ACOUSTIC DETECTION AND NUMERICAL MODELS OF LANDSLIDE INDUCED TSUNAMIS IN THE GULF OF MEXICO

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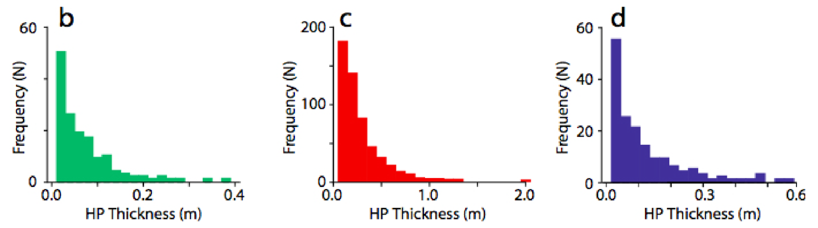
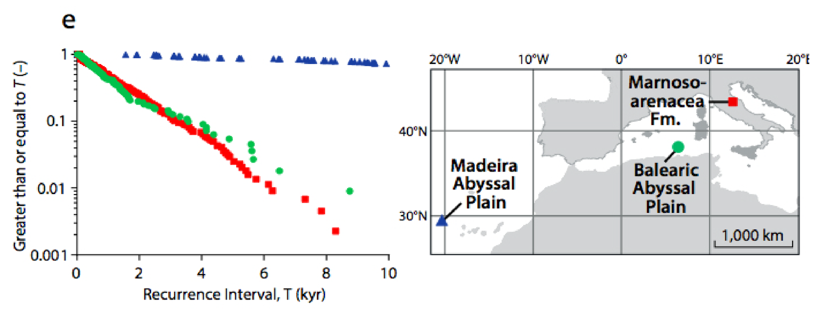
Introduction

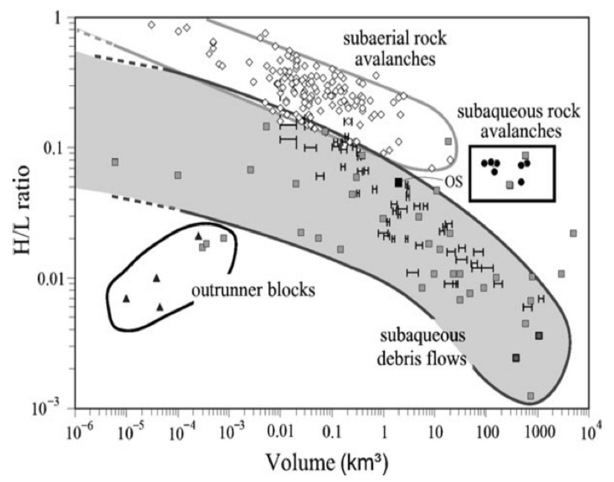
Semi-closed coastal regions such as Gulf of Mexico (GoM) are particularly affected by hazards due to submarine landslides, such as damage to offshore hydrocarbon extraction infrastructure. The risk associated with landslide-induced large tsunamis that could potentially devastate the coastal regions has not been widely addressed for the GoM. Tsunami cannot be prevented, however community preparedness can mitigate its impact. Early detection of a tsunami would allow timely warnings and effective responses.

