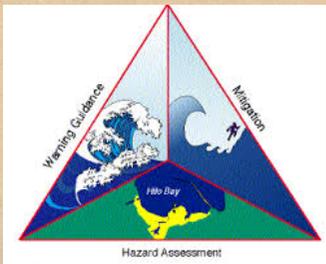


Atlantic Tsunami sources used for tsunami hazard assessment and Inundation mapping along the US East Coast



舟江島一景
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James Kirby, F. Shi and B. Tehranirad
Center for Appl. Coastal Res
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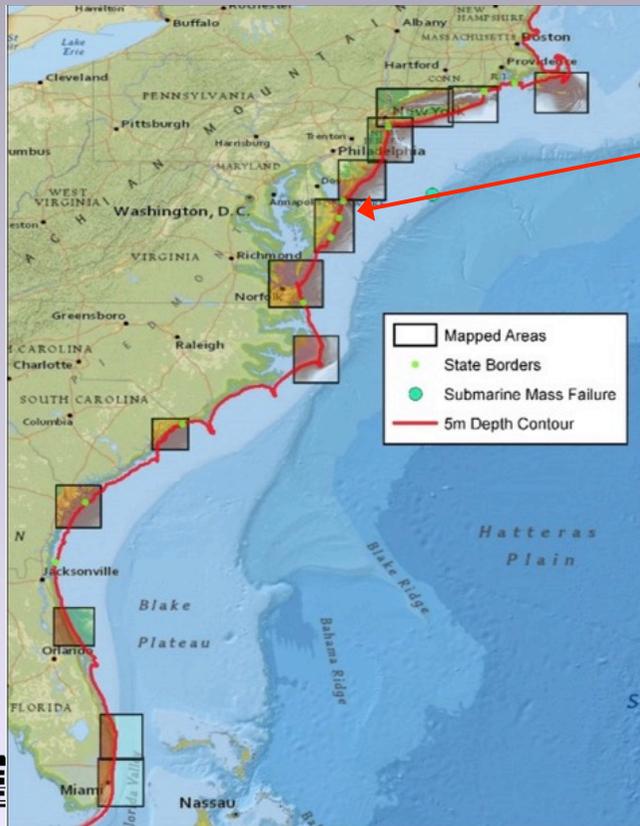


USGS-NTHMP-16

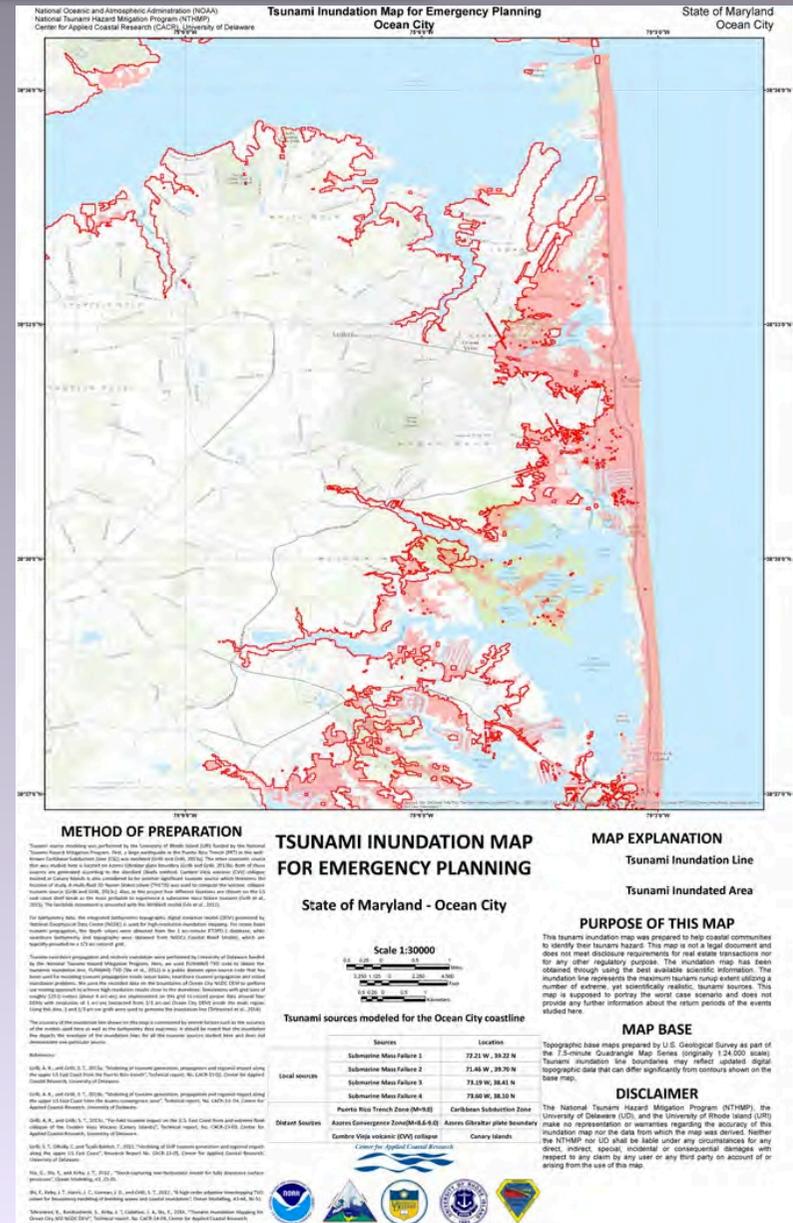
02/02/16

NTHMP East Cpast Mapped areas FY10-15

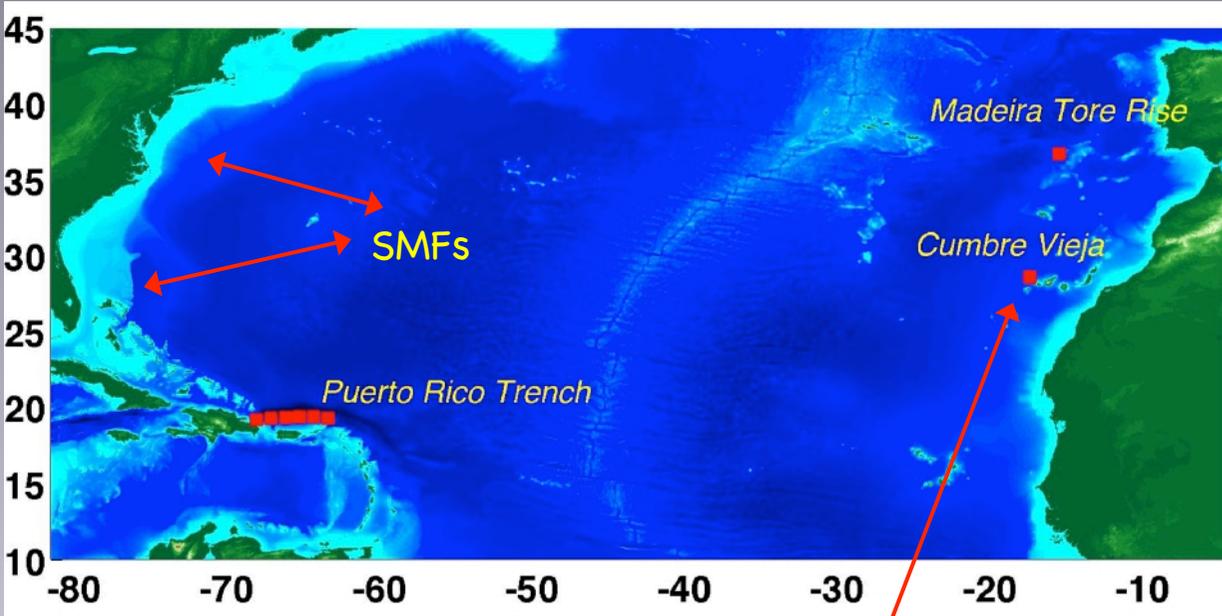
- > First generation maps based on **Probable Maximum Tsunami (PMT)** sources in the Atlantic Ocean Basin
 - => not a probabilistic study; envelope maps
 - => variety of models (not discussed here)
- > **Locations of Maps, East Coast (2010-2015) :**
www.udel.edu/kirby/nthmp_protect.html



