Tsunami Mapping Projects, GOM

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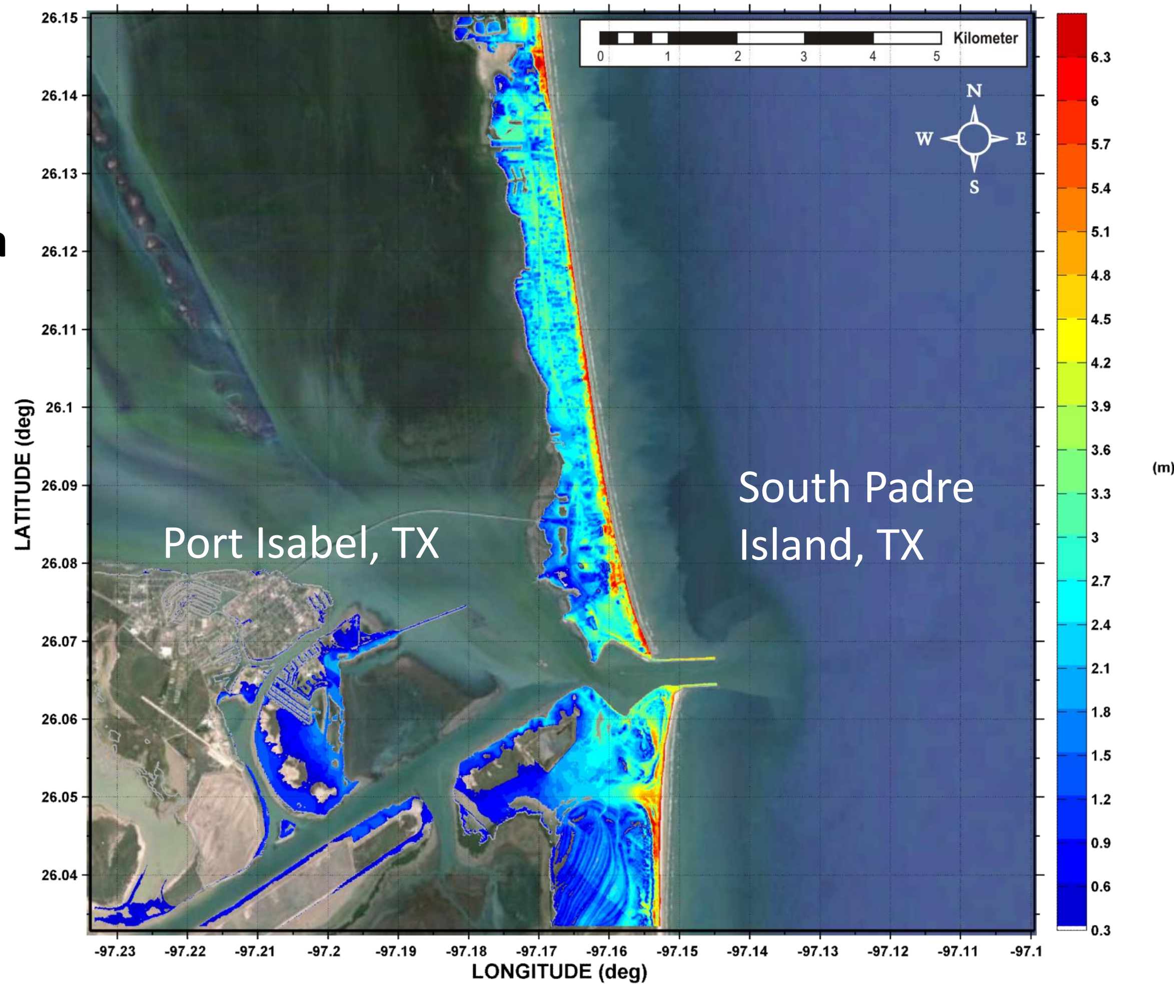


Seattle, WA., 2014

What are the concerns for the GOM?

Source: OTC 15158. Geotechnical Properties of the Sigbee Escarpment from Deep Soil Borings. (2003). Z.A. Al-Khafaji, Fugro-McClelland Marine Geosciences, Inc. (FMMG); A.G. Young, Geosciences Earth & Marine Services, inc. (GEMS); W. DeGroff and G.D. Humphrey, Fugro-McClelland Marine Geosciences, Inc. (FMMG).

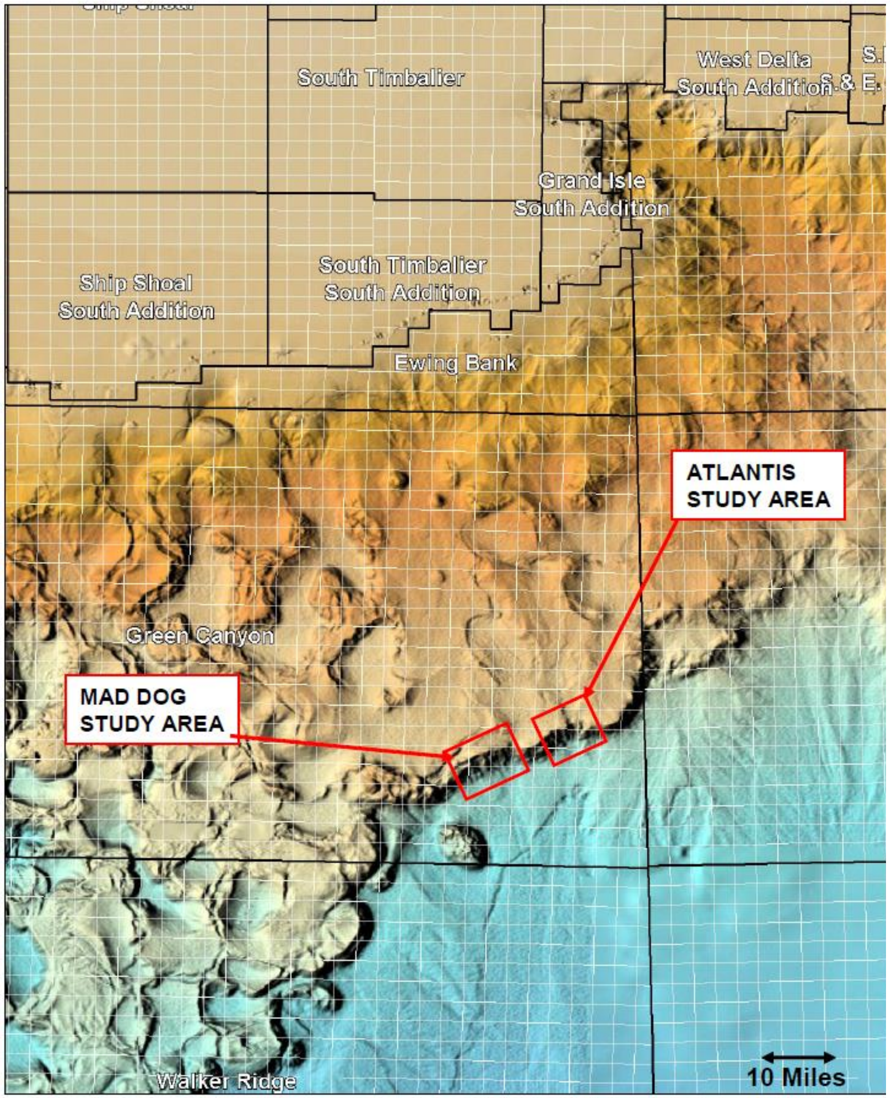


Fig.1: Gulf of Mexico Seafloor Rendering Showing Location of the Mad Dog and Atlantis Study Areas, Southern Green Canyon Area.

