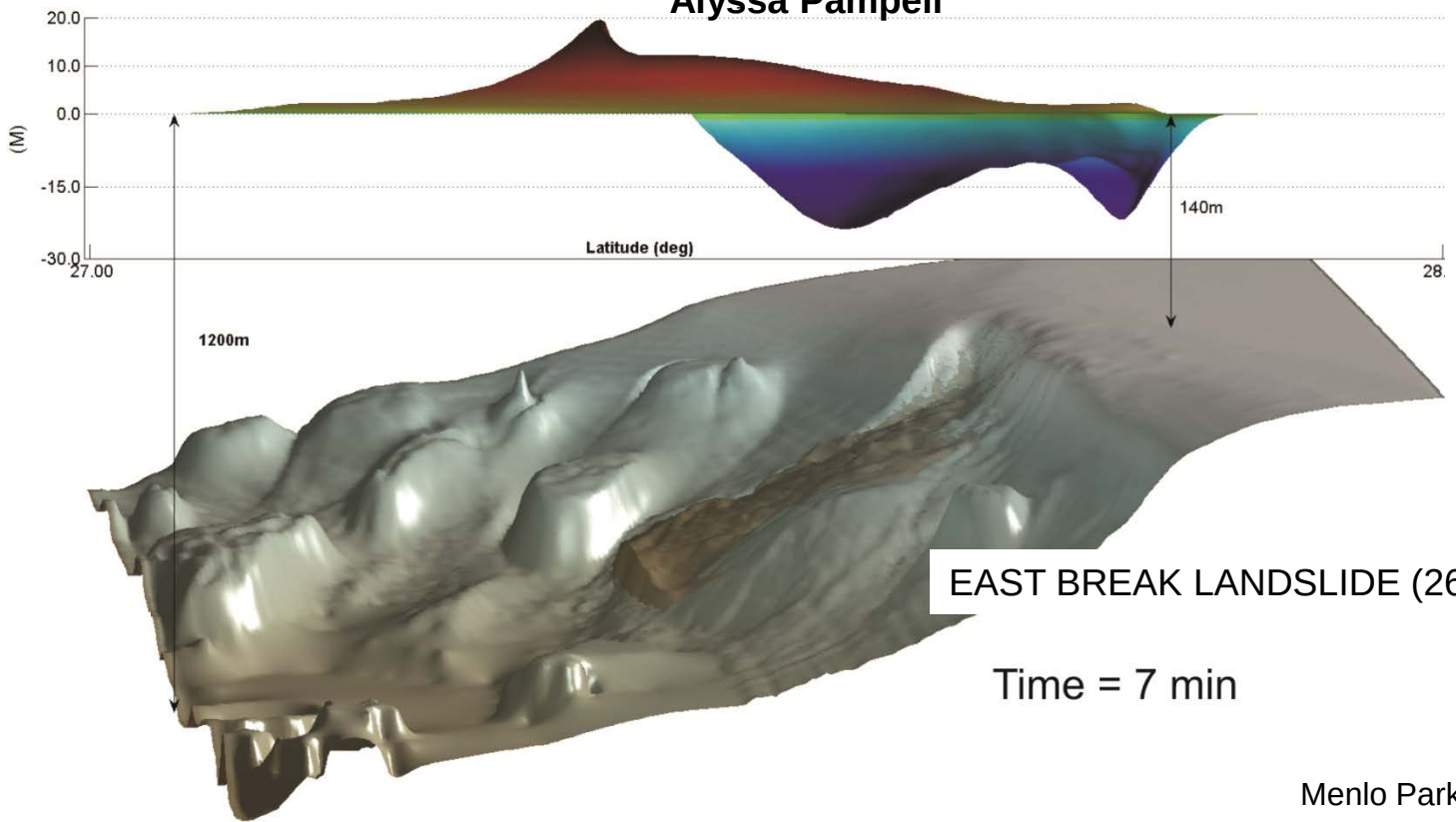
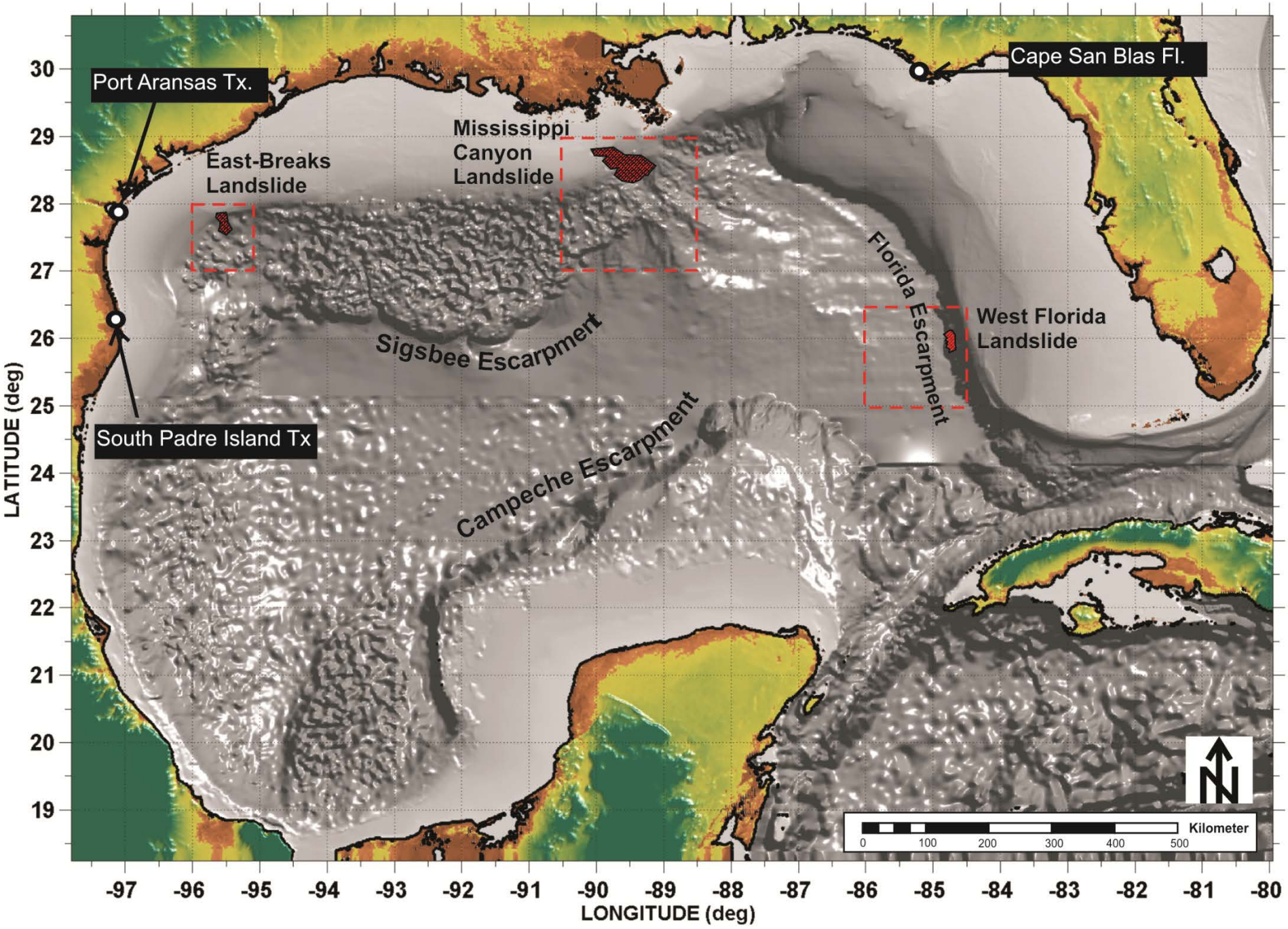
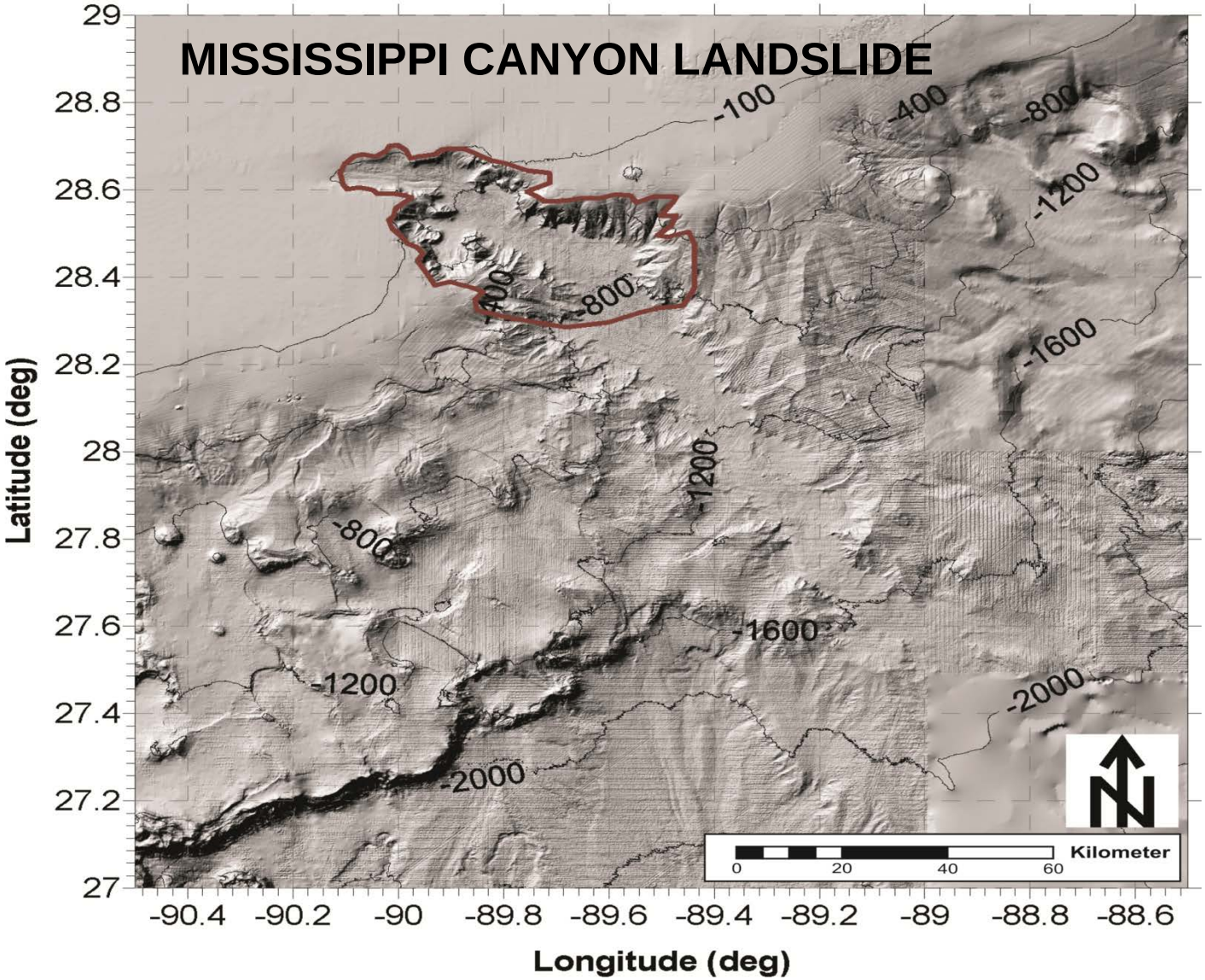
# GOM Mapping Project

**By:**
**Juan Horrillo,**
**Charles Williams (Amy Godsey)**
**Collaborators: Yoshinori Shigihara**
**Lisha Parambath**
**Alyssa Pampell**



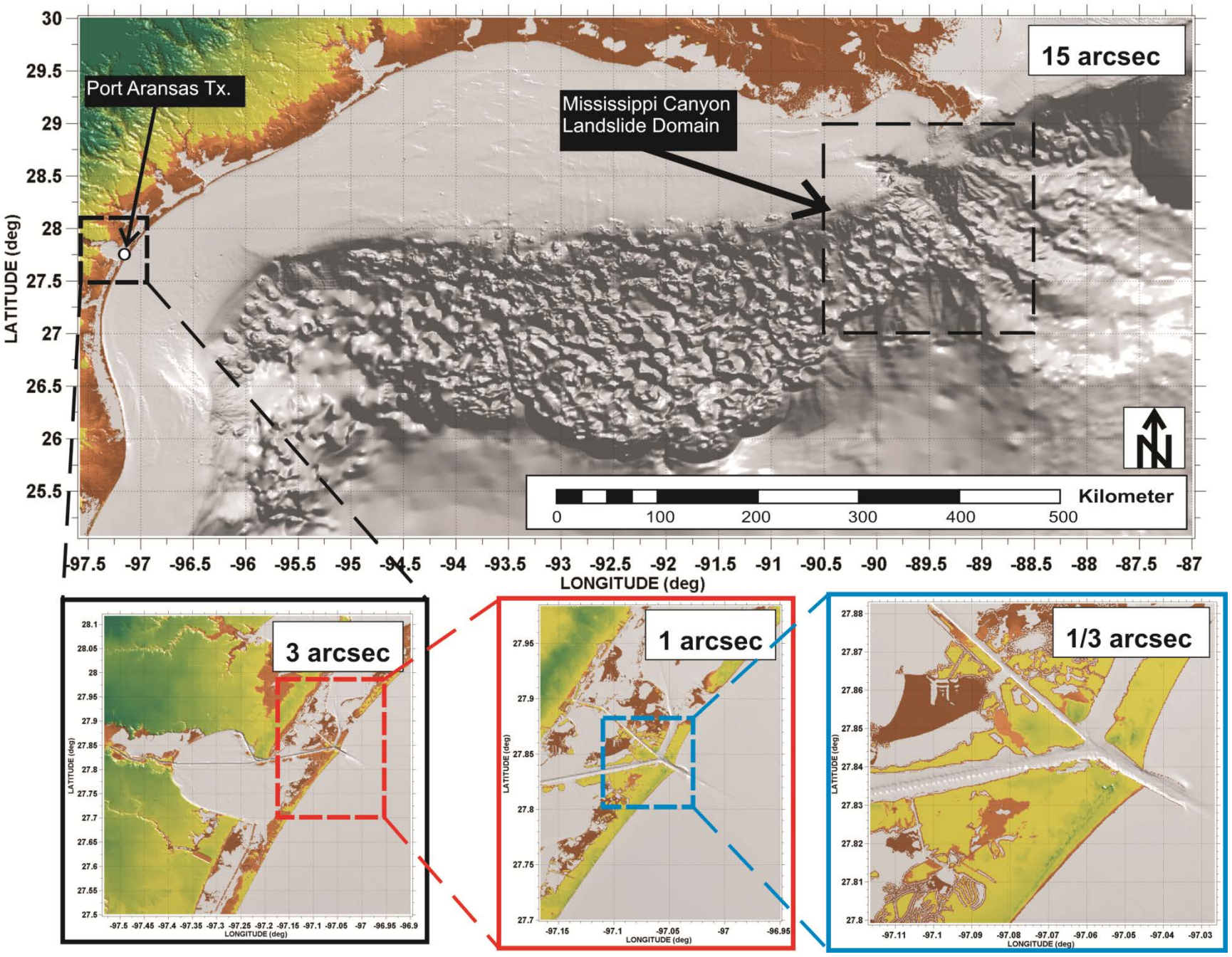

Menlo Park, CA., 2014


Port Aransas Tx.
Cape San Blas Fl.
East-Breaks Landslide
Mississippi Canyon Landslide
Florida Escarpment
West Florida Landslide
Sigsbee Escarpment
South Padre Island Tx
Campeche Escarpment
LATITUDE (deg)
LONGITUDE (deg)
30
29
28
27
26
25
24
23
22
21
20
19
-97
-96
-95
-94
-93
-92
-91
-90
-89
-88
-87
-86
-85
-84
-83
-82
-81
-80
Kilometer
0
100
200
300
400
500
N

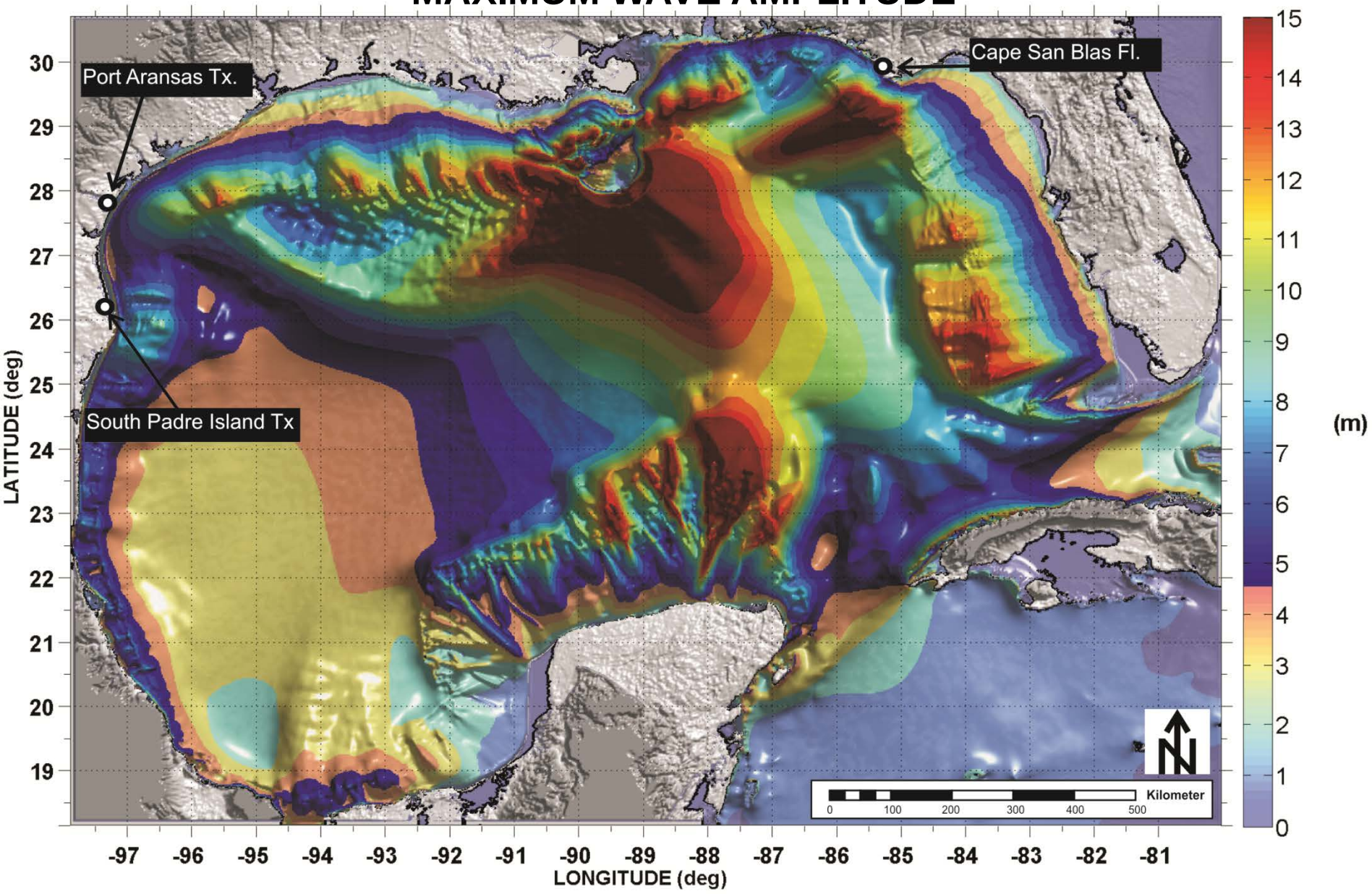



Mississippi Canyon submarine landslide, excavation limits and surrounding bathymetry (in meters).

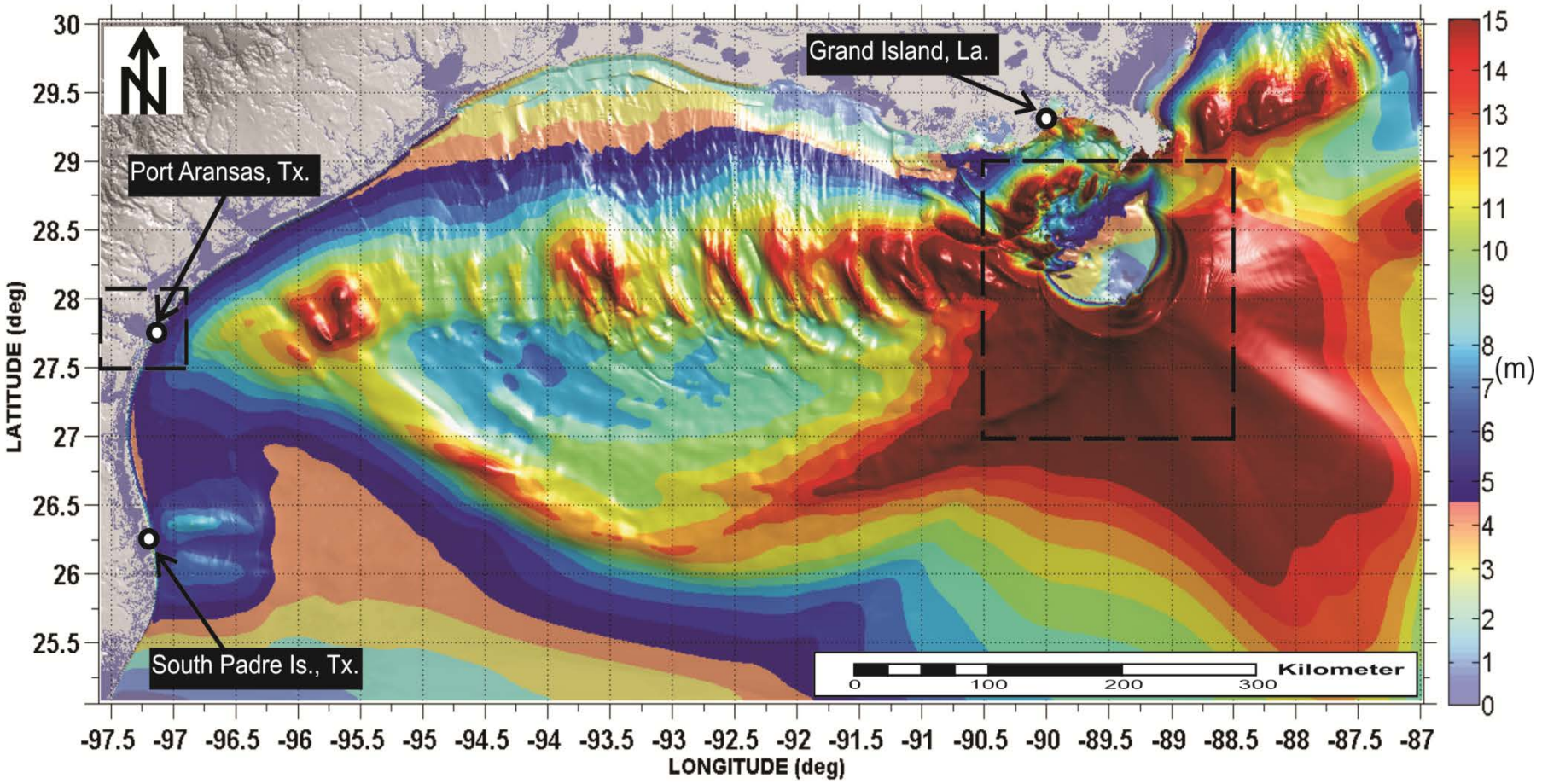
# TYPICAL NESTED MODEL



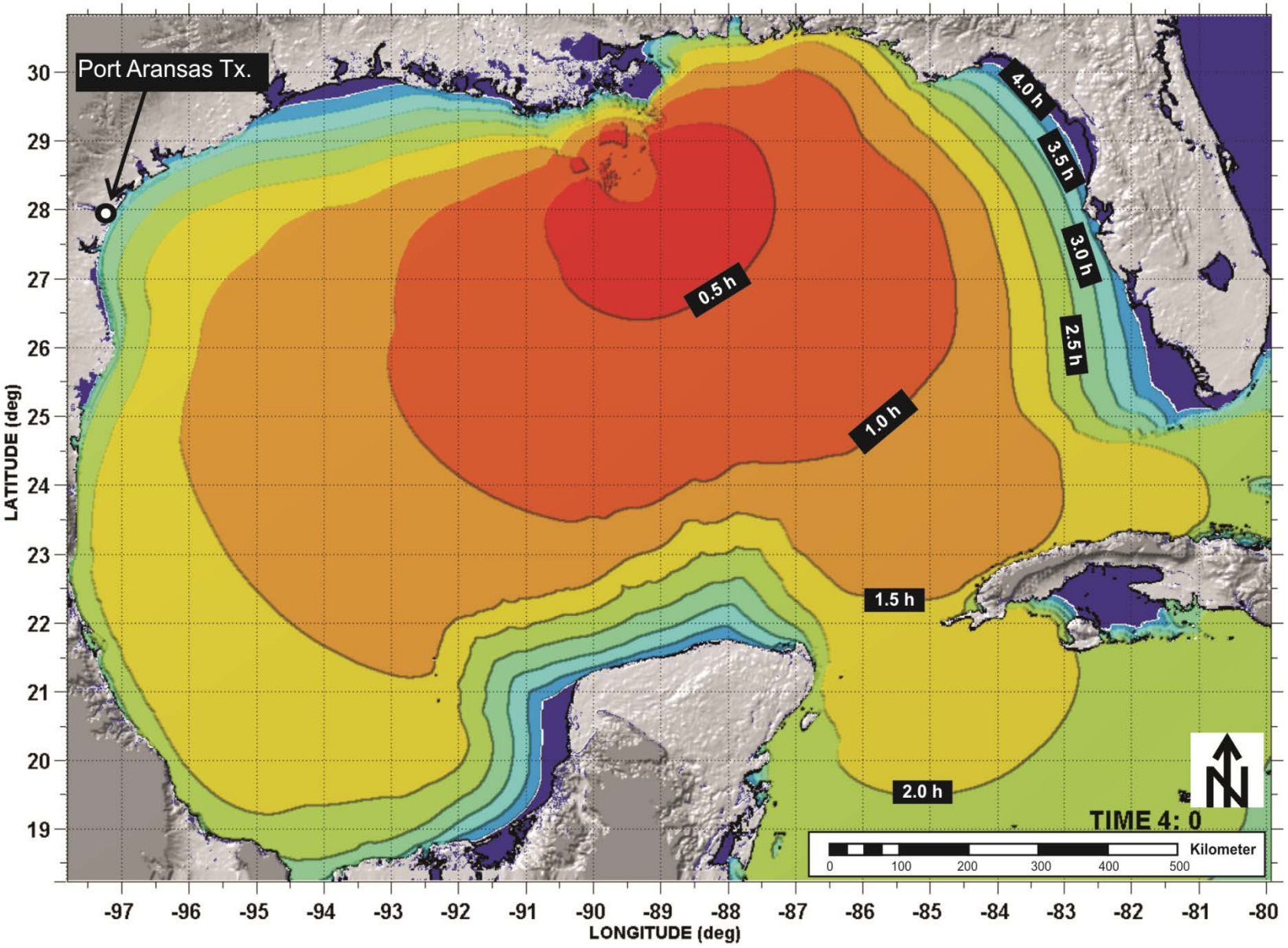
# MISSISSIPPI CANYON LANDSLIDE
# MAXIMUM WAVE AMPLITUDE



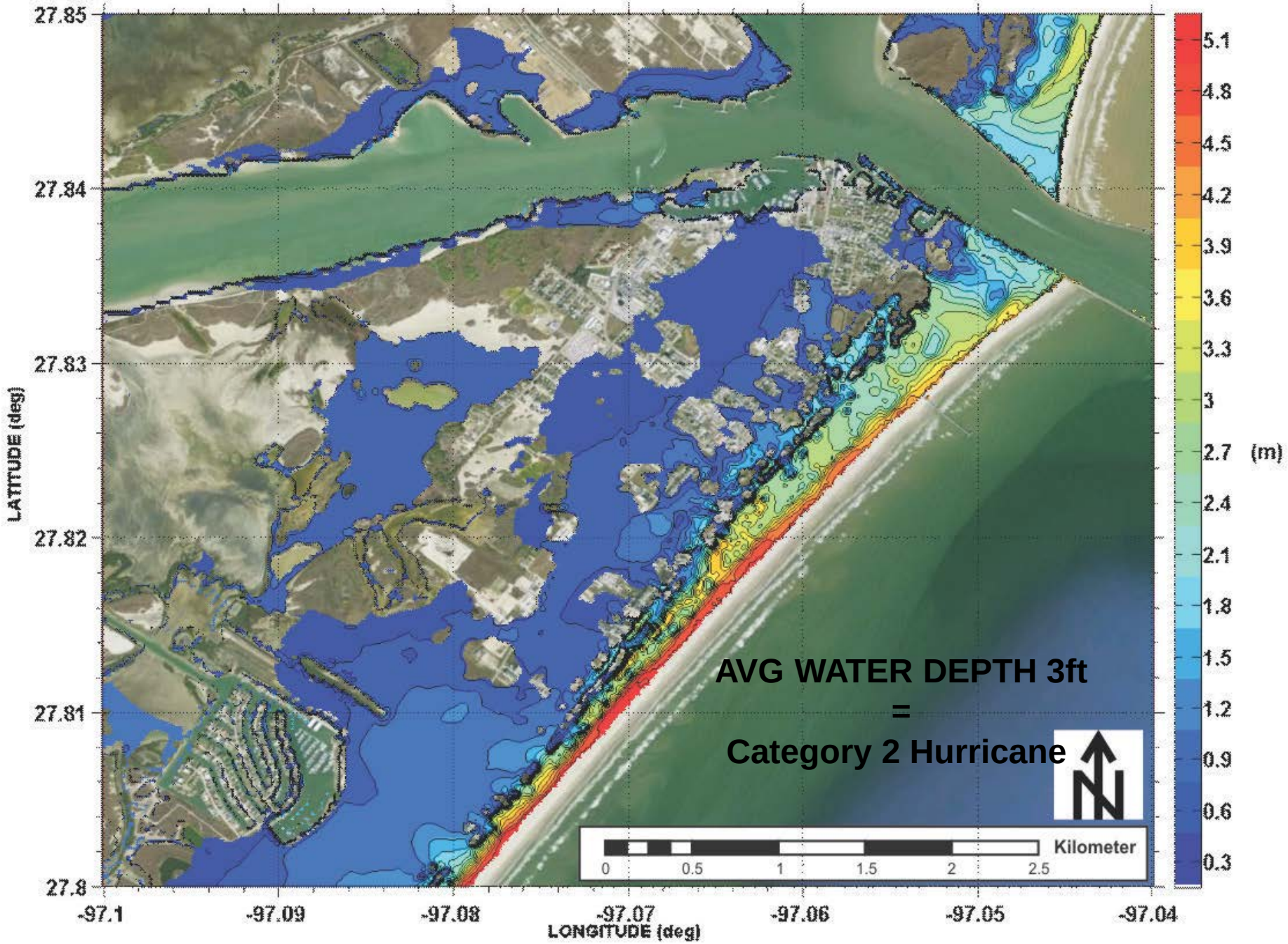
# MISSISSIPPI CANYON LANDSLIDE - ZOOM UP - MAXIMUM WAVE AMPLITUDE



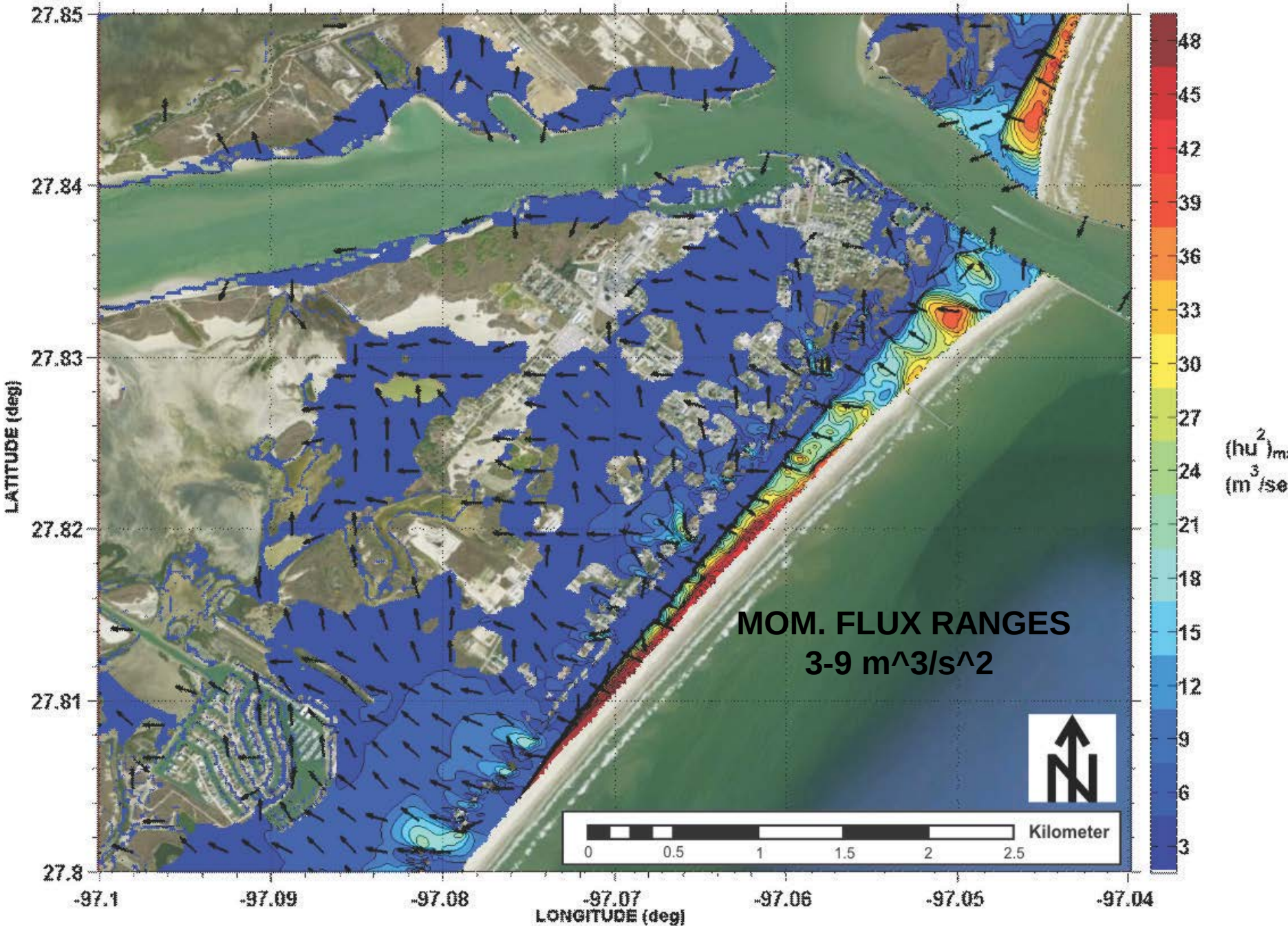
# - MISSISSIPPI CANYON LANDSLIDE -
# TSUNAMI ARRIVAL TIME



# EAST BREAKS INUNDATION DEPTH



# EAST BREAKS MOMEMTUM FLUX



# Probabilistic approach

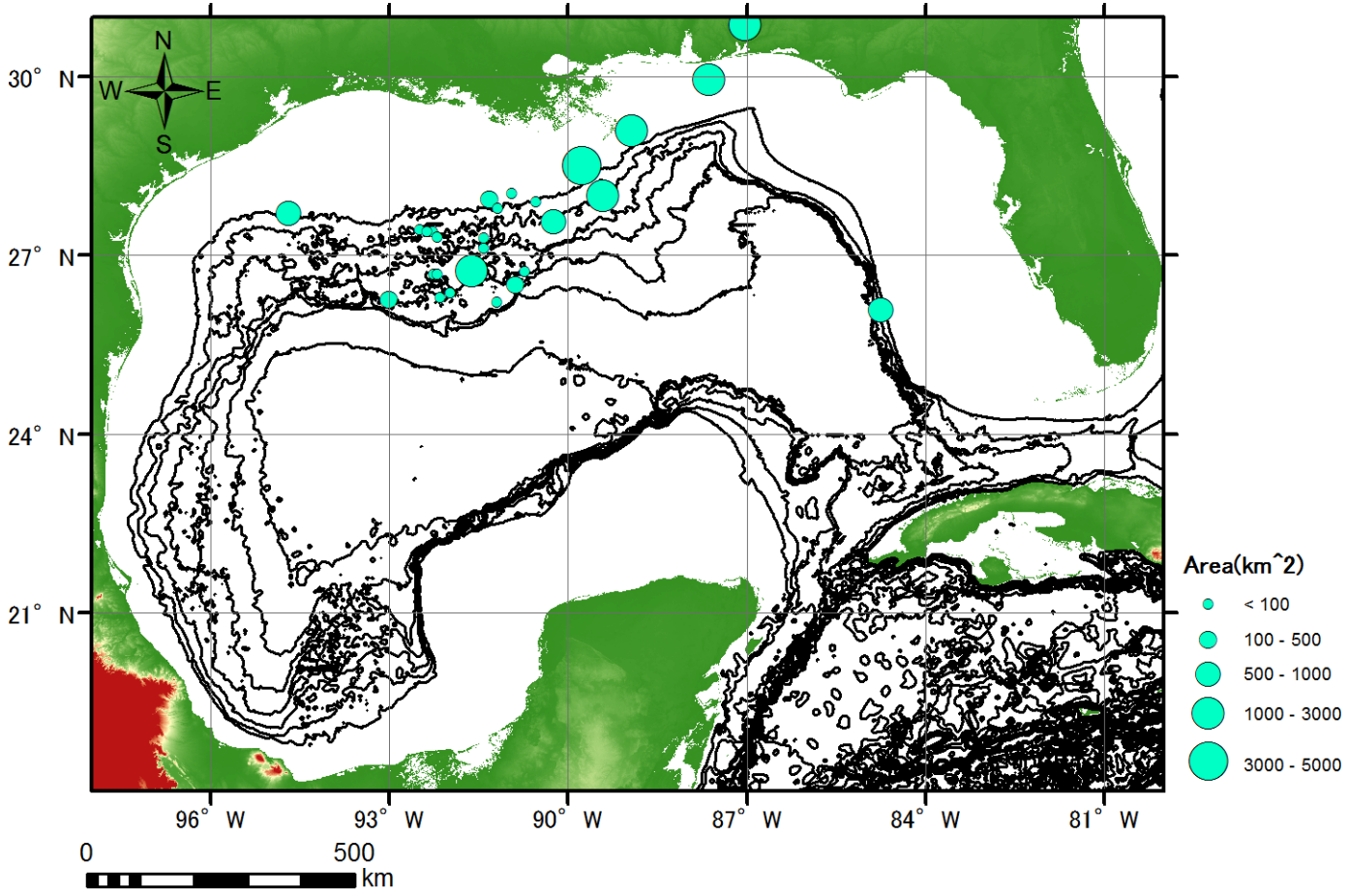
Monte Carlo Simulations (MCS)

- Past events (we obtain geometry and distribution)
- bathymetry data
- Data of soil parameter
- Seismicity data (PHA)

MCS

- Calculate the Factor of Safety
- Calculate annual probability of landslide and initial tsunami amplitude
- Define the landslide  size for the associated period of recurrence (e.g, 500, 2500, 5000 10000)

