Devastation after the 2011 M_W 9.1 Tōhoku, Japan tsunami (images courtesy of creativecommons.org & AP)

In Preparation for the Next Megathrust Cascadia Earthquake and Tsunami

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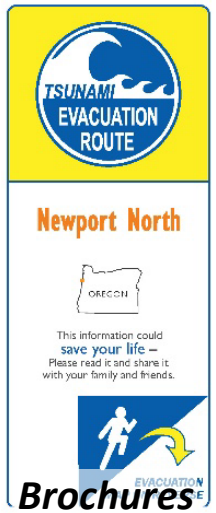
Oregon Department of Geology and Mineral Industries

"DOGAMI provides earth science information and regulation to make Oregon safe and prosperous"

DOGAMI Roles and Responsibilities

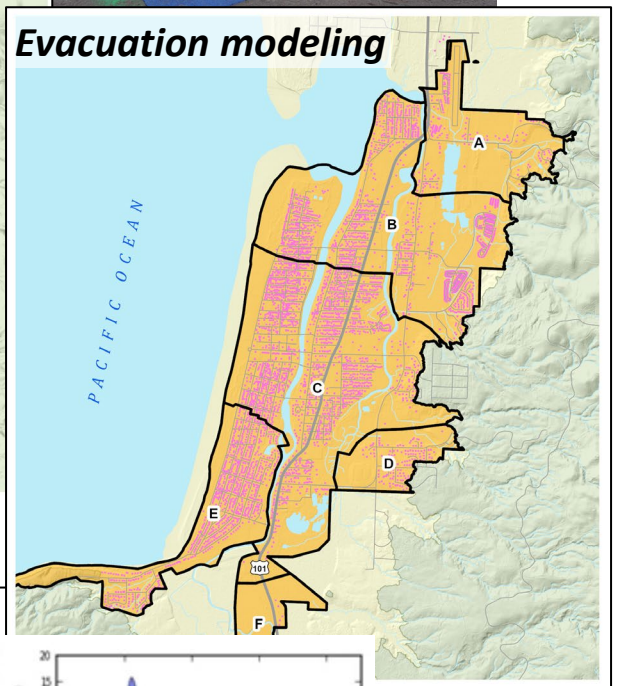
- NTHMP reps: Tsunami science (DOGAMI) , E&O (OEM)
- Mapping, modeling, product development
- Help facilitate Oregon Tsunami Advisory Committee discussions (e.g., review potential map changes)
- Participating with ASCE tsunami loads committee
- Tsunami hazard science representative in response to a tsunami threat



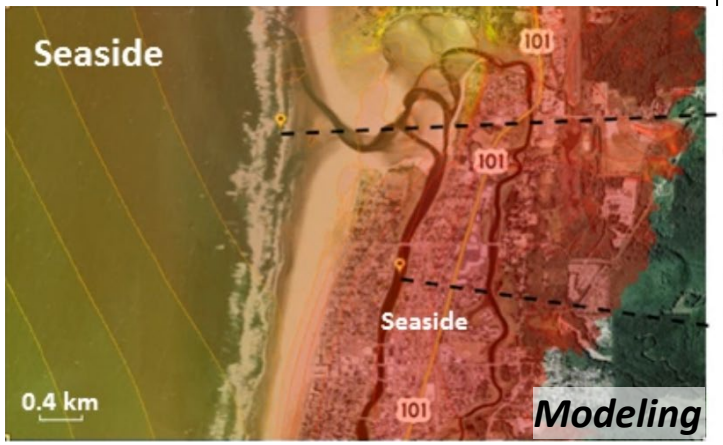
Brochures

Risk assessments

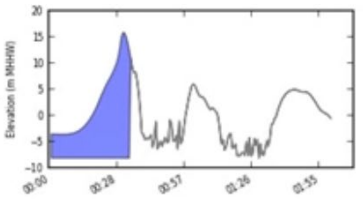
Wayfinding



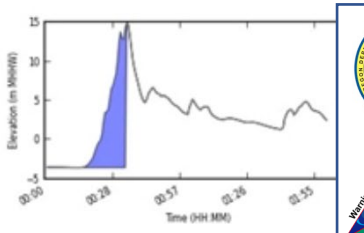
Evacuation modeling



Modeling



Zone	Permanent	Temporary
A	482	84
B	1,784	2,398
C	2,860	4,590
D	325	12
E	808	2,203
F	7	225

