

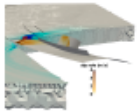
CRESCENT *Generation 0* Community Velocity Model

Bin He^{1,2}, Jonathan R. Delph¹, Shihan Wu¹, Emilie E.E. Hooft², Alex Grant³,
Valerie J. Sahakian², Pieter-Ewald Share⁴, William J. Stephenson³, Erin A. Wirth³,
Brandon Herr⁵, Ross Maguire⁶, Guoliang Li⁷, Rasheed Ajala⁸



The Need for a Community Velocity Model in Cascadia

Understanding seismic hazard and risk
necessitates accurate estimates of seismic properties
at both broad and fine spatial scales



DET

Dynamic Rupture,
Earthquake Cycle,
and Tsunamis

[VISIT DET](#)



CFM

Community Fault
Model

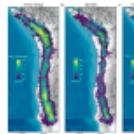
[VISIT CFM](#)



CPAL

Cascadia
Paleoseismology

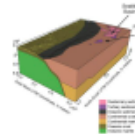
[VISIT CPAL](#)



C3S

Coupling, Seismicity,
and Slow Slip

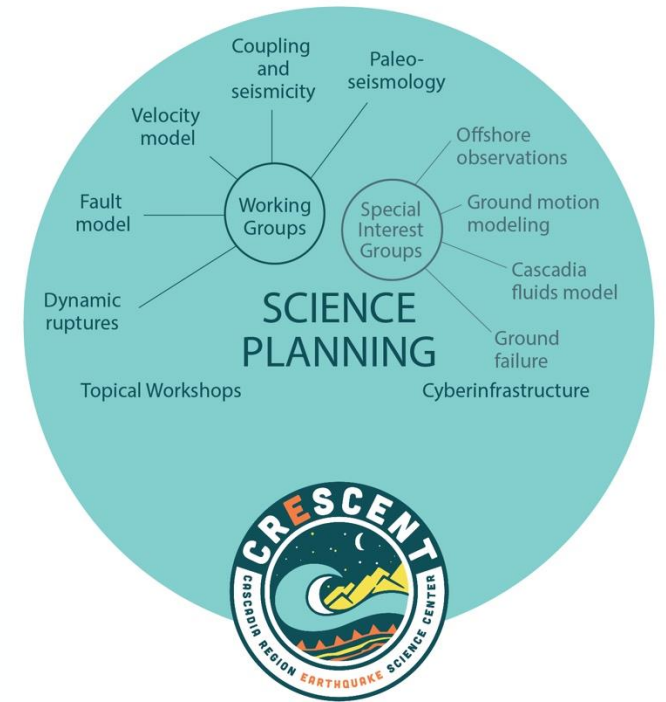
[VISIT C3SS](#)



CVM

Community
Velocity Model

[VISIT CVM](#)