# Location and scale of existing landslide



# Landslide statistics summary of the GOM

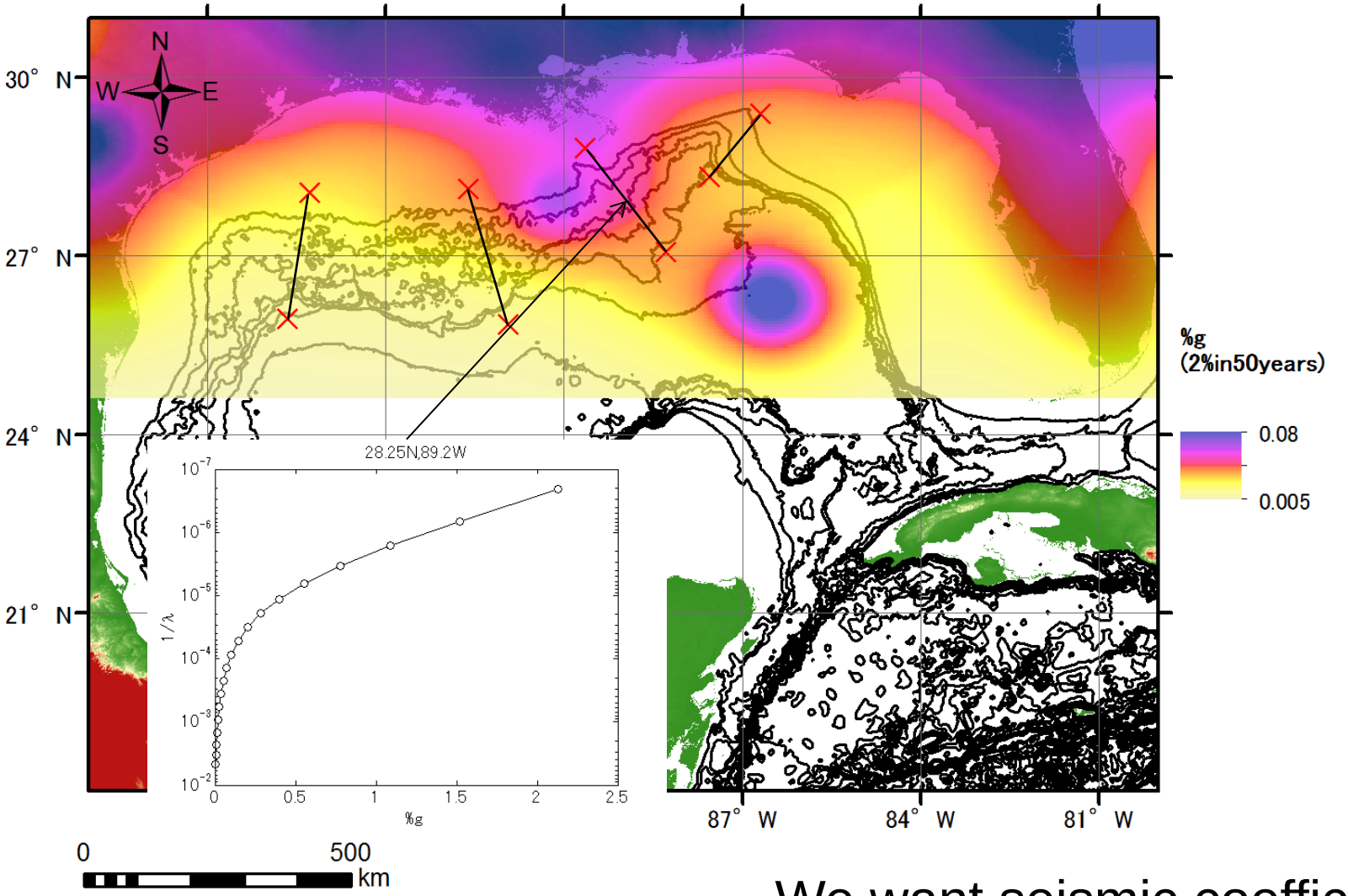
| No | Latitude | Longitude | type | Area | Depth of headscarp : d | Runout (HS to toe) : L | Width : W | W/L | Unfailed adj. slope | Headscarp height : T | Slide volume | HS/RO (Headscarp/ Runout) | Volume | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | degrees | degrees | | sq. km | m | km | km | | degrees | m | cubic km | unitless | cubic km | |
| 1 | 26.25 | −93 | Disint. | 452 | −1918 | 49 | 9.2 | 0.2 | 1.1 | 60 | 8.9 | 0.00122 | 13.6 | |
| 2 | 27.42 | −92.49 | Slump | 44 | −1423 | 3.8 | 11.6 | 3.0 | 2.1 | 140 | 2 | 0.03684 | 3.1 | |
| 3 | 27.39 | −92.37 | Disint. | 29 | −1469 | 12 | 2.4 | 0.2 | 3 | 111.7 | 1.1 | 0.00931 | 1.6 | |
| 4 | 27.4 | −92.27 | Slump | 62 | −1356 | 12 | 5.2 | 0.4 | 3.1 | 148.3 | 3 | 0.01236 | 4.6 | |
| 5 | 27.3 | −92.19 | Disint. | 48 | −1301 | 5.5 | 8.7 | 1.6 | 5.5 | 75 | 1.2 | 0.01364 | 1.8 | |
| 6 | 26.67 | −92.26 | Disint. | 52 | −2024 | 14 | 3.7 | 0.3 | 5 | 200 | 3.4 | 0.01429 | 5.2 | |
| 7 | 26.67 | −92.19 | Blocky | 15 | −1874 | 8.8 | 1.7 | 0.2 | 11.5 | 160 | 0.8 | 0.01818 | 1.2 | |
| 8 | 26.28 | −92.14 | Disint. | 15 | −2053 | 8.6 | 1.7 | 0.2 | 1.1 | 110 | 0.5 | 0.01279 | 0.8 | |
| 9 | 26.36 | −91.98 | Disint. | 10.3 | −2019 | 3 | 3.4 | 1.1 | 6 | 203.3 | 0.7 | 0.06777 | 1.0 | |
| 10 | 26.74 | −91.61 | Disint. | 1156 | −2150 | 79 | 14.6 | 0.2 | NaN | 263.3 | 100.4 | 0.003 | 152.2 | |
| 11 | 27.29 | −91.41 | Blocky | 9.6 | −1757 | 4.9 | 2.0 | 0.4 | 12 | 160 | 0.5 | 0.03265 | 0.8 | |
| 12 | 27.11 | −91.41 | Disint. | 34 | −1733 | 7.6 | 4.5 | 0.6 | 2.5 | 60 | 0.7 | 0.00789 | 1.0 | |
| 13 | 27.94 | −91.32 | Blocky | 143 | −1076 | 12 | 11.9 | 1.0 | 5 | 176.3 | 8.3 | 0.01469 | 12.6 | |
| 14 | 26.21 | −91.19 | Disint. | 28 | −2399 | 7.3 | 3.8 | 0.5 | 5.1 | 191.7 | 1.8 | 0.02626 | 2.7 | |
| 15 | 27.79 | −91.18 | Blocky | 42 | −1332 | 6.8 | 6.2 | 0.9 | 8.1 | 172.5 | 2.4 | 0.02537 | 3.6 | |
| 16 | 28.03 | −90.95 | Disint. | 70 | −910 | 5.8 | 12.1 | 2.1 | 3.1 | 146.7 | 3.4 | 0.02529 | 5.1 | |
| 17 | 26.51 | −90.88 | Disint. | 148 | −2262 | 12 | 12.3 | 1.0 | 7.5 | 315 | 15.1 | 0.02625 | 23.3 | |
| 18 | 26.72 | −90.72 | Disint. | 55 | −2395 | 7.1 | 7.7 | 1.1 | 9.9 | 255 | 5.6 | 0.03592 | 7.0 | |
| 19 | 27.9 | −90.54 | Disint. | 40 | −1091 | 4.2 | 9.5 | 2.3 | 4.4 | 161.3 | 2.1 | 0.03840 | 3.2 | |
| 20 | 27.57 | −90.24 | Disint. | 748 | −1404 | 45 | 16.6 | 0.4 | 1 | 55 | 13.6 | 0.00122 | 20.6 | |
| 21 | 27.46 | −90.04 | Disint. | 5509 | −2328 | 167 | 33.0 | 0.2 | 1.3 | 53.8 | 97.7 | 0.00032 | 148.2 | |
| 22 | 28.01 | −89.42 | Disint. | 1394 | −2228 | 79 | 17.6 | 0.2 | 1.6 | 73.8 | 33.9 | 0.00093 | 51.4 | |
| 23 | 29.1 | −88.93 | Disint. | 2913 | −1136 | 124 | 23.5 | 0.2 | 2 | 48.3 | 46.4 | 0.00039 | 70.3 | |
| 24 | 29.95 | −87.64 | Disint. | 2460 | −1414 | 111 | 22.2 | 0.2 | 1.3 | 97.5 | 79.1 | 0.00088 | 119.9 | |
| 25 | 30.87 | −87.02 | Disint. | 1098 | −121 | 89 | 12.3 | 0.1 | 1.9 | 60 | 13.1 | 0.00067 | 32.9 | |
| 26 | 27.71 | −94.69 | Disint. | 519 | −150 | 39 | 13.3 | 0.3 | 1.1 | 160 | 21.95 | 0.00410 | 21.95 | East Break |
| 27 | 28.51 | −89.78 | Disint. | 3687 | −250 | 145 | 25.4 | 0.2 | 1 | 300 | 425 | 0.00207 | 425 | Mississippi Ca |
| 28 | 26.09 | −84.75 | Disint. | 647 | −800 | 19 | 34.1 | 1.8 | 5.8 | 150 | 16.2 | 0.00789 | 16.2 | West Florida |
| Mean | 27.5 | −90.9 | | 765.3 | −1513.3 | 38.6 | 11.8 | | 4.2 | 146.7 | 32.5 | | | |
| Standard deviation | 1.1 | 2.0 | | 1334.5 | 661.8 | 48.2 | 9.0 | | 3.3 | 75.1 | 82.1 | | | |
| Median | 27.4 | −91.3 | | 66.0 | −1446.0 | 12.0 | 10.6 | | 3.1 | 149.2 | 4.5 | | | |
| c.o.v. | | | | | 0.44 | 1.25 | | | | 0.51 | | | | |
| c.o.v._Median | | | | | 0.46 | 4.02 | | | | 0.50 | | | | |
| max | | | | | | 167 | | | | 315 | | | | |
| min | | | | | | 3 | | | | 48.3 | | | | |

0.0003≦T/l≦0.07

c.o.v. (coefficient of variance) = STD/Mean

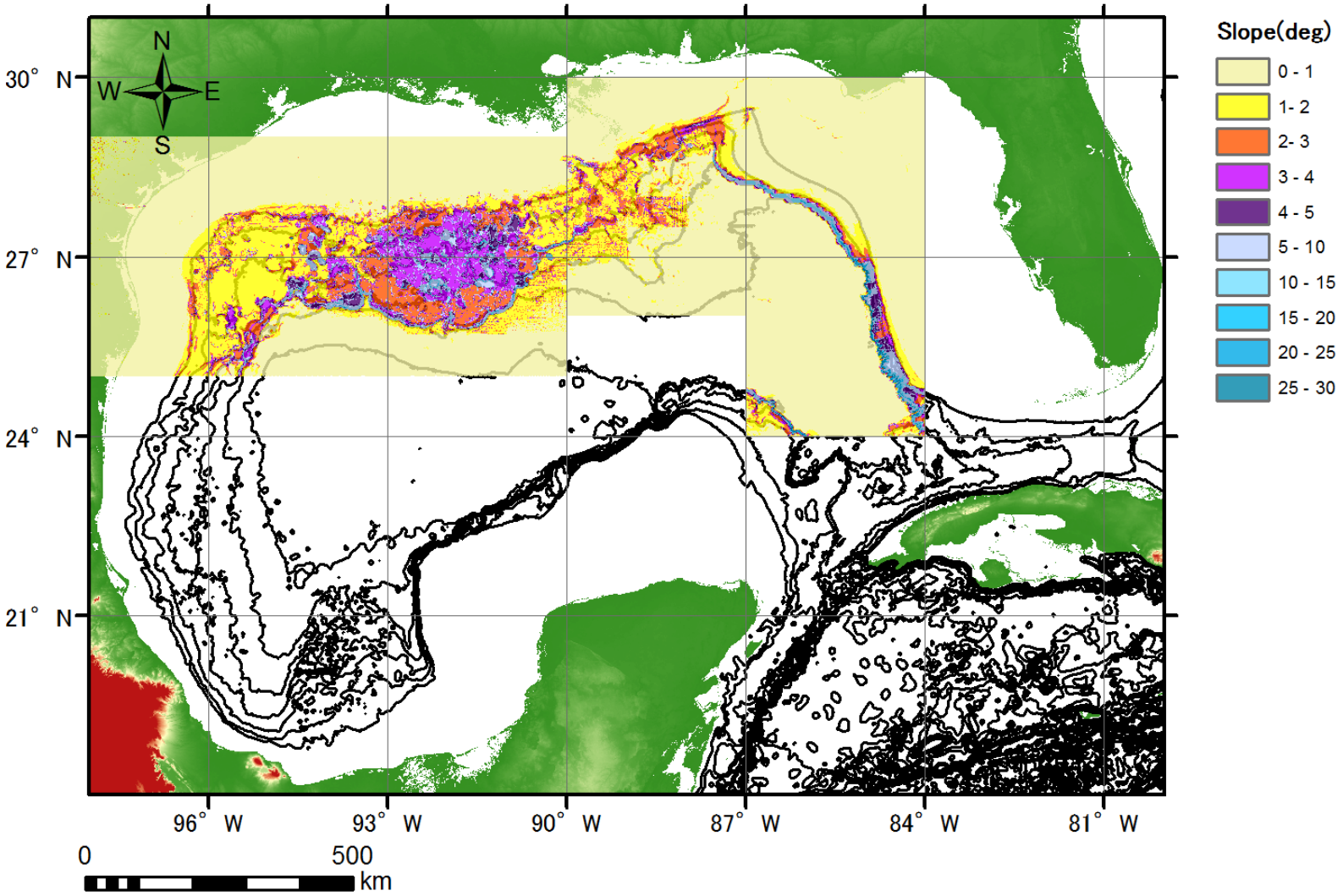
# Seismicity

Peak Horizontal Acceleration (PHA) probability map from USGS(2

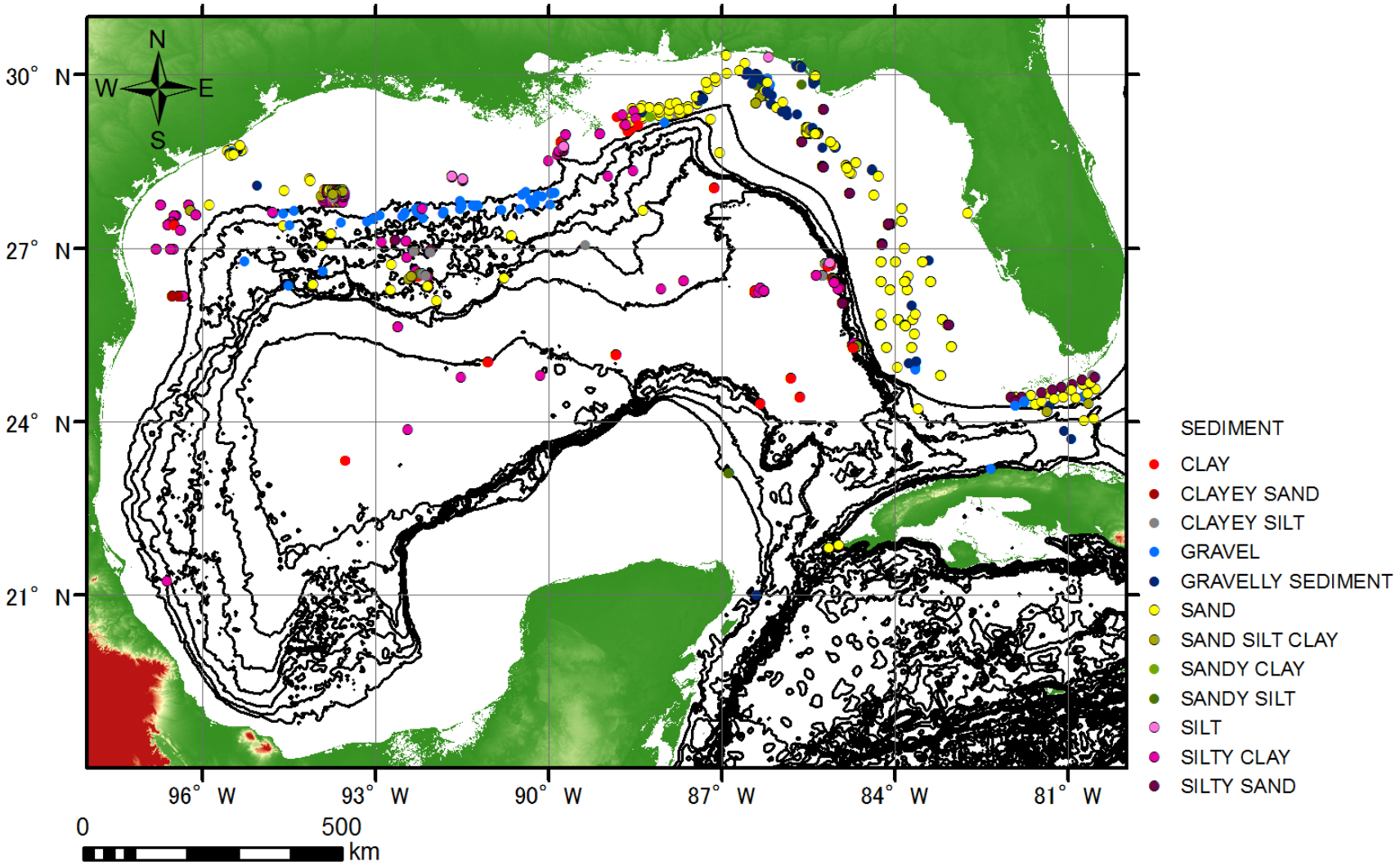



We want seismic coefficient k

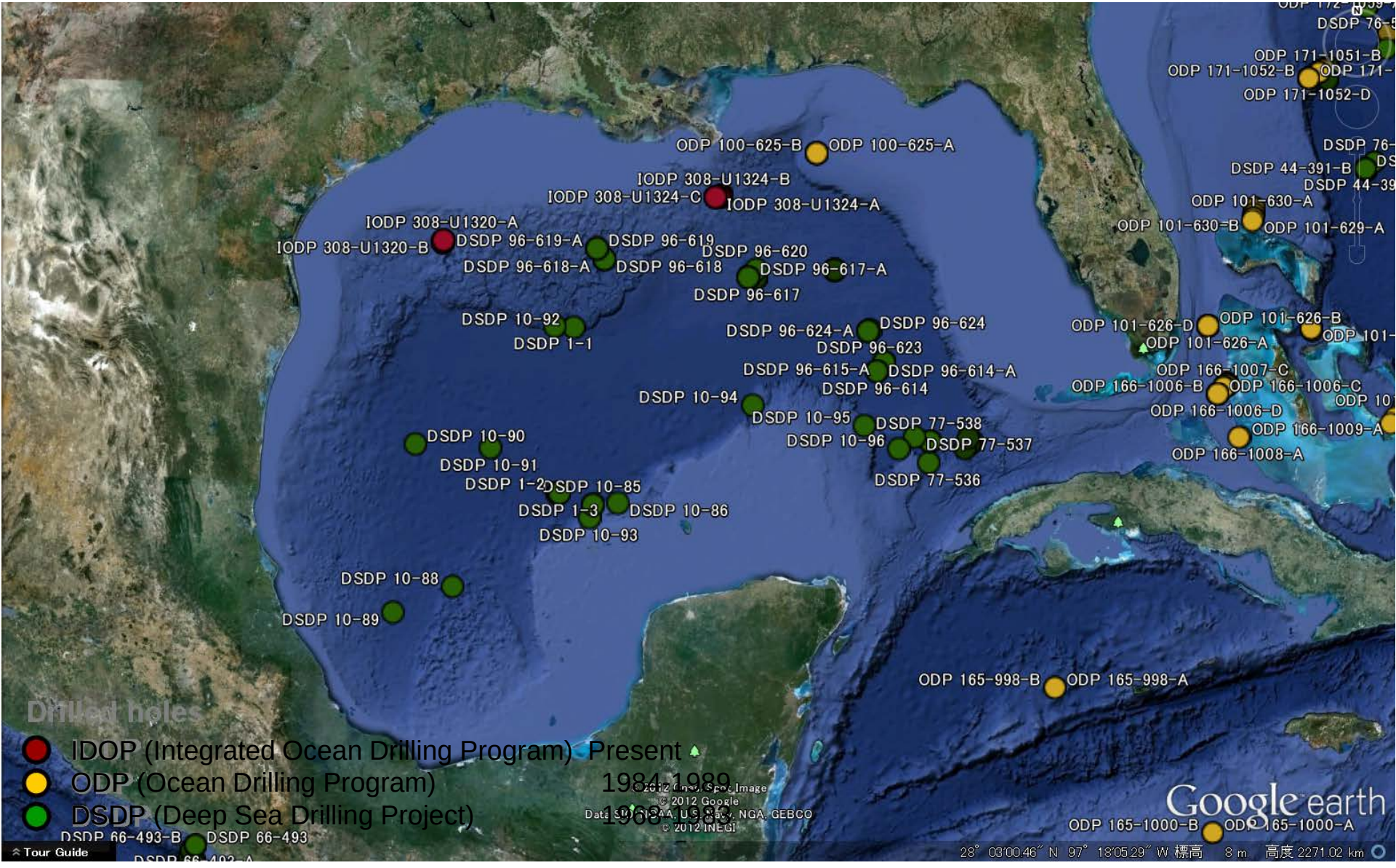
# Distribution of slope angle



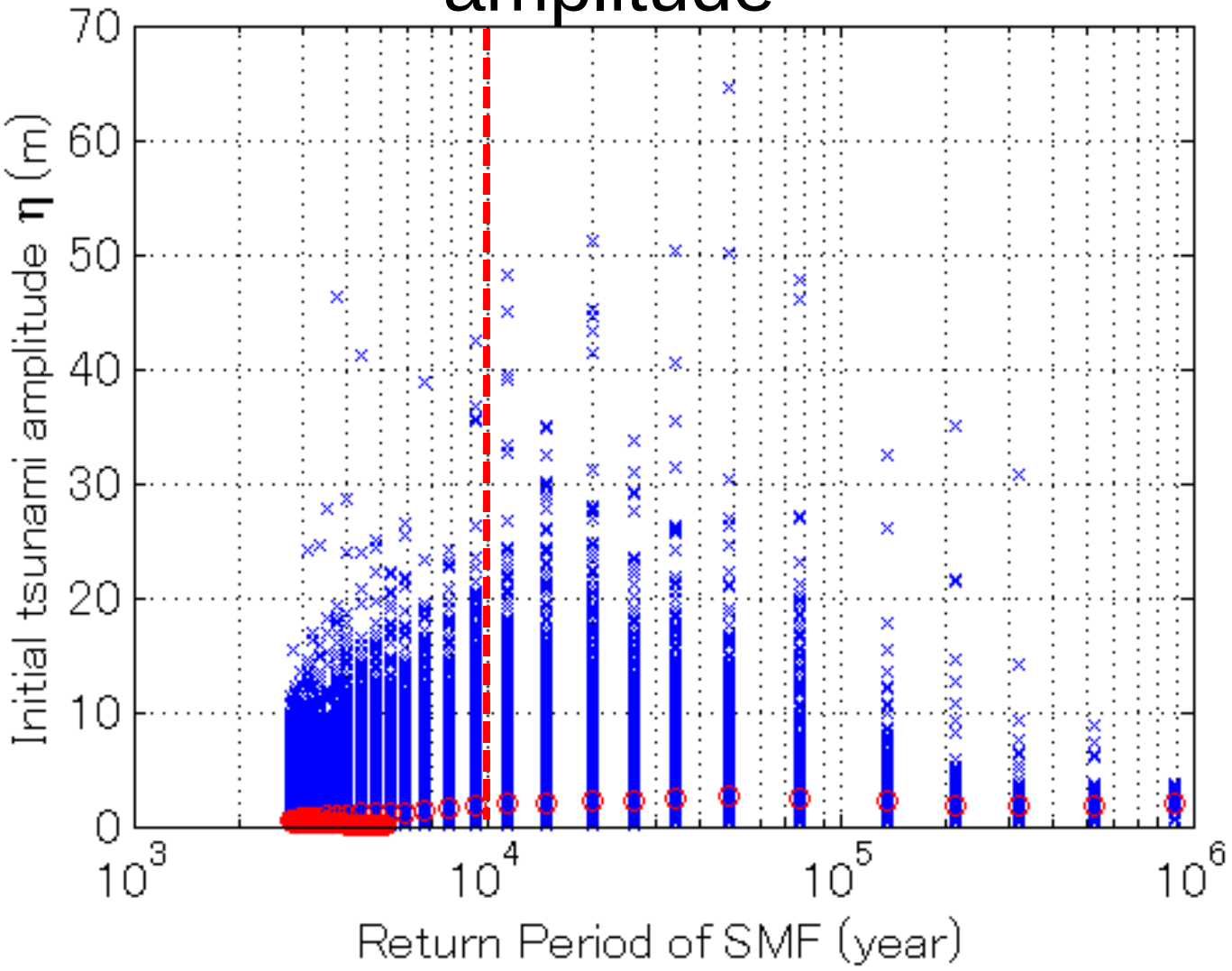
# Distribution of Sediment



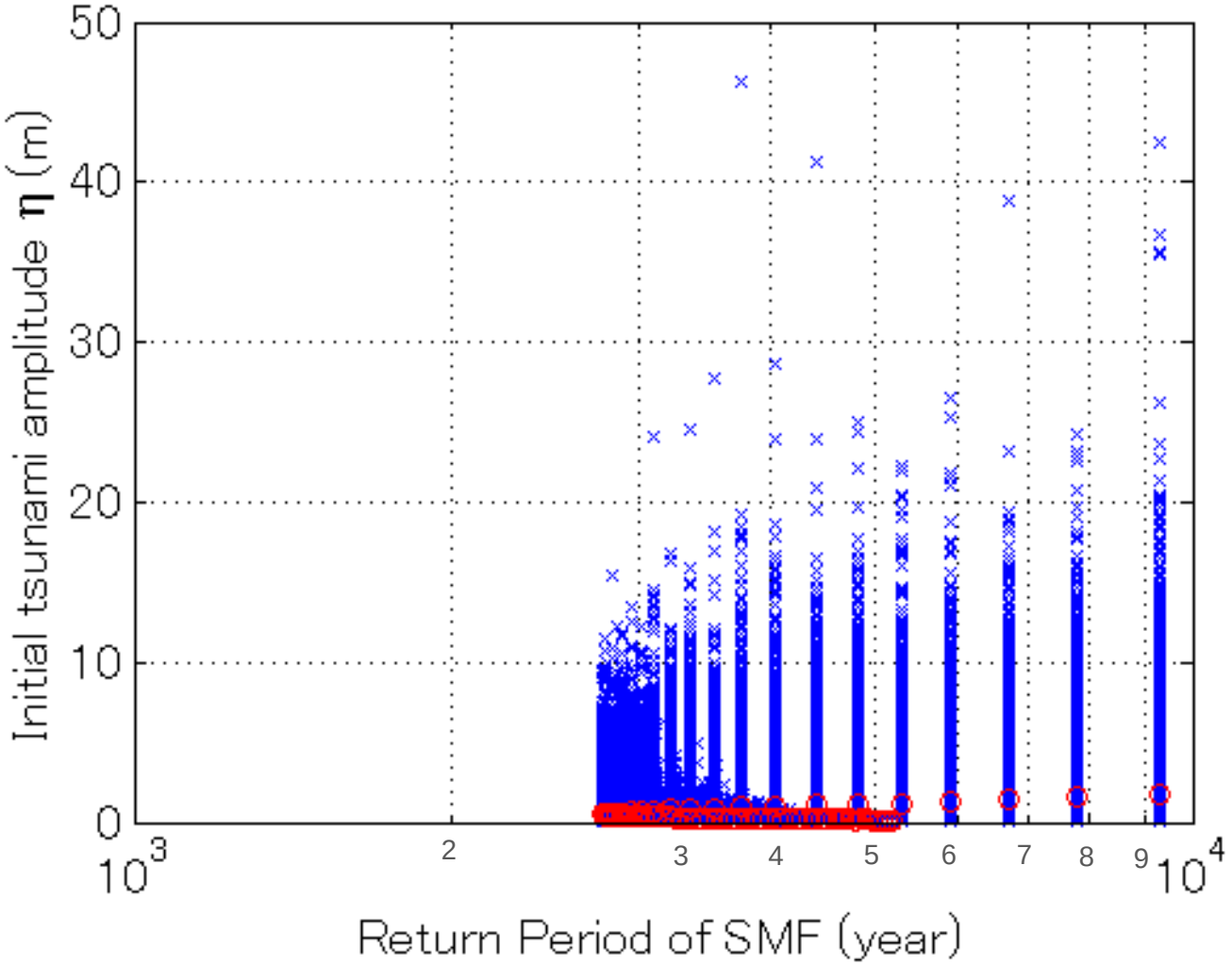
# Publicly available Soil data (GOM )



# Relationship between Return Period of SMF and Initial tsunami amplitude



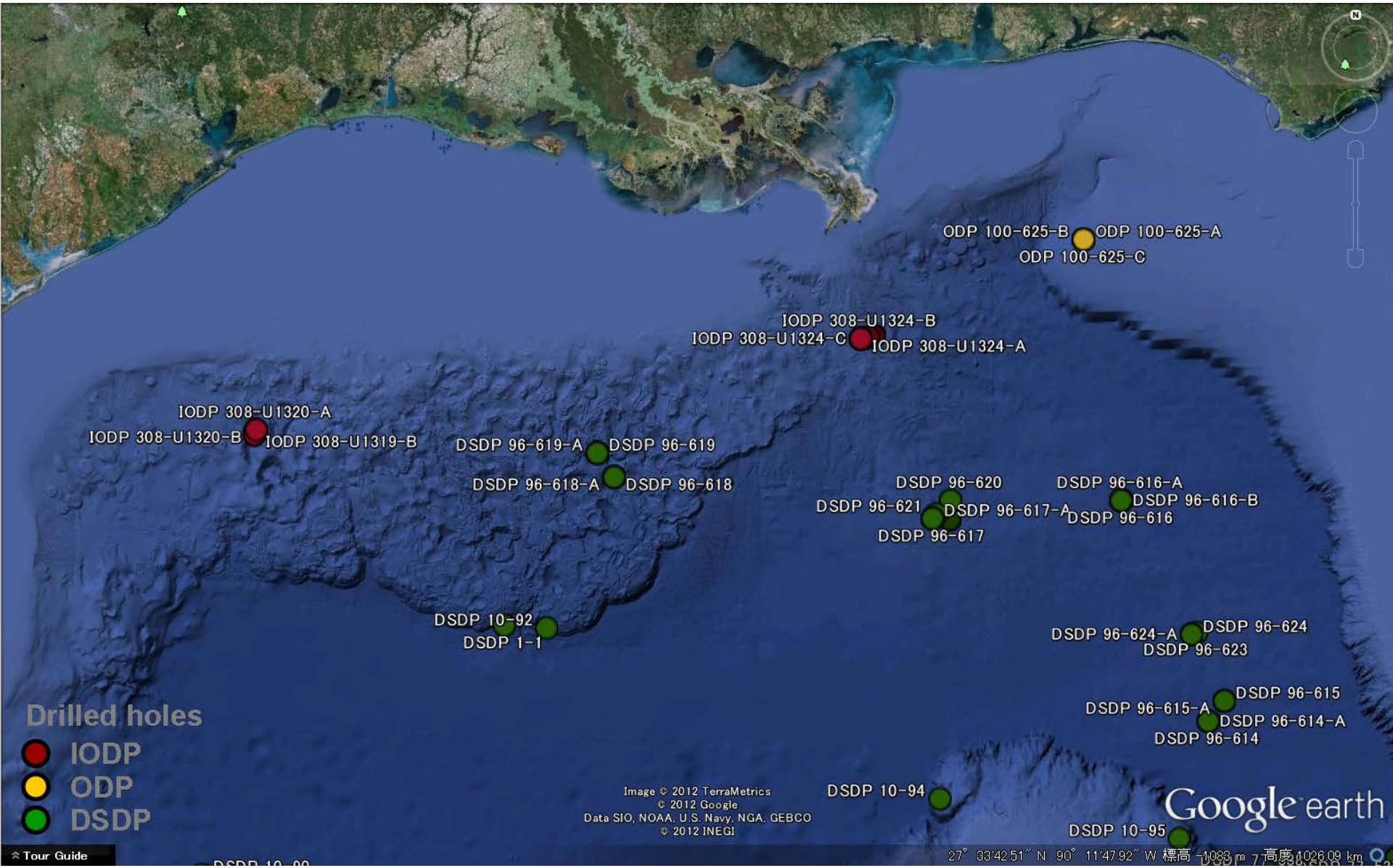
# Relationship between Return Period of SMF and Initial tsunami amplitude



# Conclusion

- A  probabilistic methodology (MCS) has been integrated to obtain tsunami sources and inundation (runup) for the construction of tsunami maps in the GOM
- Four transects with soil information  has been incorporated into the probabilistic approach
- Six (6) additional transects will be added for a total of ten (10)
- Tsunami inundation maps in five (5) locations in the GOM will be determine for 500, 2500, 5000, 10000 years period of recurrence

# Publicly available boring data



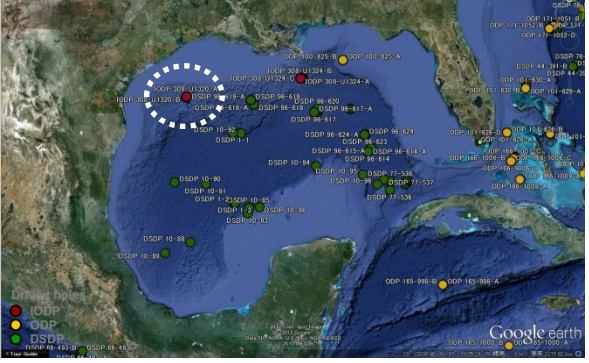
# What kinds of data we need ?

## Ocean Drilling Data - Leg 308

### Data Overview

Moratorium Login | Janus Paleo Dictionaries

| ANALYSIS | Site Total | 1324 | 1323 | 1322 | 1321 | 1320 | 1319 |
|---|---|---|---|---|---|---|---|
| Site/Hole Summary (meters recovered) | 1300 | 625 | 0 | 269 | 0 | 251 | 155 |
| Hole/Core Summary (cores) | 192 | 91 | 1 | 46 | 1 | 34 | 19 |
| Core/Section Summary (sections) | 1095 | 526 | 0 | 227 | 0 | 213 | 129 |
| Corelog (samples) | 11215 | 4519 | 0 | 2347 | 0 | 1974 | 2375 |
| GRA Bulk Density (sections) | 941 | 456 | 0 | 183 | 0 | 180 | 122 |
| Magnetic Susceptibility (sections) | 941 | 456 | 0 | 184 | 0 | 179 | 122 |
| Natural Gamma Radiation (sections) | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| P-Wave Vel (Whole Core) (sections) | 329 | 207 | 0 | 121 | 0 | 0 | 1 |
| P-Wave Vel (Split Core) (samples) | 314 | 215 | 0 | 58 | 0 | 12 | 29 |
| Moisture Density (samples) | 1019 | 511 | 0 | 216 | 0 | 174 | 118 |
| Thermcon (samples) | 168 | 79 | 0 | 40 | 0 | 31 | 18 |
| Shear Strength (samples) | 480 | 207 | 0 | 135 | 0 | 84 | 54 |
| Color Reflectance (sections) | 951 | 448 | 0 | 201 | 0 | 185 | 117 |
| Point Susceptibility - MS2F (sections) | 938 | 438 | 0 | 198 | 0 | 184 | 118 |
| Downhole Temp. - Adara (samples) | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Splicer (tie points) | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Tensor (cores) | 85 | 45 | 0 | 23 | 0 | 6 | 11 |
| Cryomag (sections) | 817 | 365 | 0 | 164 | 0 | 170 | 118 |
| Paleo Investigation (samples) | 287 | 156 | 0 | 30 | 0 | 65 | 36 |
| Range Table (taxa) | 1903 | 1090 | 0 | 10 | 0 | 489 | 314 |
| Age Profile (datum list) | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Depth-Age Model | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| X-Ray Diffraction (samples) | 31 | 8 | 0 | 14 | 0 | 3 | 6 |
| XRD Images (samples) | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| X-Ray Fluorescence (samples) | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ICP (samples) | 56 | 0 | 0 | 0 | 0 | 12 | 44 |
| Chem: Rock Eval (samples) | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Chem: Carbonates (samples) | 209 | 68 | 0 | 48 | 0 | 43 | 50 |
| Chem: Gas Elements (samples) | 147 | 72 | 0 | 26 | 0 | 31 | 18 |
| Chem: Interstitial Water (samples) | 203 | 68 | 0 | 47 | 0 | 40 | 48 |
| Smear Slides (samples) | 141 | 55 | 0 | 24 | 0 | 26 | 36 |
| Sedimentary Thin Sections (samples) | 0 | 0 | 0 | 0 | 0 | 0 | 0 |



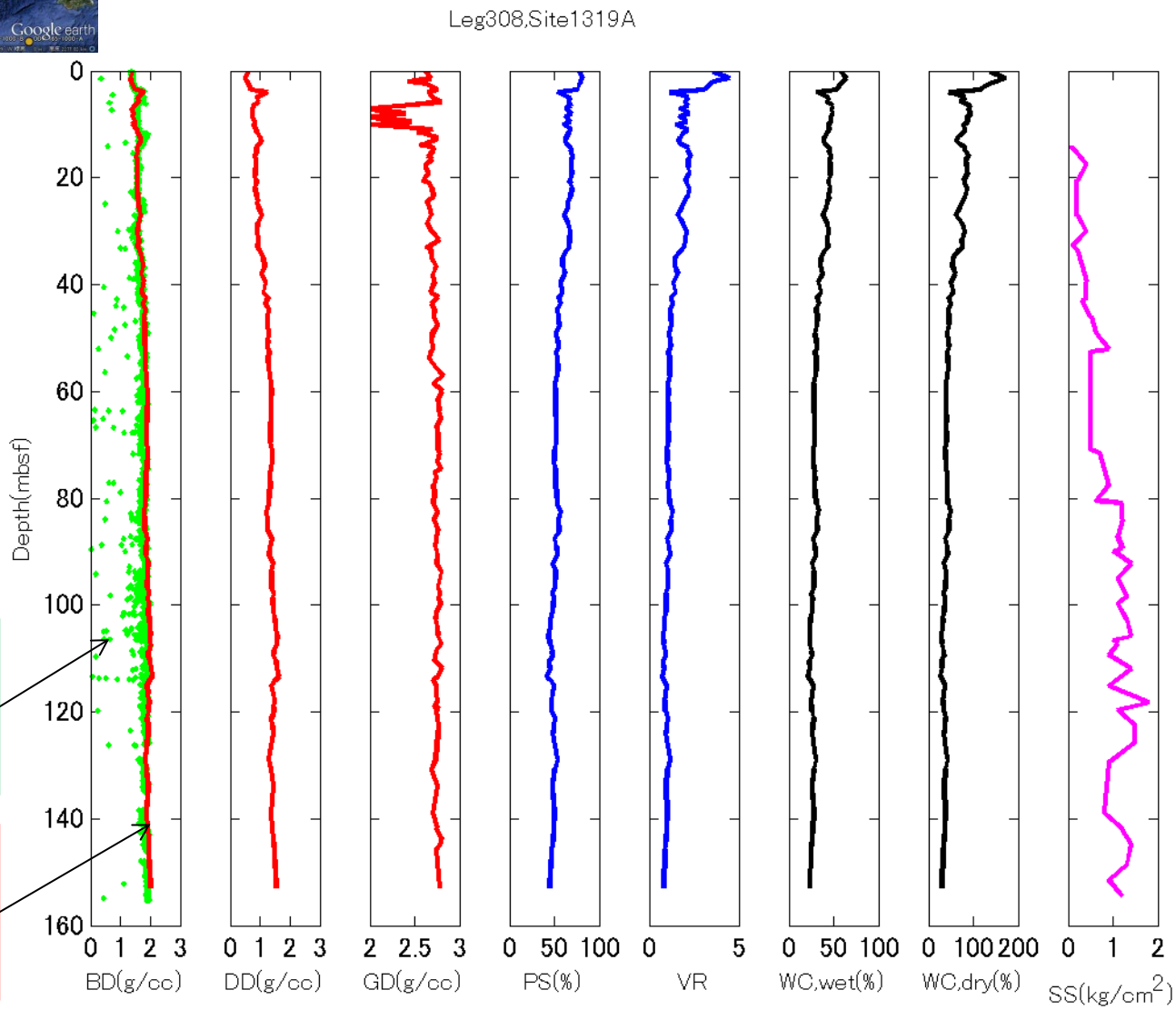

# IDOP Leg308, Site1319A

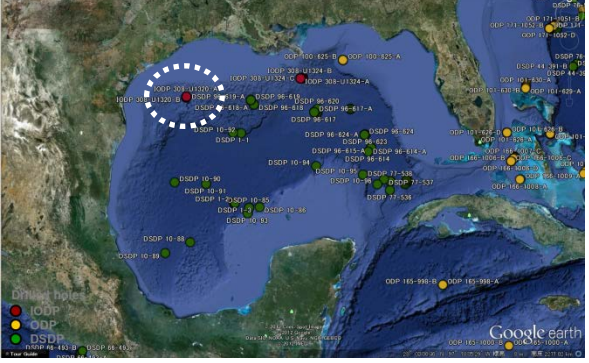
## Water Depth(mbsl) = 1429.6 m

Where,
BD: Bulk Density
DD: Dry Density
GD: Grain Density
PS: Porosity
VR: Void Ratio
WC: Water Content
SS: Shear Strength
(=2Su)

Green plot
BD by Gamma-Ray Densiometry

Red plot
BD estimated by gas pycnometry

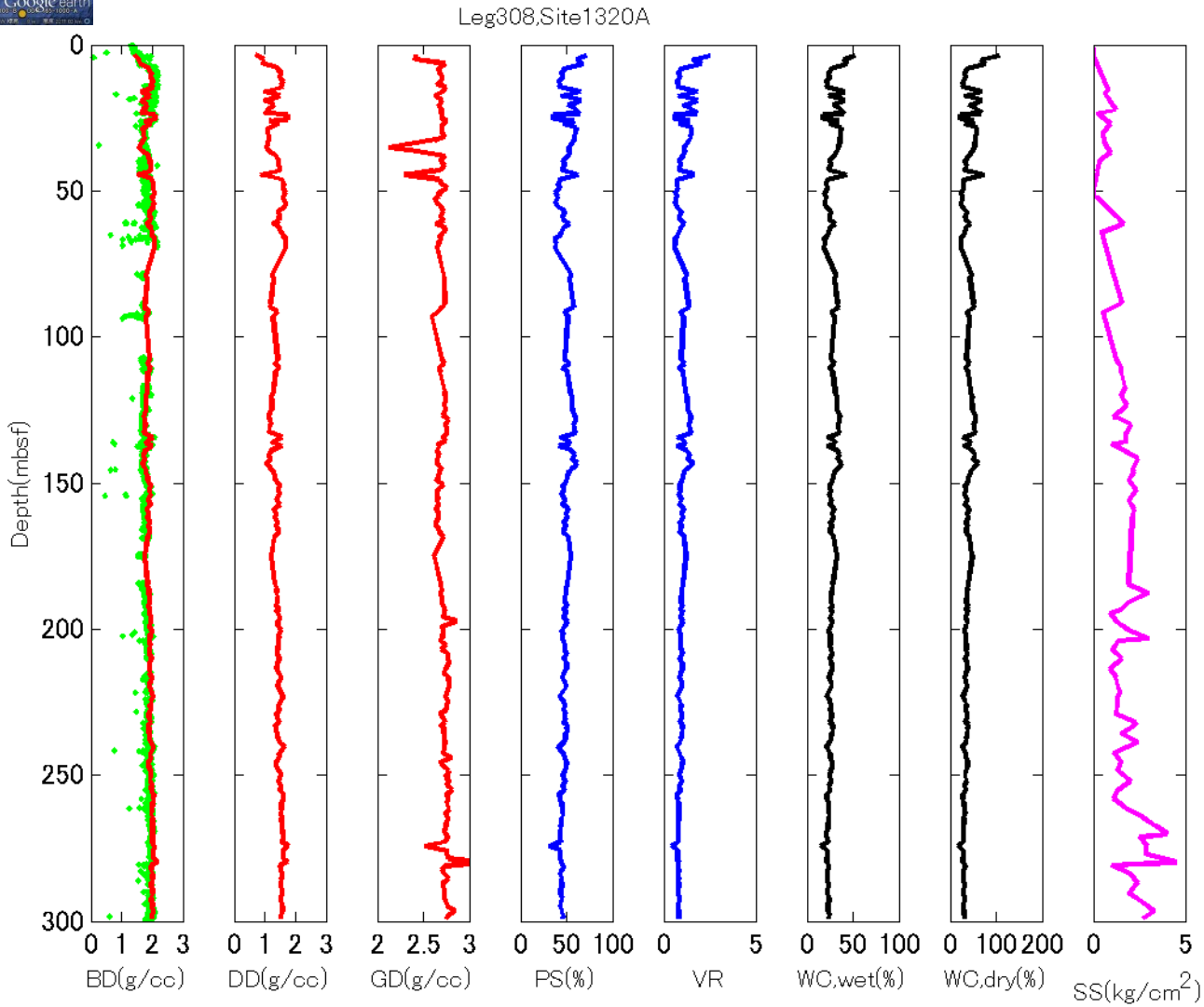


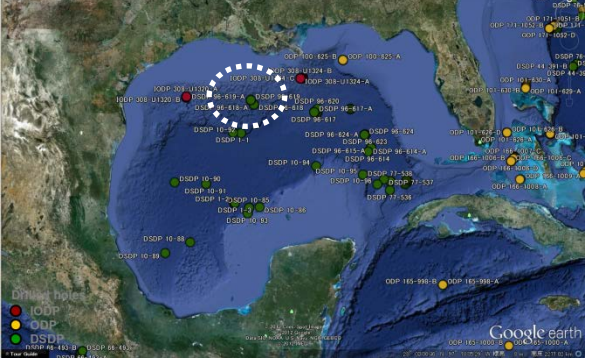



# IDOP Leg308, Site1320A

Water Depth(mbsl) = 1470.0 m

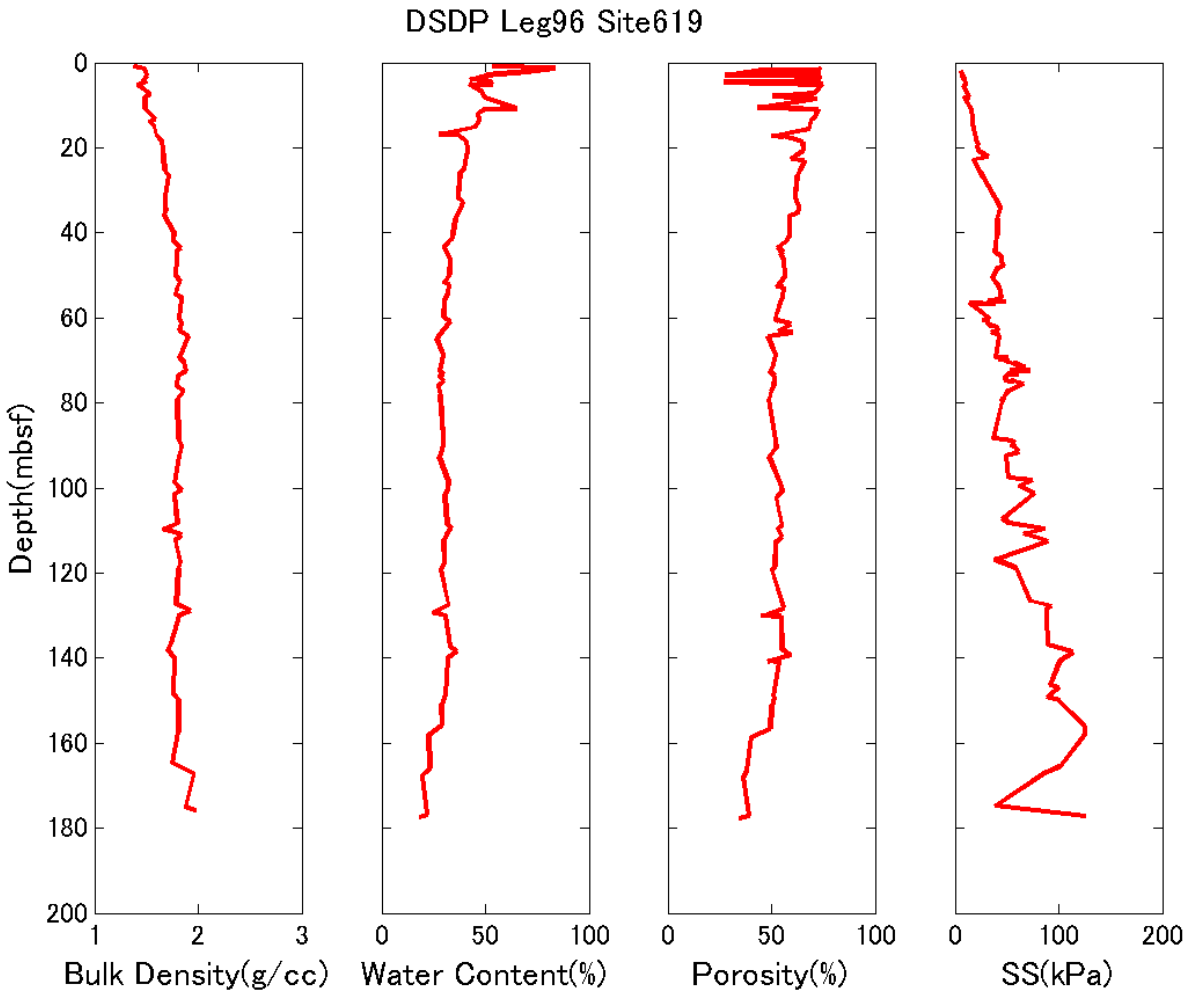
Where,
BD: Bulk Density
DD: Dry Density
GD: Grain Density
PS: Porosity
VR: Void Ratio
WC: Water Content
SS: Shear Strength
(=2Su)

