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

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NTHMP-19
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.
-> **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)
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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Salt Lake City 08/21/19
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 km³ Currituck SMF proxies (rigid slump/deforming slides) (Grilli et al., 2015; Schambach et al., 2019)
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 km³ 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
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

\[ F = \text{density} \times \text{flow depth} \times \text{velocity square} \]
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