The Need for a Community Velocity Model in Cascadia

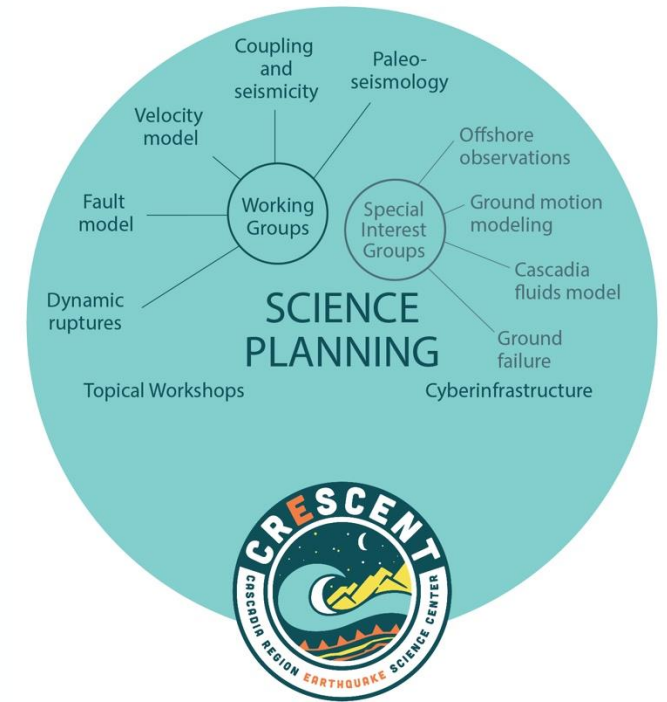
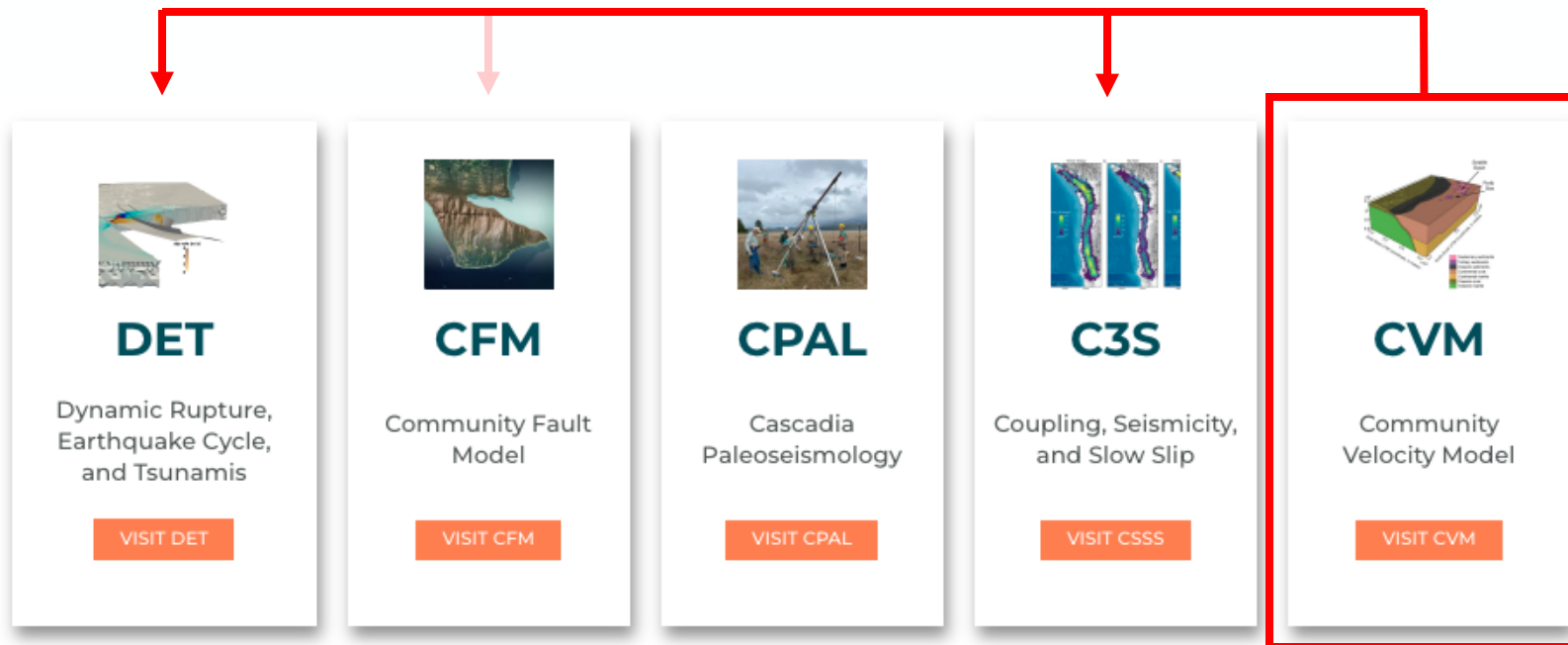
Constraining the velocity properties of Earth's lithosphere and upper mantle in *3 dimensions* allows us:

- 1) Creating **more accurate wave propagation simulations** and **ground motion predictions**
- 2) Define **elastic properties for modeling**
- 3) Delineate **“blind” geologic features in the subsurface**

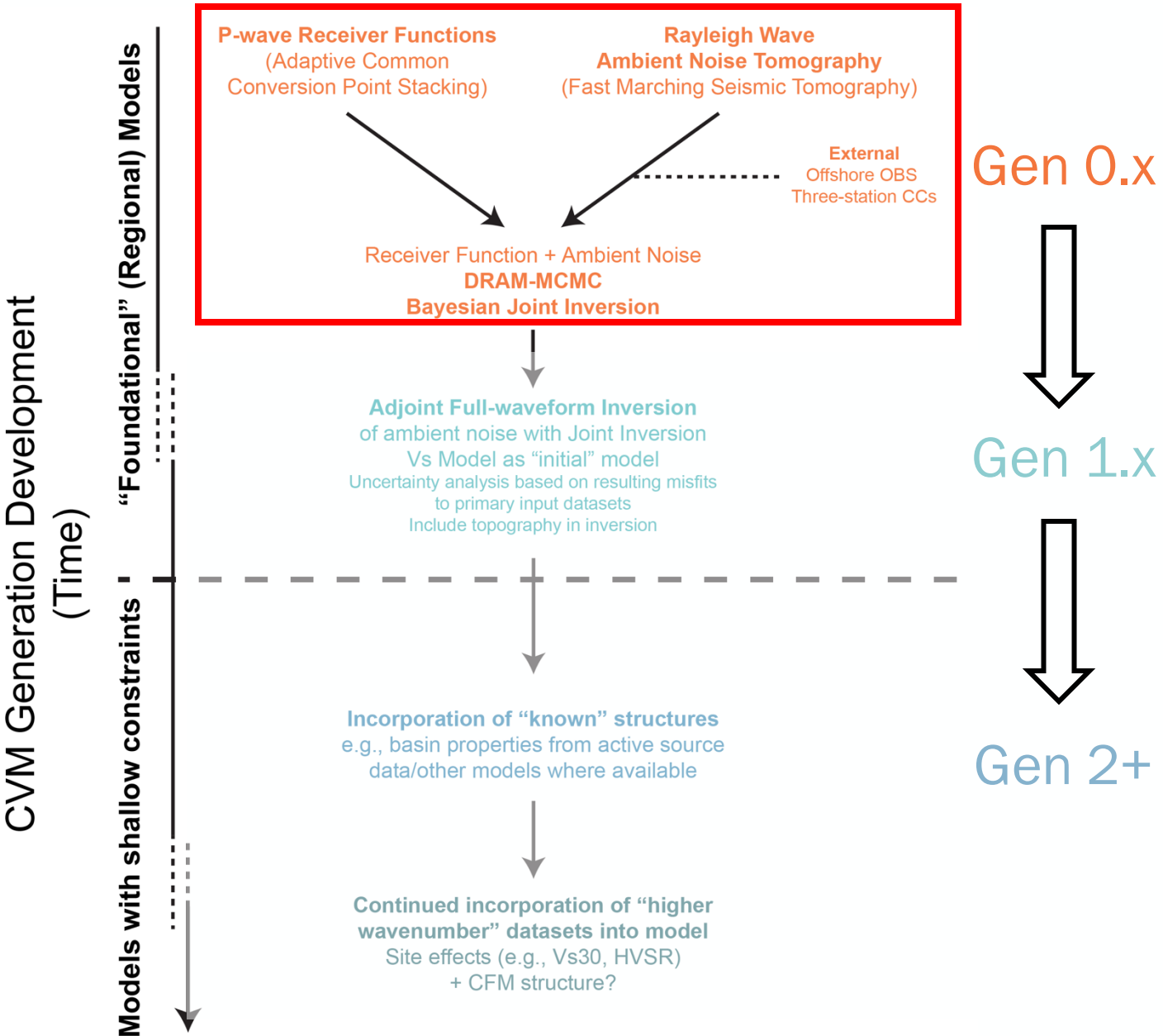
WG/SIG

GMM

DET and C3S
CFM



The CRESCENT CVM Workflow



Create *families* of models with similar base methodologies that *build on each other*

