Coupled Earthquake-Tsunami-TEC Simulator in a Parallel HPC Environment

*John B Rundle[1], David Grzan[1], John Wilson[1], Kasey Schultz[1], Steven Ward[2]

1. University of California Davis, 2. University of California Santa Cruz

We describe the implementation of a tsunami simulator code in a parallel High Performance Computing environment using the Tsunami Squares method first proposed by SN Ward. Due to the destructive nature of tsunamis, early warning systems are necessary to avoid loss of human life. This talk outlines the groundwork for such a system that will link Total Electron Content signatures of tsunamis detected by GNSS satellites to maps of inundated areas along the coast. The tsunami simulator that will be used for this early warning system is called Tsunami Squares, a simulator that utilizes a numerical method of solving the shallow water approximation equations over a grid of cells. To validate its accuracy, it was compared to the Regional Ocean Modeling System tsunami simulator, a simulator that solves the Navier-Stokes equations using a finite-difference method. The two simulation techniques showed good agreement over a variety of tests using several different initial conditions. As a preliminary step to creating the early warning method, many earthquakes off the coast Japan were simulated and from those earthquakes, tsunamis were simulated. From the simulated tsunamis, the runup heights along the coast were averaged and mapped, giving us a catalog of earthquakes and inundated locations. Examples of simulation movies for both Pacific Basin-wide and local inundation on the Sanriku coast are available. Unlike purely hydrodynamic codes, Tsunami Squares has the advantage that inundation and runup can be computed directly.

In future works, we plan to combine these methods with our earthquake and tsunami nowcasting methods to enable forecasting of both tsunami occurrence in tsunamigenic zones, as well as forecasting of potential coastal runups.

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