Development of Probabilistic Tsunami Hazard Maps for ASCE 7-16

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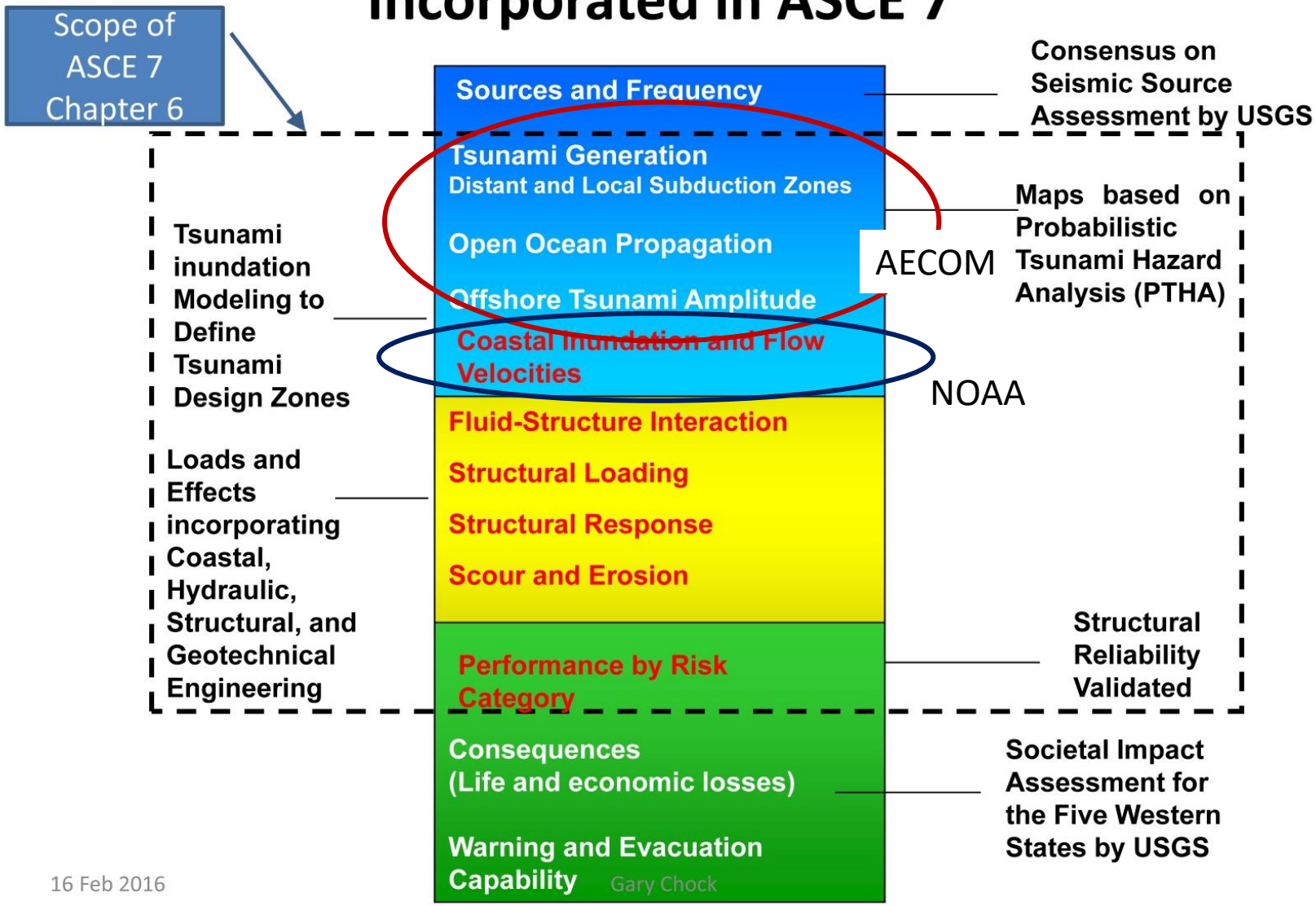
Tsunami-Resilient Engineering Subject Matter Incorporated in ASCE 7