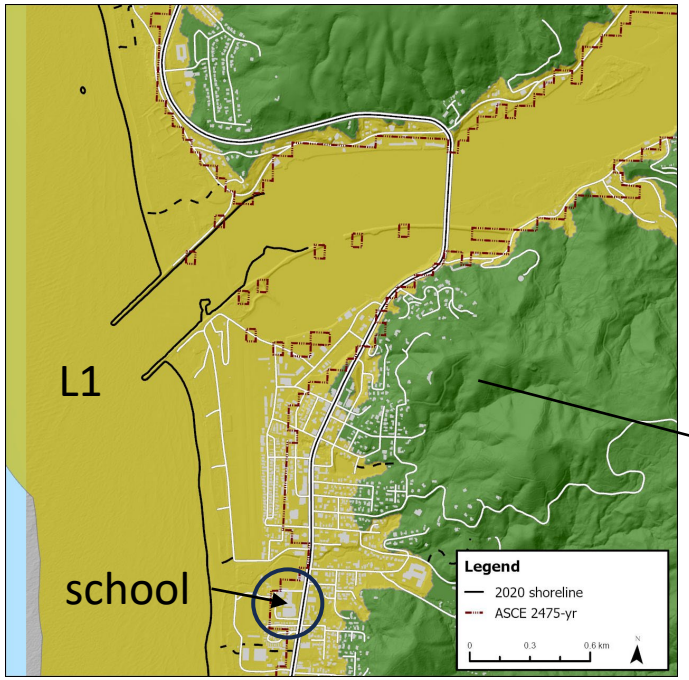


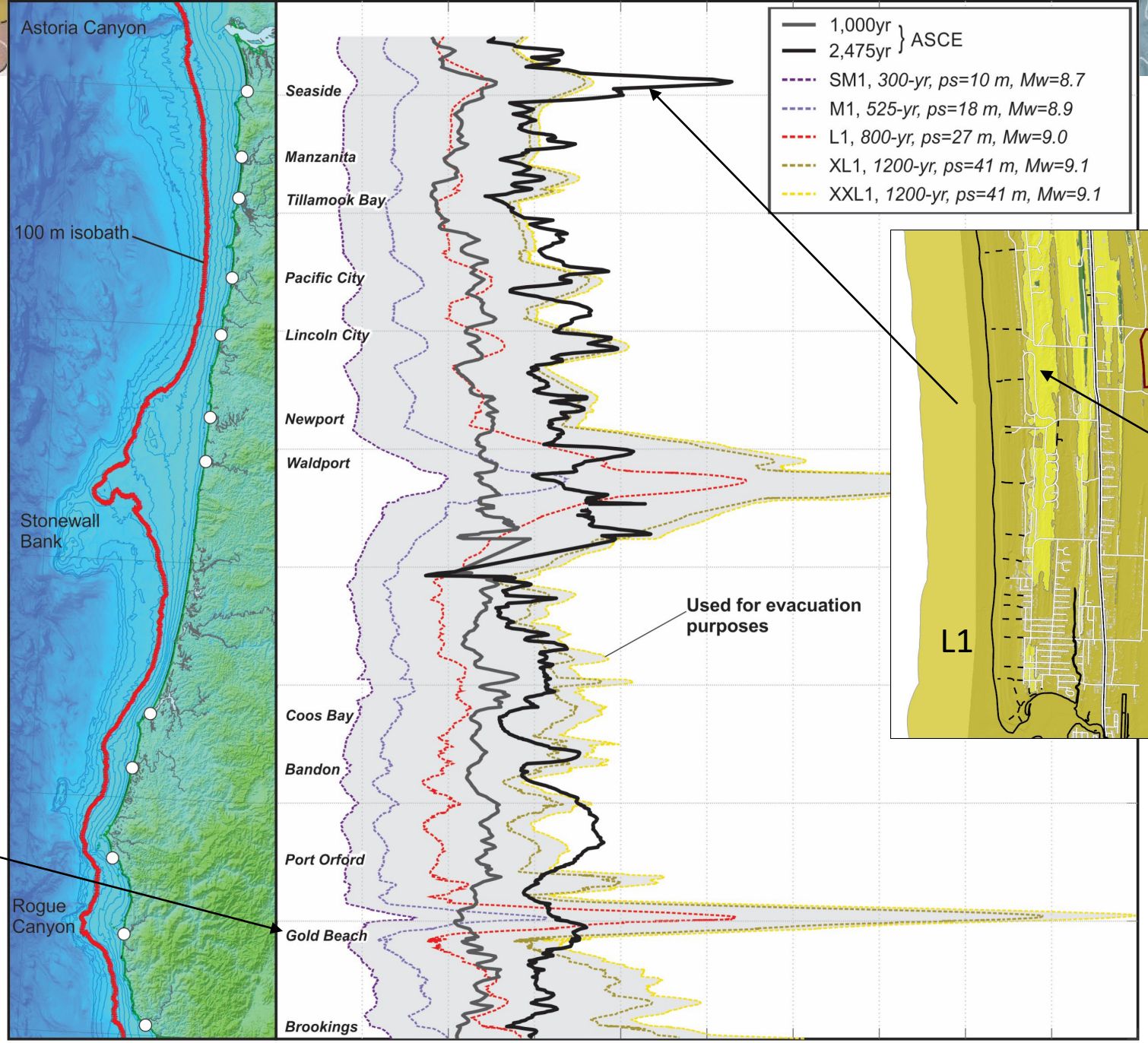
Oregon Tsunami History

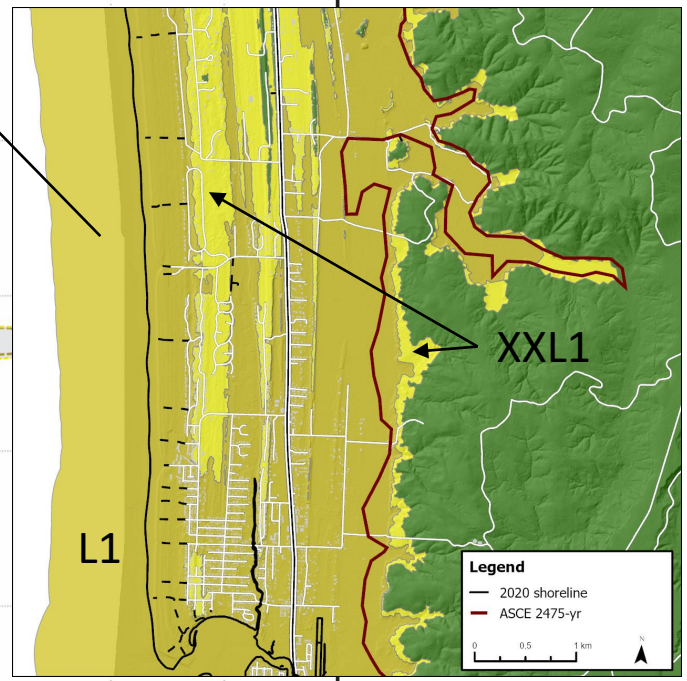
- ***1995:*** first tsunami inundation maps for the Oregon coast (*Priest, 1995*)
- ***1995:*** SB379 tsunami regulatory line adopts Priest (1995) maps; ORS 455.446 & 455.467 limits construction of new essential facilities and special occupancy structures in tsunami flooding zones
- ***1996***: NTHMP is formed (collaboration between NOAA & five western states). Goals: *produce evacuation maps and implement a tsunami warning system*
- ***1997 – 2007***: *first generation* detailed tsunami maps produced for 12 communities
- ***2009:*** second generation mapping begins. Pilot study at Cannon Beach (*Priest et al., 2009*) and Bandon (*Witter et al., 2011*). State adopts 5 local CSZ sources (SM, M, L, XL, XXL) & 2 distant (AK64, Akmax)
- ***2010 – 2013:*** *Second generation* modeling initiated. Results reviewed by Oregon TAC and communities Two-zone maps adopted for evacuation planning (distant (AKmax) and local (XXL))
- ***2011:*** NTHMP tsunami inundation benchmarking workshop (*Horrillo et al., 2015*)
- ***2013:*** second generation mapping is completed (evacuation maps produced for entire Oregon coast)
- ***2016:*** NTHMP tsunami currents benchmarking workshop (*Lynett et al., 2017*)
- ***2017:*** ASCE7-16 tsunami loads chapter (tsunami design guidance for various *risk category* buildings, adopted 2,475-yr tsunami design zone for the five western states). ***ASCE updates occur on a 6-year cycle***
- ***2020:*** OR HB 3305 repeals SB379 (building of critical facilities in the tsunami zone briefly allowed)
- ***2021:*** OR HB 2605 passed. BCD adopts ASCE TDZ and tsunami design guidance. However, BCD makes it 'optional' for communities to enforce tsunami design requirements
- ***2023:*** NTHMP debris/sediment transport benchmarking workshops (*Lynett et al., in prep; Kirby et al., in prep*)
- ***2024 – 2028:*** OR/WA update ASCE7-16 2,475-yr TDZ. New Cascadia PTHA developed - adoption in 2028

