On the Job Training on

Tsunami Inundation Modelling and Mapping and Development of Tsunami Hazards Maps for Implementation of UNESCO-IOC Tsunami Ready Pilot Sites in Madagascar, Maldives, Seychelles and Sri Lanka

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TIMM 2.4: ComMIT Custom Propagation Runs

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Session Overview – TIMM 2.4

Topics Covered

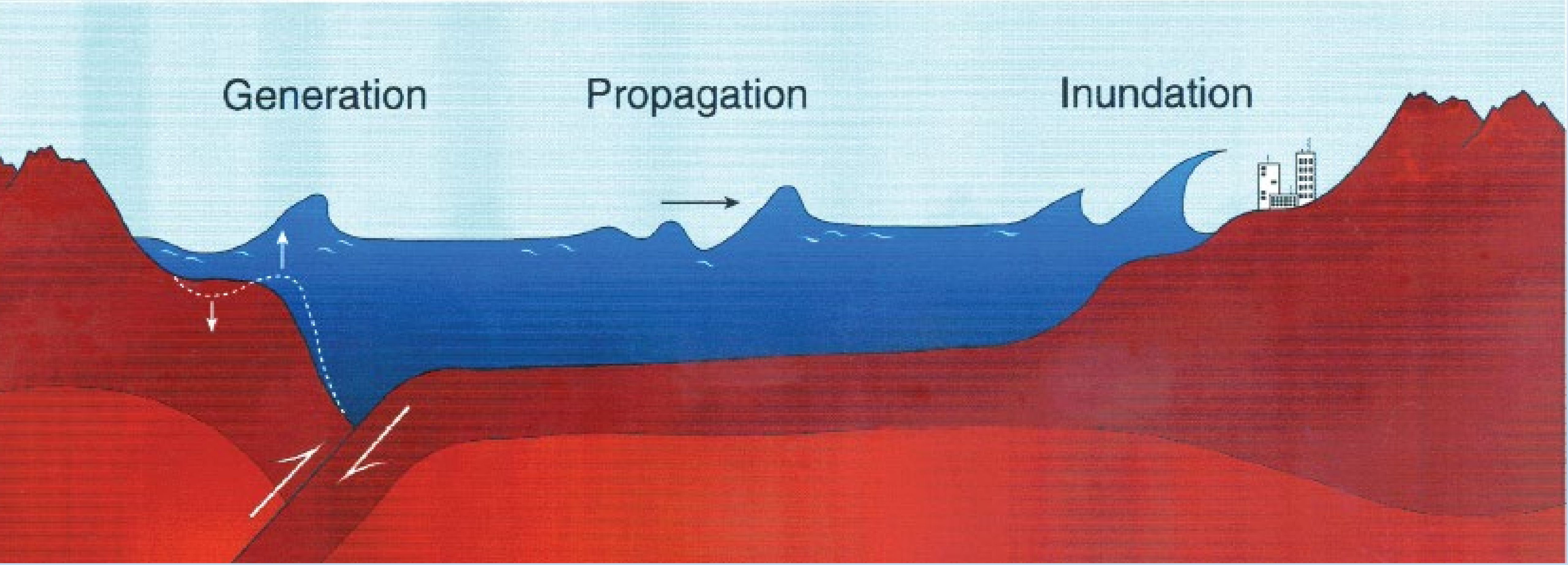
- Introduction to Custom Propagation in ComMIT
- The Custom Propagation Window – Interface
- Configuring Seismic Info Parameters
- Setting the Epicenter & Fault Plane Geometry
- Source Identification & NOAA Naming Convention
- Animation Controls & Model Parameters
- Running a Custom Propagation Simulation
- Using Custom Sources in the Main ComMIT Window
- Viewing Output – Wave Animation & Max Amplitude

Learning Outcomes

- Define custom earthquake sources using standard MOST fault plane parameters
- Set up and run custom propagation simulations in ComMIT
- Visualize wave amplitude and animate propagation results
- Integrate custom sources into the main ComMIT inundation workflow
- Apply custom sources for Indian Ocean pilot site scenarios

