Tsunami Hazard Assessment and Inundation Modeling

Preliminary Results at Majuro

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OUTLINE

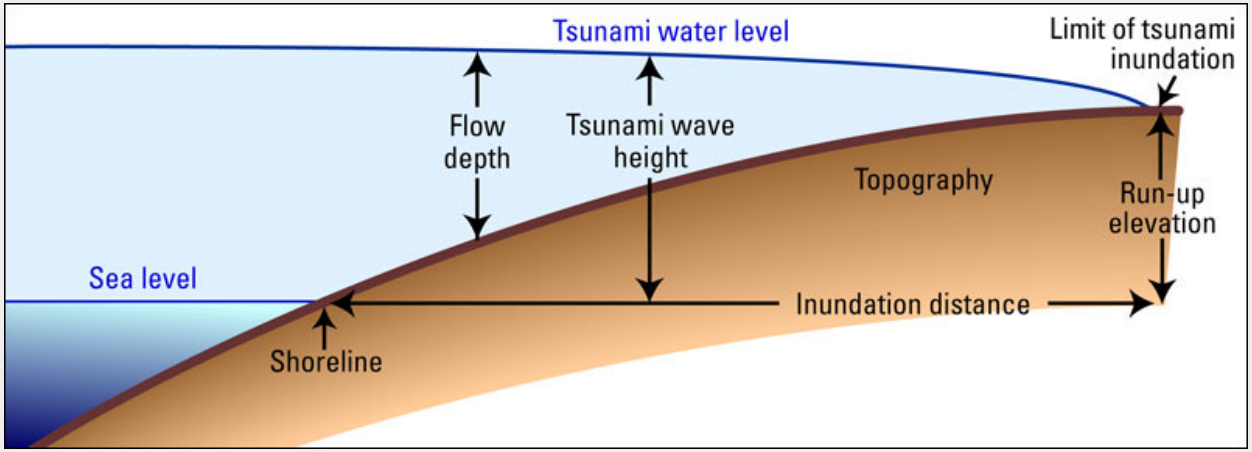
Inundation & Modeling
- Tsunami Inundation & Runup
- Inundation Modeling
- Method and Challenges

Preliminary Example Results for Majuro

Summary

TSUNAMI INUNDATION & RUNUP

What are they?



Tsunami inundation is the furthest extent that water travels from a shoreline. Distances depend on tsunami wave energy, offshore and coastal bathymetry and local topography.

Runup is a measure of vertical or maximum height of tsunami waves above mean sea level at the point of maximum inundation.

INUNDATION MODELING

Inundation Modeling

Model-produced inland extent of water at a given location
Provides the basis for community planning and product development
Used in real-time forecasting for immediate community action

Hazard Assessment and Inundation for Planning

- NOT time critical
- Models are run using highest resolution bathymetry and topography to assess hazard and focus inundation runs on the most hazardous sources

Outcome High resolution mapping that communities can use to develop evacuation routes, strategies, and products to inform and educate populations.

Forecast Modeling

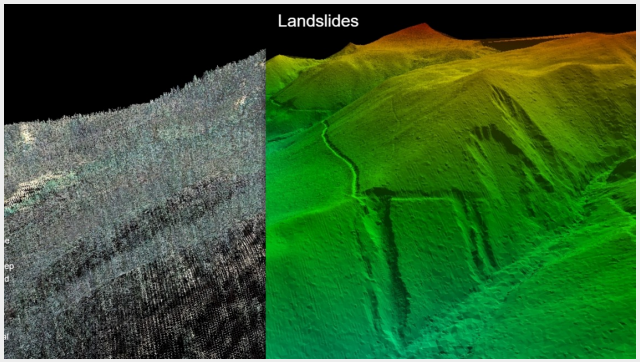
- Time critical estimate of wave arrival time, wave height, and inundation
- Run in real time as tsunami waves are propagating across open ocean

Outcome A tsunami forecast that provide communities with critical information to act quickly

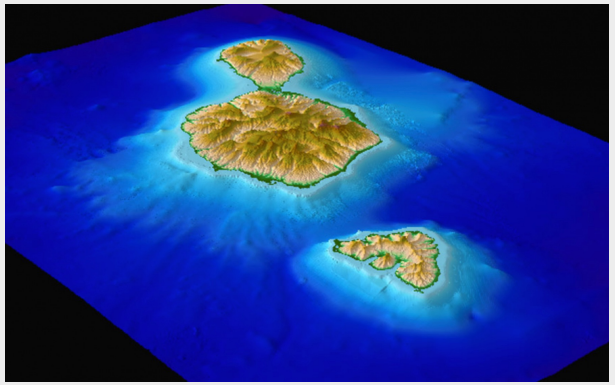
METHOD & CHALLENGES

Method

Tsunami inundation is modeled by simulating scenarios then passing the generated waves over a digital elevation model (a representation of seafloor features and bare earth topography put together from survey data)



USGS Public Domain data and image



DEM of French Polynesia Society Island constructed by NCEI in 2017

Data are Critical!

