Tsunami hazard assessment on US East Coast (2009-19)

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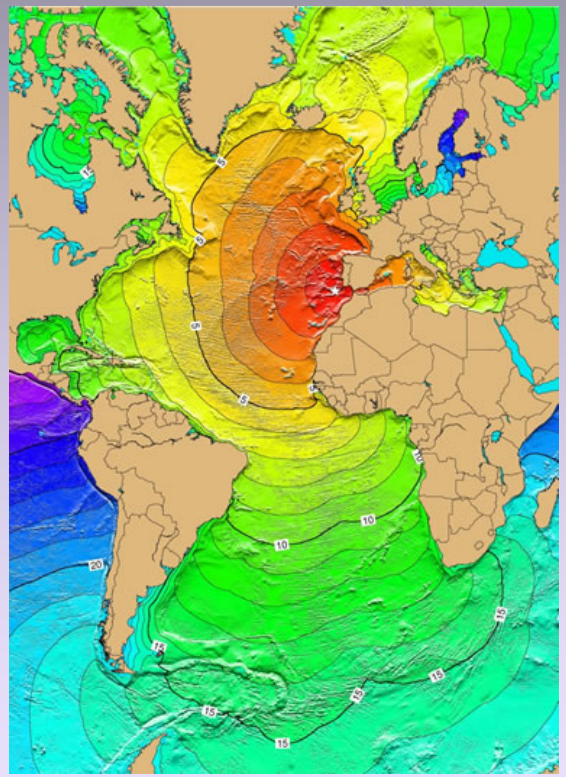
NTHMP-19

USEC sources: some historical events

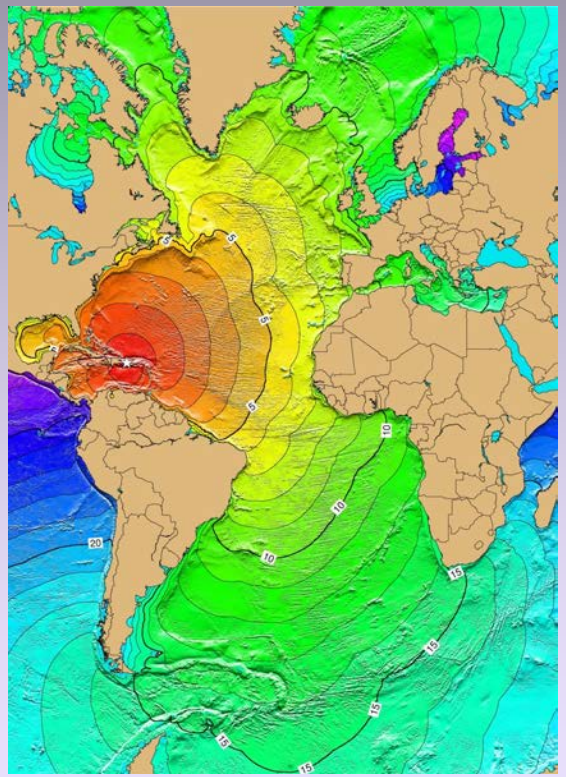
Lisbon, Portugal, 1755

A M8.9 (estimated) earthquake and tsunami killed between 60,000 and 100,000 people.



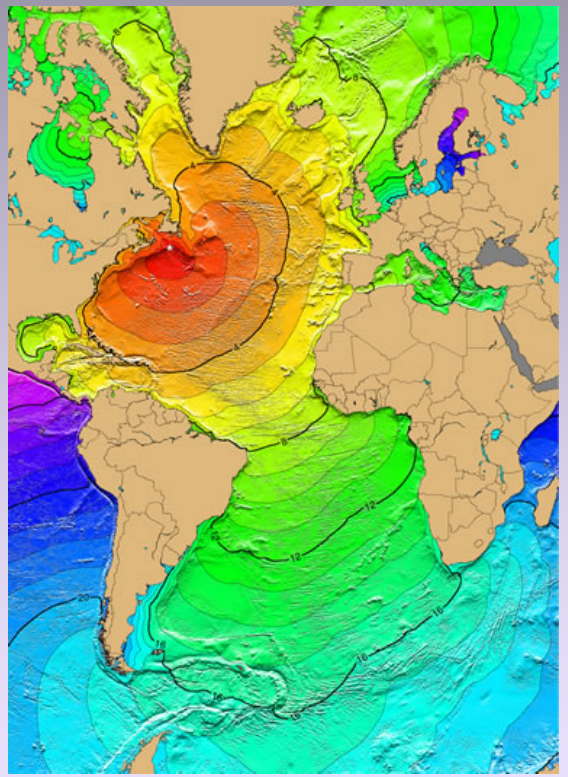
Puerto Rico, 1918

A M7.1 earthquake and tsunami killed 116 people, 100 missing, and caused $29M in damage.

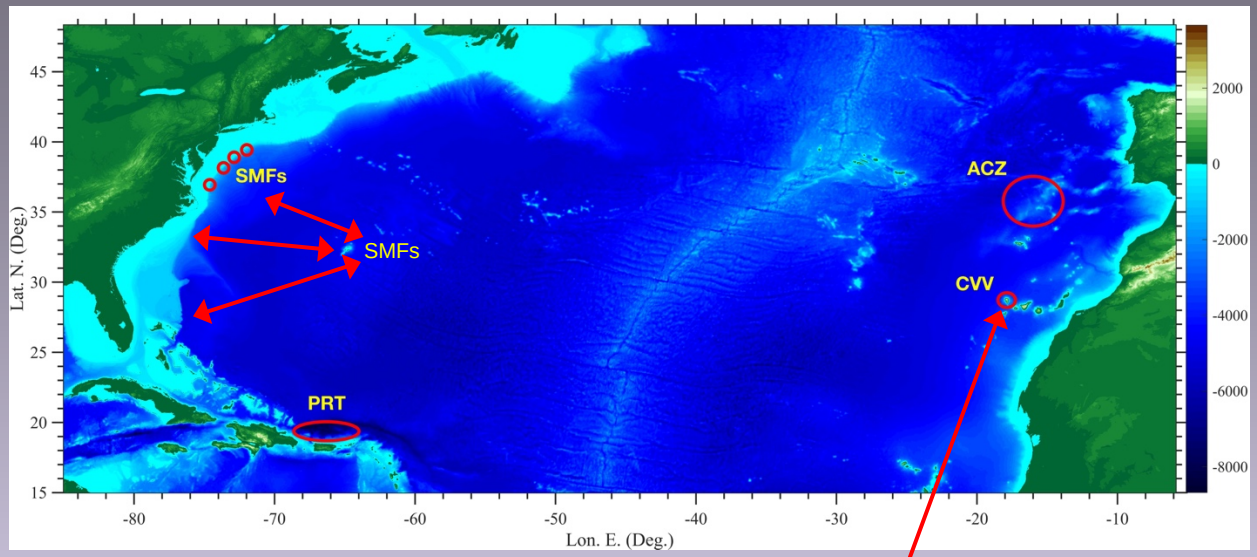


Grand Banks - 1929

A M7.2 earthquake triggered a large submarine slump which caused a tsunami, killing 20+ people.