Tsunami Modelling and Forecasting

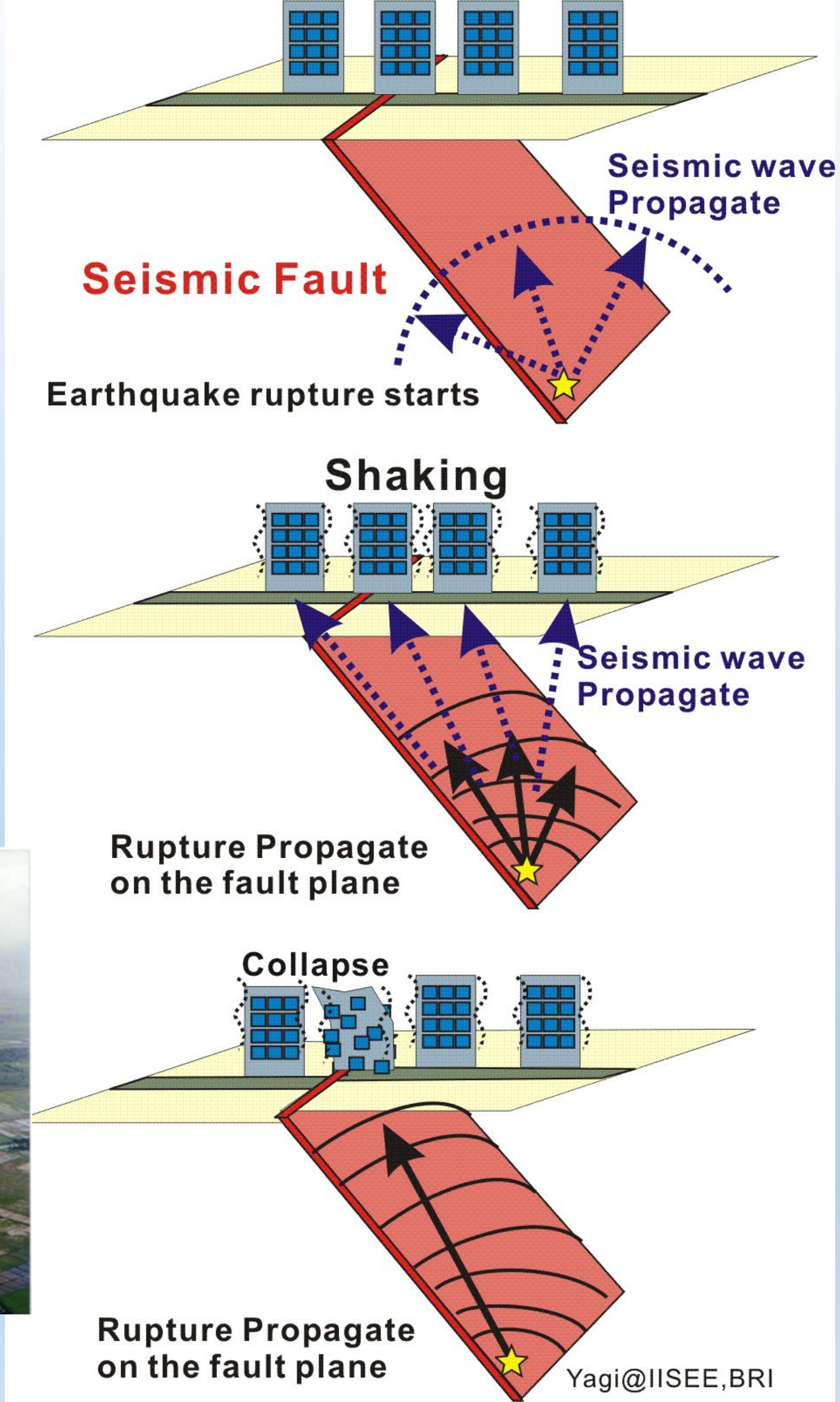
Tsunami Models



Earthquake

Earthquake is a term used to describe both failure process along a fault zone, and the resulting ground shaking and radiated seismic energy caused by the slip, or by volcanic or magmatic activity, or other sudden stress changes in the earth.

Surface rupture (Taken by Prof. Abe, the University of Tokyo)

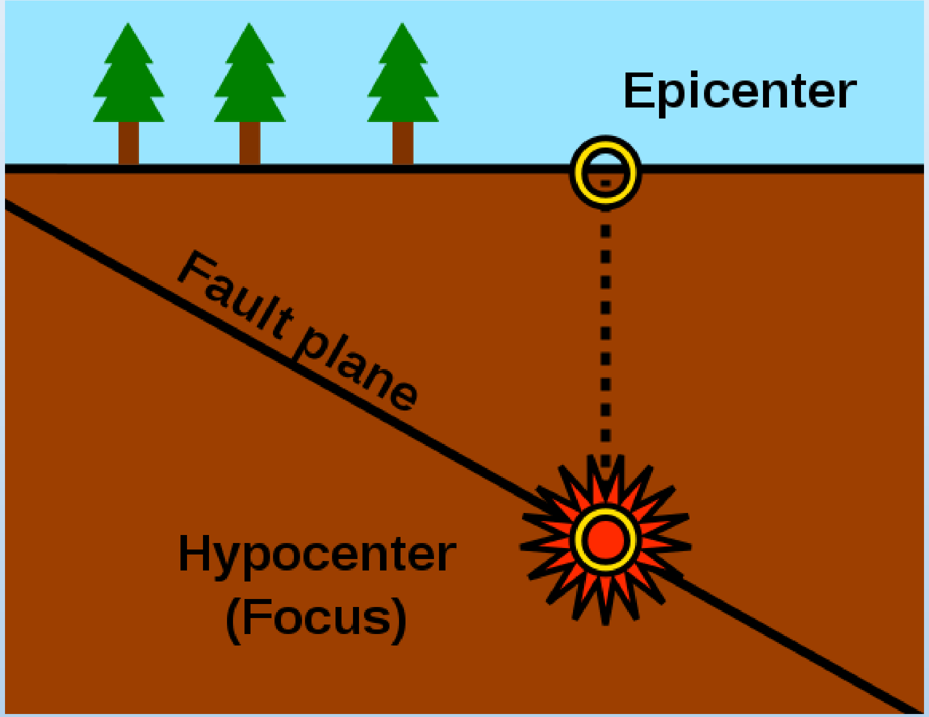


Earthquake Source Parameter

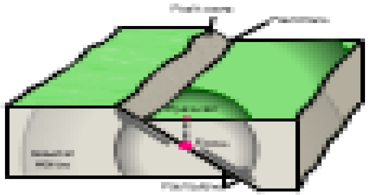
- **Hypocenter** (Latitude, Longitude, Depth)
- **Origin Time** (Start time of earthquake)
- **Faulting Type** (focal mechanism)
- **Faulting Size** (Length, Wide and Dislocation)
- **Magnitude** (Size of earthquake)
- **Seismic moment** (Size of earthquake)
- **Stress Drop** (Shear Stress Change)
- **Source Process** (Rupture Process)

Input for tsunami modelling

Hypocenter



Source : https://simple.wikipedia.org/wiki/Hypocenter



Latitude, Longitude, Depth

Location in the Earth where energy in the rock being strained is released

Epicenter : Latitude, Longitude

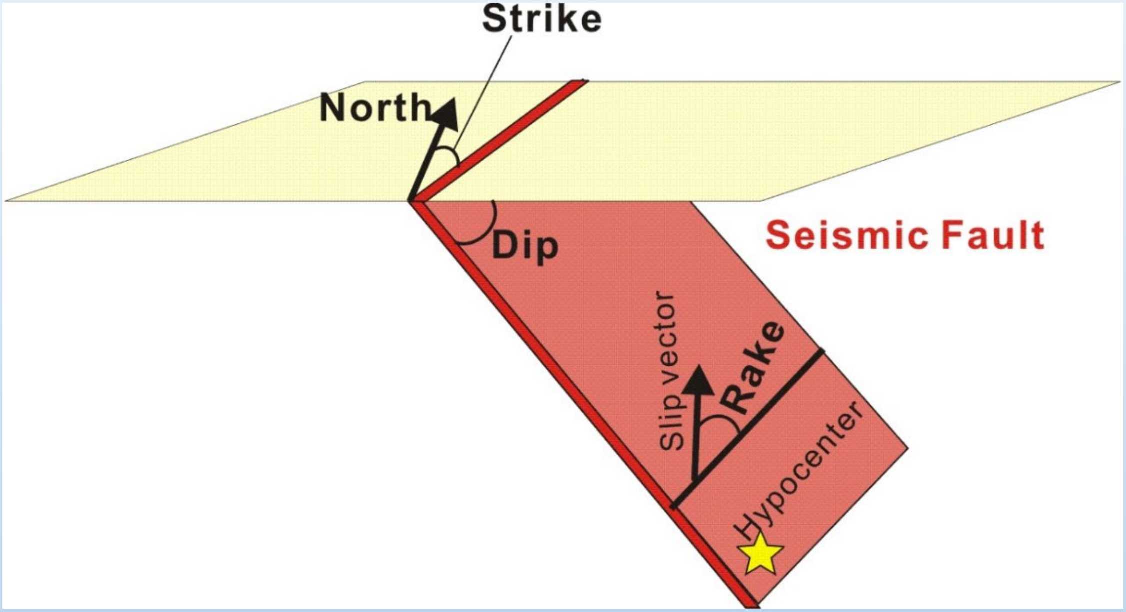
Point on Earth's surface directly above Hypocenter

Outline

- Earthquake Source Parameter for Tsunami Modelling
- Fault Motion and Seafloor Deformation
- Determination of Fault Plane Area

Fault plane parameters

To represent *fault plane* and *fault slip*, we used (*strike, dip*) and (rake), respectively.

