

Introduction:

- One of the most important applications of high performance computing is the simulation and prediction of natural disasters like tsunamis and storm surges.
- Funwave is a hydrodynamics code used by coastal modeling researchers for this very purpose.
- Cactus is a general purpose parallel programming environment written and maintained by the Cactus numerical relativity group.
- The Cactus framework has many benefits for computational research, i.e. AMR (Adaptive Mesh Refinement).
- Funwave was ported to Cactus to take advantage of the parallel computing techniques within the environment as well as its implementation of AMR.
- The research problem is the Cactus port of Funwave is not complete and additions to the source code have to be made for it to be suitable for tsunami simulations.

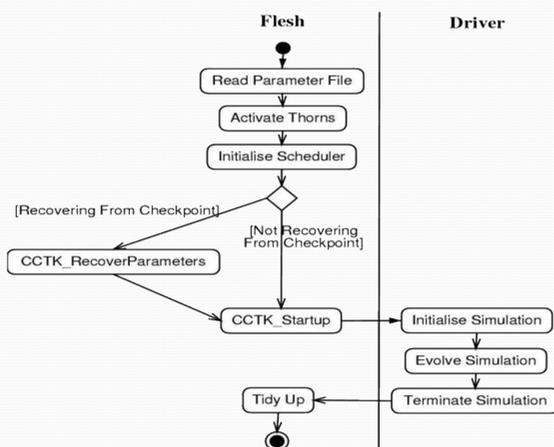


Figure 1. An example flow control diagram of a program running inside Cactus

Research Tasks Completed:

- Translated Funwave source code from FORTRAN to C++
- Built source code using Eclipse IDE and Mojave plugin for Cactus
- Tested source code using idealized models and parameters
- Visualized data using VISIT scientific visualization software
- Tested the data for accuracy through comparison with original Funwave results.
- Used a Mathematica script for this purpose.

Results:

1. Figure 2 demonstrates the visualizations of the local water displacement data after different number of time steps completed by Funwave in Cactus. The model is of an island in front of a shelf of land.
2. Tested results of Cactus version for accuracy through comparison with original Funwave data. Figure 3 shows a plot of the difference in results vs position within the testing domain between the original Funwave and the Cactus version with my modifications to the wave generator. Difference in results are $\sim 10^{-5}$.

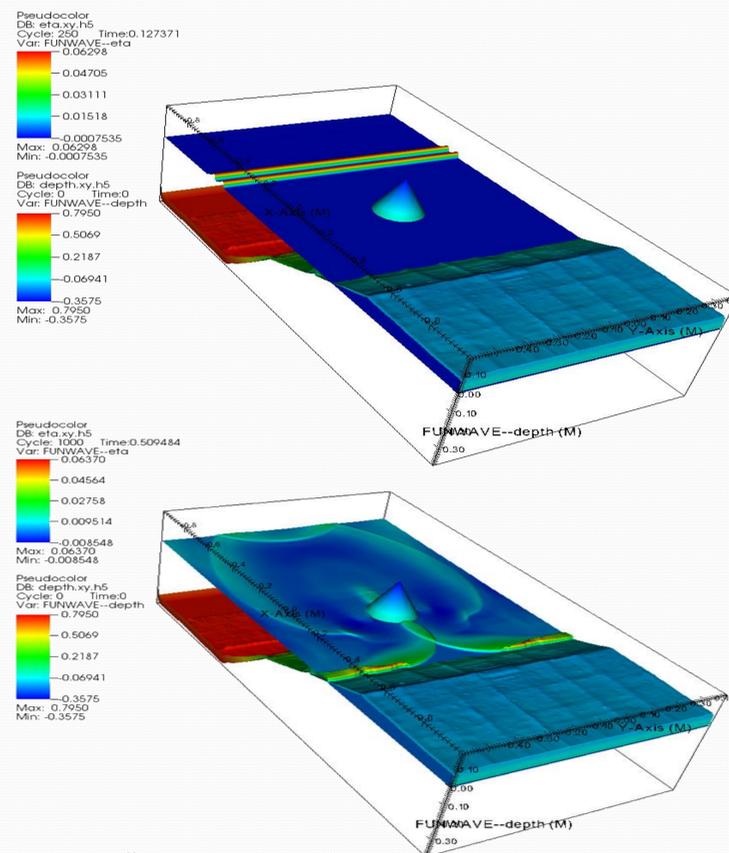


Figure 2. Top image is after Funwave completing 250 time steps, bottom image is after 1000 time steps. For each image, top legend indicates elevation of water above a reference level, bottom legend indicates elevation of land.

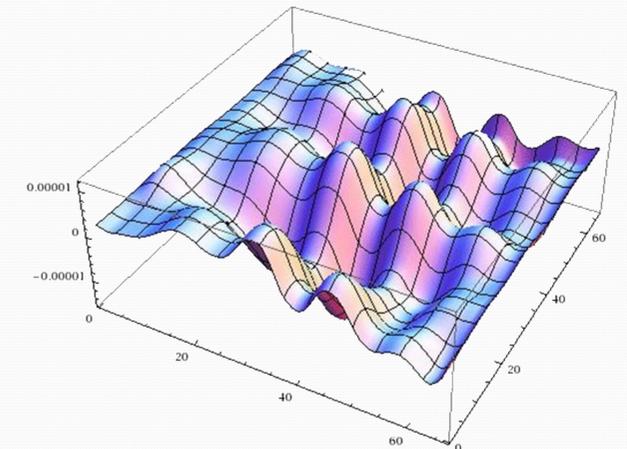


Figure 3. Difference in results between Cactus version of Funwave and original version

Conclusion:

From figure 2, we can say qualitative that Funwave in Cactus is able to generate a solitary wave that can be used in tsunami simulations. According to figure 3, we see quantitatively that our results are close to that of the original Funwave. This means that we were able to successfully improve the Cactus implementation of Funwave for use in tsunami simulations.

Future Work:

- Improve upon the accuracy of the results from the Cactus version of Funwave.
- Include all of the features and functionality of the original Funwave to complete the Cactus version and make it more versatile and capable of simulating different coastal phenomena.

References:

- <http://cactuscode.org/>
- <http://cactuscode.org/documentation/tutorials/>
- Shi, F., Kirby, J. T., Tehranirad, B. and Harris, J. C., 2011, "FUNWAVE-TVD, documentation and users' manual", Research Report, CACR-11-03, University of Delaware, Newark, Delaware.

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