The CRESCENT Dynamic Rupture, Earthquake Cycle, and Tsunamis Working Group (DET)

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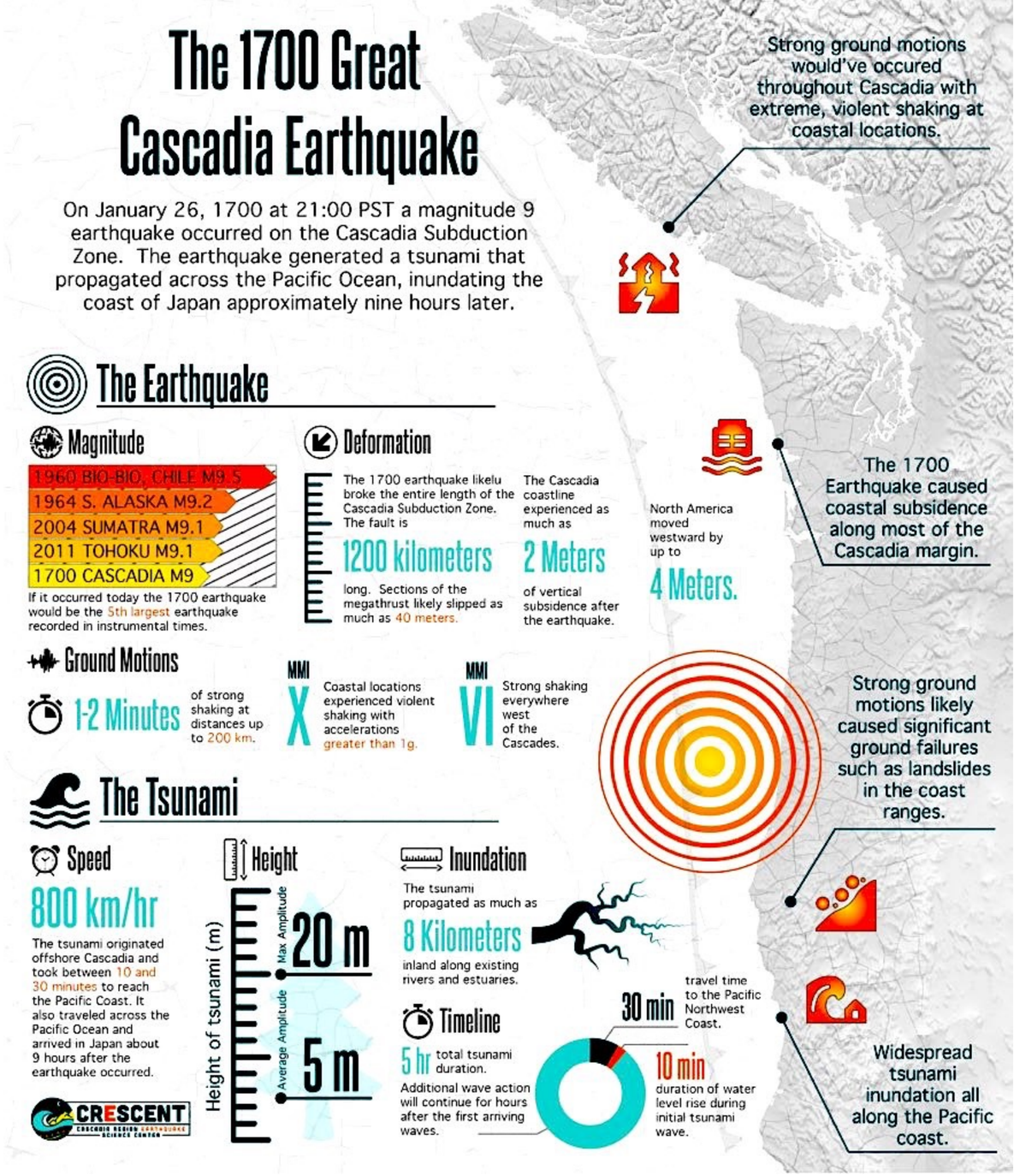
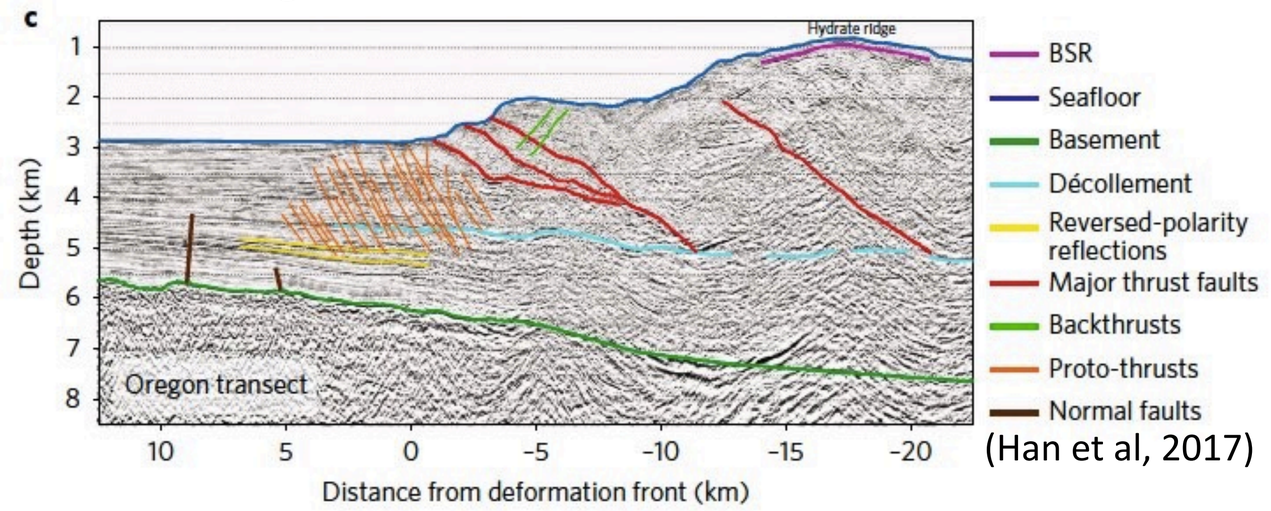