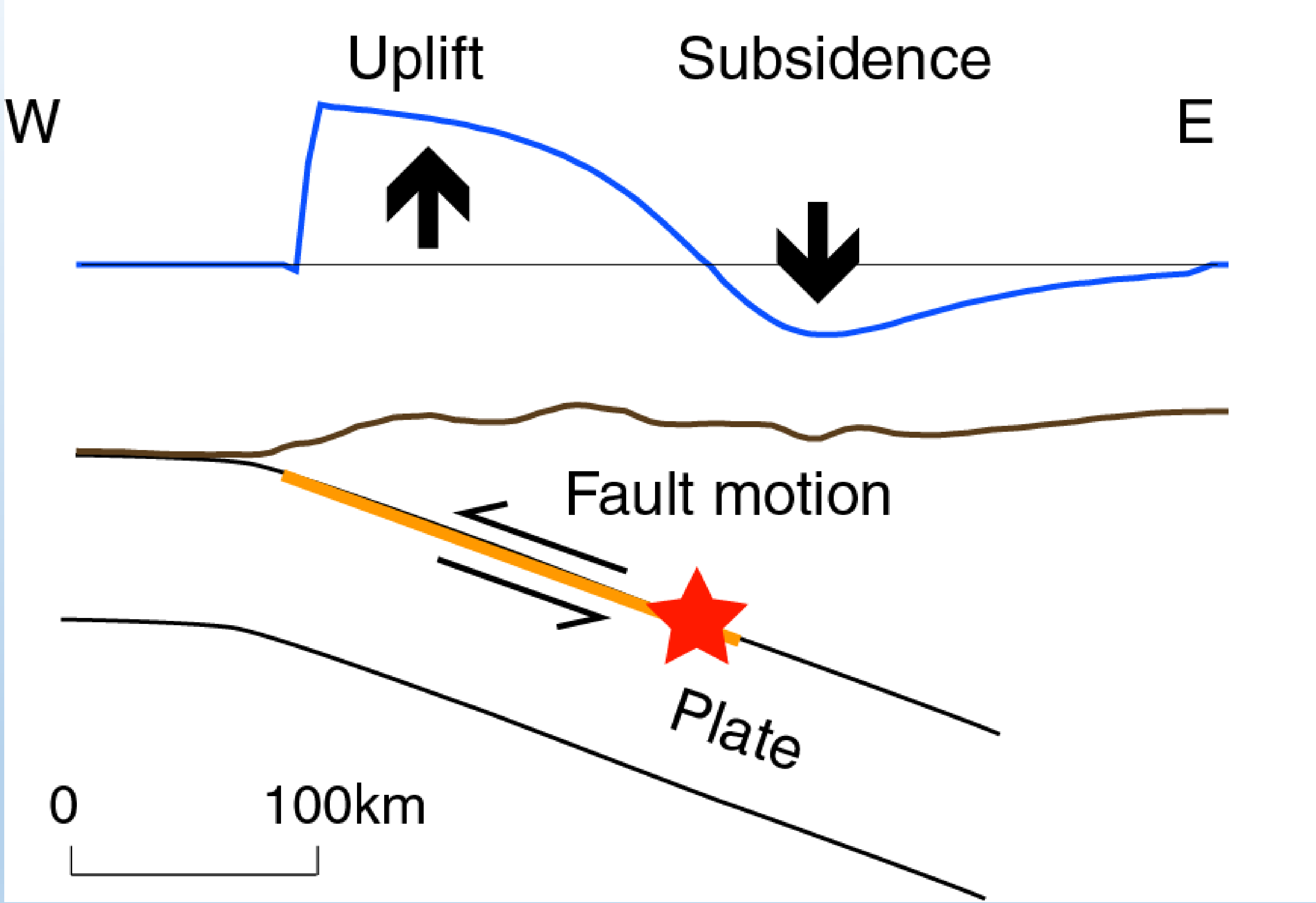


Strike: The direction of the surface intersection of the fault measured clockwise from north (0 ~ 360)

Dip: A slop angle of the foot-wall block measured clockwise from horizontal (0 ~ 90)

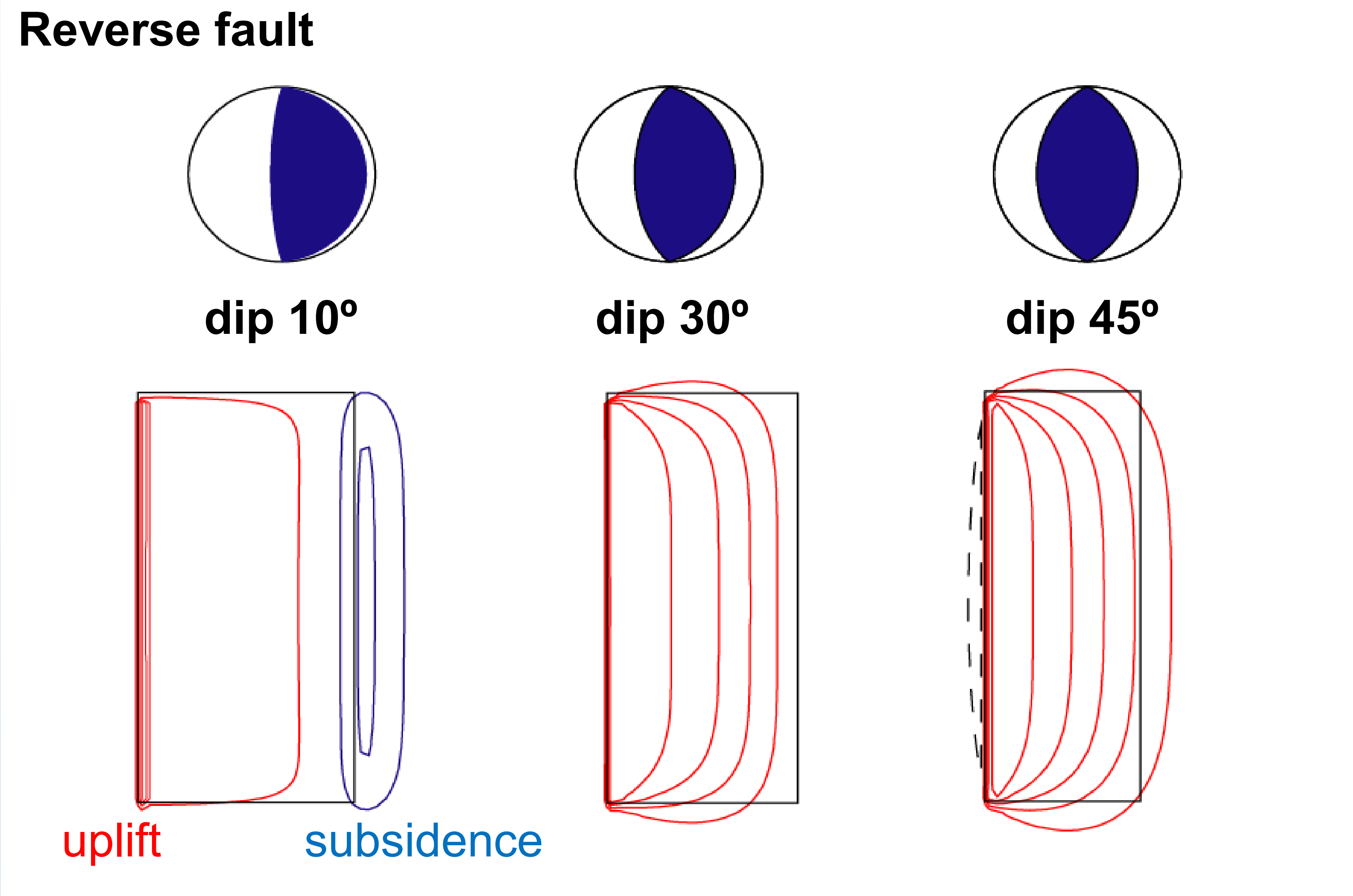
Rake (or Slip): The direction of fault movement measured counterclockwise from strike and slip direction (-180 ~ 180)