USGS-NTHMP 01/02/2016



Tsunami sources: SMFs, seismic, volcano collapse



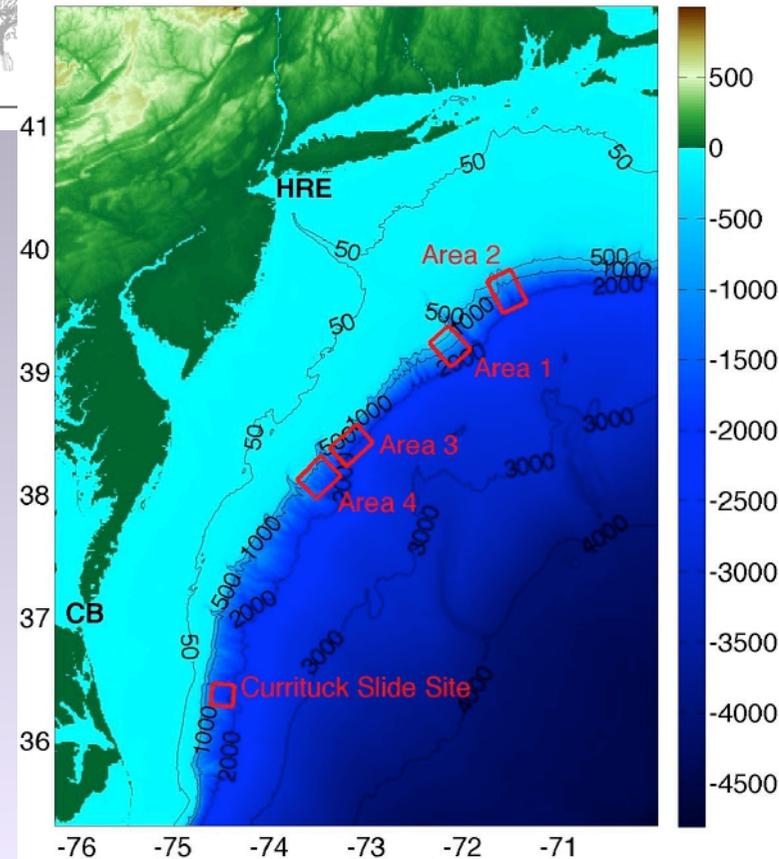
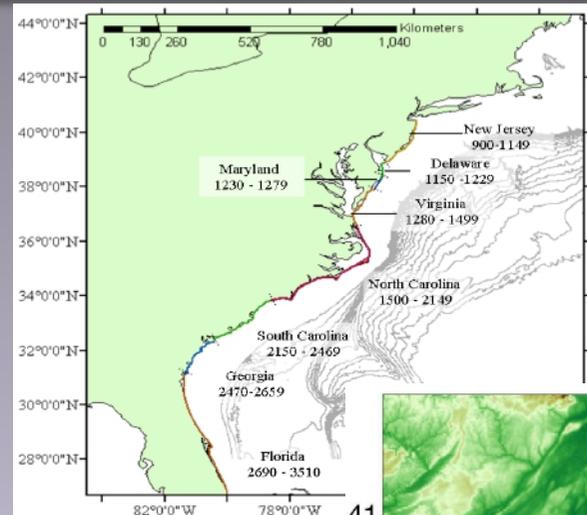
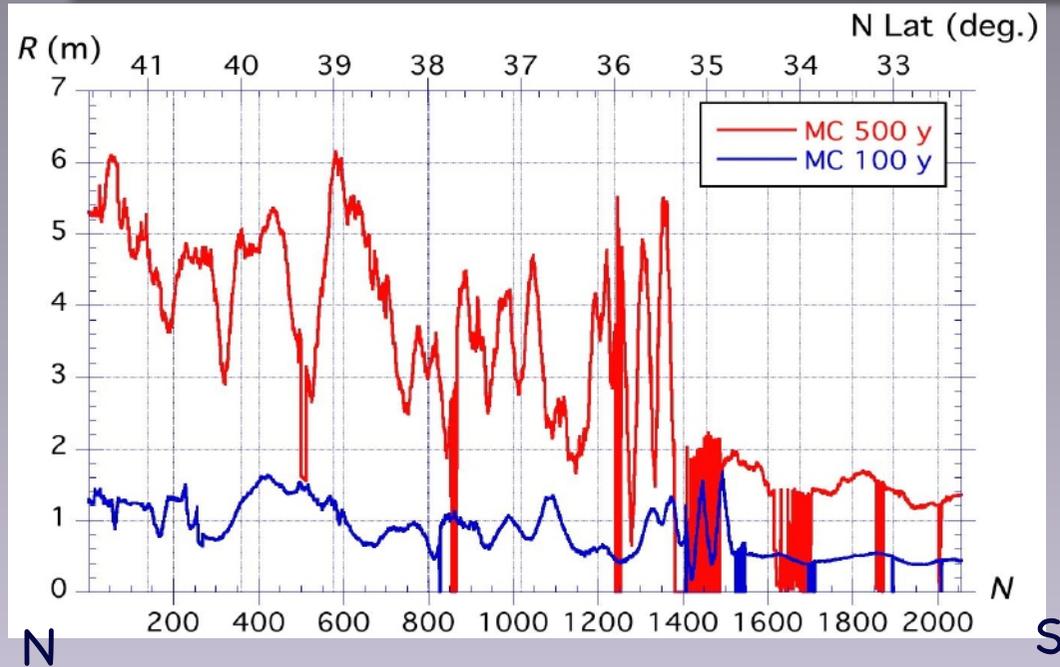
-> M9 far-field seismic source in MTR: repeat of Lisbon 1755 (multiple sources, various strike angl.) (Barkan et al., 2008)

-> M9 far-field seismic source in PRT: designed as extreme event, 600x150 km (12 SIFT sources), 12 m slip (600 yrs of convergence) (Knight, 2006; Grilli et al., 2010; NHESS)

-> Far-field flank collapse of CVV (Ward and Day, 2001; Abadie et al., 2012, JGR; Tehranirad et al., 2015, PAGEOH), with 80 or 450 m³ volume (extreme and most extreme events), with return period (?) perhaps 1,000-100,000 yrs.



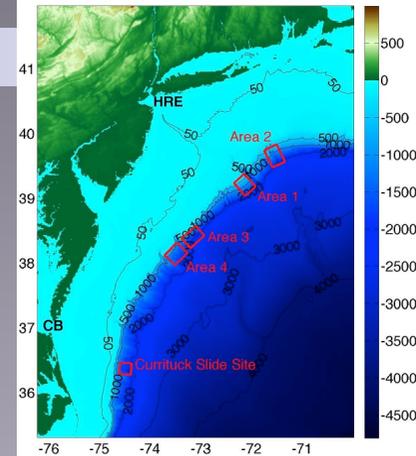
Near-field SMF sources: Monte Carlo + proxies



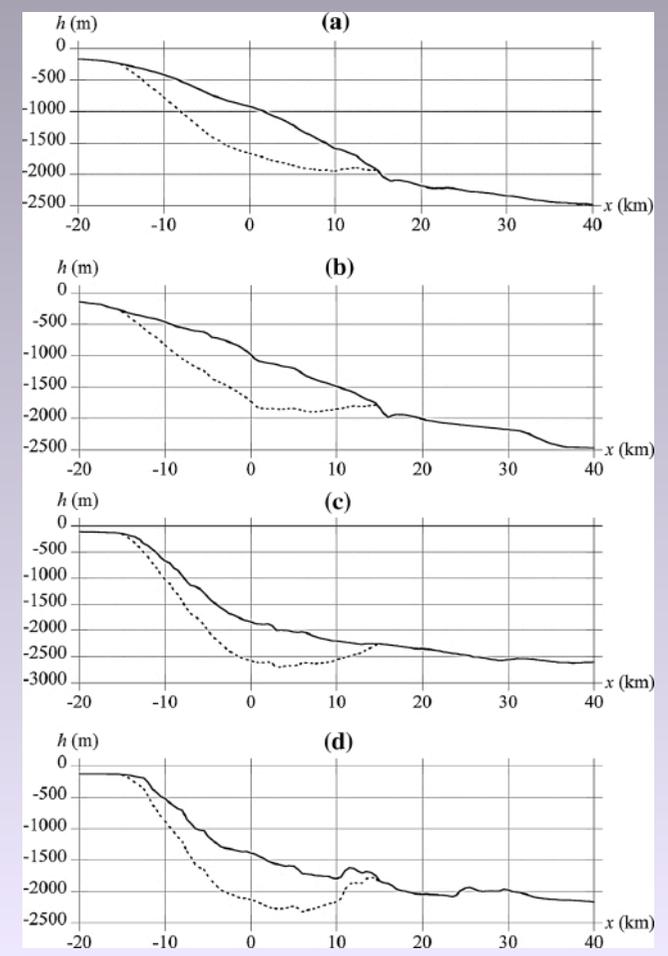
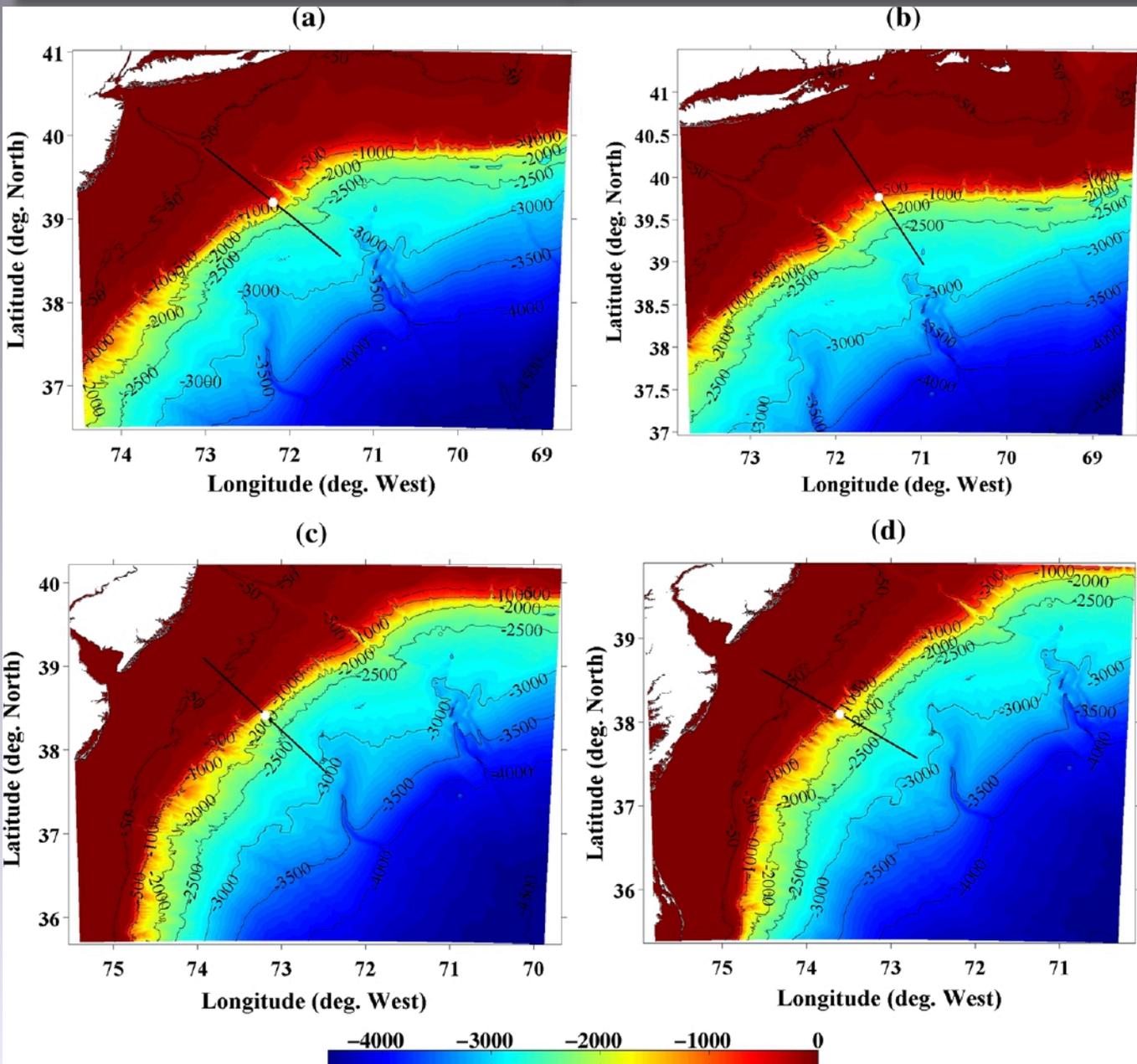
- > Grilli et al.'s (2009, MG) Monte Carlo slope stability analyses along transects, for a => areas of estimated (100-500 year) runup
- > Sediment availability/geology => Areas 1 to 4: Currituck SMF proxies (Grilli et al., 2015; NH)