USEC sources: coseismic, volcanic, SMFs

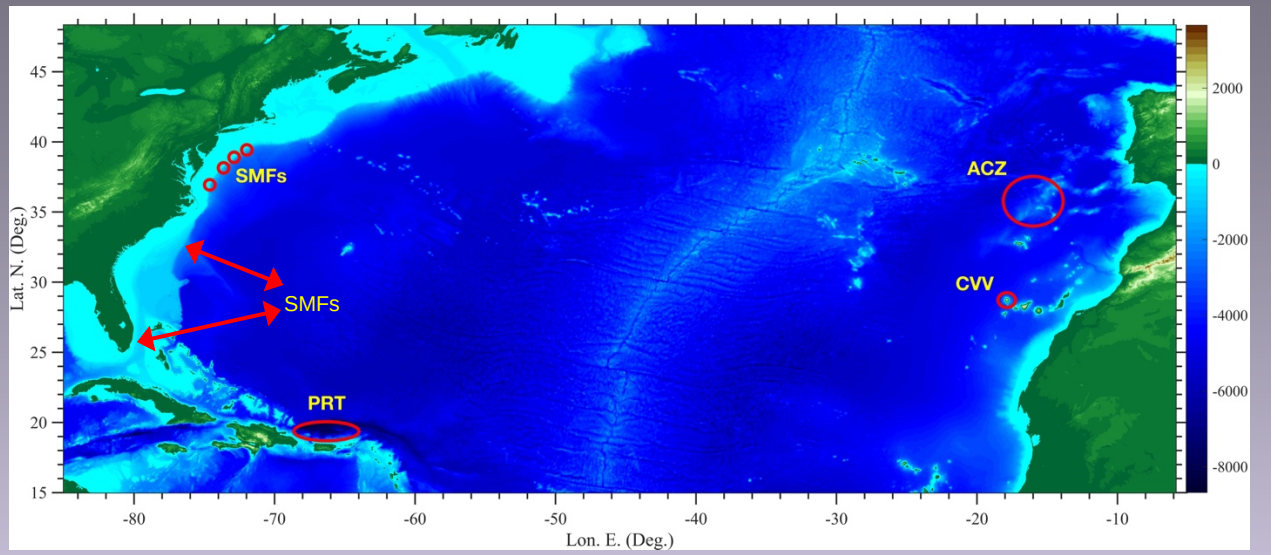


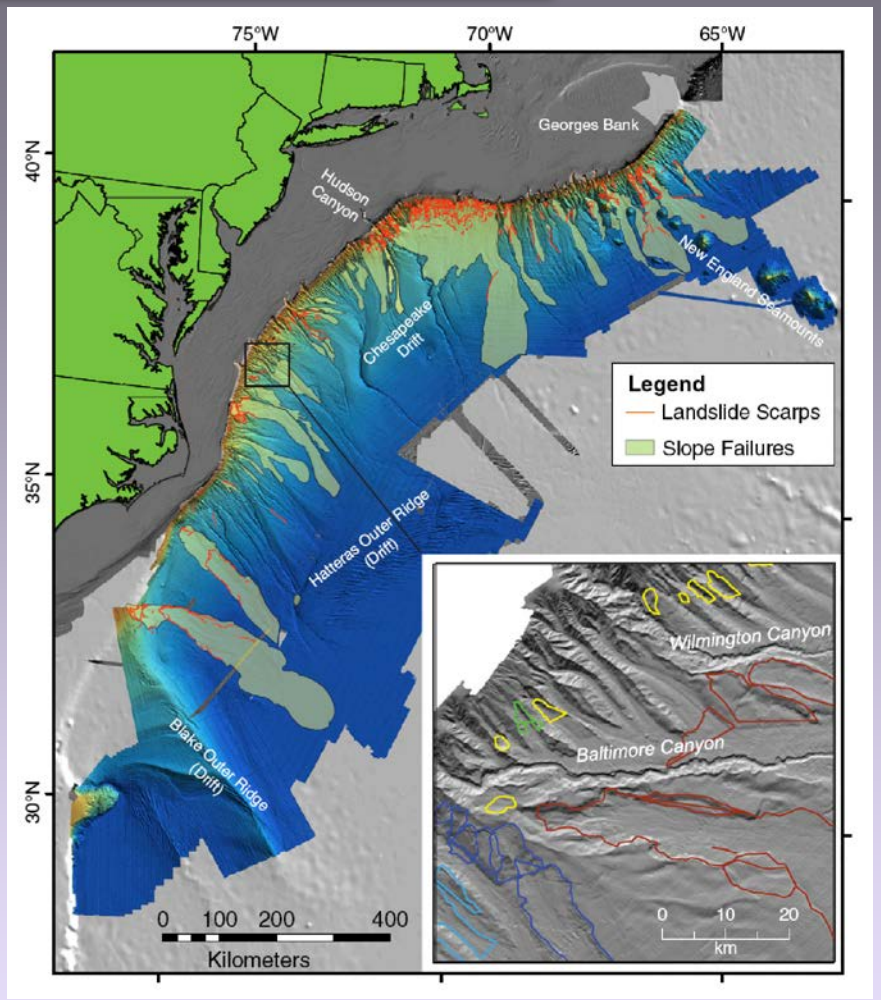
-> ACZ/LSB: M9 far-field seismic source in Açores convergence zone: repeat of Lisbon 1755, designed as multiple extreme events (various locations/strike angles) (Barkan et al., 2008)

-> PRT: M9 far-field seismic source in Puerto Rico Trench: designed as single extreme event, (Knight, 2006; Grilli et al., 2010)

-> CVV: Far-field flank collapse of Cumbre Vieja Volcano (Ward and Day, 2001; Abadie et al., 2012; Tehranirad et al., 2015); multiple sources; 80 and 450 m^3 volume are used (extreme and most extreme events)

USEC sources: coseismic, volcanic, SMFs





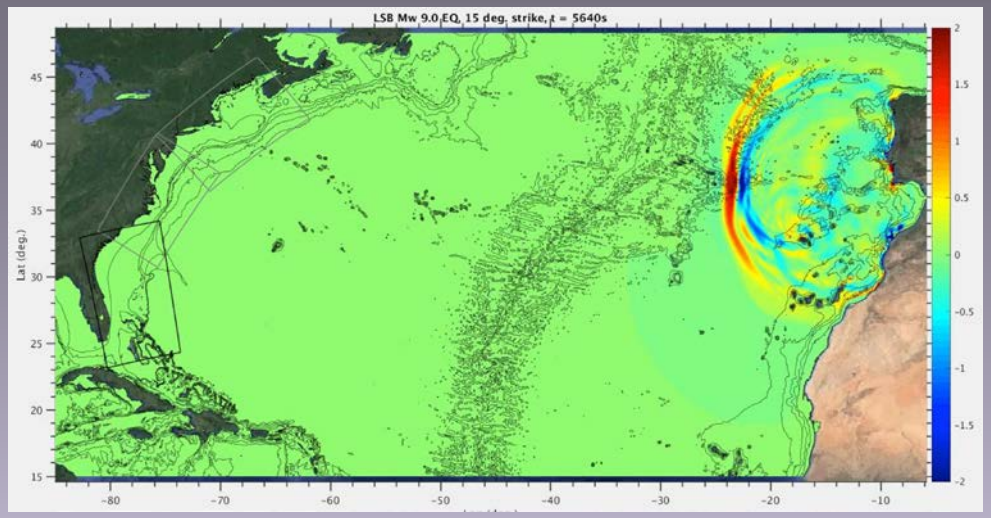
-> SMFs: triggered by earthquakes (or not) can generate large damaging tsunamis

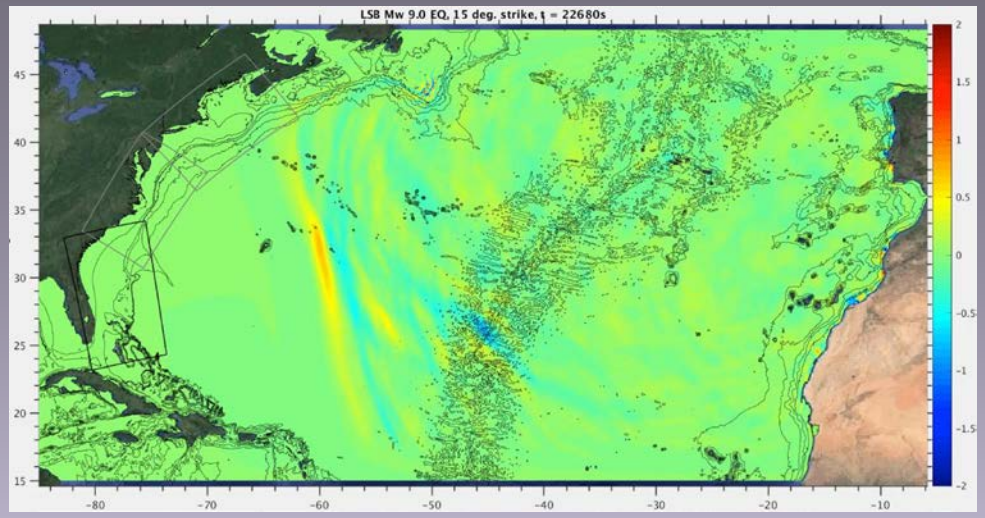
-> SMF scars are widespread on US Atlantic margin, but are mostly old events (1,000s of yrs.