Seafloor Deformation



Satake@ERI, Tokyo Univ.

Crustal Deformation due to Faulting



What is Custom Propagation in ComMIT?

The Custom Propagation Run feature allows users to define new earthquake sources beyond the pre-built NOAA Propagation Database — enabling simulation of any seismic event using the MOST model.

Standard ComMIT

Pre-built Database

Uses pre-computed NOAA unit sources limited to known historical fault zones in the Pacific & Indian Ocean

Custom Propagation

User-Defined Source

Allows definition of any fault plane with full seismic parameters — for unique or regional scenarios not in the database

MOST Model Engine

Tsunami Propagation

Runs the Method of Splitting Tsunamis (MOST) to simulate ocean-wide wave propagation from the defined source

Key Use Cases: Historical earthquake recreation • Hypothetical worst-case scenarios • Pilot site-specific Indian Ocean sources

Accessing the Custom Propagation Run Feature

01

Launch ComMIT

Open ComMIT application. Ensure the propagation database is loaded and accessible on your system.

02

Navigate to Menu

From the main ComMIT menu bar, locate and click on the Custom Propagation Run menu item.

03

New Window Opens

A dedicated Custom Propagation window launches — separate from the main inundation model window.

04

Configure Parameters

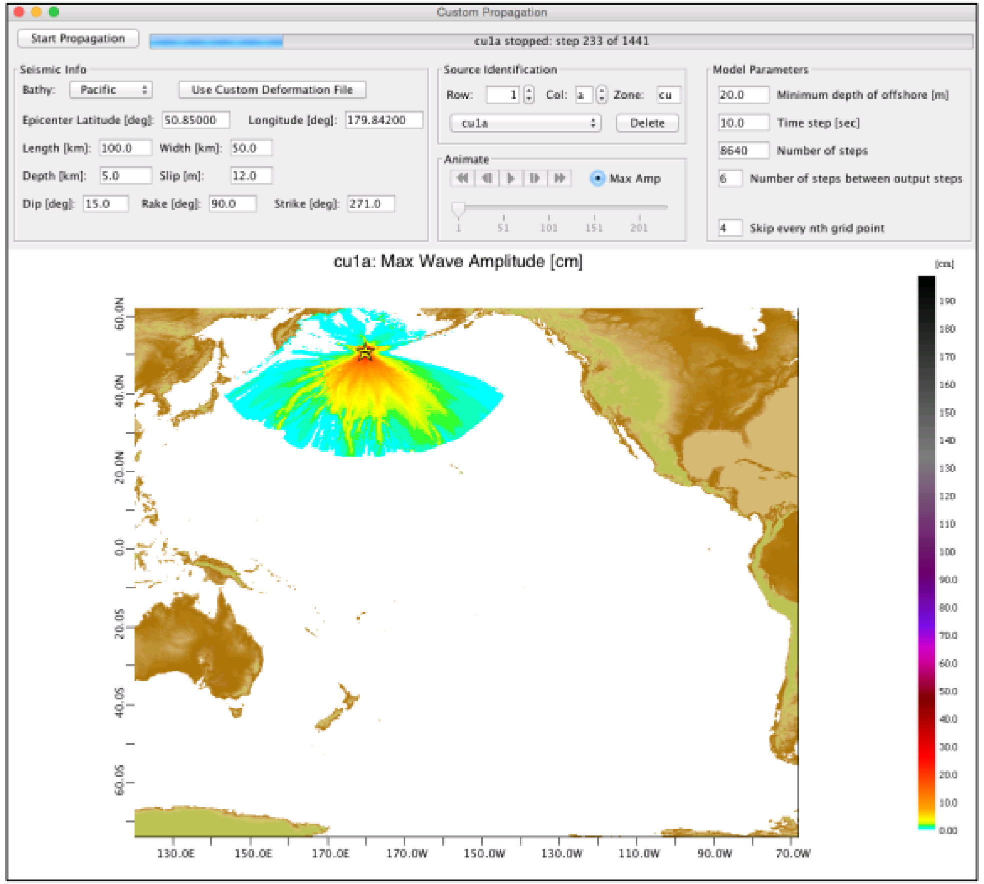
Set Seismic Info, Source Identification, and Model Parameters using the three panels at the top.

The Custom Propagation window resembles the main ComMIT inundation window — same Start button, progress bar, and output visualization.