“low wavenumber”

Regional Structure

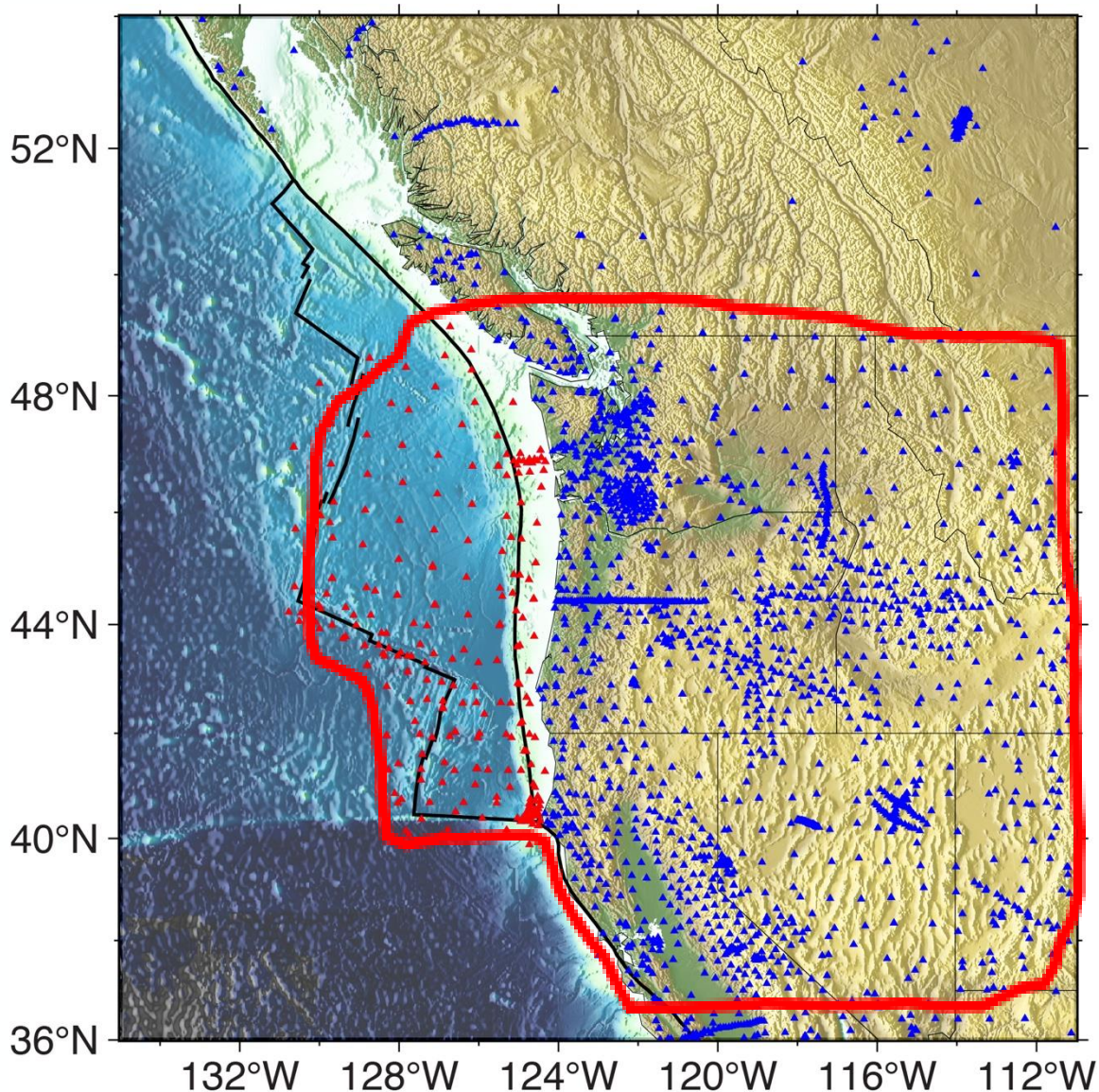
(e.g., teleseismic body waves, surface waves)