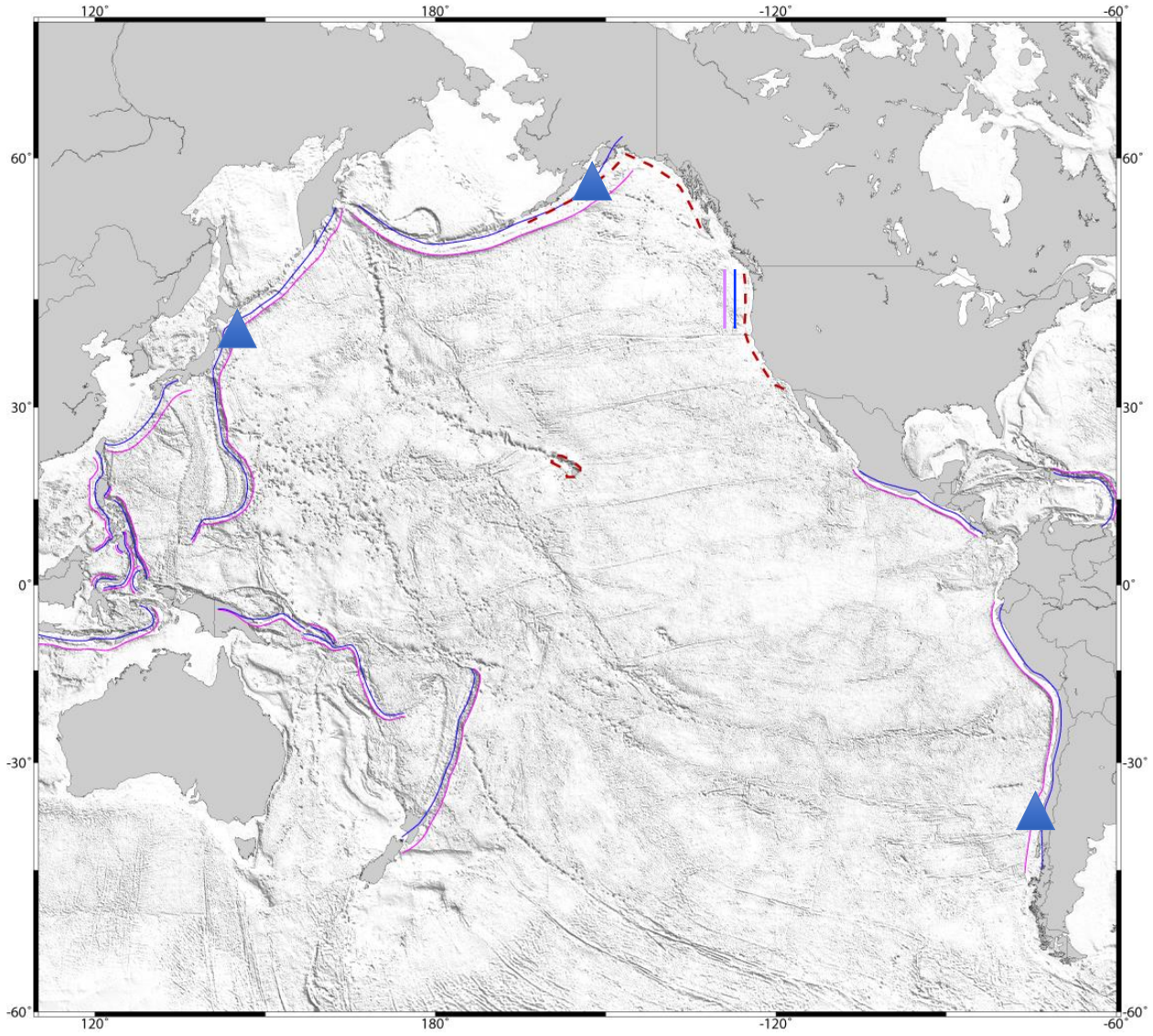


16 Feb 2016

Probabilistic Tsunami Hazard Analysis

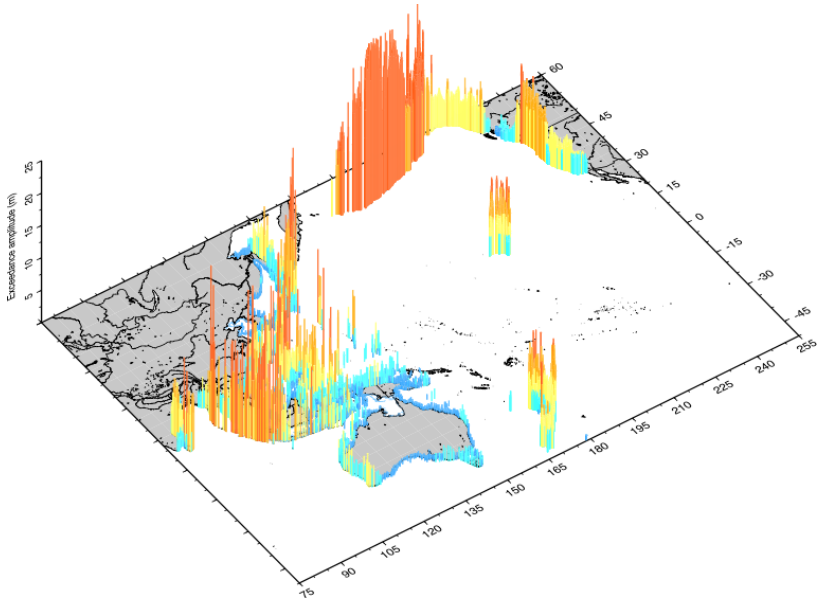
- Probabilistic hazard analysis that is consistent with other hazards (especially earthquake) in its philosophy, approach and model parameters
  - Consistency with USGS NSHMP models as much as possible
- Full consideration of epistemic (knowledge) uncertainties and aleatory (natural) variability
- A probabilistic analysis therefore not only addresses the statistical variability in Earth's processes, but also alternative opinions on how the Earth works

Source regions included in ASCE 7-16



AECOM tsunami hazard studies:

- ASCE 7-16
- AASHTO
- 2015 Global Assessment of Risk (UN-ISDR)
- National tsunami hazard map for Indonesia
- National tsunami map for Australia
- National tsunami map for Israel
- SOPAC (Worldbank)
- etc.