The Custom Propagation Window – Interface Overview

Interface Components

- Start Propagation Button: Initiates the custom propagation model
- Progress Bar: Shows real-time model completion status
- Seismic Info Panel: Enter fault plane parameters and set the epicenter location
- Source Identification: Name and manage custom propagation sources (cu prefix)
- Model Parameters: Set time steps, depth limits, and output frequency
- Animation Controls: Play, step through, and scrub wave propagation time steps
- Max Amp Button: Display maximum wave amplitude over the full simulation run
- Map Output Area: Animated visualization of wave propagation across the ocean basin



Similarities to Main Window

- Same animation controls as main inundation window
- Shared model parameter interface
- Progress bar behaves identically
- Output compatible with main ComMIT database

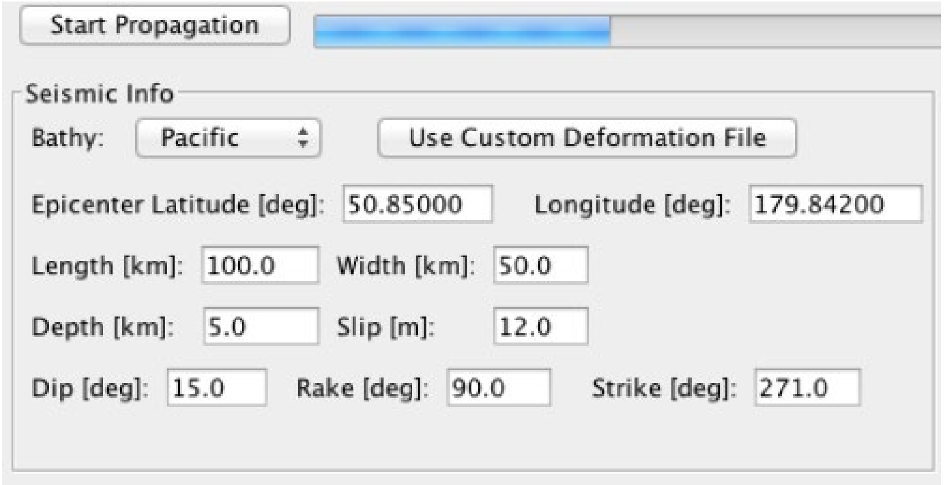
Important Notes

- Full propagation runs can take several hours
- No inundation algorithm settings in this window
- Grid sizes are considerable for ocean-basin runs
- Custom results auto-added to main ComMIT database

Seismic Info Panel – Key Parameters

The Seismic Info panel defines the earthquake source geometry using standard fault plane parameters as described in the MOST manual.

Parameter	Description	Example
Bathymetry File	Select ocean basin bathymetry file — defaults to India Ocean basin bathymetry	**Indian Ocean**
Epicenter Latitude	Latitude of earthquake epicenter — set by double-clicking on the map display	**3.35° N**
Epicenter Longitude	Longitude of the earthquake epicenter point	**93.84° E**
Length (km)	Along-strike length of the fault rupture plane	**100.0 km**
Width (km)	Down-dip width of the fault rupture plane	**50.0 km**
Depth (km)	Depth to the top of the fault rupture (shallow = larger tsunami)	**5.0 km**
Slip (m)	Average slip (displacement) along the fault plane	**12.0 m**
Dip (°)	Inclination of the fault plane from horizontal (0°–90°)	**15.0°**
Rake (°)	Direction of slip on the fault plane — 90° = pure thrust fault	**90.0°**
Strike (°)	Orientation of fault trace measured clockwise from North (0°–360°)	**271.0°**



Setting the Epicenter & Fault Plane Geometry

Setting the Epicenter

Interactive Map Method

- Double-click anywhere on the map display to place epicenter
- Marked with a yellow star (☆) on the map
- Fault plane outline appears around the star, reflecting geometry
- Latitude/Longitude fields update automatically
- Adjusting any parameter instantly reshapes the fault plane outline

Fault Plane Geometry

Key Geometric Relationships

- Strike: direction of fault trace from North (0°–360°)
- Dip: inclination from horizontal — 0° flat, 90° vertical
- Rake: direction of slip (90° = pure thrust/reverse fault)
- Length × Width define total rupture area on the fault plane
- Shallow depth = larger seafloor displacement = larger tsunami

Reference: MOST manual – Standard fault plane description (epicenter, length, width, depth, slip, dip, rake, strike)

Fault Plane Parameters – Worked Example

Example Custom Source: cu2a – Offshore Andaman Island Chain (Mw ~8.2)

Epicenter Lat

3.28° N

Andaman region

Epicenter Lon

93.06° E

Bay of Bengal basin

Length

300.0 km

Along-strike rupture

Width

150.0 km

Down-dip extent

Depth

5.0 km

Shallow source

Slip

12.0 m

Large displacement

Dip

15.0°

Gentle dip angle

Rake

90.0°

Pure thrust fault

Strike

230.0°

SW-NE orientation

Interpretation: Shallow (5 km), large slip (12 m), pure thrust — typical of major subduction zone tsunamigenic earthquakes

Source Identification – NOAA Naming Convention

Custom sources follow the NOAA Propagation Database naming convention, using the "cu" identifier prefix to distinguish them from standard unit sources.

Naming Structure:

cu	2	a
"Custom" prefix *marks user-defined source*	**Row Number** *increment: 1, 2, 3 ...*	**Column Letter** *increment: a, b, c ...*

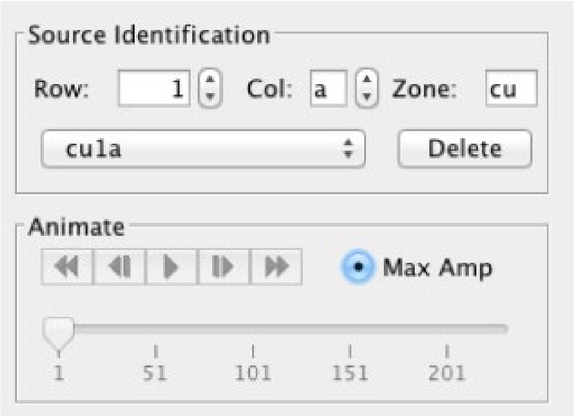
Adding Multiple Sources

- Increment row and column to create many custom sources (cu1a, cu2a, cu3a … or cu1a, cu1b, cu1c …)
- All custom sources accumulate in the drop-down selector and can be selected at any time

Deleting Sources

- Select the custom source from the drop-down selector by name
- Click the "Delete" button to remove it from the list and propagation database

The "cu" prefix distinguishes custom sources from standard unit sources (e.g., acsA, acsB …) in the NOAA Propagation Database.



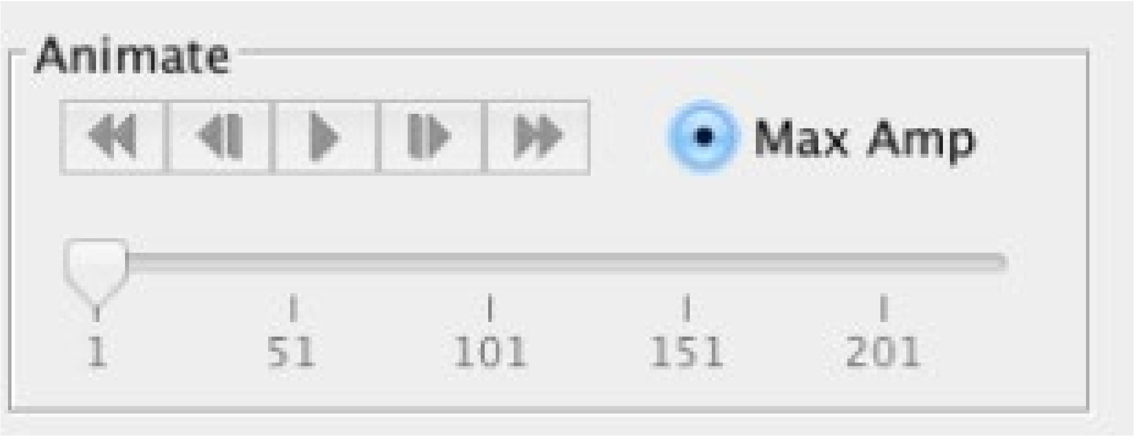
Animation Controls in the Custom Propagation Window

Animation controls in the Custom Propagation window are identical to those in the main ComMIT inundation window.