Infographic from https://cascadiaquakes.org/

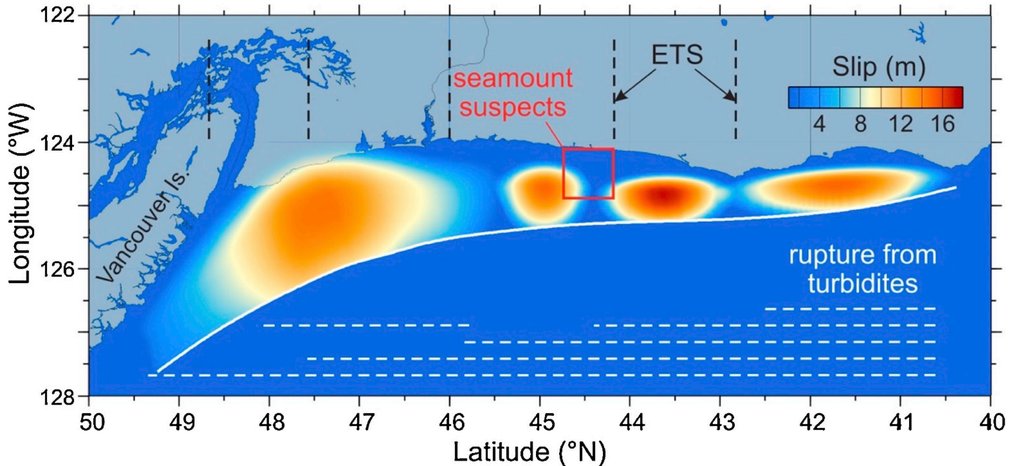
Motivating science questions

Shallow rupture behavior, splays and yielding and tsunami generation



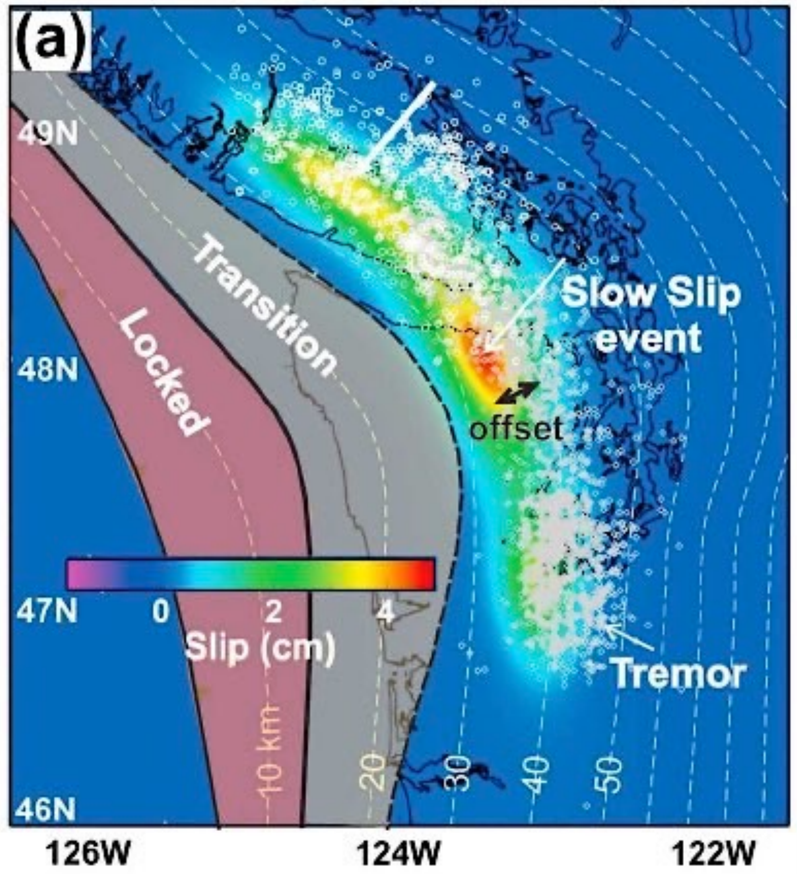
(Han et al, 2017)

Controls on along-strike variations, segmentation and rupture extend



(Wang & Tréhu, 2016)