Existing PTHA (ASCE7-16) versus DOGAMI modeling

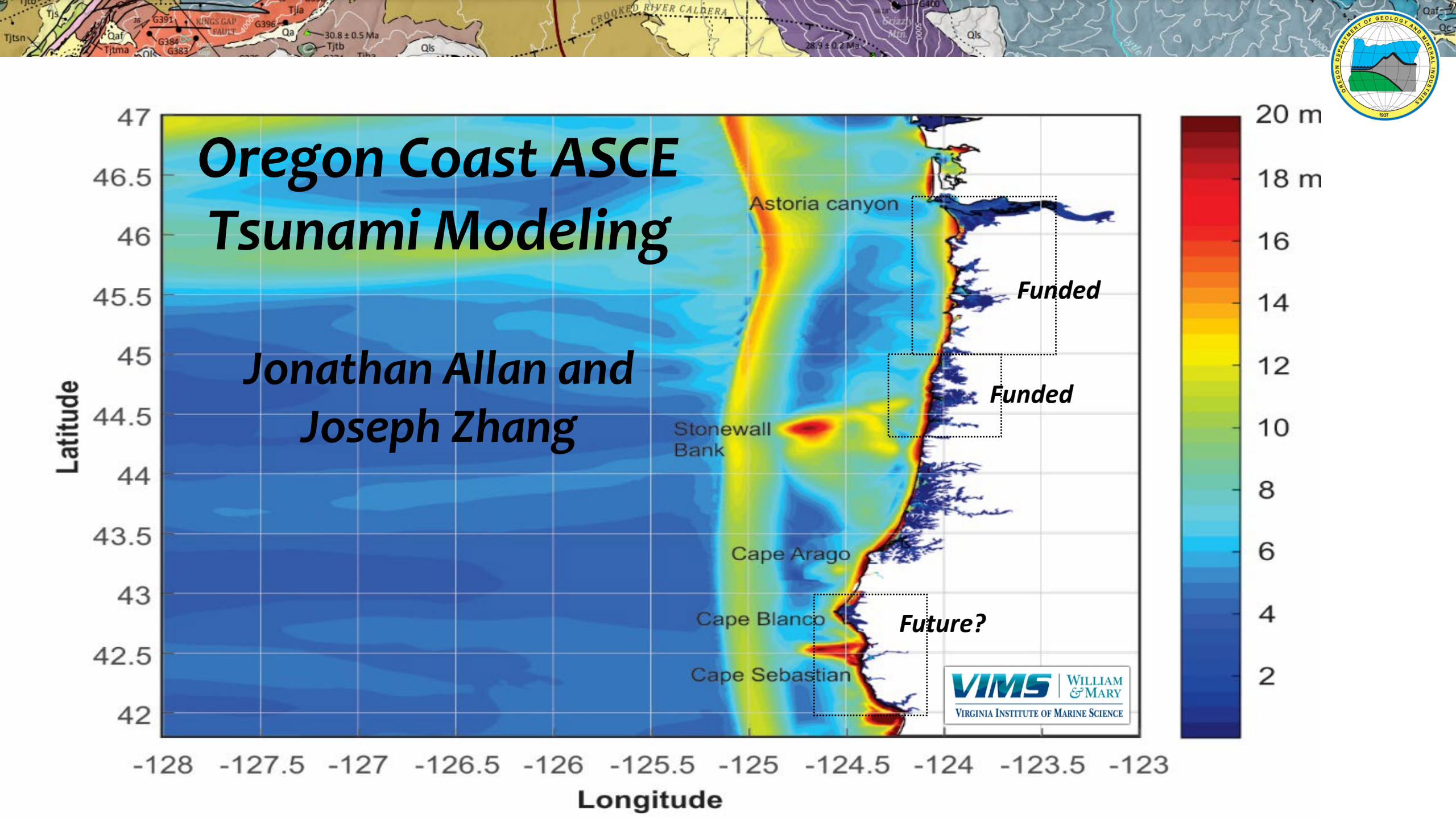
Notes:
ASCE 1,000-yr closest to L1
ASCE 2,475-yr closest to XL1







(Thio, 2017; Wei et al, 2017)


Oregon Coast ASCE
Tsunami Modeling
Jonathan Allan and
Joseph Zhang
Astoria canyon
Stonewall
Bank
Cape Arago
Cape Blanco
Cape Sebastian
Funded
Funded
Future?
VIMS | William & Mary
Virginia Institute of Marine Science
Latitude
Longitude
47
46.5
46
45.5
45
44.5
44
43.5
43
42.5
42
-128
-127.5
-127
-126.5
-126
-125.5
-125
-124.5
-124
-123.5
-123
20 m
18 m
16
14
12
10
8
6
4
2

Oregon coast ASCE7-28 2,475-year Inundation Modeling: *Clatsop, Tillamook and Lincoln Counties*.