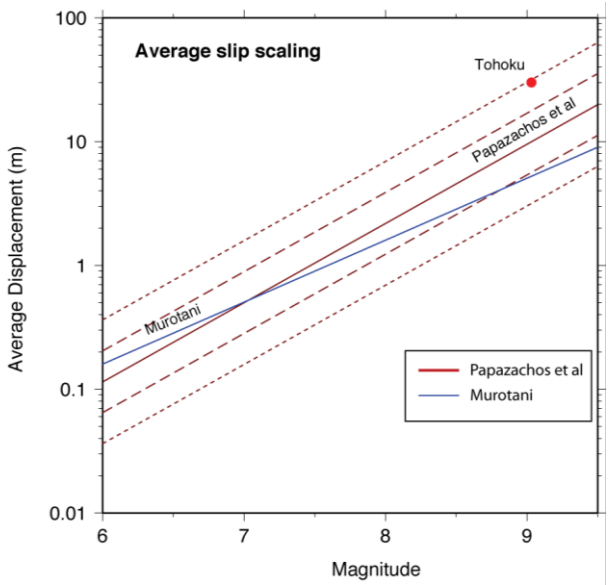


Cascadia subduction zone

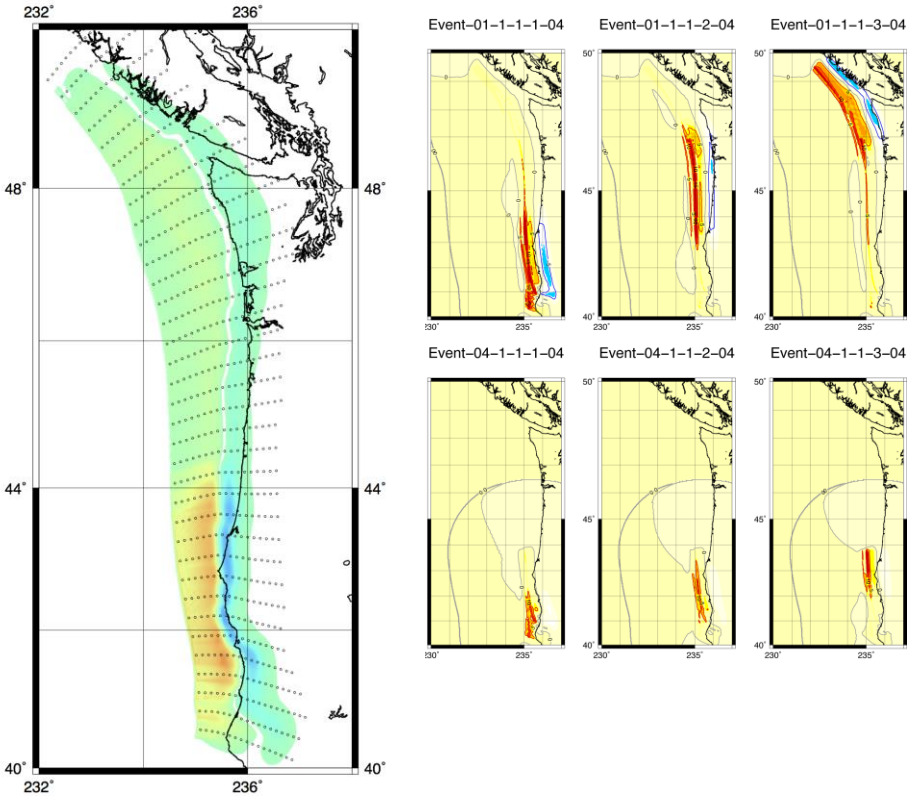
- No direct observations for earthquakes and tsunami
  - Only recognized in the 1980's as a subduction zone
  - Big issue for structural designs pre-dating the 1980's
- Therefore large gap in knowledge (epistemic uncertainty), which needs to be considered in the hazard model
- Gaps in source-specific data are filled with global data (also standard practice in seismic hazard analysis)

Natural (aleatory) variability at the source

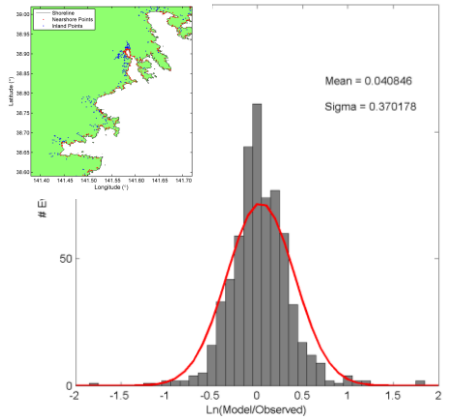
Earthquake scaling



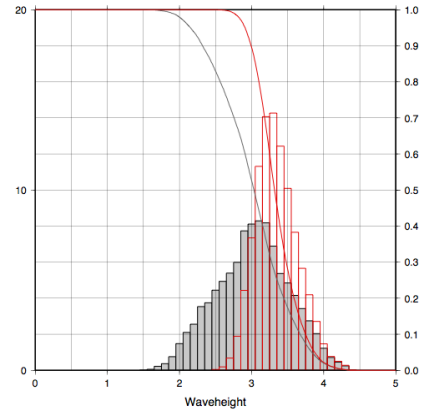
Variable slip



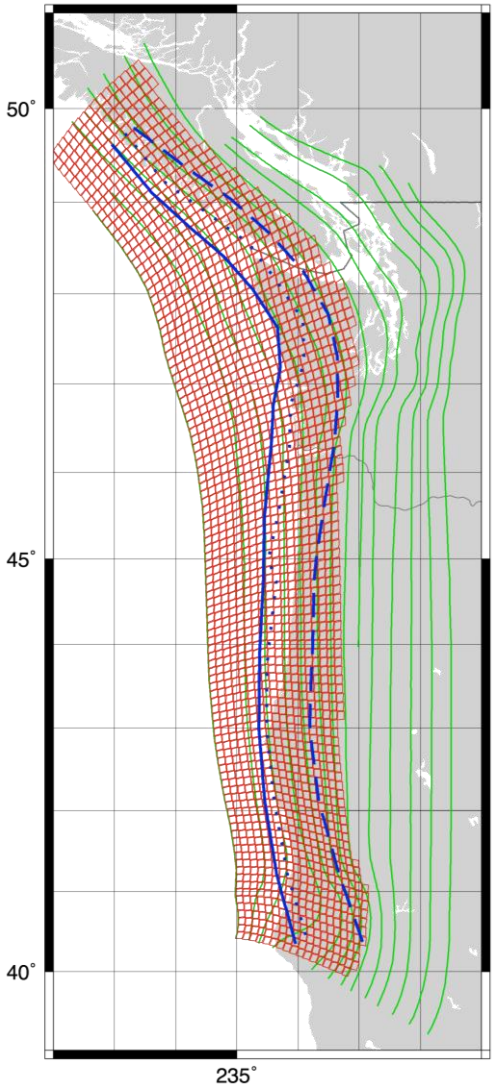
Modeling “error”