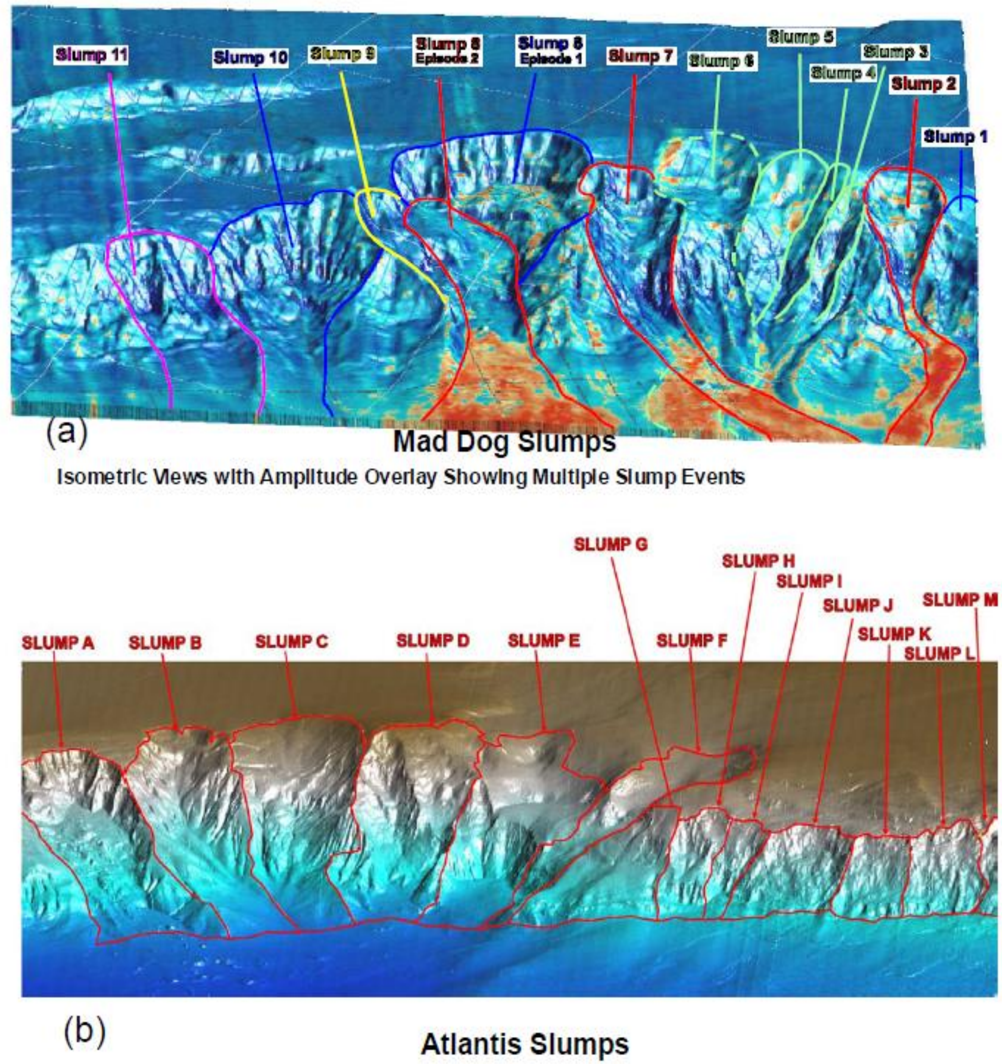
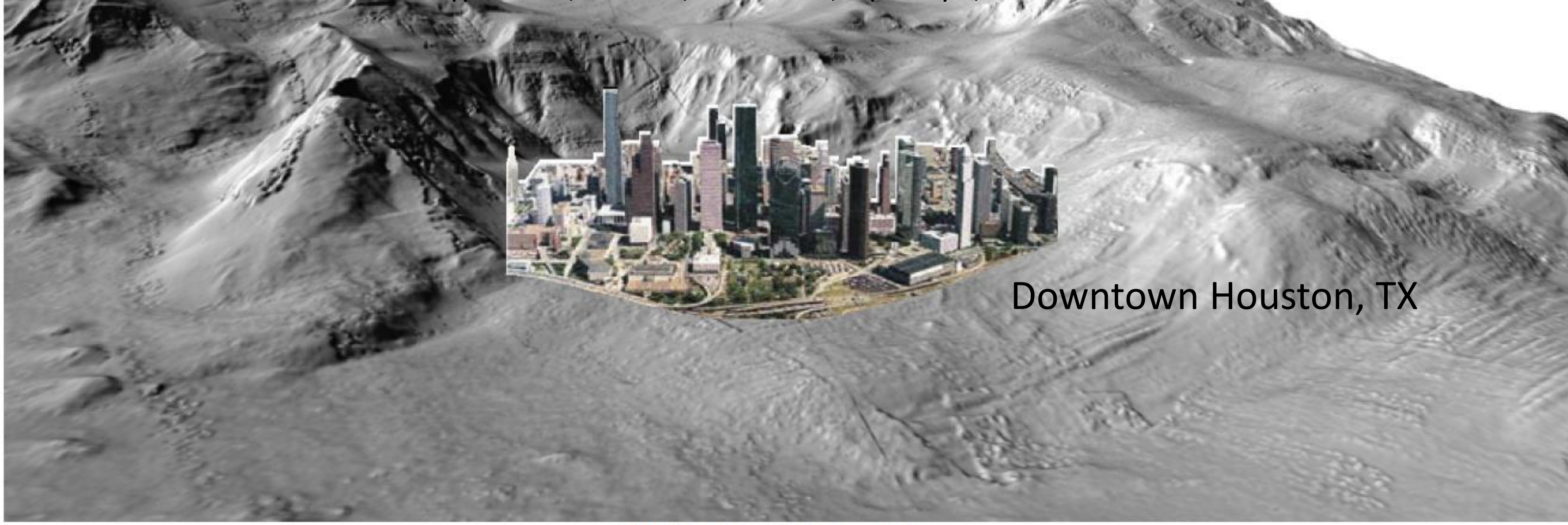


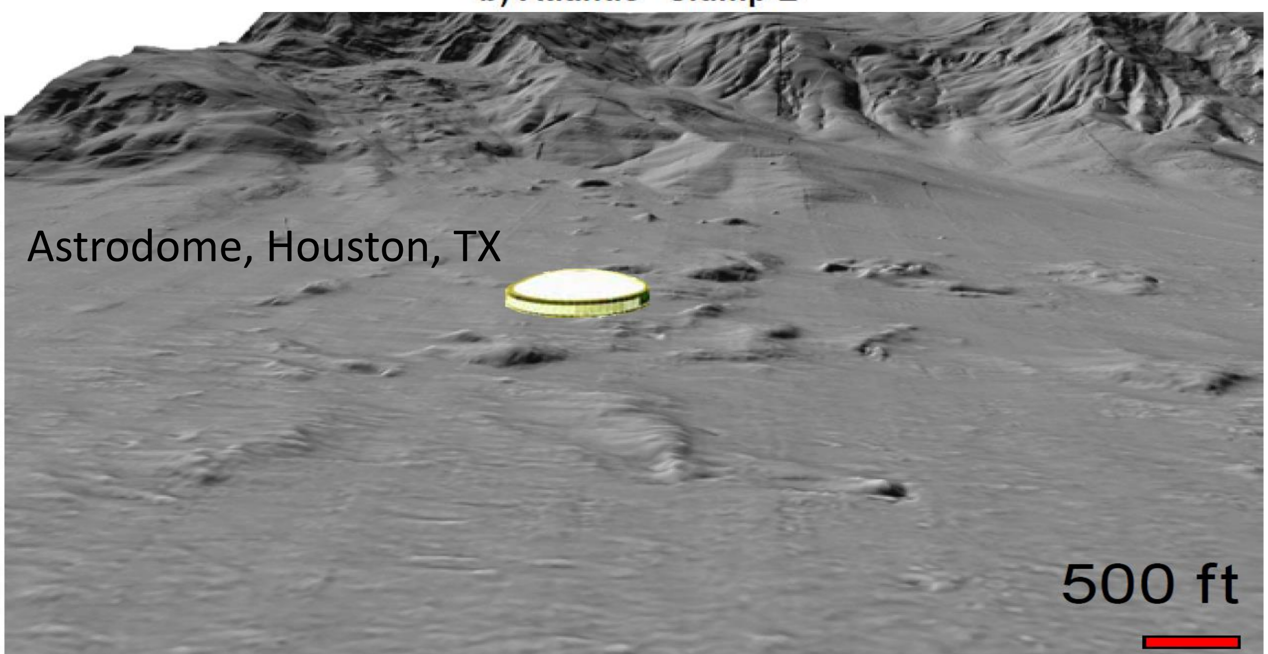
Fig.2: Isometric View and Nomenclature of Identified Slumps in the Mad Dog and Atlantis Study Areas.

