Tsunami Mapping Projects, GOM

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Seattle, WA., 2014
What are the concerns for the GOM?

Scale of Past GOM Events


Downtown Houston, TX

b) Atlantis “Slump E”

Astrodome, Houston, TX

500 ft
Landslide Sources and Coastal Locations for Inundation Mapping
Generation (TSUNAMI3D), Propagation and Runup (NEOWAVE)
GOM Bathymetry
Maximum Wave Amplitude
Probabilistic Source Transect D
Maximum Wave Amplitude
Historical Source Mississippi Canyon
Maximum Wave Amplitude
Historical Source East Breaks
Probabilistic approach: Monte Carlo Simulation (MCS)

- Determine possible landslide scenarios and likelihood of failure based on:
  - Past landslide database
  - Sediment parameters (Ocean Drilling program)
  - Bathymetry data
  - Seismicity data

1. Calculate a set of possible landslide configurations based on parameter distributions of submarine past events (area, volume, thickness, etc.)
2. Perform sediment stability analysis (i.e. Factor of Safety) for each possible source using:
   - sediment characteristic (e.g. slope, type, soil strength, etc.)
   - regional seismicity (PHA)
3. Tsunamigenic events are those configurations which fail and produce a tsunami amplitude above a threshold value
4. Each tsunamigenic scenario is associated to a rate of recurrence, e.g., 2500, 5000, 10,000 years
Parameter Correlations from Data

- Volume vs. Area: $\rho=0.9572$
- Length vs. Area: $\rho=0.9331$
- Length vs. Volume: $\rho=0.8698$
Random Correlated Variables: Cholesky Decomposition

- Determine random $A$, $V$, and $L$ in MCS routine while maintaining correlations among parameters
- Cholesky decomposition of covariance matrix $\Sigma$:
  \[ \Sigma = CC^T, \quad C \text{ lower triangular} \]
- $A$, $V$, $L$ follow lognormal distributions (determined by data)
  \[ \rightarrow \log(A), \log(V), \log(L) \text{ are normally distributed with means } \mu_A, \mu_V, \mu_L \]
- From a set of random normal variables $u_i \sim N(0, 1)$, determine correlated normal variables:
  \[
  \begin{bmatrix}
  X \\
  Y \\
  Z
  \end{bmatrix}
  =
  C
  \begin{bmatrix}
  u_1 \\
  u_2 \\
  u_3
  \end{bmatrix}
  +
  \begin{bmatrix}
  \mu_A \\
  \mu_V \\
  \mu_L
  \end{bmatrix}
  \]
- Then random correlated $A$, $V$, and $L$ are found from:
  \[
  \begin{bmatrix}
  A \\
  V \\
  L
  \end{bmatrix}
  =
  \exp((X, Y, Z)^T)
  \]
MCS Landslide Source Dimensions - Transect D
South Padre Island, TX
Maximum Inundation – East Breaks
South Padre Island, TX
Maximum Momentum Flux – East Breaks
South Padre Island, TX
Maximum Inundation – Transect D
South Padre Island, TX
Maximum Momentum Flux – Transect D
Future Work

• Include maritime products (e.g. currents, vorticity, time above threshold current speed) in harbors, bays, etc.

• Correlate tsunami inundation with hurricane storm surge inundation
END