⏮	◀	▶	▶▶	⏭
Rewind	**Step Back**	**Play**	**Step Forward**	**Fast Forward**
Jump to the first time step of the propagation animation	Move one time step backward through the animation	Continuously play the wave propagation animation forward	Move one time step forward through the animation	Jump to the last time step of the propagation animation

Time Step Slider: Located below the animation buttons — drag to jump directly to any time step, enabling rapid navigation through hours of modelled wave propagation.

★ Max Amp Button: Disables animation and displays the maximum wave amplitude envelope across the entire propagation run — essential for rapid hazard assessment and identifying high-impact coastal zones.

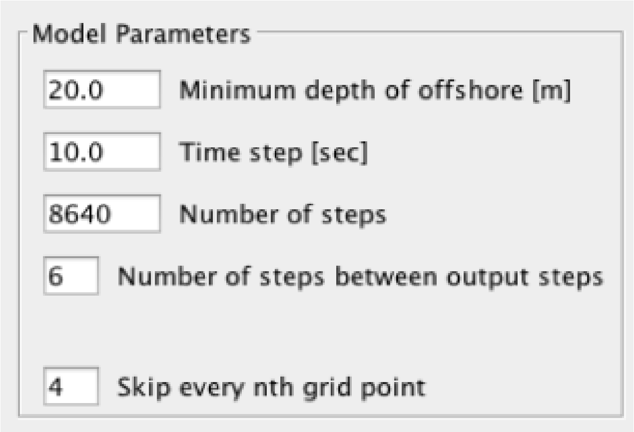


Model Parameters Configuration

The Model Parameters panel controls the numerical settings of the tsunami propagation simulation — analogous to main ComMIT inundation parameters, except there are NO inundation algorithm settings.

Parameter	Default Value	Purpose & Notes
Minimum Depth of Offshore (m)	**20.0 m**	Sets minimum water depth for offshore propagation calculations
Time Step (sec)	**10.0 sec**	Temporal resolution — smaller = more accurate but slower runtime
Number of Steps	**8640 steps**	Total steps: 8640 × 10 sec = 86,400 sec = 24 hours of simulation
Steps Between Output Steps	**6 steps**	Output frequency — every 6th step saved for animation display
Skip Every Nth Grid Point	**4 points**	Display resolution reduction — every 4th grid point shown to speed rendering

Key Difference: Custom Propagation does NOT include inundation algorithm settings — it computes ocean-basin wave propagation only.



Running a Custom Propagation Simulation – Step by Step

1 **Select Bathymetry**

Choose appropriate ocean basin bathymetry (e.g., Pacific basin for Kuril/Pacific sources)

2 **Set Epicenter**

Double-click on the map to place epicenter; verify lat/lon coordinates for your target location

3 **Enter Fault Parameters**

Input Length, Width, Depth, Slip, Dip, Rake, Strike based on your earthquake scenario

4 **Assign Source Name**

Set Source Identification (e.g., cu1a). Increment row/column for additional custom sources

5 **Configure Parameters**

Set time step, number of steps, and output frequency to match your study requirements

6 **Start Propagation**

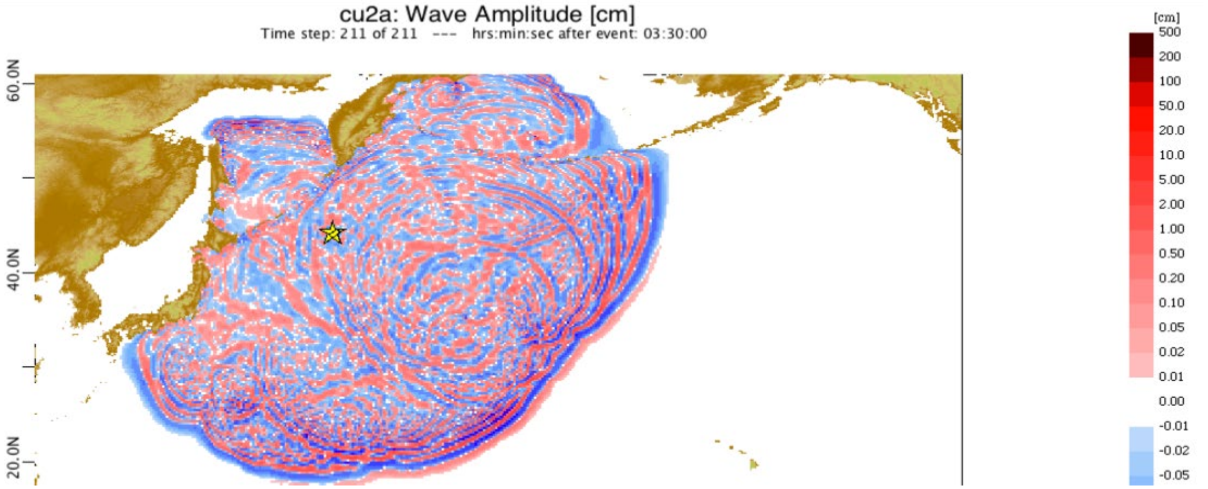
Click 'Start Propagation'. Monitor the progress bar. Full run may take several hours

⏱ Runtime Note: Full ocean-basin propagation runs can take several hours due to global grid size. Plan runs in advance.