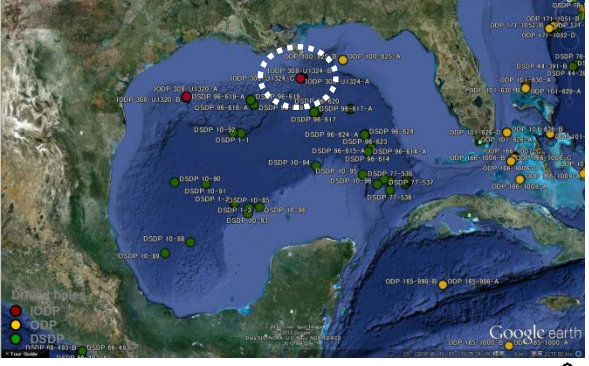





# DSDP Leg96, Site619

Water Depth(mbsl) = 2259 m

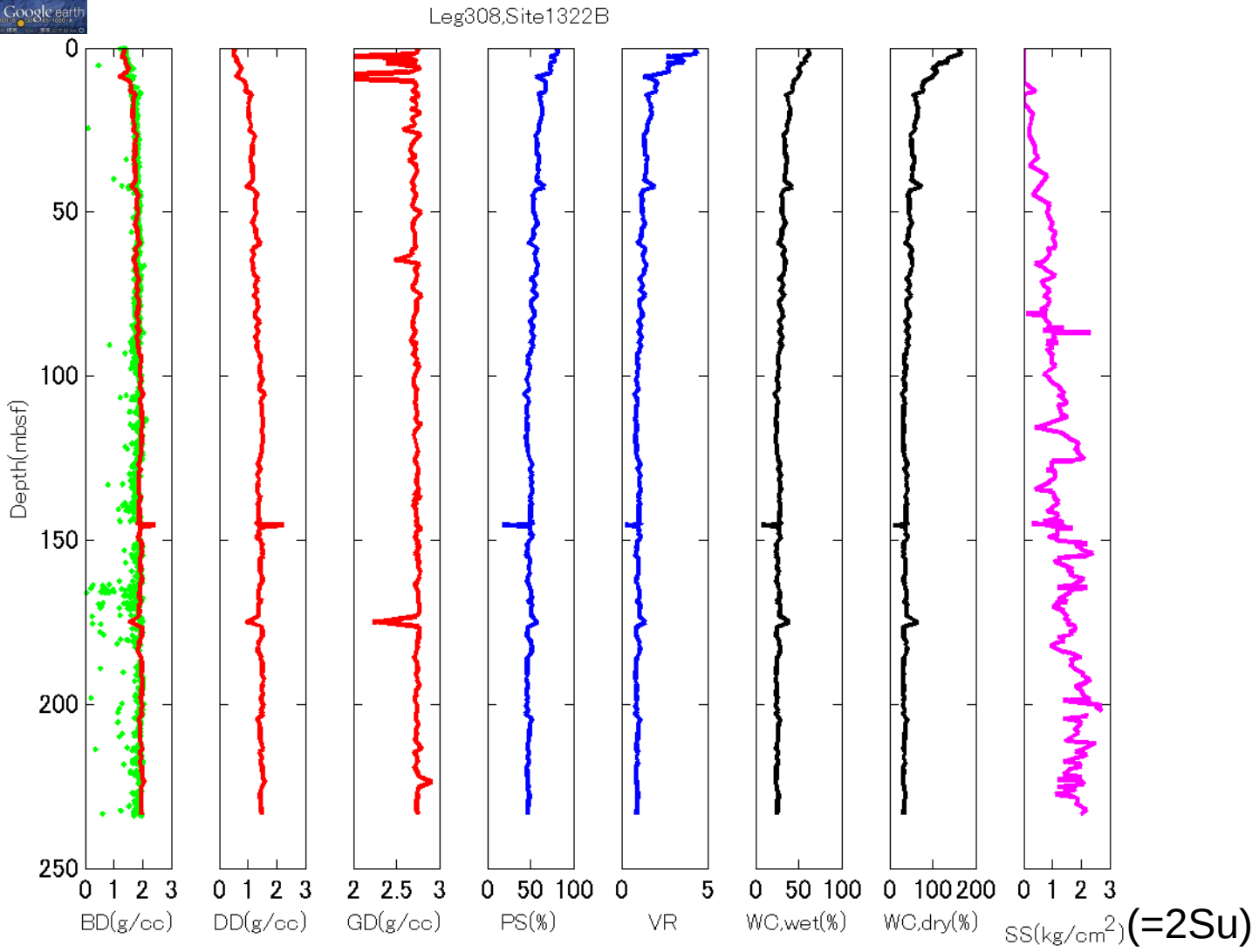


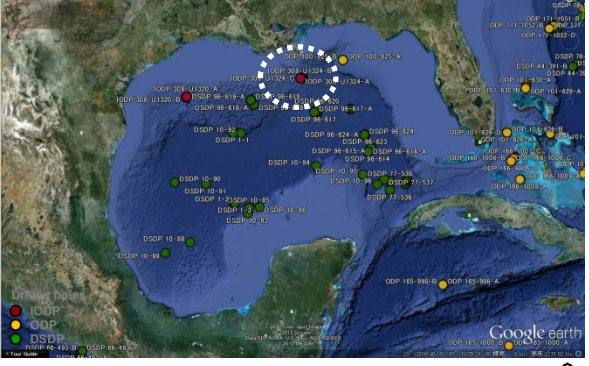



# IDOP Leg308, Site1322B

Water Depth(mbsl) = 1319.5 m

Where,
BD: Bulk Density
DD: Dry Density
GD: Grain Density
PS: Porosity
VR: Void Ratio
WC: Water Content
SS: Shear Strength
(=2Su)

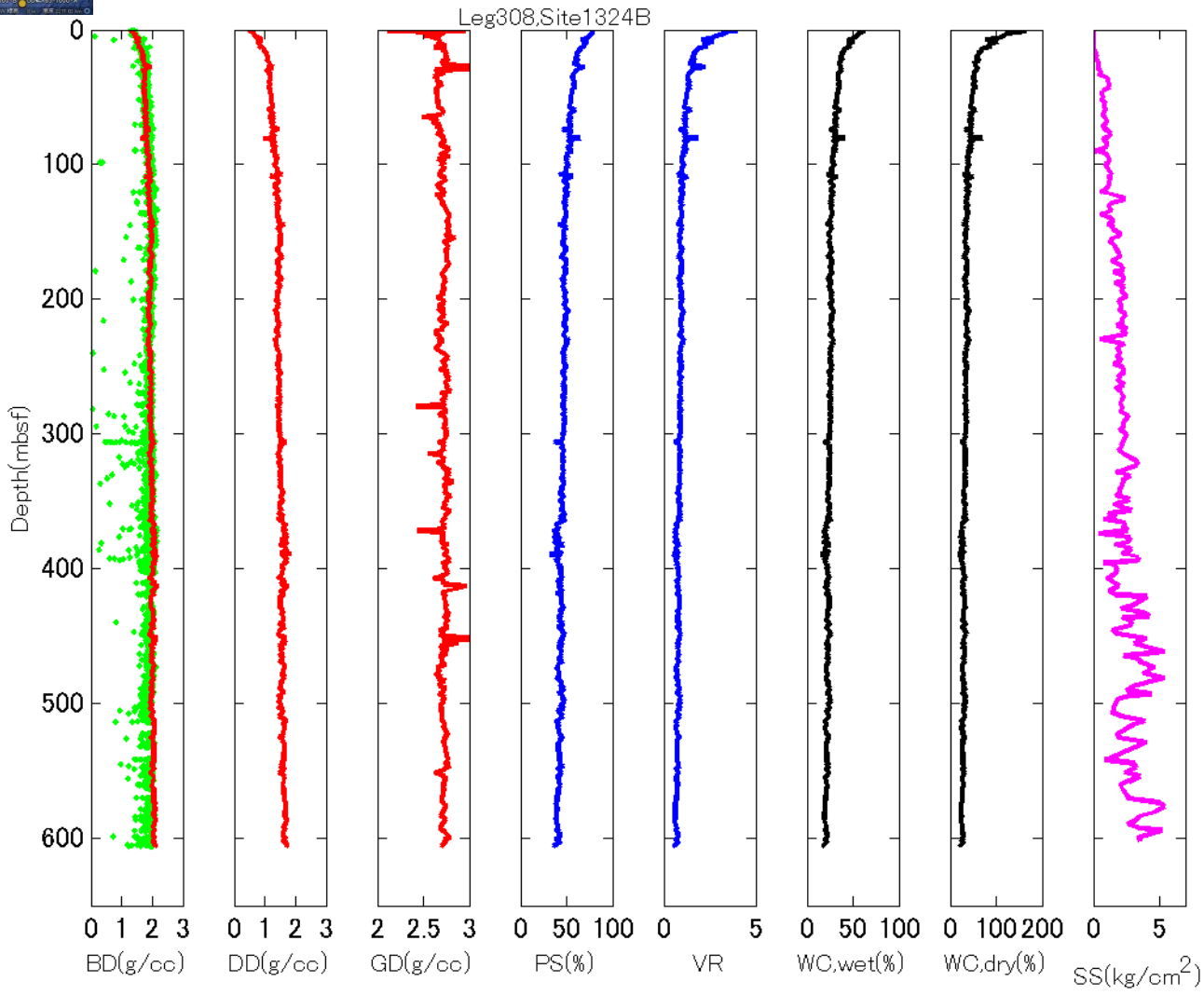


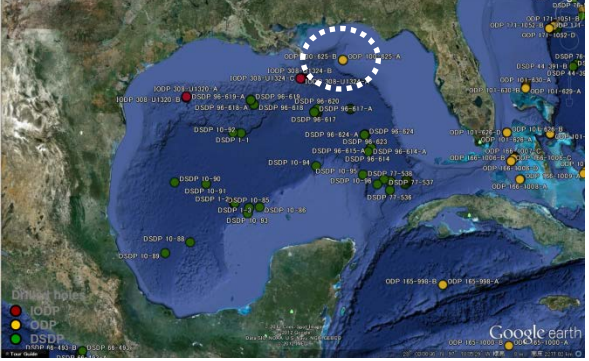



# IDOP Leg308, Site1324B

Water Depth(mbsl) = 1056.8 m

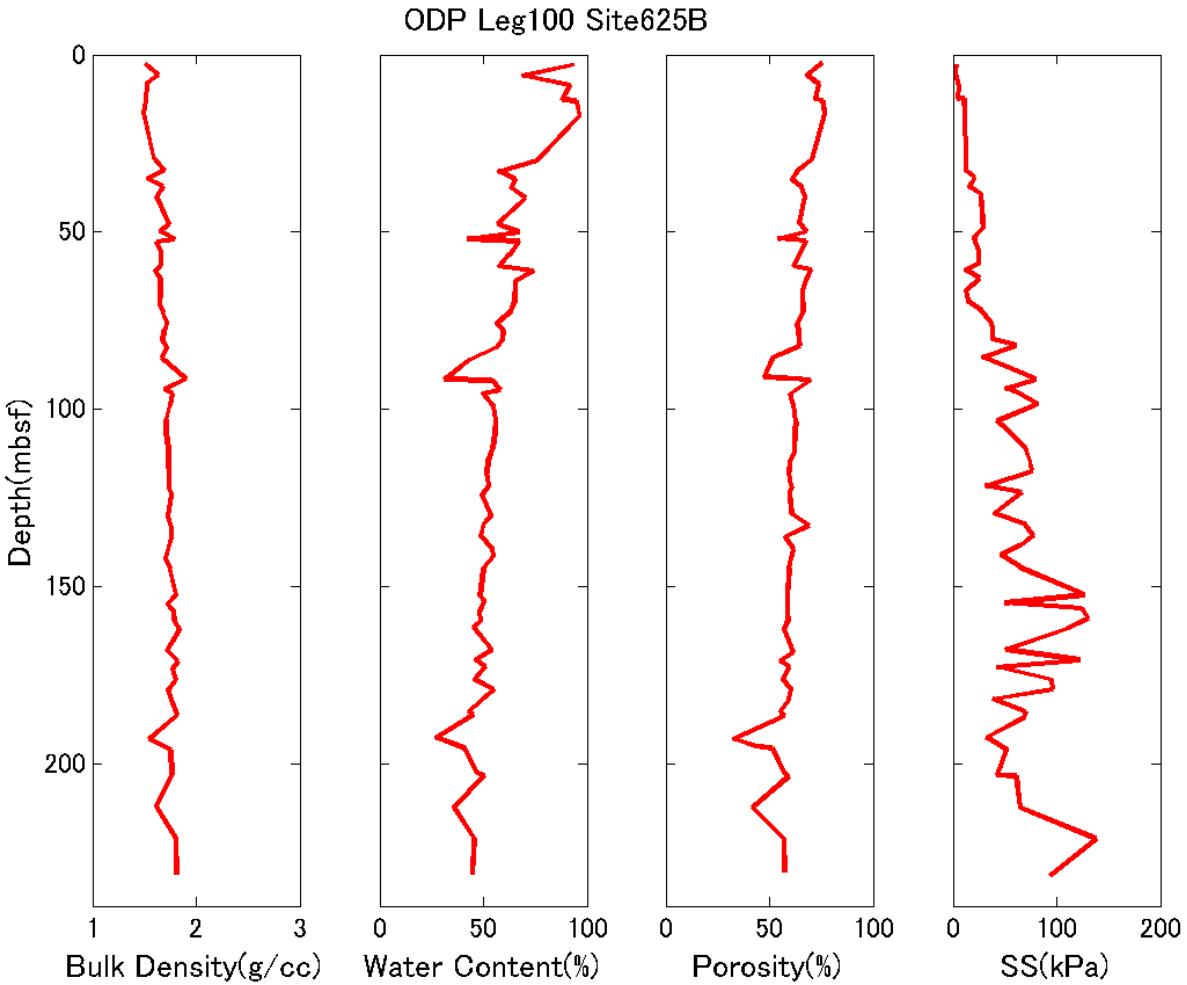
Where,
BD: Bulk Density
DD: Dry Density
GD: Grain Density
PS: Porosity
VR: Void Ratio
WC: Water Content
SS: Shear Strength
(=2Su)






# ODP Leg100, Site625B

Water Depth(mbsl) = 889.5 m



# Dataset

Bathymetric chart

- GEBCO08 : 30 arc-second grid
- Coastal Relief Model (CRM) : 3 arc-second grid, from NOAA

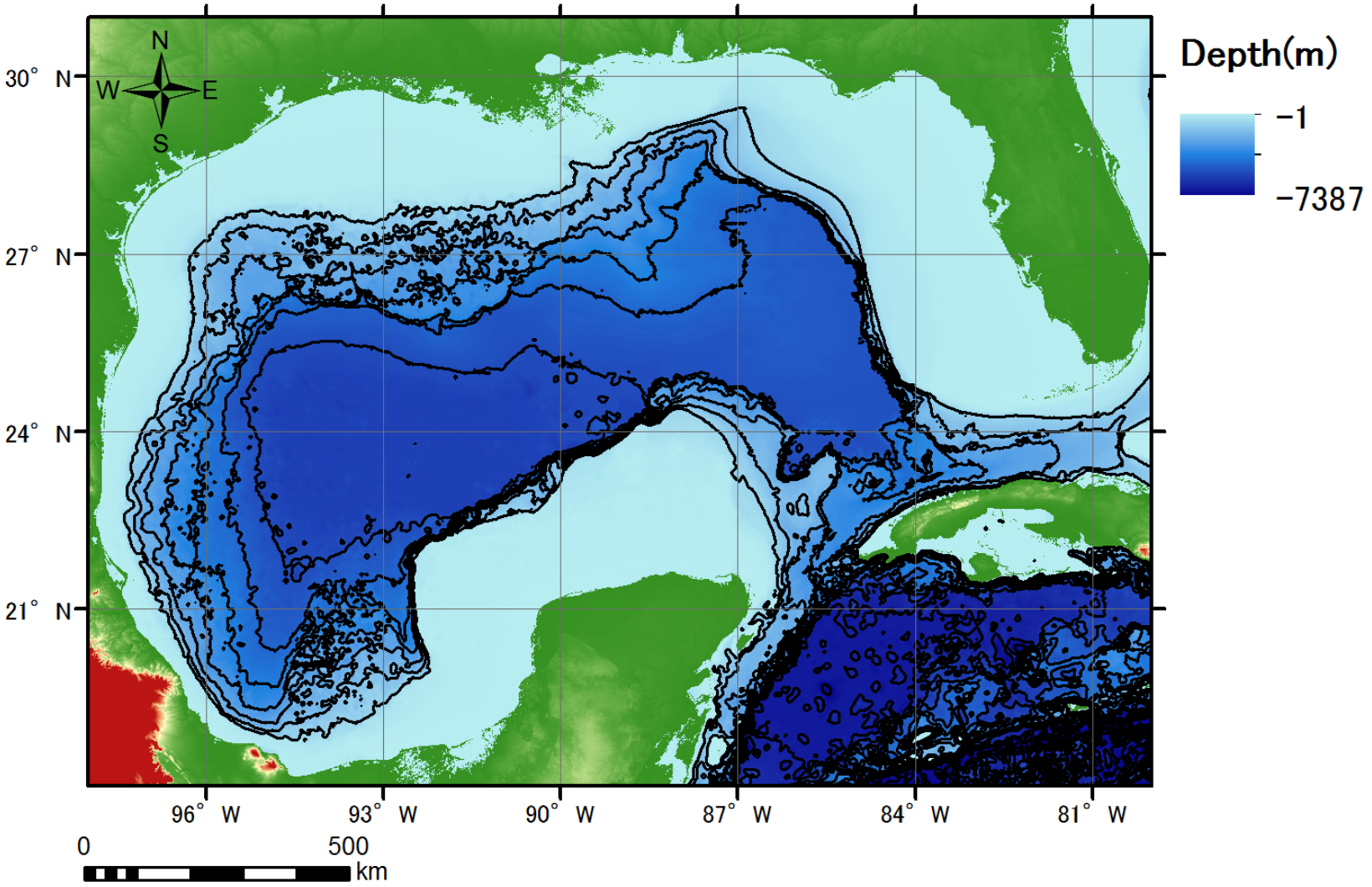
Geological data

- usSEABED: Gulf of Mexico and Caribbean Offshore Surficial Sediment Data Release, Ver.1.0 from USGS

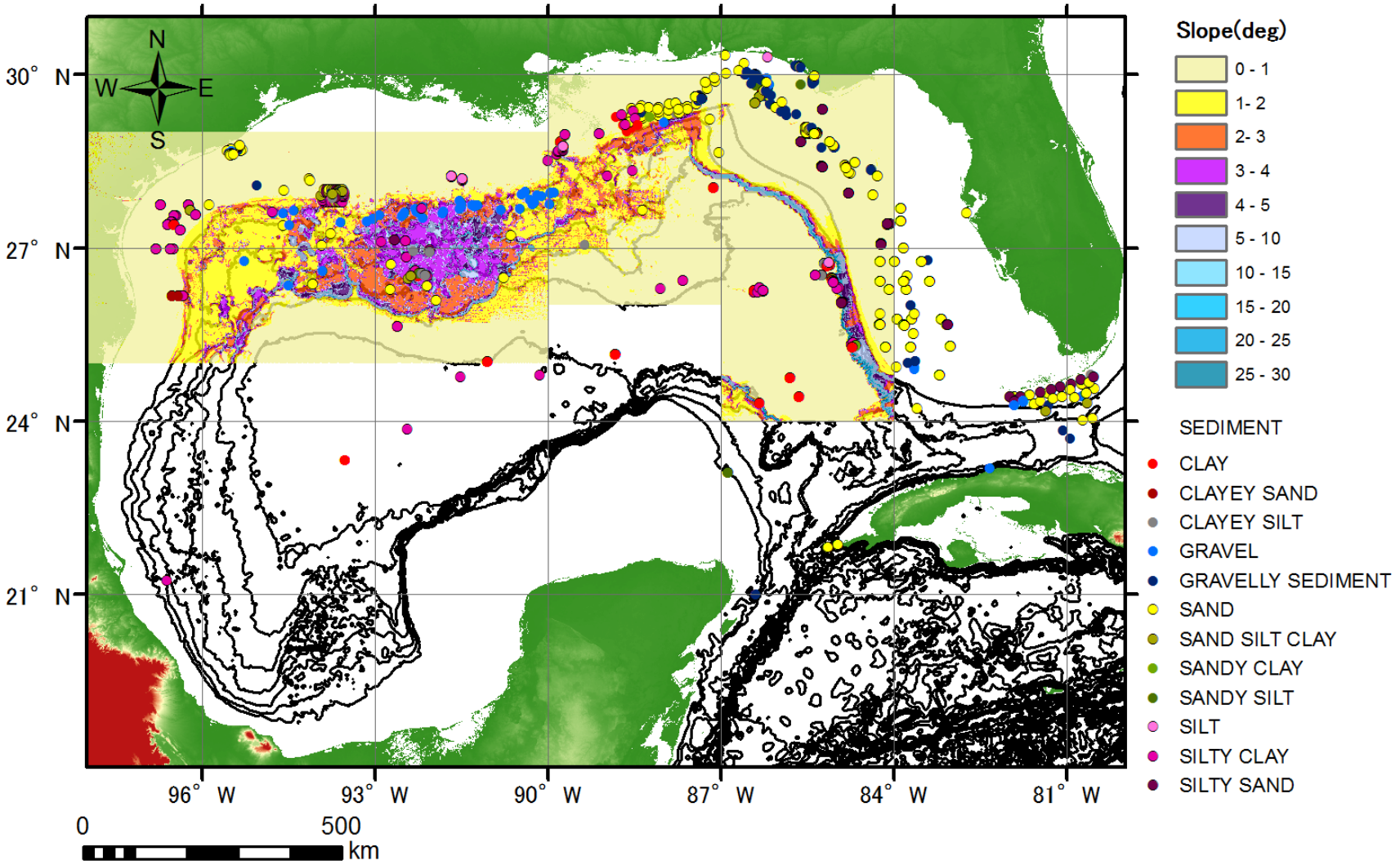
# Data analysis procedure for slope

- Used data : CRM
- Used software to plot data : ArcGIS 10
- Function tool ‘slope’ is used to calculate slope angle
- Function tool ‘Fill’ is applied to smooth the surface of slope
- Coordinate system : UTM for calculation of slope and then, transform from UTM to Spherical coordinate (WGS84) for plot on ArcGIS

# Sea depth of the GOM

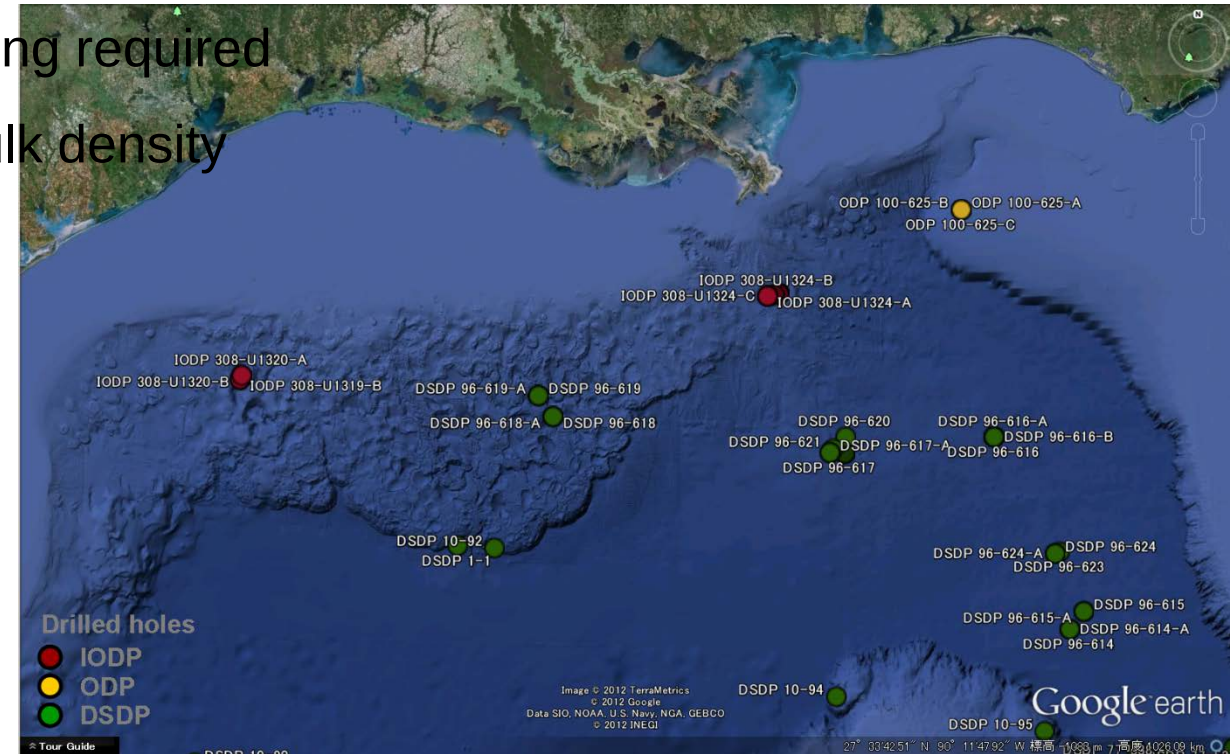


# Slope and Sediment distribution



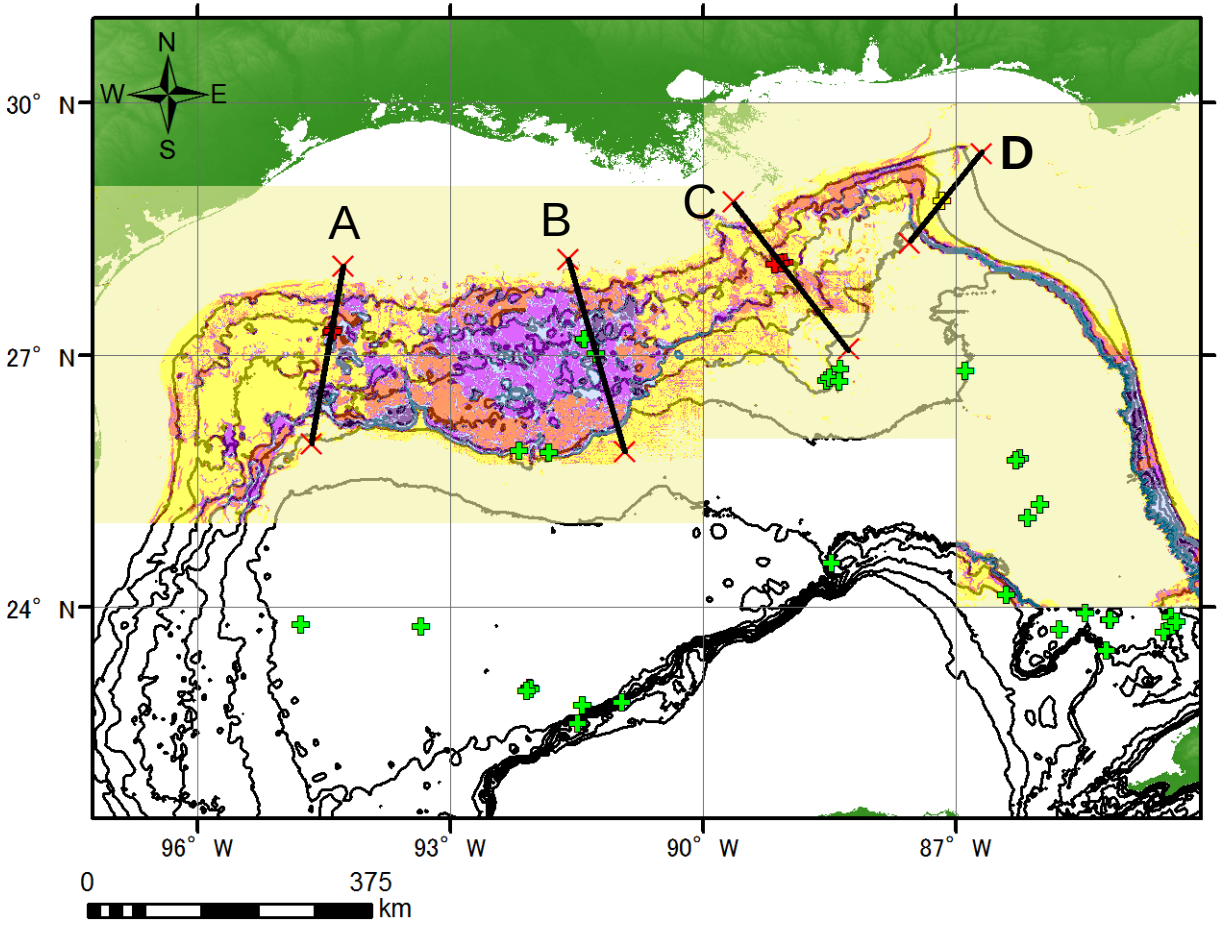
# Data Points and available data

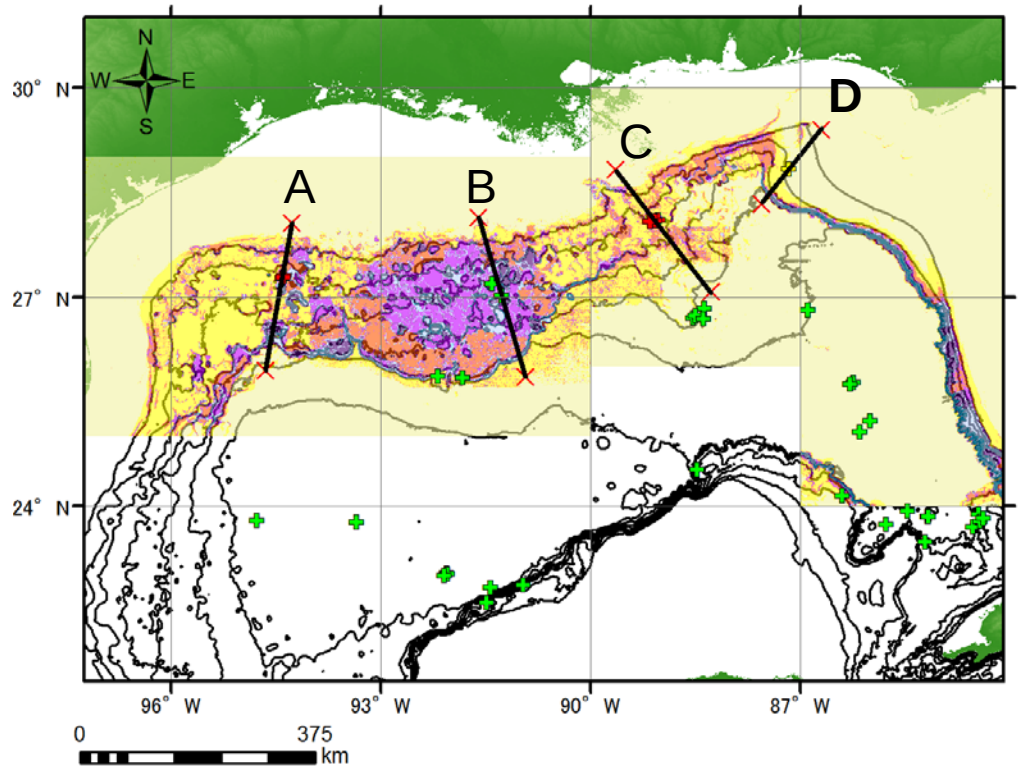
- IDOP Expedition 308, Site 1319 – 1324
  - ✓ Report(PDF files), digital data
- ODP  Leg 100, Site 625
  - ✓ Report(PDF), digitizing required
- DSDP Leg 96, Site 619 (614-624, actually)
  - ✓ Report(PDF), digitizing required
  - ✓ Digital data : only bulk density



# Bathymetry for transects

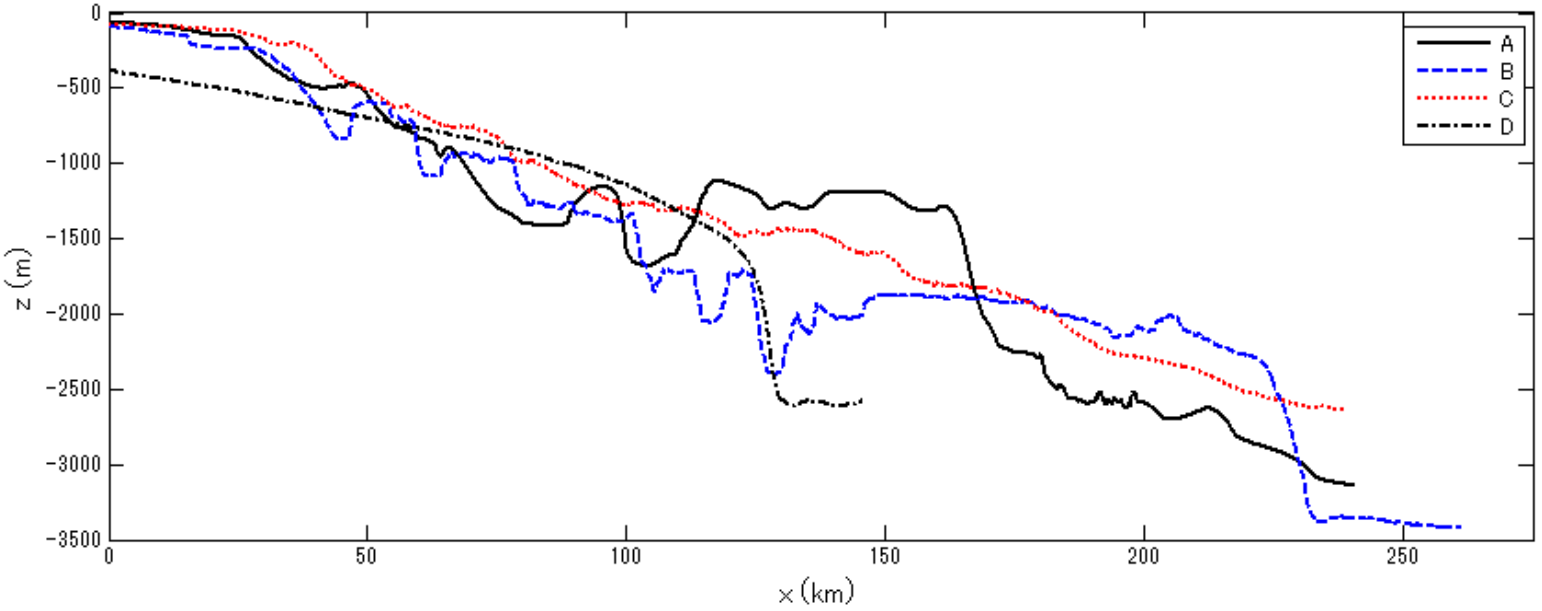
transect A : IDOP Leg308, Site1319A&1320A
transect B : DSDP Leg96, Site619
transect C : IDOP Leg308, Site1322B&1324B
transect D : ODP Leg100, Site625B





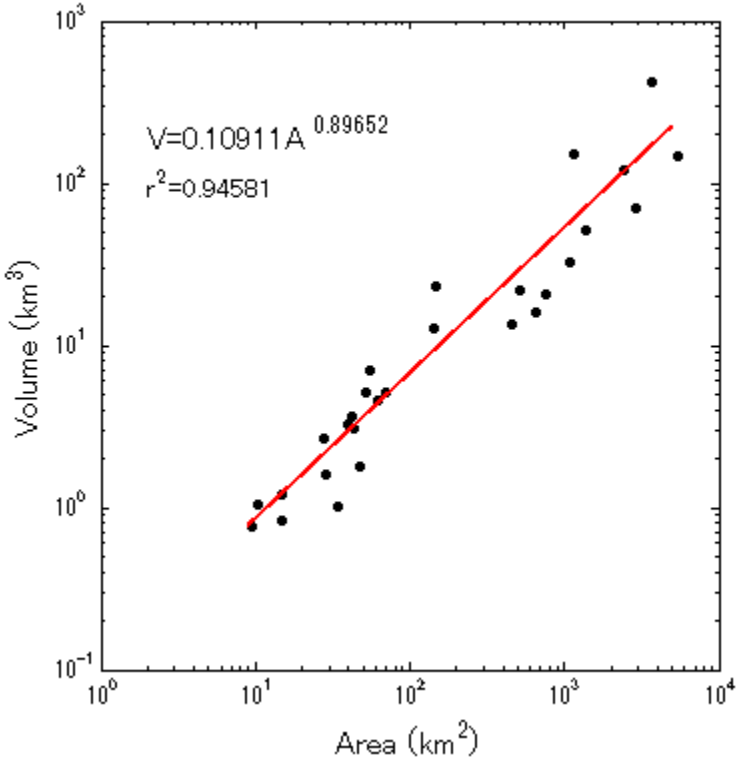

# Most part of slope angle very gentle

Example
500m/50km = 1/100,
Slope angle = arctan(100) = 0.57 degr

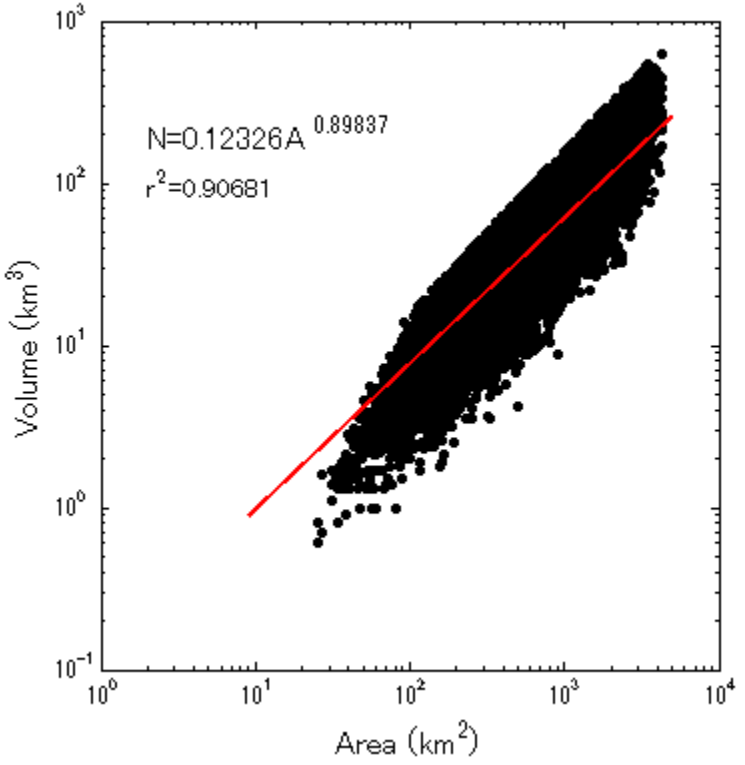


# Relationship between Slide Area and Volume

Observation




Result of the MCS : Case1
Limitation of L=167km,
T=315m, n = 20,000



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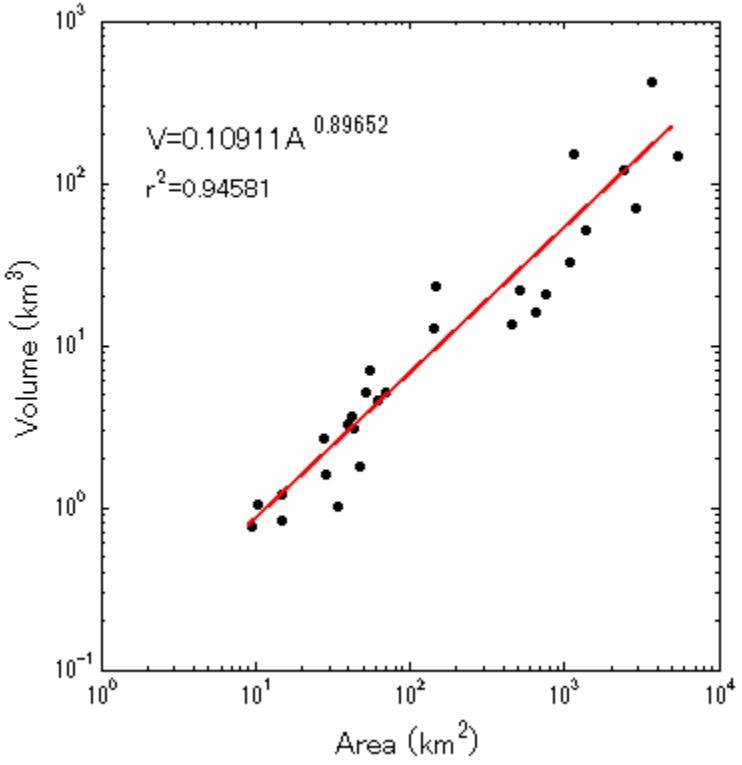


