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NUMERICAL MODEL FOR THE KRAKATOA HYDROVOLCANIC EXPLOSION AND TSUNAMI

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ABSTRACT

Krakatoa exploded August 27, 1883 obliterating 5 square miles of land and leaving a crater 3.5 miles across and 200-300 meters deep. Thirty three feet high tsunami waves hit Anjer and Merak demolishing the towns and killing over 10,000 people. In Merak the wave rose to 135 feet above sea level and moved 100 ton coral blocks up on the shore.

Tsunami waves swept over 300 coastal towns and villages killing 40,000 people. The sea withdrew at Bombay, India and killed one person in Sri Lanka.

The tsunami was produced by a hydrovolcanic explosion and the associated shock wave and pyroclastic flows.

A hydrovolcanic explosion is generated by the interaction of hot magma with ground water. It is called Surtseyan after the 1963 explosive eruption off Iceland. The water flashes to steam and expands explosively. Liquid water becoming water gas at constant volume generates a pressure of 30,000 atmospheres.

The Krakatoa hydrovolcanic explosion was modeled using the full Navier-Stokes AMR Eulerian compressible hydrodynamic code called SAGE with includes the high pressure physics of explosions.

The water in the hydrovolcanic explosion was described as liquid water heated by the magma to 1100 degree Kelvin or 19 kcal/mole. The high temperature water is an explosive with the hot liquid water going to a water gas. The BKW steady state detonation state has a peak pressure of 89 kilobars, a propagation velocity of 5900 meters/second and the water is compressed to 1.33 grams/cc.

The resulting Krakatoa tsunami had a period of less than 5 minutes and wavelength of less than 7 kilometers and thus rapidly decayed. The far field tsunami wave was negligible. The air shock generated by the hydrovolcanic explosion propagated around the world and coupled to the ocean resulting in the explosion being recorded on tide gauges around the world.