Relation between megathrust ruptures, transition zone, slow slip & tremors



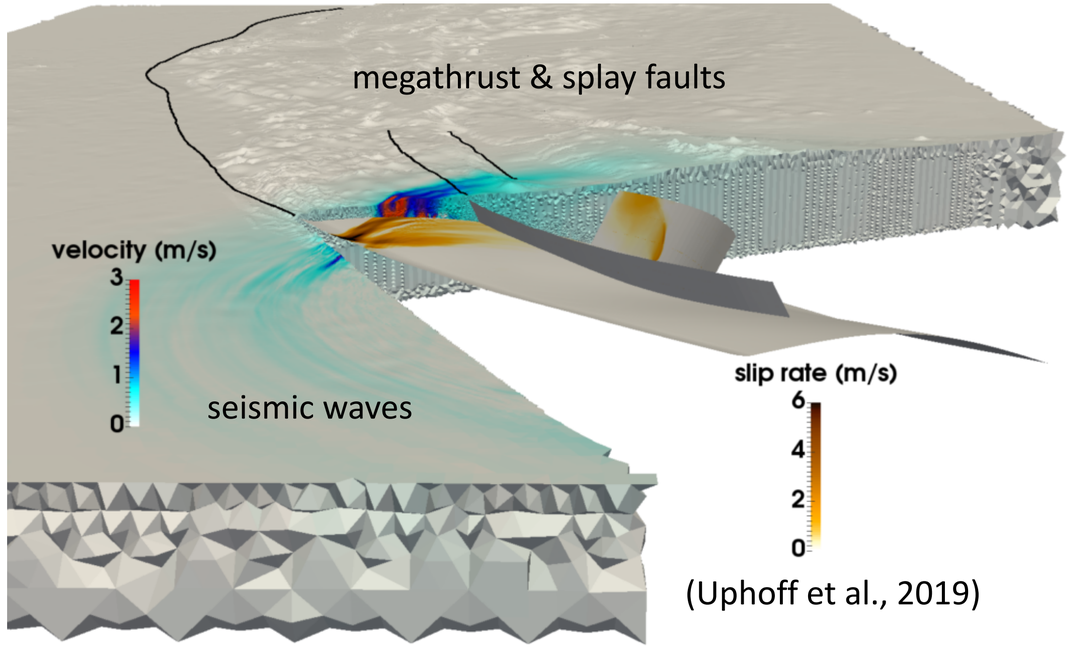
(Hyndman et al., 2015)

DET Community Products

Self-consistent earthquake dynamic rupture and tsunami models (it's the same source!)

3D dynamic rupture simulations (SeisSol)

- **complex geometries (CFM, bathymetry)**
- **heterogeneous elastic properties (CVM)**
- **splay faults**
- **sediment yielding**
- **sources informed by coupling model**
- **validation with paleoseismology**



(Uphoff et al., 2019)

Tsunami generation as part of simulation (minutes), tsunami propagation (hours) with different codes

DET Community Products

Self-consistent earthquake dynamic rupture and tsunami models (it's the same source!)

*(Glehman, Gabriel, Ulrich, Ramos, Huang and Lindsey, **preprint**)*

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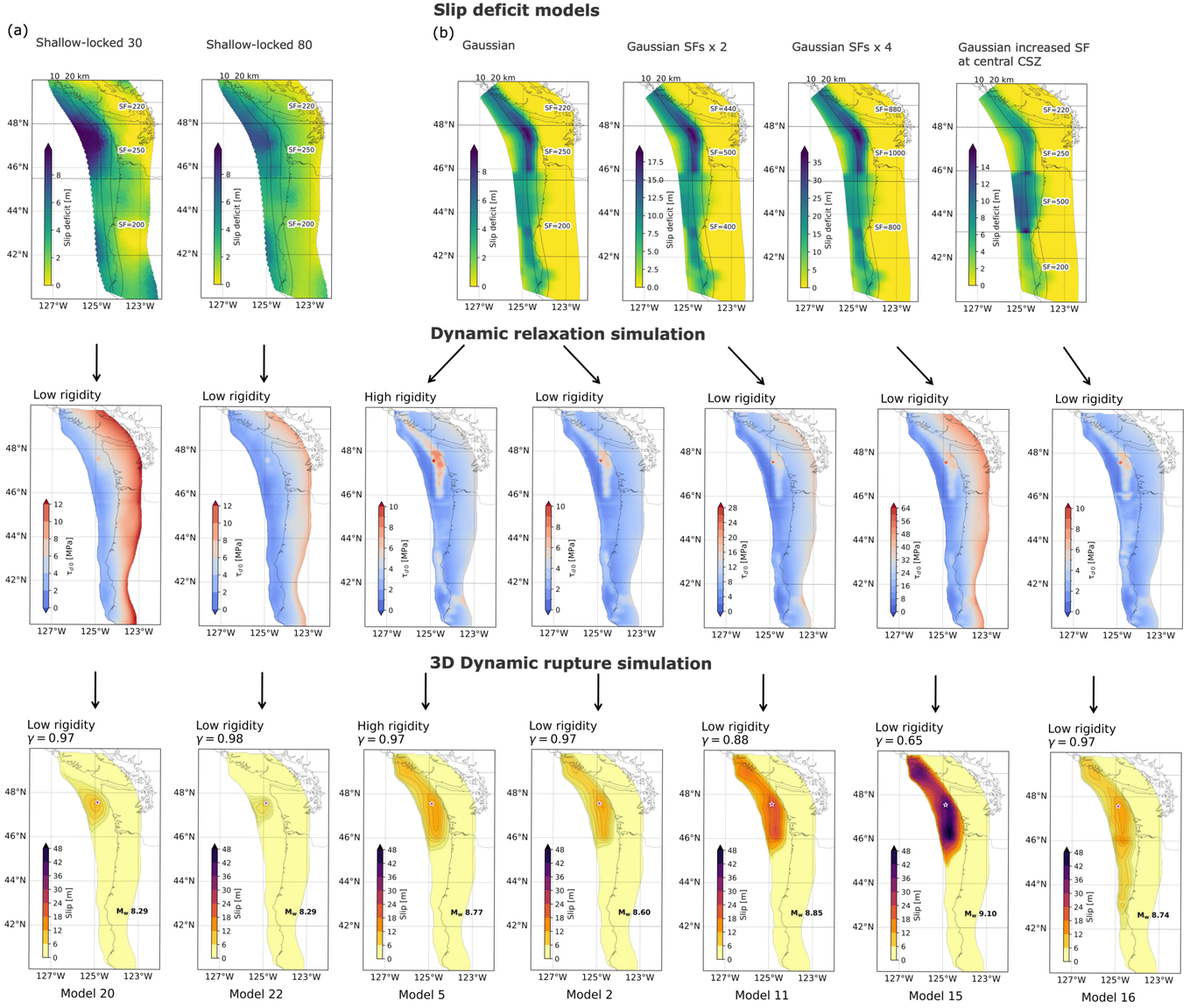
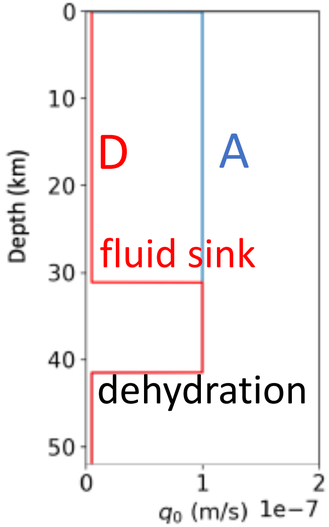