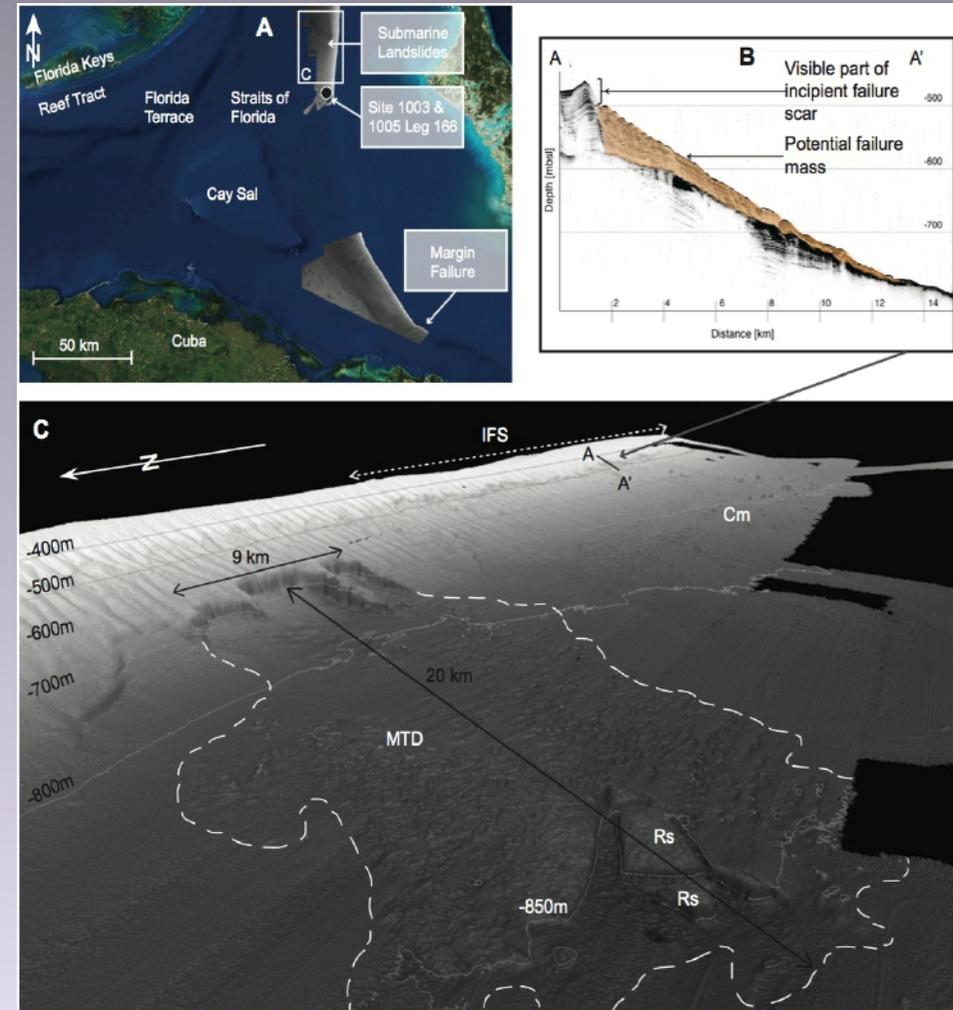
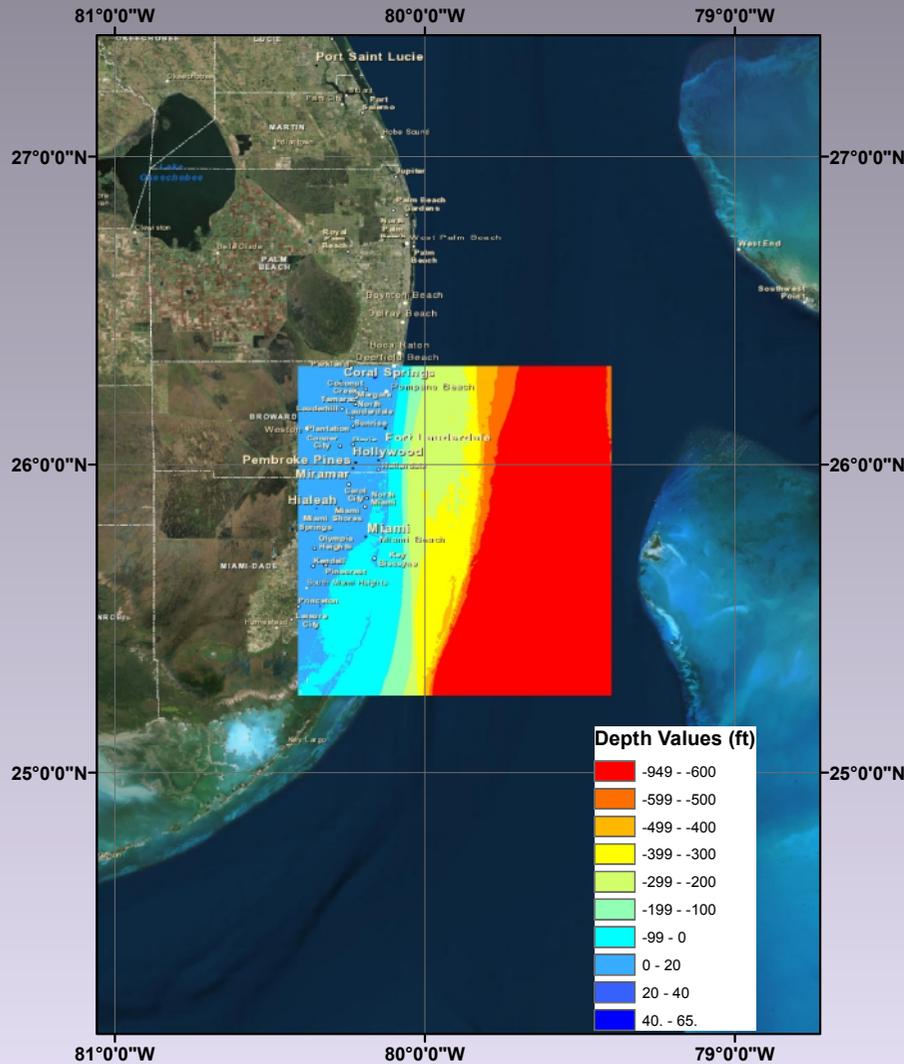
Currituck SMF proxies in areas 1 to 4