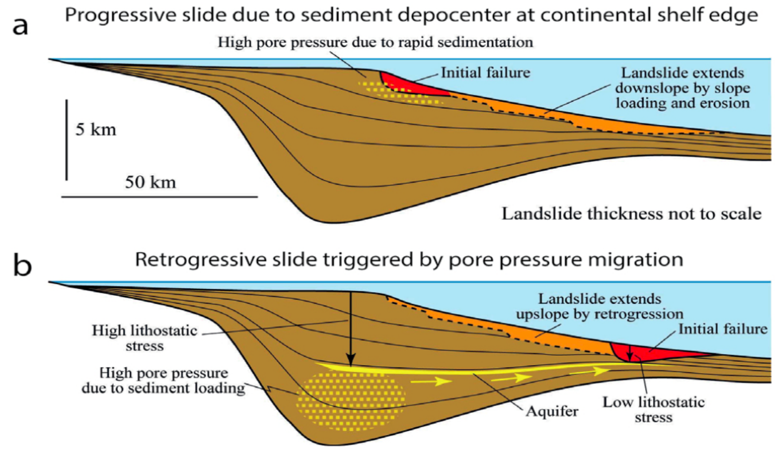
Historical data on Submarine Landslides

Process	Volume	Average Frequency
SUBMARINE LANDSLIDES		
Storegga Slide offshore Norway	> 3,000 km^3	–
15 nonvolcanic slides in last 36,000 years > 100 km^3	> 100 km^3	Less than 2,400 years
1929 Grand Banks landslide-turbidite	~ 175 km^3	–
Volcanic island flank collapses of the western Canary Islands	50–500 km^3	1 per 150,000 years
SEDIMENT FLUXES DURING A SINGLE FLOOD OF INDIVIDUAL RIVER		
Largest floods of single rivers	0.03–0.06 km^3	1–50 years
Jokullhlaup in Iceland, 1996	0.07 km^3	–
AVERAGE ANNUAL RIVER SEDIMENT FLUXES		
Largest annual sediment flux from a single river (Amazon)	0.4 km^3	Annual
Sediment flux from all the rivers in world for a year	~ 6 km^3	
VOLCANIC PROCESSES		
Largest explosive volcanic eruptions (Magnitude > 8; e.g., Toba ~ 74,000 years ago)	> 350 km^3	100,000–800,000 years
Magnitude 6 explosive eruptions (e.g., Krakatau, 1883 CE)	~ 10 km^3	50–100 years
Magnitude 4–5 explosive eruptions (e.g., Mount St. Helens, 1980 CE)	~ 1 km^3	~ 10 years
OTHER PROCESSES		
Snow avalanches	Typically < 0.001 km^3	–
Sediment mobilized on land during a single major earthquake	5–15 km^3	–