Scale of Past GOM Events

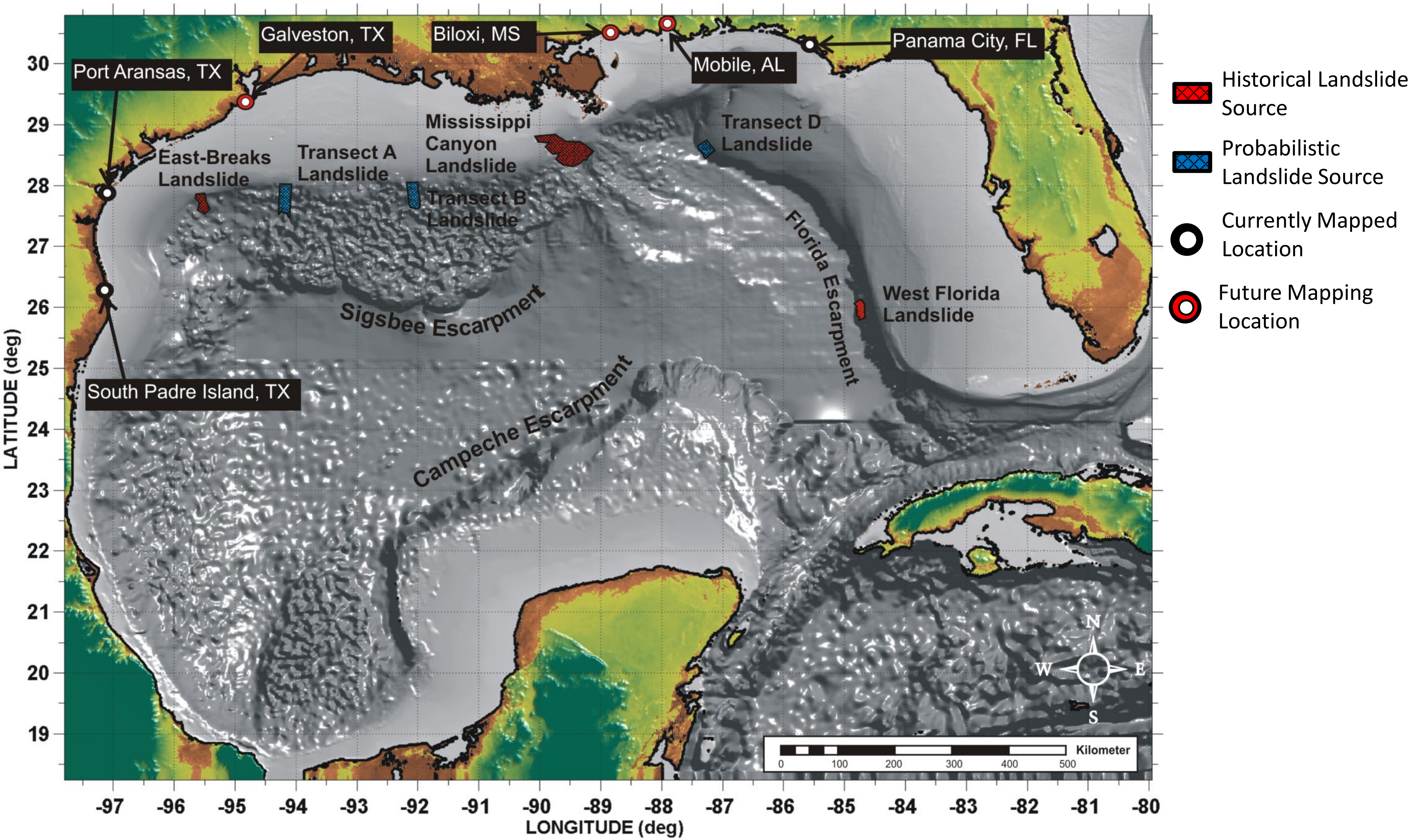
Source: OTC 15156. The Challenges of Siting Facilities along the Sigsbee Escarpment in the Southern Green Canyon Area of the Gulf of Mexico: Framework for Integrated Studies. Philippe JeanJean, Andrew Hill, BP America Inc., Stephen Taylor, BHP Billiton Petrolum



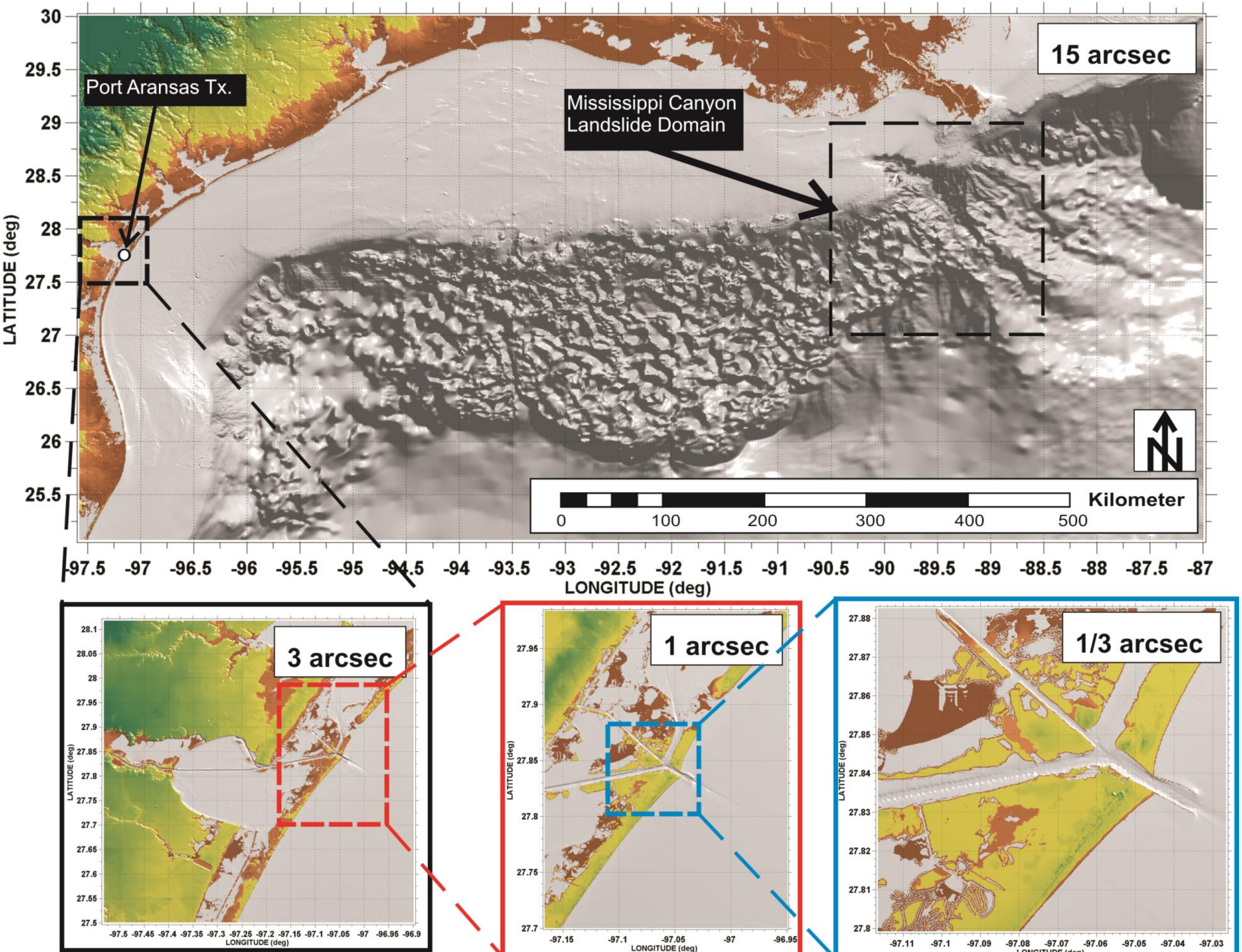
b) Atlantis "Slump E"



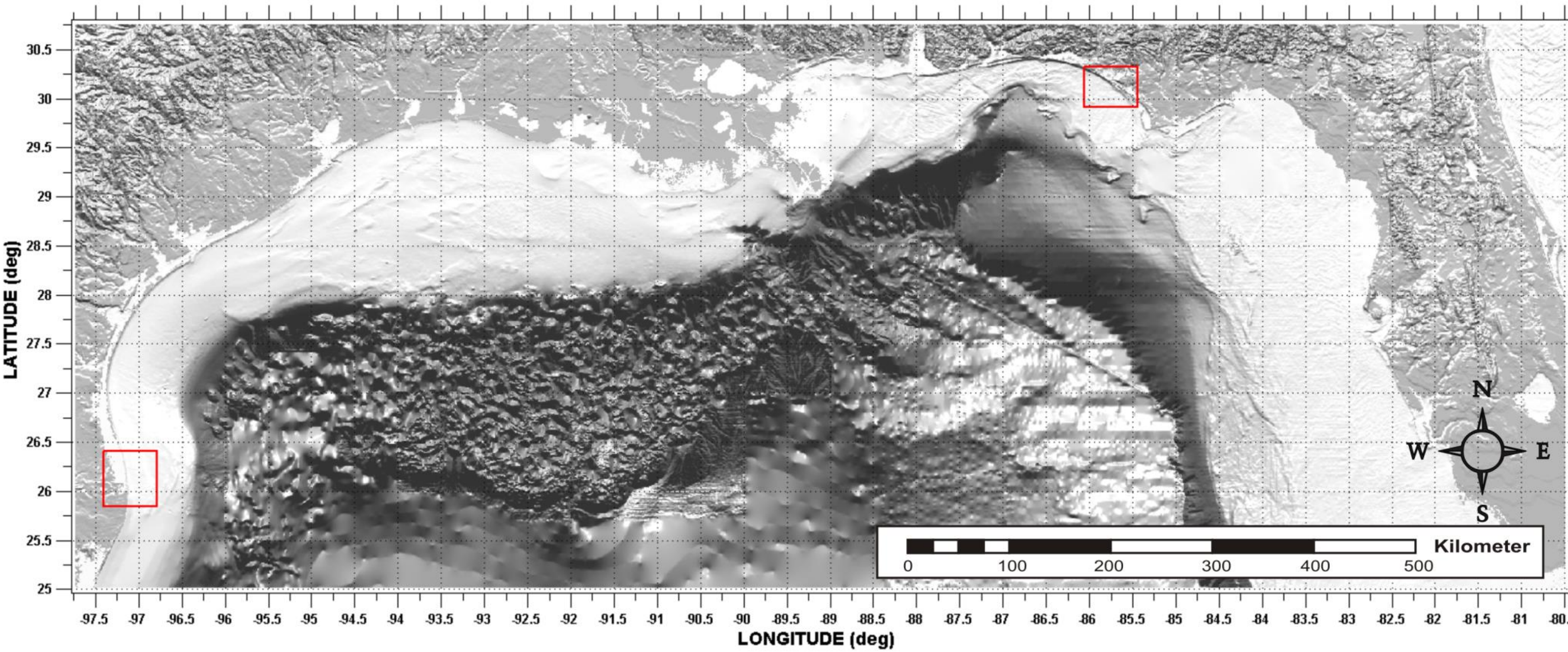
Landslide Sources and Coastal Locations for Inundation Mapping