“high wavenumber”

Local Structure

(e.g., basins, geotechnical layers)

CVM-Gen0: datasets and model settings

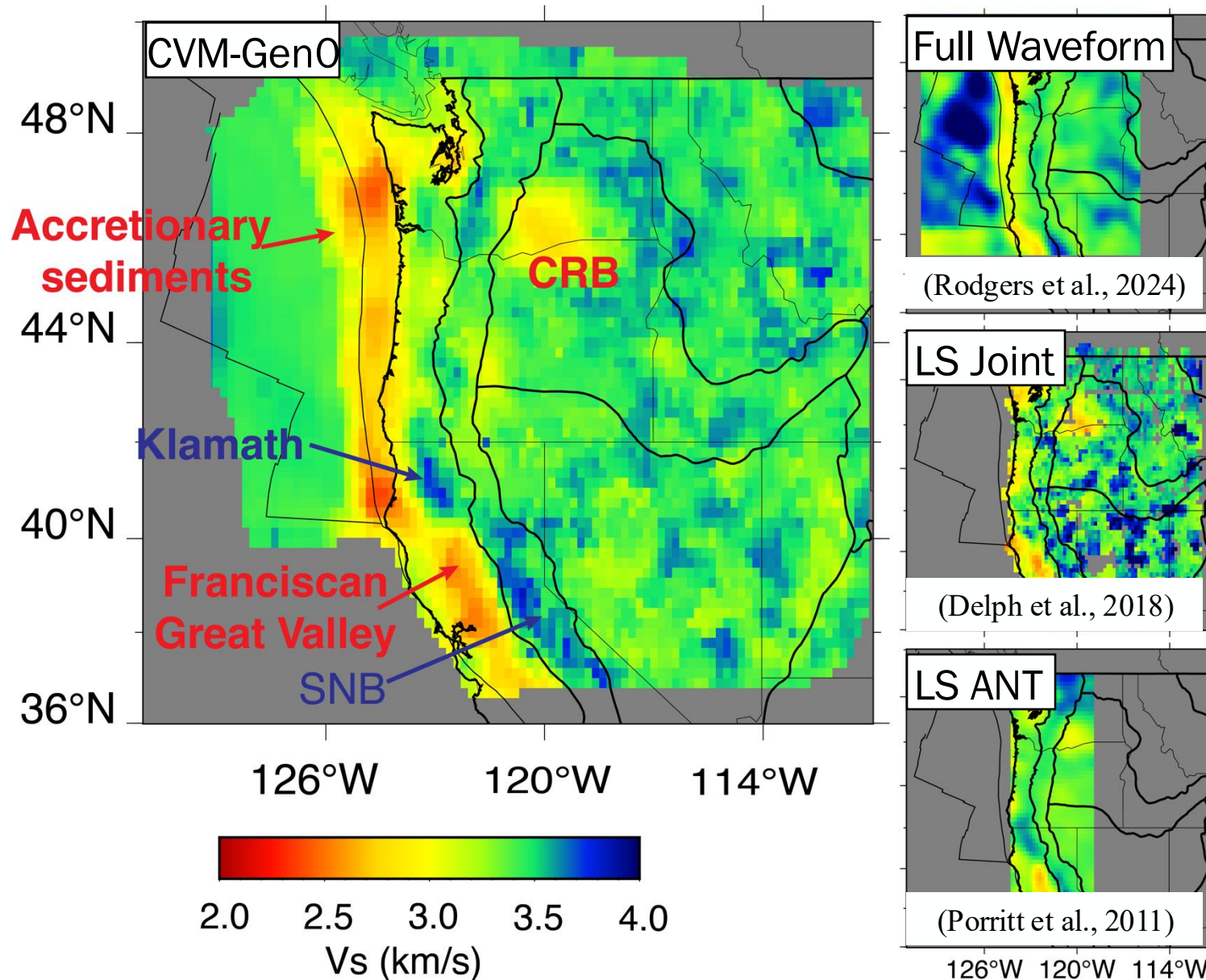


**DATA: 20+ years Ambient Noise +
Teleseismic P-wave Receiver functions**
→ Good constraints on **absolute shear-wave
velocity and discontinuity structure**
→ Bayesian Joint inversion = uncertainties for
crustal thickness and velocities

Model metadata:

Lat: 35N-50N Lon: 132W-110W
Depth: 80km Lateral grids: ~ 0.2 deg
Vertical spacing: ~ 1.0 km

CVM-Gen0: comparison to other models (5 km in depth)



Onshore structures:

- Broadly consistent with Delph2018 and Porritt2011;

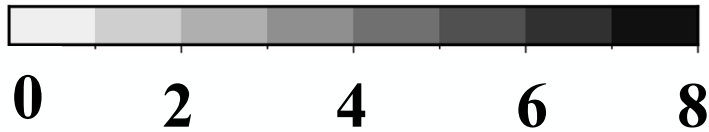
Offshore structures:

- Prominent low-velocity along the coast, accretionary prism.