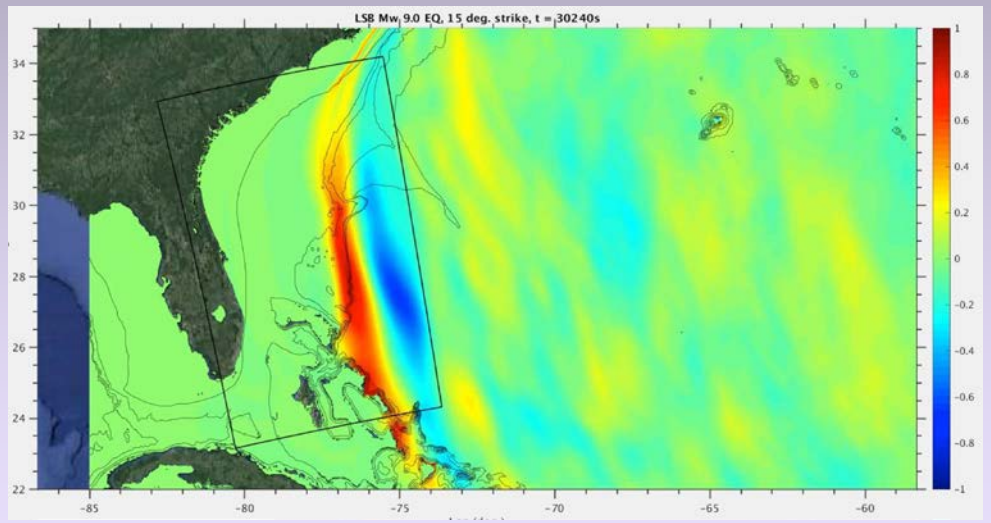
-> But see 1929 Grand Bank SMF tsunamis

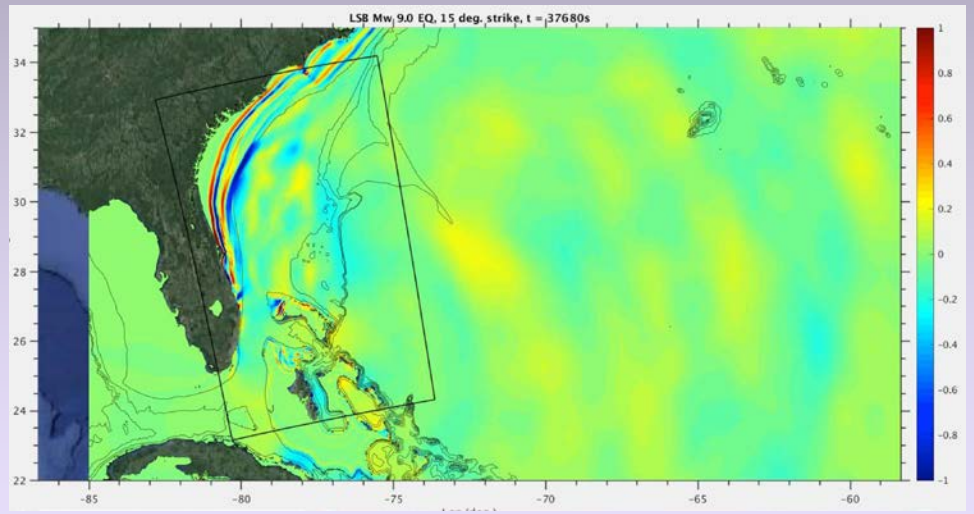
[Ten Brink et al (2014)]

ACZ/LSB M9 coseismic tsunami





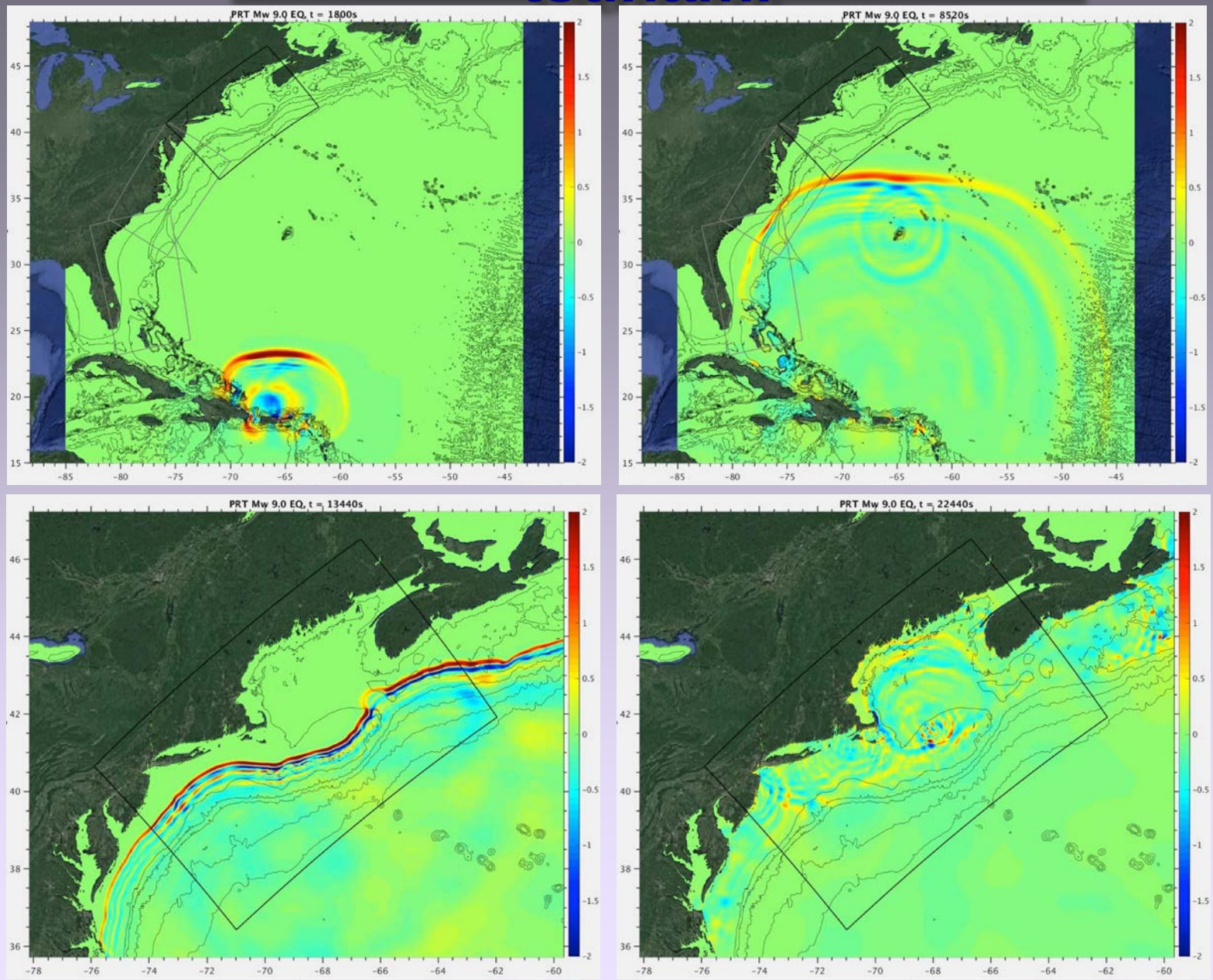




-> ASZ/LSB: Flow depth: 1-2 m

Arrival: 7-12 h

PRT M9 coseismic tsunami

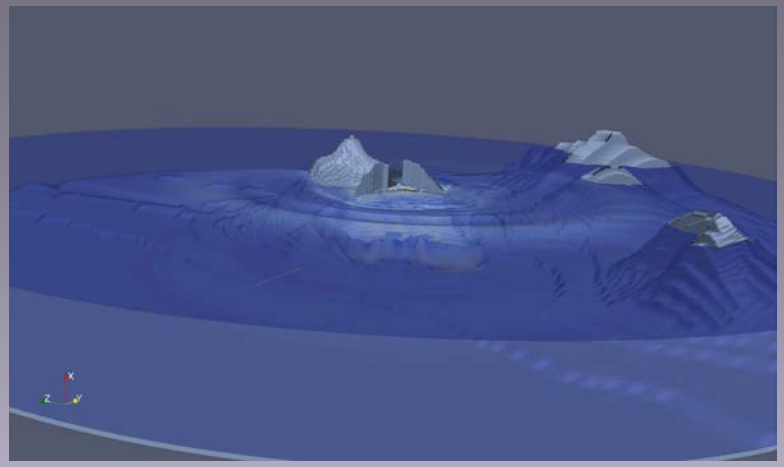


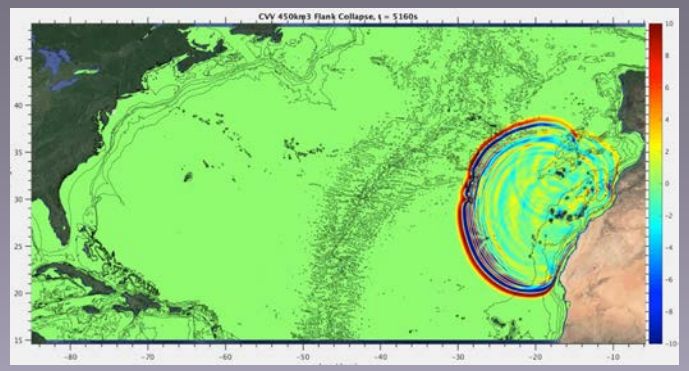
-> PRT:

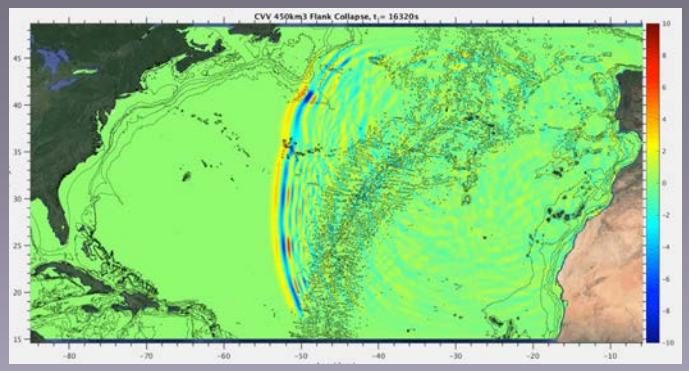
Flow depth: 2-3 m

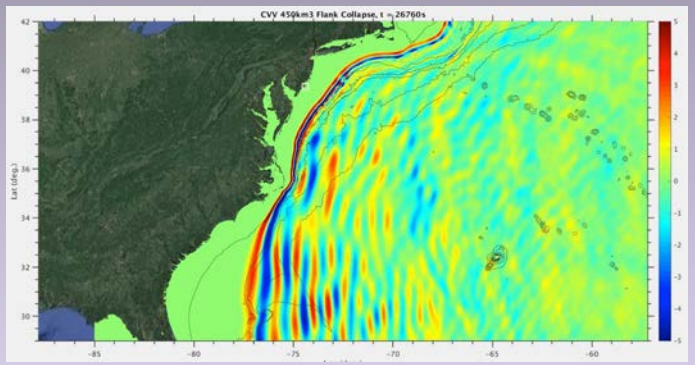
Arrival: 0.25-3.5 h

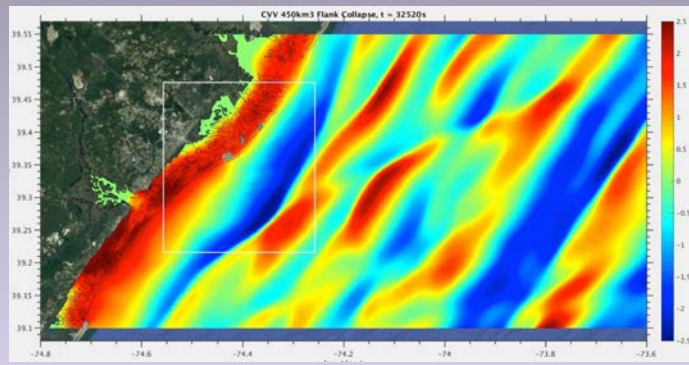
CVV 80/450 km^3 volcanic collapse tsunamis











-> 3D generation: Order 200 m (80 km^3) and 600 m (450 km^3) initial surface elevation

-> 2D propagation after 30'

-> Order 1-4 m (80 km^3) and 3-10 m (450 km^3) flow depth

-> Arrival 7.5-10.5 h

-> Inundation in Atlantic City

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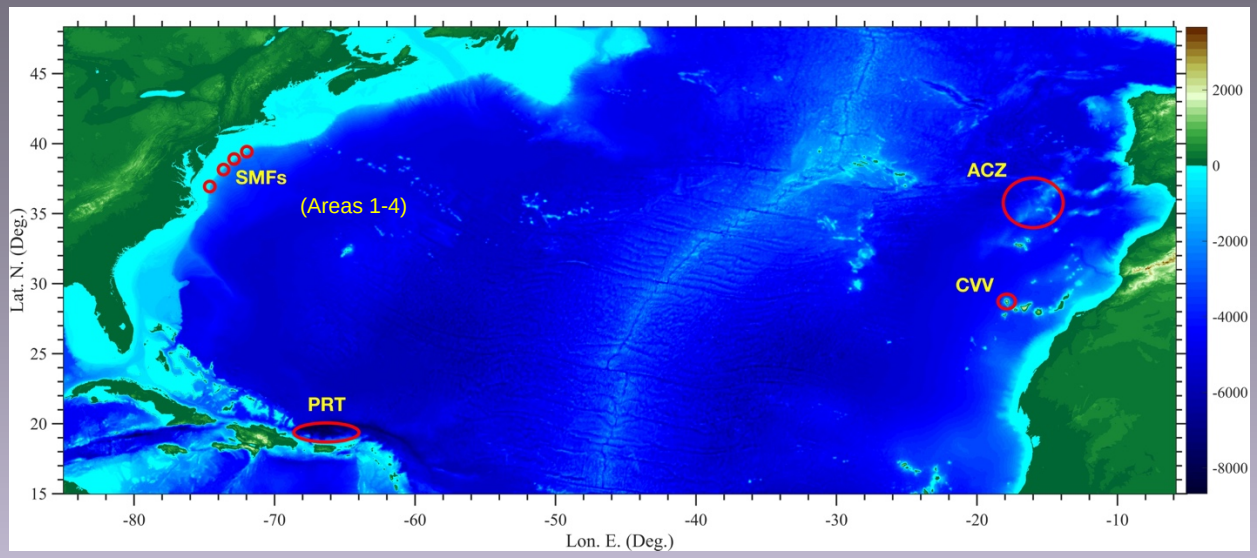
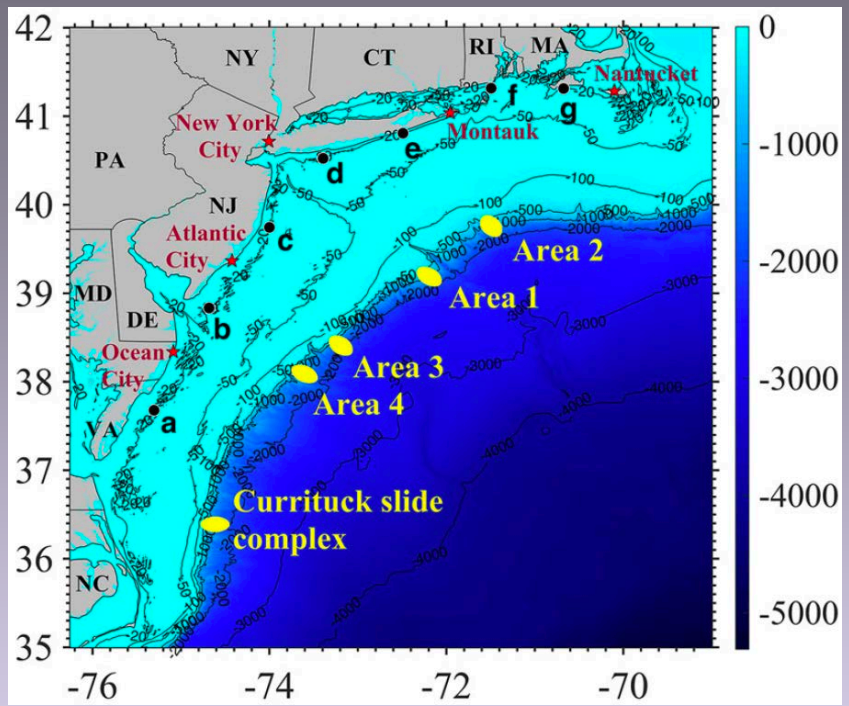
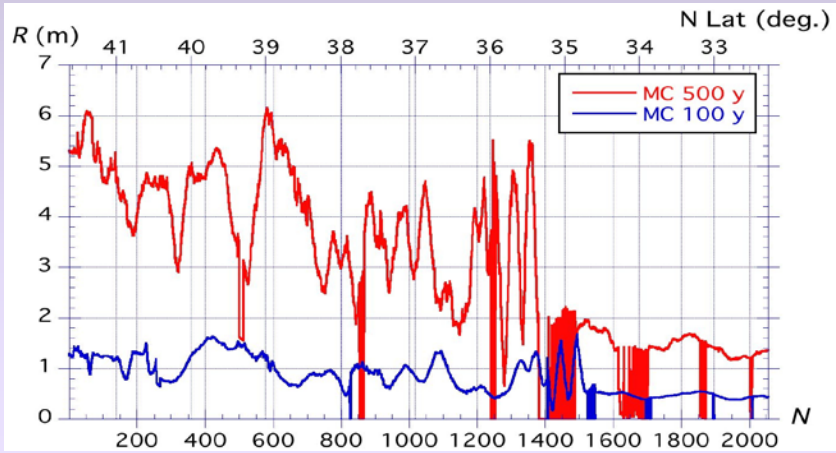
SMF tsunamis: upper EC