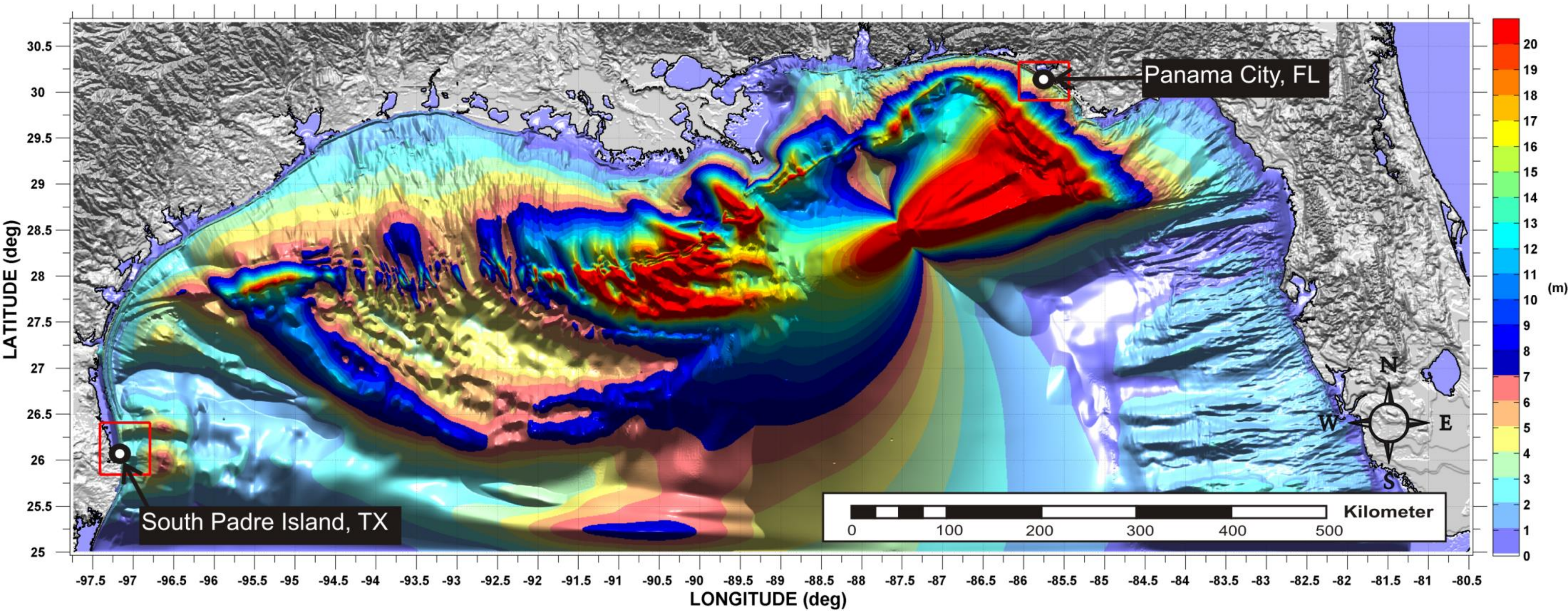
Generation (TSUNAMI3D), Propagation and Runup (NEOWAVE)



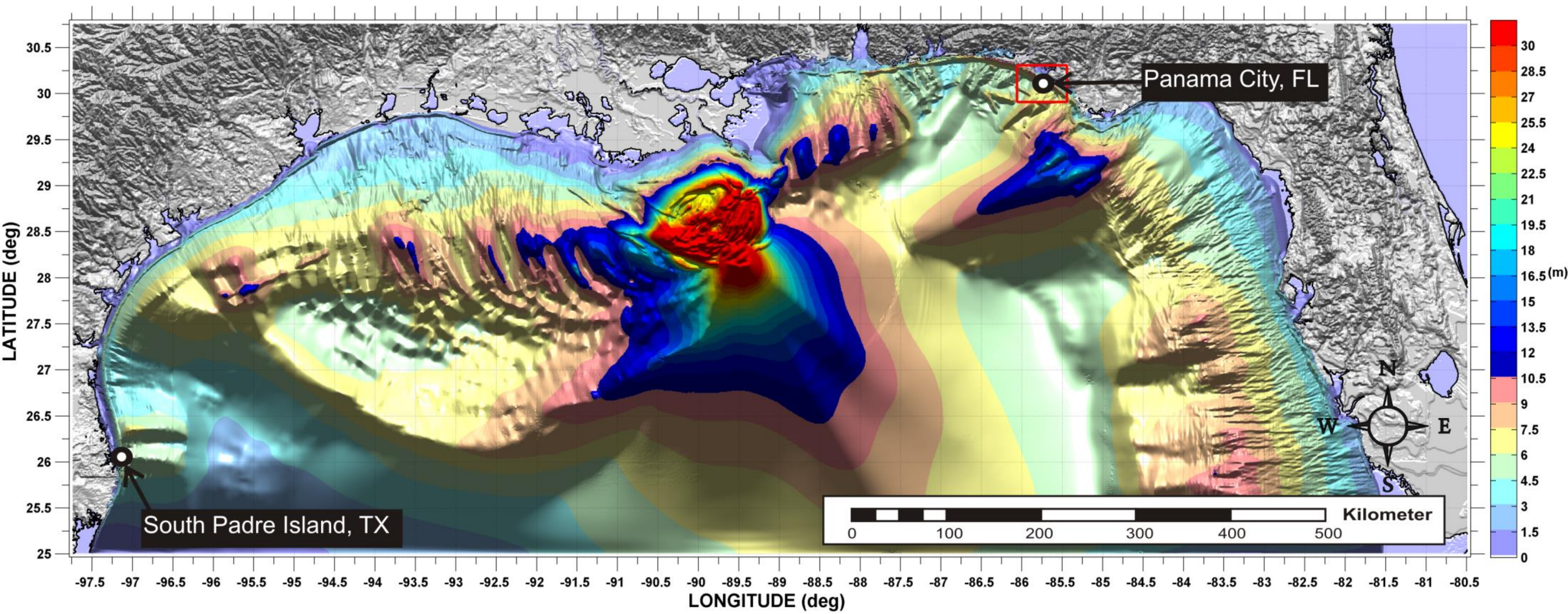
GOM Bathymetry



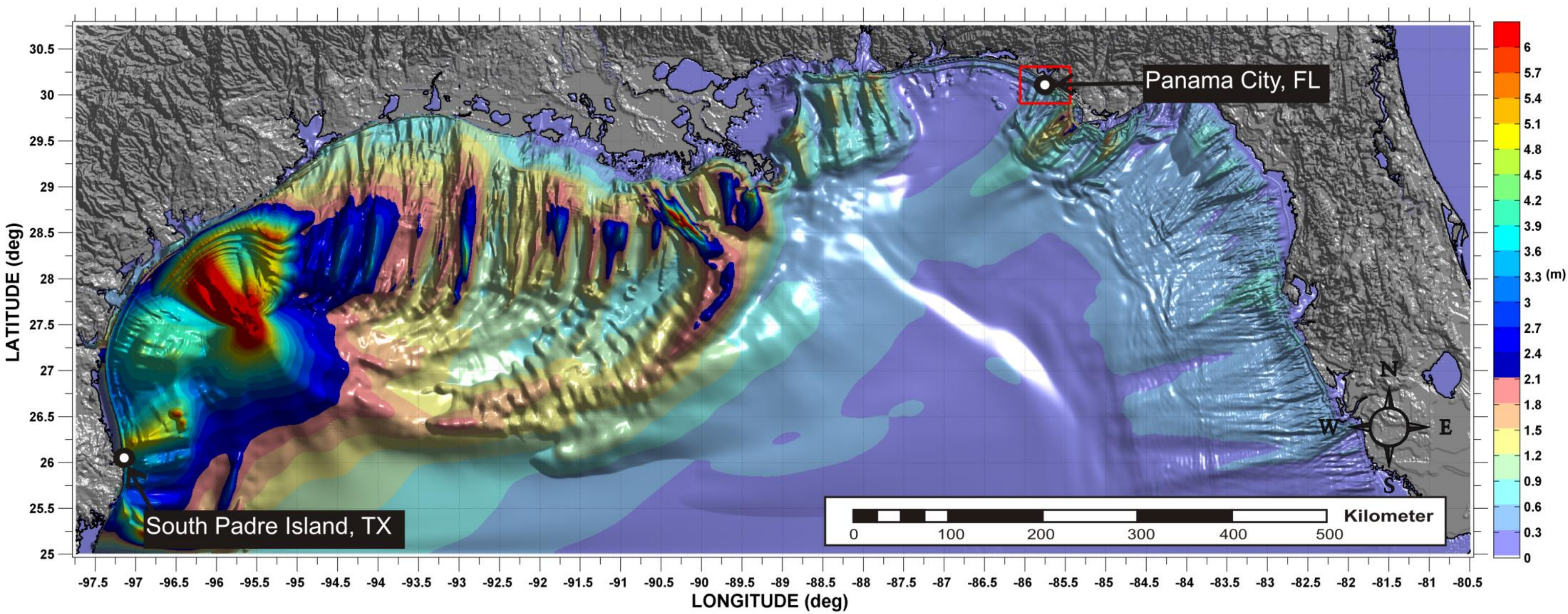
Maximum Wave Amplitude
Probabilistic Source Transect D