Partial ruptures governed by the complex interplay between geodetic slip deficit, rigidity, and pore fluid pressure in 3D Cascadia dynamic rupture simulations

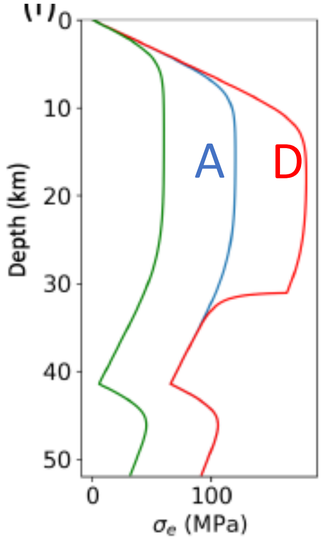
DET Community Products

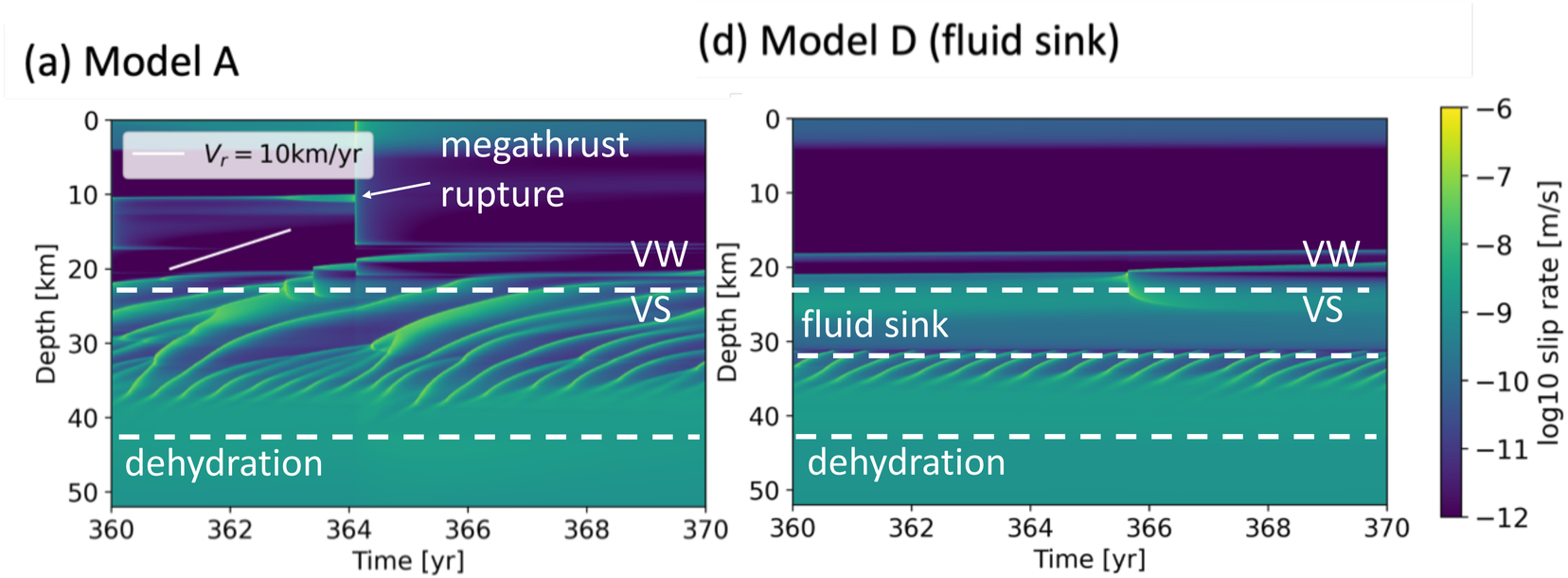
2D and 3D earthquake cycle models with fluid transport and viscoelasticity