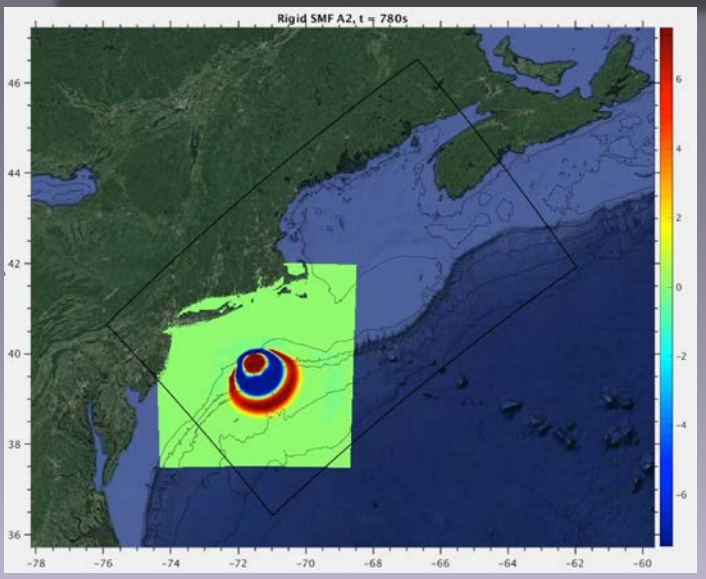
-> Probabilistic SMF analysis (Monte Carlo slope stability + tsunami generation) => high hazard areas (based on 100-500 year runups) (Grilli et al., 2009; Krause, 2011)

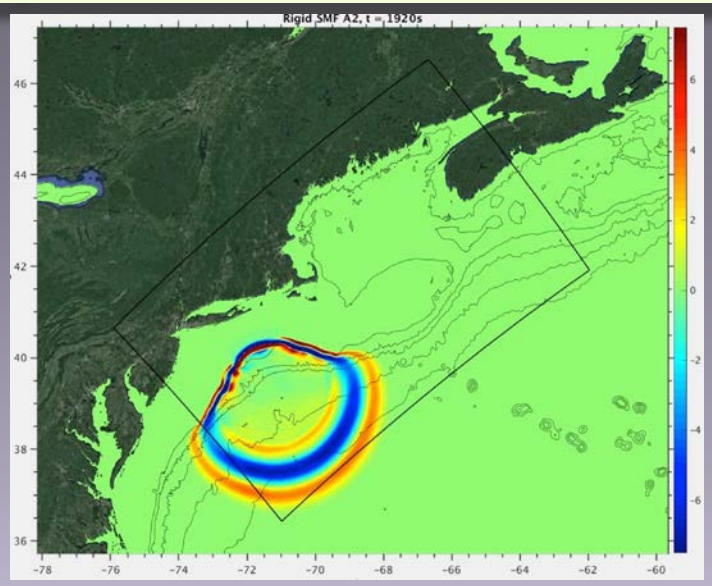
-> Geotechnical/geological analyses => Areas 1-4: Modeled as 160 km^3 Currituck SMF proxies (rigid slump/deforming slides) (Grilli et al., 2015; Schambach et al., 2019)

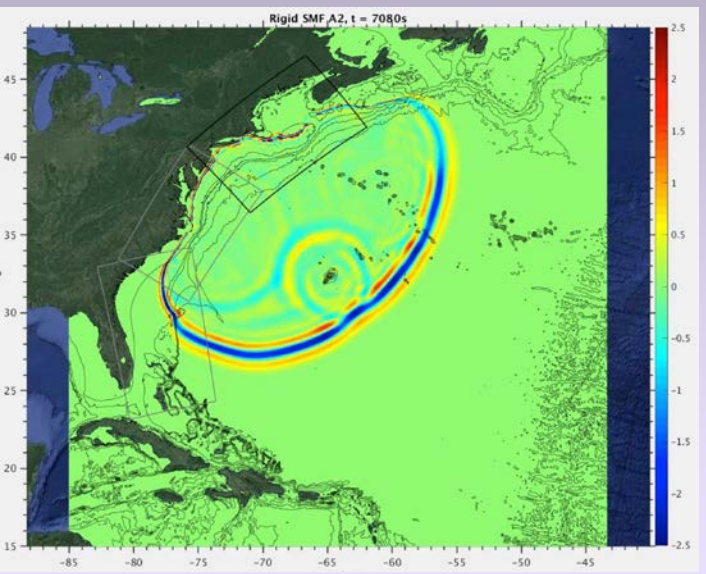


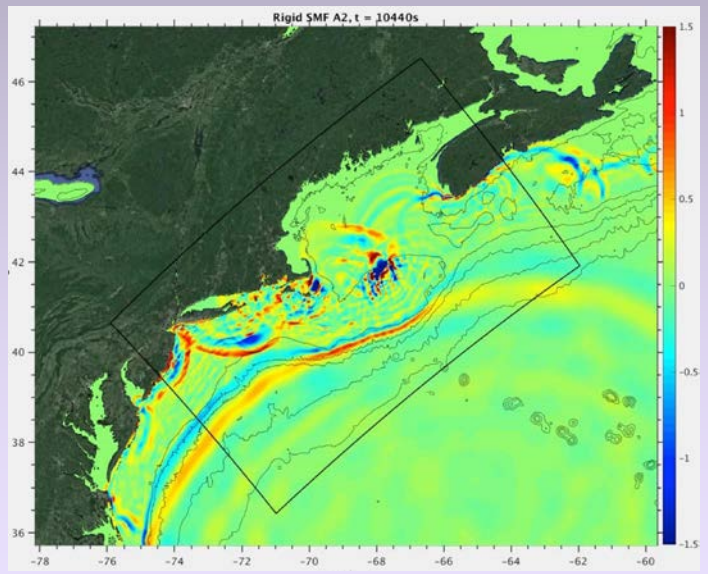
North South

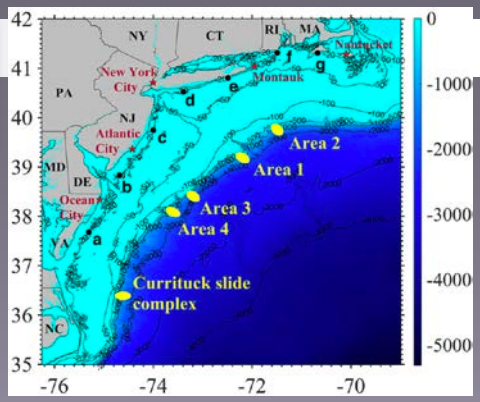
Currituck SMF proxies in Areas 1 to 4









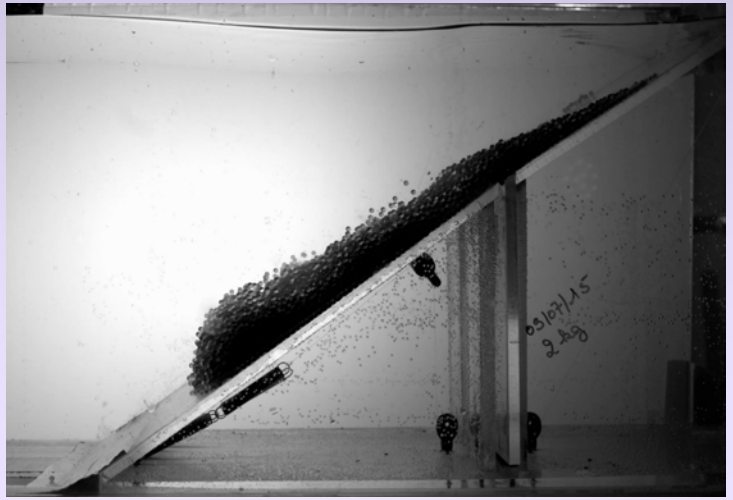


SMF: Area 2 (off of Montauk, NY), rigid slump

-> Near-field flow depth: 3-7 m

-> Far-field flow depth: 1-3 m

-> Arrival: 1.5-3 h



NTHMP EC 1st generation inundation maps

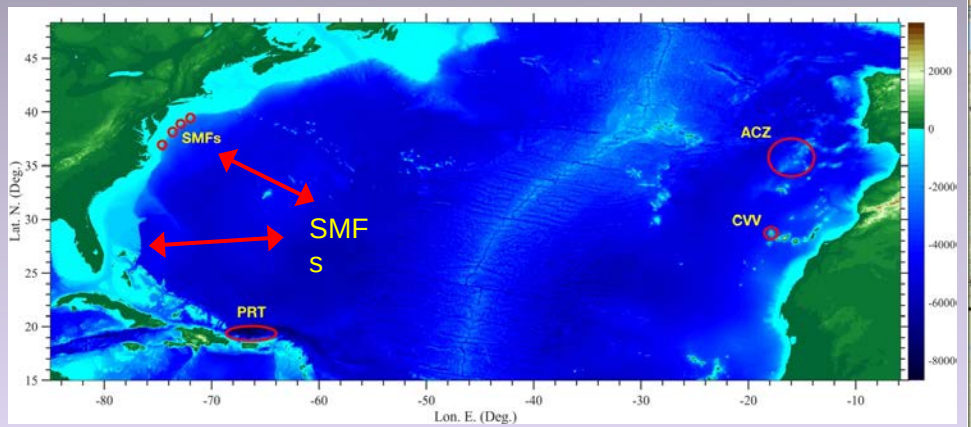
-> Based on all Probable Maximum Tsunami (PMT) sources in Atlantic basin:

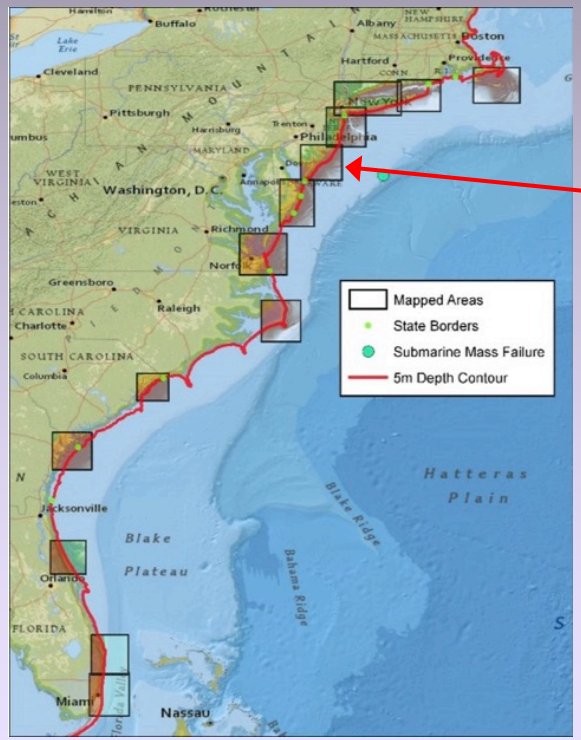
=> M9 LSB/PRT, CVV 80 km^3 and all SMF sources used

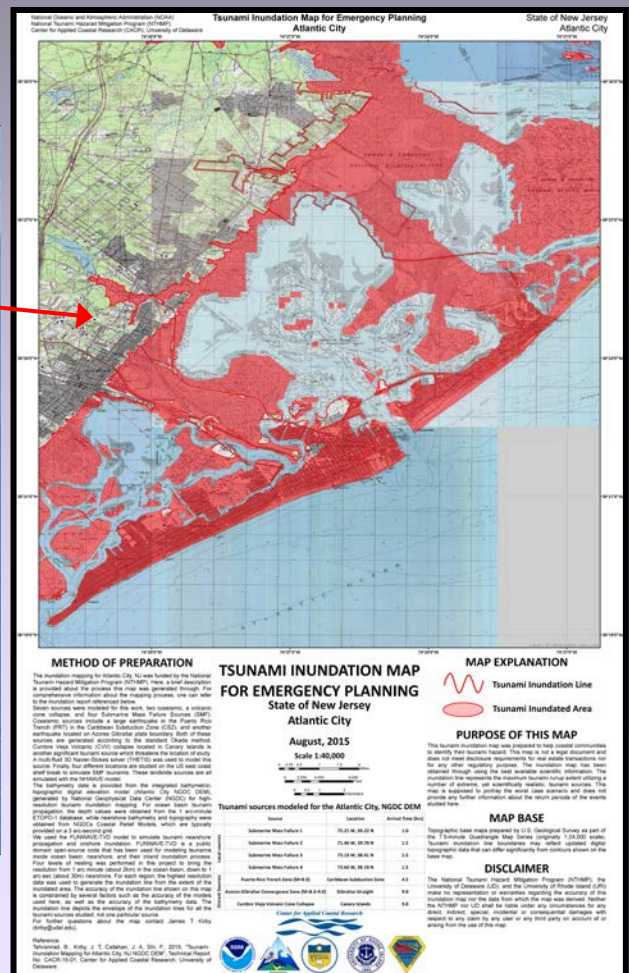
=> not a probabilistic study -> envelope maps of inundation limit

=> variety of numerical models used (not discussed here), other products available

=> Example: Atlantic City, NJ







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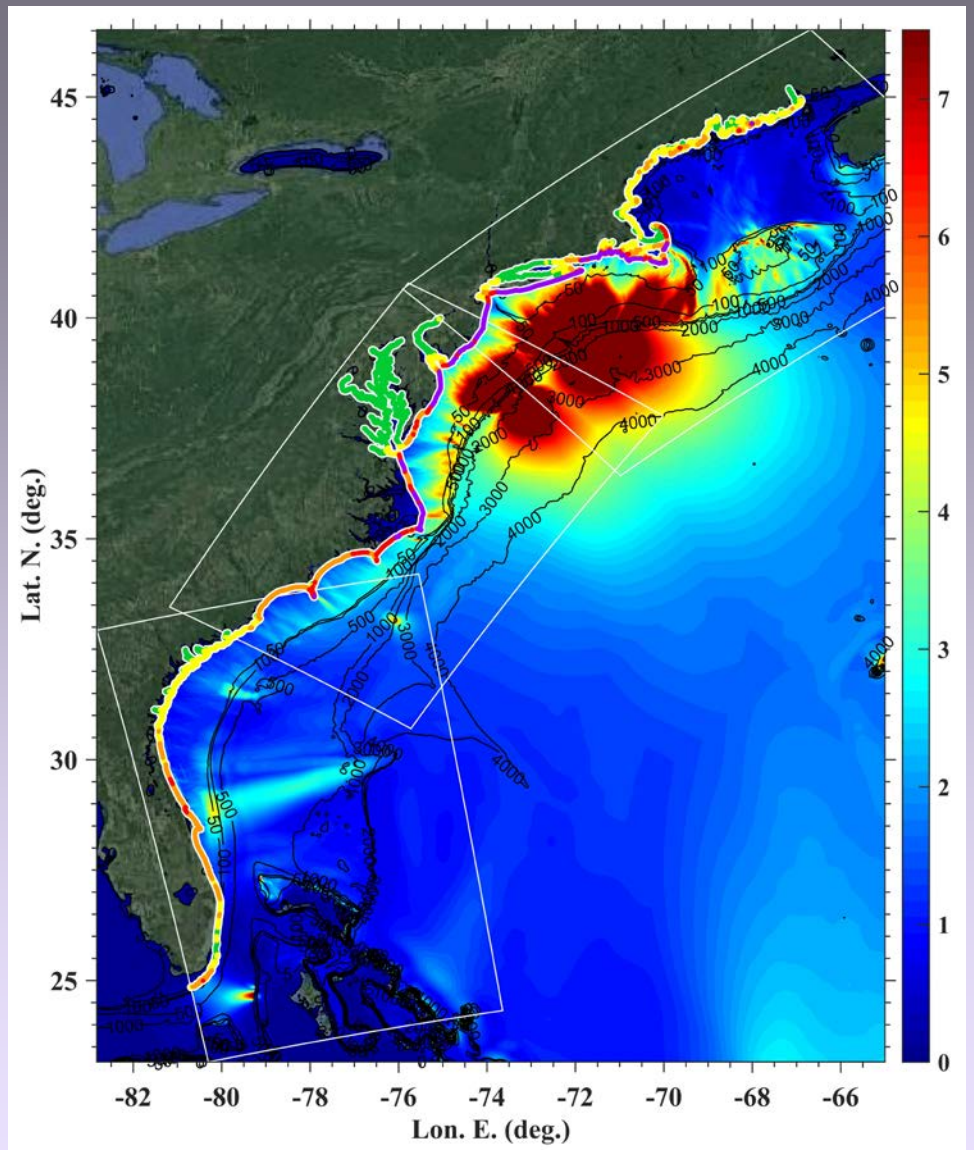
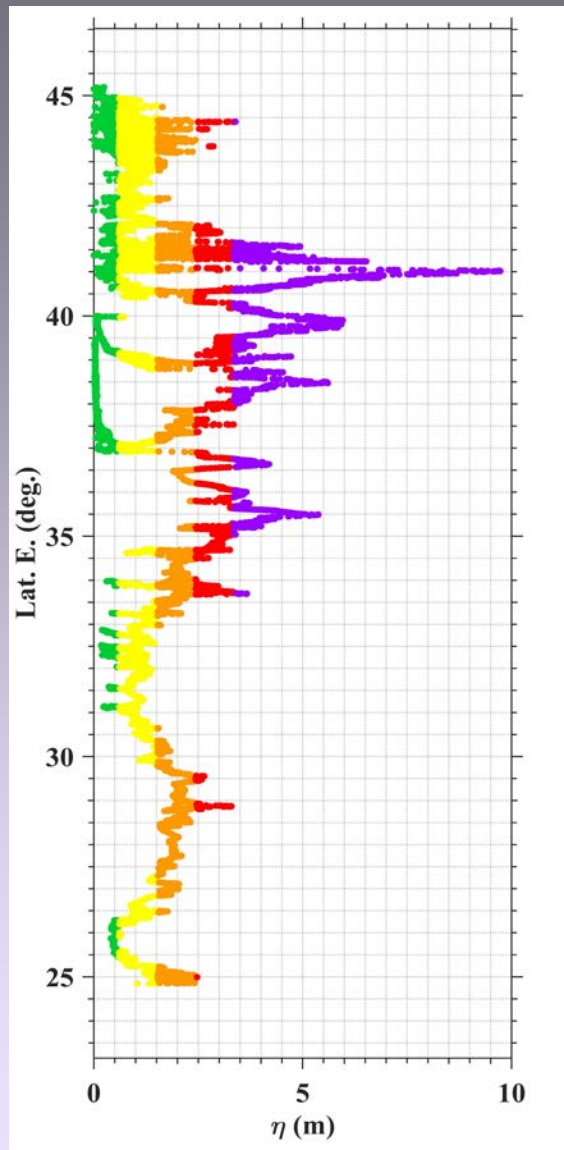
Salt Lake City 08/21/19