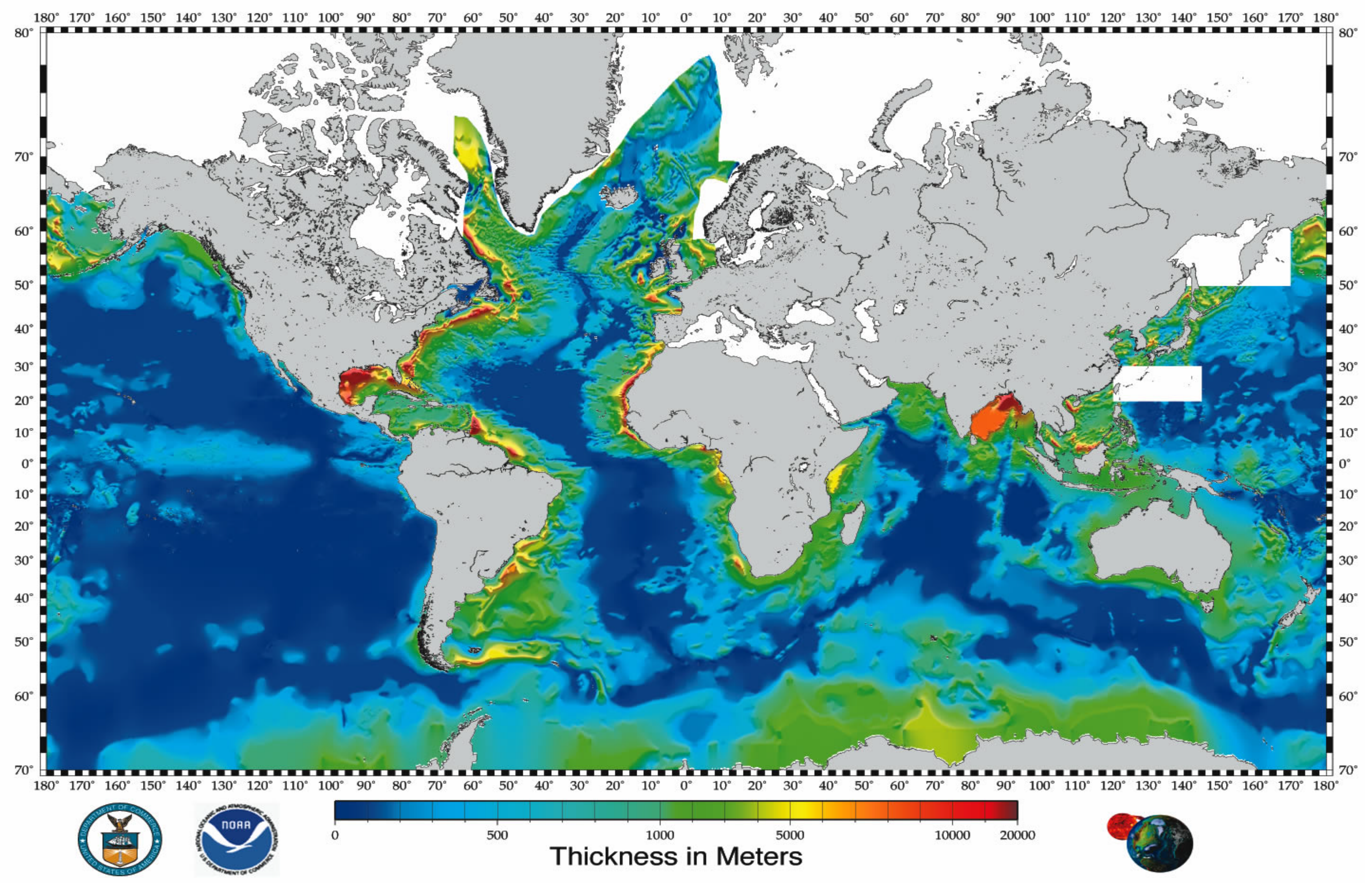




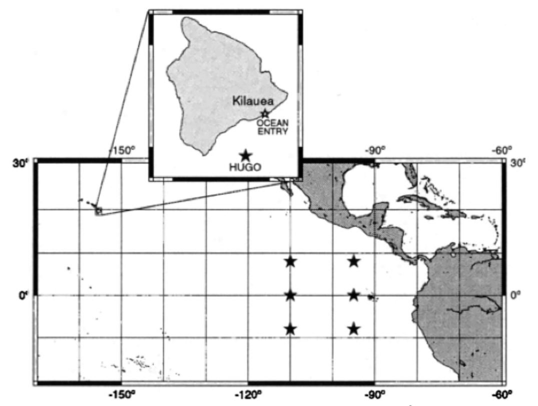