SMFs: 165
km³ rigid
slumps



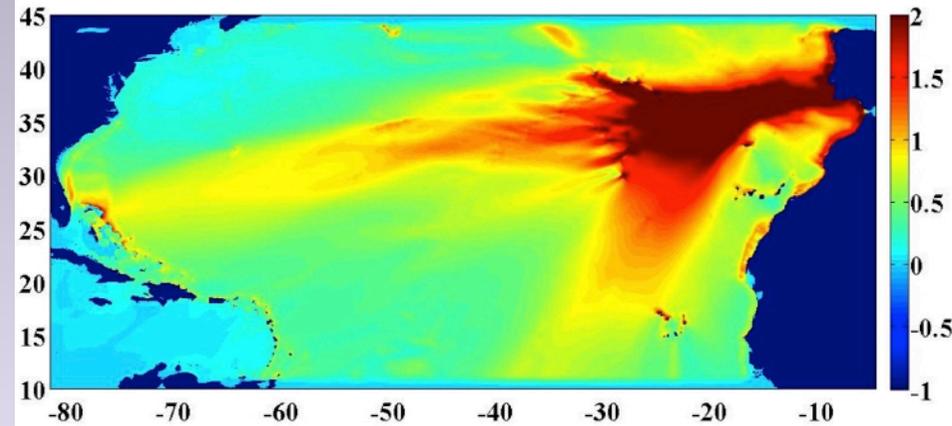
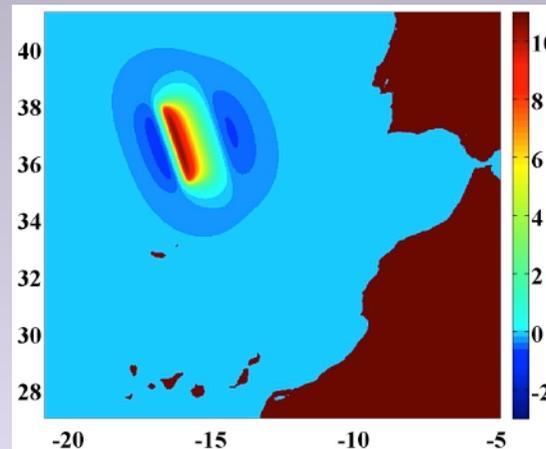
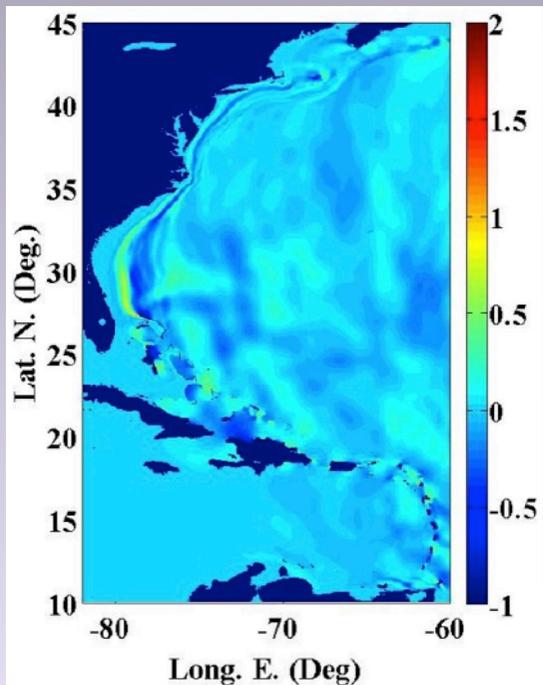
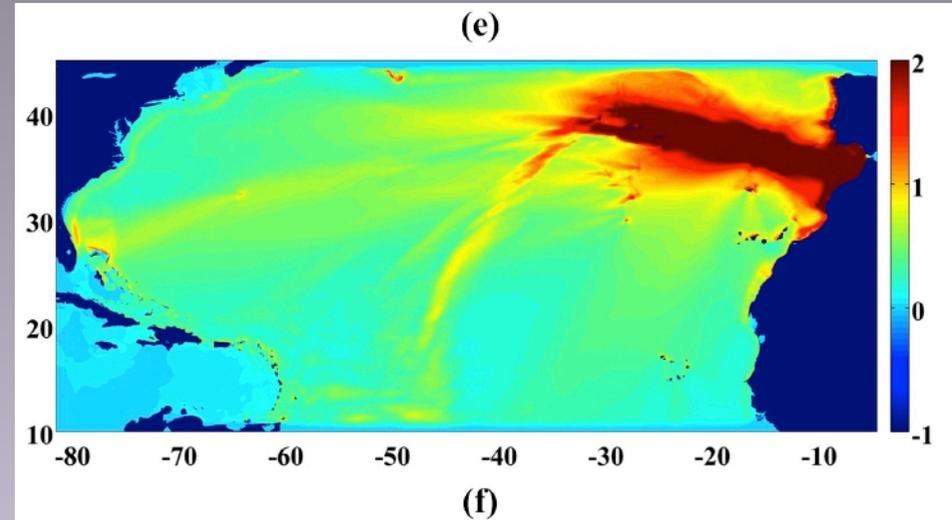
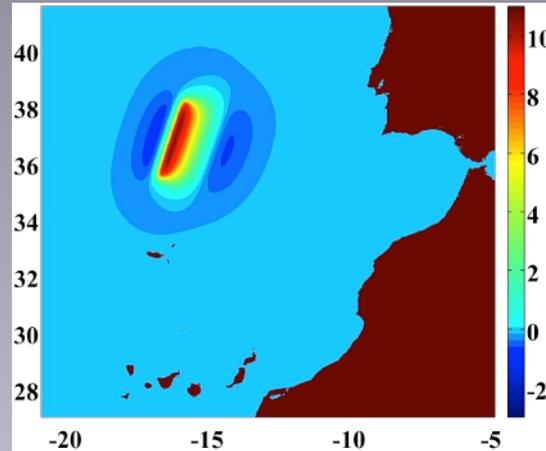
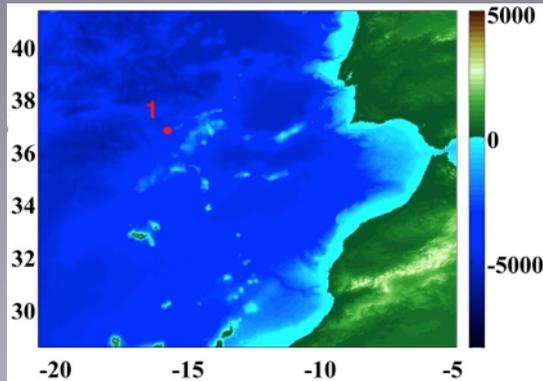
Near-field SMF sources: West Bahamas Banks



(Schnyder et al., 2013)



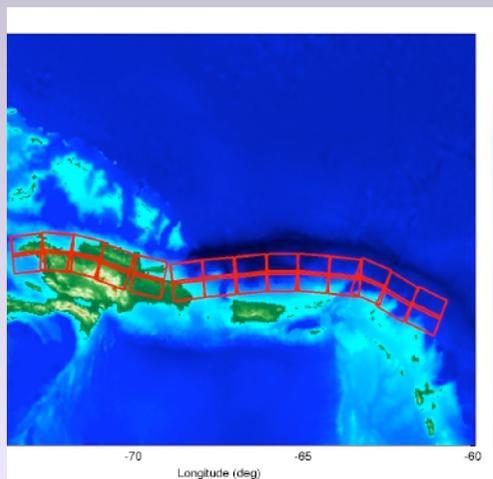
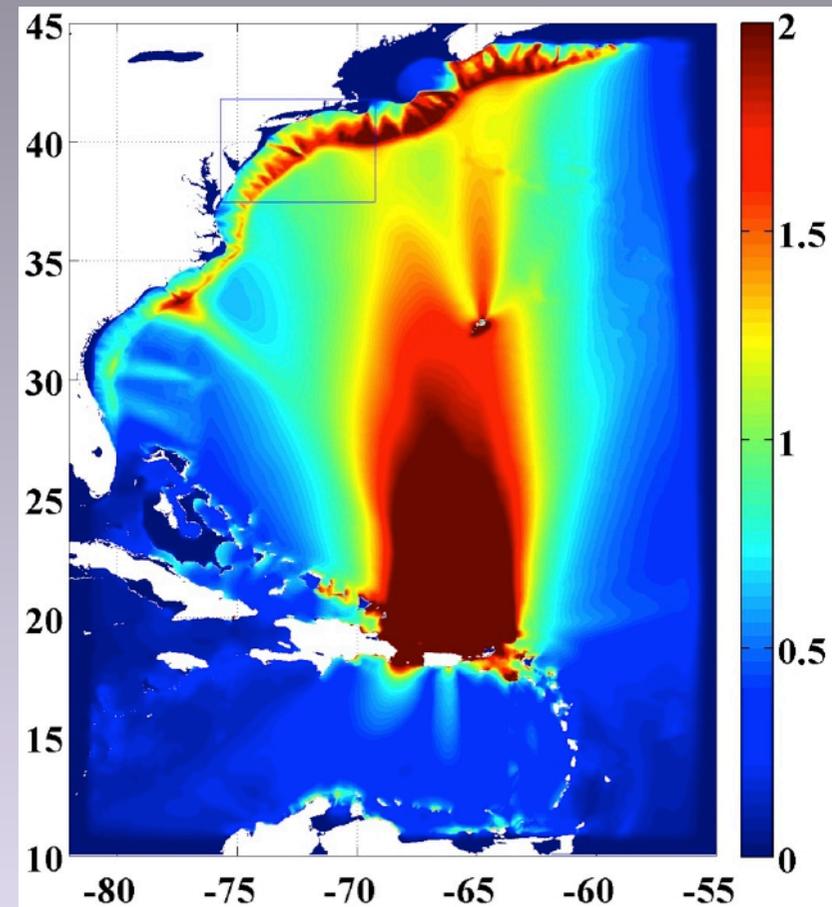
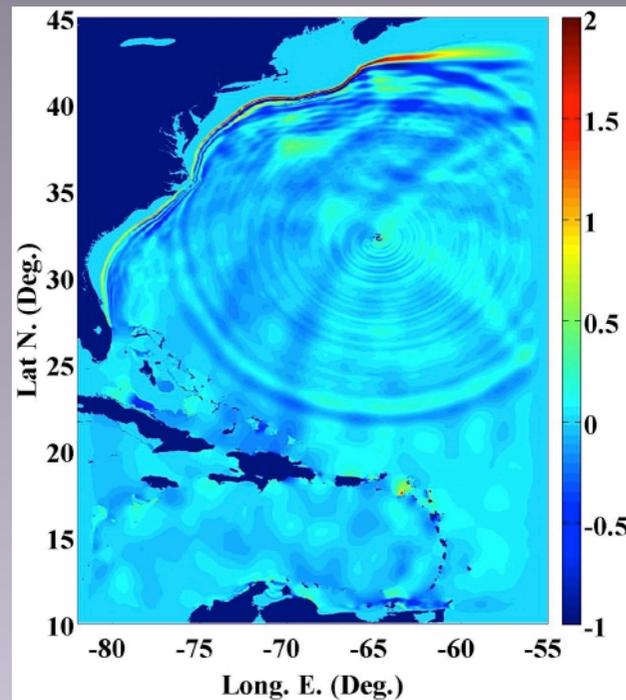
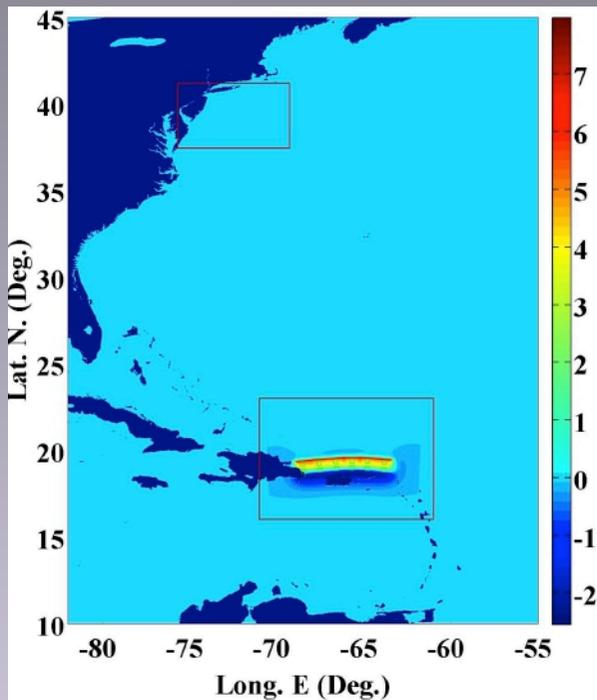
Far-field source modeling : M9 MTR