Data that goes into construction of DEM governs how good results really are. Data from all available sources are quality checked and converted to the same datum then merged. Topographic features are stripped out (left).

PRELIMINARY RESULTS
for MAJURO

Modeled by
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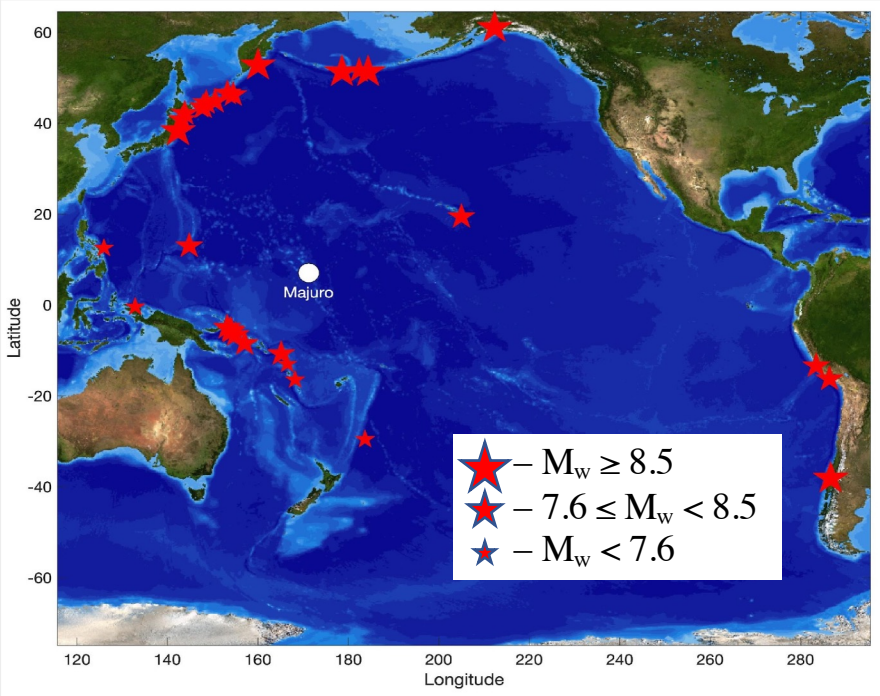
MAJURO ATOLL: HISTORICAL EVENTS
Global Historical Tsunami Database (NCEI, 2022)



32 earthquake generated tsunamis

Largest measured tsunami runups

11 March 2011 Tohoku
66 cm at Kwajalein, 51 cm at Majuro

22 May 1960 Chile
38 cm at Kwajalein

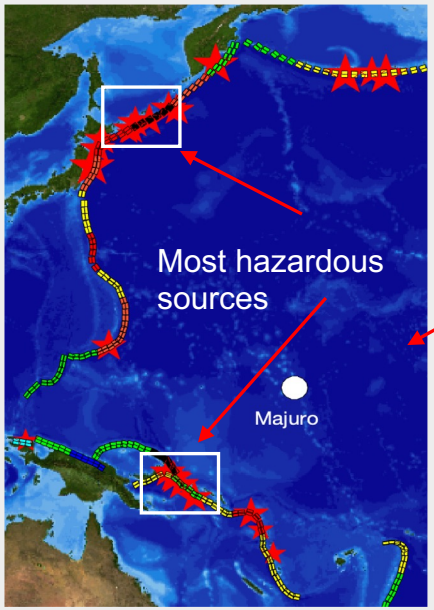
09 March 1957 Andreanof Islands
30 cm at Kwajalein and Enewetak