updip fluid flux



fault effective normal stress



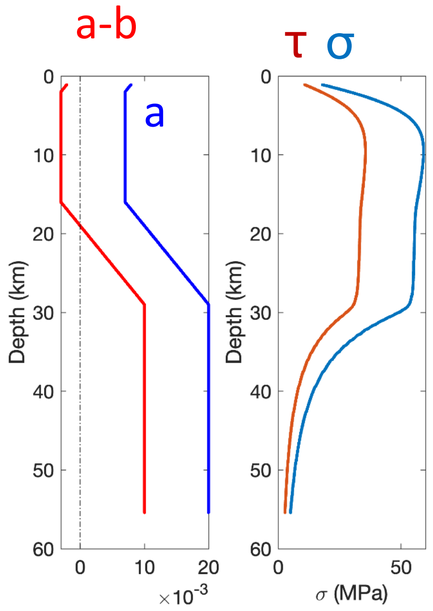


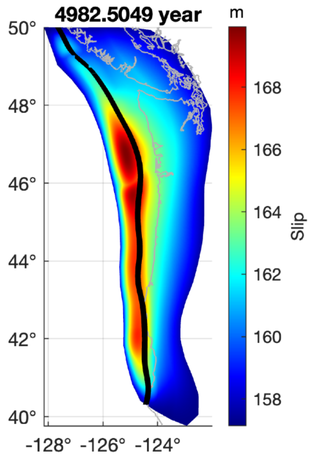
- **initially 2D, then moving to 3D**
- **test hypotheses for slow slip events and their relation to megathrust ruptures**
- **self-consistency with fluid production and transport (Fluids SIG)**

(Ozawa, Yang, & Dunham, 2023, in progress)

3D Cascadia earthquake cycle modeling with viscous flow

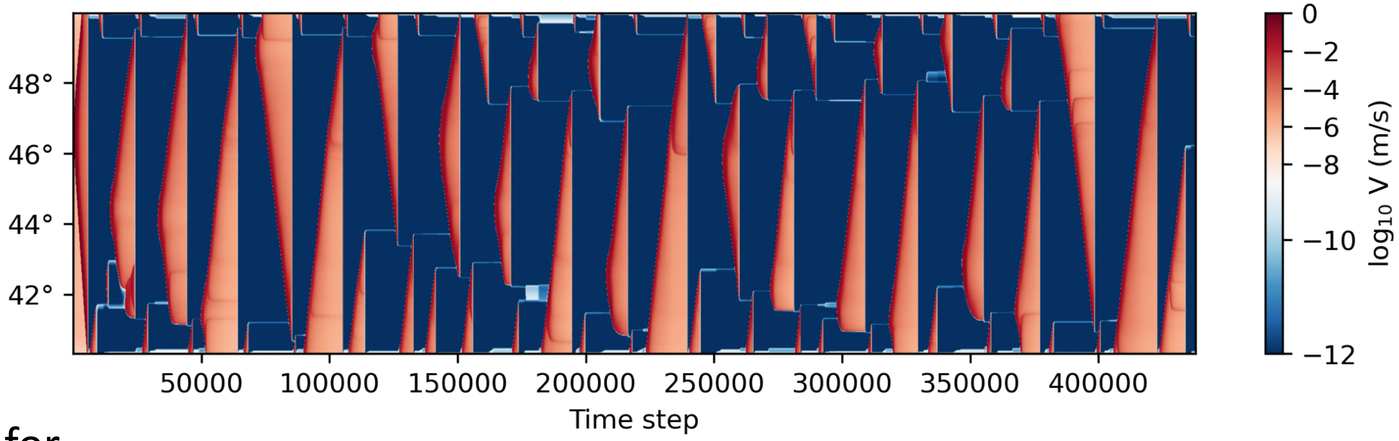
Zhang, Ozawa, Dunham (in progress)