-> Order 1 m runup/inundation, not dominant



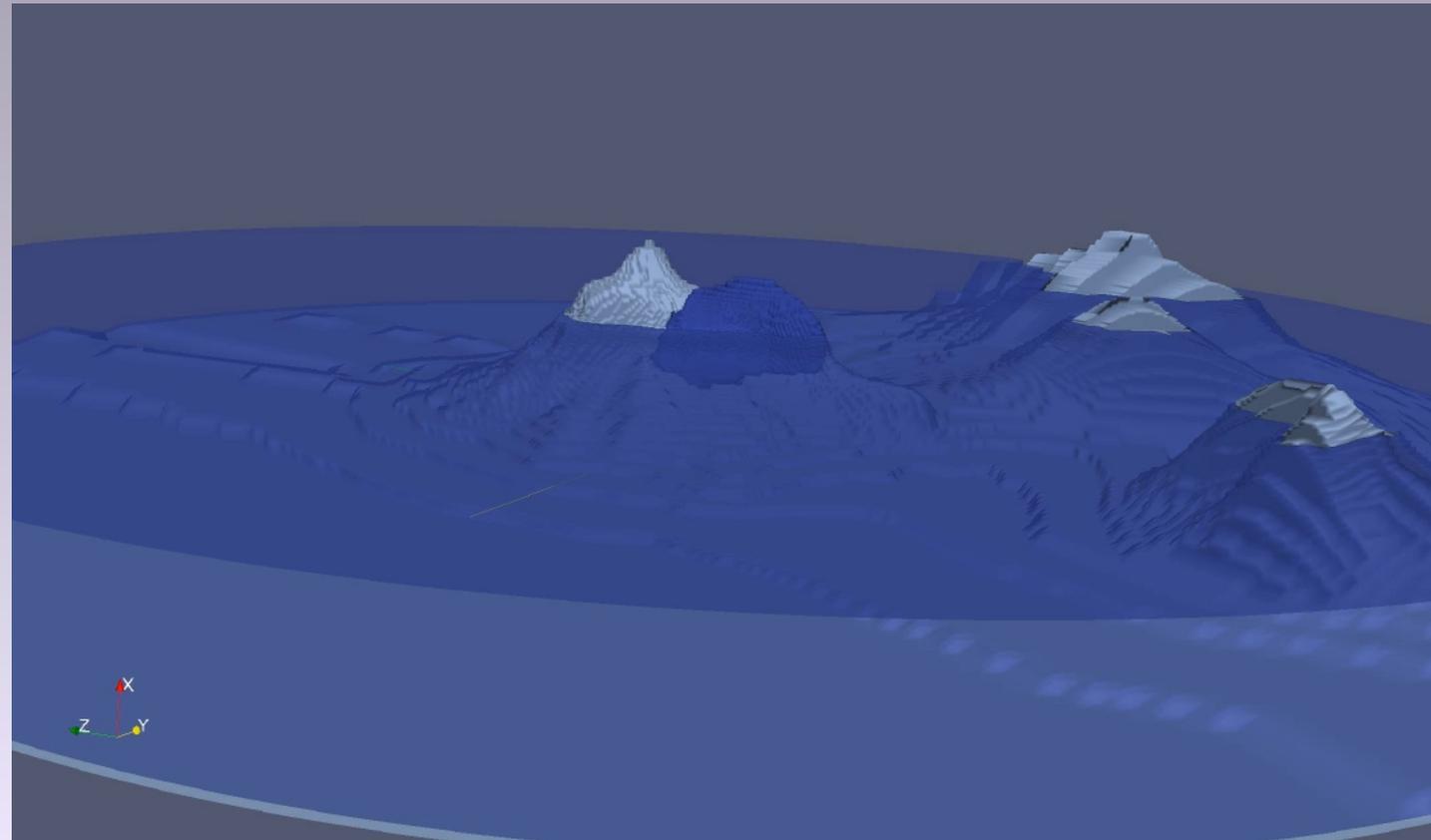
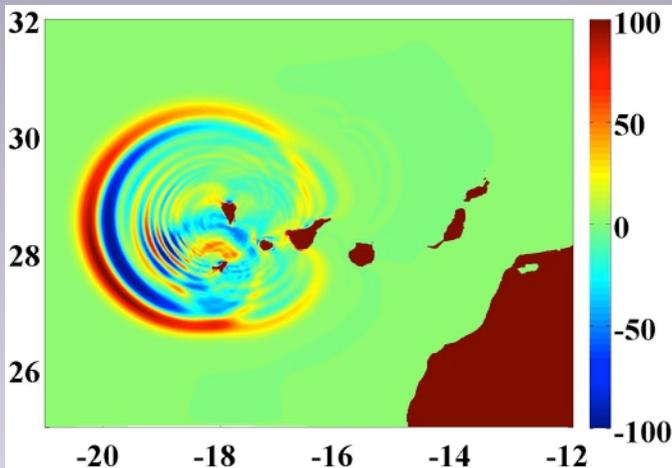
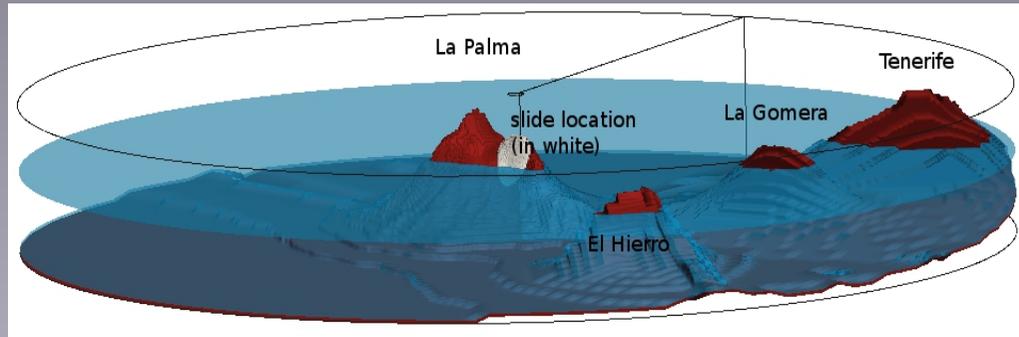
Far-field source modeling : M9 PRT