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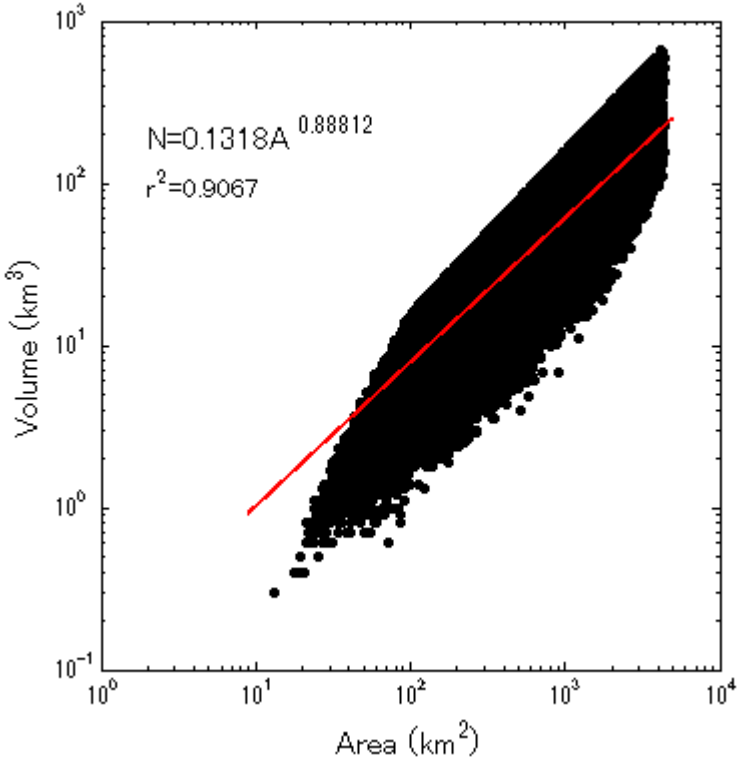

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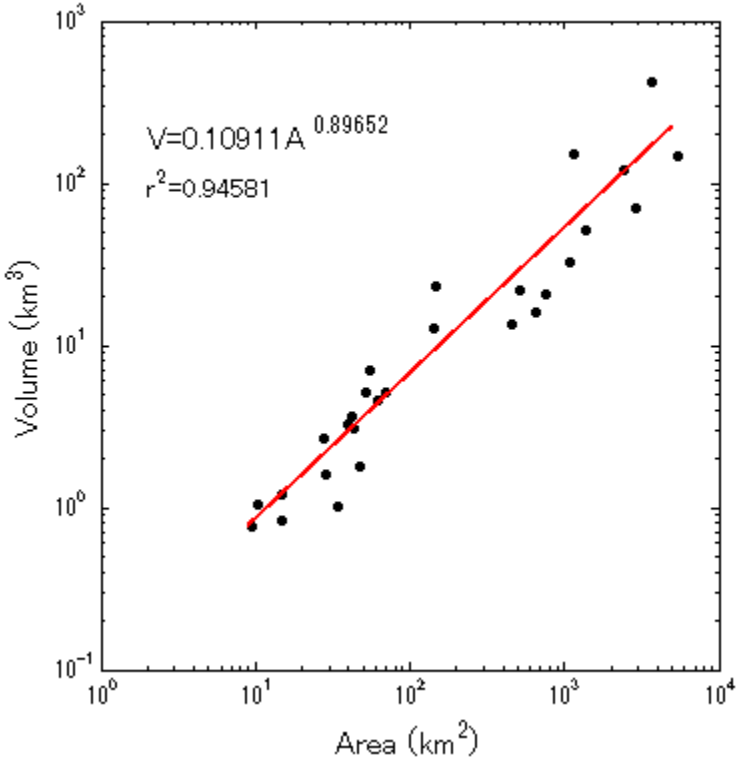
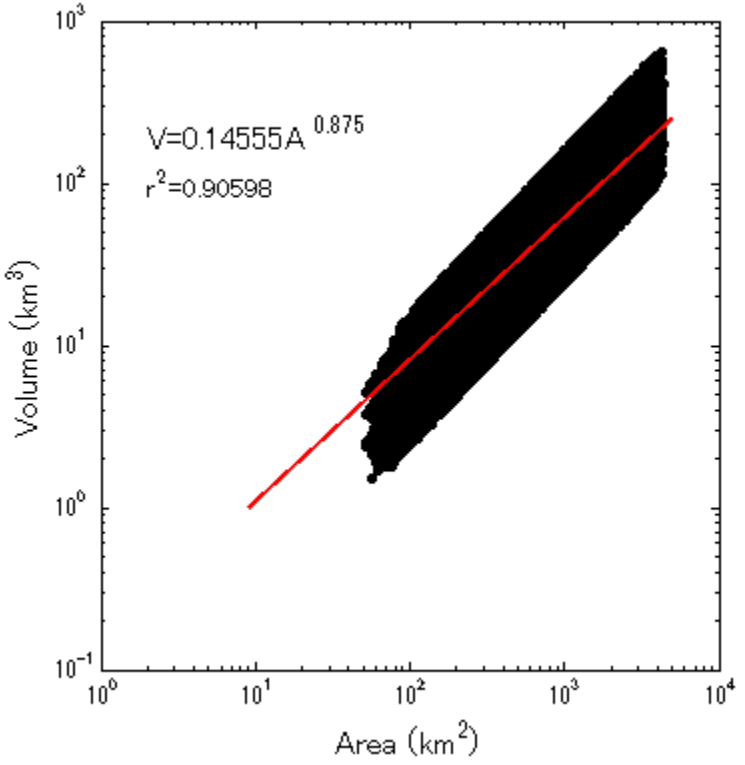
Observation




Result of the MCS : Case2
n= 200,000



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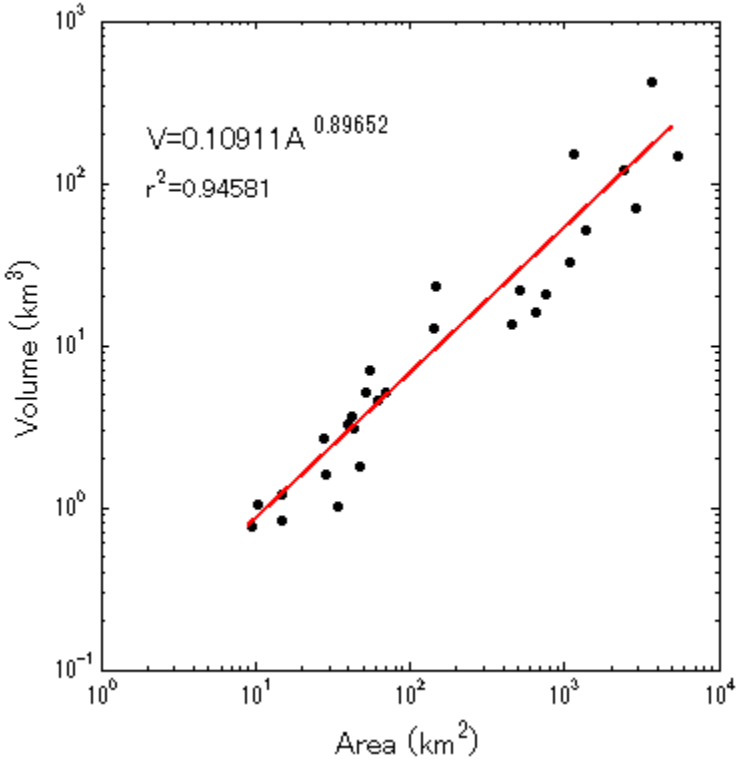
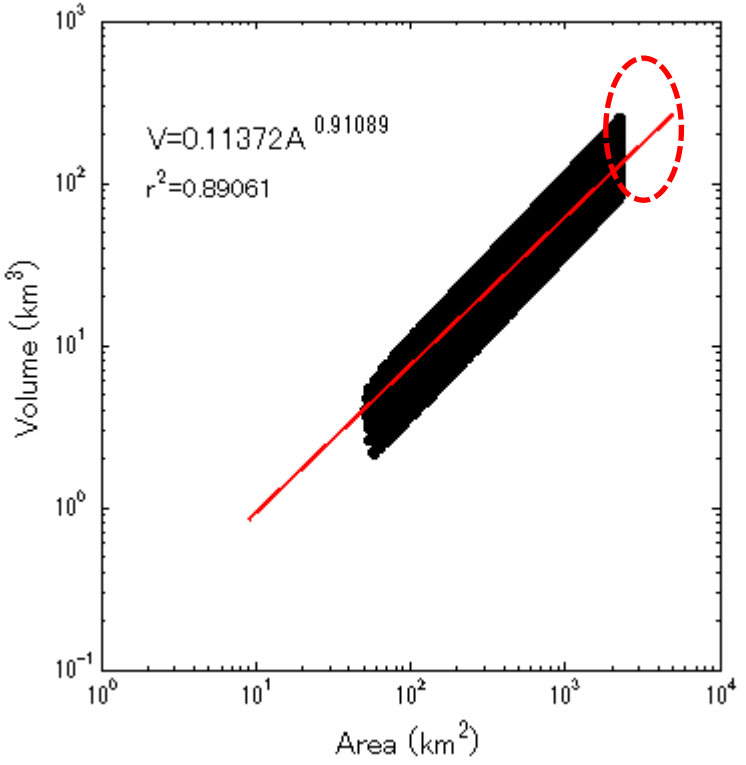
Observation

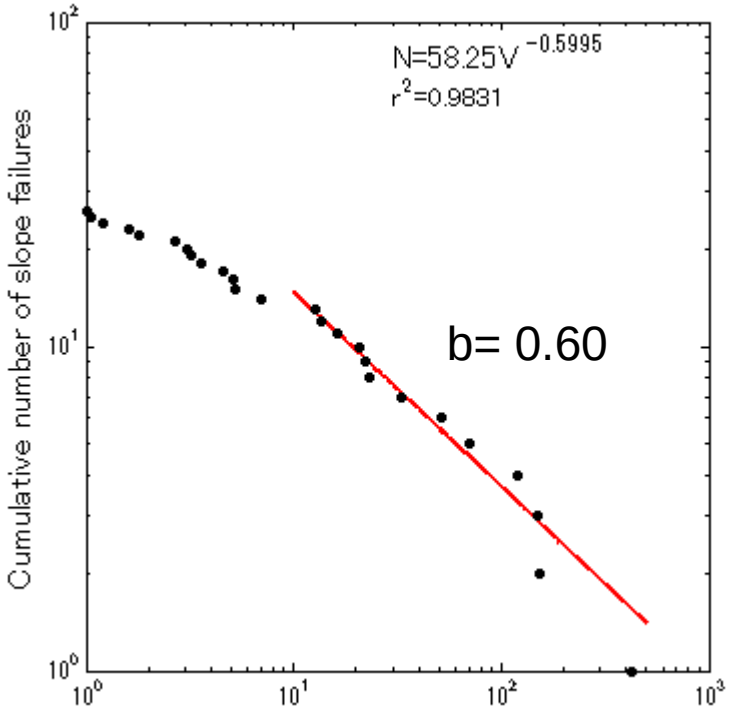



Result of the MCS : Case3
n= 200,000

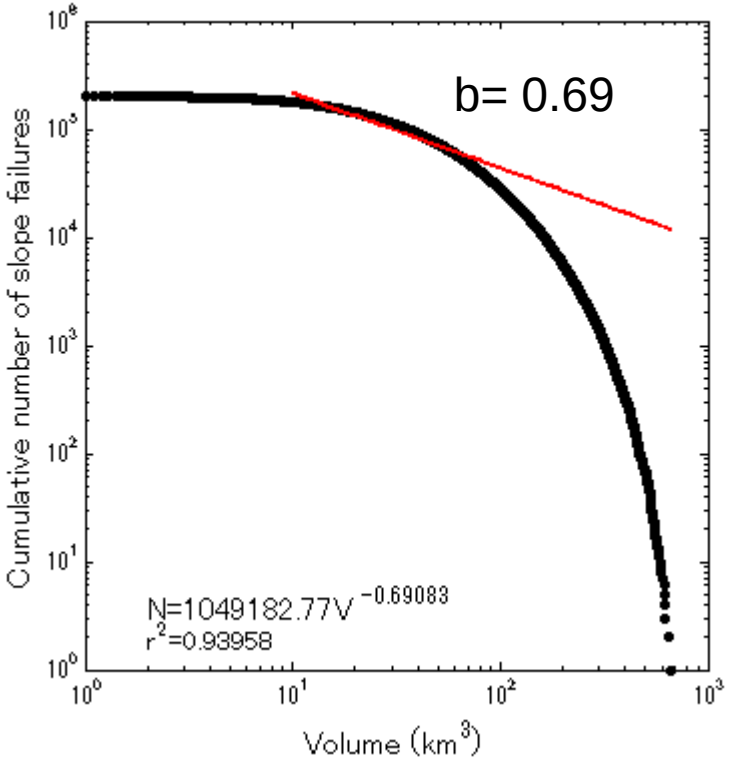


# Relationship between Volume and Cumulative number of slope failures

Observation



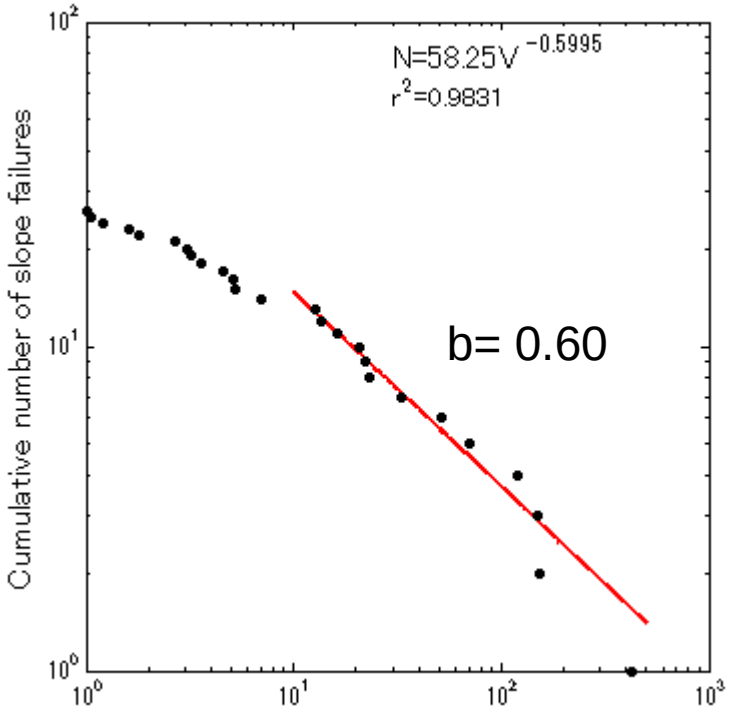

Result of the MCS : Case1
n = 200,000



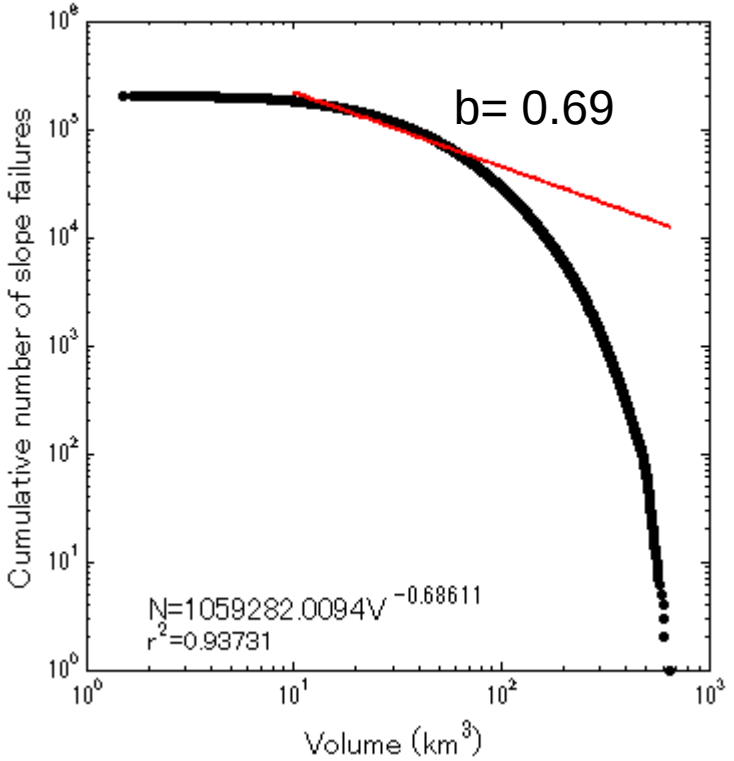

- Sub aerial : b=0.5±0.2
- Submarine, Puerto Rico (ten Brick):

# Relationship between Volume and Cumulative number of slope failures

Observation



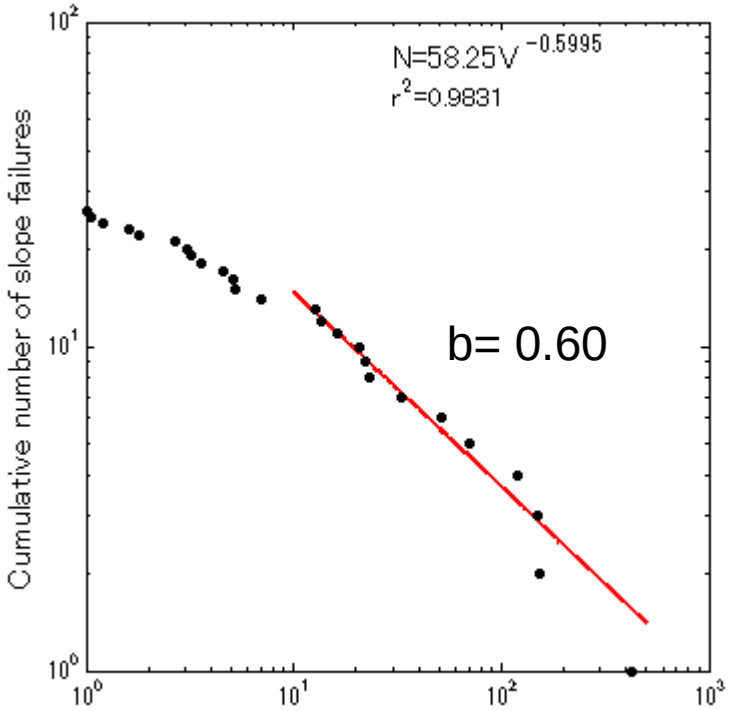

Result of the MCS : Case2
n = 200,000



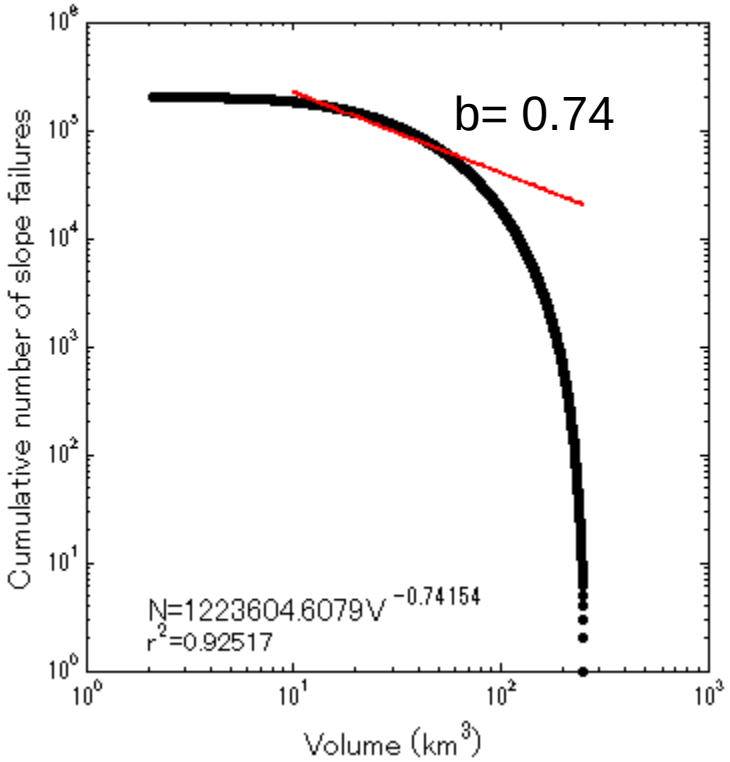

- Sub aerial : b=0.5±0.2
- Submarine, Puerto Rico (ten Brick):

# Relationship between Volume and Cumulative number of slope failures

Observation



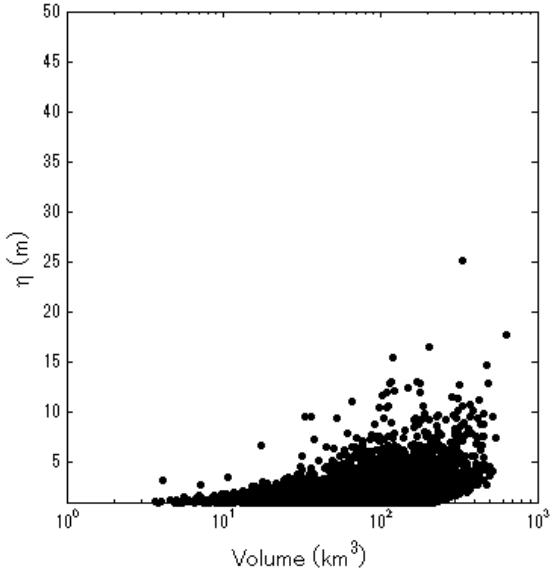

Result of the MCS : Case3
n = 200,000



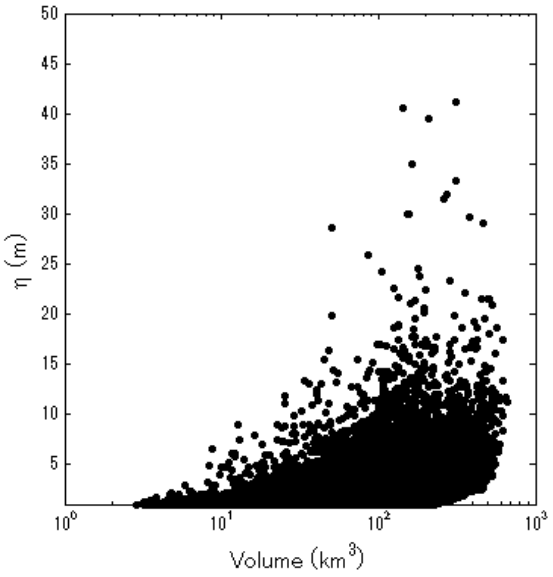

- Sub aerial : b=0.5±0.2
- Submarine, Puerto Rico (ten Brick):

# Relationship between Volume and initial Tsunami height (depression)

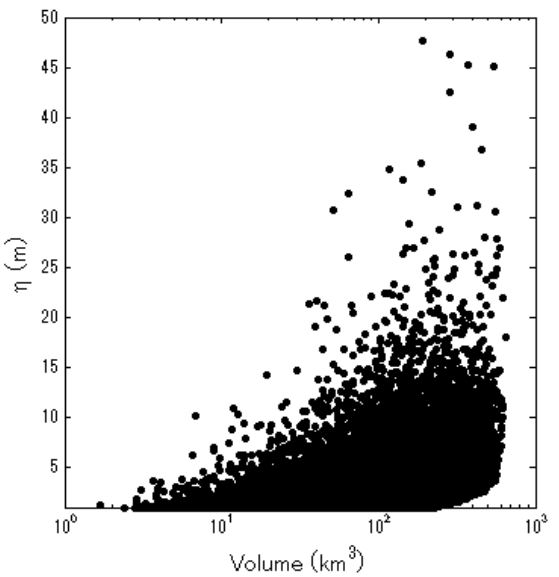
Case1 n=20,000




Case1 n=200,000

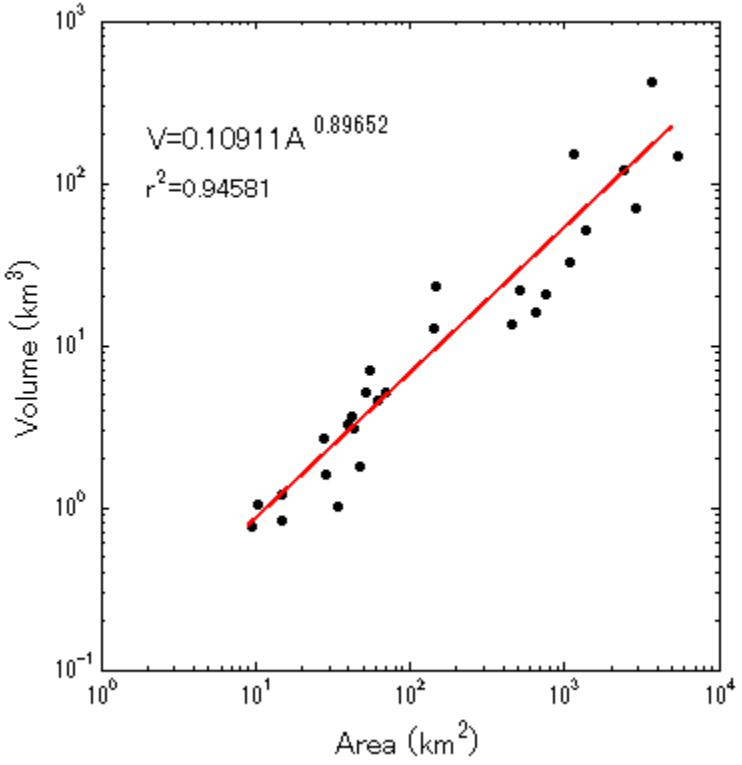



Case1 n=500,000

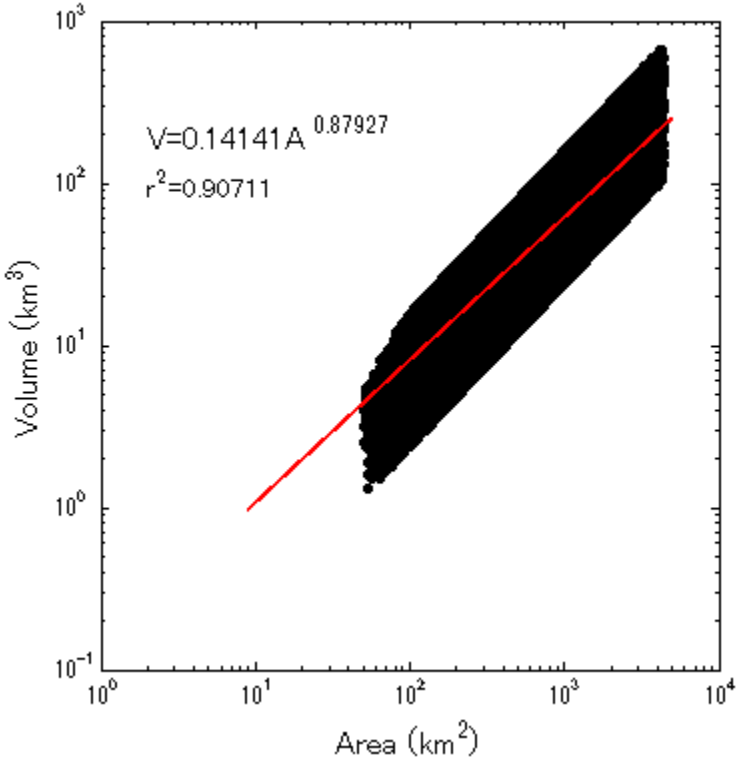


# Result of simulation: Comparison to observation

Observation




Result of the MCS : Case2
n= 1,000,000



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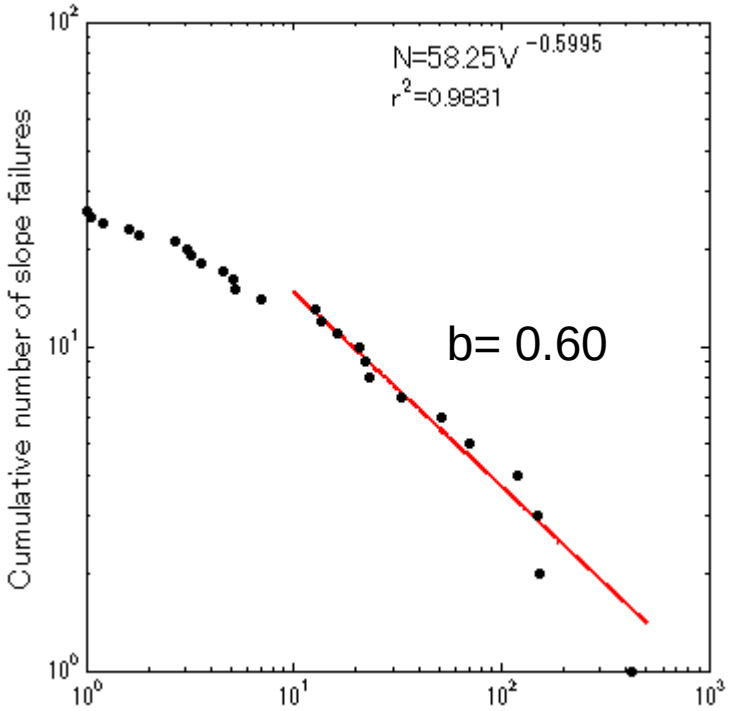


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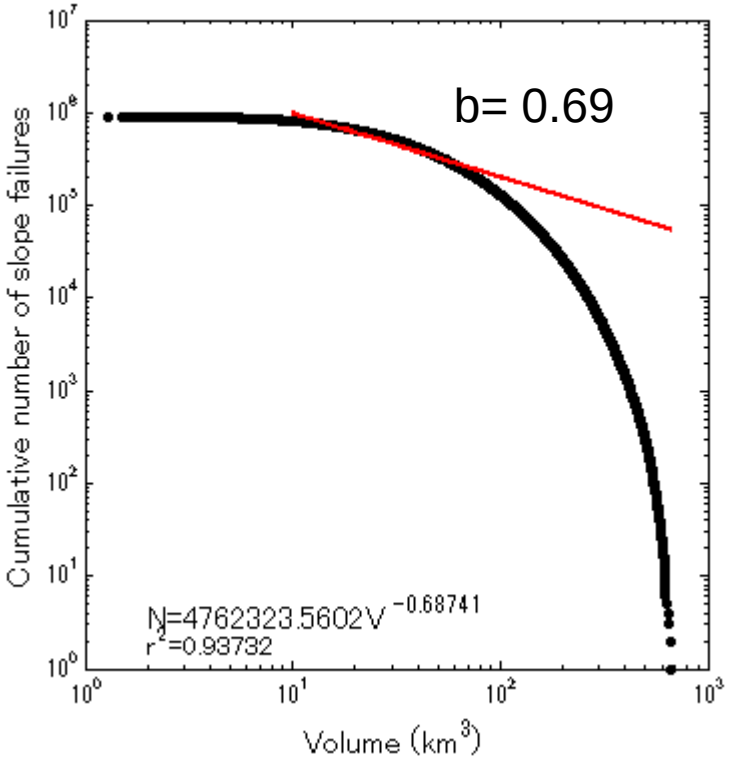


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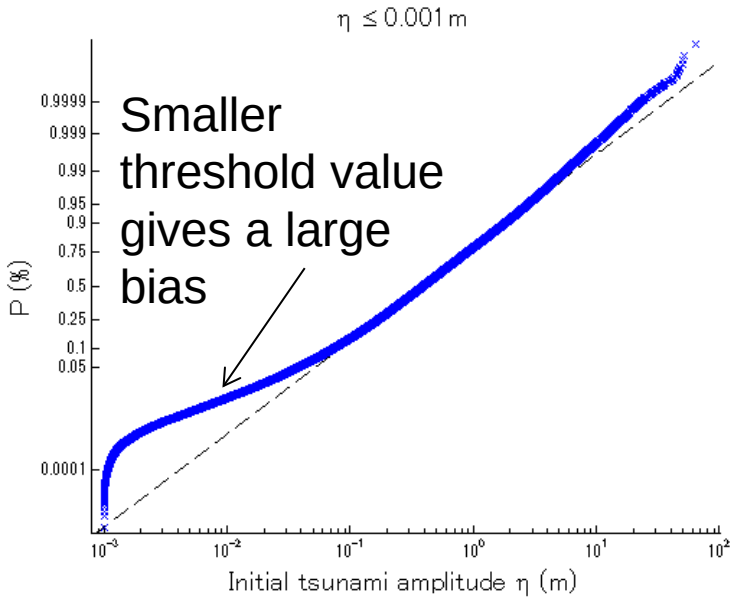
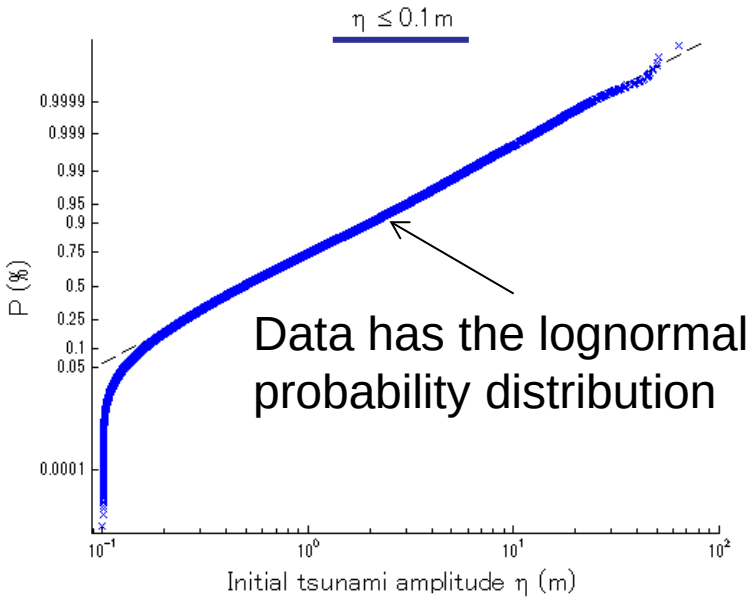
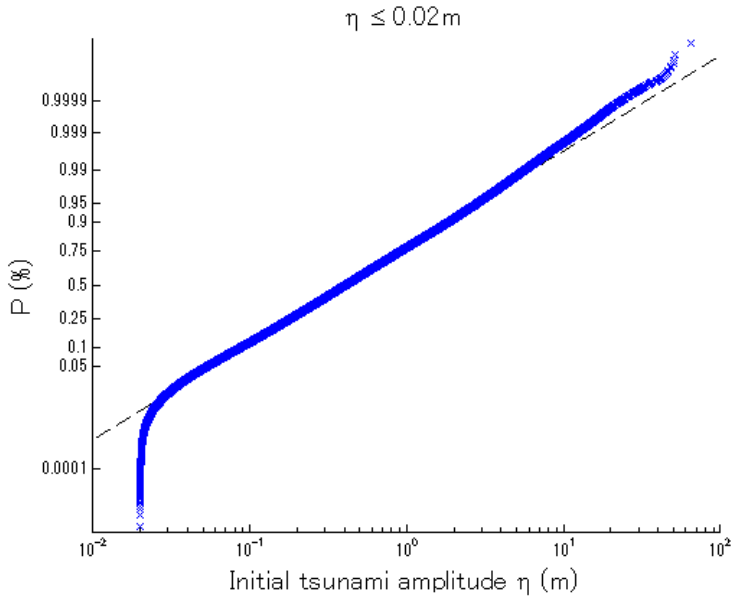
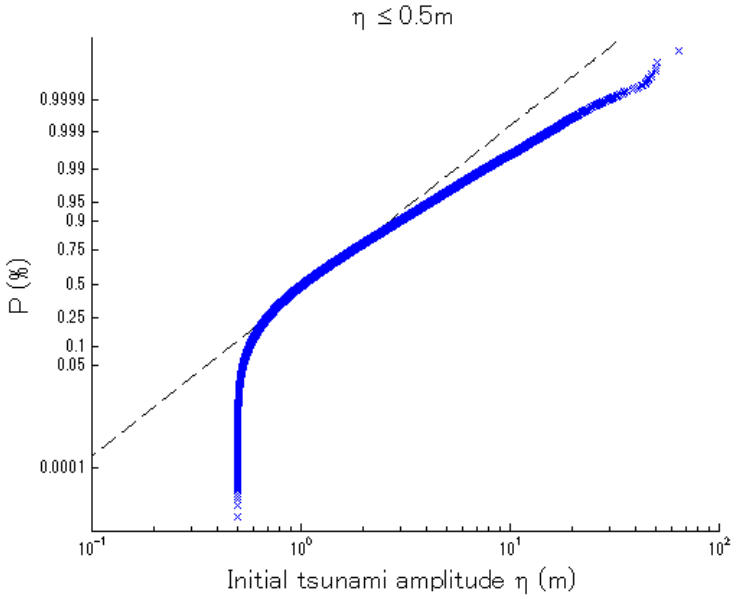
# Cumulative frequency distribution with various η

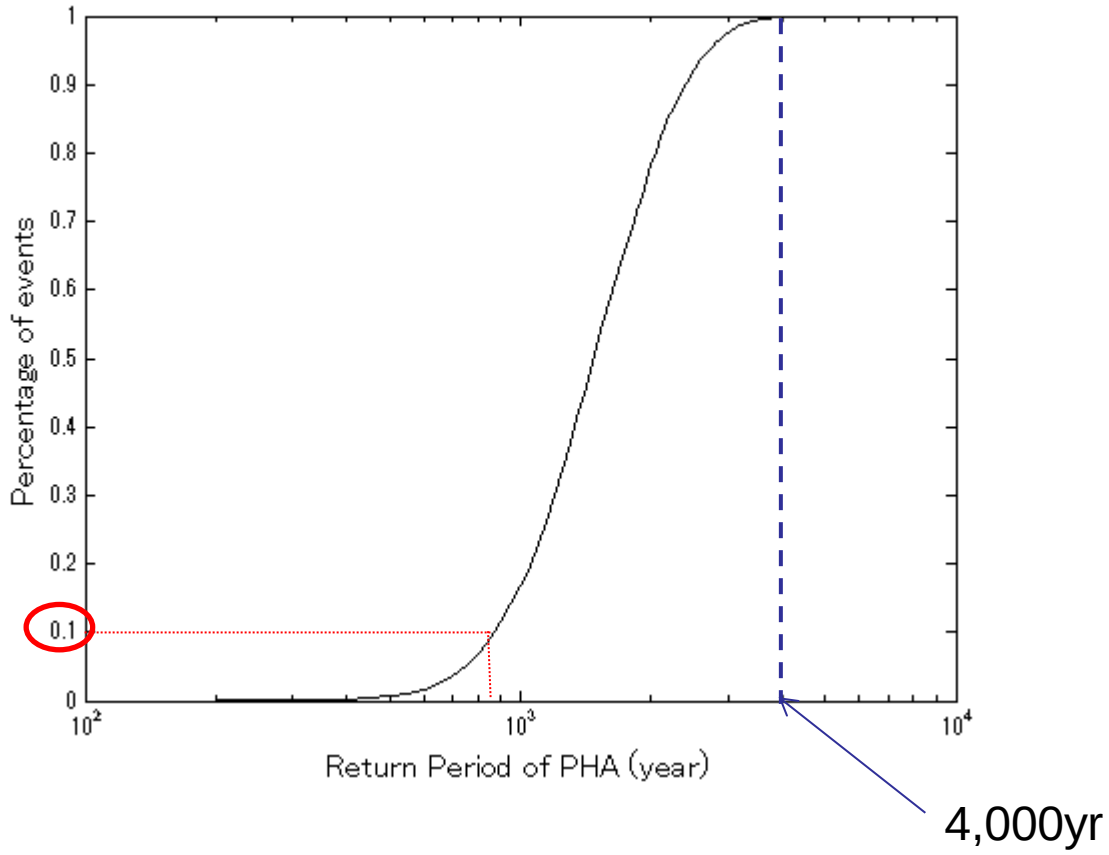


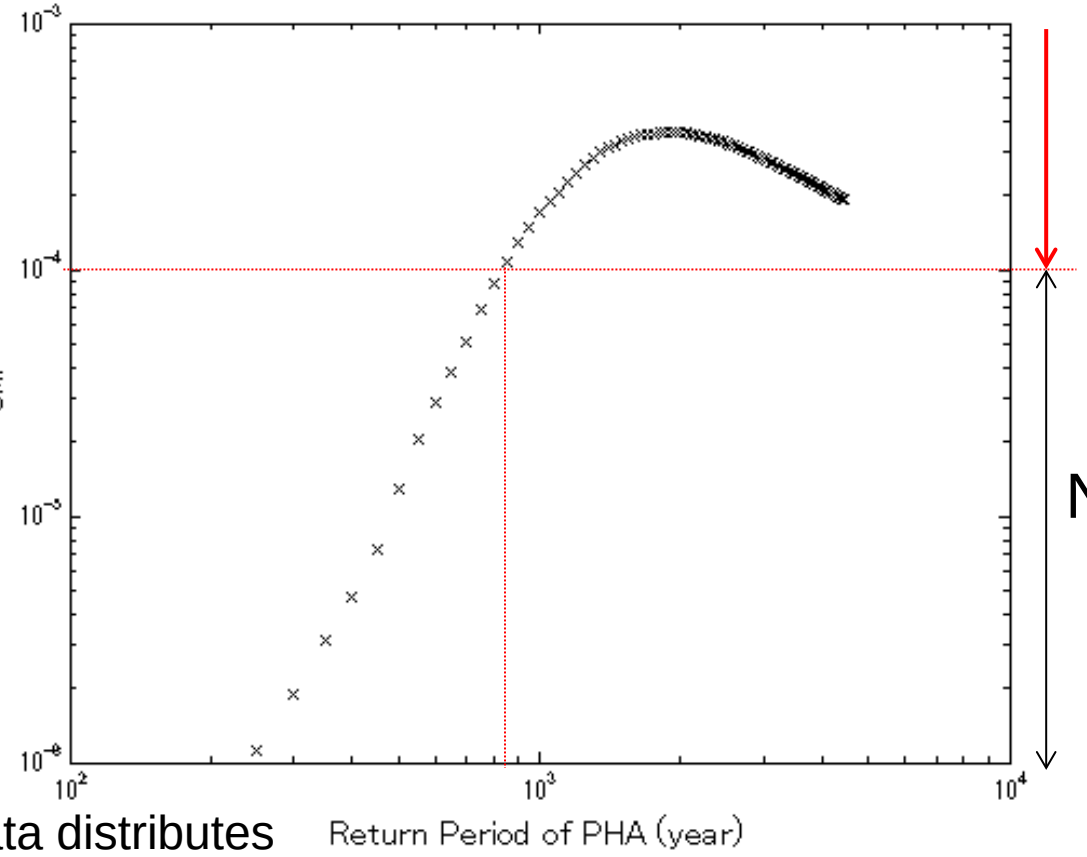
# Cumulative frequency distribution with Return Period of PHA




90% of total landslide events occur greater than 800-900 year of return period of PHA