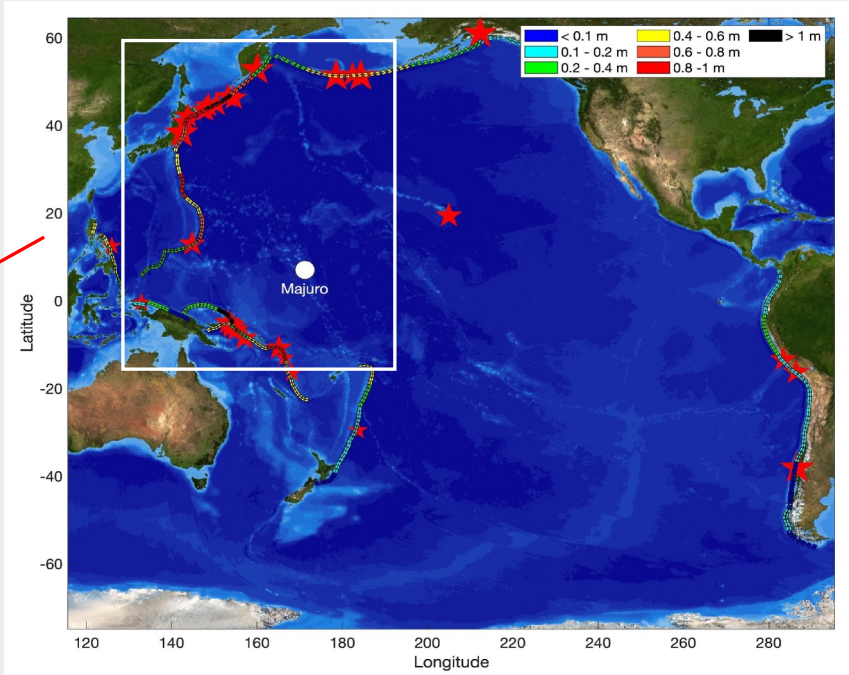
Majuro measured runups

03/11/2011 Tohoku (51 cm)
10/07/2009 Vanuatu (2 cm)
11/15/2006 S. Kuril Islands (8 cm)

Preliminary Results

MAJURO ATOLL HAZARD ASSESSMENT





A model designed for earthquake-generated tsunamis was used.

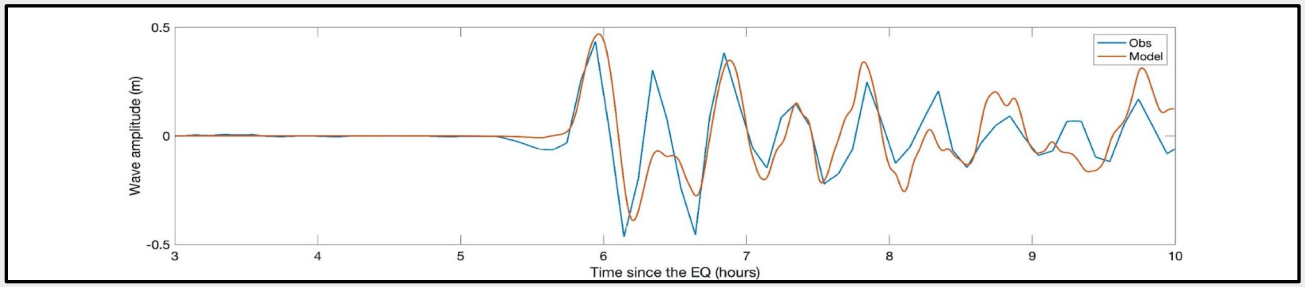
The model showed maximum wave amplitudes > 1 m from source areas along the Kuril-Japan-Izu-Mariana-Yap and Manus subduction zones.

