National Tsunami Hazard Mitigation Program Benchmarked Tsunami Models

Reference: http://nthmp.tsunami.gov/documents/nthmpWorkshopProcMerged.pdf

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Model Name	Model affiliation & contact Download website (if available)	States or Territories that use	Digital Elevation Model		Model specifics		NTHMP Benchmarks			Documentation or peer-review	Pros	Cons	Comments
			Developer	Resolution	Physics	Uses (sources)	Inundation	Currents	Landslide				
Alaska GI'-T	Alaska Geophysical Institute Dmitry Nicolsky djnicolsky@alaska.edu	Alaska: Inundation	NCEI	?	SW	Seismic; Landslide	Y	Pending	Pending				User interface
ATFM	National Tsunami Warning Center Paul Huang paul.Huang@noaa.gov	US TWCs: Forecasting	NCEI	?	SW	Seismic	Y	Pending					
FUNWAVE-TVD, v.1.0	University of Delaware Jim Kirby kirby@udel.edu	East Coast: Inundation	NCEI, ?	?	B	Seismic	Y	Pending					
GeoClaw	University of Washington Randy LeVeque http://www.clawpack.org/installing.html	Washington: Inundation	NCEI	?	B	Seismic	Y	Pending		http://www.clawpack.org	Adaptive mesh refinement		
MOST	NOAA PMEL Diego Arcas diego.arcas@noaa.gov	US TWCs: Forecasting Washington: Inundation	NCEI, PMEL	1/3 - 3 arcSec	SW	Seismic	Y	Pending			Computationally Fast	Can become unstable	User interface: ComMIT
NEOWAVE	University of Hawaii Kwok Fai Cheung cheung@hawaii.edu	Hawaii, Am. Samoa, Puerto Rico, Gulf of Mexico, BC	Hawaii	1/3 - 3 arcSec	NH	Seismic	Y	Y?			Two-way nested grids	-	
SELFE	Oregon Health & Science University Joseph Zhang http://www.stccmop.org/CORIE/modeling/selfe/	Oregon: Inundation	Oregon, NCEI?	?	CFD	Sceismic	Y	Pending			Resolves current vortices		
THETIS	Univ. of Rhode Island Stephan Grilli http://thetis.enscbp.fr	N/A	NCEI, ?	?	CFD	Seismic; Landslide	Y	Pending	Pending		Resolves current vortices		
TSUNAMI3D	Texas A&M University at Galveston Juan Horrillo horrillj@tamug.edu	Gulf of Mexico: Inundation	NCEI	?	CFD	Seismic; Landslide	Y	Pending	Pending		Resolves current vortices		
BOSZ	Tohoku Univ. & Univ of Hawaii Voelker Roeber roeber@irides.tohoku.ac.jp	Hawaii: Inundation	Hawaii, NCEI?	1/9 - 3 arcSec	B	Seismic	Y	Pending			Resolves current vortices, works also for swell waves	no grid nesting	
Cliffs	NW Research Associates Elena Tolkova, e.tolkova@gmail.com https//:github.com/Delta-function/cliffs-src	Alaska (testing):Tsunami Modeling	NCEI	Any	SW	Seismic	Y	Pending		E.Tolkova, PAAG, 171(9), 2289-2314 (2014); User Manual at: http://arxiv.org/abs/1410.0753	Computationally Fast; easy set-up	-	NetCDF I/O
HySEA	University de Malaga Jorge Macias (jmacias@uma.es) NOAA/PMEL Diego Arcas (diego.arcas@noaa.gov) https://edanya.uma.es/hysea/	PMEL (testing)- US TWCs: forecasting	NCEI	1/3 - 3 arcSec	SW/B	Seismic; Landslide	Y	Pending	Pending	https://edanya.uma.es/hysea/index.php/references	Computationally Fast; Robust; Stable	-	Nested meshes; run on GPUs and mulit-GPU architectures
NHWAVE	University of Delaware	East Coast: landslide tsunami generation	NCEI	?		Seismic	Y	Pending	Pending				

Definitions

Dispersion — Refers to waves of different wavelengths traveling at different phase speeds, or the pulling apart of tsunami waves into their component frequencies. Effects of dispersion are important near the source region and when the tsunami is traveling over a very long distance, such as basin-wide or global events. Dispersion effects also become more enhanced for shorter wave periods, (caused by lower magnitude tsunami-generating earthquakes which have smaller rupture areas), and in deep water.

Dissipation — The decay of tsunami energy. This largely occurs through bottom friction, turbulence, and wave breaking as the tsunami approaches the coastline and inundates. In deep water, as in open ocean tsunami propagation, the effects of dissipation are minimal.

Bottom friction — Model parameter or coefficient usually set to a standard default. May be important to more accurately model tsunamis currents in harbors

Wave breaking — Important for tsunami propagation when traveling across long shallow water regions like the US East Coast

*The majority of these models specify bottom friction coefficients and wave breaking parameters empirically

Physics based Model types

SW — A 2D model which employs linear and non-linear **Shallow Water (SW)** equations for tsunami generation, propagation and wave runup/drawdown. Pressure field is hydrostatic and the formulation ignores viscous effects, so these models are not recommended for landslide generated tsunamis. No vertical velocity and the modeled horizontal velocities are depth-averaged. Physical tsunami dispersion is often mimicked through numerical model dispersion. A practical choice for tsunami propagation and inundation simulations, however, models using depth-averaged wave equations cannot adequately address all the wave-structure interaction issues near the coast.

B — A 2D model which uses **Boussinesq-type (B)** approximations, to parametrize the vertical wave characteristics allowing for non-uniform horizontal velocities in the vertical. A non-hydrostatic model with a multi-layer approach, where more layers used increases the model accuracy, but also the computation time and complexity. Includes dispersion and can better simulate tsunami waves near the seismic source and the coastline and inside harbors as well as wave-structure interactions.

CFD — A 3D Computational Fluid Dynamic (CFD) model which employs non-linear Navier-Stokes, or Euler equations, and is computationally quite intensive. Generally CFDs are parallelized to decrease runtime. Pressure field is non-hydrostatic, viscous effects are included, and since the model is 3D the depth profile of the horizontal velocity is not averaged. Fully nonlinear CFD models can simulate wave breaking and overtopping. They are often necessary for civil engineering applications, such as tsunami force and scour on local infrastructure. The most complex model choice - it includes dispersion and can better simulate tsunami waves near the coastline and inside harbors as well as wave-structure interactions.