# Relationship between Return Period of PHA and $P_{SMF}$

Case2 N=1,000,000 threshold $\eta$>= 0.1m




Converged MCS data distributes in the range greater than 800-900 year of return period of PHA

$= 1/P_{PHA}$

# Determination of the probability for tsunami-genic mass failures

Definition: Type of probabilities

$P_{max}$ : Maximum annual probability (=0.0001)
Maximum return period of MCS : $1/P_{max}$ = 10,000 yr

$P_f$ : Probability of slope failure
$P_{PHA}$ : Annual probability of given seismic ground motion
$P_{SMF}$ : Annual probability of tsunami-genic slope failure

* PHA : Peak Horizontal ground Acceleration

$P_{SMF}$ is defined by the joint probability:

$$P_{SMF} = P_{PHA} P_f \leq P_{max}$$

Where,

$$P_f = \frac{n}{N}$$

N: total number of trials

n: total number of tsunami-genic slope failures identified in the MCS

$$P_{PHA} = \frac{1}{T_R}$$

$T_R$ (year) : Return period of PHA (seismicity)

# Number of trials and model convergence

$$P_{max} = \frac{1}{(NCoV^2) + 1}$$

Assumption :
CoV (Coefficient of Variation ) = 10%
The annual-probability of the maximum return period
$P_{max}$ = 0.0001 (0.01%, or 10,000 yr)

↓

Total number of trials
N = 999,900 ≒ 1,000,000

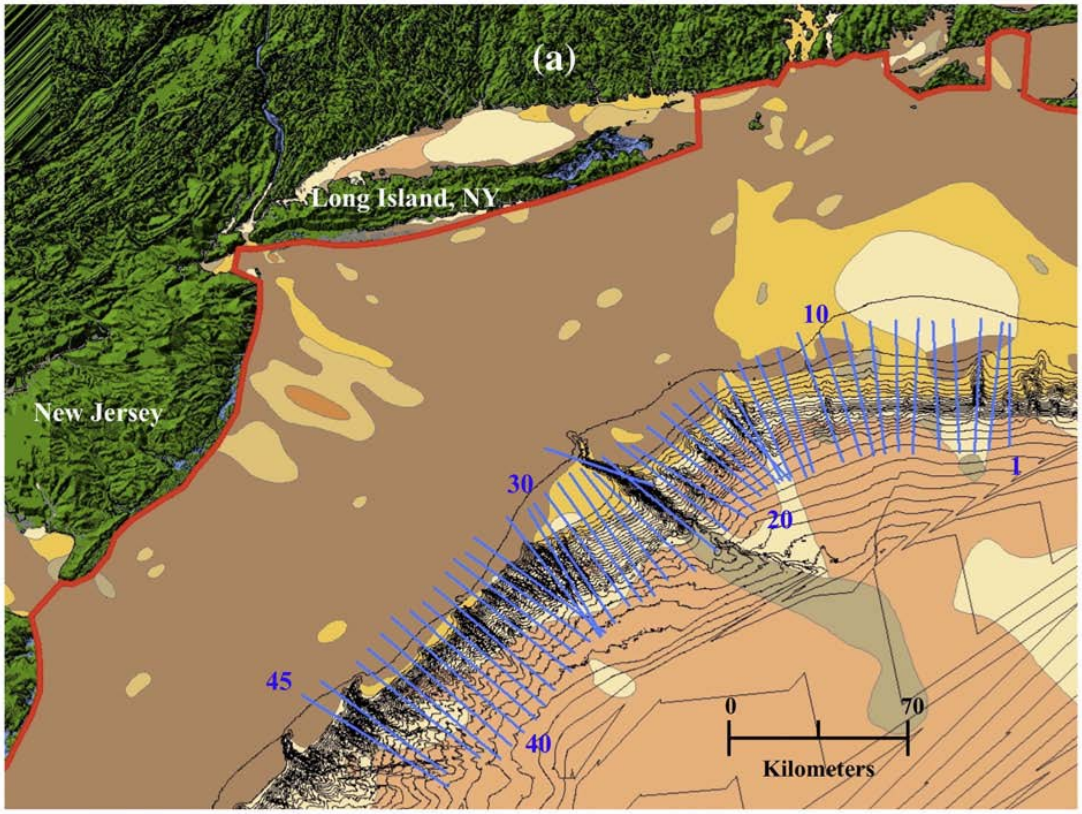
# How to count the tsunami-genic landslide event?

$$P_f = \frac{n}{N}$$

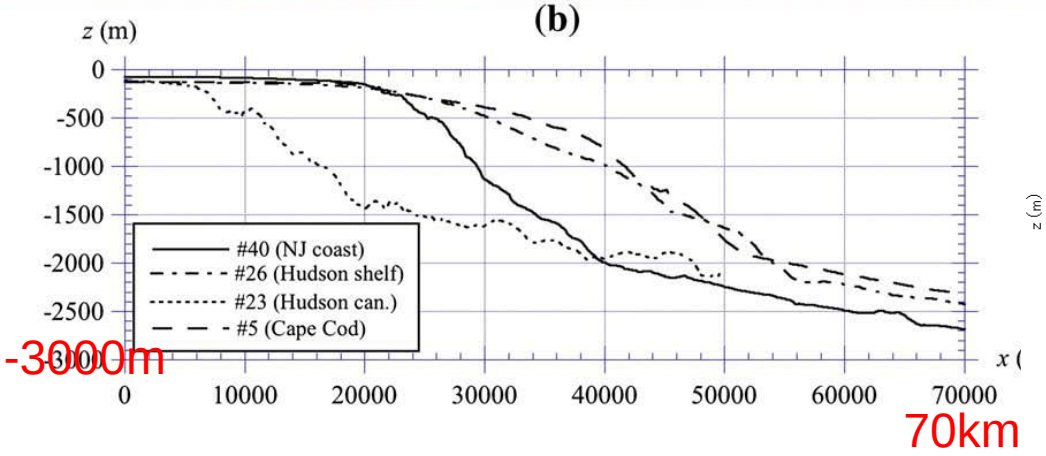
N: total number of trials (=$10^6$)

n: total number of tsunami-genic slope failures identified in the MCS

n depends on the threshold value of initial tsunami amplitudes $\eta$

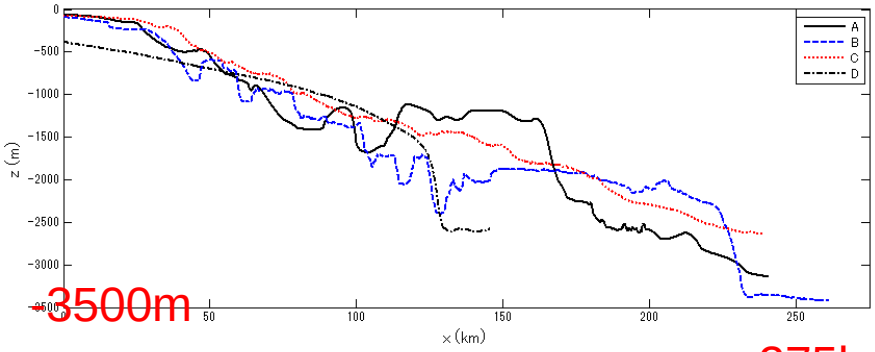



Comparison to bathymetries of East coast of the U.S.




-3000m

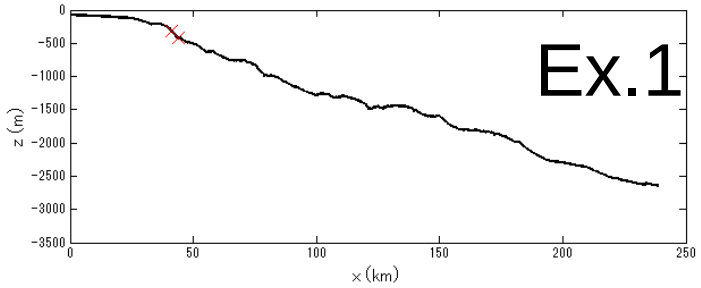
70km

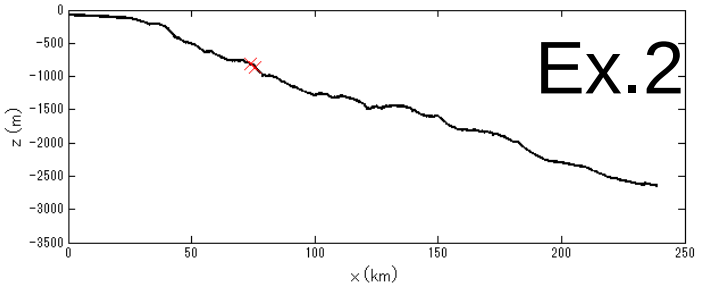


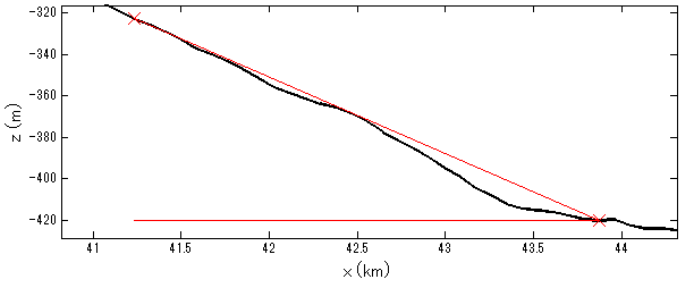

-3500m

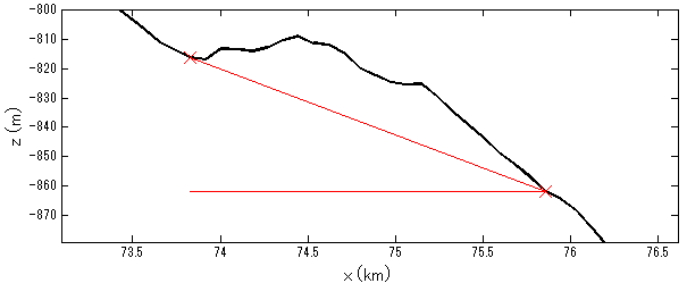
275km

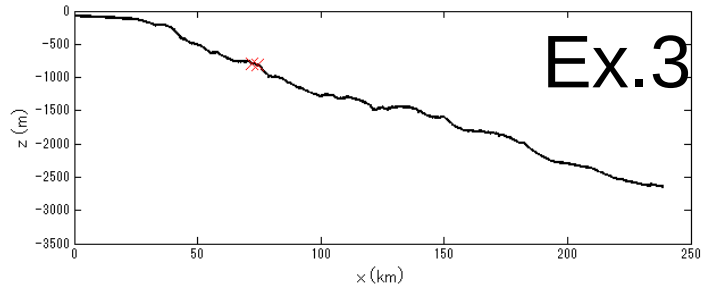
# Test for cutting of bathymetric data (Transect

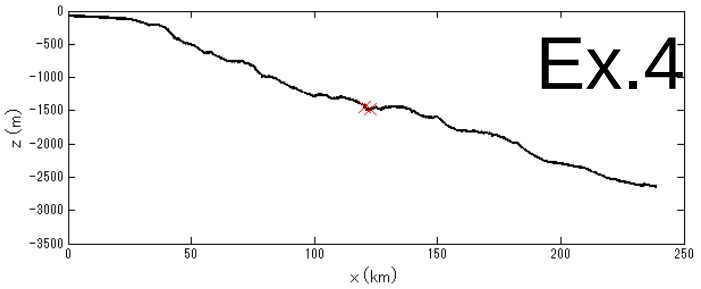


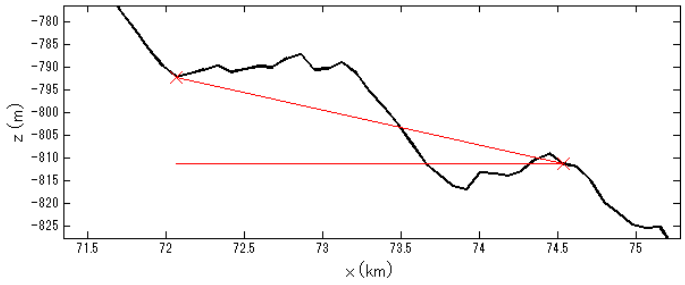



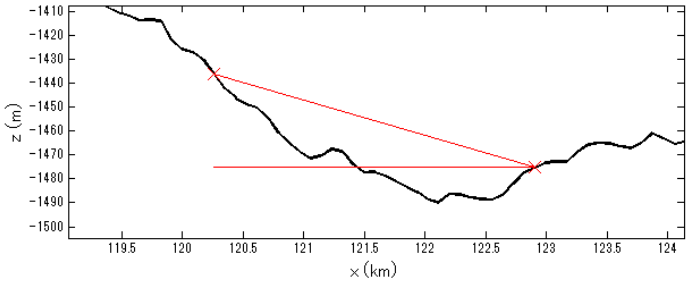



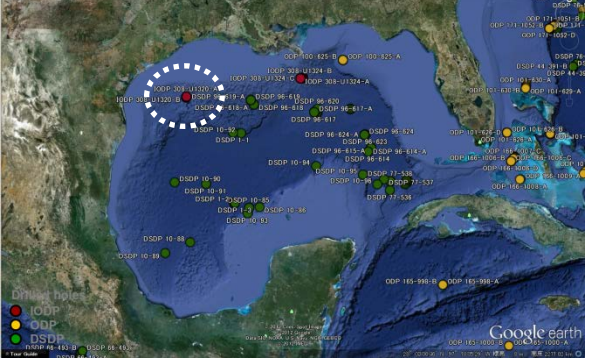



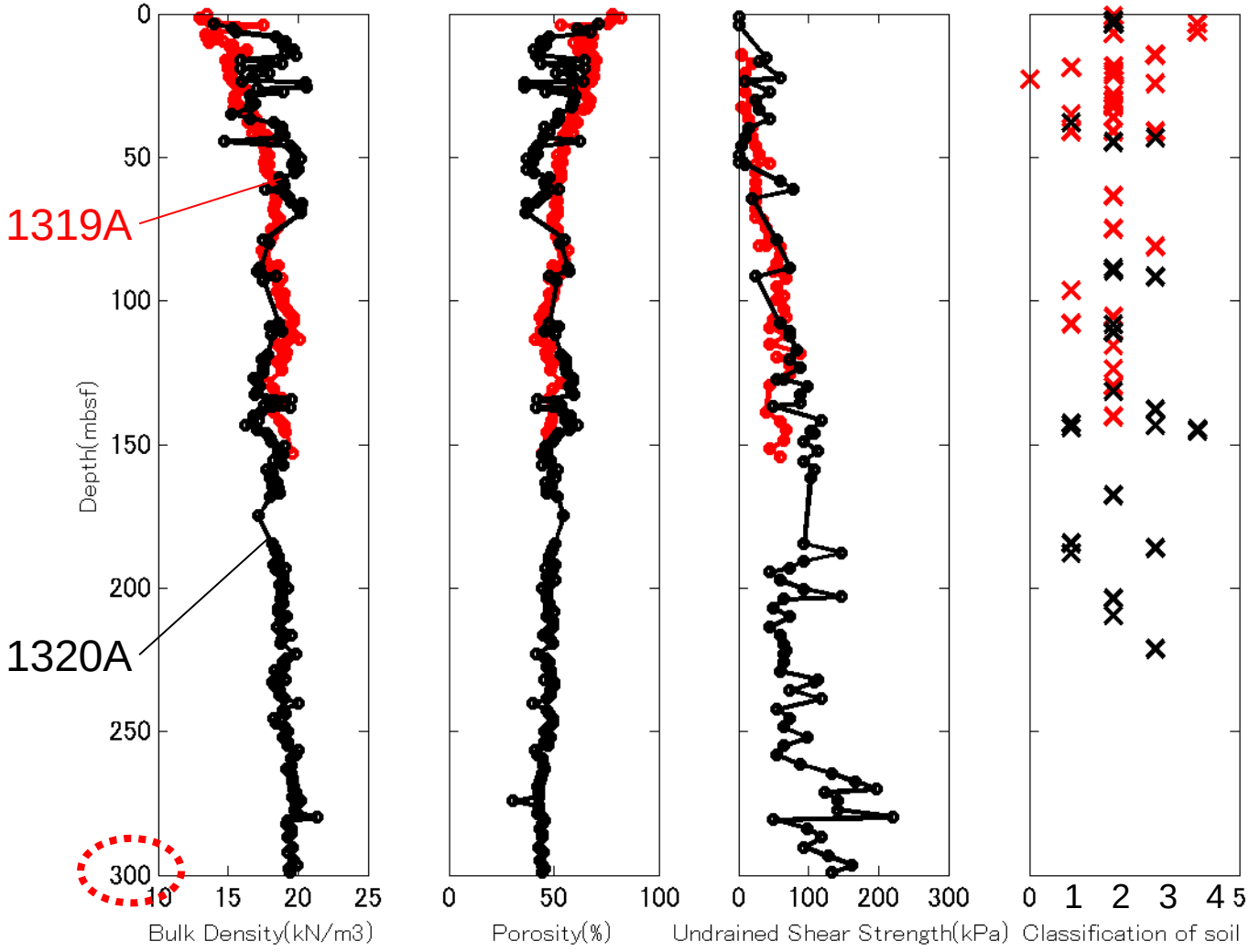






# A: IDOP Leg308, Site1319A&1320

1322B: 1429.6m sea depth

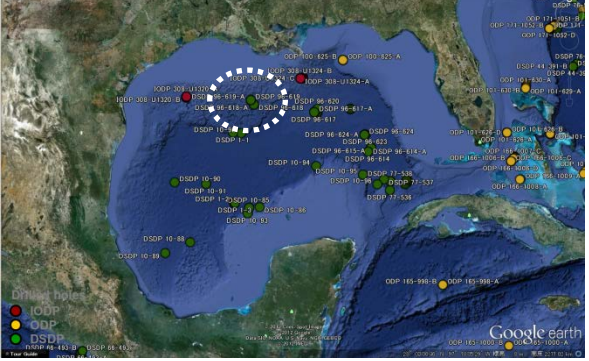
1324B: 1470.0m sea depth




Classification of soil
5 = Gravel
4 = Sand
**3 = Silt**
**2 = Clay**
**1 = Mud**
0 = Other descriptions

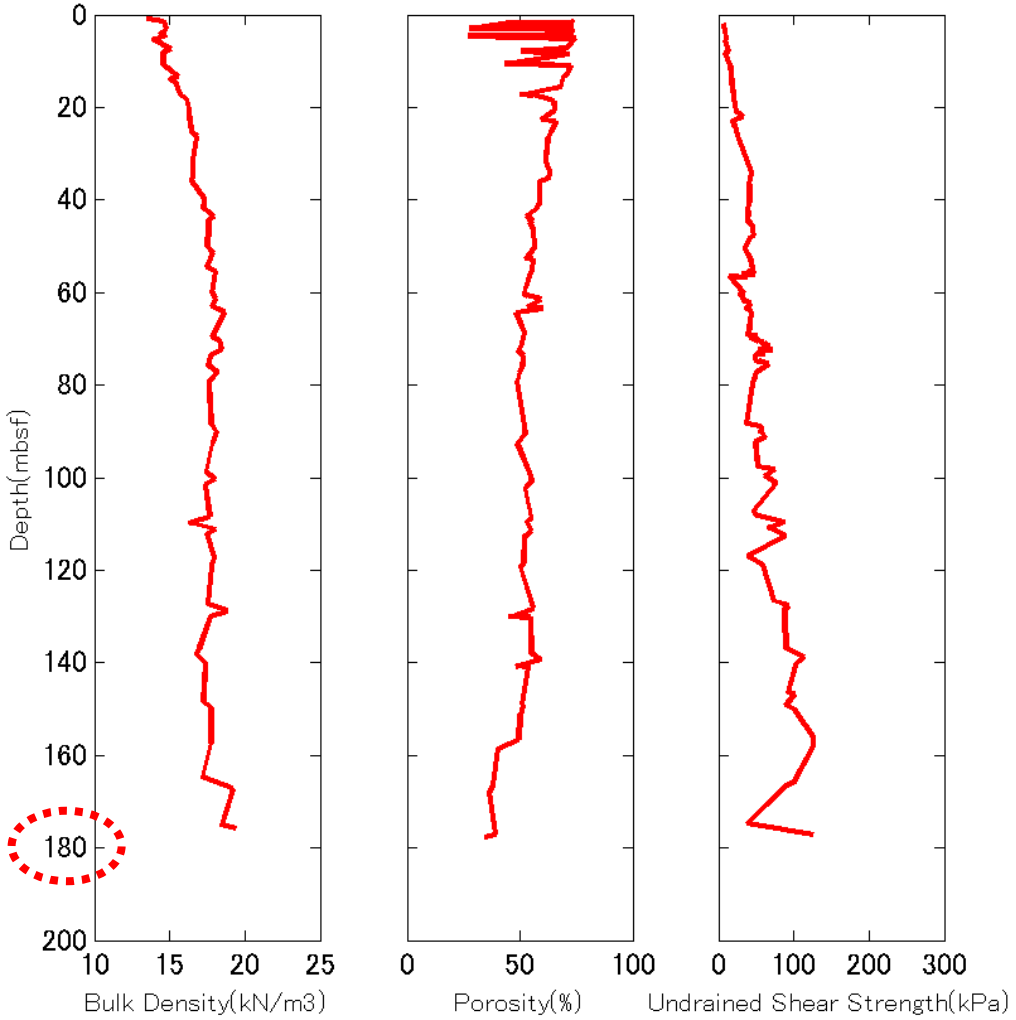
Most of data are categorized as “fine-grained cohesive materials, under undrained loading conditions”

Characteristics of soli between 1319A and 1320A are able to be supposed as same




# B: DSDP Leg96, Site619

619: 2259m sea depth



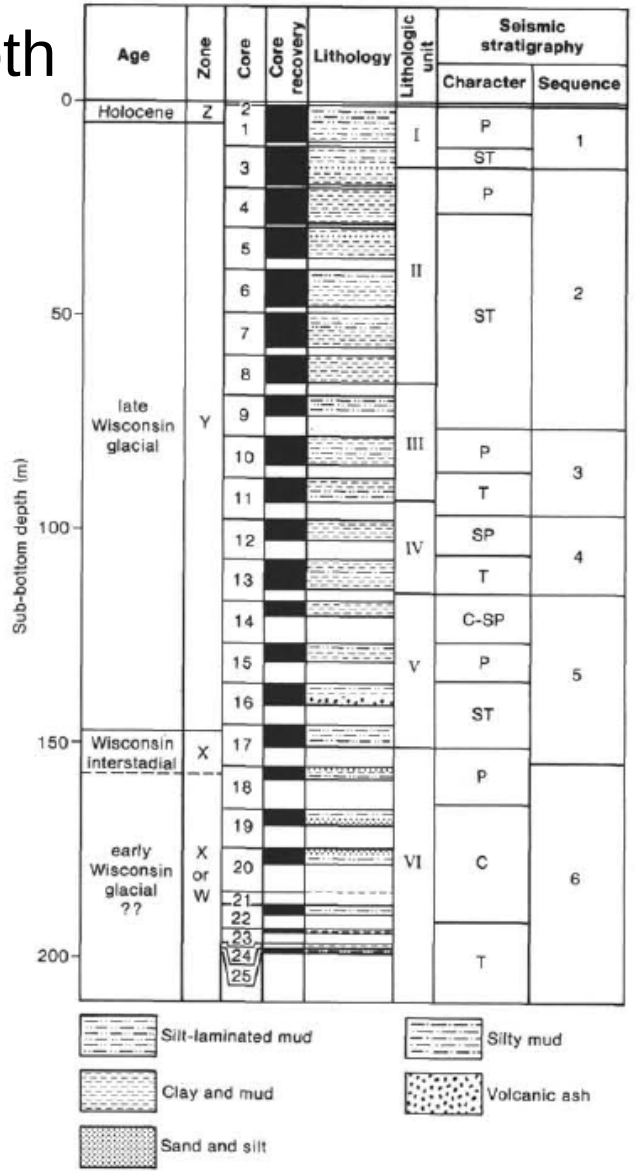
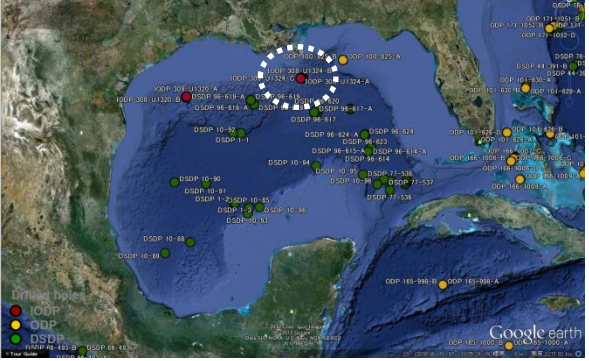
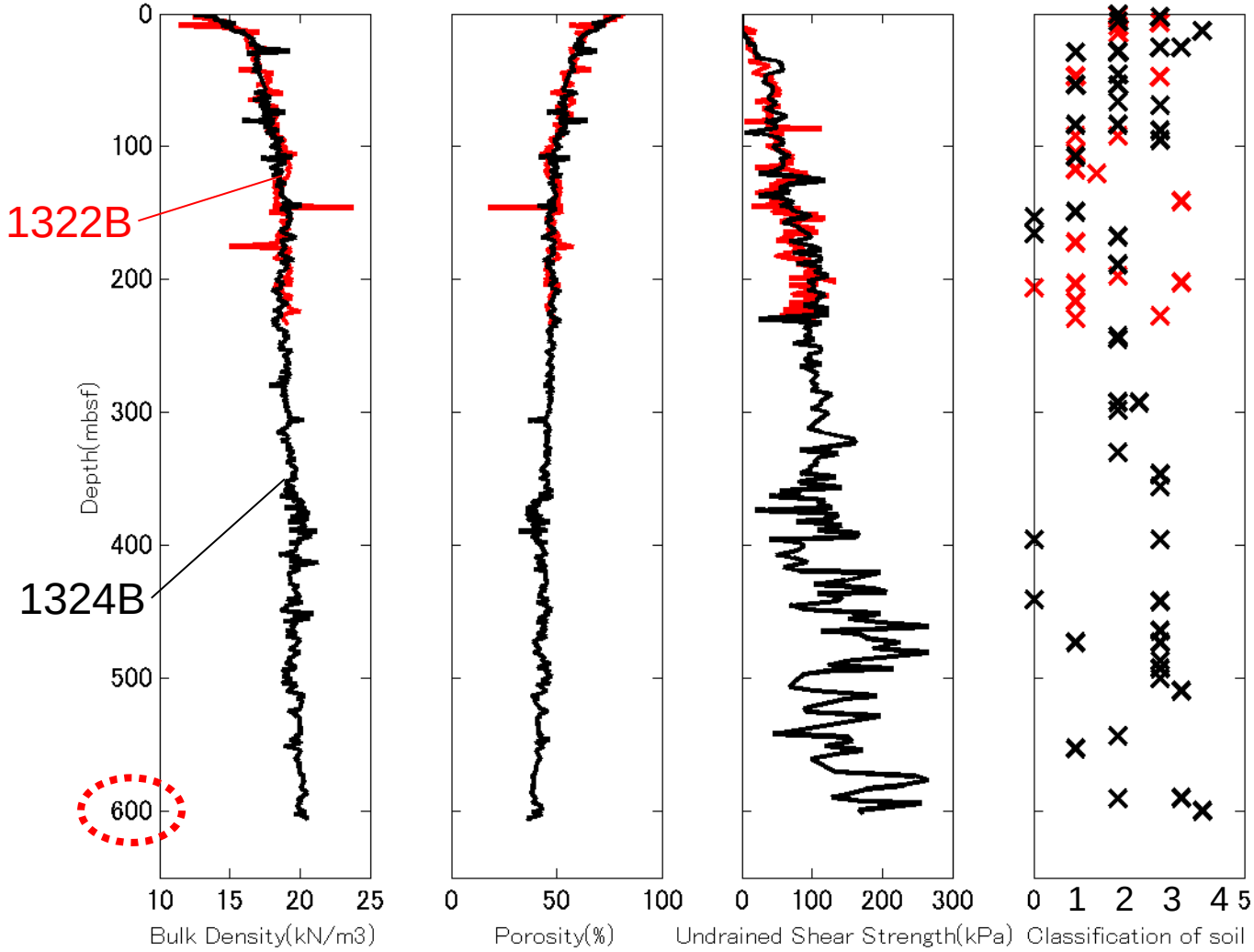




Figure 3. Lithostratigraphy of Site 619 showing age, lithology, core recovery, lithologic units, and comparison with seismic stratigraphy. Seismic character: C = chaotic; P = parallel; SP = subparallel; ST = semitransparent; T = transparent.




# C: IDOP Leg308, Site1322B&1324

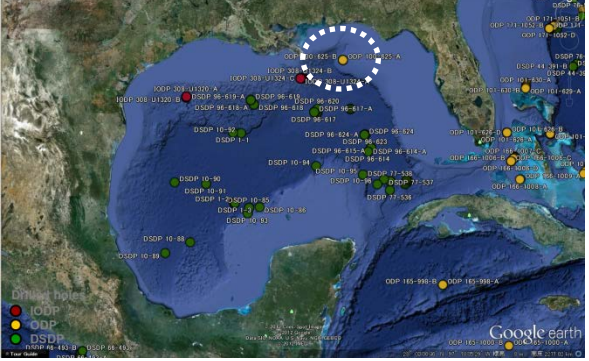
1322B: 1319.5m sea depth
1324B: 1056.8m sea depth




Classification of soil
5 = Gravel
4 = Sand
**3 = Silt**
**2 = Clay**
**1 = Mud**
0 = Other descriptions

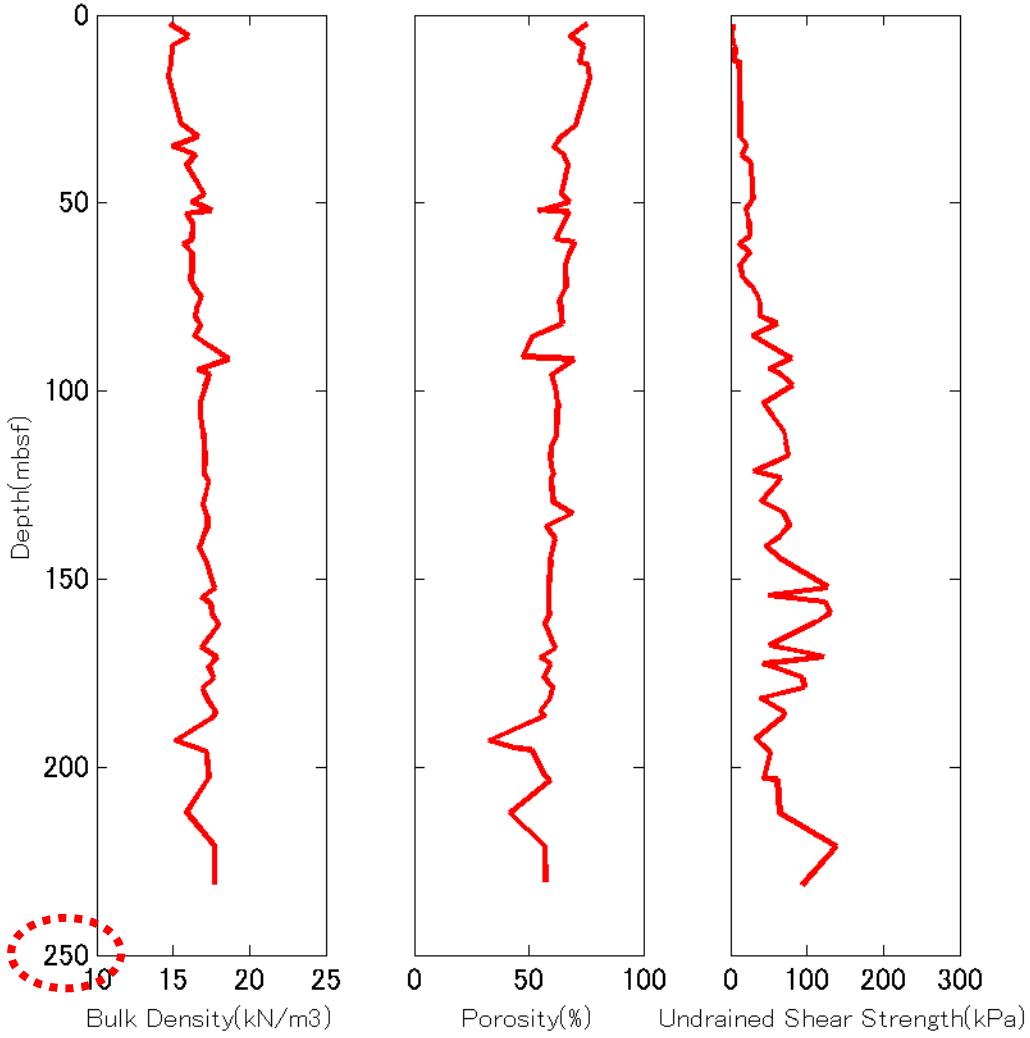
Most of data are categorized as “fine-grained cohesive materials, under undrained loading conditions”

Characteristics of soli between 1322B and 1324B are able to be supposed as same




# D: ODP Leg100, Site625B

625B: 889.5 m sea depth




Calcareous Mud and Marly Nannofossil ooze => Mud

Marly Nannofossil ooze and Nannofossil ooze=> Silt or Clay

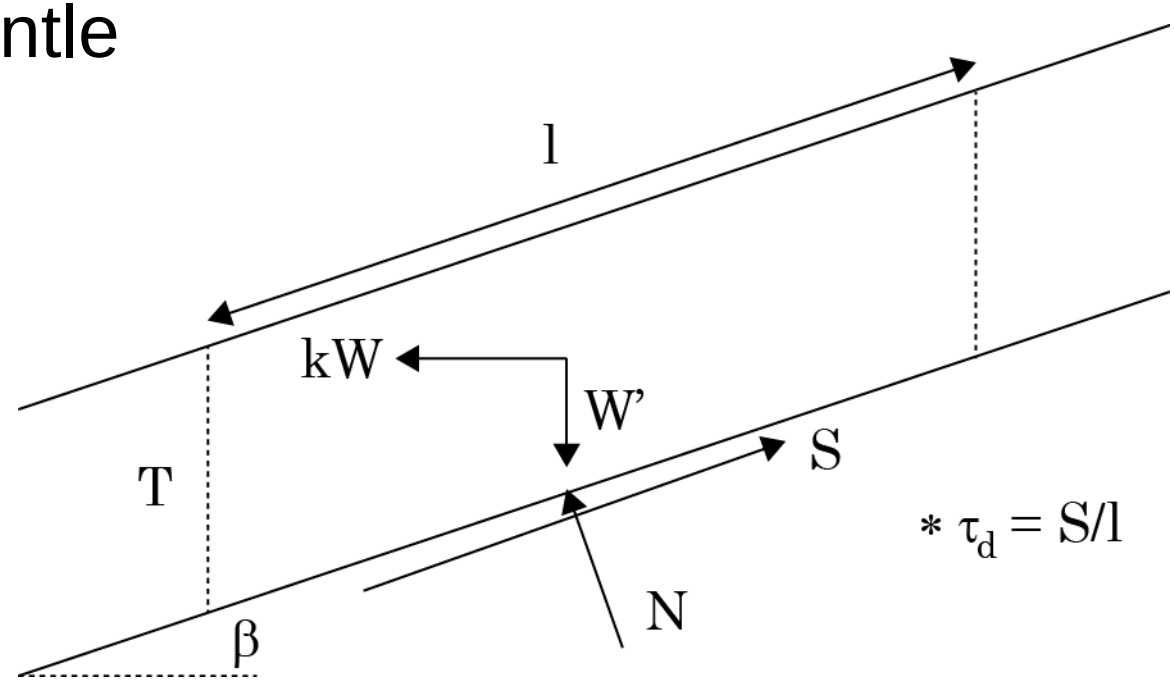
Classification of soli (Lithology)

# Calculation of the Factor of Safety

## Translational slope method

* Slope of GOM gentle

$$FS = \frac{c' + \sigma' \tan \phi'}{\tau_d}$$




Assumption of cohesive solid

effective friction angle $\phi$' = 0

Undrained shear strength c' = Su

# Calculation of the Factor of Safety

$$FS = \frac{S_u}{(\rho_s - \rho_w) g T \sin\beta + k \rho_s g T \cos\beta}$$

$$0.0003 \leq T/l \leq 0.07$$

Where,

$\rho_s$ : density of soil
$\rho_w$ : water density
$S_u$ : undrained shear strength
g : gravity acceleration
T : thickness
$\beta$ : seafloor slope angle
K : seismic coefficient

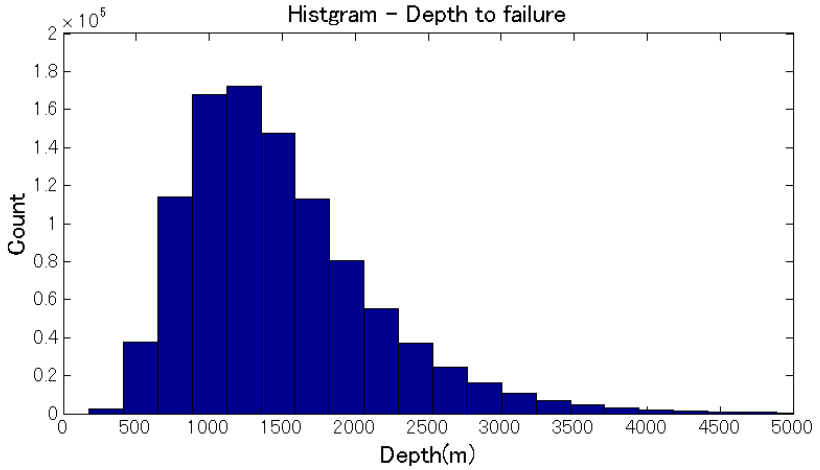
Topographic parameters inputted using probabilistic approach

# Input parameters for FS

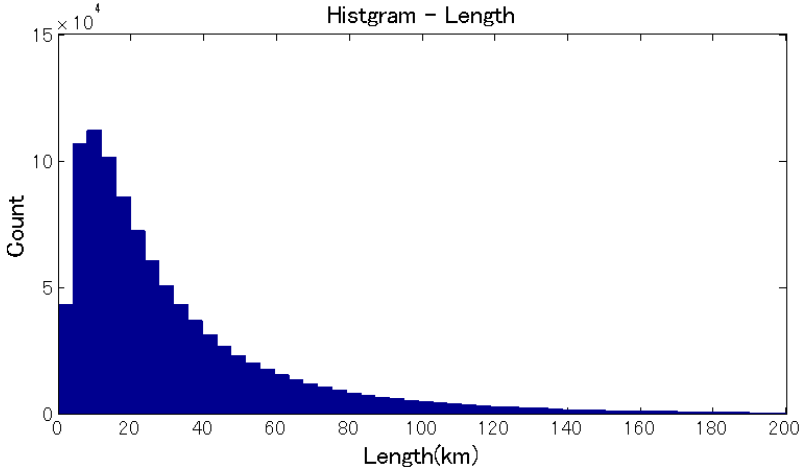
Log-normally distributed input parameters

- Depth to failure (d)
- Length (l)
- Thickness (T)

* Slope angle β can be determined by bathymetry data, l and T.




Ex. depth: mean=1513m, STD=661.8m




Ex. length: mean=38.6km, STD=48.2km

# Landslide statistics summary of the GOM

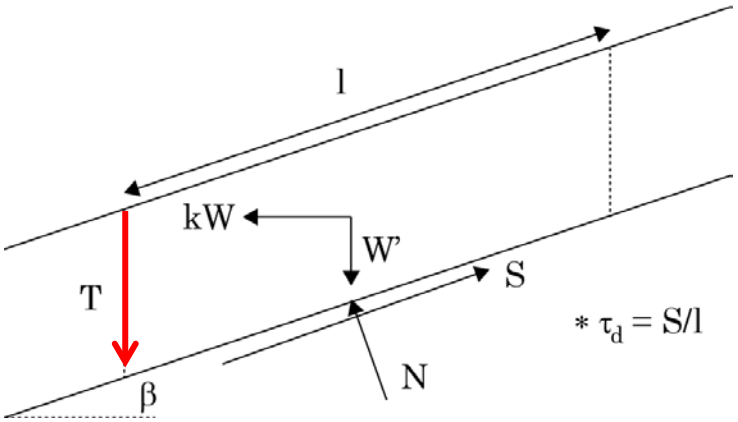
## Reference data

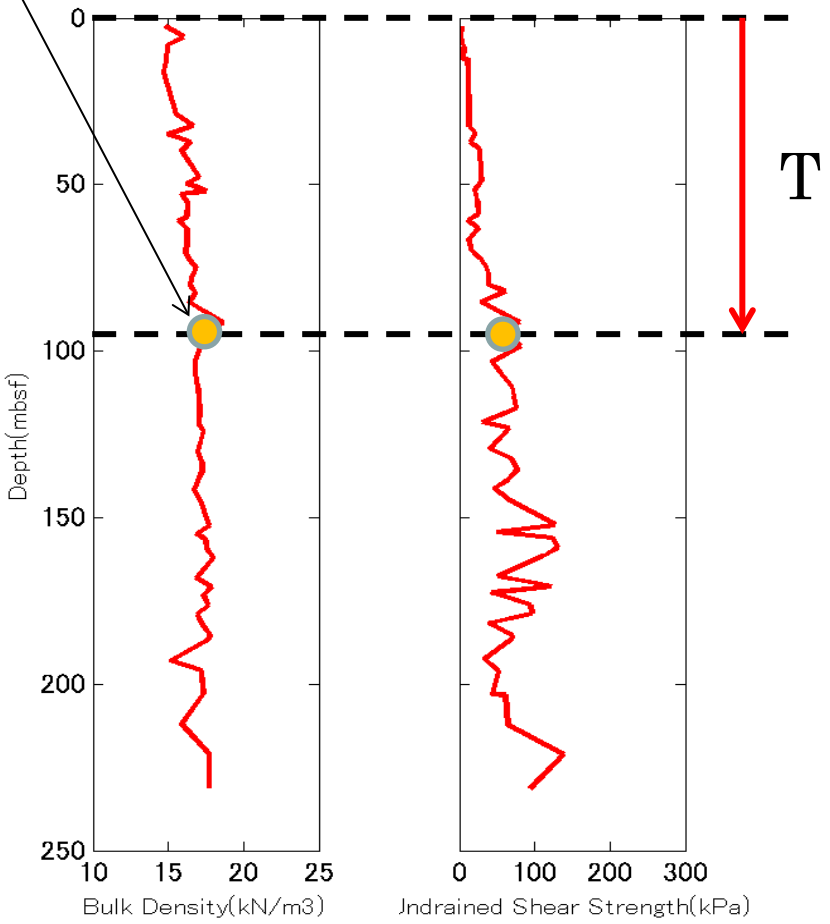
| | |
|---|---|
| author | B.G. McAdoo, L.F. Pratson, D.L. |
| title | OrangeSubmarine landslide geomorphology, US continental slope |
| year | 2000 |
| journal | Marine Geology |
| volume | 169 |
| pages | 103–136 |

# Input parameters for FS

It is better to use averaged density
Need to modify in the program !!!!!