Why?

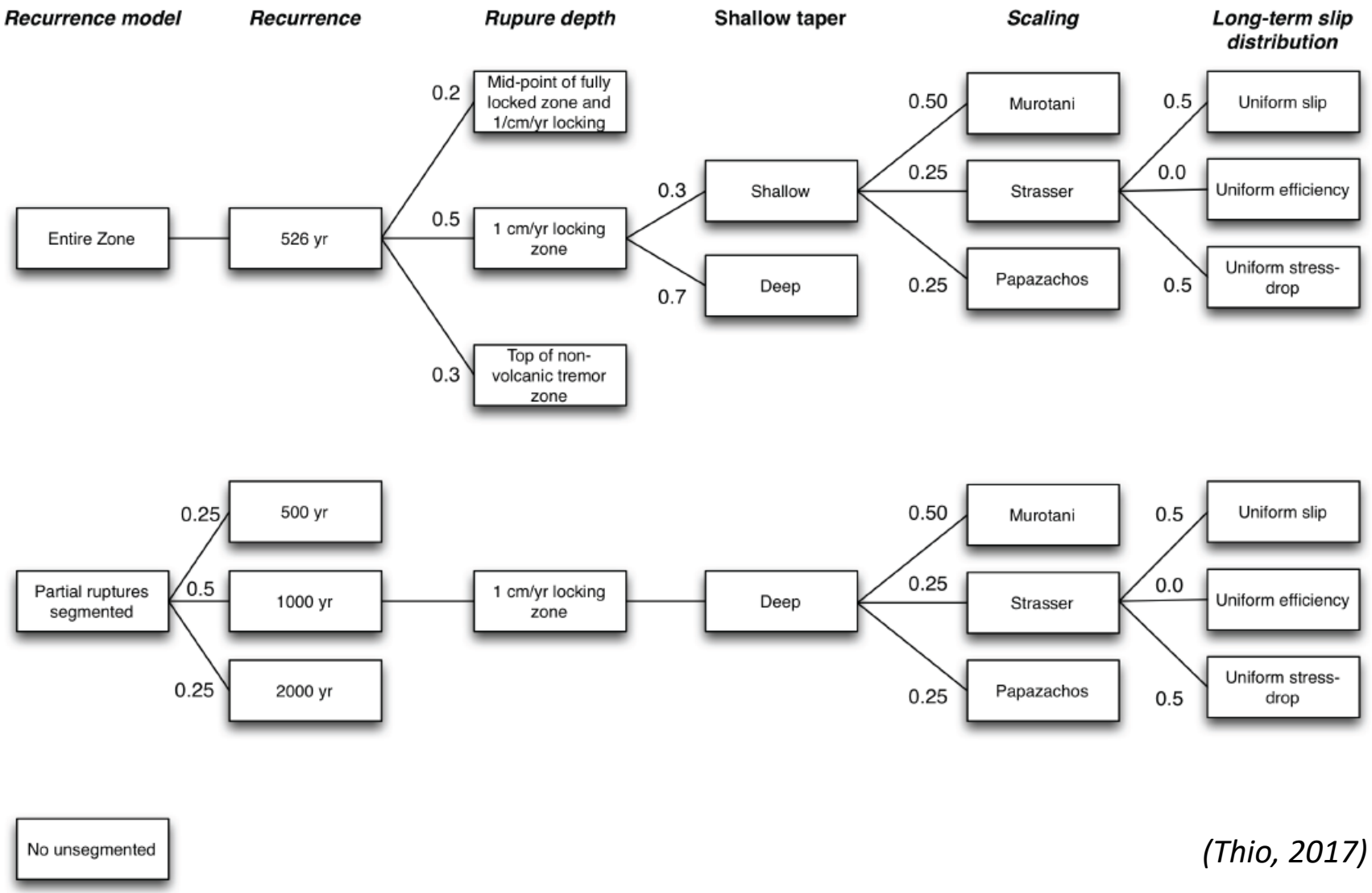
- **Improvements to coastal DEMs (Carignan et al., 2019; 2021; 2022; Lim et al., 2024)**
- **Refinements to Cascadia sources, e.g., USGS Powell Center workshop, (05/2022), Sypus and Wang (2024)**
  - **New CASIE21 seismic imaging data (*Carbotte et al., 2022; Canales, et al., 2023*) → refinements to the fault zone geometry (dip, fault depth) and earthquake rupture types:**
    - **Modified splay model constrained by new seismic data (*Ledeczi et al., 2024*)**
    - **Tohoku type trench breaching scenario included (guided by new seismic data)**
    - **Buried rupture models and floating slip models**
- **Original inundation modeling used 60 m grids (we will use ≤ 10 m model grids).**

