2019 SCEC Report

Earthquake Simulators, Statistics and Software: Forecasting, Nowcasting, and Tsunami Early Warning-II

A Proposal to the Southern California Earthquake Center

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A summary of our research under the current proposal is provided here. Two papers associated with the proposed research have been submitted in the past year:

1. JM Wilson et al., Tsunami Squares simulation of megathrust-generated waves: Application to the 2011 Tohoku Tsunami, *Prog. Disaster Sci*: https://doi.org/10.1016/j.pdisas.2019.100063

Tsunamis are one of the most damaging natural disasters. They are often caused by seafloor displacement due to large subduction zone earthquakes. However, these large earthquakes happen relatively infrequently, so observational data is limited. Physics-based computational simulations provide synthetic data that yields insights into such systems. Tsunami Squares is a numerical method for simulating the wave propagation and inundations of such events. We demonstrate the performance of a new C++ port of Tsunami Squares in replicating the 2011 Great East Japan Earthquake and Tsunami. Initial seafloor uplifts are calculated using tools from the Virtual Quake earthquake simulator. We compare simulated coastal run-up and wave heights to observed inundations and NOWPHAS buoy wave observations. We find good agreement between simulation and observation.

The image at bottom of the report depicts a basin wide tsunami from the Tohoku source region.

2. JB Rundle et al., Constrained invasion percolation model: Growth via Leath bursts and the origin of seismic b-value, *Phys. Rev. Lett.*: https://journals.aps.org/prl/abstract/10.1103/PhysRevLett.124.068501
We analyzed a new model for growing networks, the constrained Leath invasion percolation (CLIP) model. Cluster dynamics are characterized by bursts in space and time. The model quantitatively reproduces the observed frequency-magnitude scaling of earthquakes in the limit that the occupation probability approaches the critical bond percolation probability in d=2. The model may have application to other systems characterized by burst dynamics.

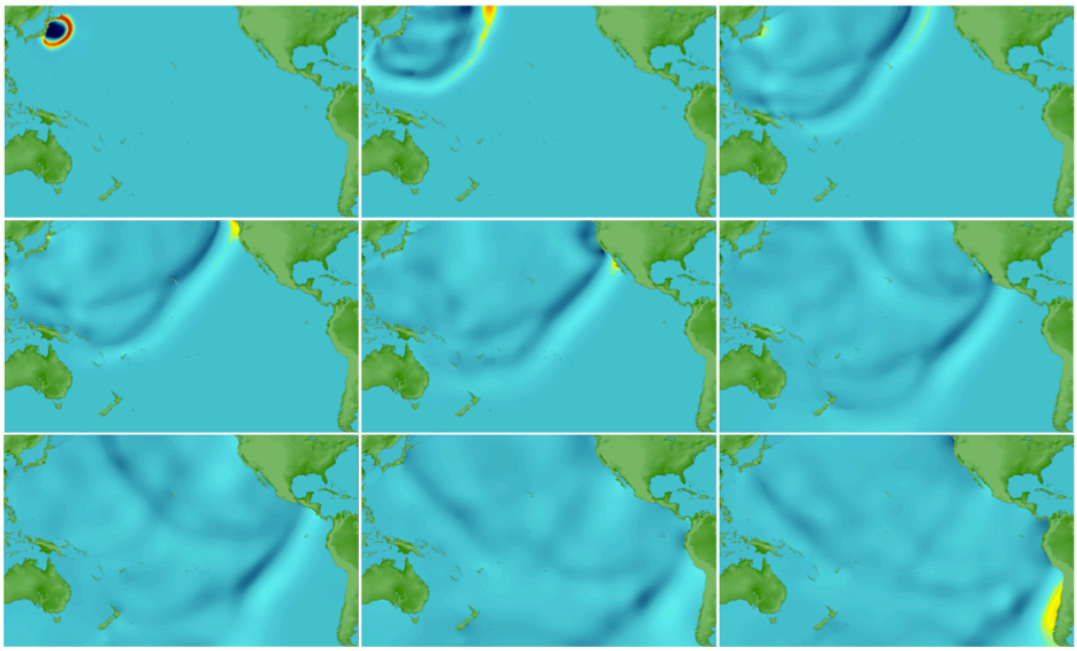

Figure. Montage of tsunami propagating across the Pacific basin from the Tohoku, Japan, source region.