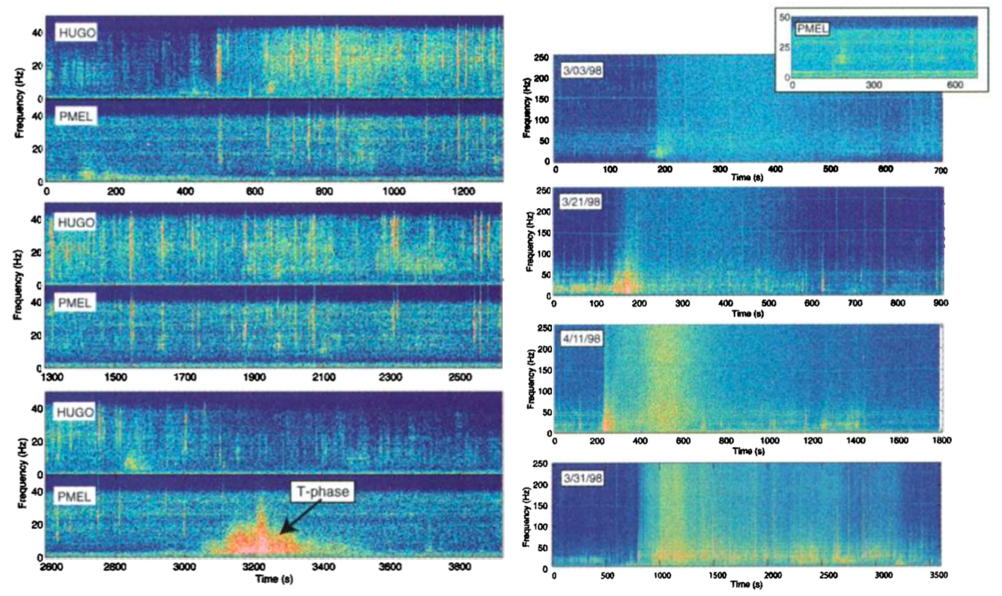
Total Sediment Thickness at Marginal Seas