Viewing Output – Wave Animation & Max Amplitude

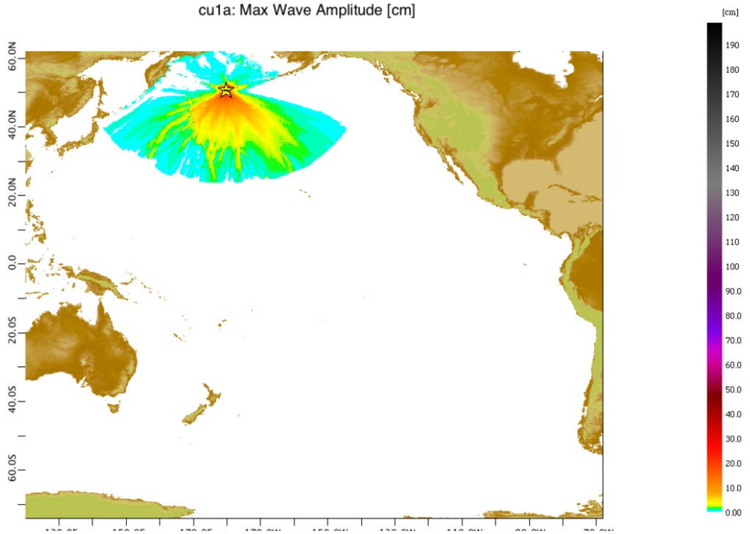
Wave Propagation Animation

- Map shows animated wave amplitude in real time during propagation
- Positive amplitudes (red/warm colors) = wave crest
- Negative amplitudes (blue/cool colors) = wave trough
- Play button: watch wave energy radiate from the source epicenter
- Slider bar: jump to specific times of interest for inspection
- Observe directivity patterns and energy focusing on coastlines



Max Wave Amplitude Display

- Click 'Max Amp' button to view maximum amplitude envelope
- Shows the max wave height at each grid point over the full simulation
- Color scale in centimetres (cm) — warm colors = higher amplitude
- Identifies areas of maximum wave impact along coastlines
- Assesses far-field tsunami hazard and energy distribution
- Compare directivity across different custom source scenarios



Application: Max Amplitude maps feed directly into tsunami hazard assessment and coastal evacuation zone delineation for pilot sites.

Using Custom Sources in the Main ComMIT Window

After a custom propagation run completes, the source is automatically integrated into the main ComMIT workflow for inundation modelling.

1

Custom Run Completes

Source cu[N][x] auto-added to Propagation Database in main ComMIT

2

Model Setup Tab

Open main ComMIT → Model Setup tab → custom source appears in Unit Sources panel

3

Select Custom Source

Click on the custom source (e.g., cu2a) in the Unit Sources list

4

Choose Run Location

Select target inundation site (e.g., pilot site in Maldives, Sri Lanka, etc.)

5

Start Inundation Model

Click 'Start model' — inundation results for your custom scenario are computed

✓ Using a custom source is as easy as: select it → choose pilot site location → click 'Start model'. Same workflow as standard sources.

Subduction Zone	Segment	Maximum Magnitude (Mw) Historical	Low Hazard	High Hazard
Andaman-Sunda Arc	A	unknown (1762[1])	0.0	9.5
	B	9.2 (1881[2], 2004[3])	9.2	
	C	8.7 (1861,2005[4])	8.7	
	D	9.1 (1797,1833,2007[5])	9.1	
	E	7.6 (2000[5])	7.6	
	F	7.8 (1994[7],2006[8])	7.8	
	G	none	0.0	
Makran	H	unknown (1483[8])	0.0	9.1
	I	8.1 (1945[9])	8.2	
South Sandwich		none	0.0	9.0

Table 2: Summary of megthrust earthquake tsunami source zones used in the low-hazard and high-hazard maps. The three subduction zones considered are shown, along with the segmentation that was used for the low-hazard maps (see Fig. 5a). The maximum magnitude of the historical earthquakes listed in brackexts is listed in the third column. The maximum magnitudes used to generate the low-hazard and high-hazard assessments are shown in columns four and five. Where the maximum magnitude for historical earthquakes is listed as 'unknown' that indicates that a large (possibly megathrust) earthquake occurred, but its magnitude is unknown. By contrast 'none' indicates that there is no known historical occurrence of a megathrust earthquake large enough to generate a destructive tsunami. The years of historical earthquakes are indicated in parentheses with superscripts to indicate the following references: [1] Cummins (2007), [2] Ortiz and Bilham (2003), [3] Stein

Guidance for Selection of Scenarios

- Selection of appropriate scenarios and magnitude may be based on the results of PTHA which provides a range of maximum tsunami amplitude with a 1 in 2000-year chance of being exceeded for each country for a low and high hazard source. The table also provides information on the subduction zone segments that contribute to tsunami hazard for each country.

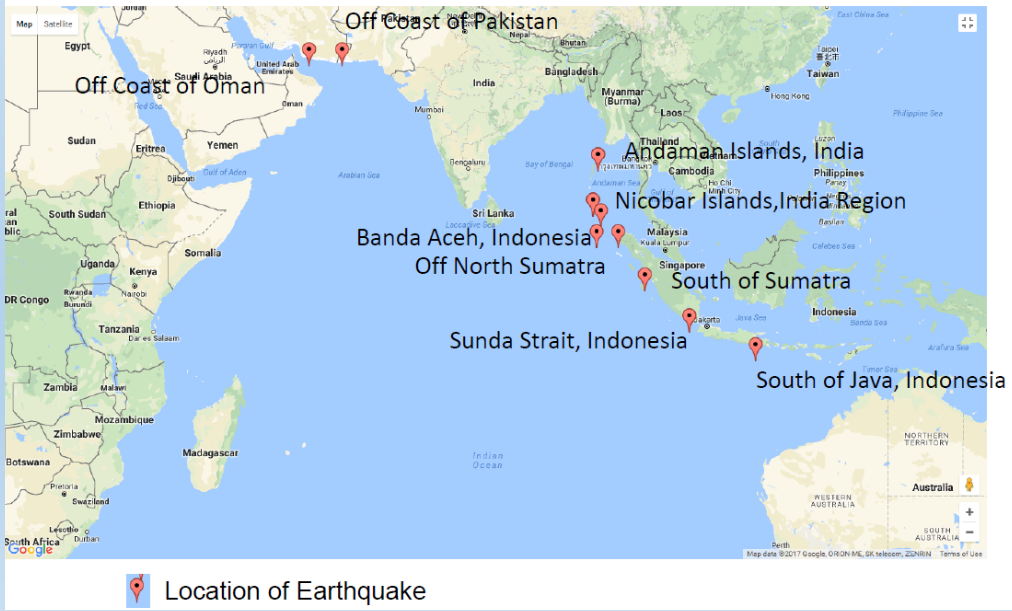
Indian Ocean nation	1/2000yr tsunami amplitude (m)		Most Important Subduction Zone Segments
	low	high	
Bangladesh	0.5	0.6	Andaman
British Ocean Territory	1.1	1.7	Andaman, Sumatra
Burma	1.1	1.5	Andaman, Sumatra
Comoros	0.3	0.5	Makran, Andaman, Sumatra
Djibouti	0.2	0.4	Makran
India	1.9	3.1	Makran, Andaman, Sumatra
Indonesia	5.6	7.1	Andaman, Sumatra, Java and Sumba
Iran	0.3	2.7	Makran
Kenya	0.5	0.8	Andaman, Sumatra
Madagascar	1.0	2.2	Andaman, Sumatra, Java, Sth Sandwich
Maldives	2.2	3.0	Andaman, Sumatra, Makran
Mauritius	1.2	1.7	Andaman, Sumatra, Makran
Mayotte	0.3	0.4	Andaman, Sumatra, Makran
Mozambique	0.5	1.4	Andaman, Sumatra, Sth Sandwich
Oman	0.6	3.8	Andaman, Sumatra, Makran
Pakistan	0.9	2.8	Makran
Reunion	0.7	1.4	Andaman, Sumatra, Sth Sandwich
Seychelles	0.8	1.2	Andaman, Sumatra, Makran
Somalia	0.7	1.1	Andaman, Sumatra, Makran
South Africa	0.6	1.6	Andaman, Sumatra, S Sandwich
Sri Lanka	2.9	3.7	Andaman, Sumatra
Tanzania	0.5	0.9	Andaman, Sumatra, Makran
Thailand	1.9	2.6	Andaman, Sumatra
United Arab Emirates	0.1	0.8	Makran
Yemen	0.8	1.3	Makran, Andaman, Sumatra