Maximum Wave Amplitude
Historical Source Mississippi Canyon



Maximum Wave Amplitude
Historical Source East Breaks

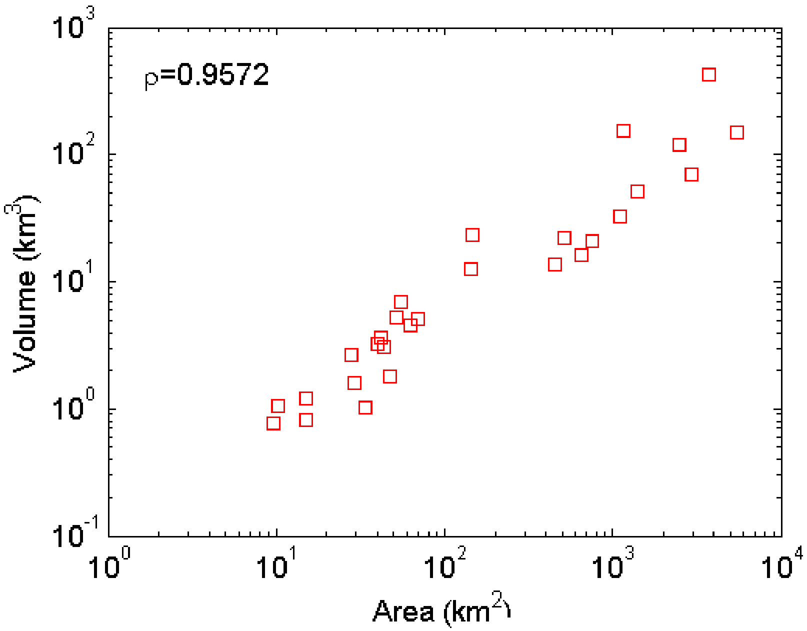


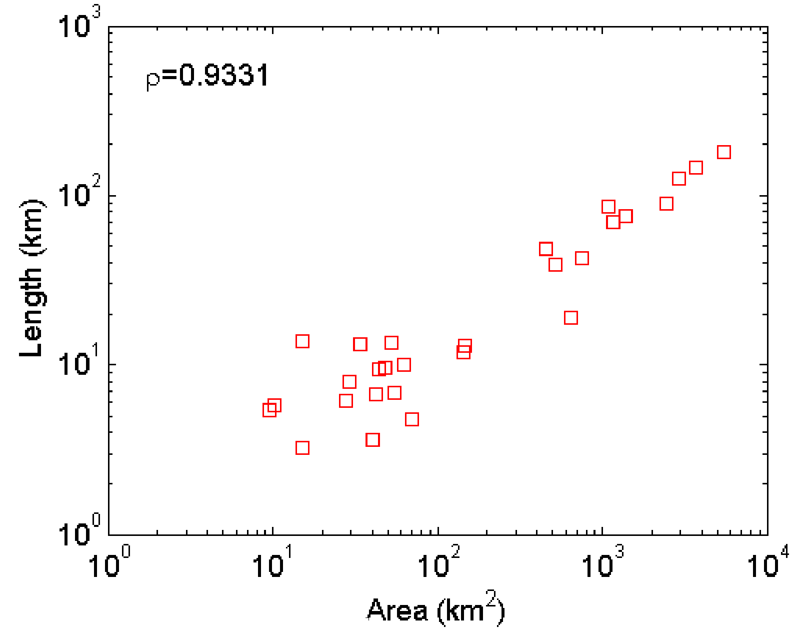
Probabilistic approach: Monte Carlo Simulation (MCS)

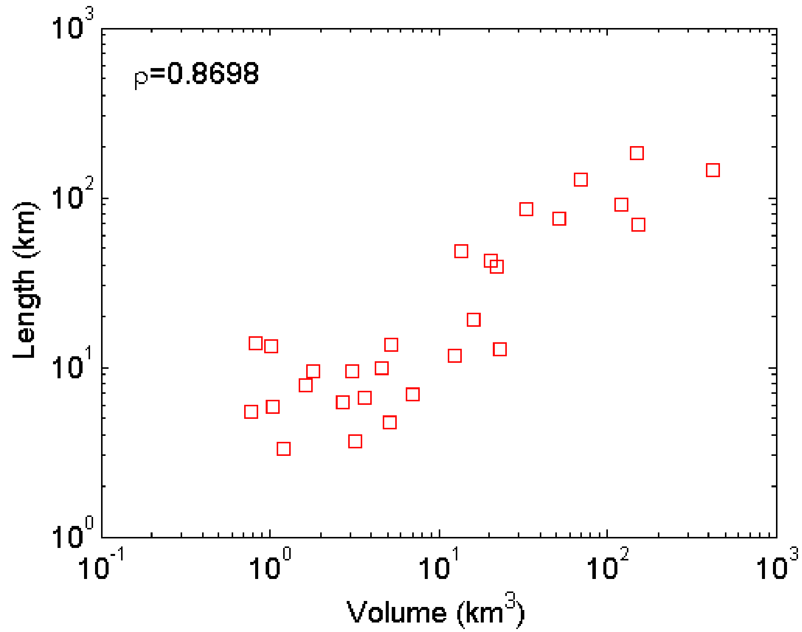
- Determine possible landslide scenarios and likelihood of failure based on:
  - Past landslide database
  - Sediment parameters (Ocean Drilling program)
  - Bathymetry data
  - Seismicity data

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







Random Correlated Variables: Cholesky Decomposition

- Determine random A, V, and L in MCS routine while maintaining correlations among parameters
- Cholesky decomposition of covariance matrix Σ:

$$\Sigma = CC^T, \quad C \text{ lower triangular}$$

- A, V, L follow lognormal distributions (determined by data)

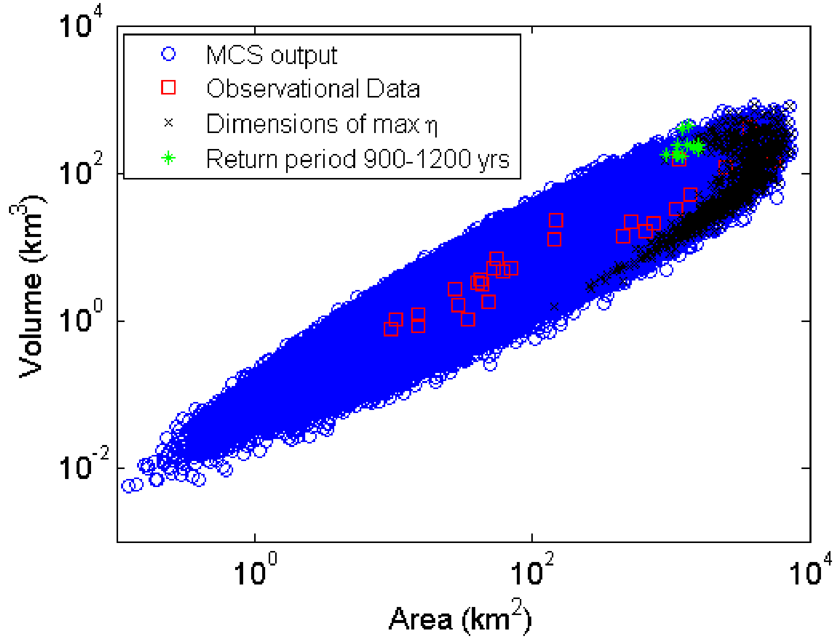
  $\rightarrow \log(A)\,, \log(V)\,, \log(L)$ are normally distributed with means μ_A, μ_V, μ_L
- From a set of random normal variables $u_i{\sim}N(0{,}1)$, determine correlated normal variables:

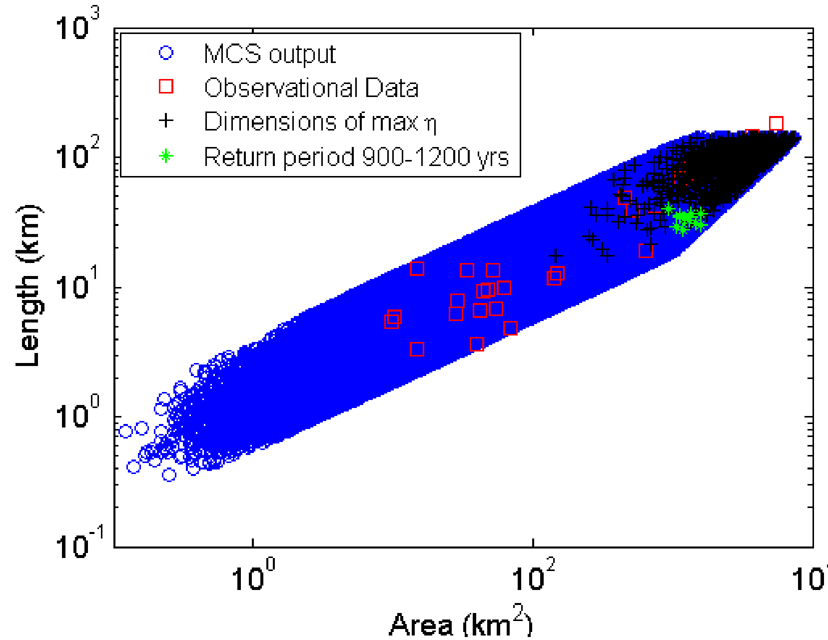
$$\begin{bmatrix} X \\ Y \\ Z \end{bmatrix} = C \begin{bmatrix} u_1 \\ u_2 \\ u_3 \end{bmatrix} + \begin{bmatrix} \mu_A \\ \mu_V \\ \mu_L \end{bmatrix}$$

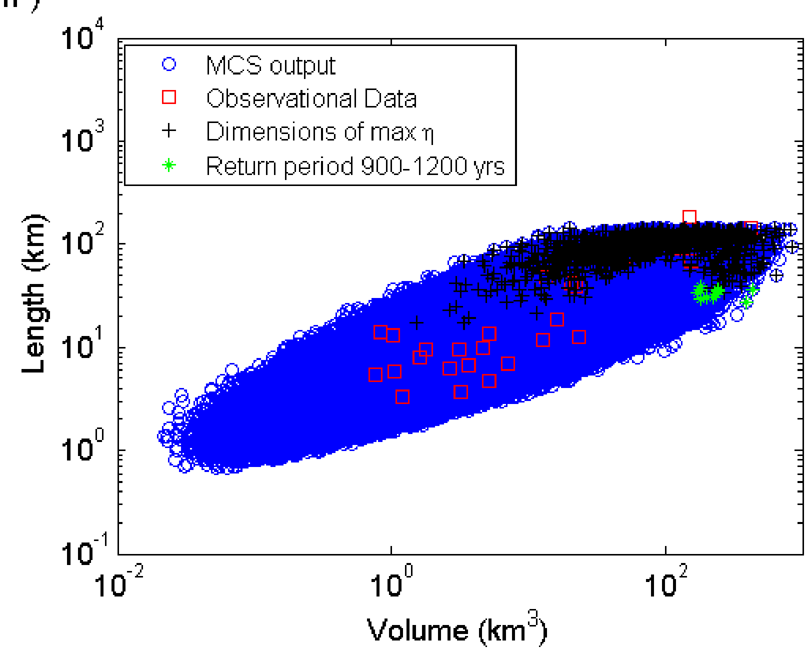
- Then random correlated A, V, and L are found from:

$$\begin{bmatrix} A \\ V \\ L \end{bmatrix} = \exp((X, Y, Z)^T)$$

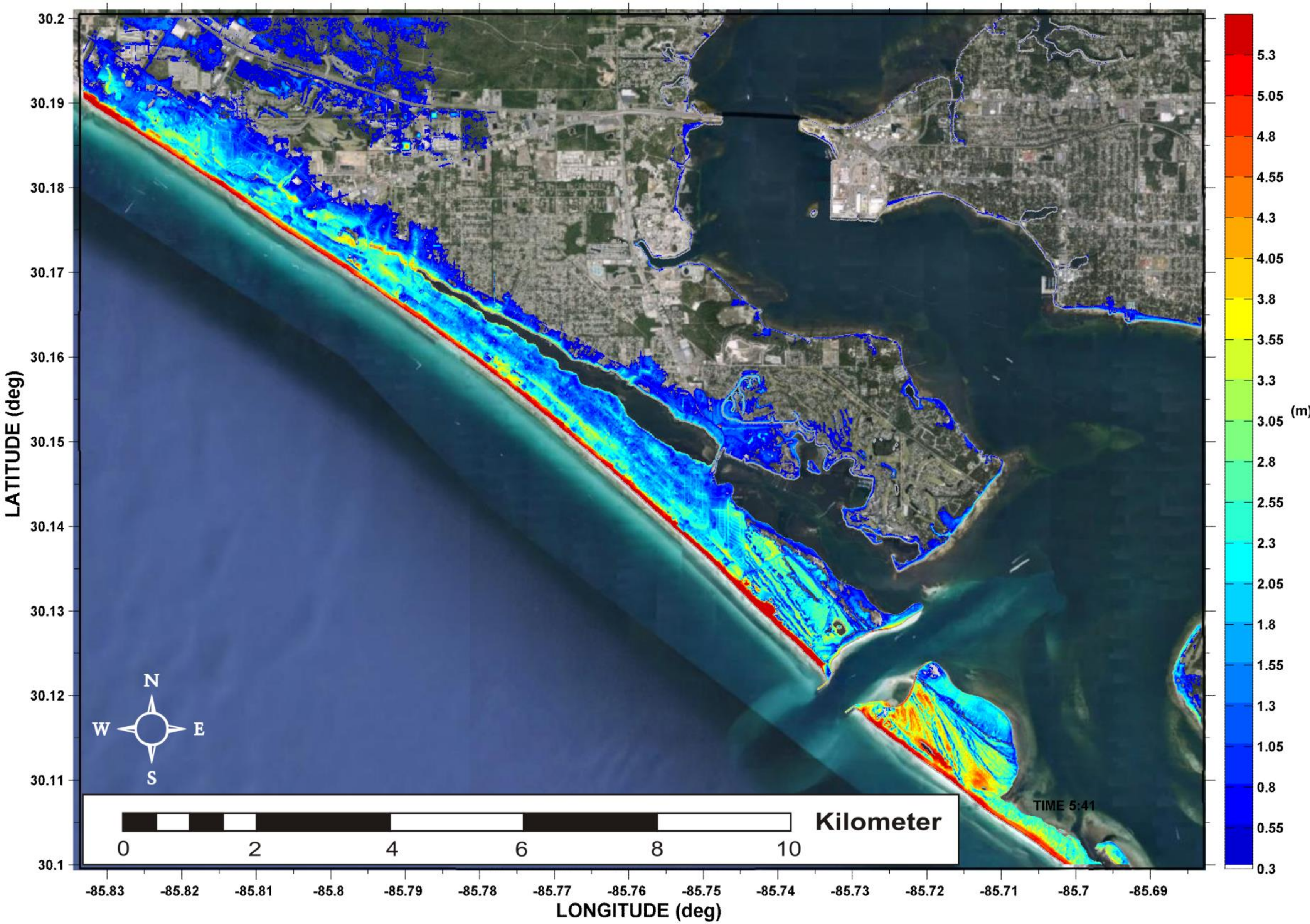
MCS Landslide Source Dimensions - Transect D