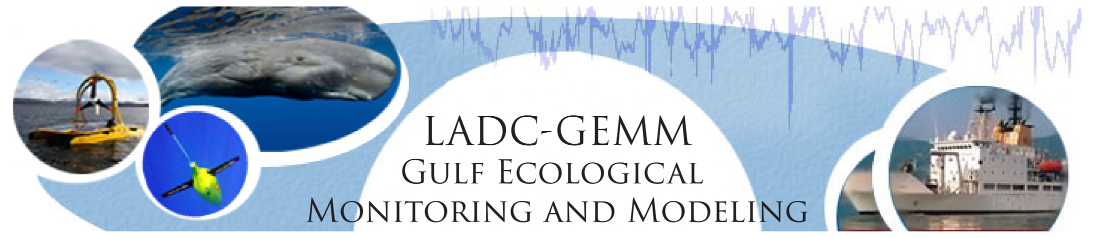
Landslide detection



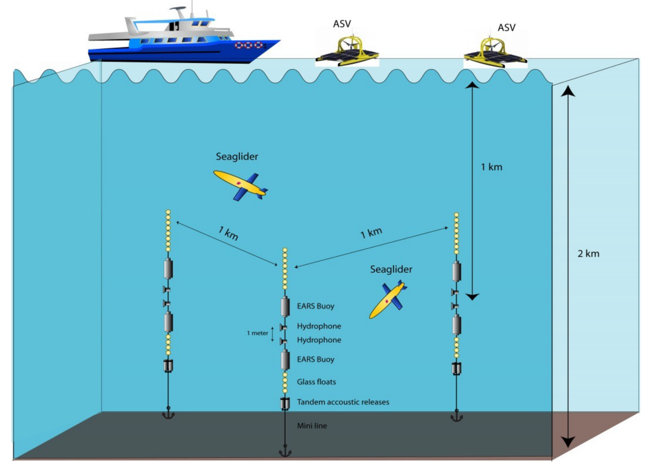
Up to 10 landslides per day were detected. Largest of these landslides, detected 5 5000-7000 km away from the source

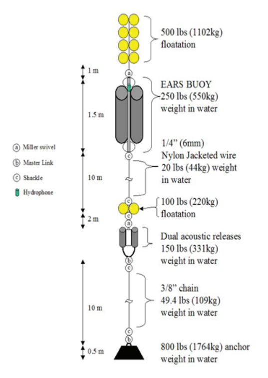


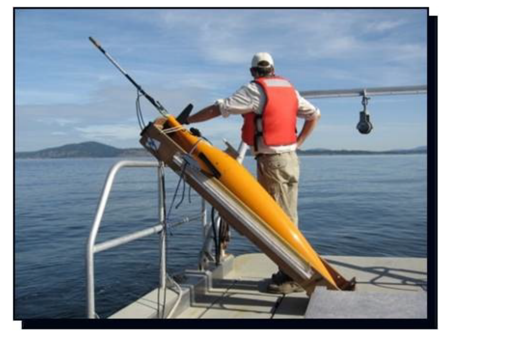
Caplan-Auerbach, J., Fox, C. G., & Duennebier, F. K. (2001).



We propose to deploy autonomous broadband (up to 96 kHz) Environmental Acoustic Recording System (EARS) buoys, successfully used in GoM for PAM since 2001, in the Mississippi Canyon for extended amount of time to monitor acoustic signatures of the GoM landslides. The EARS buoys can be deployed in a two-hydrophone configuration at three sites to provide tracking capabilities of slide events. Concurrent (with the EARS deployment and recovery) bottom side-scan sonar and high-resolution photography surveys can be conducted to assist with the identification of landslide events.