“SIFT”
sources
Fault planes,
in the area

-> Order 2 m runup/inundation

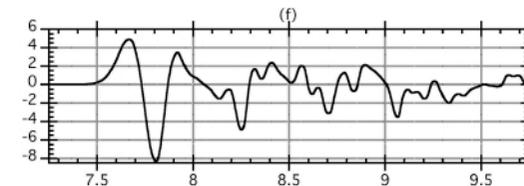
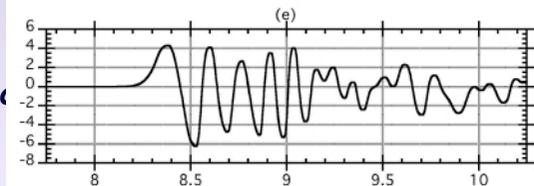
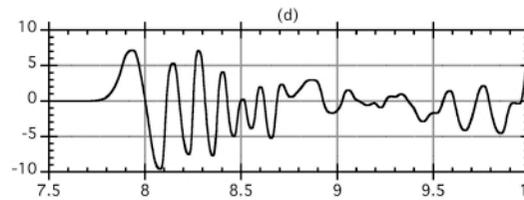
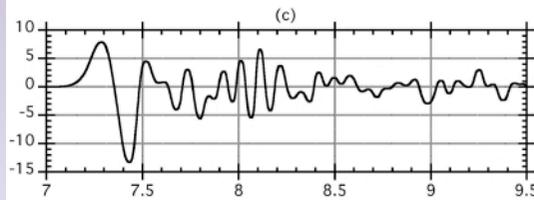
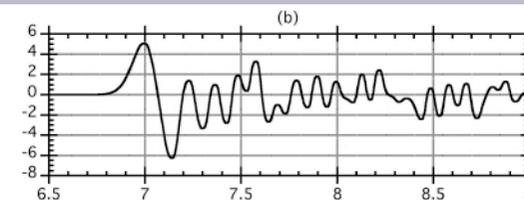
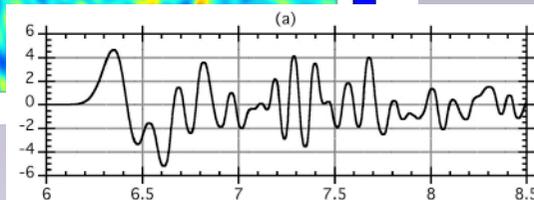
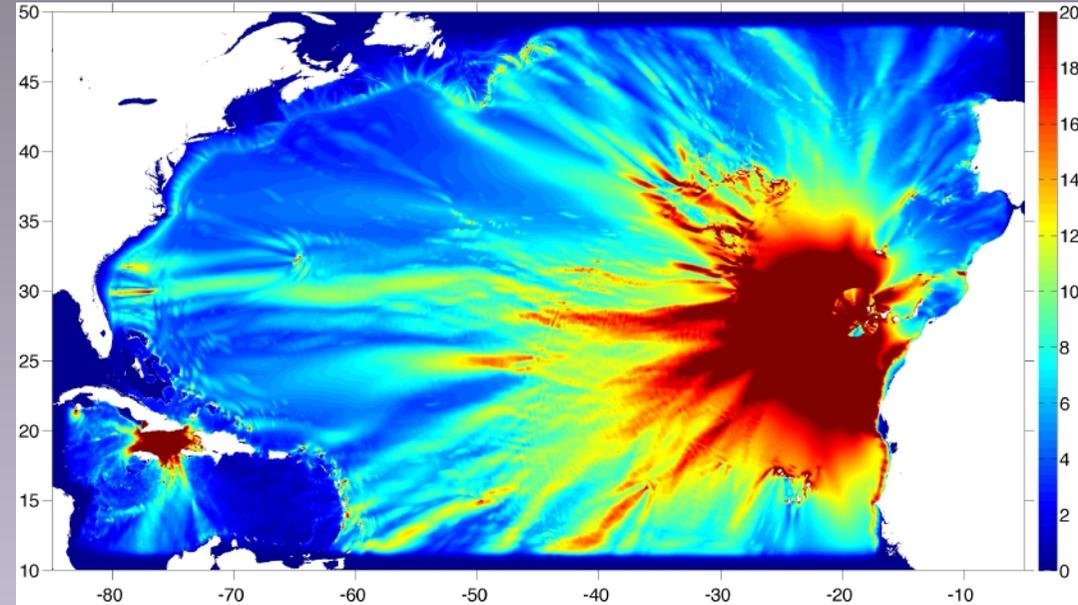
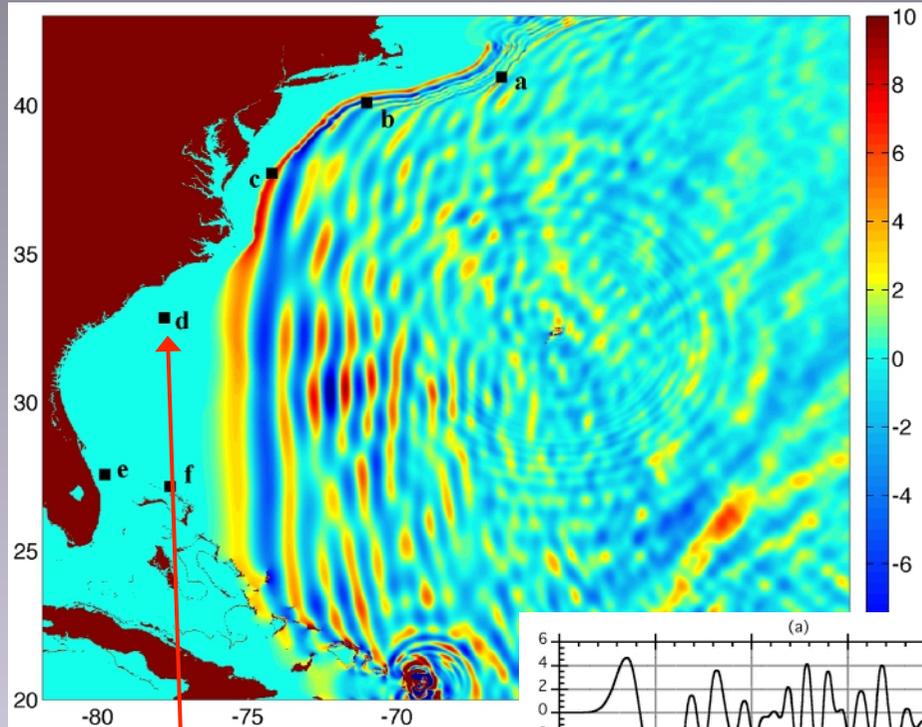
CVV Flank Collapse source (450 km³)



-> Surface elevation
(meter) after 20 min



CVV Flank Collapse source (450 km³)



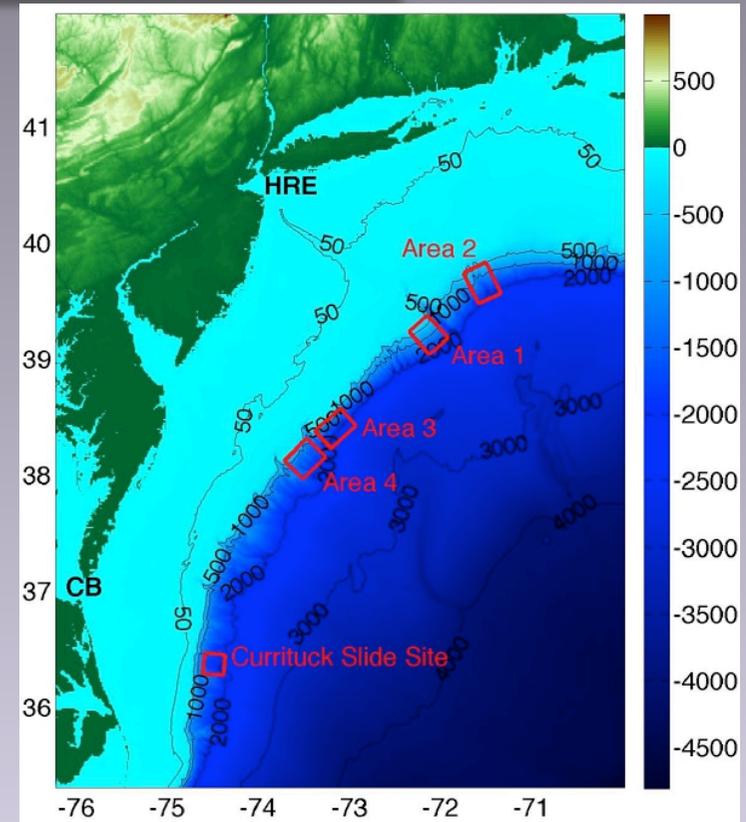
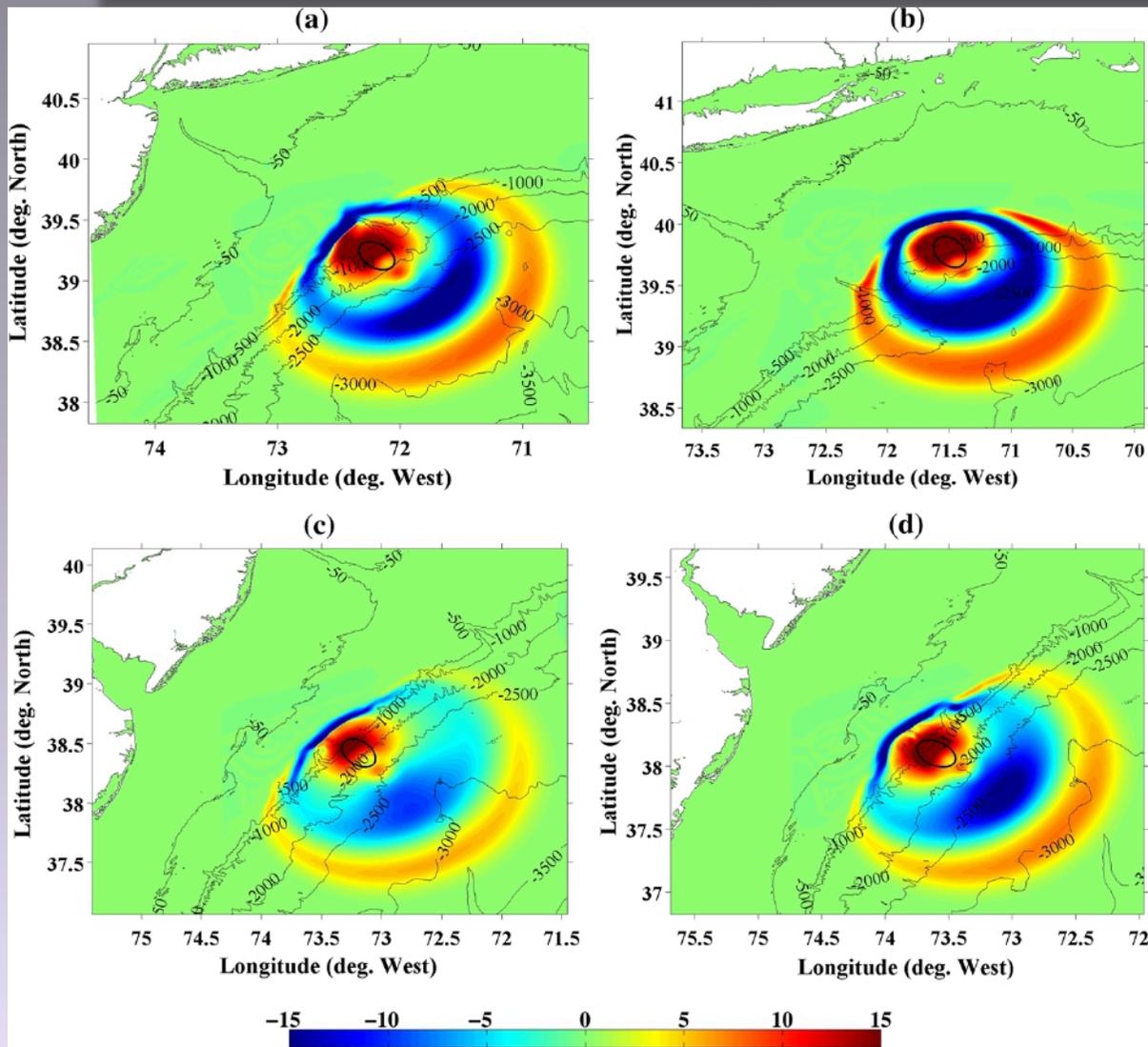
-> Dispersive trains of large waves, 9-12 min period