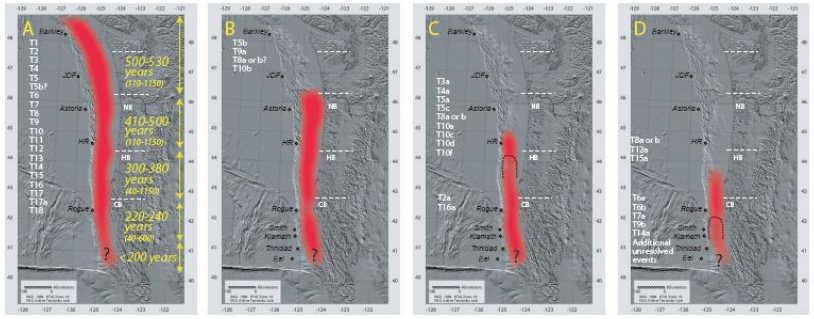


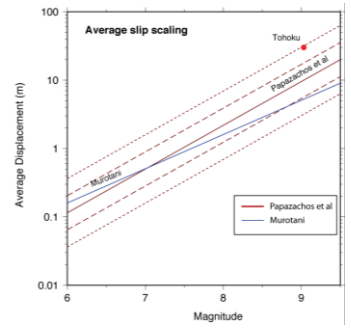
Tides

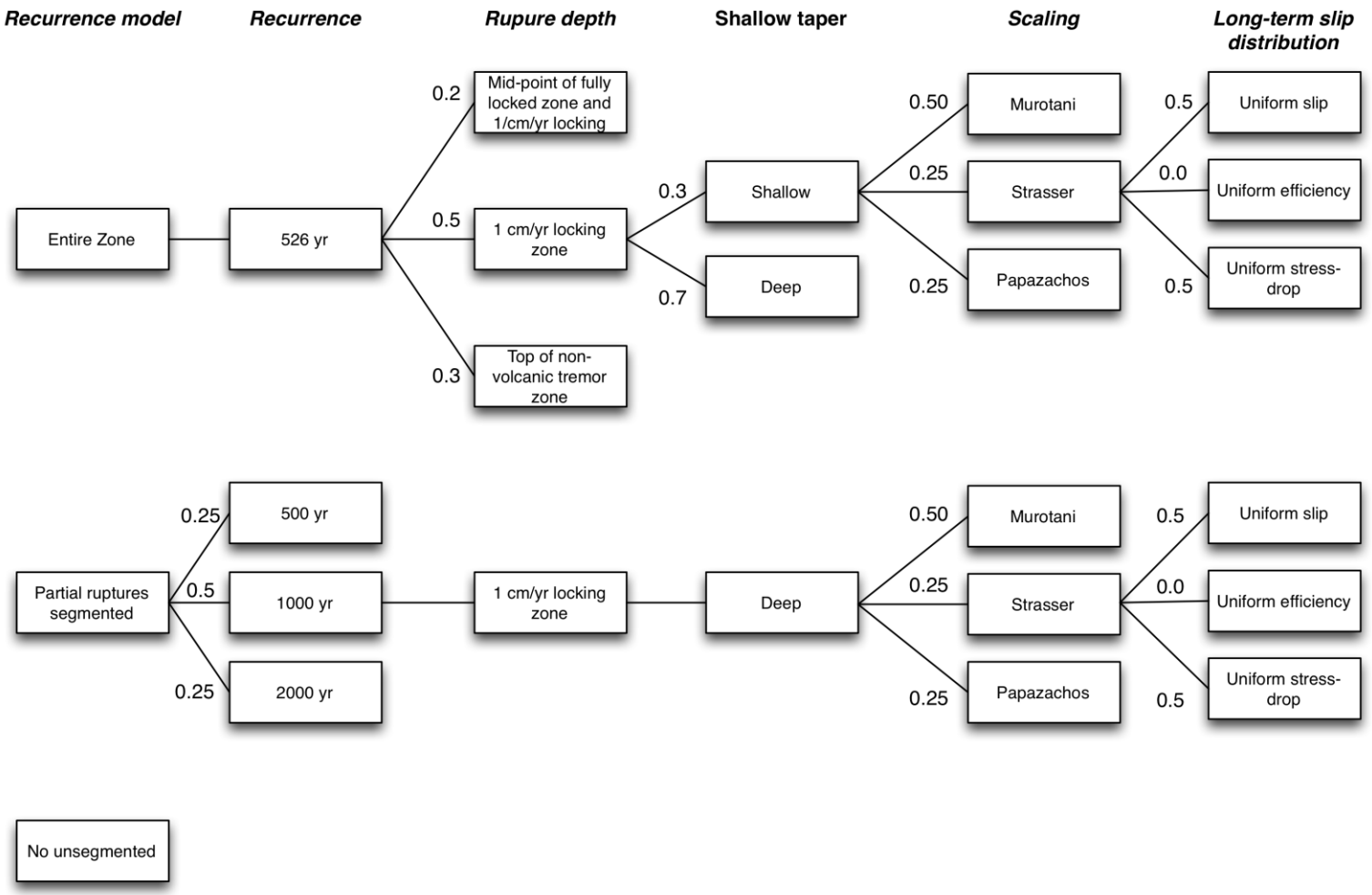


Knowledge (Epistemic) uncertainty





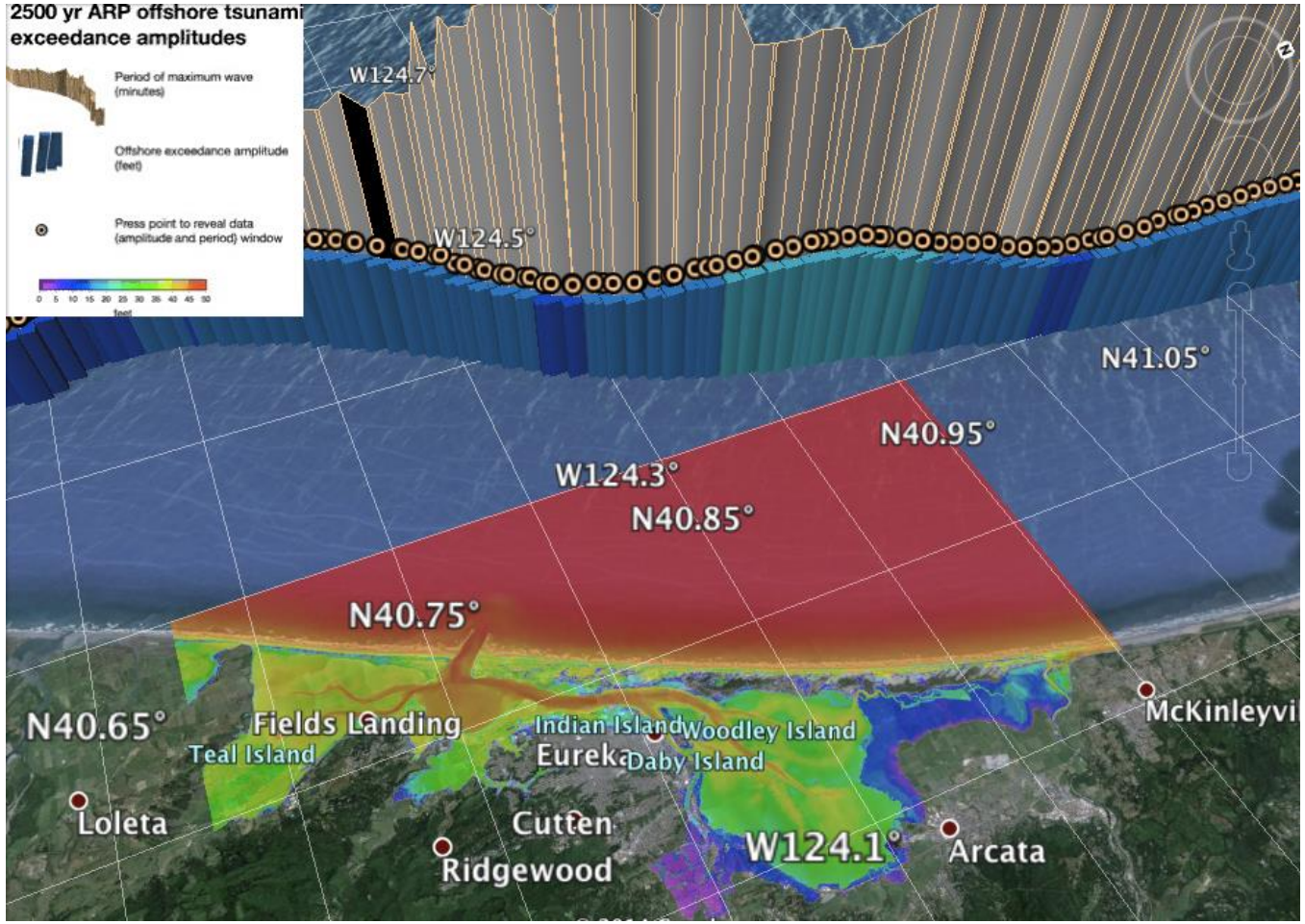


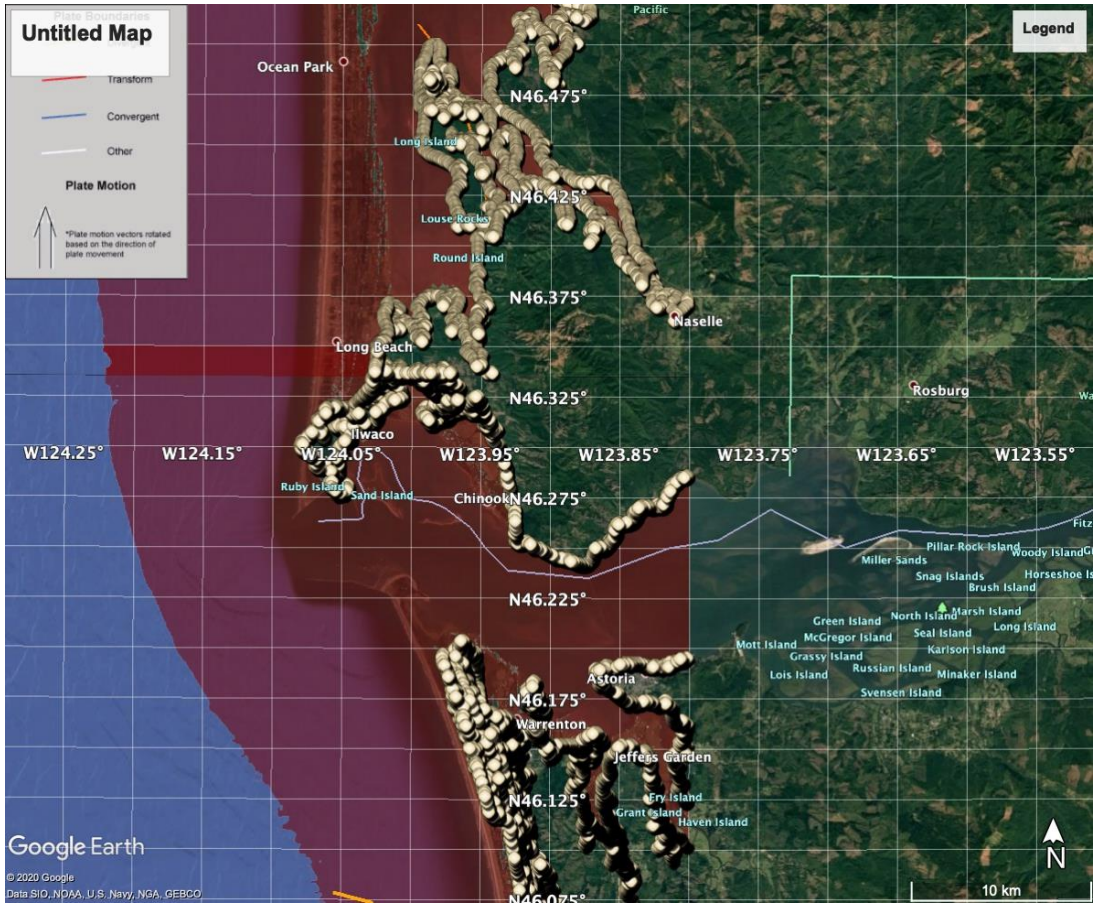


Development of Inundation Maps

- Offshore hazard based on circum-Pacific subduction zone earthquakes – AECOM
  - Source characterization (geometry, recurrence relations) follows USGS 2014 model for Cascadia, home-grown models for other subduction zones
  - Also used for probabilistic subsidence maps
- Process ran concurrent with CA tsunami hazard mapping program
  - Included expert review (USGS, CGS, USC)
- 60m inundation zones (including runup line) for most of the Pacific coastlines – NOAA PMEL
  - Consistent with the offshore hazard
  - Uses pre-existing NOAA source geometry