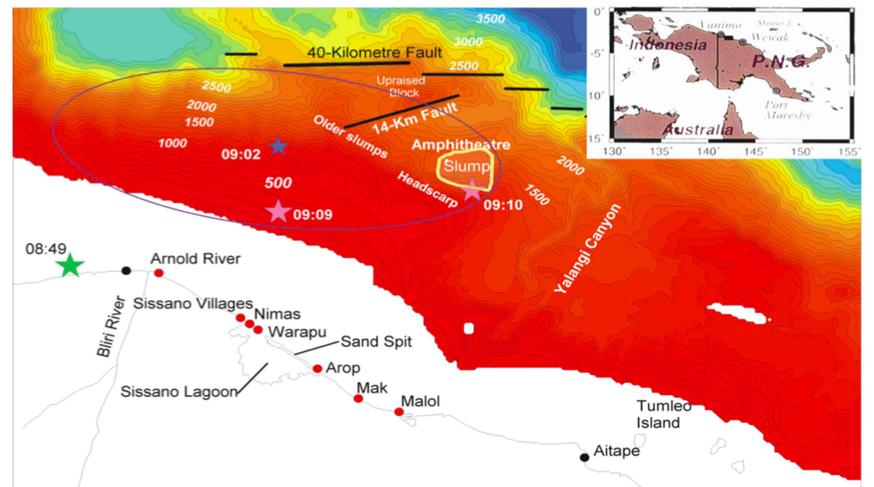


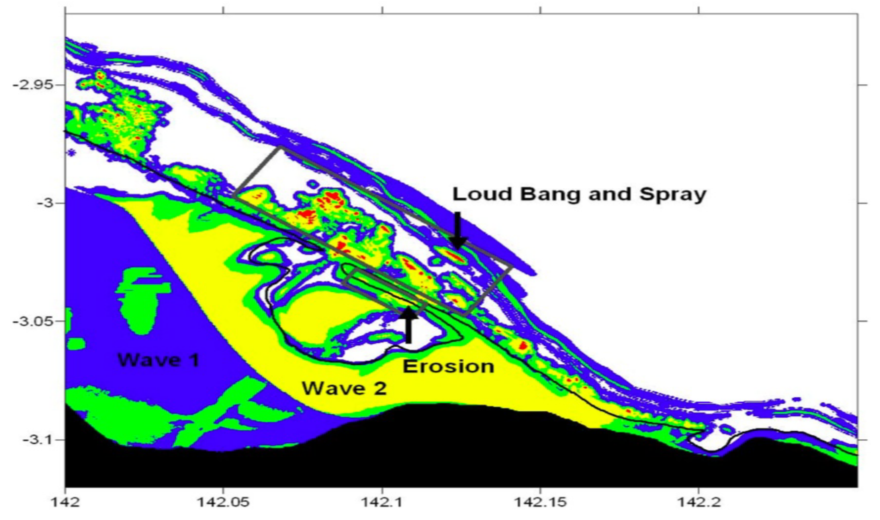


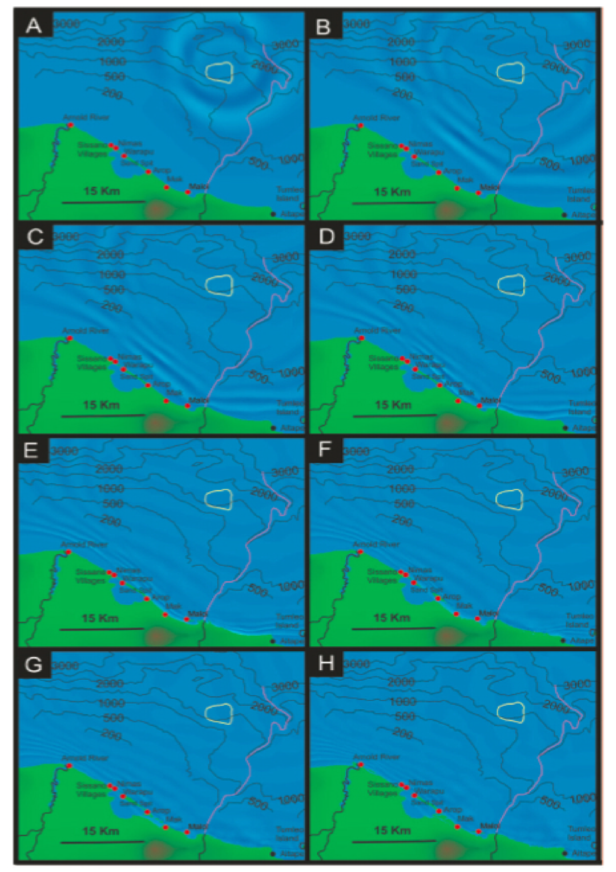


Tsunami Hazard

Landslides only can cause tsunami, without being triggered by earthquakes. The studies of the Papua New Guinea tsunami (2200 casualties) of July 1998 have been groundbreaking in demonstrating how a relatively small deepwater mass failure can cause devastating local tsunamis without any warning. In 2009, a publication of the National Tsunami Hazard Mitigation Program of the United States Geological Survey has illustrated how a slump on the Mississippi Fan in front of the city of New Orleans has the potential of generating waves up to 10 meters (Ten Brink et al, 2009). A development of the cost efficient and reliable landslide monitoring system in the GoM high risk areas and establishment of the tsunami warning network associated with the GoM landslides are of great necessity.