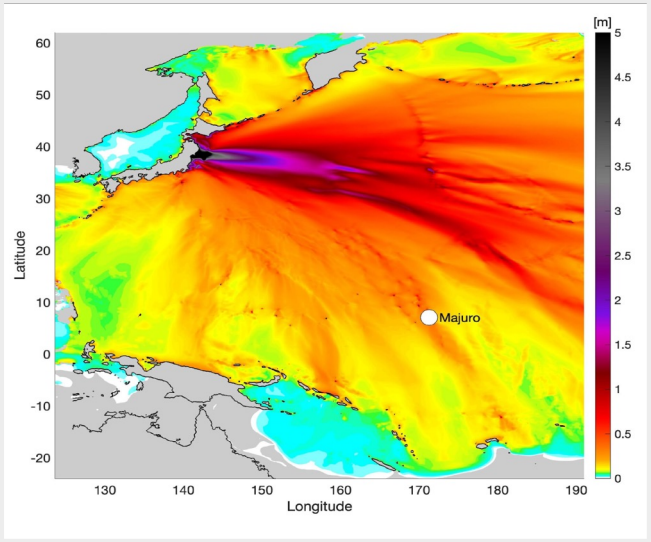
Preliminary Results

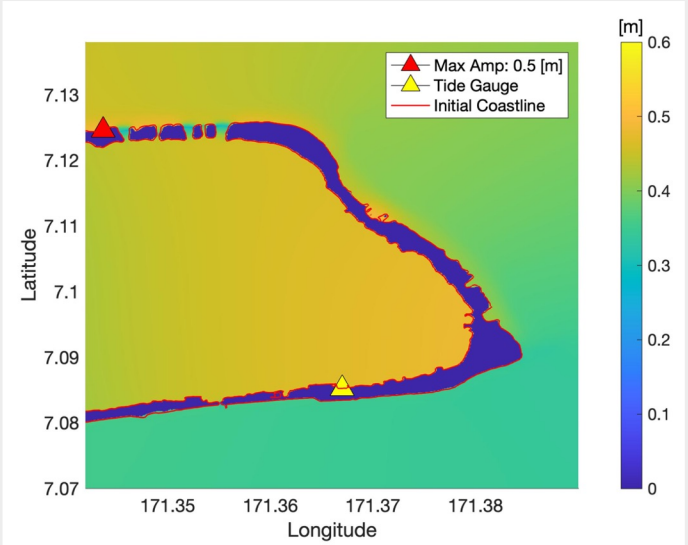
MAJURO ATOLL MODEL VALIDATION

11 March 2011 Tohoku Event

Nested Calculation Grids Resolution: 20.9, 2.6, and 0.3 arcsec (10m)