-> 450 km³:
Up to 5-6 m runup/inundation
-> 80km³:
Up to 2-2.5 m runup/inundation



Dept. of Ocean Engineering,

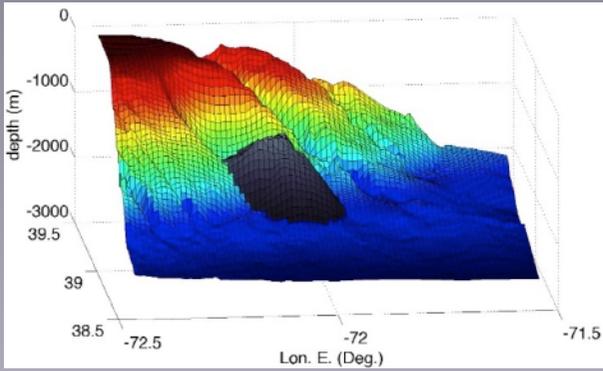
Currituck SMF proxies in areas 1 to 4



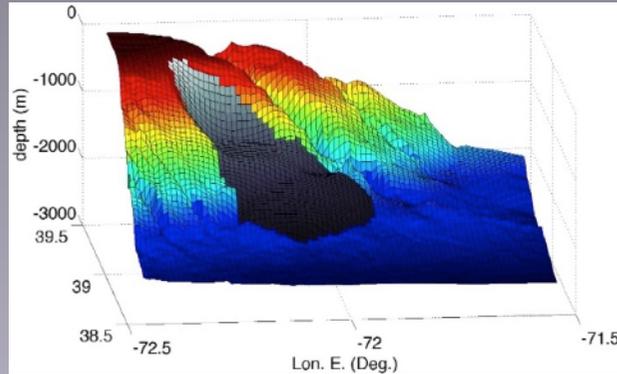
- Modeled as rigid slumps (surface elevations after 13.3 min) [Details in Grilli et al. (2015) NH]
- Deformation is being studied



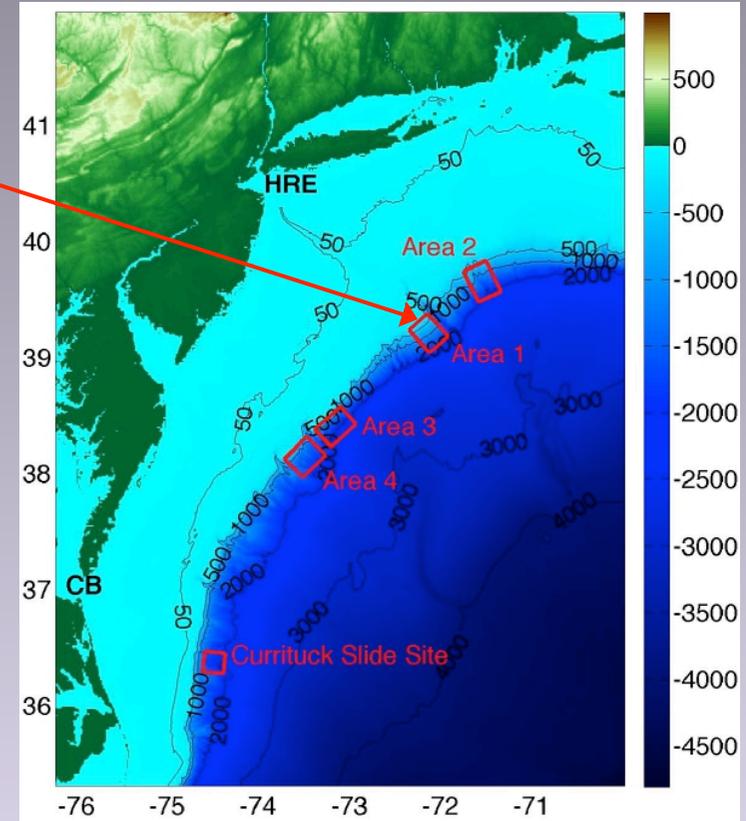
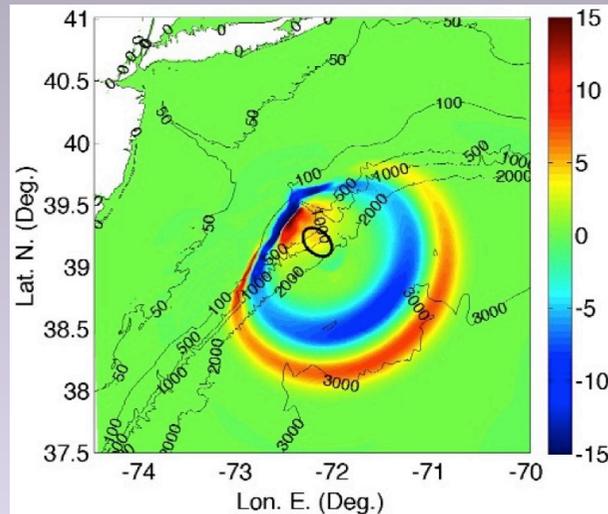
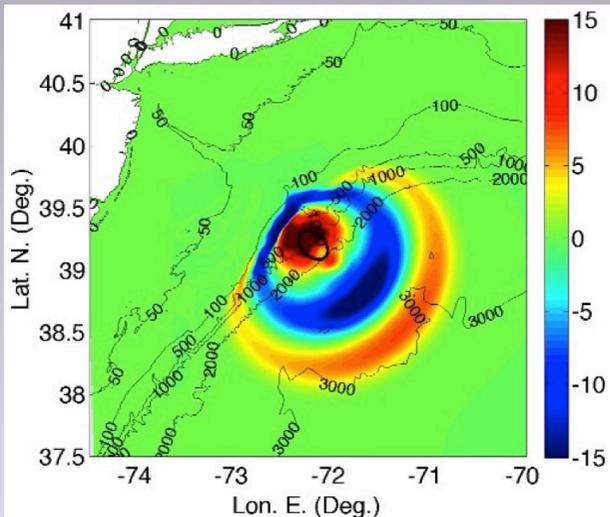
Currituck SMF proxies 1: rheology effect