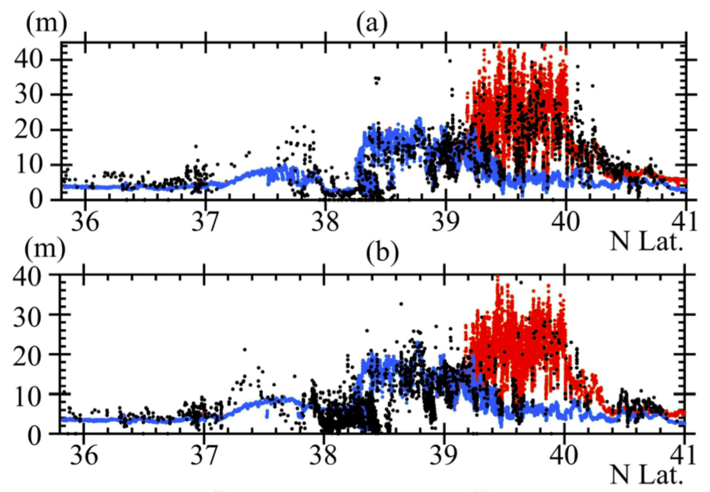


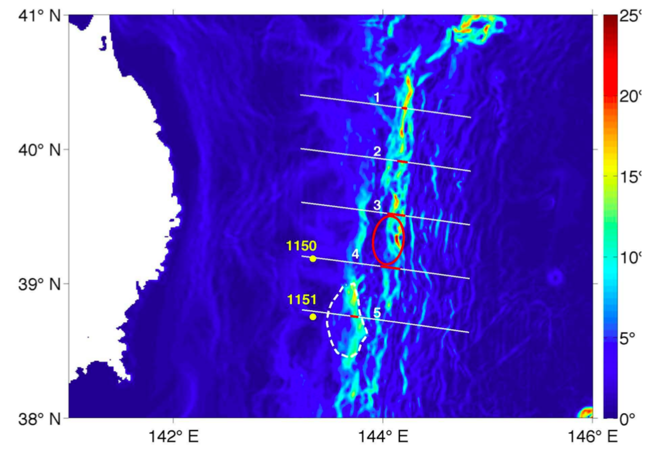


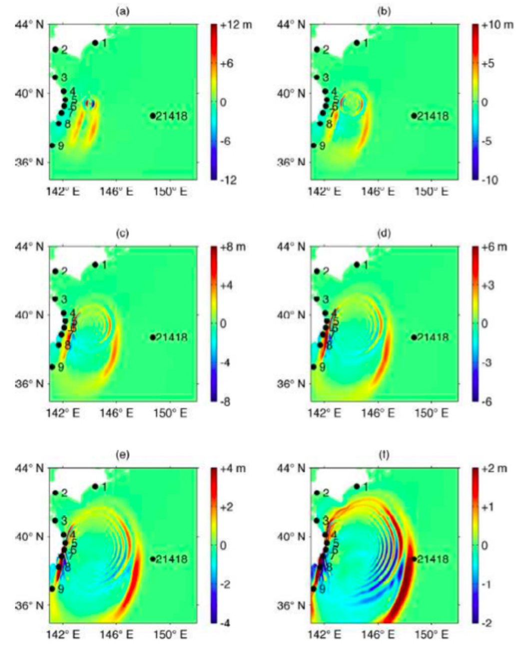


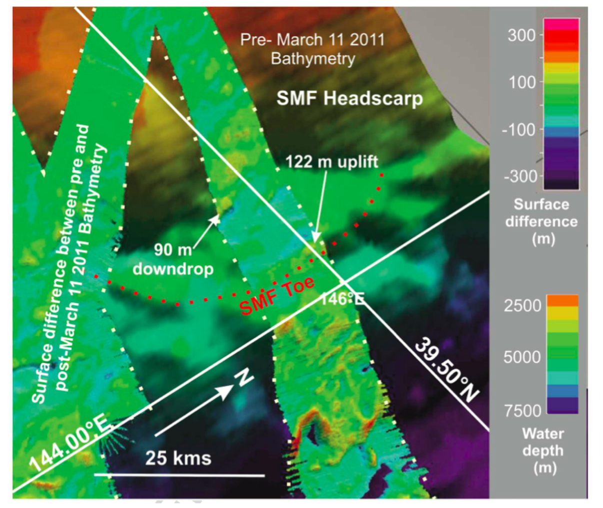
Tappin, Watts, Grilli, Natural Hazards Earth System Science,1998