Table 1: Summary of results for all the nations considered in the study for one particular measure of the offshore tsunami hazard, the name of country is listed in the first column. The second and third columns show the maximum tsunami amplitude with a 1 in 2000 year chance of being exceeded for any point off the Indian Ocean nation shown in the first column for the low hazard and high hazard assessments, respectively. The nations shown in red have the highest (greater than 2m maximum tsunami amplitude in the high hazard map) hazard at this return period. The nations shown in green have the lowest (tsunami amplitude is less than 1m in the high hazard map) at the 2000 year return period. The fourth column lists the subduction zones which make the greatest contribution to the 1 in 2000 year hazard for that particular nation.

Guidance for Selection of Scenarios

- Each country may consider selecting 4 scenarios from the table below run inundation model using ComMIT. Based on the results of the model runs, a composite inundation line may be generated for further hazard assessment

S. No.	Latitude	Longitude	Magnitude	Region	Comments
1	24.8 N	62.2 E	9.0	Off Coast of Pakistan	
2	24.8 N	58.2 E	9.2	Off Coast of Iran	IOWave 18 Scenario ???
3	12.65 N	93.5 E	9.0 to 9.2	Andaman Islands	
4	7.2 N	92.9 E	9.0 to 9.2	Nicobar Islands	
5	3.3 N	96.0 E	9.3	Banda Aceh / Off North Sumatra	Dec 26, 2004 Event IOWave18 Scenario???
6	1.93 S	99.22 E	9.2	South of Sumatra	
7	6.94 S	104.7 E	9.0 to 9.2	Sunda Strait	
8	10.4 S	112.8 E	9.1	South of Java	



ComMIT Unit Sources for PTHA Suggested Scenarios

<u>**cut and paste into "Model->Sources from Solution/Combination"**</u>

- Off Coast of Pakistan
  Mw 9.0, mk2-7, rows a-b, alpha=14.7839
  14.7839*mk2b+14.7839*mk2a+14.7839*mk3b+14.7839*mk3a+14.7839*mk4b+14.7839*mk4a+14.7839*mk5b+14.7839*mk5a+14.7839*mk6b+14.7839*mk6a+14.7839*mk7b+14.7839*mk7a

- Off Coast of Iran
  Mw 9.2, mk4-10, rows a-b, alpha=25.284
  25.284*mk4a+25.284*mk4b+25.284*mk5a+25.284*mk5b+25.284*mk6a+25.284*mk6b+25.284*mk7a+
  25.284*mk7b+25.284*mk8a+25.284*mk8b+25.284*mk9a+25.284*mk9b+25.284*mk10a+25.284*mk10b

- Andaman Islands
  Mw 9.2, io5-12, rows a-b, alpha=22.123
  22.123*io5a+22.123*io5b+22.123*io6a+22.123*io6b+22.123*io7a+22.123*io7b+ 22.123*io8a+22.123*io8b+22.123*io9a+22.123*io9b+22.123*io10a+22.123*io10b+
  22.123*io11a+22.123*io11b+22.123*io12a+22.123*io12b

- Nicobar Islands
  Mw 9.2, io11-18, rows a-b, alpha=22.123
  22.123*io11a+22.123*io11b+22.123*io12a+22.123*io12b+22.123*io13a+22.123*io13b+22.123*io14a+22.123*io14b+22.123*io15a+22.123*io15b+22.123*io16a+22.123*io16b+22.123*io17a+22.123*io17b+22.123*io18a+22.123*io18b

- Banda Aceh, North Sumatra
  Mw 9.3, io17-24, rows a-b, alpha=31.250
  31.250*io17a+31.250*io17b+31.250*io18a+31.250*io18b+31.250*io19a+31.250*io19b+31.250*io20a+31.250*io20b+31.250*io21a+31.250*io21b+31.250*io22a+31.250*io22b+31.250*io23a+31.250*io23b+31.250*io24a+31.250*io24b

- South of Sumatra
  Mw 9.2, io24-31, rows a-b, alpha=22.123
  22.123*io24a+22.123*io24b+22.123*io25a+22.123*io25b+22.123*io26a+22.123*io26b+22.123*io27a+22.123*io27b+22.123*io28a+22.123*io28b+22.123*io29a+22.123*io29b+22.123*io30a+22.123*io30b+22.123*io31a+22.123*io31b

- Sunda Strait
  Mw 9.2, io33-40, rows a-b, alpha=22.123
  22.123*io33a+22.123*io33b+22.123*io34a+22.123*io34b+22.123*io35a+22.123*io35b+22.123*io36a+22.123*io36b+22.123*io37a+22.123*io37b+22.123*io38a+22.123*io38b+22.123*io39a+22.123*io39b+22.123*io40a+22.123*io40b

- South of Java
  Mw 9.1, io44-49, rows a-b, alpha=14.7839
  14.7839*io44b+14.7839*io44a+14.7839*io45b+14.7839*io45a+14.7839*io46b+14.7839*io46a+14.7839*io47b+14.7839*io47a+14.7839*io48b+14.7839*io48a+14.7839*io49b+14.7839*io49a

Summary – Key Takeaways

1 Custom Propagation Run enables definition of ANY seismic source using standard MOST fault plane parameters

2 Sources are named with the "cu" prefix (e.g., cu2a) following NOAA convention — fully manageable

3 Double-click on the map to set epicenter; fault plane outline adjusts dynamically to all parameter changes

4 Animation and Max Amplitude views allow comprehensive inspection of wave propagation and hazard extent

5 Custom sources automatically integrate into main ComMIT Model Setup for seamless inundation modelling

6 Full propagation runs take several hours — plan ahead and save named sources for reuse across pilot sites

Thank you