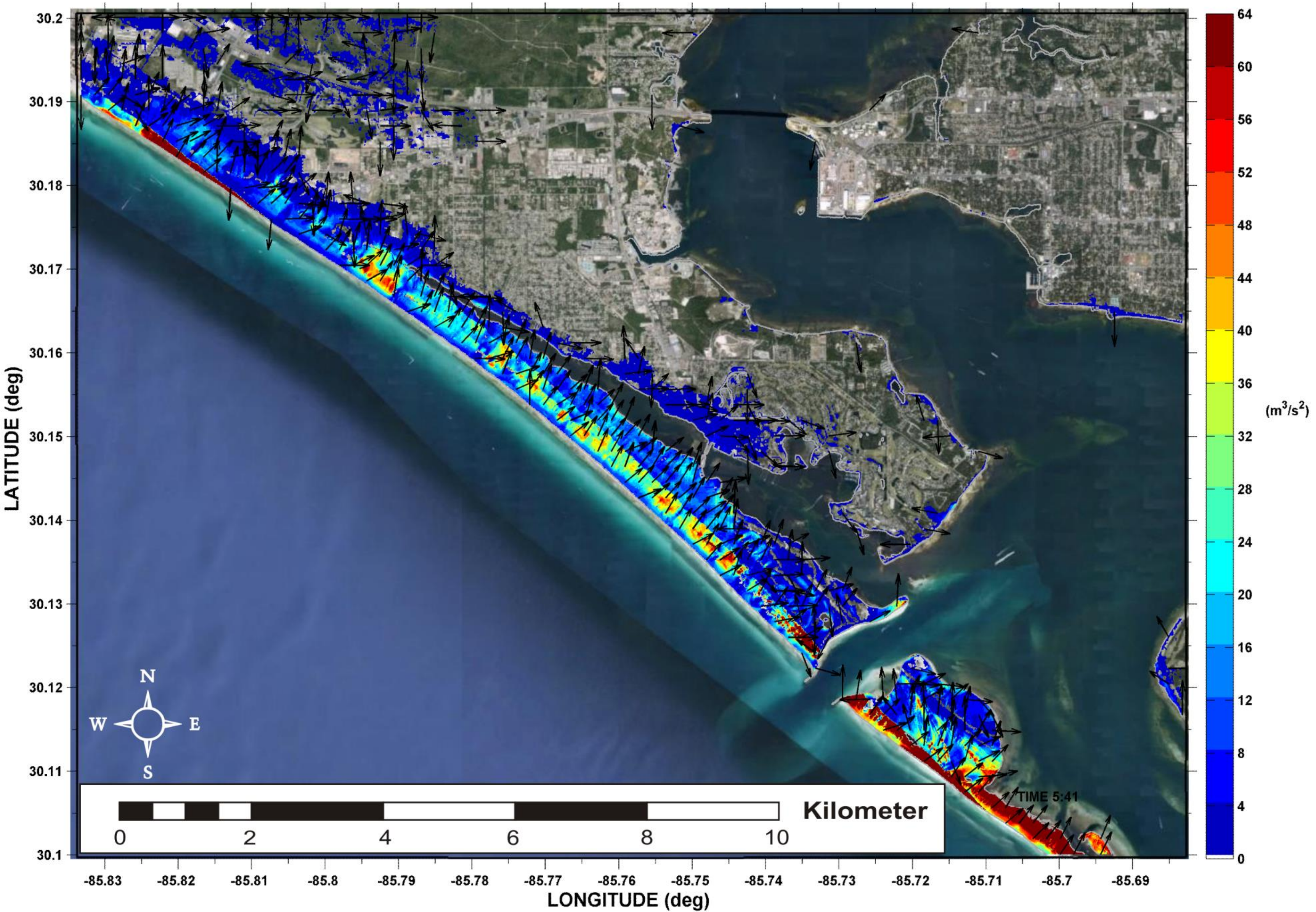




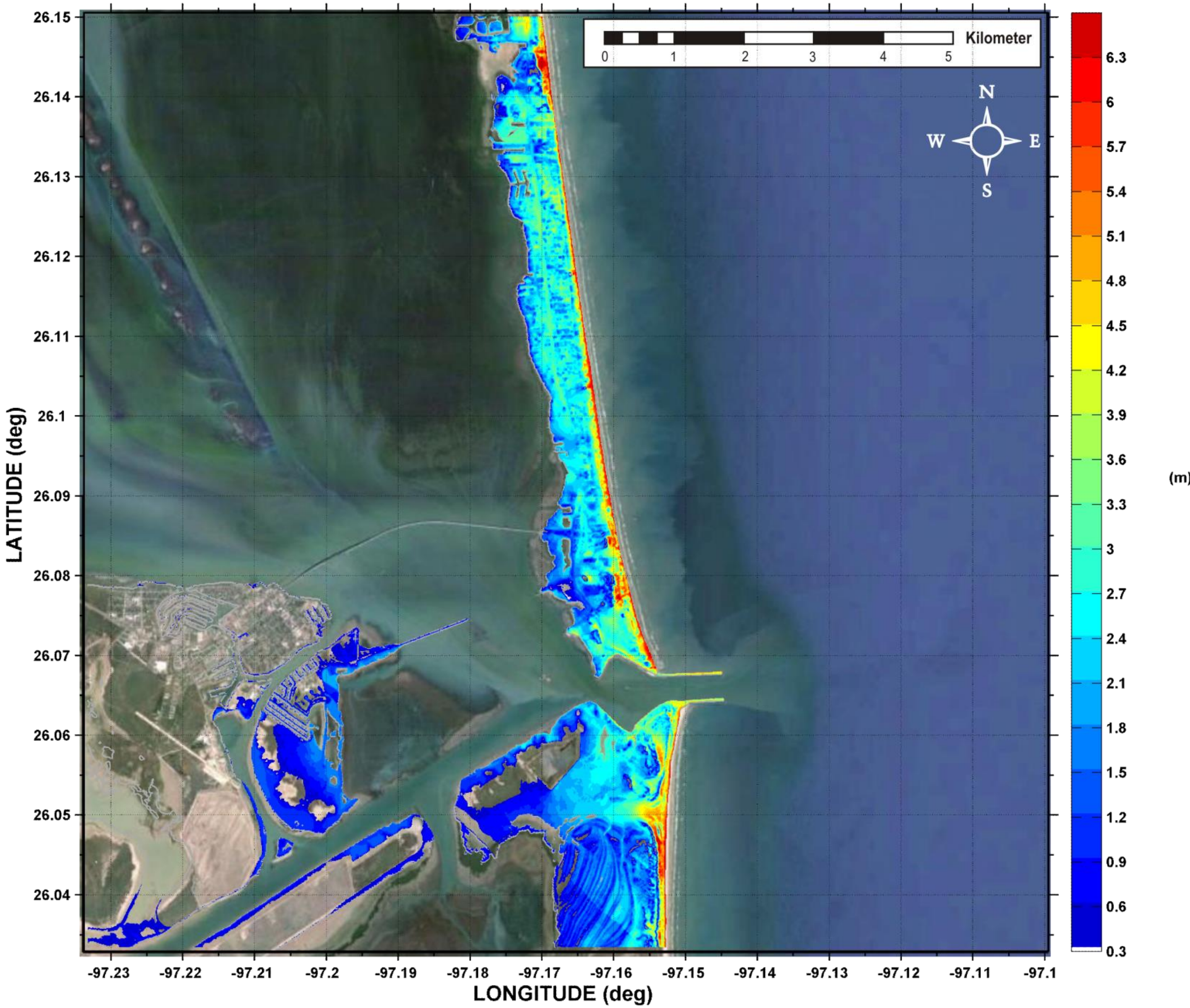
Panama City, FL
Maximum Inundation – Transect D



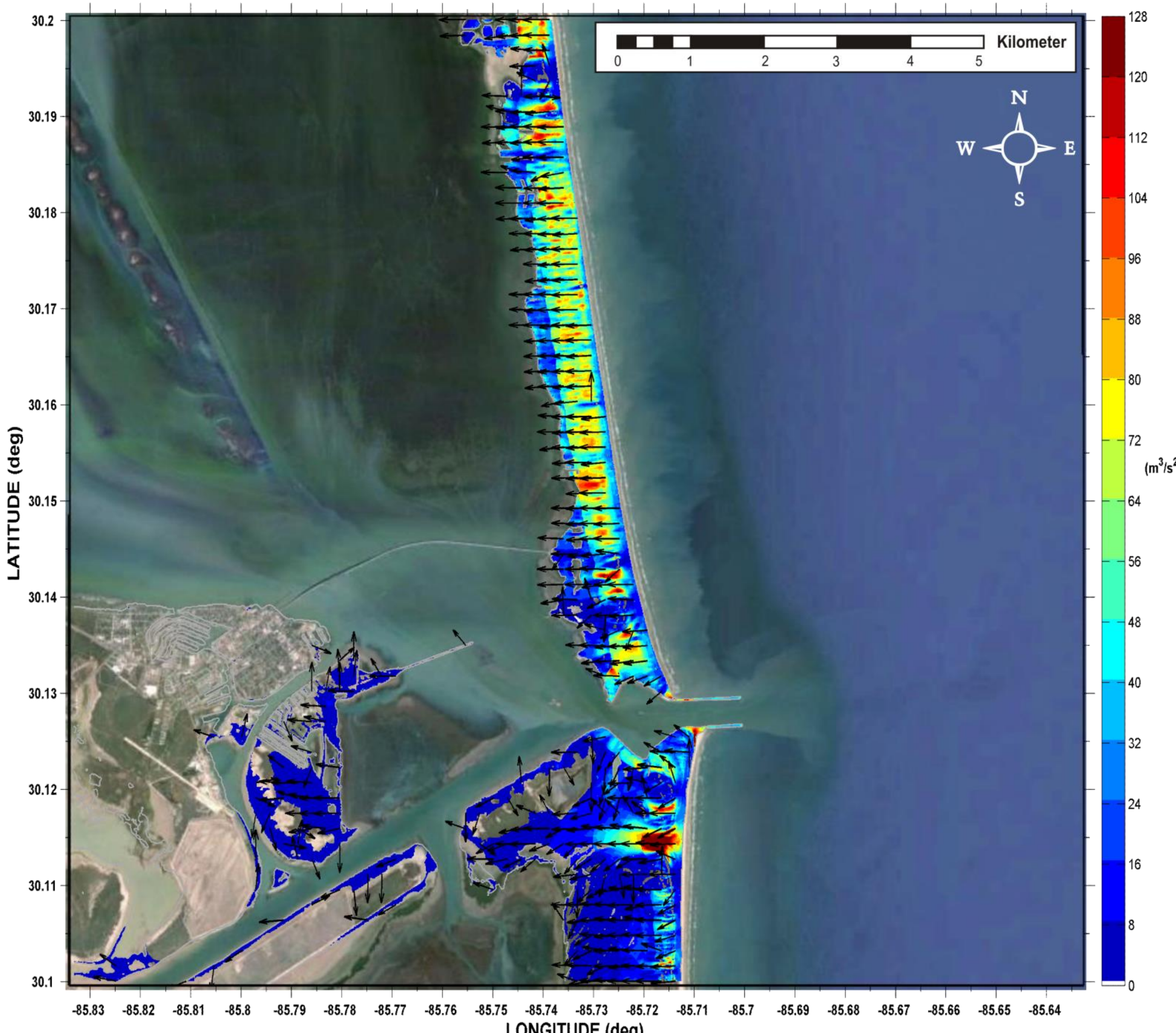
Panama City, FL
Maximum Momentum Flux – Transect D