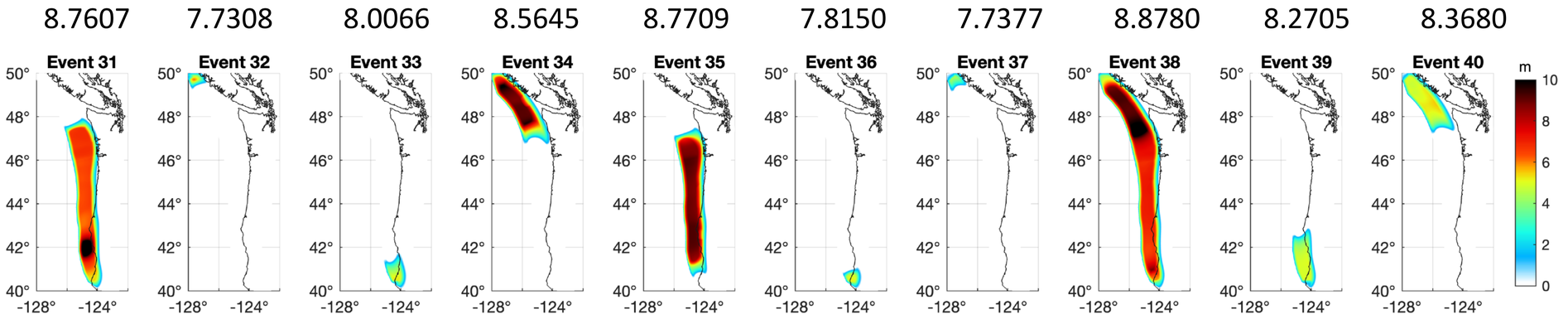




Accumulated slip for 5000 years

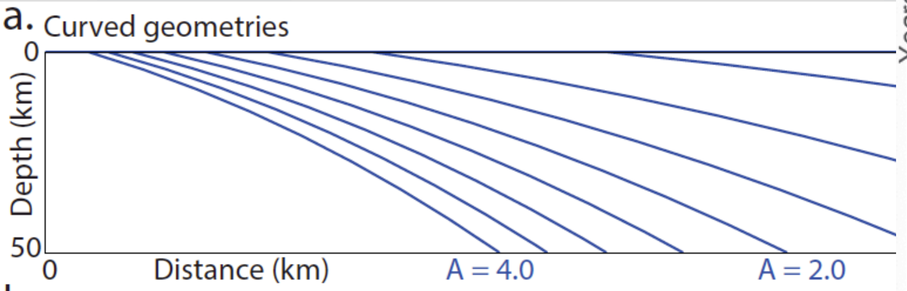
depth 10 km profile

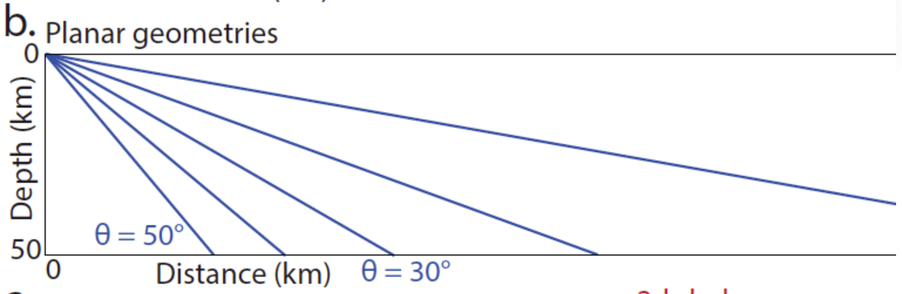


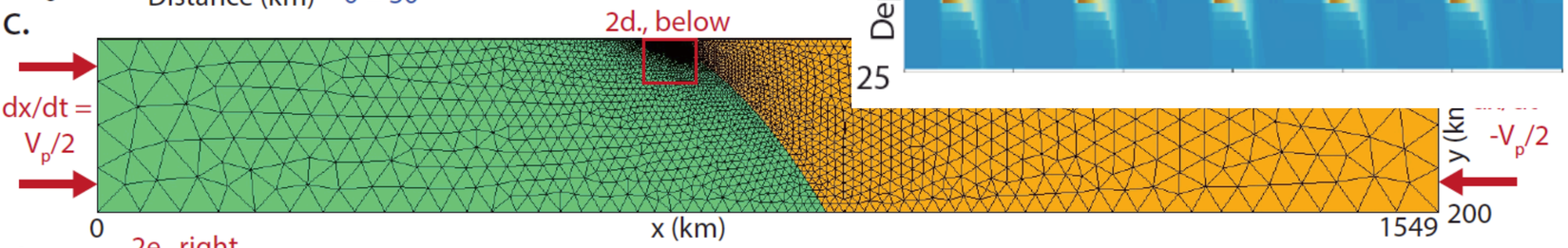


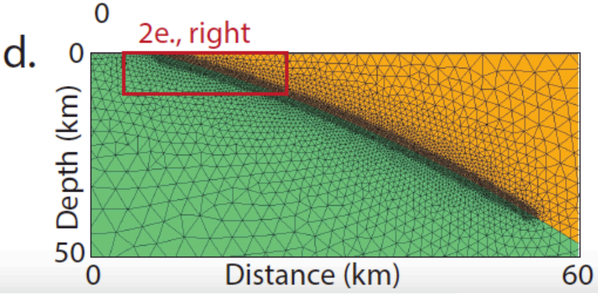
rthquake cycle models

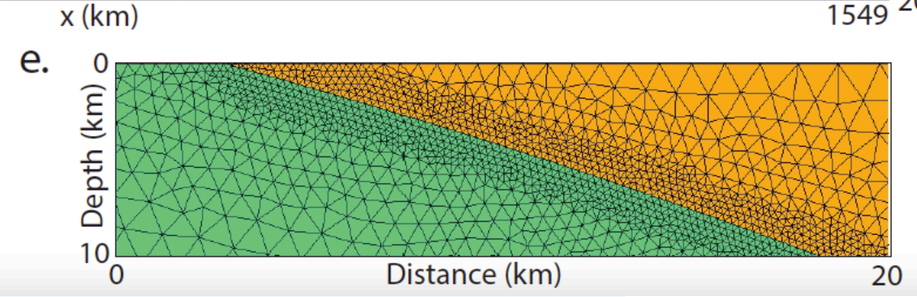
- 2D earthquake cycle simulations with *tandem*
- Varied megathrust dip & downdip curvature
- Max. earthquake size primarily *f*(W/h*) ∝ dip
- Curvature → event variability & recurrence
- e.g. periodic, bimodal, or supercyclic events