- Bulk density of soil
- Undrained shear strength

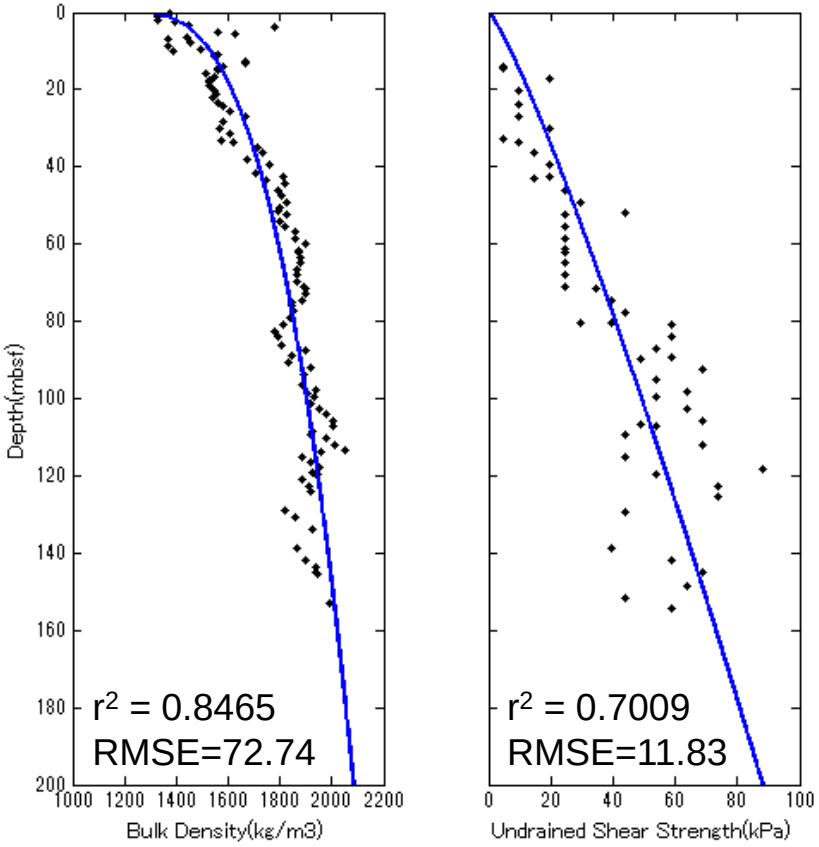



$\rho_s$ $S_u$

# Function of depth for bulk density and undrained shear strength (x=depth)

A (IDOP Leg308, Site1319A)

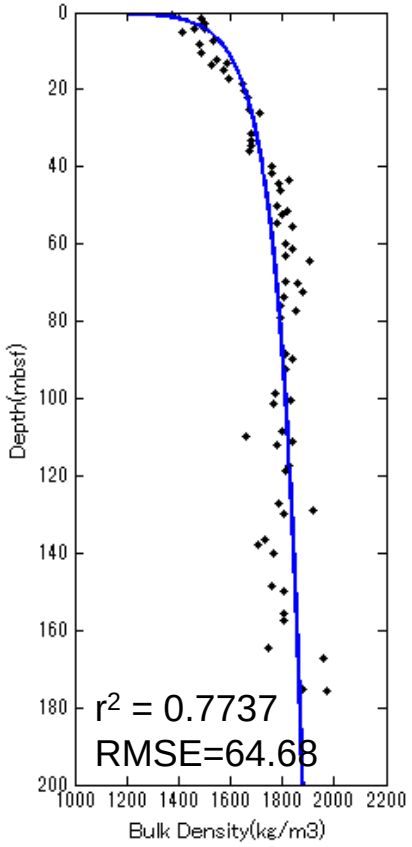



$144.2x^{0.3386} + 1216$

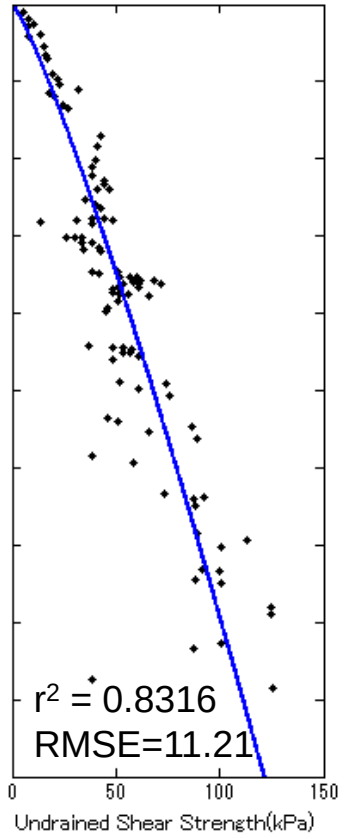



$1.028x^{0.8402}$

B (DSDP Leg96, Site619)



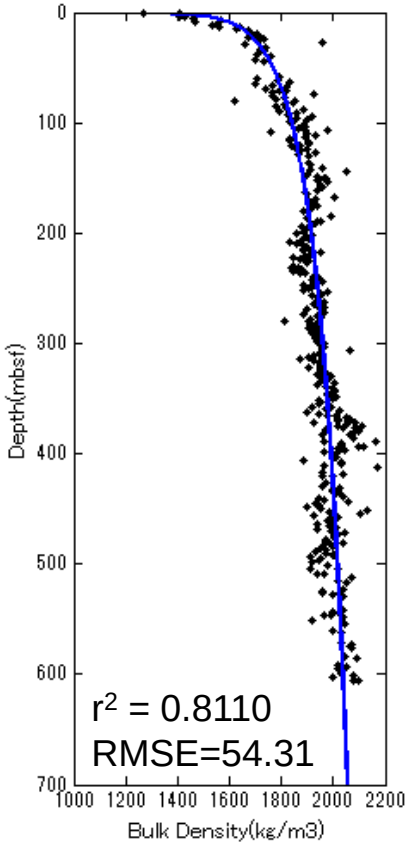

$-5209x^{-0.02} + 6561$



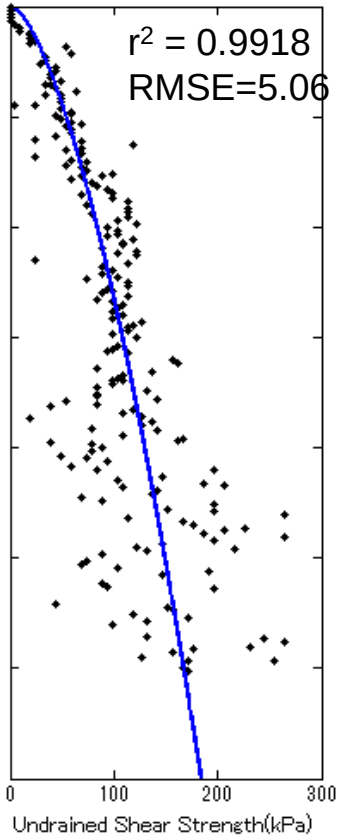

$1.441x^{0.8367}$

# Function of depth for bulk density and undrained shear strength (x=depth)

C (IDOP Leg308, Site1324B)

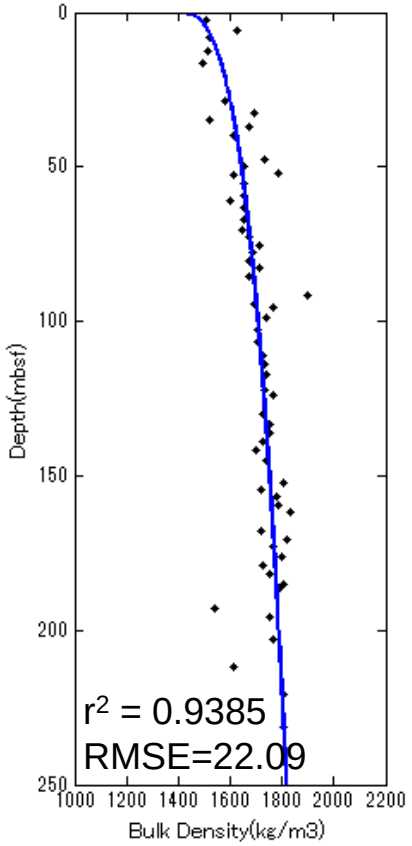



$2407x^{0.03698} - 1014$

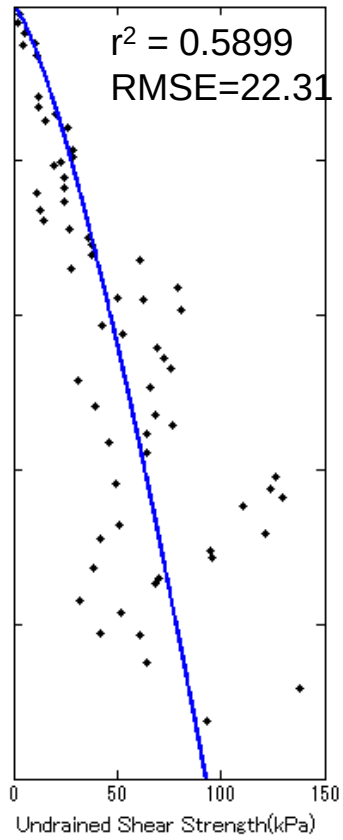



$3.007x^{0.6279}$

D (ODP Leg100, Site625B)



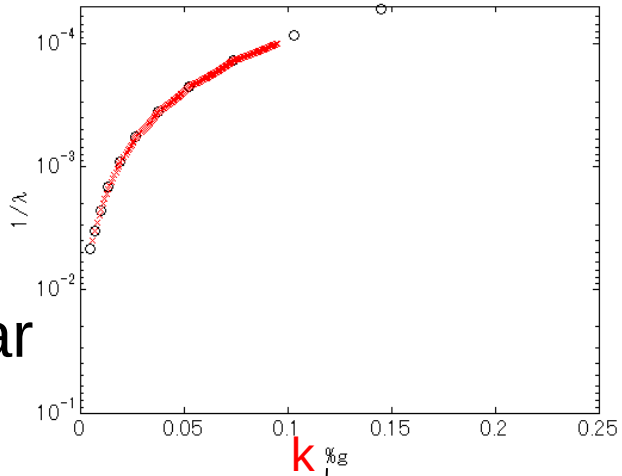

$72.78x^{0.3216} + 1386$

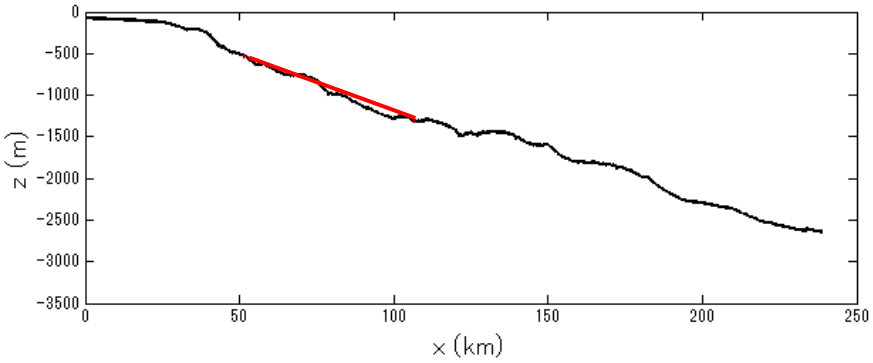


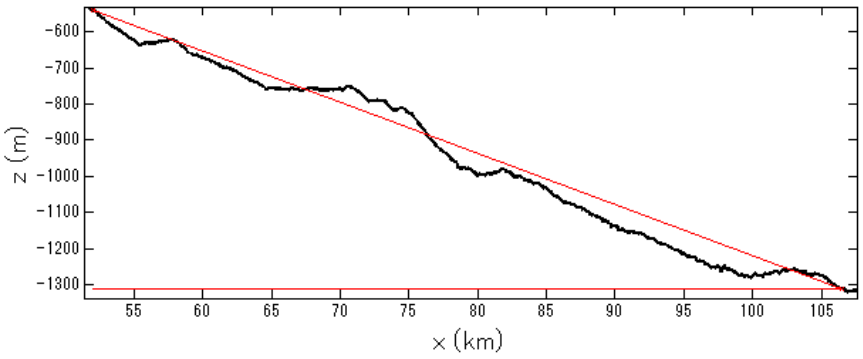

$1.489x^{0.7481}$

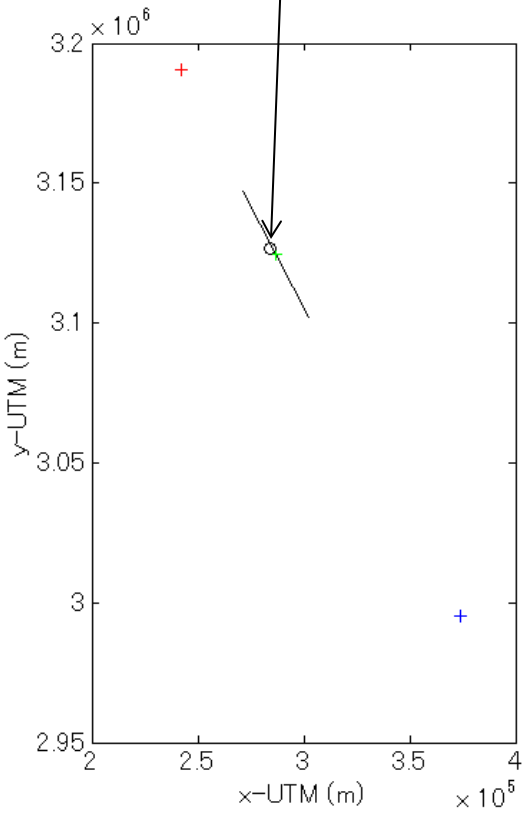
PHA increases by 50-year until getting the condition of FS < 1

$\lambda$ = 50, 100, 150, …. , 10,000 year



# Determine for initial tsunami amplitudes

$$\eta = S_c(0.0574 - 0.0431\sin\beta)\left(\frac{T}{l}\right)\left(\frac{l\sin\beta}{d}\right)^{1.25}\left(1 - e^{-2.2(s-1)}\right)\left(\frac{W}{W+\lambda}\right)$$

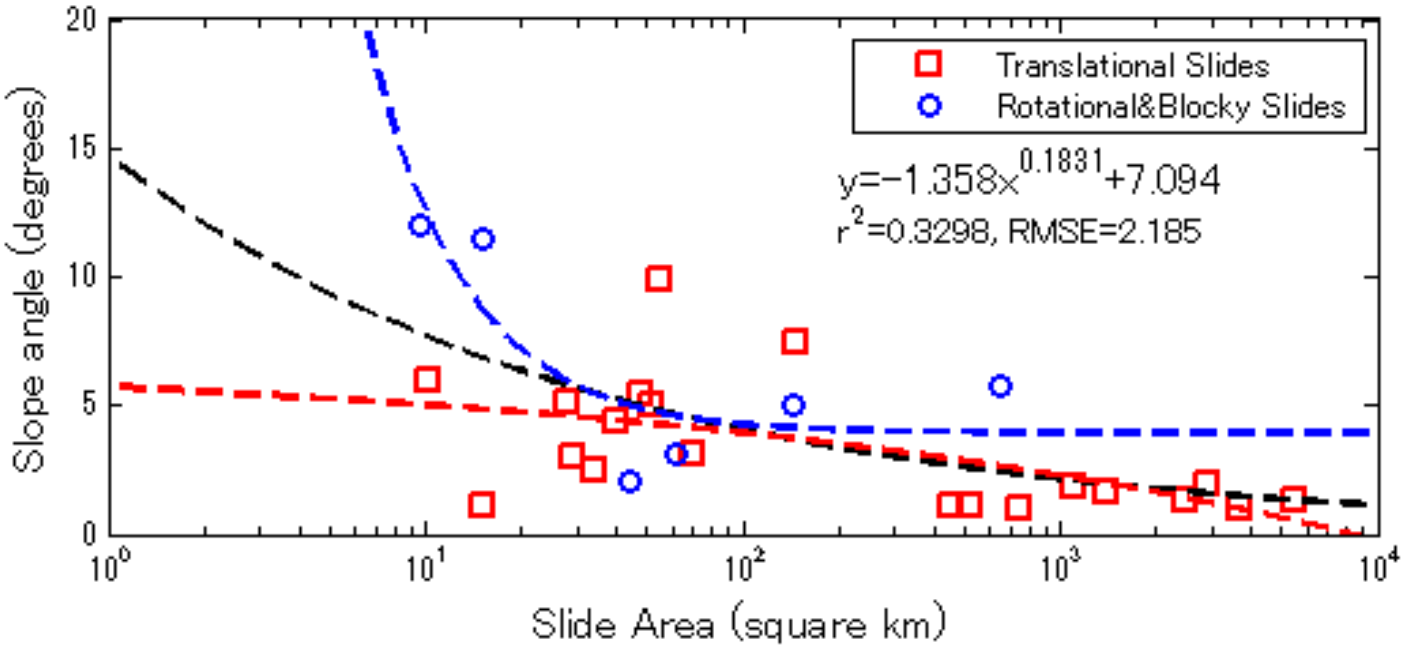
where

$$S_c = \frac{\pi}{2}l(s+1)$$ Characteristic distance of motion

$$\lambda = \sqrt{\frac{\pi l d(s+1)^2}{2\sin\beta(s-1)}}$$ Characteristic tsunami wavelength

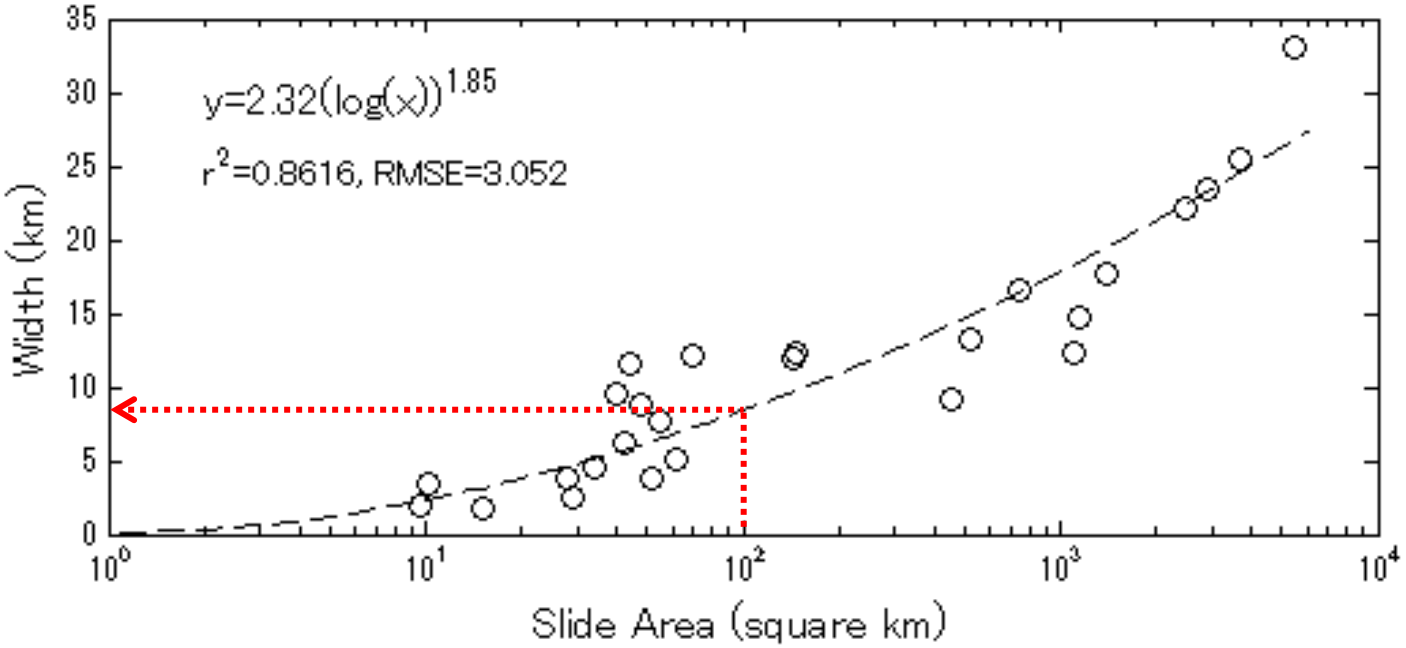
* How to get landslide width (W) ?

# Relationship between Slide Area and Slope angle




Slope angle β determines slide area(A)

# Relationship between Slide Area and Width



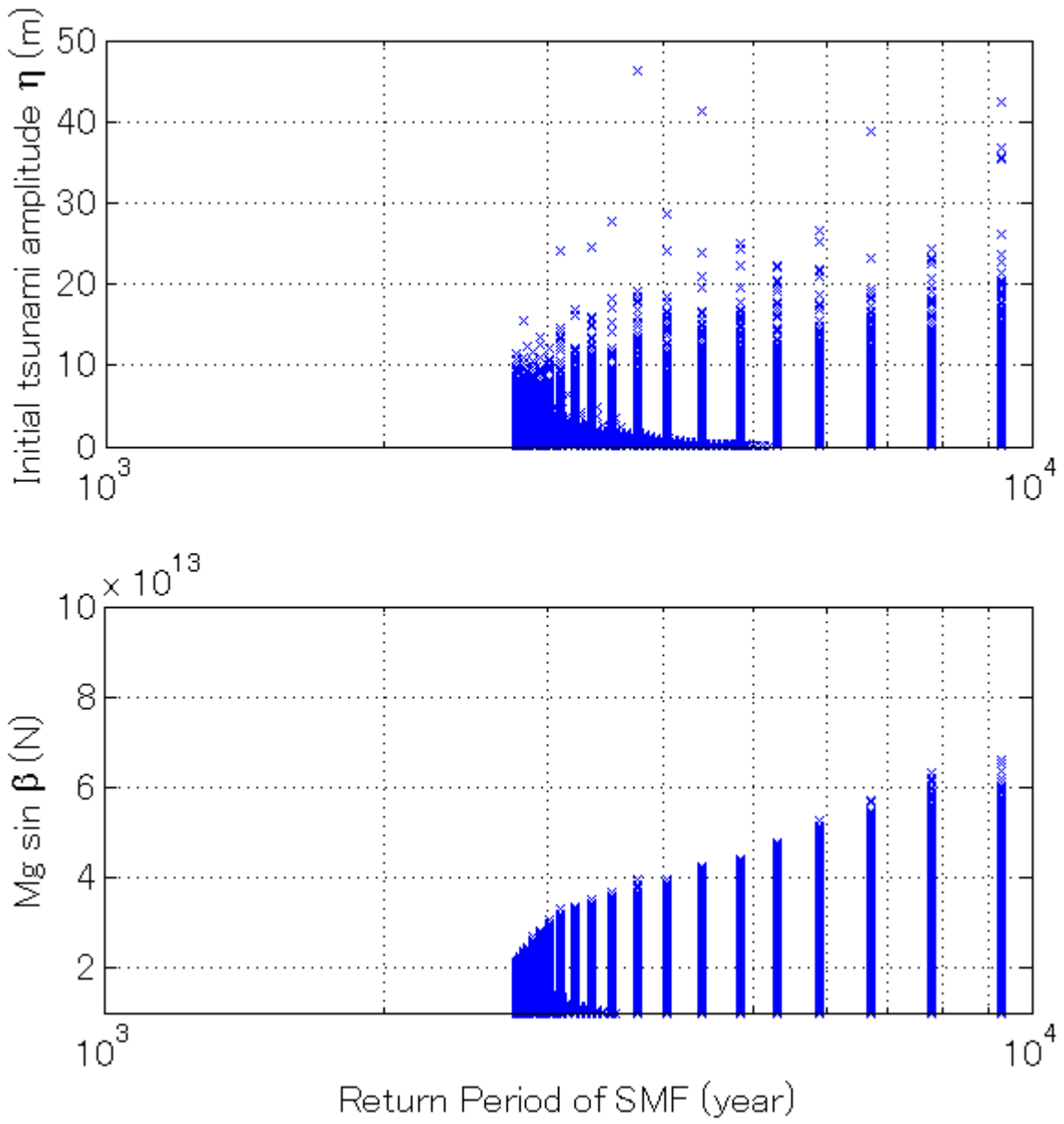

Slide area determines failure width (W)

# Test for the Monte Carlo Simulation

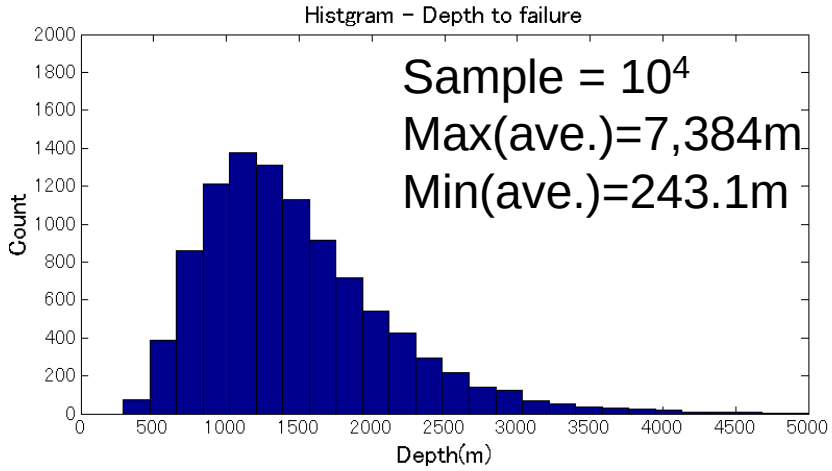
## Transect C

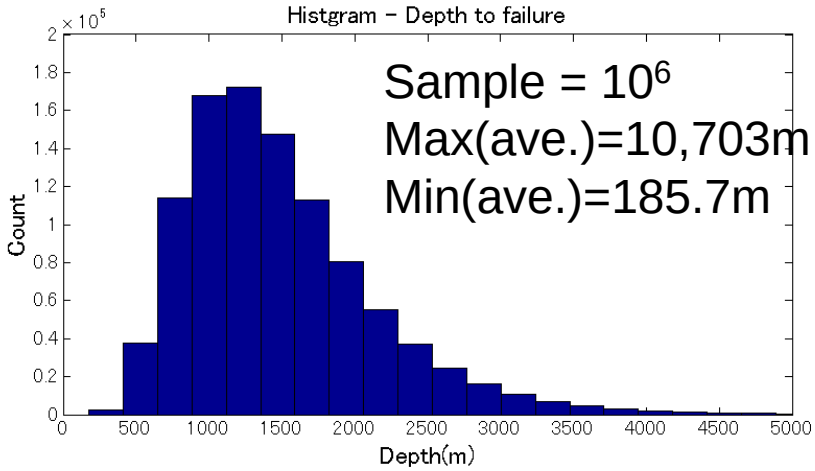
Trial Number n=20,000 , 200,000

- Case1  Limitation L=167km, T=315m
- Case2  3 < L < 167km, 48.3 < T < 315m (use Max and Min value)
- Case3  3 < L < 86.06km, 71.6 < T < 221.8m (use Mean±STD)

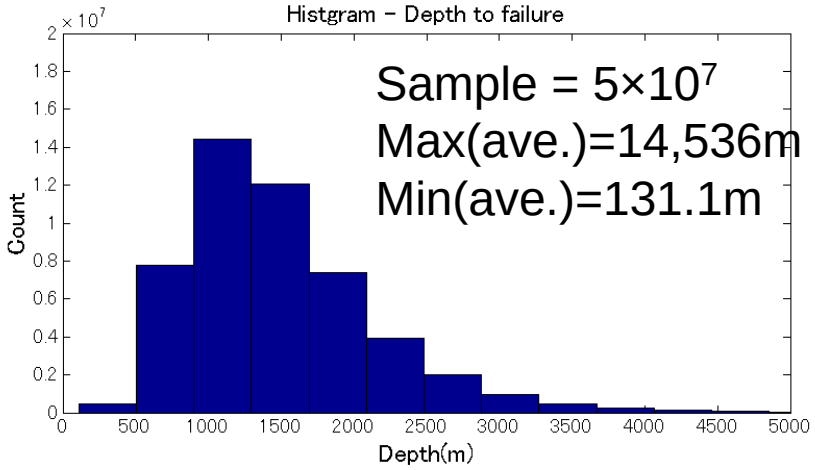

Initial tsunami amplitude η (m)
50
40
30
20
10
0
10^3
10^4
× 10^13
10
8
6
4
2
Mg sin β (N)
Return Period of SMF (year)

# Convergence of frequency distribution with the different sampling number for depth

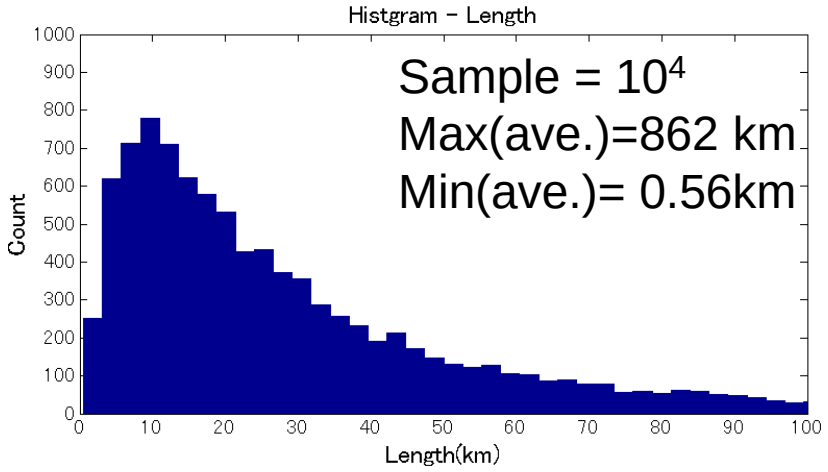


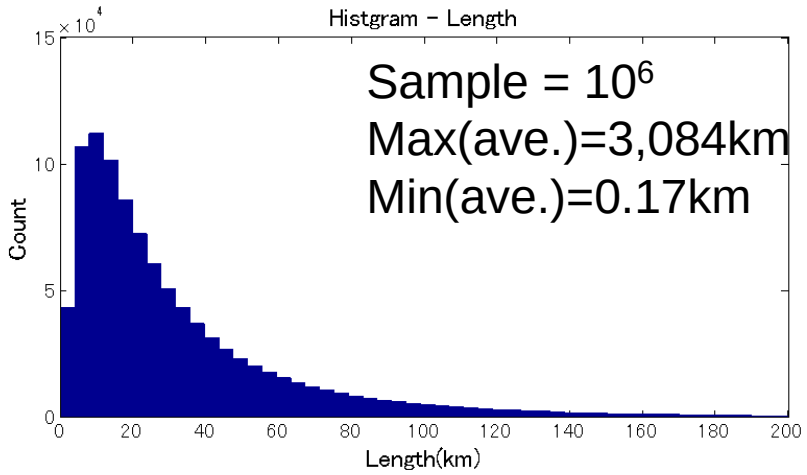




Mean = 1489.7 m
STD = 662.3 m
c.o.v = 0.44

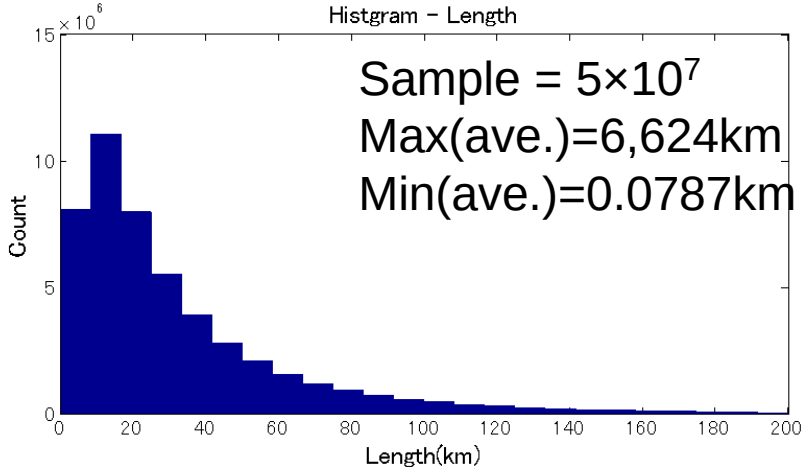


# Convergence of frequency distribution with the different sampling number for Length




Mean = 37100 m
STD = 48500 m
c.o.v. = 1.31



# Convergence of frequency distribution with the different sampling number

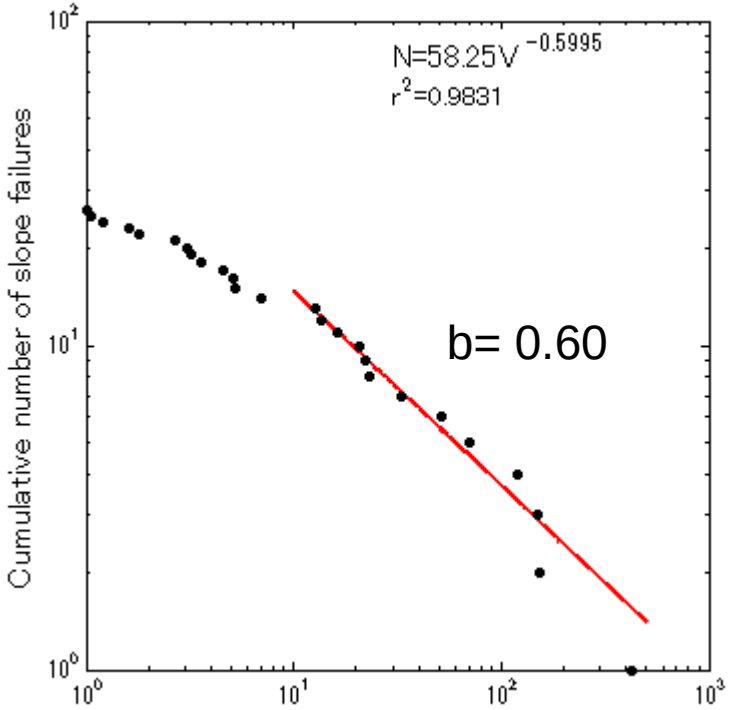
Thickness
Mean = 142.4 m
STD = 72.9 m
c.o.v. = 0.51

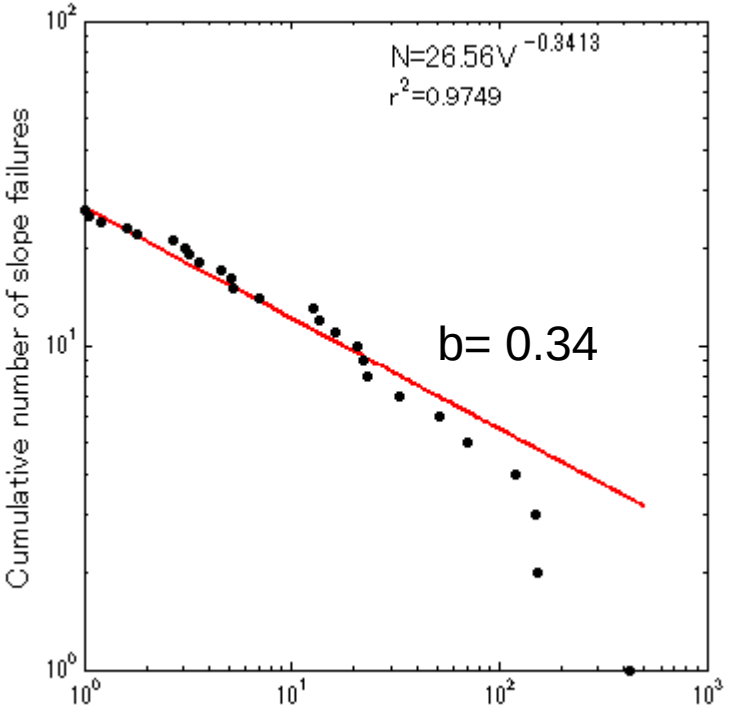
Sample = $10^4$
Max(ave.)=971.6m
Min(ave.)=17.8m

Sample = $5\times10^7$
Max(ave.)=1906.2 m
Min(ave.)=8.81m

# Relationship between Volume and Cumulative number of slope failures

## Observation



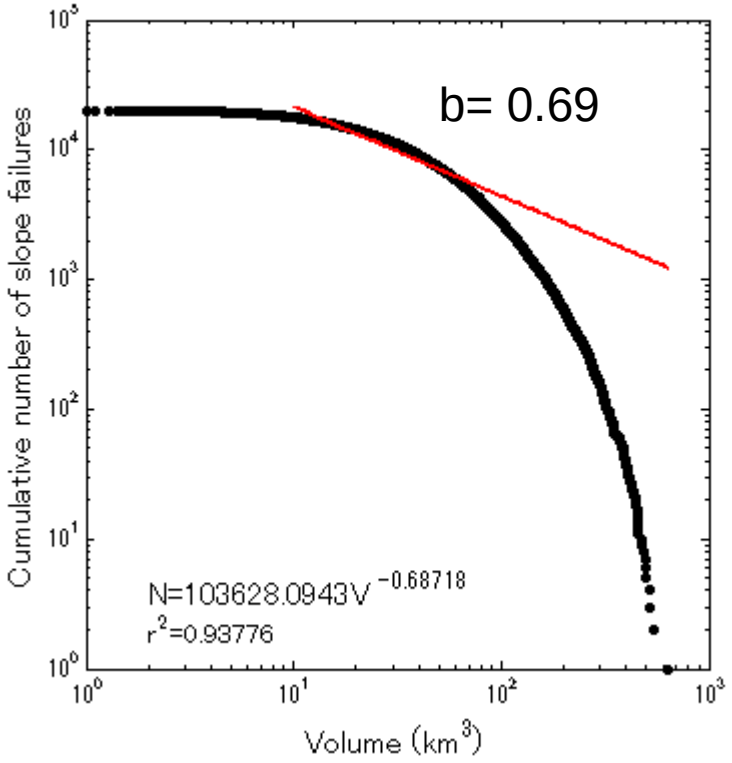



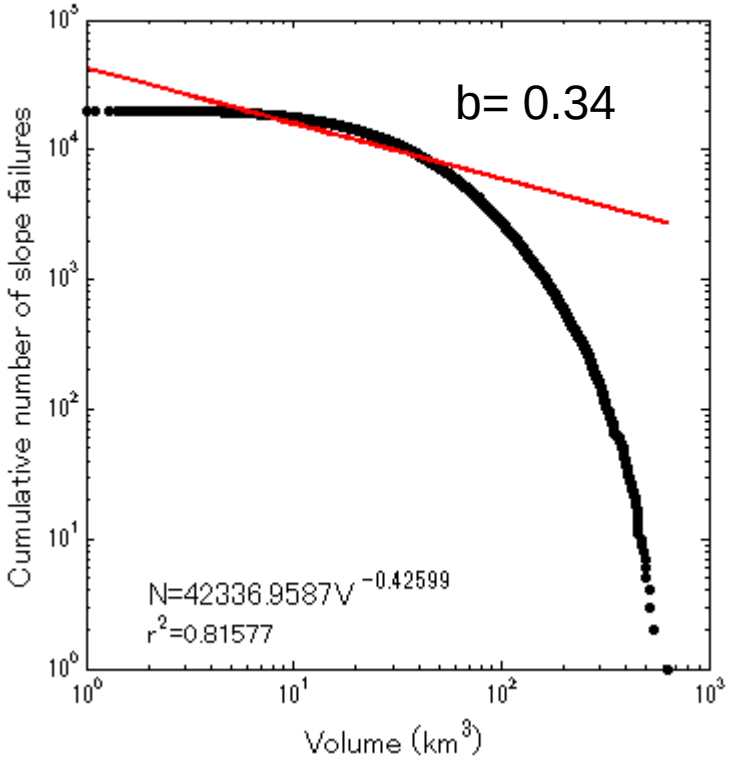

- Sub aerial : b=0.5±0.2
- Submarine, Puerto Rico (ten Brick):

# Relationship between Volume and Cumulative number of slope failures

Result of the MCS : Case1

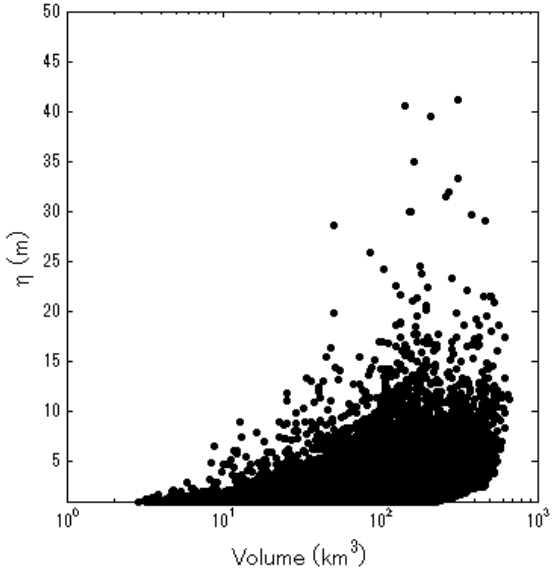
Limitation of L=167km, T=315m, n = 20,000



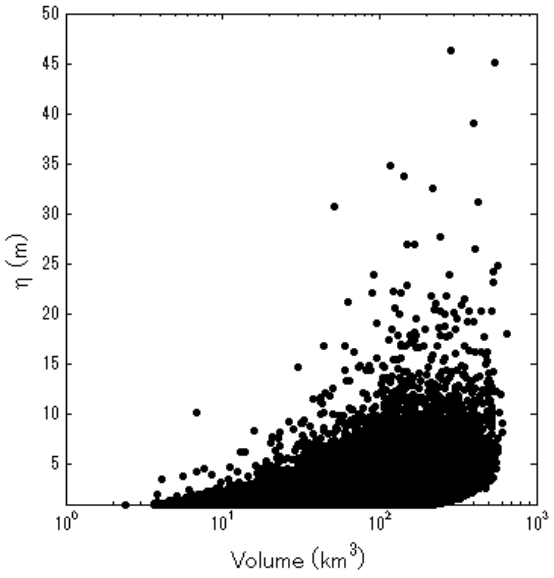



# Relationship between Volume and initial Tsunami height (depression)

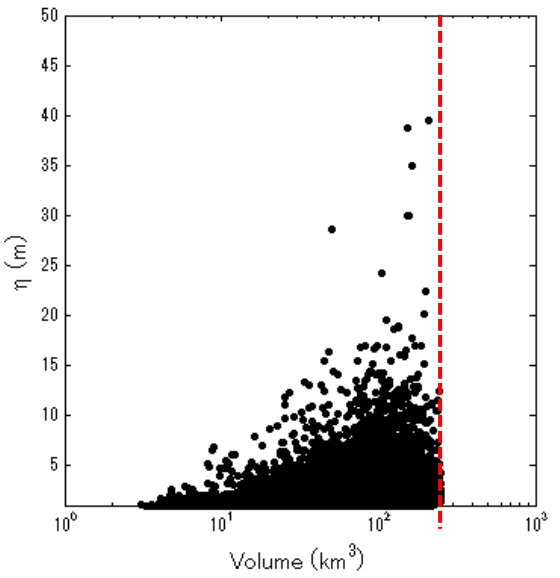
Case1 n=20,0000




Case2 n=200,000

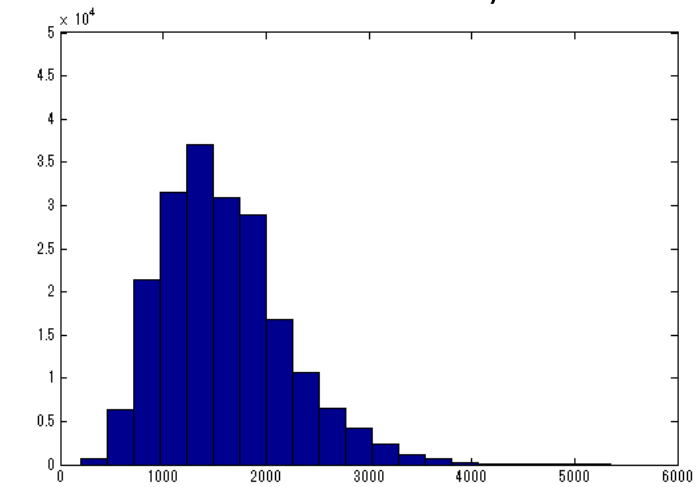


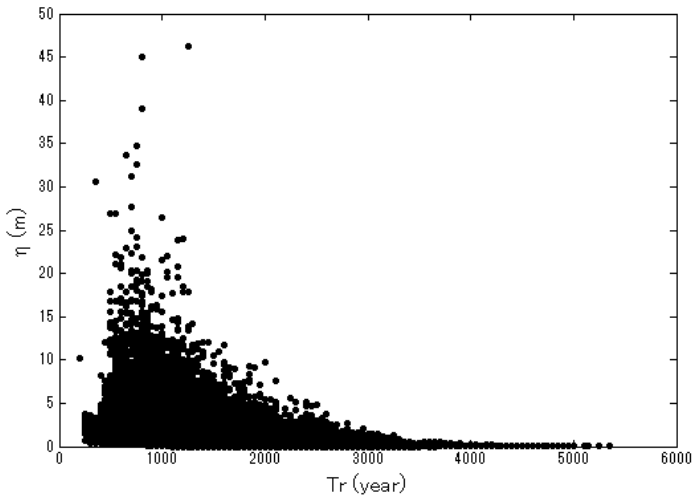

Case3 n=200,000



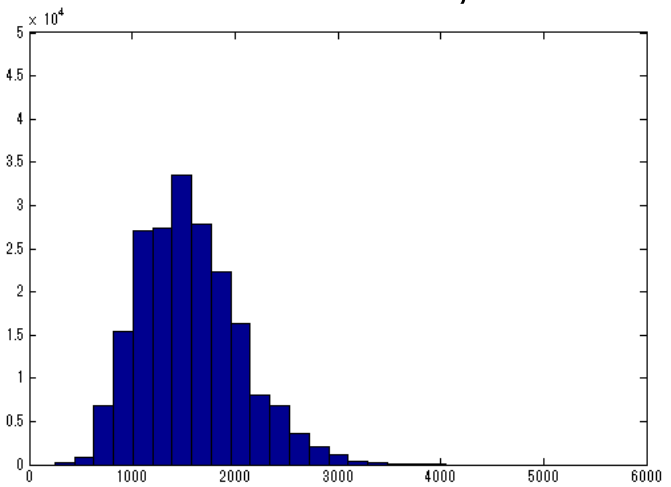
# Relationship between Return Period and initial tsunami height (depression), frequency of occurrence