Rigid slump



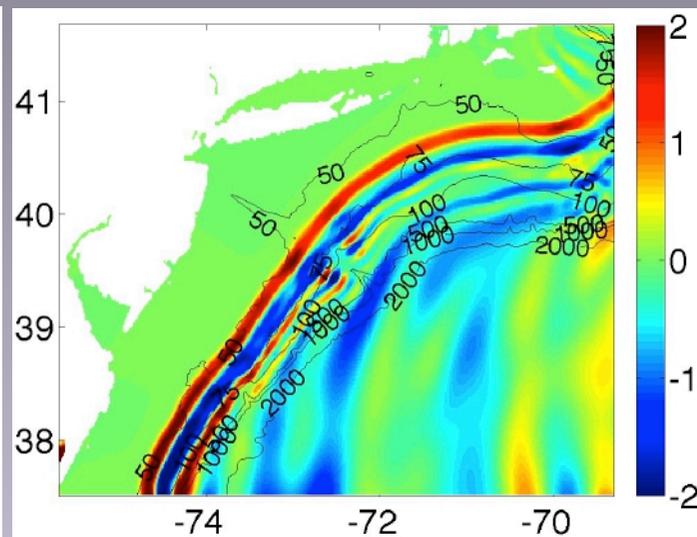
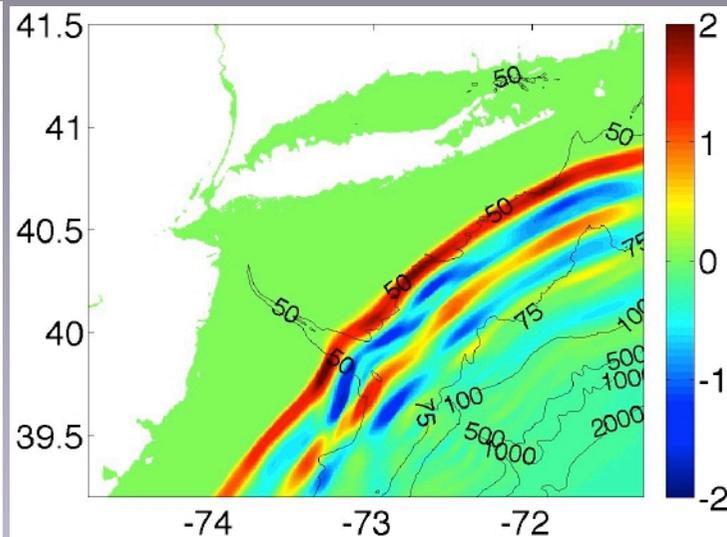
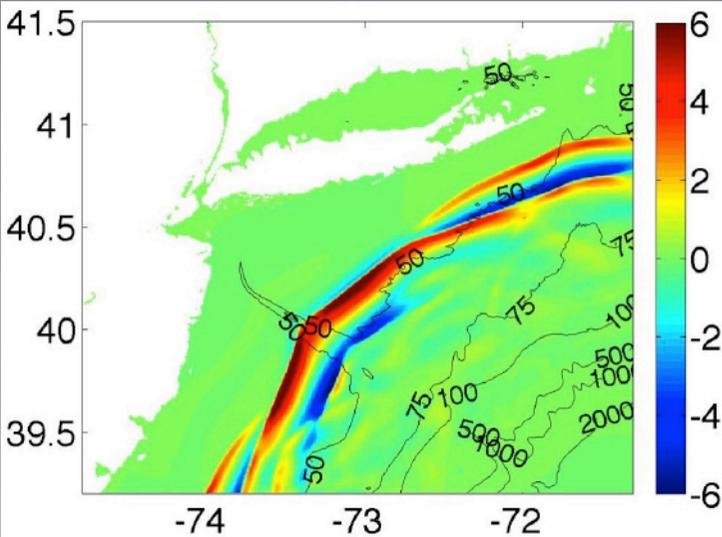
Deforming slide



Surface elevation after 13.3 min (slump stops at 12 min; same runout)



Comparing coastal impact CVV/SMF/PRT



SMF-1 (rigid slump) 1h18'

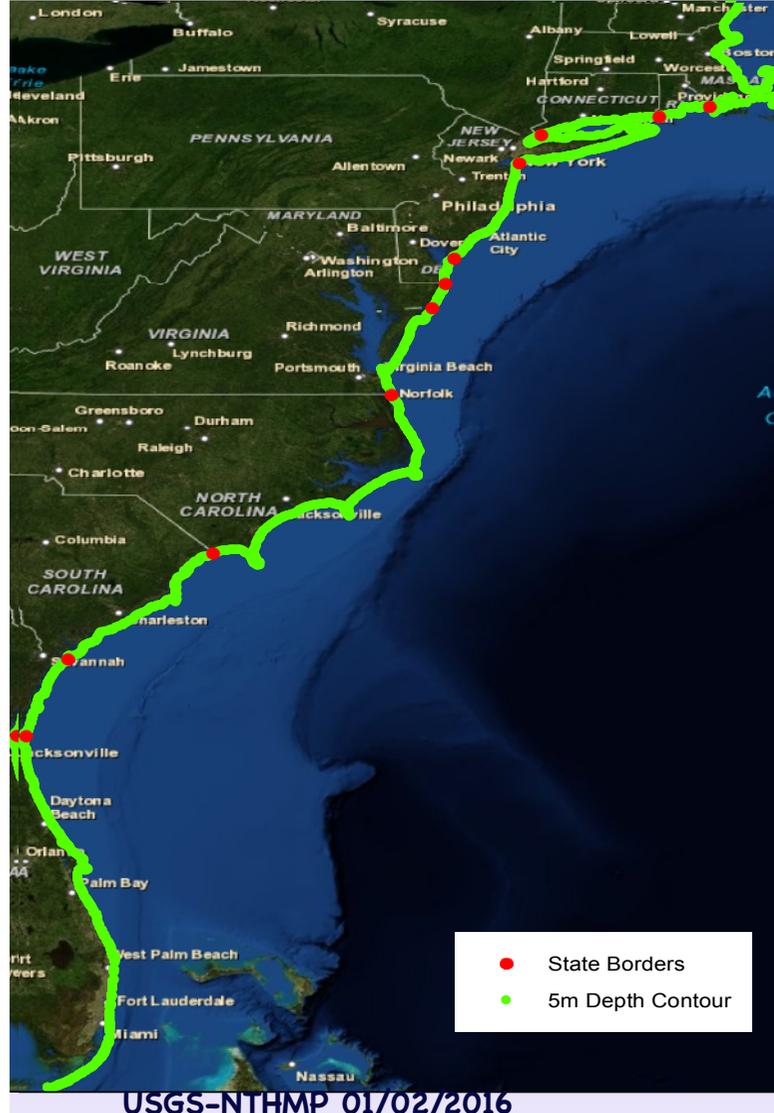
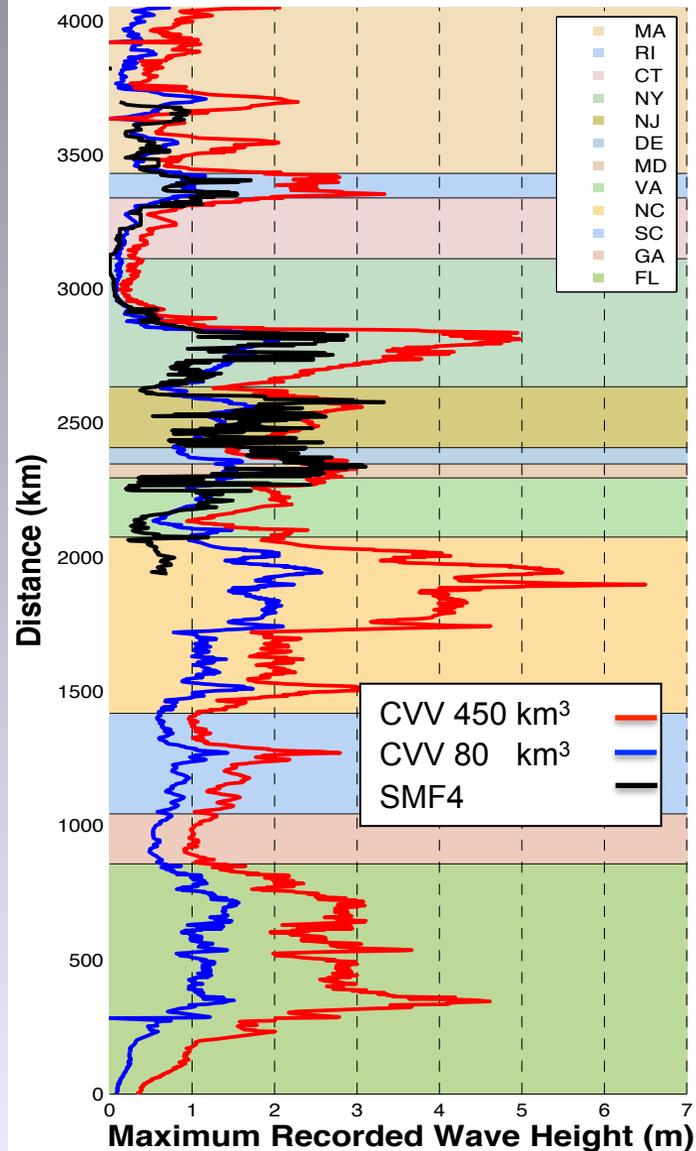
PRT (4h)

CVV (80 km³) (8h)

- > Similar patterns of nearshore waves are observed for all sources
- > Coastal wave height distribution suggest tsunami coastal hazard is controlled by nearshore bathymetry, particularly that of a wide shelf.



Comparing coastal impact CVV/SMF1-4/PRT



- -> A similar wave height distribution pattern is observed for all of the sources simulated in this study.
- -> Wave height distribution and tsunami propagation control by nearshore bathymetry,

Discussion – Needs for USGS guidance

- 1) **First generation maps** based on extreme sources/PMTs, with no consideration for **return periods of** LSB, PRT, CVV, SMFs.
=> Return periods are needed for coastal managers to **assess risk** and for future work on **PTHA**
=> **Last major PRT earthquake** was in 1787 (M8.1); is a **200–300 year** return period possible for a 600 year M9–PRT event ?
- 2) **Size and likelihood of CVV failure** (e.g., 80, 450 km³; single/multiple)
=> might **dominate** east coast hazard for most extreme case, or not ?
(see **Cape Verde mega-tsunami** 73ka ago; Ramalho et al., 2015)
- 3) **SMF siting and rheological properties** have major influence on coastal hazard
=> Need for **geological/geotechnical data**, siting, ... for east coast SMFs



Thank you