Phase 1 – New Cascadia EQ deformation models (Sypus and Wang, 2024)
Phase 2 – North Oregon Coast tsunami PTHA modeling (underway)
} NTHMP supported

***Future* – Simulate suite of tsunami inundation scenarios that would allow for developing PTHA hazard curves on land.**

2016 Logic Tree for Probabilistic Hazard Assessments

ASCE 7-16 Cascadia probabilistic tsunami hazard model (***limited community input***)



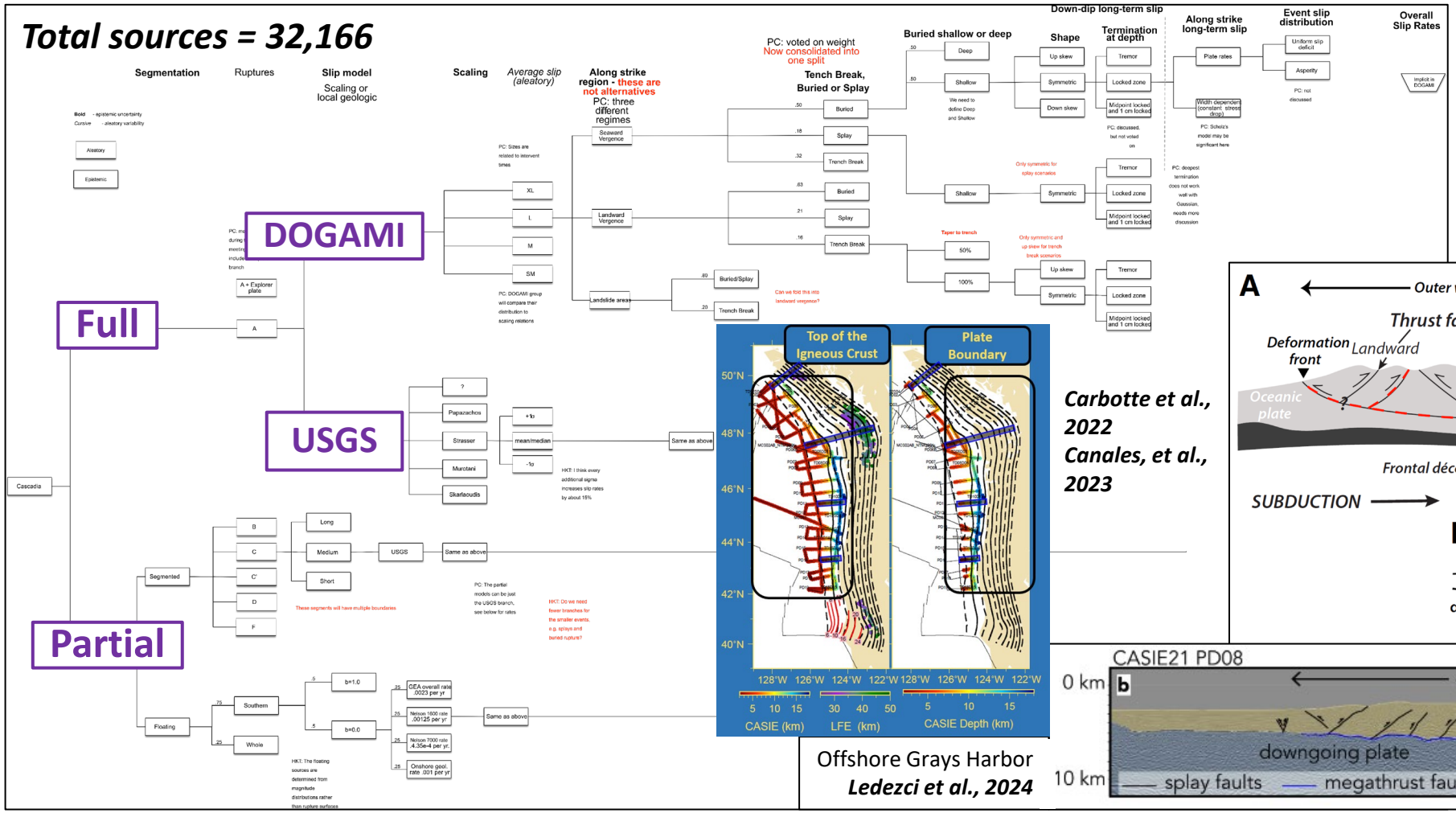
Total sources = 729

(Thio, 2017)