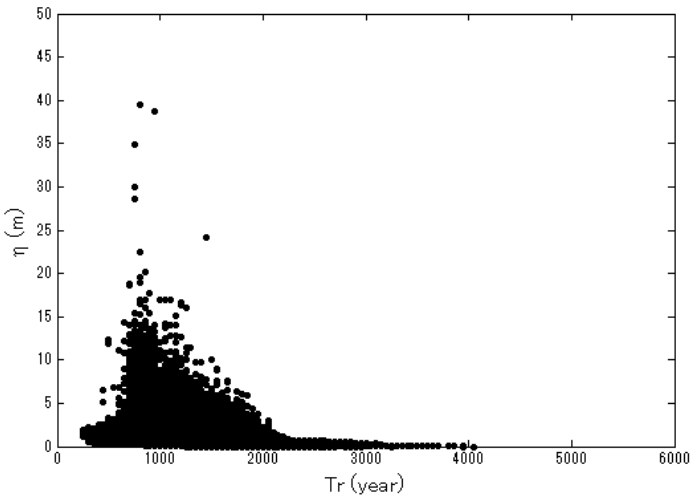
Case2 n=200,000



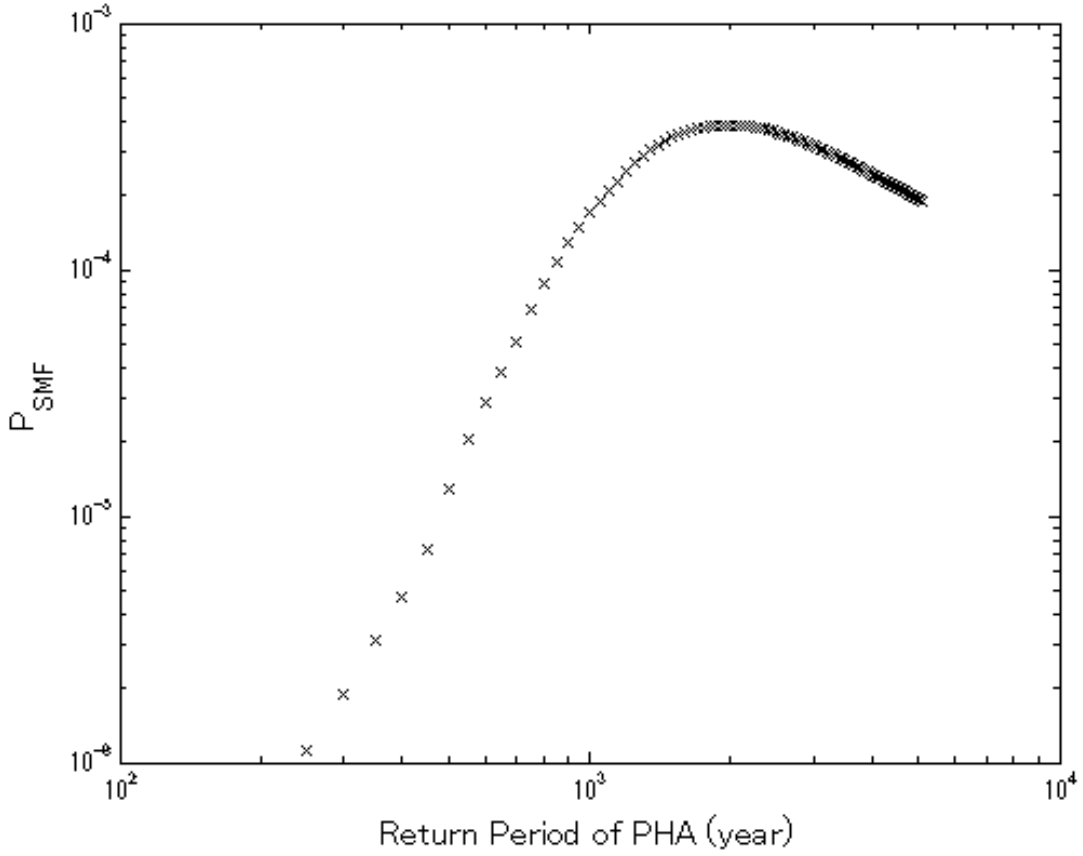

Case3 n=200,000



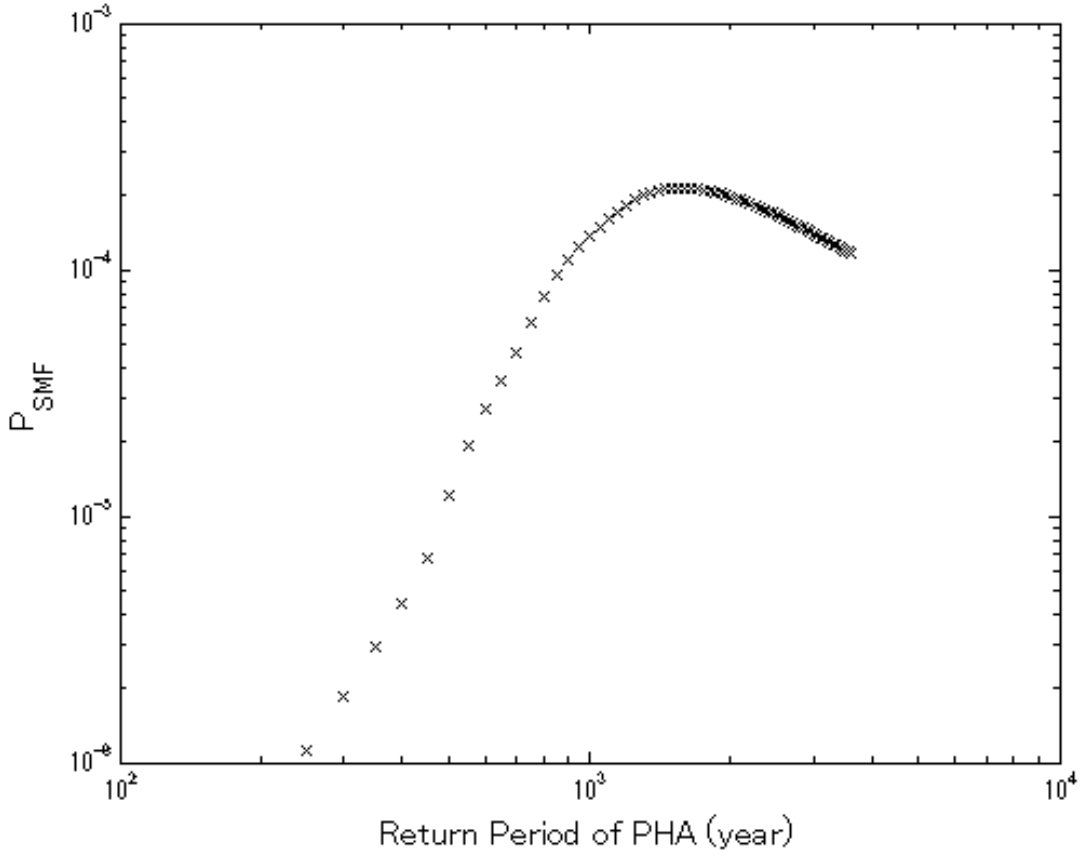
# Relationship between Return Period of PHA and $P_{SMF}$

Case2 N=1,000,000 threshold $\eta >= 0.02m$

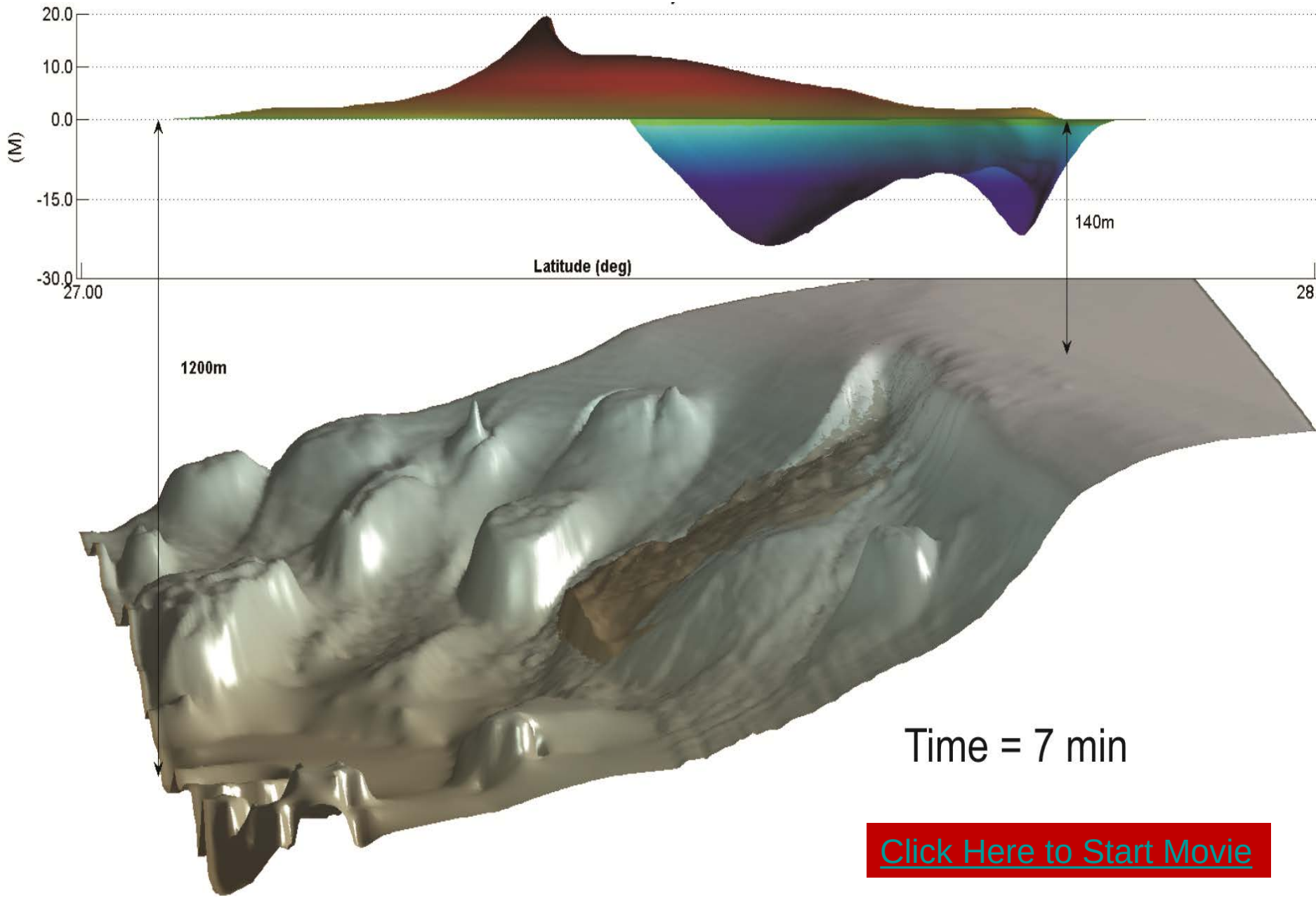


# Relationship between Return Period of PHA and $P_{SMF}$

Case2 N=1,000,000 threshold $\eta$>= 0.5m

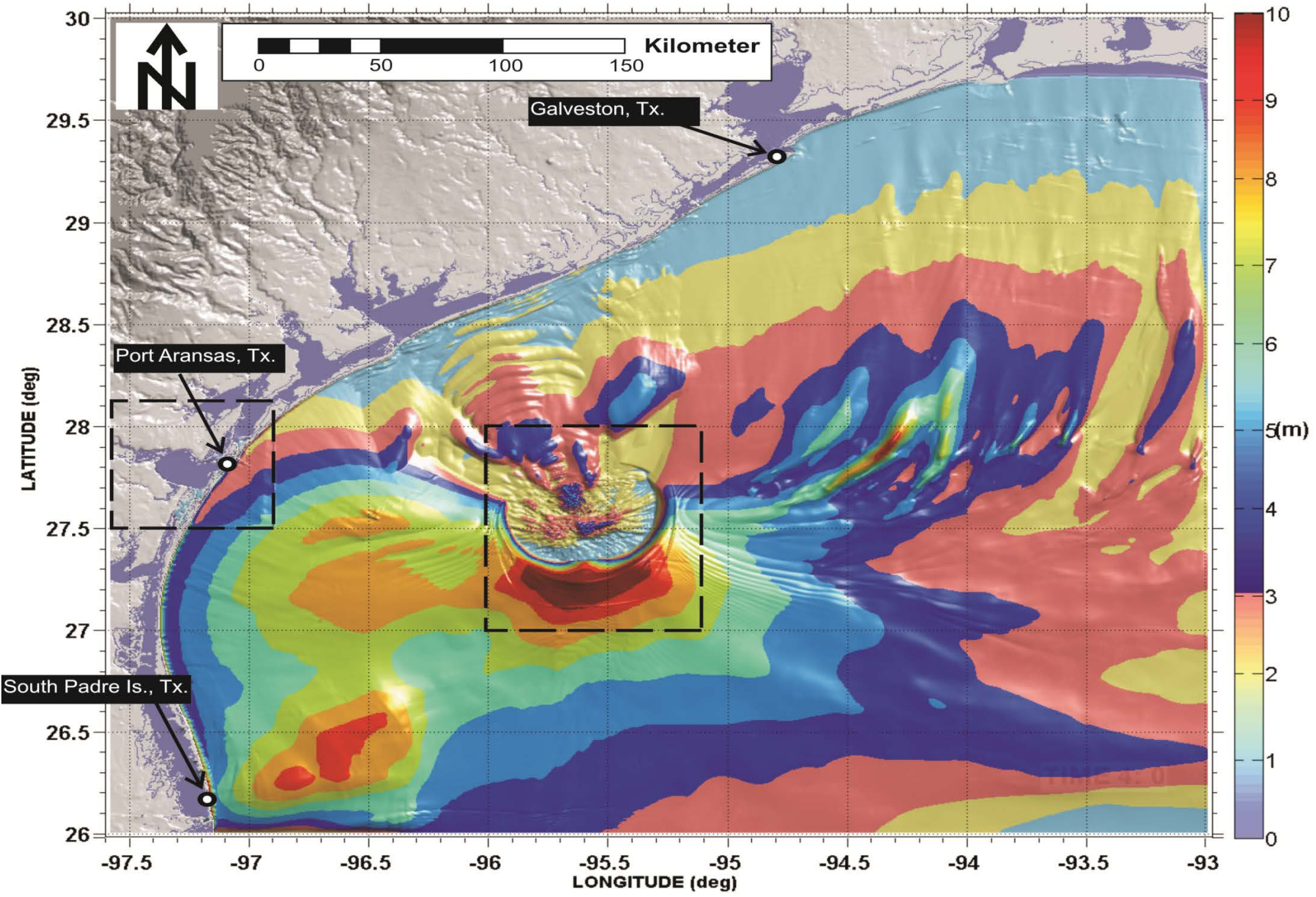


# EAST BREAKS LANDSLIDE MOVIE (SIDE)

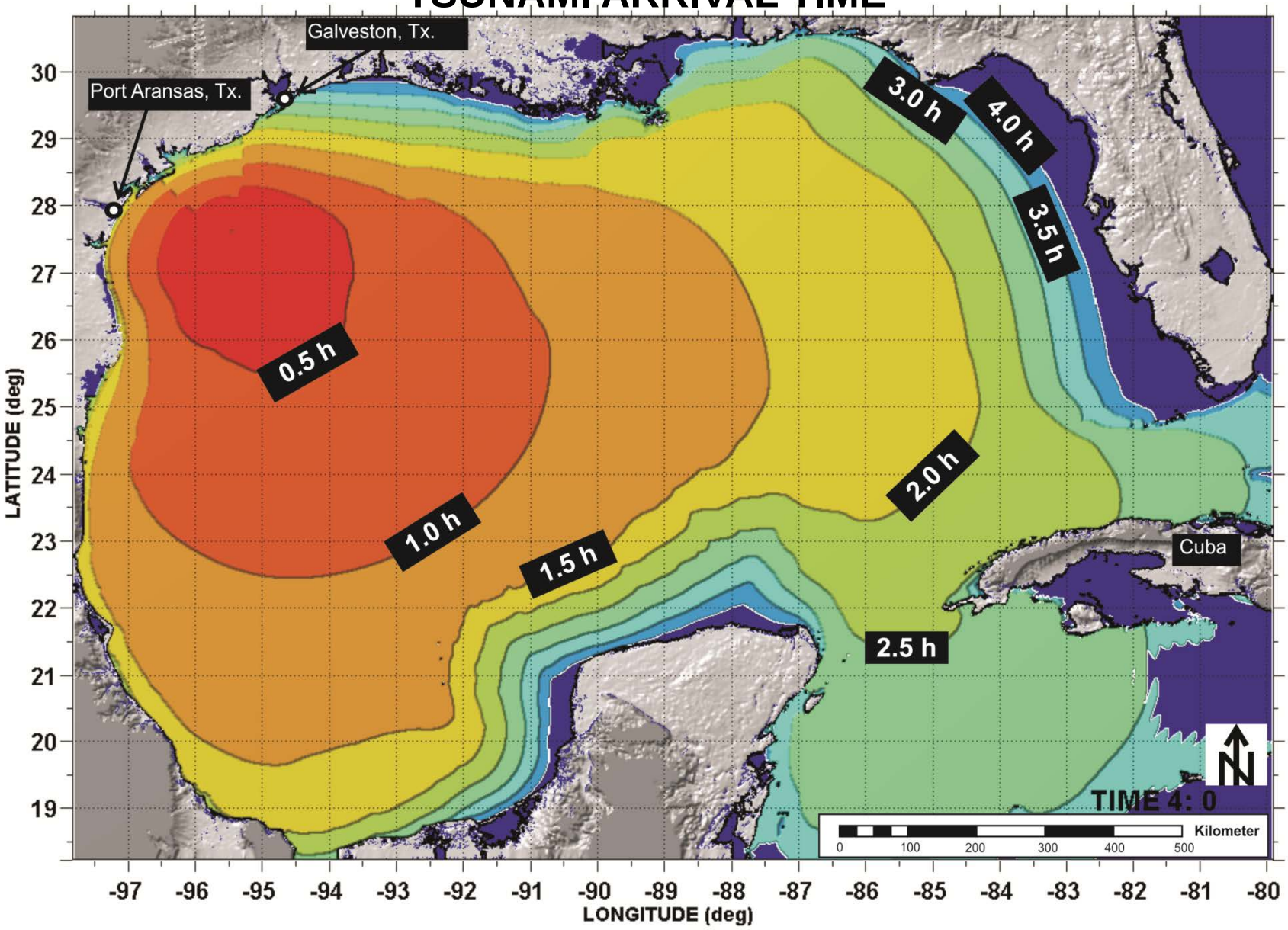



Click Here to Start Movie

# EAST BREAKS LANDSLIDE - ZOOM UP - MAXIMUM WAVE AMPLITUDE

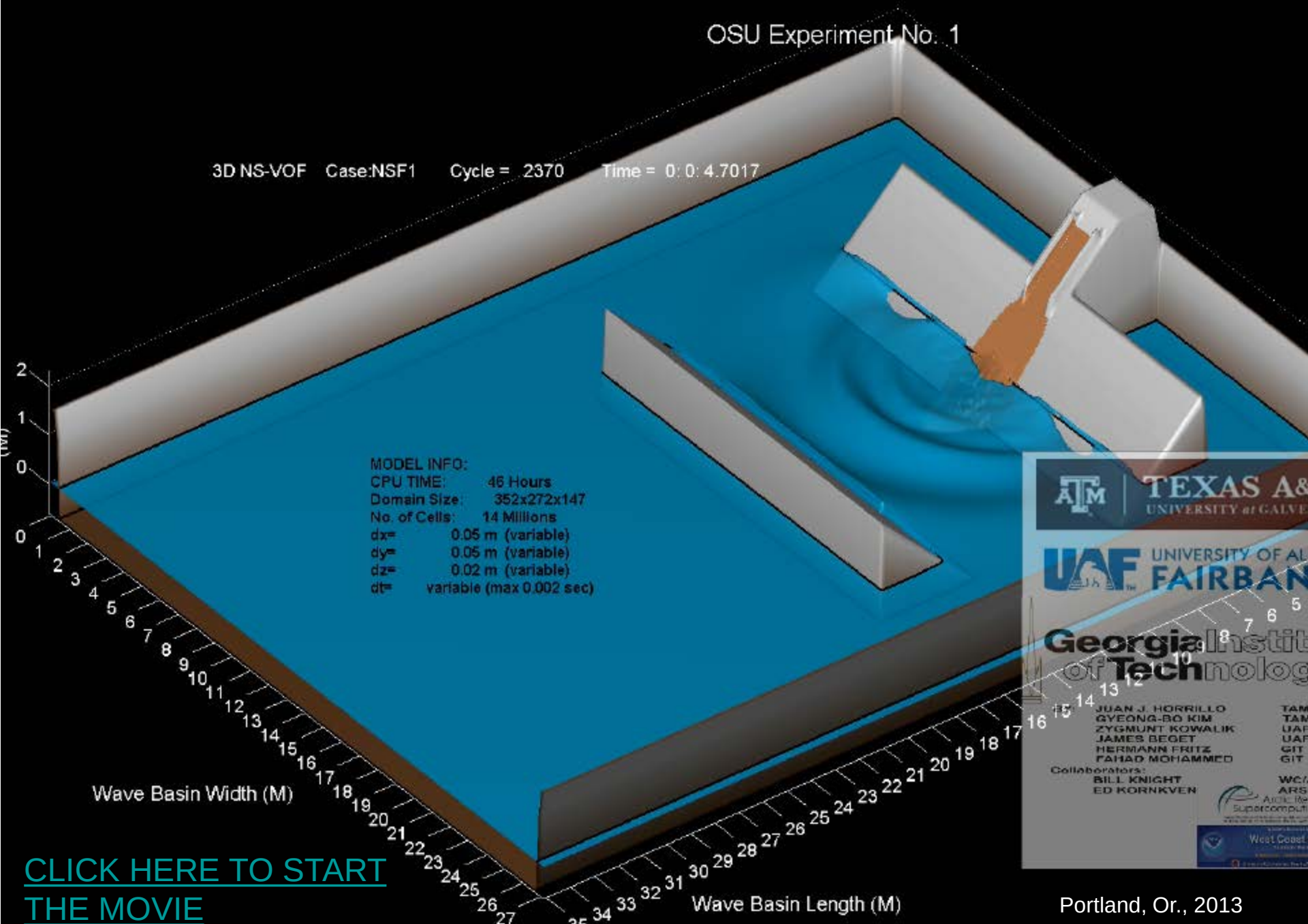


# EAST BREAKS LANDSLIDE
# TSUNAMI ARRIVAL TIME



**OSU Experiment**
**Texas A&M Galveston**
**Georgia Inst. Technology**

# OSU Experiment , NSF Georgia Inst. Technology

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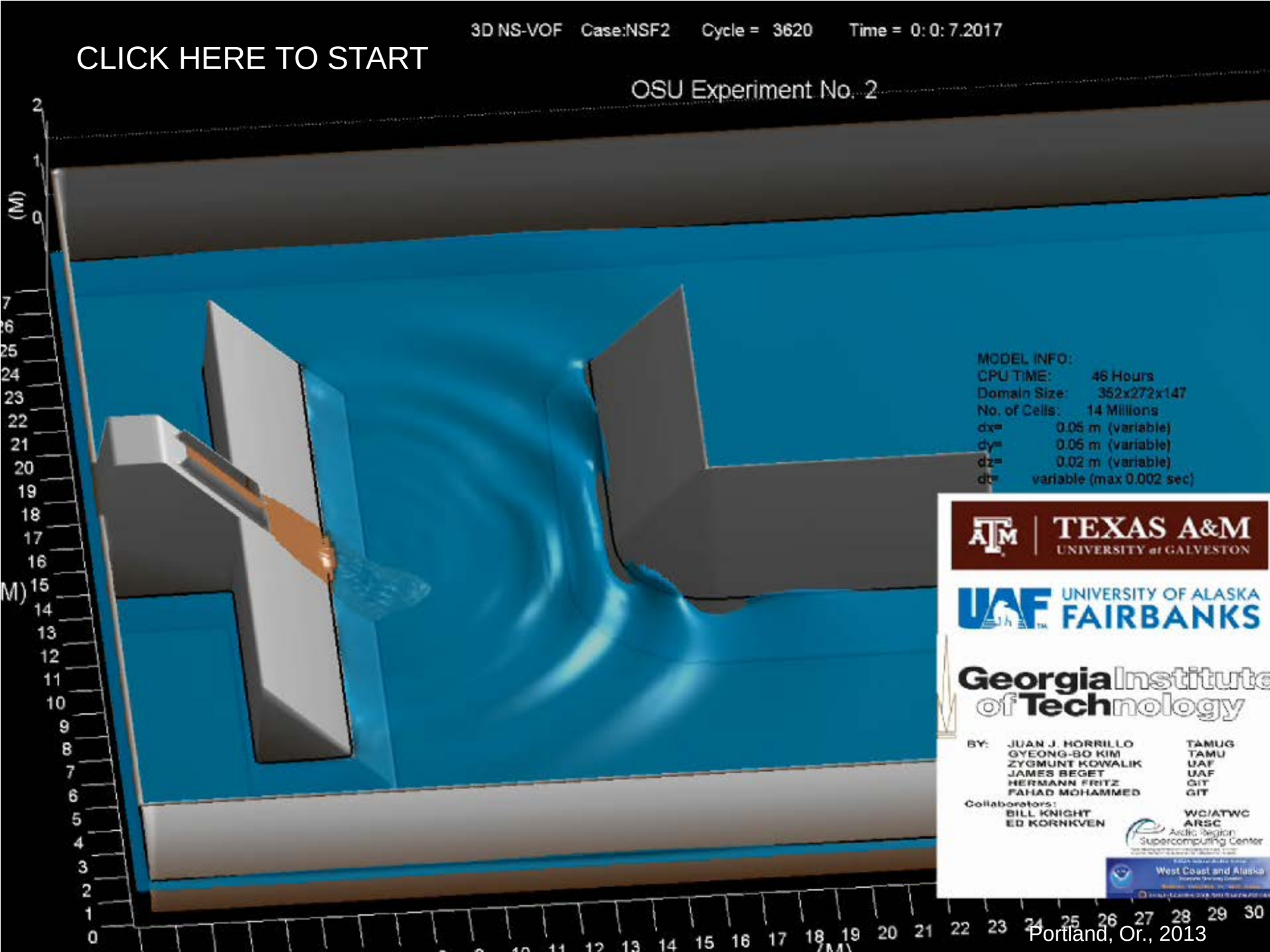


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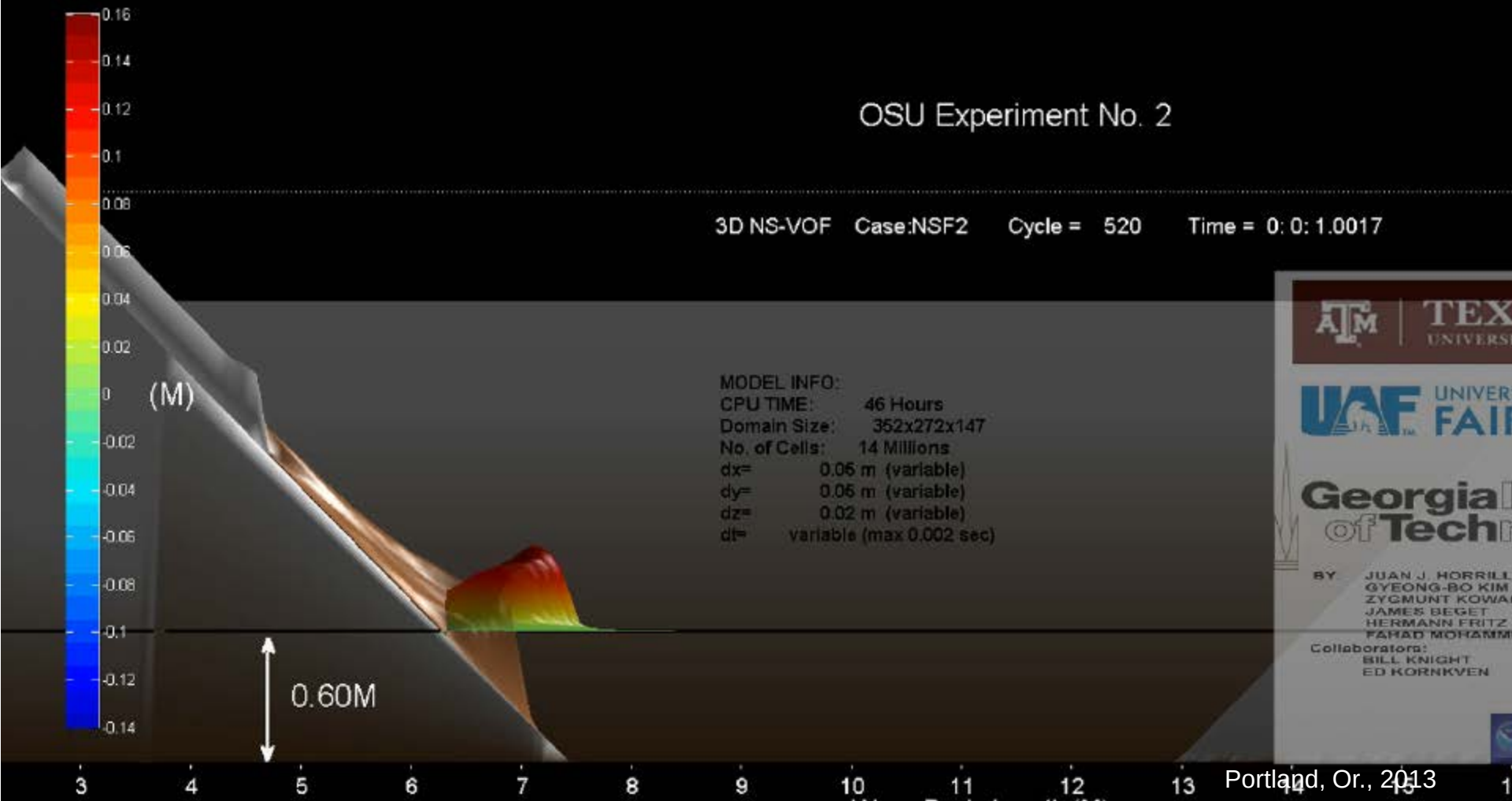


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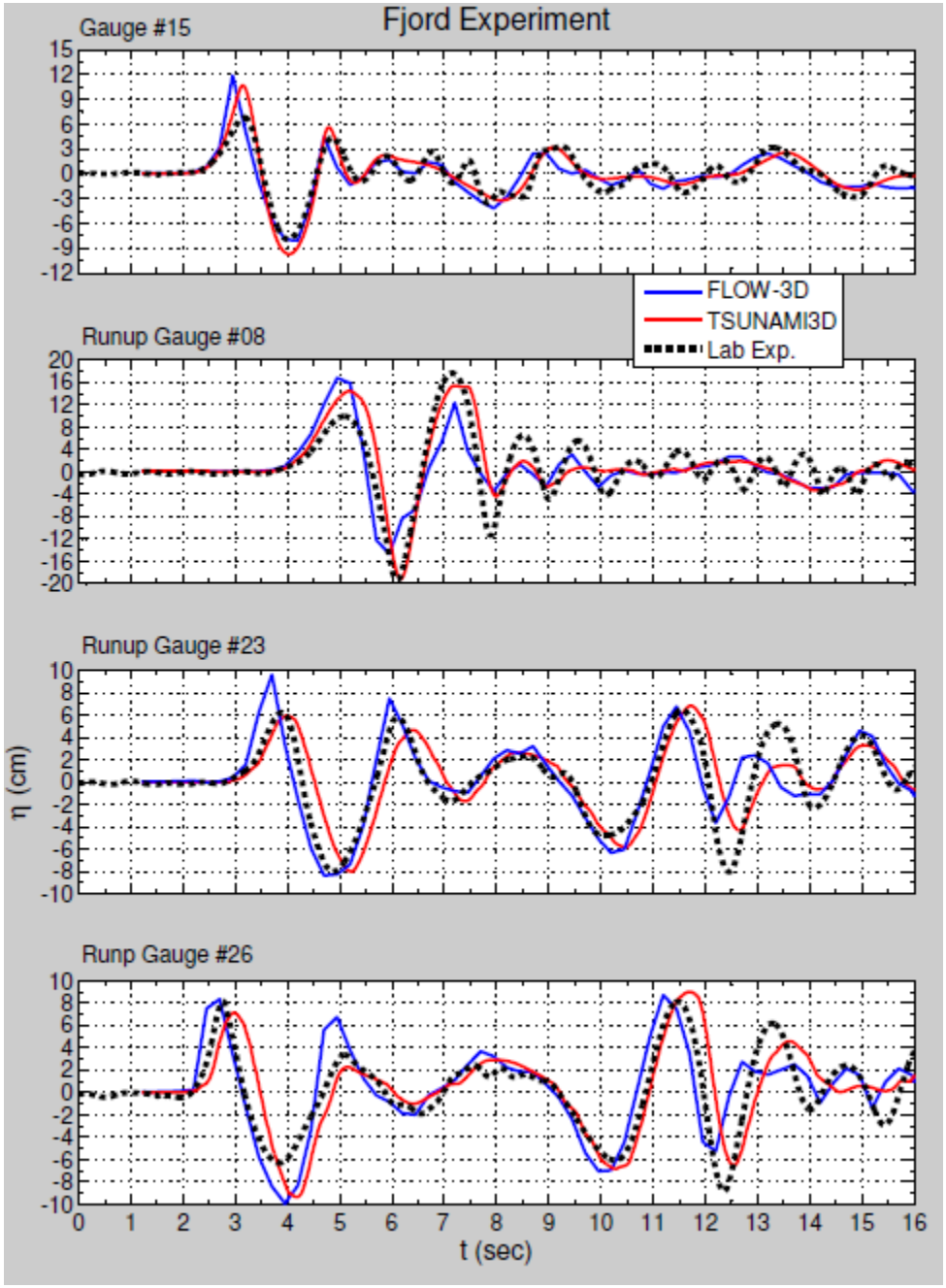
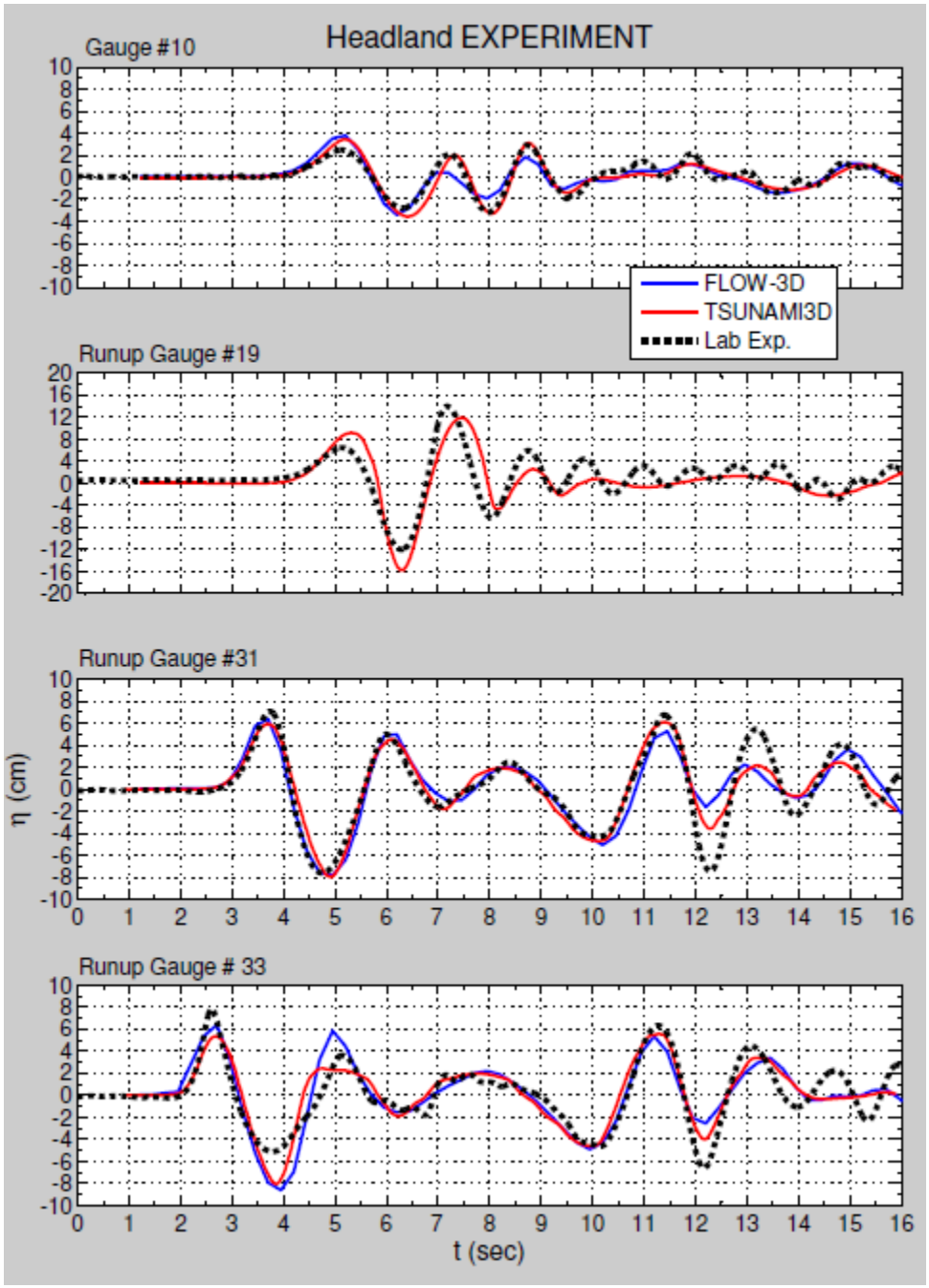



Portland, Or., 2013

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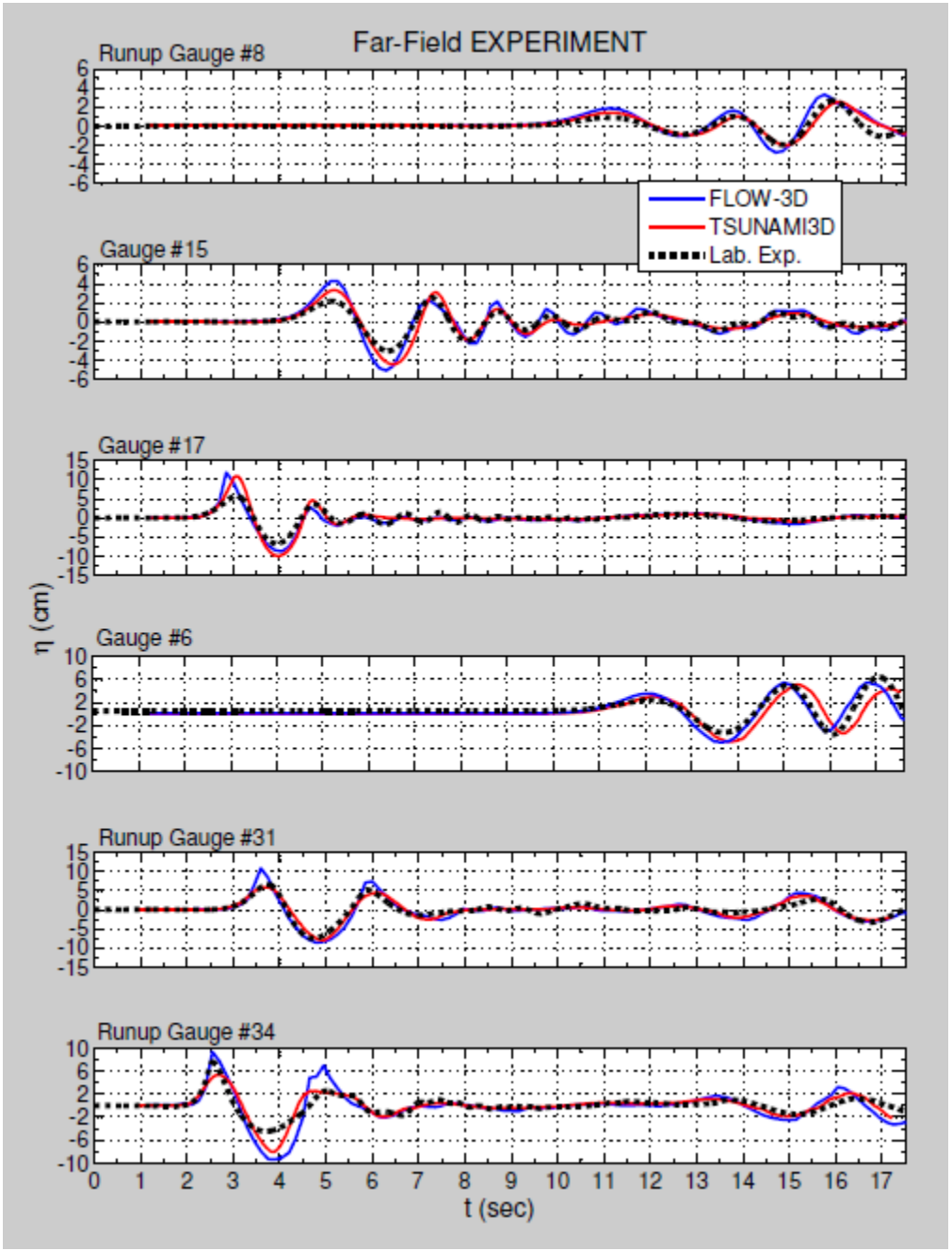