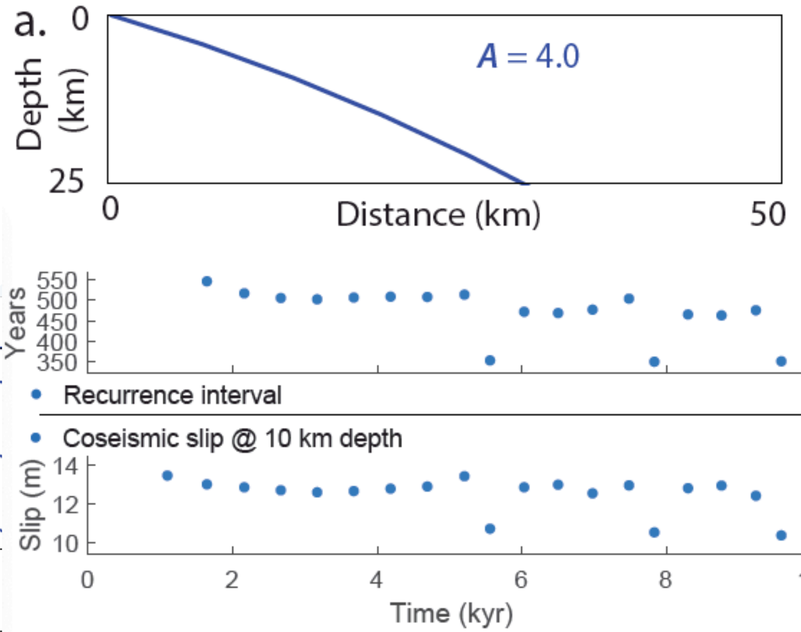


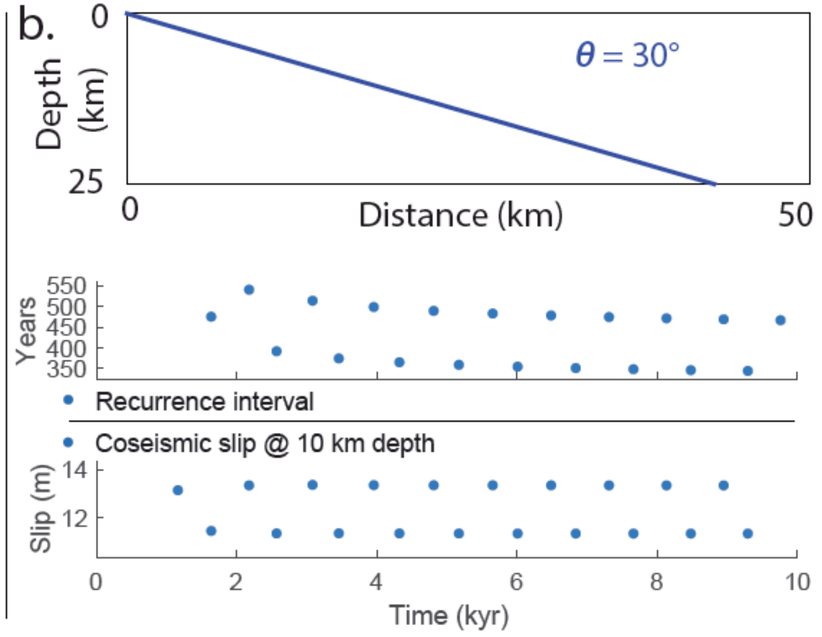


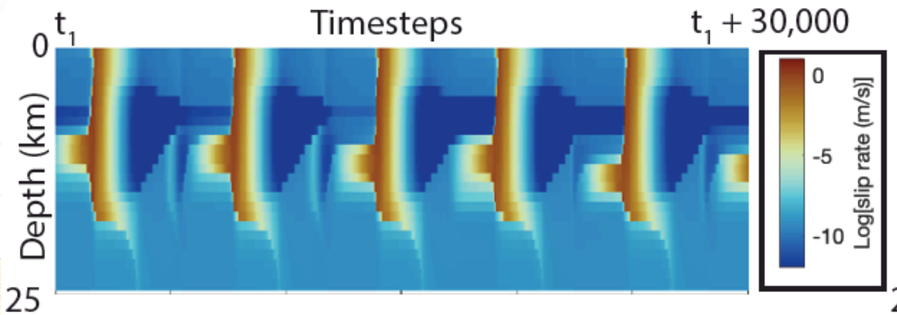


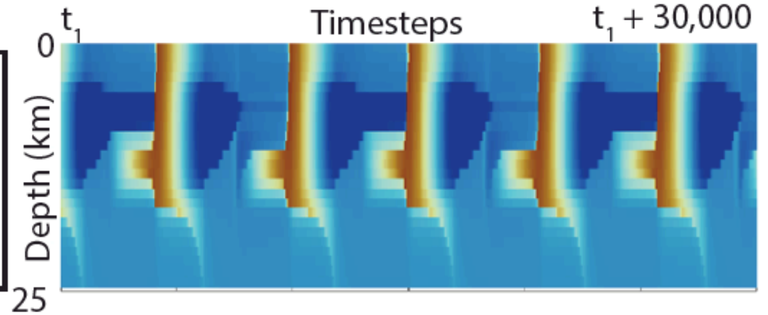












Biemiller, J., Gabriel, A.-A., May, D., Staisch, L., Subduction zone geometry modulates the megathrust earthquake cycle: magnitude, recurrence, and variability. *JGR: Solid Earth*.