2024 Logic Tree for Probabilistic Hazard Assessments

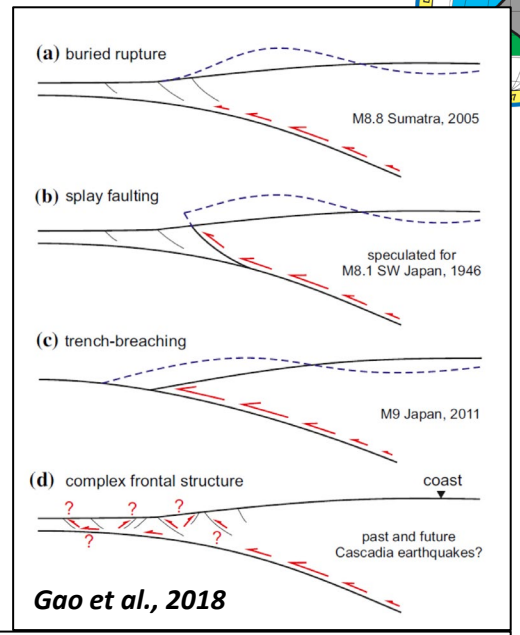
- Updated Cascadia probabilistic tsunami hazard model (***extensive community input***)
- Revised offshore (100 m) 2,475-yr tsunami amplitudes near completion for Cascadia
  (next cycle for adoption is 2028)

Patton et al., in prep

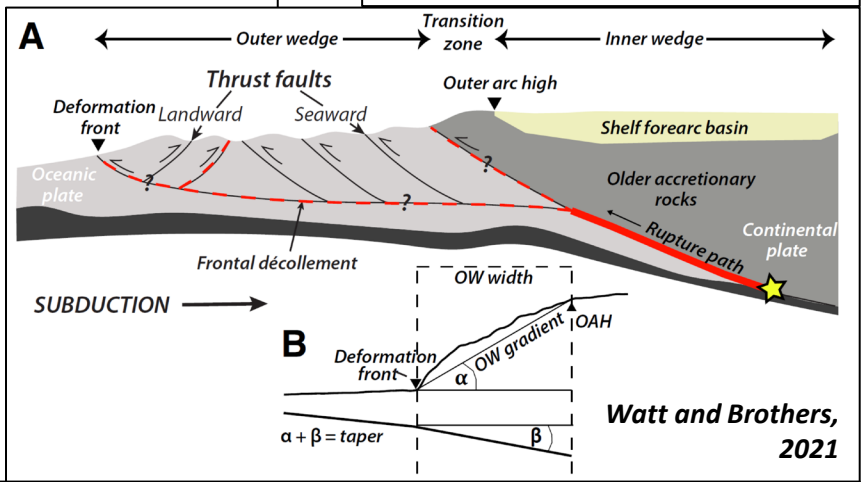


Carbotte et al., 2022
Canales, et al., 2023

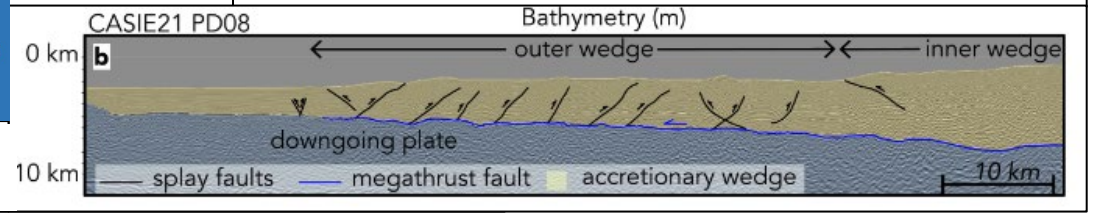
Offshore Grays Harbor
Ledezci et al., 2024