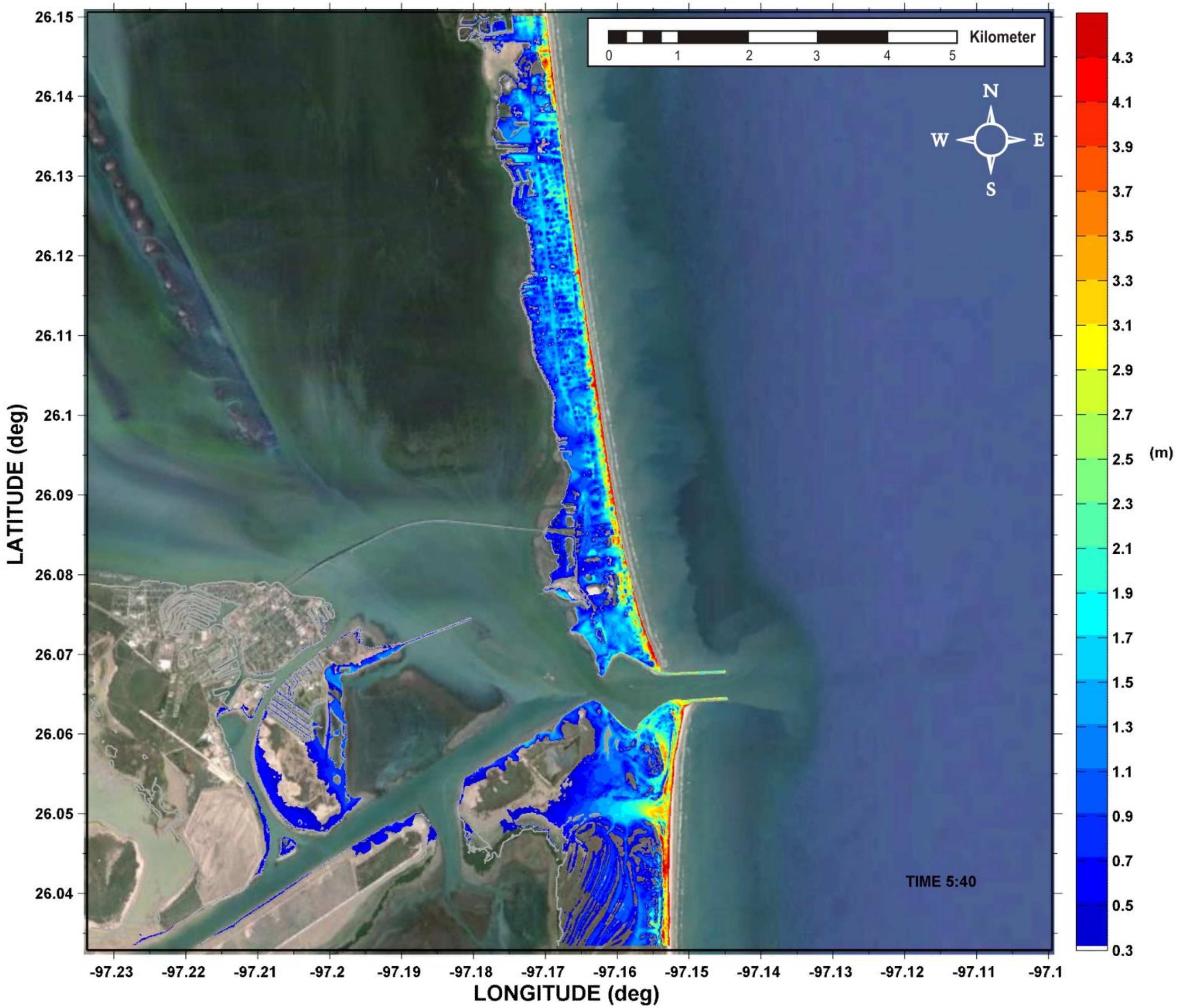
South Padre Island, TX
Maximum Inundation – East Breaks



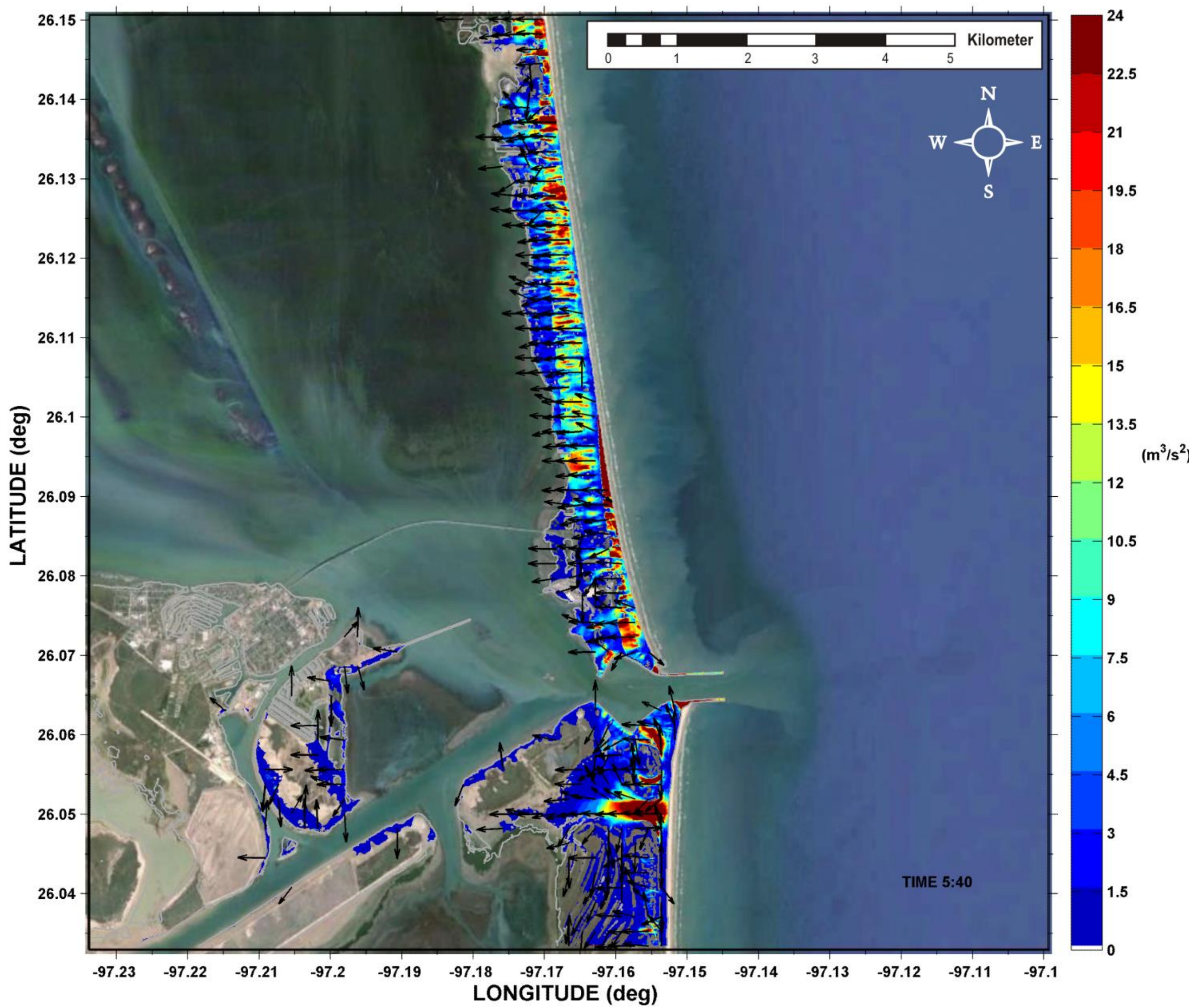
South Padre Island, TX
Maximum Momentum Flux – East Breaks



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