The mysterious size of the Tsunami in Tohoku

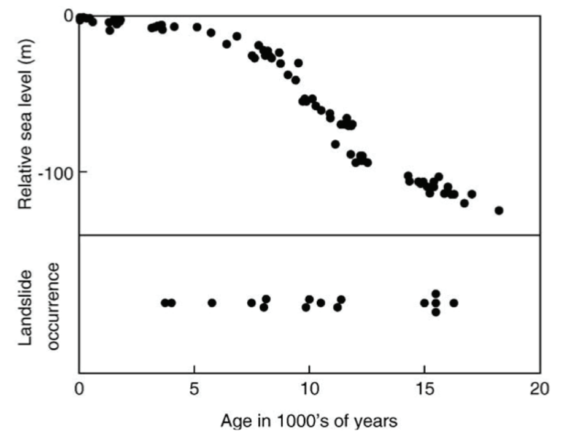


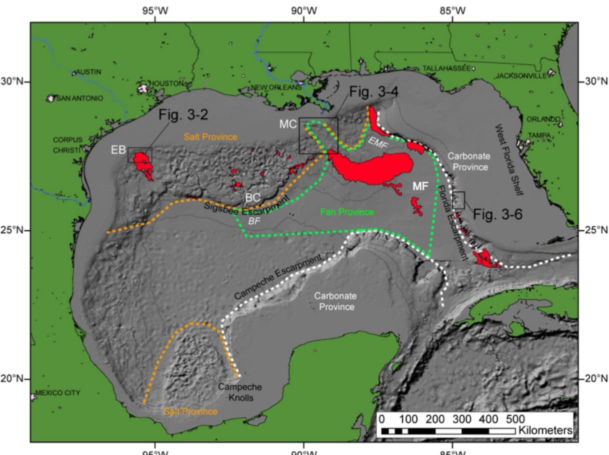




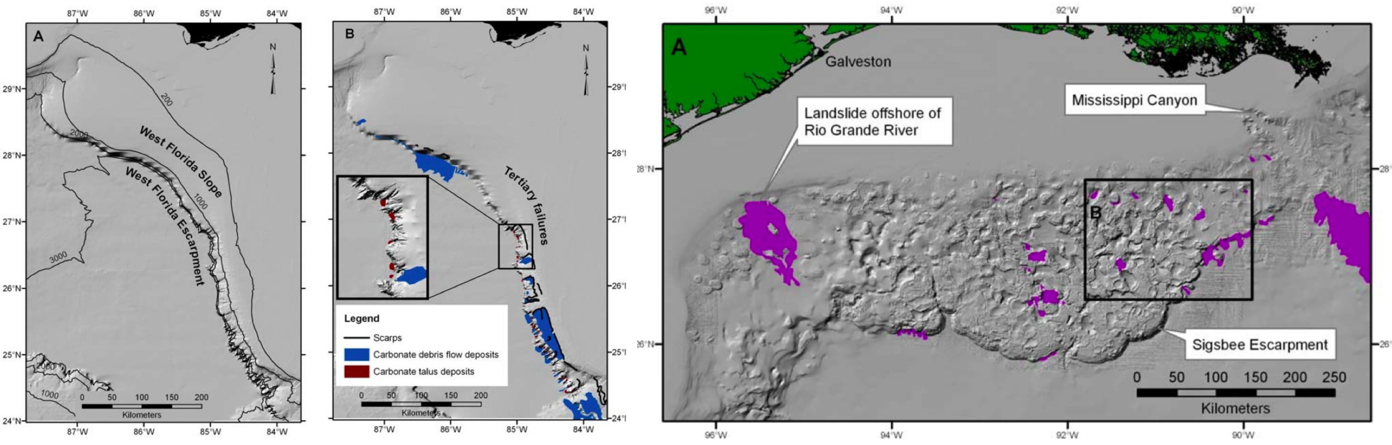


Gulf of Mexico

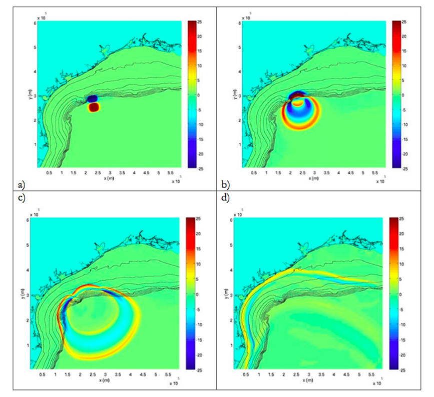




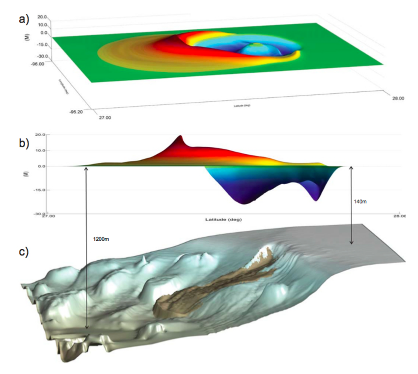
Ten Brink et al, USGS Report, 2009

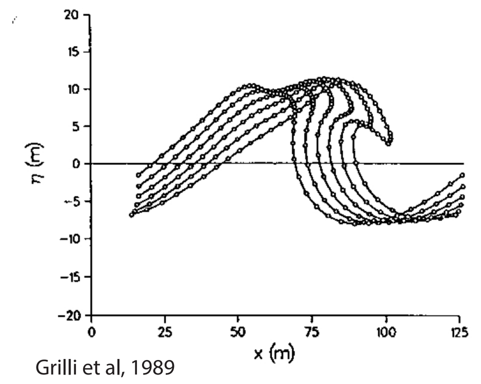


Numerical Models

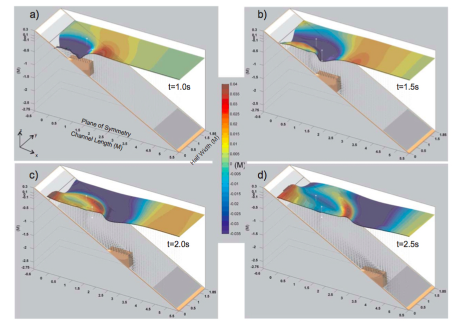


Ten Brink et al, USGS Report, 2009





Grilli et al, 1989



Horrillo et al, OCeans, 2013

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