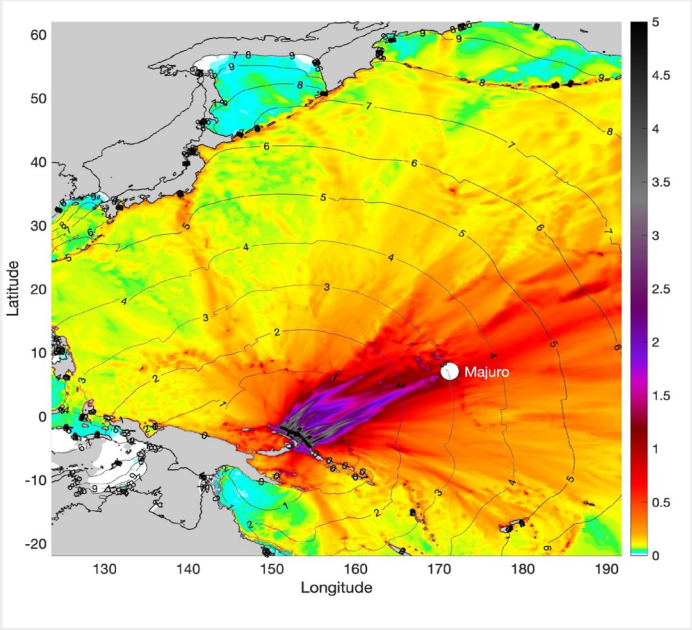




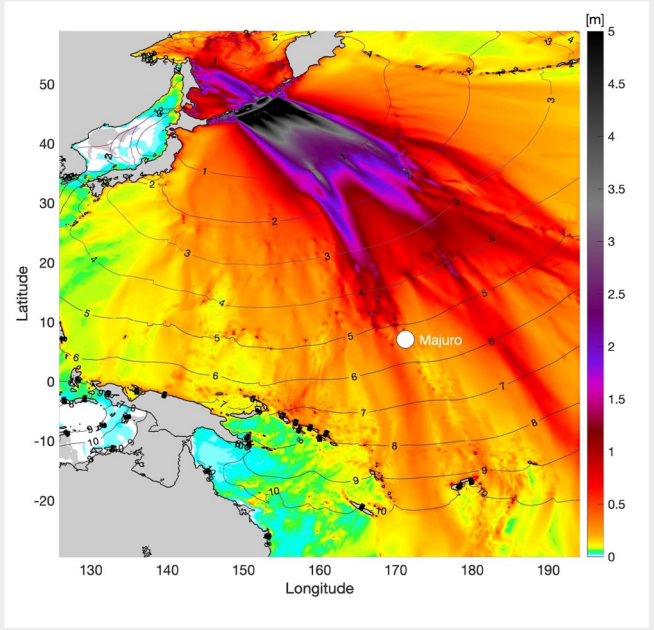


Preliminary Results

MAJURO ATOLL: MANUS and TOHOKU Mw 9.1 SOURCES



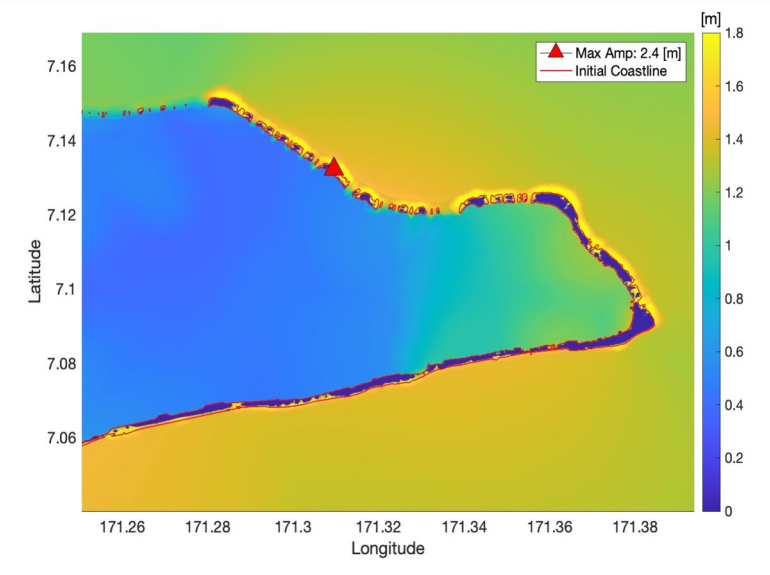
Maximum Amplitudes at Majuro from **Manus** source

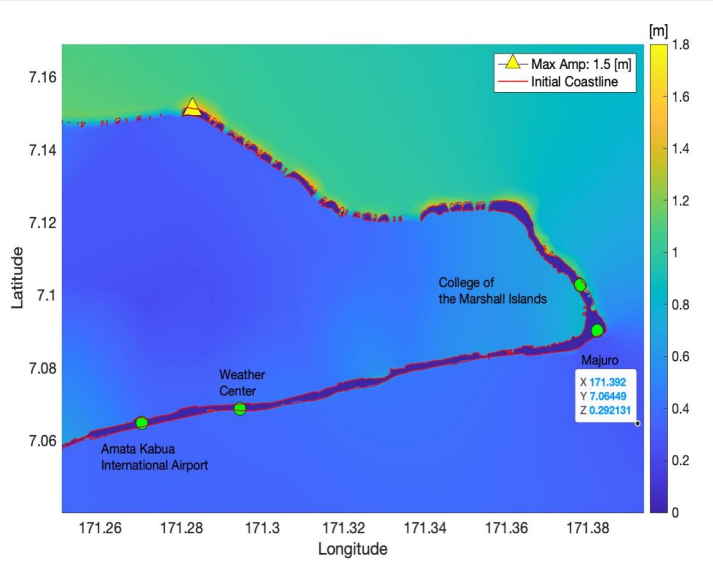


Maximum Amplitudes at Majuro from **Tohoku source**

Preliminary Results

MAJURO ATOLL INUNDATION





The bright areas show model predicted inundation from a tsunami generated along the South American Andean subduction zone (left) and from a segment of the Japan subduction zone. Calculations were performed with a grid resolution of 10 m

SUMMARY

- Measurements of tsunami waves in the oceans and at coastlines are rare compared with other natural disasters. Numerical modeling fills in to support tsunami activities and efforts aimed at saving lives.

- Quality and density of bathymetry and topography data are critical to get model results that represent reality.

  Models will give results no matter how good or bad the data are that went into constructing the DEM. Common problems include low resolution sampling, datums that are mismatched, shifting of survey data locations

- Atolls are especially challenging. Tsunami waves could pass around a vertical shear but many atolls have areas of slope that will not be correctly modeled with poor data. Data for Majuro was excellent giving confidence in results.

NOTE: I have preliminary results for Chuuk and Pohnpei that I would be happy to go over on the side with anyone interested.

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