemented a GPU, the speedup received was about seven times faster. This simulation contained four hundred time steps and a grid size of 30 by 30. Overall, running a RBF simulation in conjunction with the GPU produces the speediest results, thereby allowing the shortest time in issuing a tsunami warning.

Grid Size	Laptop (CPU)	Laptop (GPU)	SpeedUp Times
30 x 30	~315 seconds	~105 seconds	3X
Laptop	Standard MacBook Pro		
GPU	nVidia 8600M GT Graphics Card		

Natural catastrophic disasters, like tsunamis, commonly strike with little warning. For most people, tsunamis are underrated as major hazards. People wrongly believed that they occur infrequently and only along some distant coast. Tsunamis are usually caused by earthquakes. Seismic signals usually can give some margin of warning, since the speed of tsunami waves travels at about 1/30 of the speed of seismic waves. Still there is not much time, between one hour and a few hours for distant earthquakes and much less, if you happen to be unluckily situated in the near field region.

It is important to have codes which are fast to respond to the onset of tsunami waves. It is desirable to have codes which can deliver the output in the course of a few minutes. Radial basis functions (e.g. [1]) are a novel method to solve partial differential equations. They represent a gridless approach [2] and require fewer grid points for solving the partial differential equations because of its high accuracy. The authors illustrate their use in the shallow-water equations together with their implementation on a GPU with Jacket software. The authors have provided results on the comparison in computational times of CPU versus GPU for both linear shallow-water equations and a swirling flow problem in atmospheric flows.

The faster growth curves in the speed of GPUs relative to CPUs have spawned a new area of development in computational technology. There is much potential in utilizing GPUs for solving evolutionary partial differential equations and producing the attendant visualization. The authors were concerned with modeling tsunami waves, where computational time is of extreme essence in broadcasting warnings. They employed Jacket software and an NVIDIA board on a MacBook Pro to test the efficacy of the GPU on the set of shallow-water equations, and compared the relative speeds between CPU and GPU for two types of spatial discretization based on second-order finite differences and radial basis functions. Results showed the GPU produced a speedup of a factor of 8 in favor for the finite-difference method and a factor of 7 for the RBF scheme. They also studied the atmospheric dynamics problem of swirling flows over a spherical surface and found a speedup of 5.3 by the GPU. The time steps employed for the RBF method are larger than those used in finite-differences, because of the fewer number of nodal points needed by RBF. Thus, RBF acting in concert with GPU holds great promise for tsunami modeling because of the spectacular reduction in the computational time.

Authors:
DAVID A. YUEN, Minnesota Supercomputing Institute, University of Minnesota, Minnesota
JESSICA SCHMIDT, Saint Scholastica College, Duluth, Minnesota
ERIK O.D. SEVRE, Minnesota Supercomputing Institute, University of Minnesota, Minnesota
NAN ZHANG, Medical School, University of Minnesota Minnesota
GRADY B. WRIGHT Dept. of Mathematics , Boise State University, Boise, Idaho
Cécile Piret, National Center for Atmospheric Research, Boulder, Colorado
Yingchun Liu, Minnesota Supercomputing Institute, University of Minnesota
Natasha Flyer, National Center for Atmospheric Research, Boulder, Colorado

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