Code verification through community benchmark problems and cross-comparison

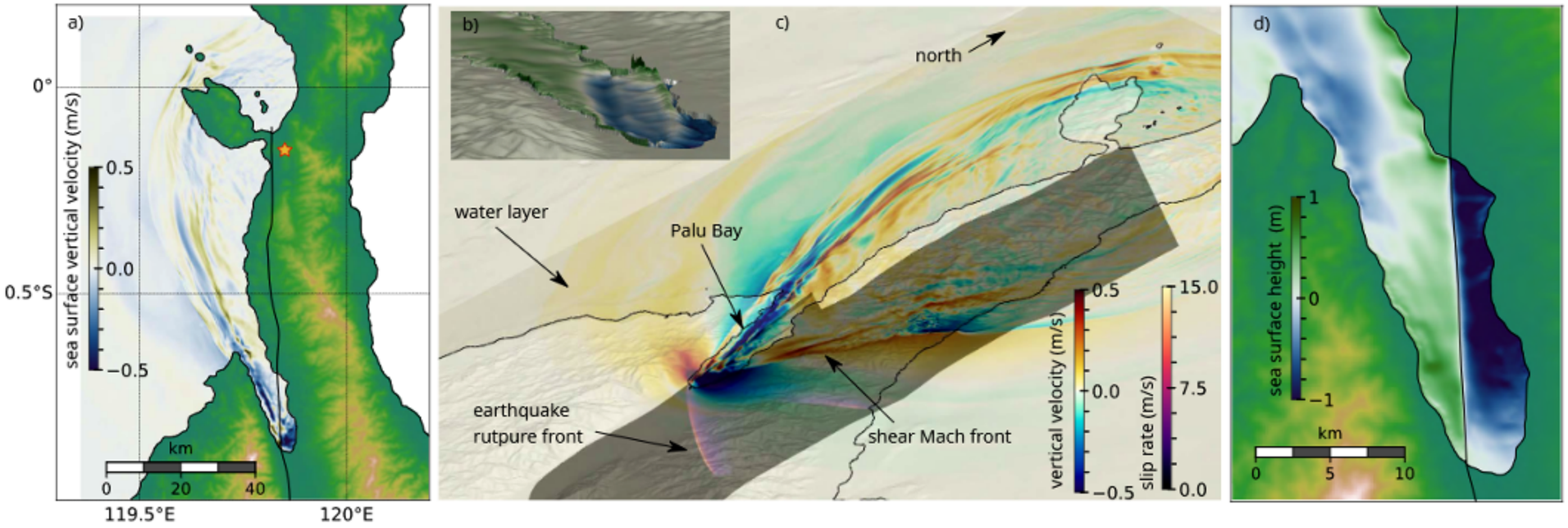
- **Our current TPV36/37 benchmark is jointly organized and includes the calculation of seafloor uplift**
- **Upcoming in Spring 2025: added water layer (and off-fault plasticity?)**

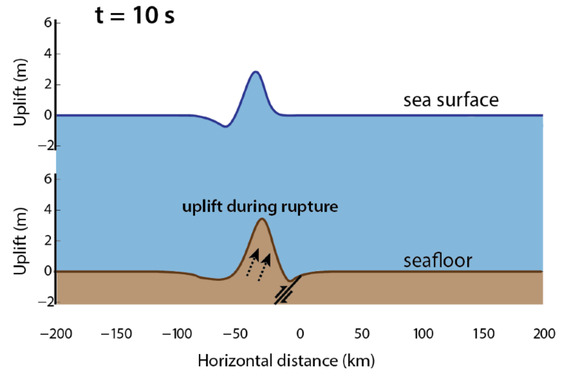
Upcoming earthquake cycle benchmarks for megathrusts

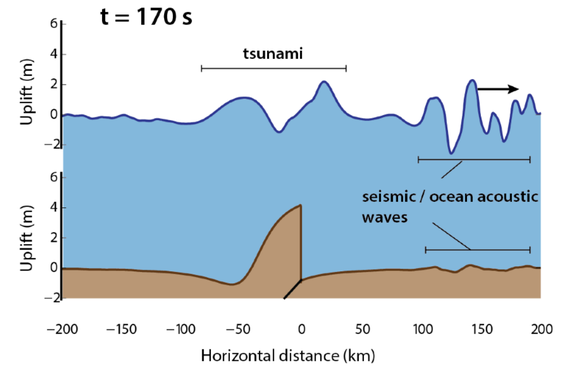
YR 2. Elastic solid, general solution

YR 3. Elastic solid, focus on slow slip events

YR 4&5. Viscoelasticity and fault-zone fluid transport







(Lotto & Dunham, 2015; now in 3D, Krenz et al., 2021)

Timeline and upcoming topical and training workshops

Wokshops:

- **fluids and faulting (YR2)**
- **shallow rupture (YR3)**
- **slow slip (YR4)**
- **model validation with paleoseismic data (YR5)**
- **training for DET modeling software (YR5)**