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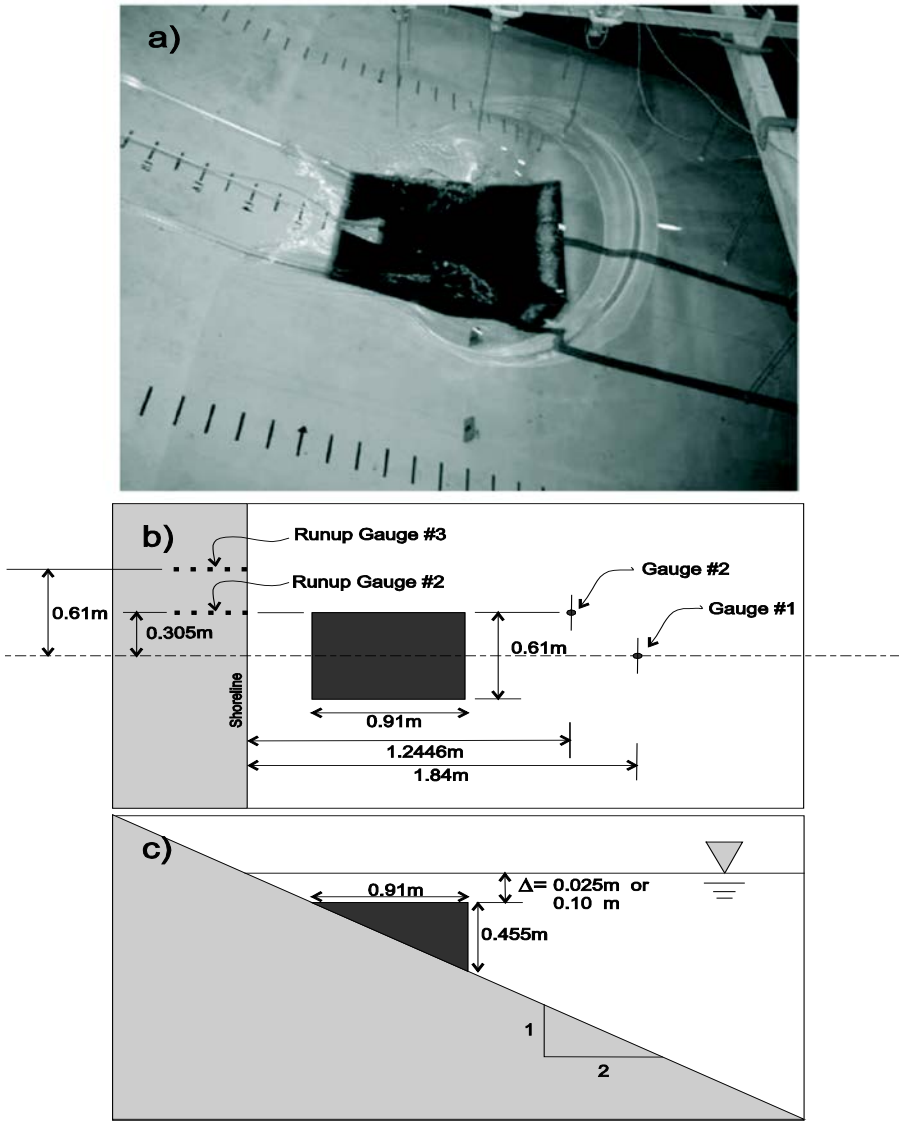
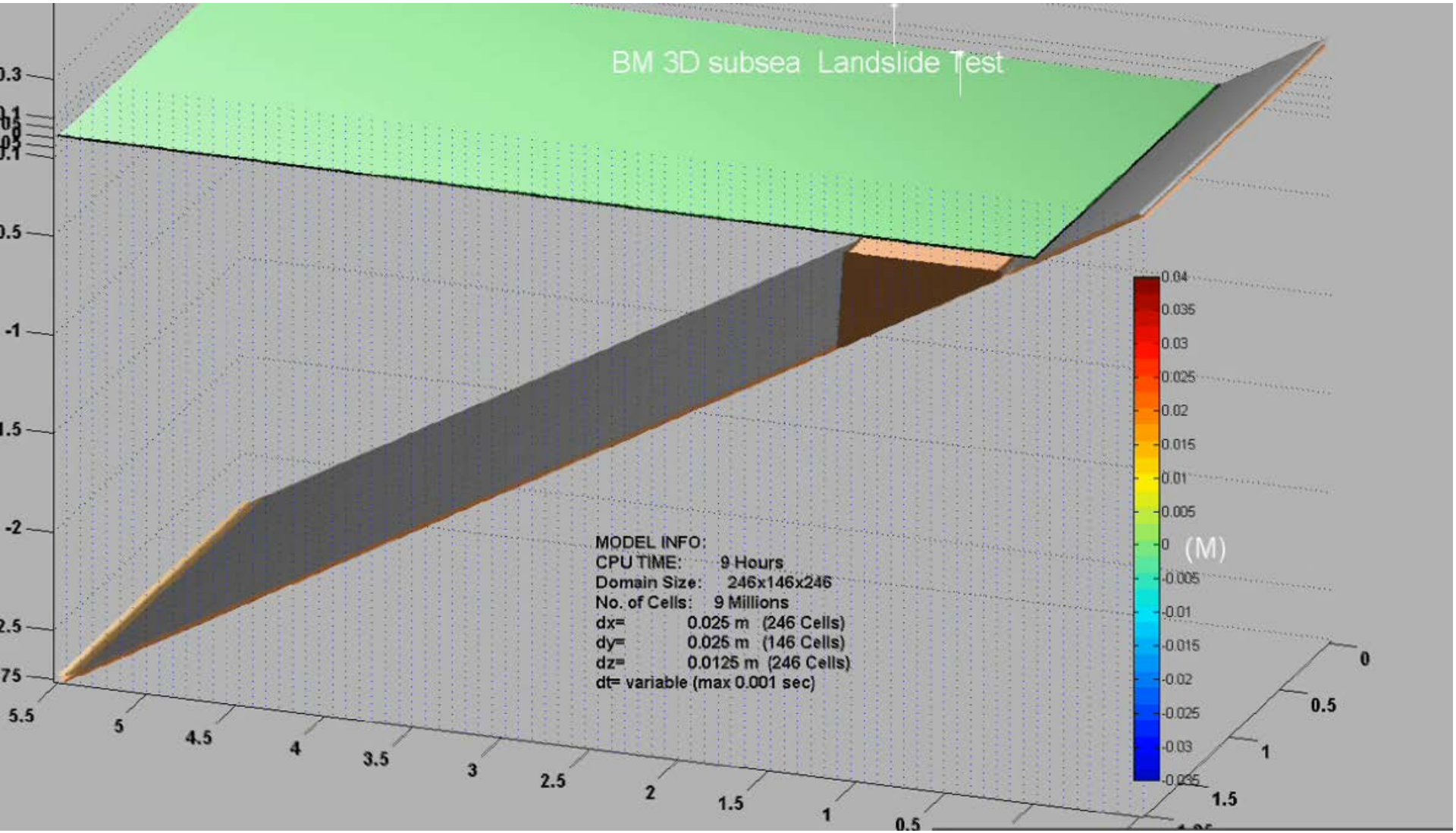
# Tsunami generation and runup due to 3D landslide



# Tsunami generation and runup due to 3D landslide

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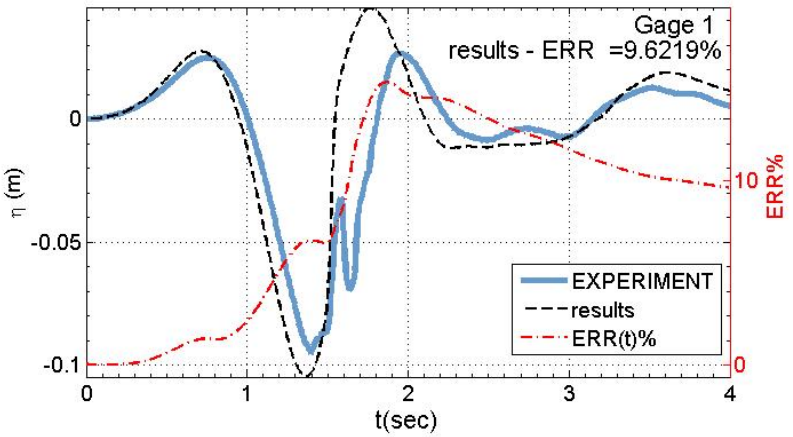
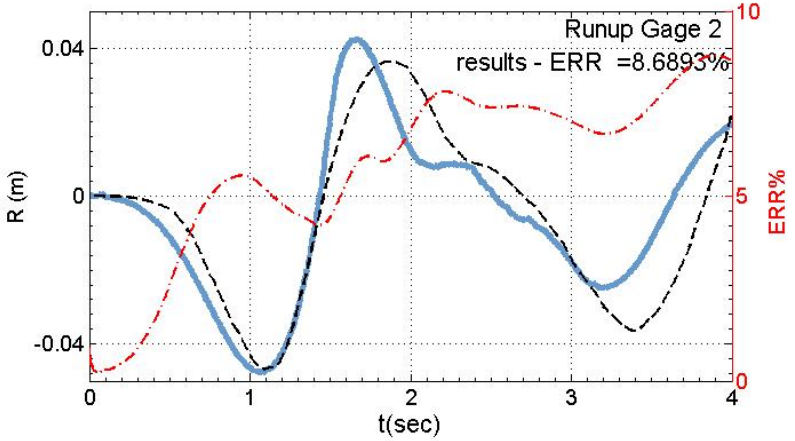
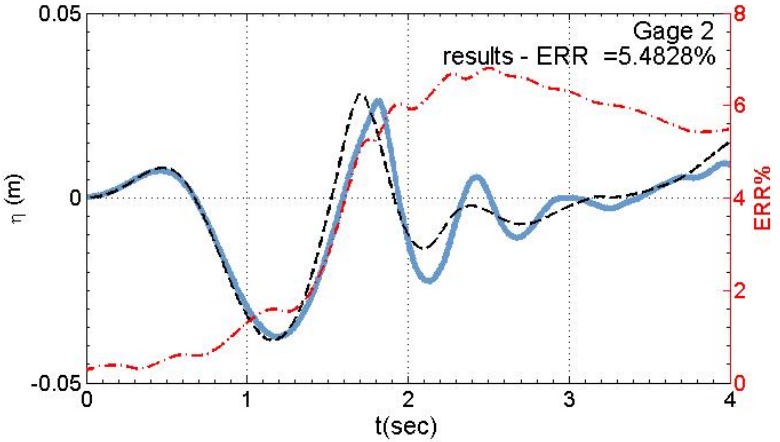
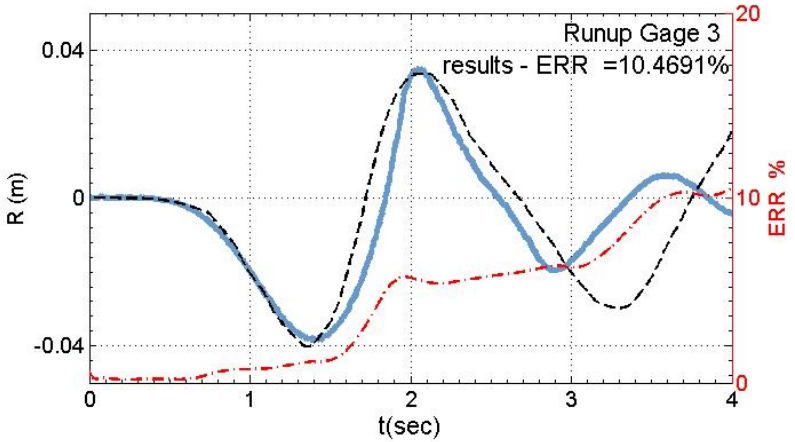
# Tsunami generation and runup due to 3D landslide
# Experiment Δ=0.10m

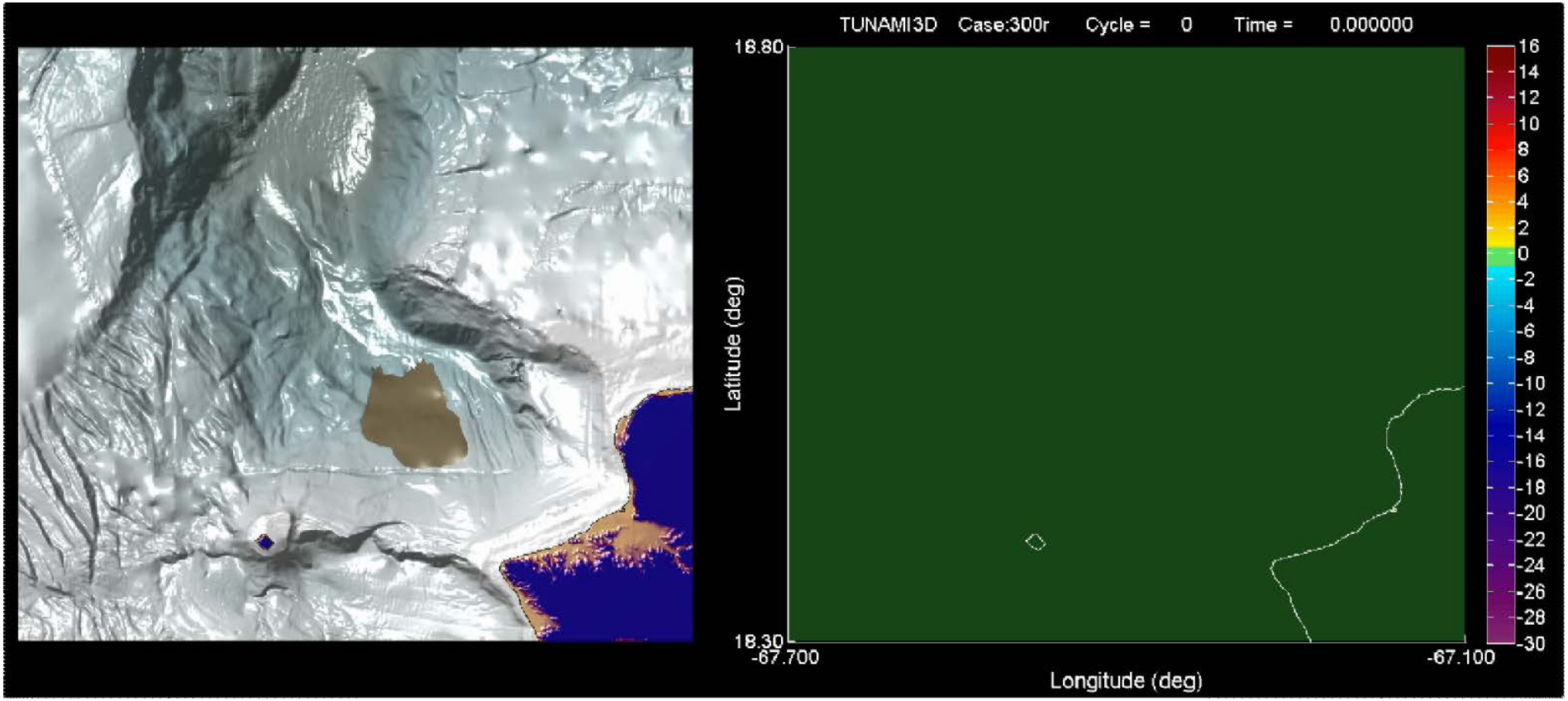


# EARTHQUAKE PR 1918 (MONA TSUNAMI)

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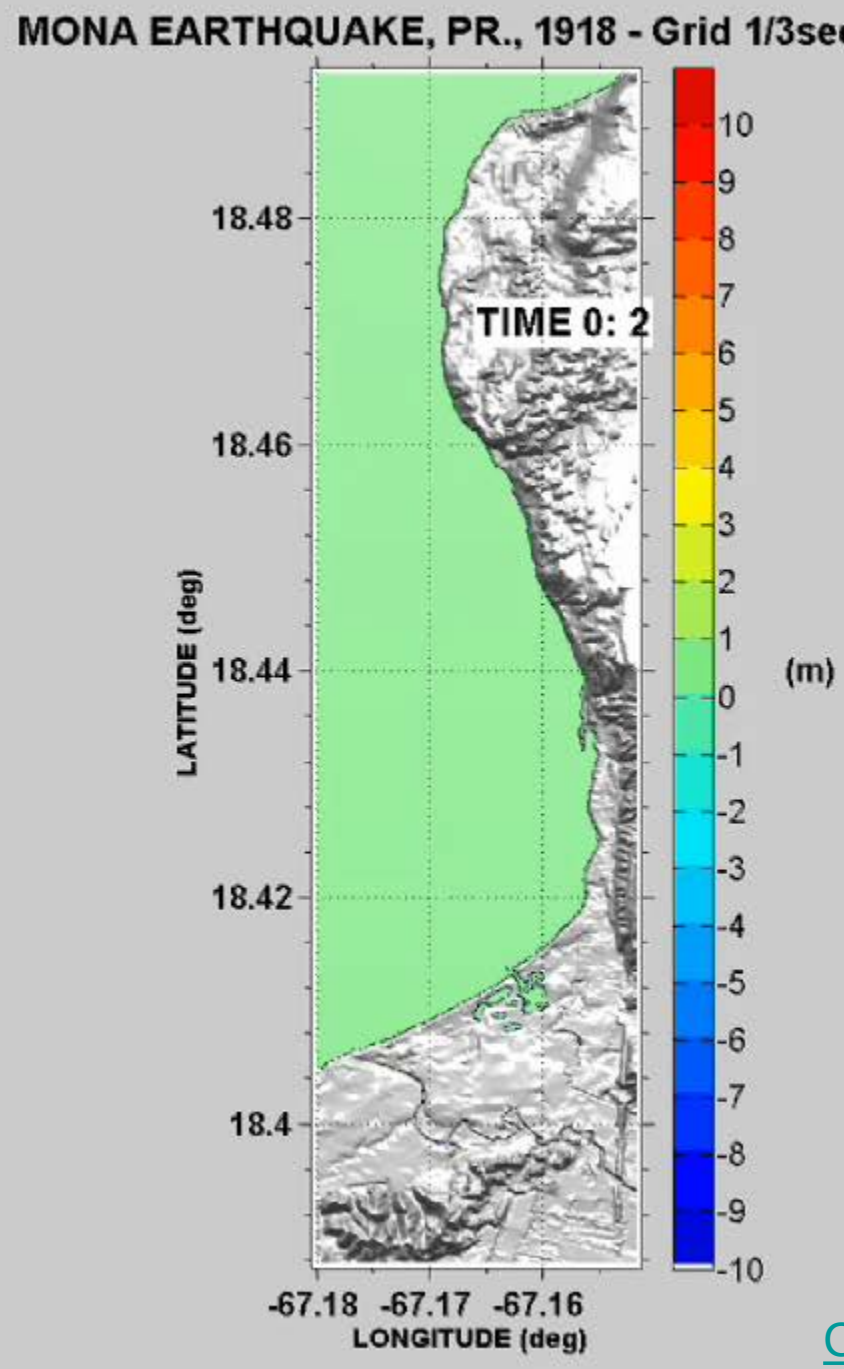


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## Texas A&M University at Galveston,
## States of Alabama, Florida, Louisiana, Mississippi and Texas

# Proposal to the National Tsunami Hazard Mitigation Program
# FY12 funding
# Construction of five (5) tsunami inundation maps in the Gulf of Mexico.

Portland, Or., 2013

TEXAS A&M UNIVERSITY at GALVESTON

M A S E
Maritime Systems Engineering

# National Tsunami Hazard Mitigation Program
# Construction of tsunami inundation maps in the Gulf of Mexico

NEW PROPOSAL Funding for GOM tsunami mapping effort

## A probabilistic methodology for risk assessment of tsunami generated by subsea landslide and its application in the Gulf of Mexico

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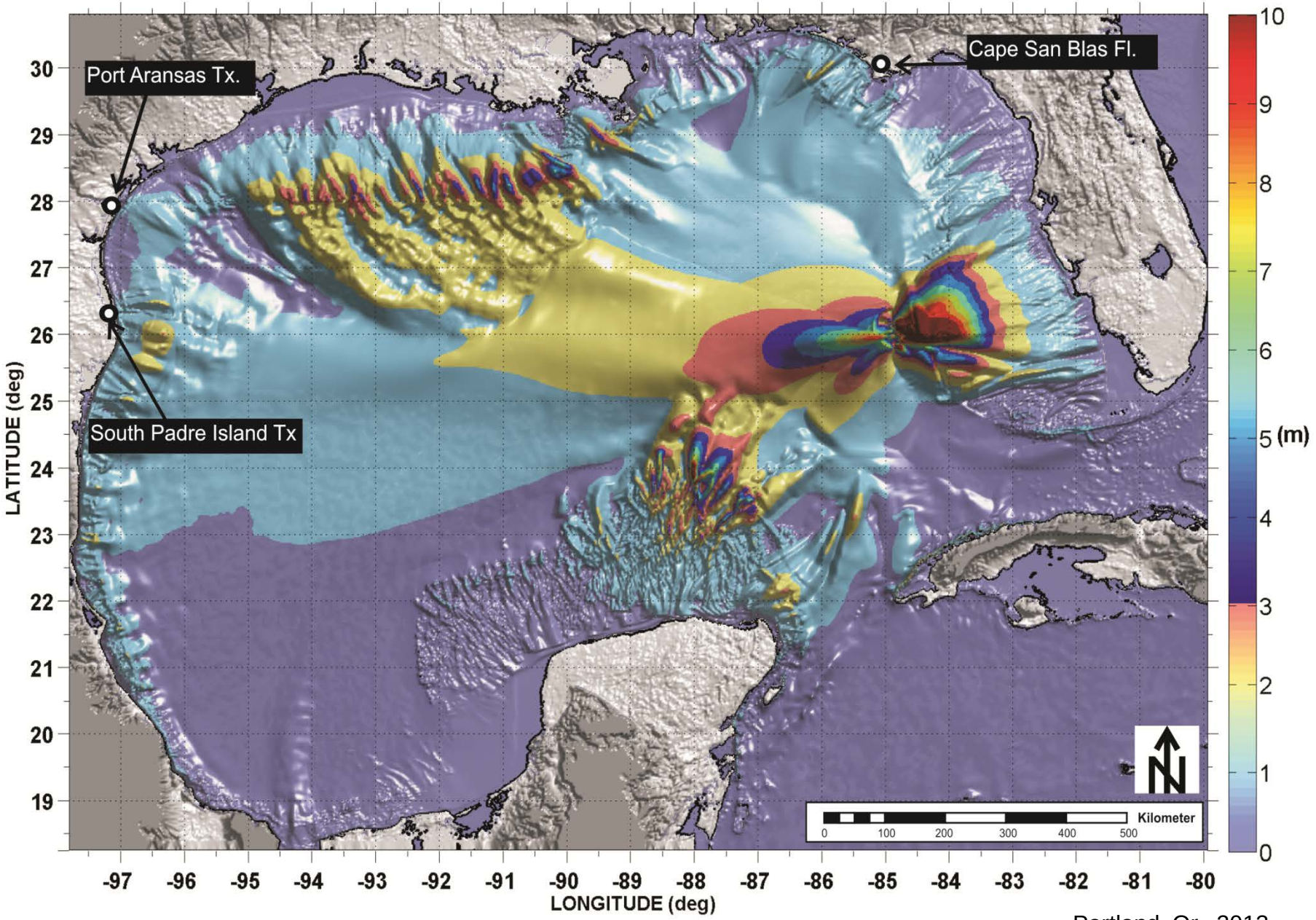
# WEST FLORIDA LANDSLIDE
# MAXIMUM WAVE AMPLITUDE

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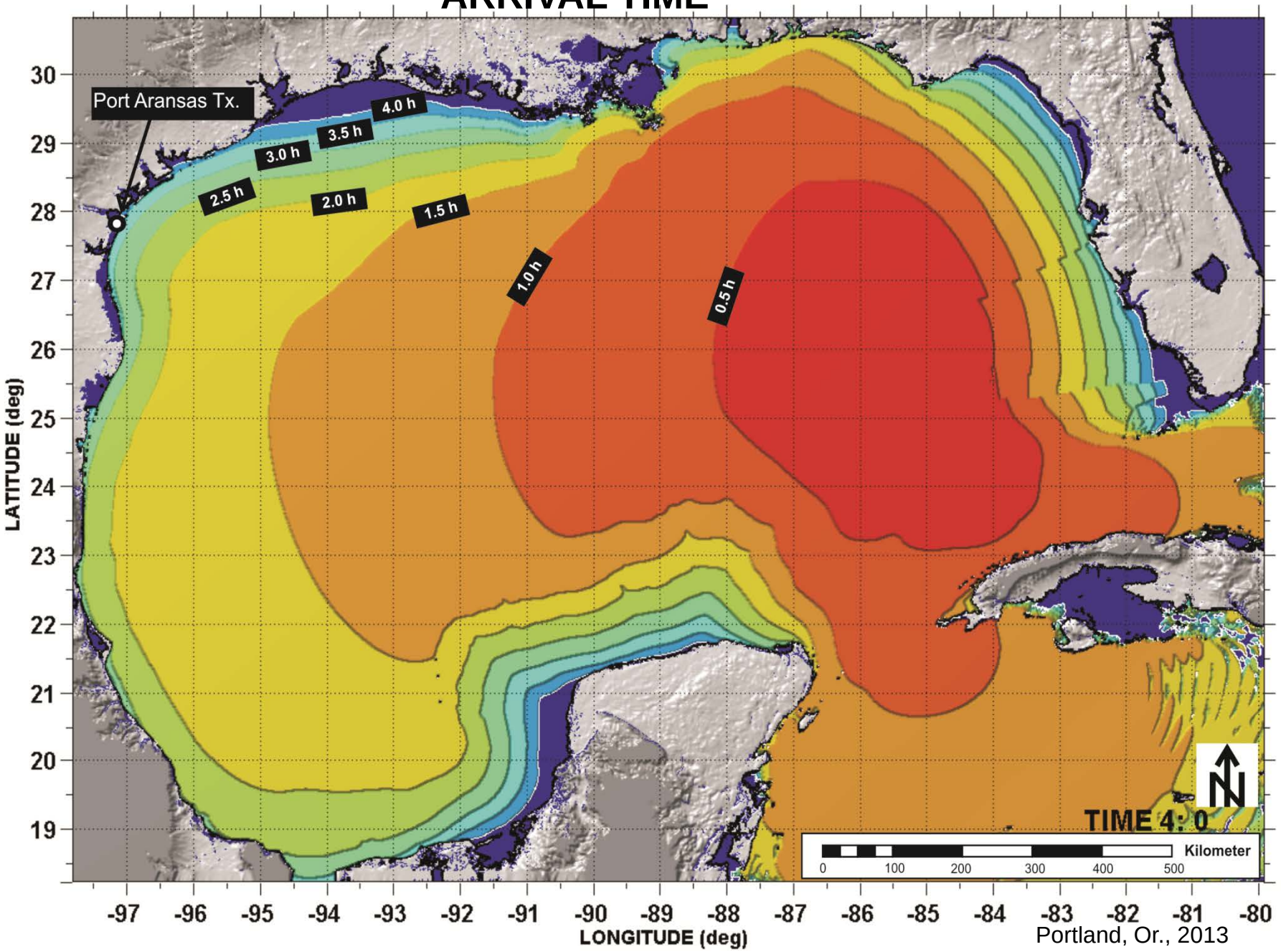
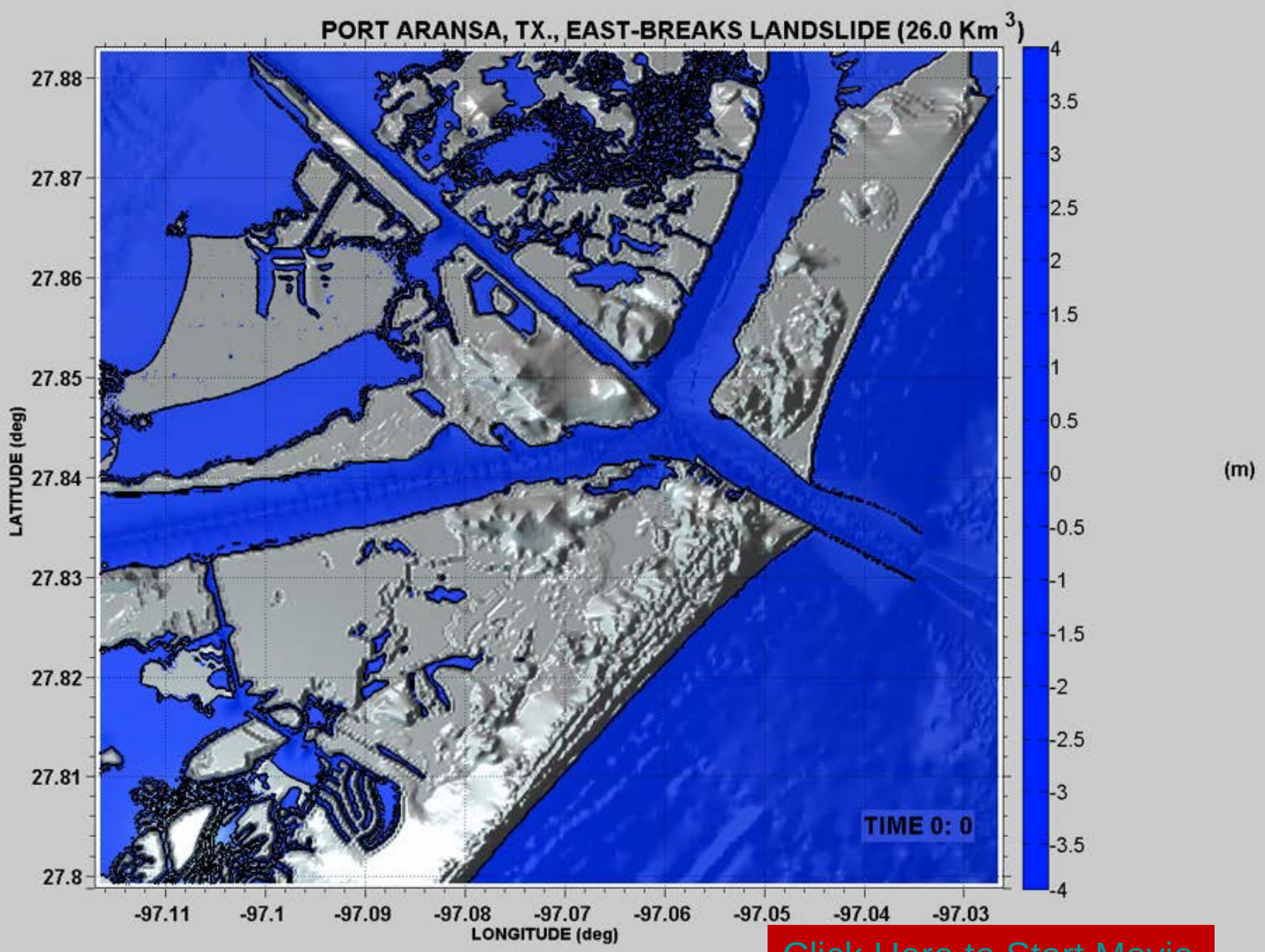
# - WEST FLORIDA LANDSLIDE -
# ARRIVAL TIME



Note new toolbar buttons: data brushing & linked plots Play video

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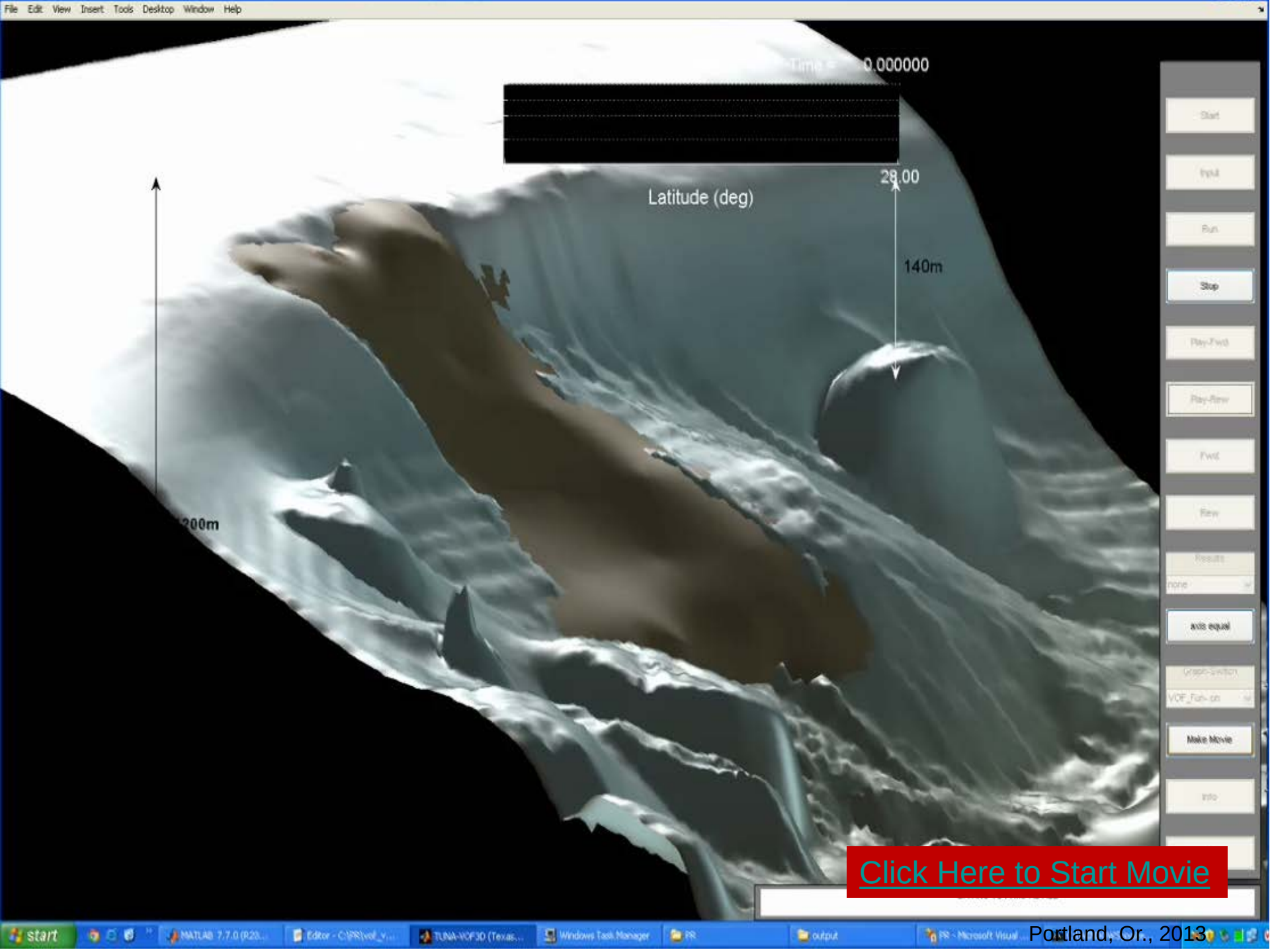
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140m
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Start
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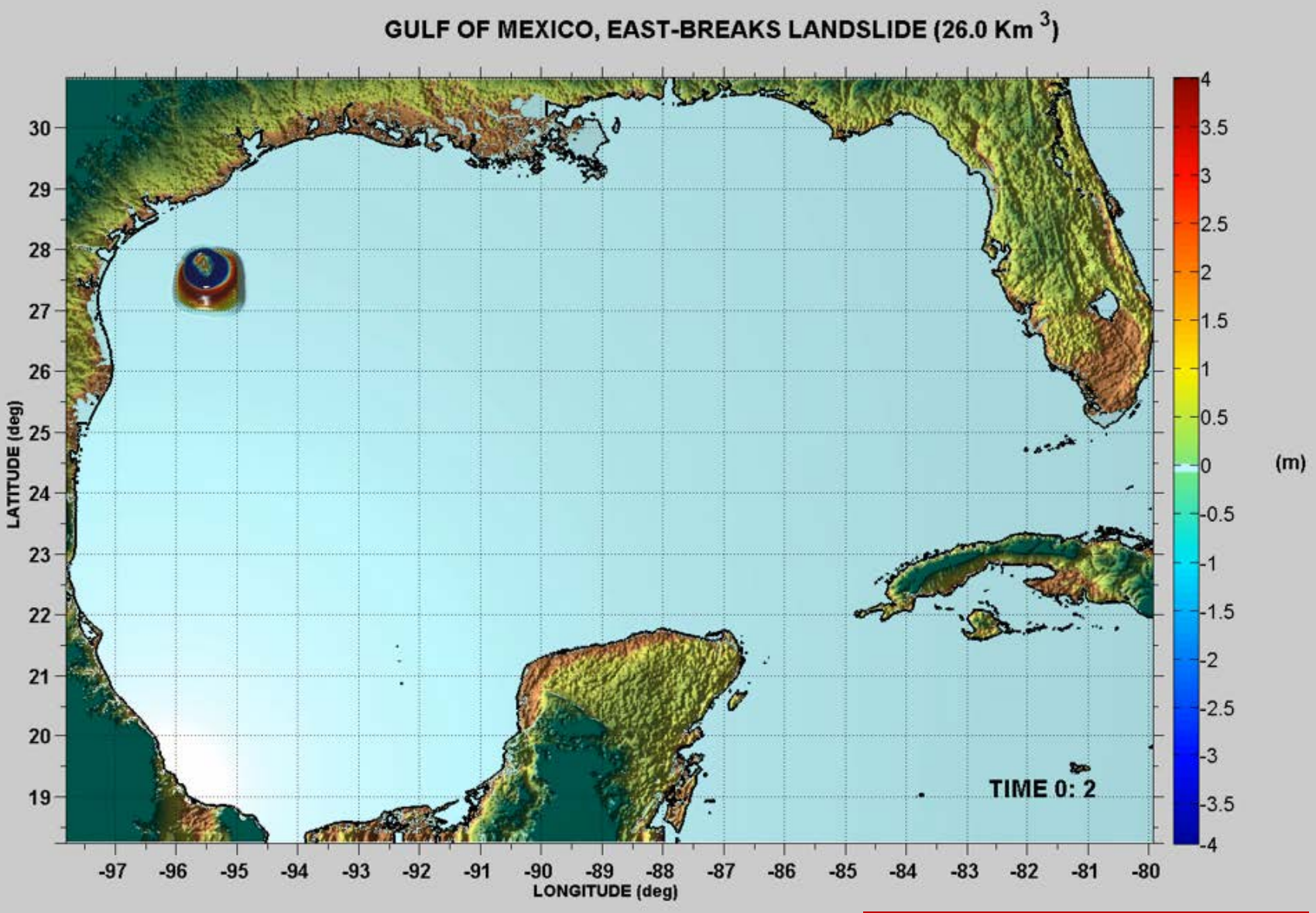
Make Movie
Info
Click Here to Start Movie

Note new toolbar buttons: data brushing & linked plots Play video

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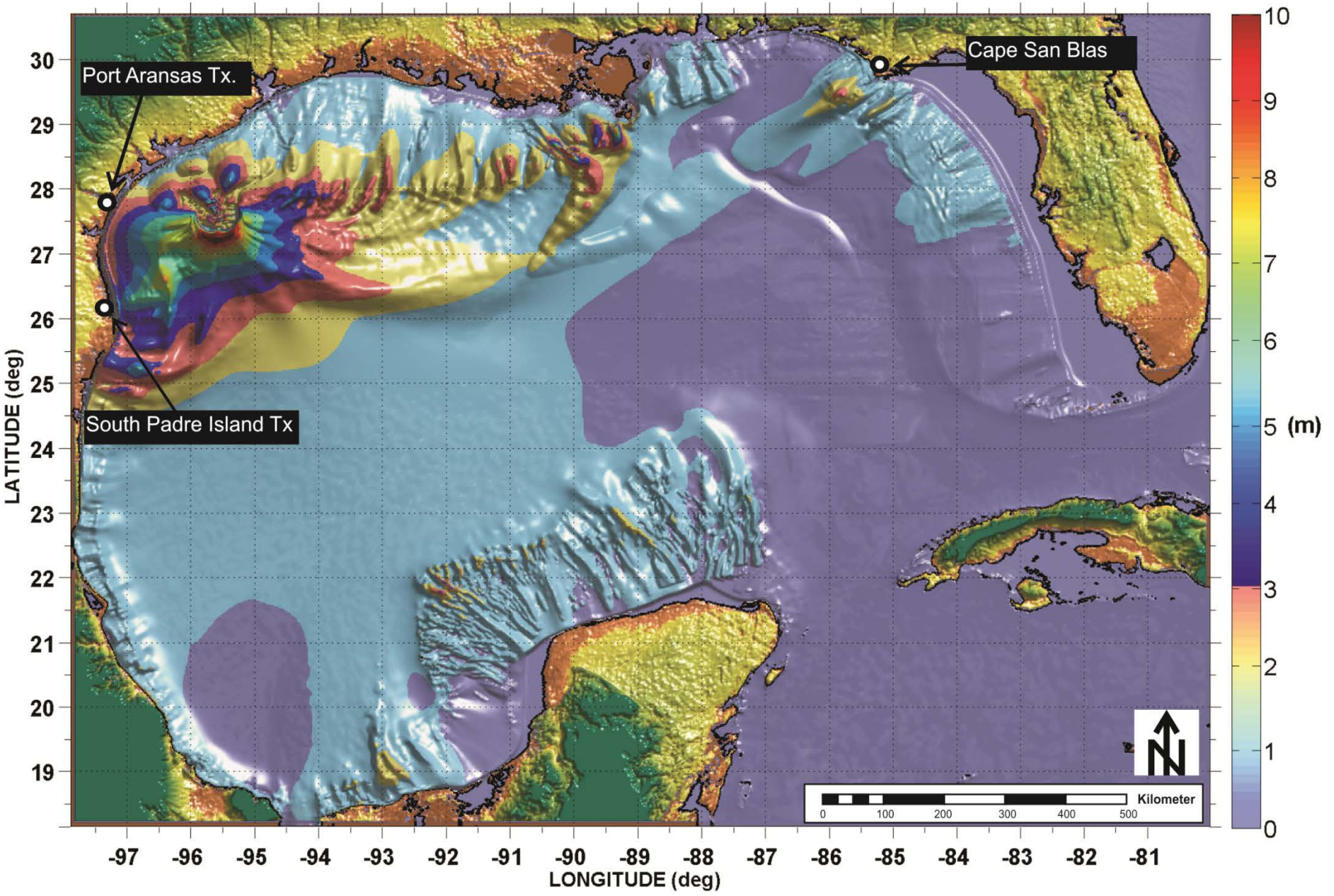
# EAST BREAKS LANDSLIDE

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