FY18 Global regional hazard impact

-> Maximum surface elevation along the 5 m isobath based on tsunami impact for all individual EC sources and for the envelope of all of those

=> Envelope of max. surface elevation

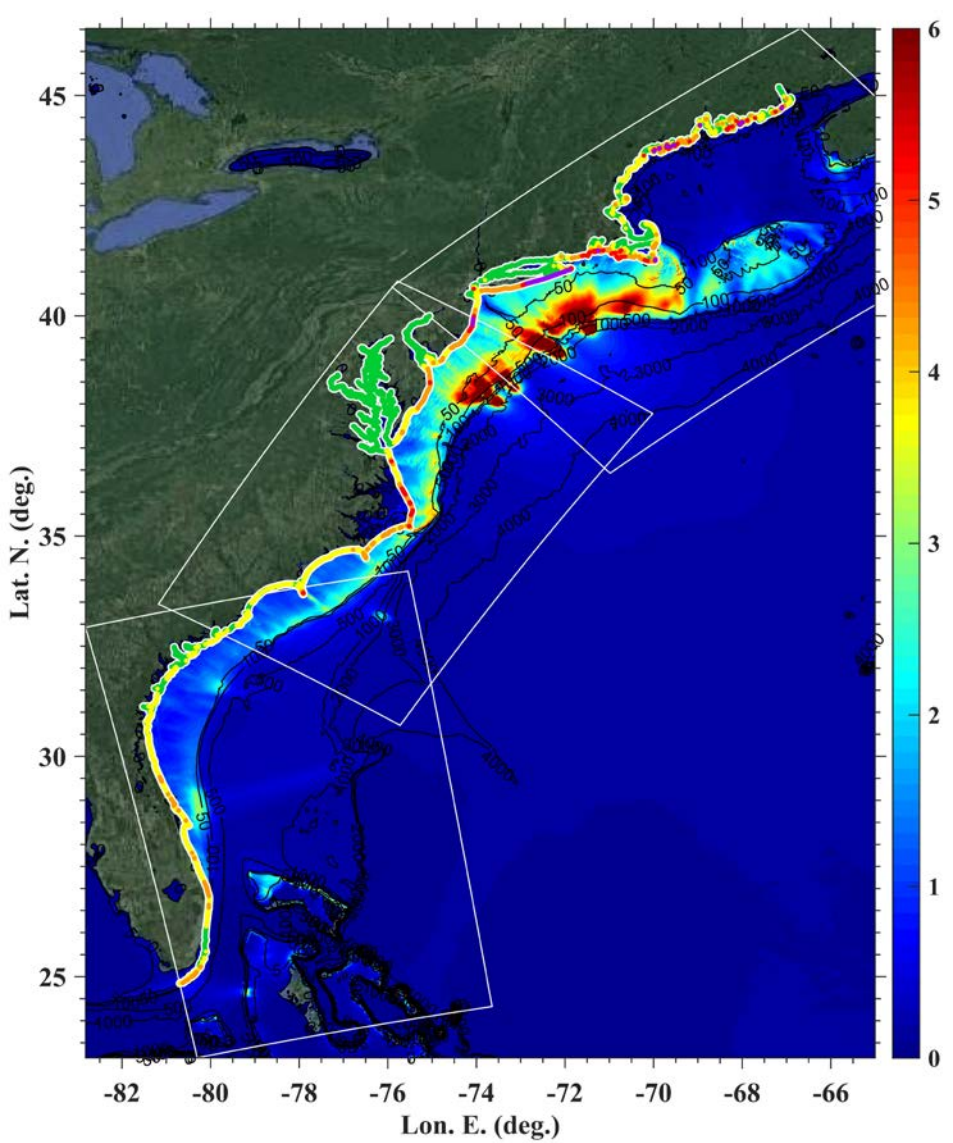


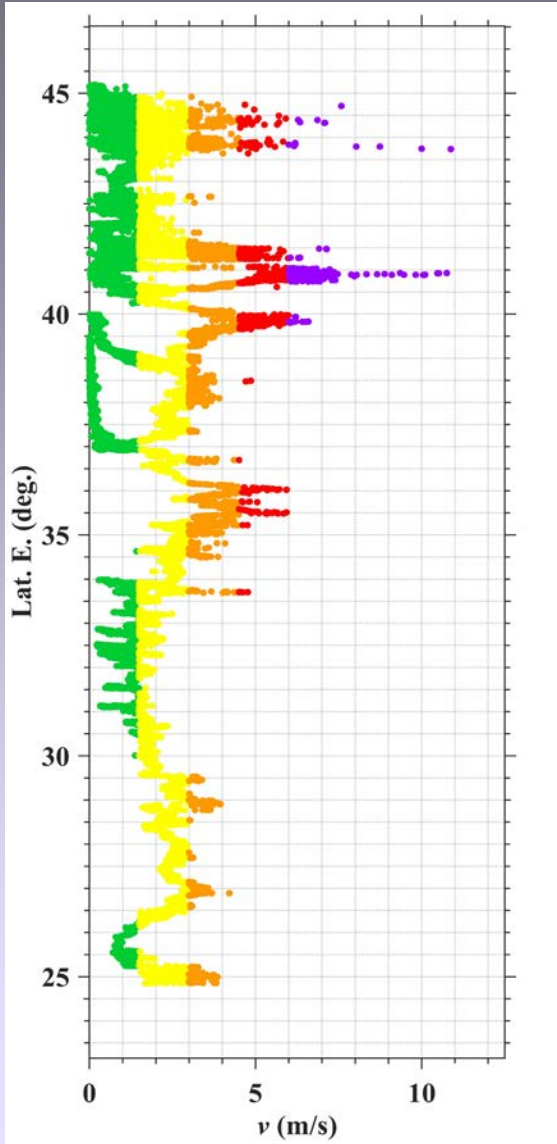


FY18 Global regional hazard impact

-> **Maximum surface elevation** along the 5 m isobath based on impact of all individual EC sources and for the envelope of all of those