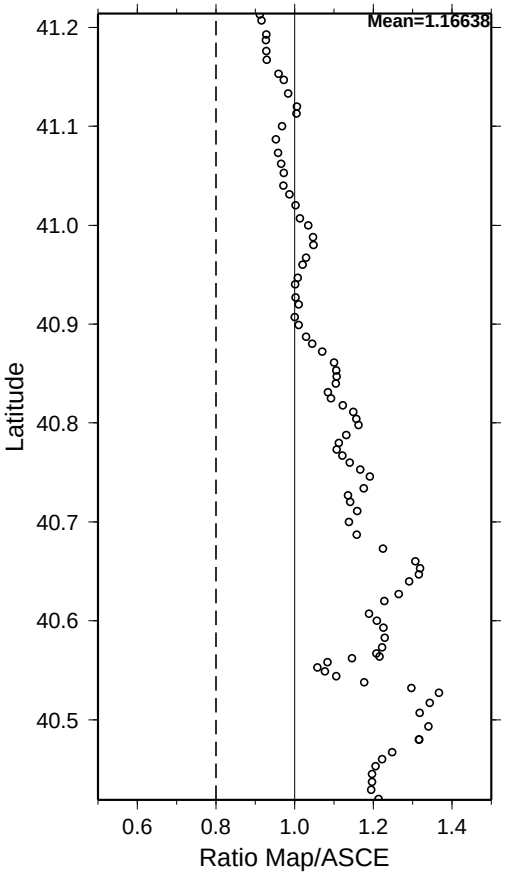
Inundation mapping



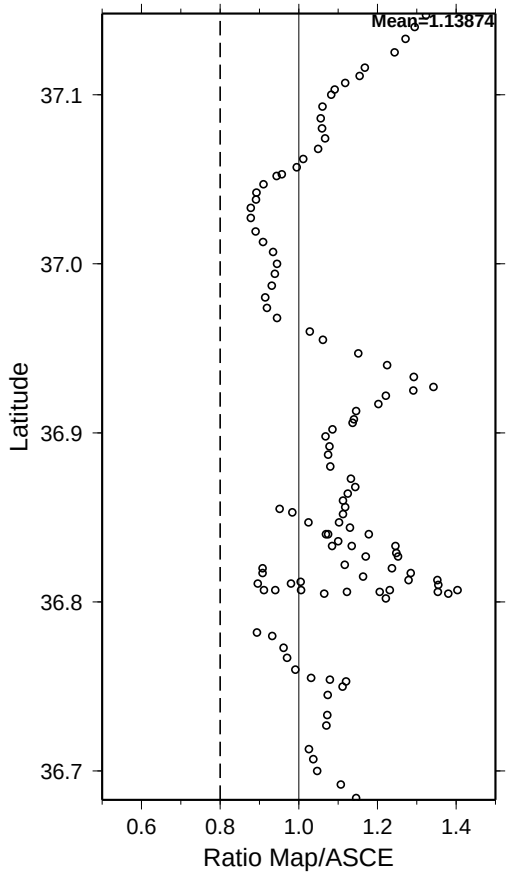


Offshore match to ASCE 7-16

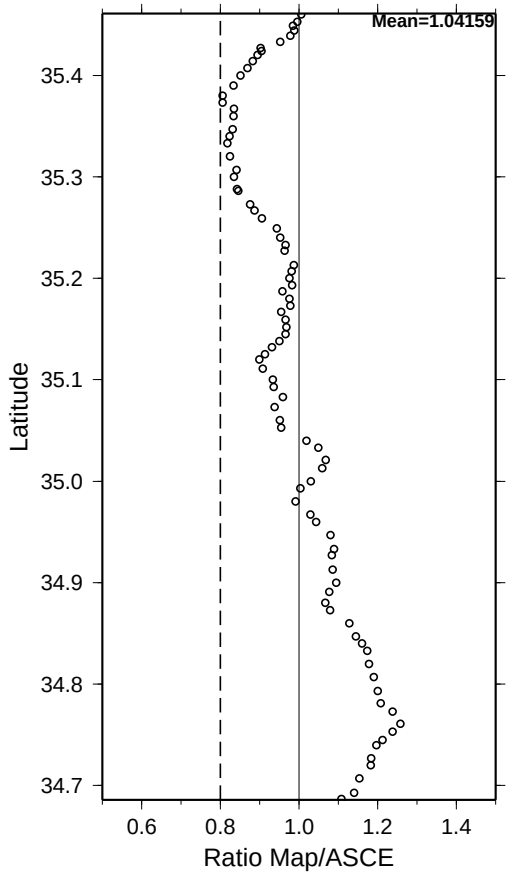
07_Humboldt_Bay



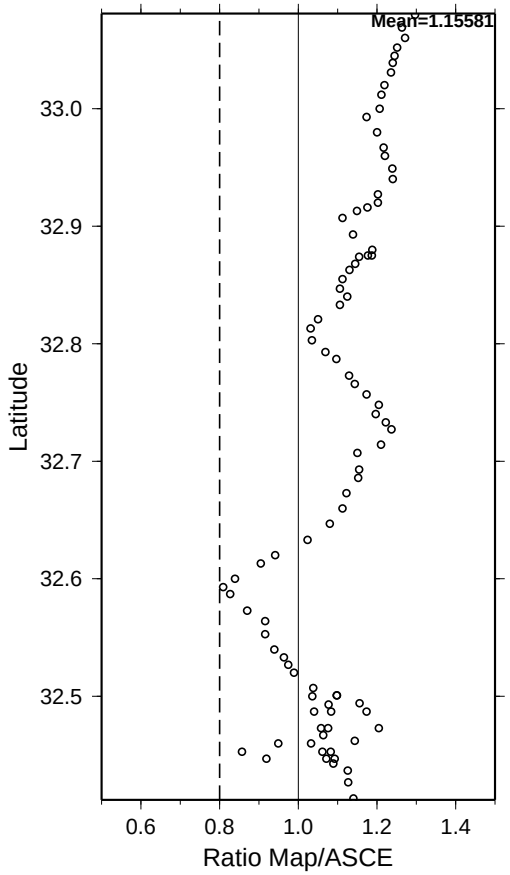
22_Santa_Cruz



34_Avila_Beach

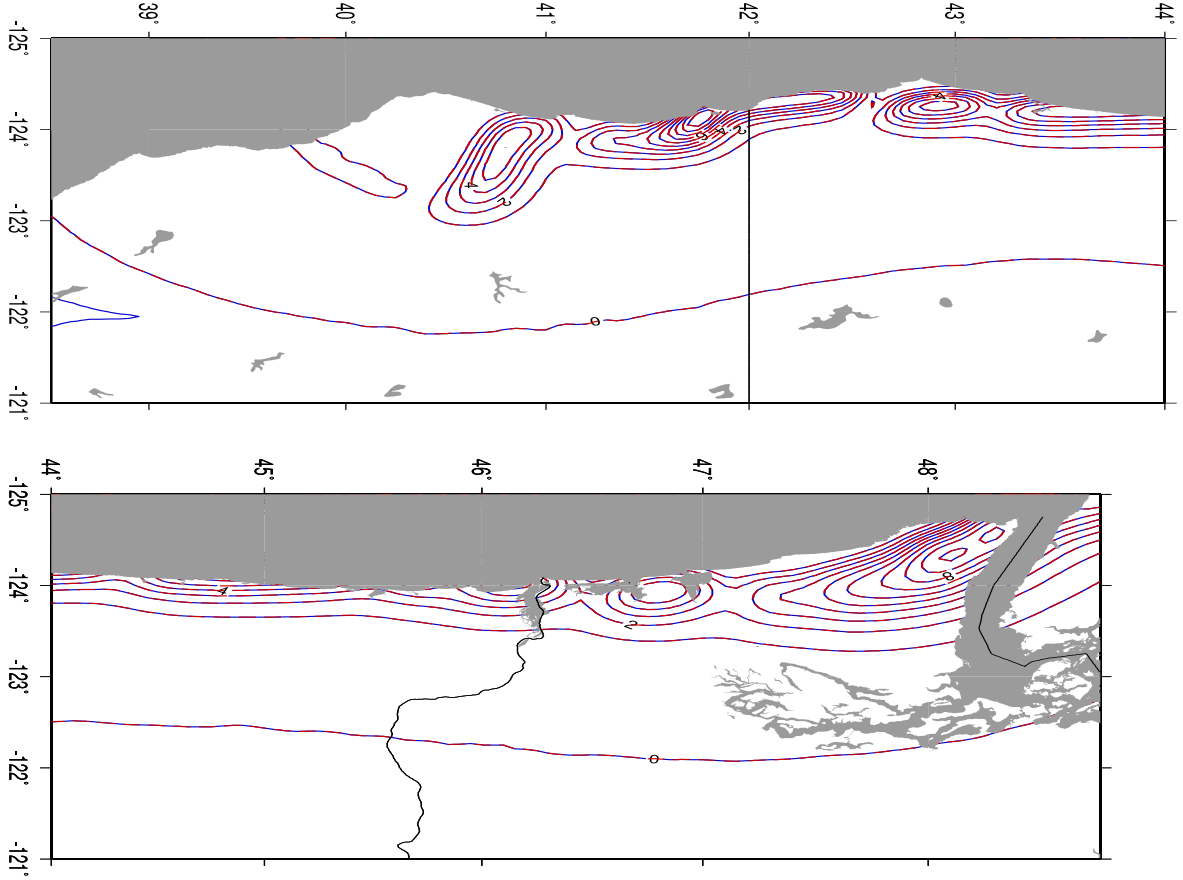


62_San_Diego

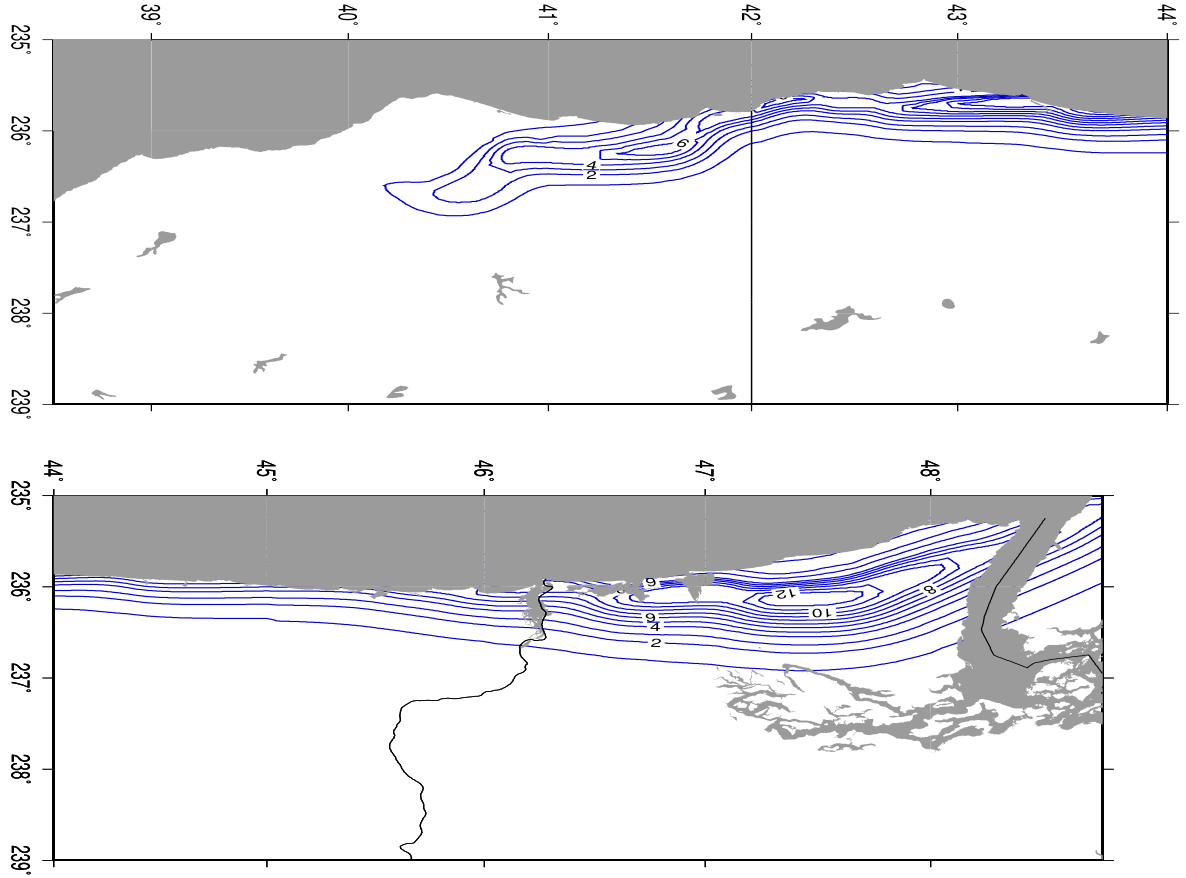


Interim (ASCE 7-22) improvements

7-16



7-22 proposed



Further room for improvement? Yes….

- Any hazard analysis represents a “snap-shot” of the current state of knowledge
  - Fix shortcomings in model (e.g. splay faulting)
  - Range of epistemic uncertainty will (hopefully) decrease
  - More local data -> better site-specific constraints
- Use a community-based approach to develop a consensus model
  - Consensus model recognizes and quantifies differences in opinion
  - e.g. Powell Center, USGS NSHMP, CA and OR workshops
- Take advantage of computational and other improvements
- Lengthy process, will have to start preparing the process for 7-28

Tsunami history