Gao et al., 2018



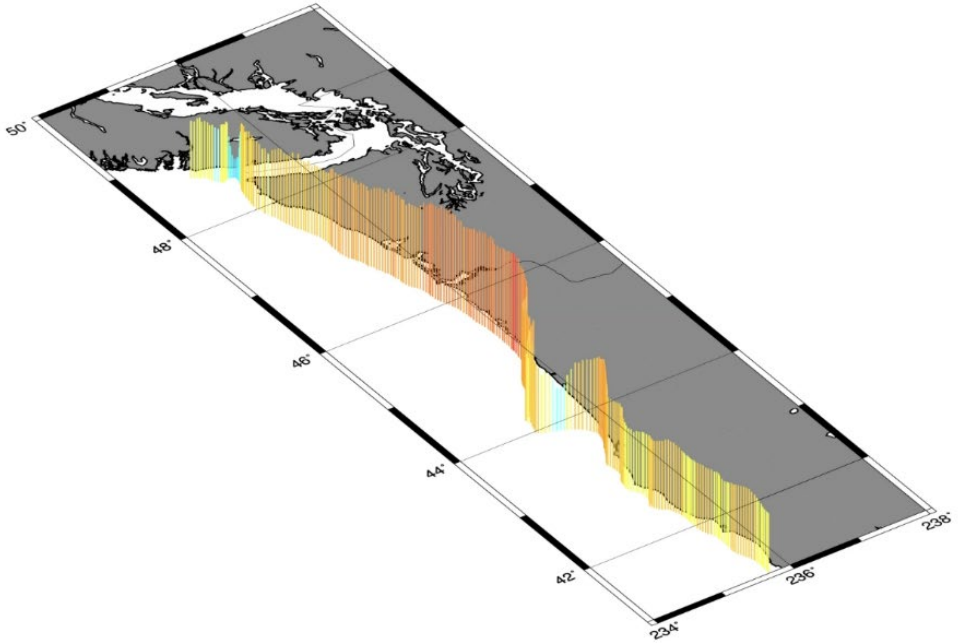
Watt and Brothers, 2021



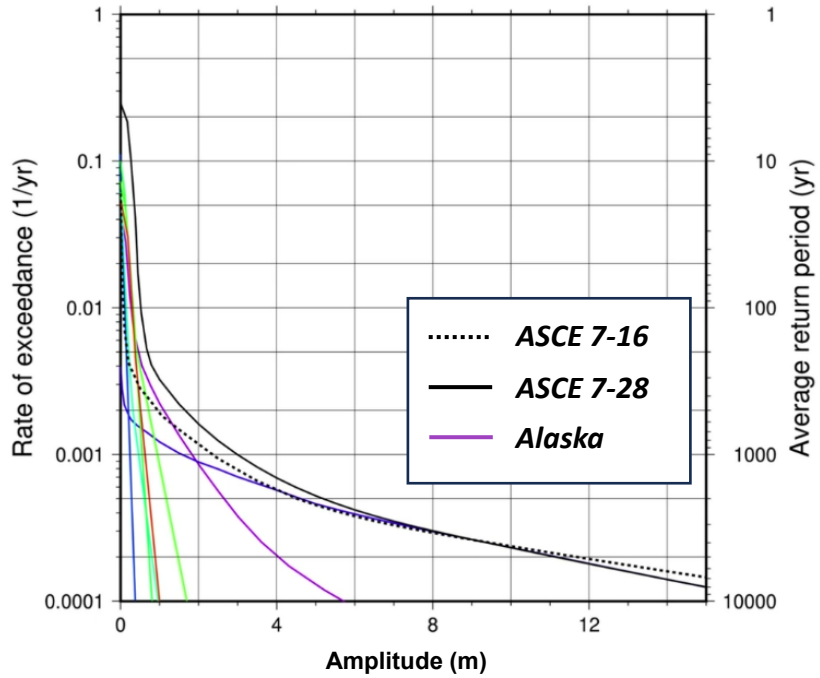
Probabilistic Tsunami Hazard Analysis (Thio, in prep)

- (*left*) Revised offshore (~100 m) 2,475-yr tsunami amplitudes for Cascadia *(scheduled for adoption by ASCE in 2028)*
- (*right*) Example offshore hazard curve developed for single location

ASCE 7-28 Offshore hazard for Cascadia



Comparison between 7-16 and 7-28 hazard curves



Needs…

1. Recast existing Oregon Cascadia sources into a probabilistic framework – ***underway***
2. Better constraints on paleoseismology (recurrence) and coseismic responses – ***Powell Center, CRESCENT, Copes Hub***
3. Tsunami modeling that accounts for the erosion of dunes due to tsunami waves and currents (**initial NTHMP benchmarking undertaken in 2023**)
4. Understanding future tsunami inundation models in the face of a changing climate (i.e., SLR)
5. Integration of onshore seismic hazard modeling with tsunami modeling
6. Better integration of multihazard effects (liquefaction, landslides, erosion)