=> **Envelope** of max. current velocity



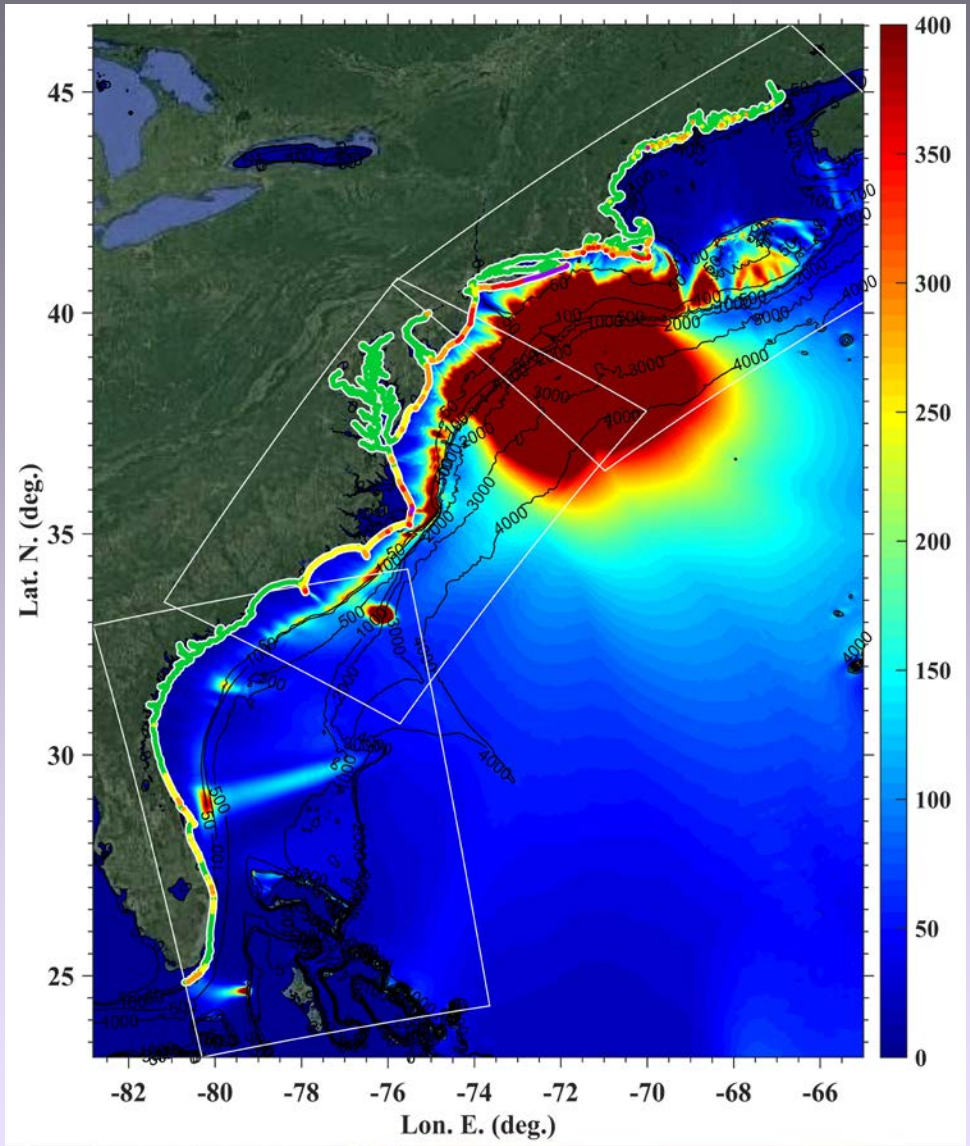


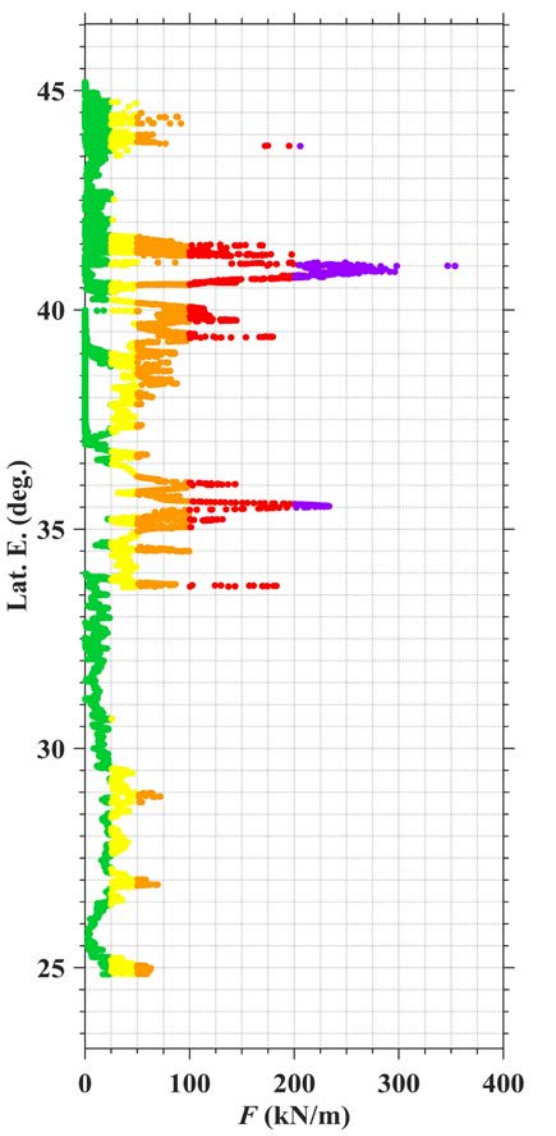
FY18 Global regional hazard impact

-> Maximum surface elevation along the 5 m isobath based on impact of all individual EC sources and for the envelope of all of those

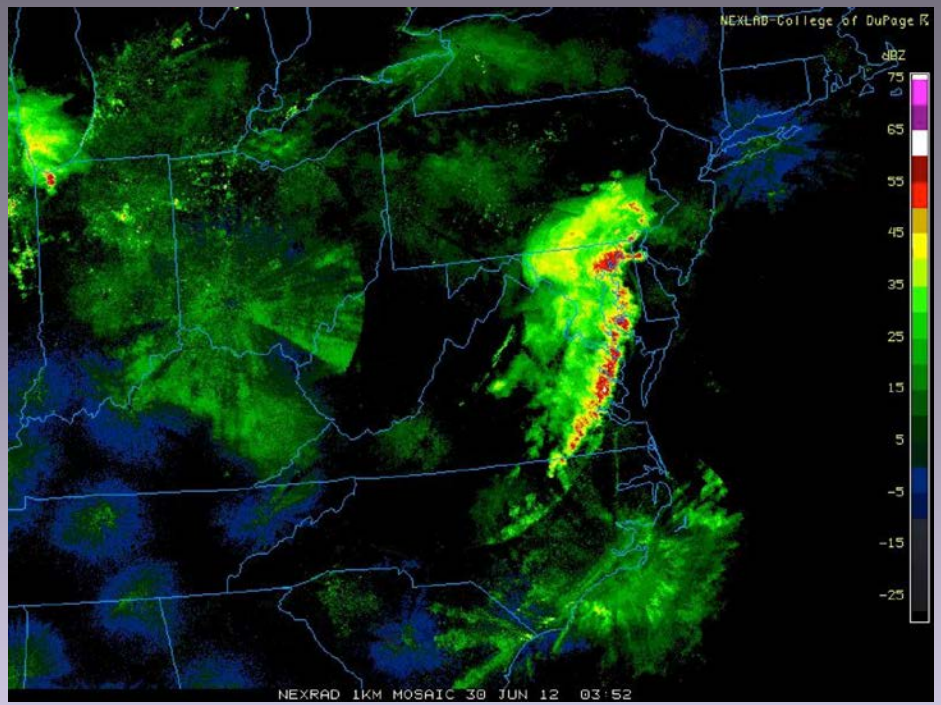
=> Envelope of max. momentum force

(F = density x flow depth x velocity square)

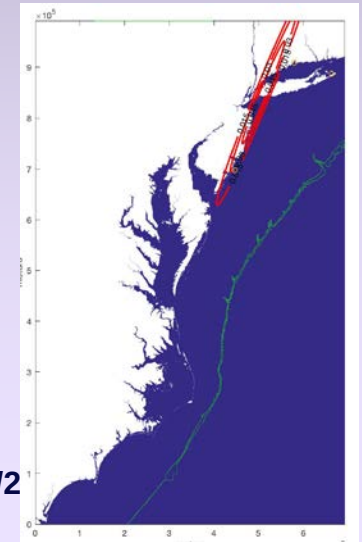


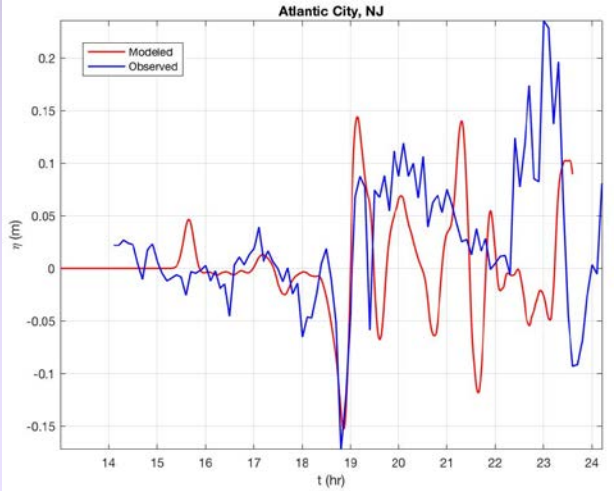


Ongoing work on meteotsunamis



- Mostly caused by *squall lines and derechos* moving E-SE onto the shelf, Frequent in *summer* (Bluestein, 1993)
- Ex: *Radar* for June 13, 2013 EC meteotsunami => **2 m waves** off of NJ
- FUNWAVE modeling (moving pressure)





Future EC work

-> 5-year strategic plan (starts in FY19)

- Assess tsunami impact in HAZUS (see Ed Fratto's earlier talk)
- Produce high-resolution 2nd-generation maps with enhanced products for 2 areas/year (with/without coastal/dune erosion effects)
- Produce enhanced regional hazard maps (Boolean combination of hazard products including arrival time)
- Identify and model a collection of sources/return periods of each type (based on Powell center meetings)
- Develop regional hazard products for meteo-tsunamis (probabilistic approach)

Thank you

NTHMP EC work Webpage:

https://www1.udel.edu/kirby/nthmp.html