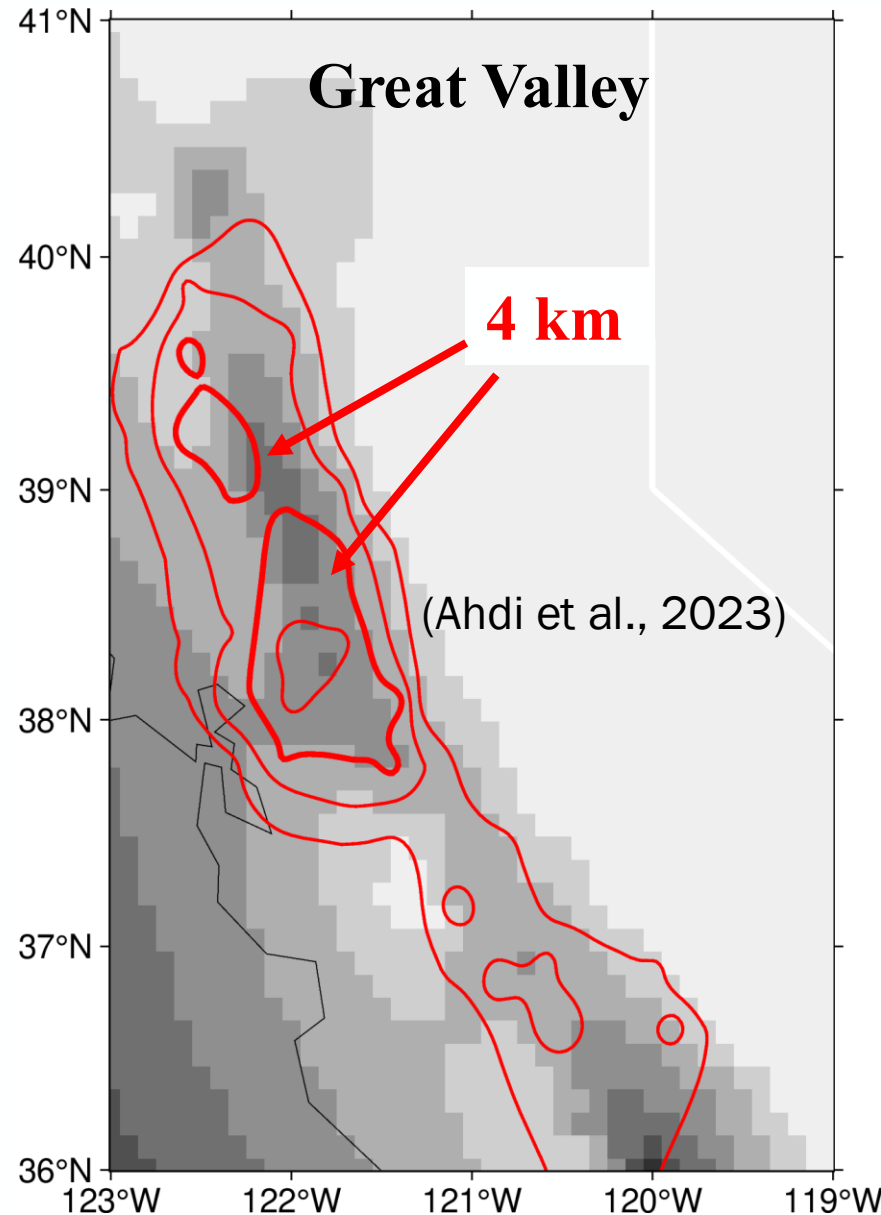
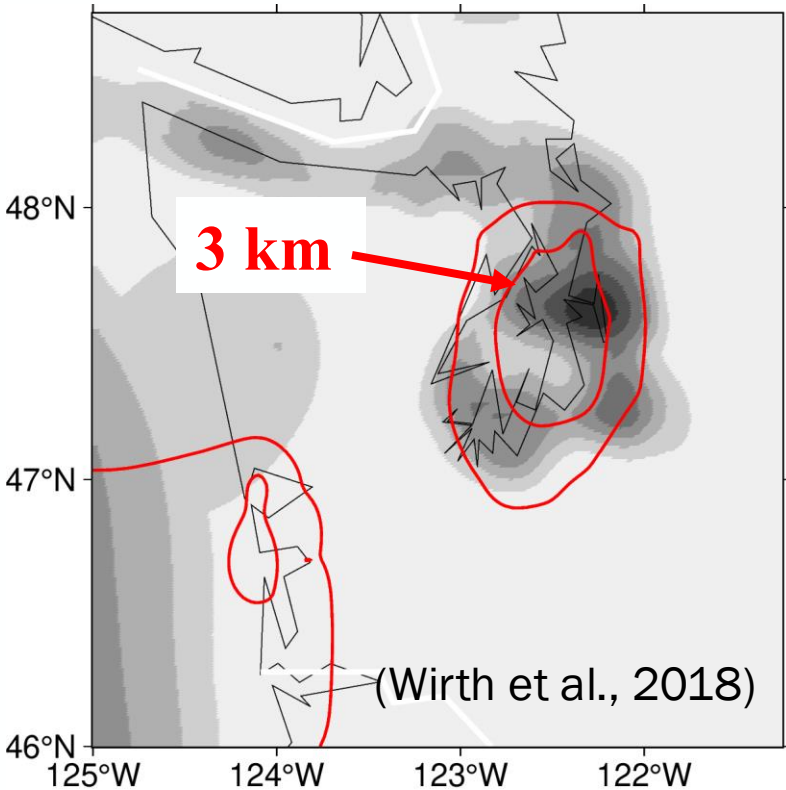
➤ CVM-Gen0 contains **model uncertainties (V_s and Moho).**

CVM-Gen0 : Implications for seismic hazard (GMM)

Z2.5 thickness (km)



Puget Lowland



➤ **Basin velocities and structure** are critical for GMMs

➤ While our model has limited resolution at shallow depths, **it still recovers their general geometry**, which will be improved in future model generations

➤ **red contours are from CVM-Gen0-Z2.5**

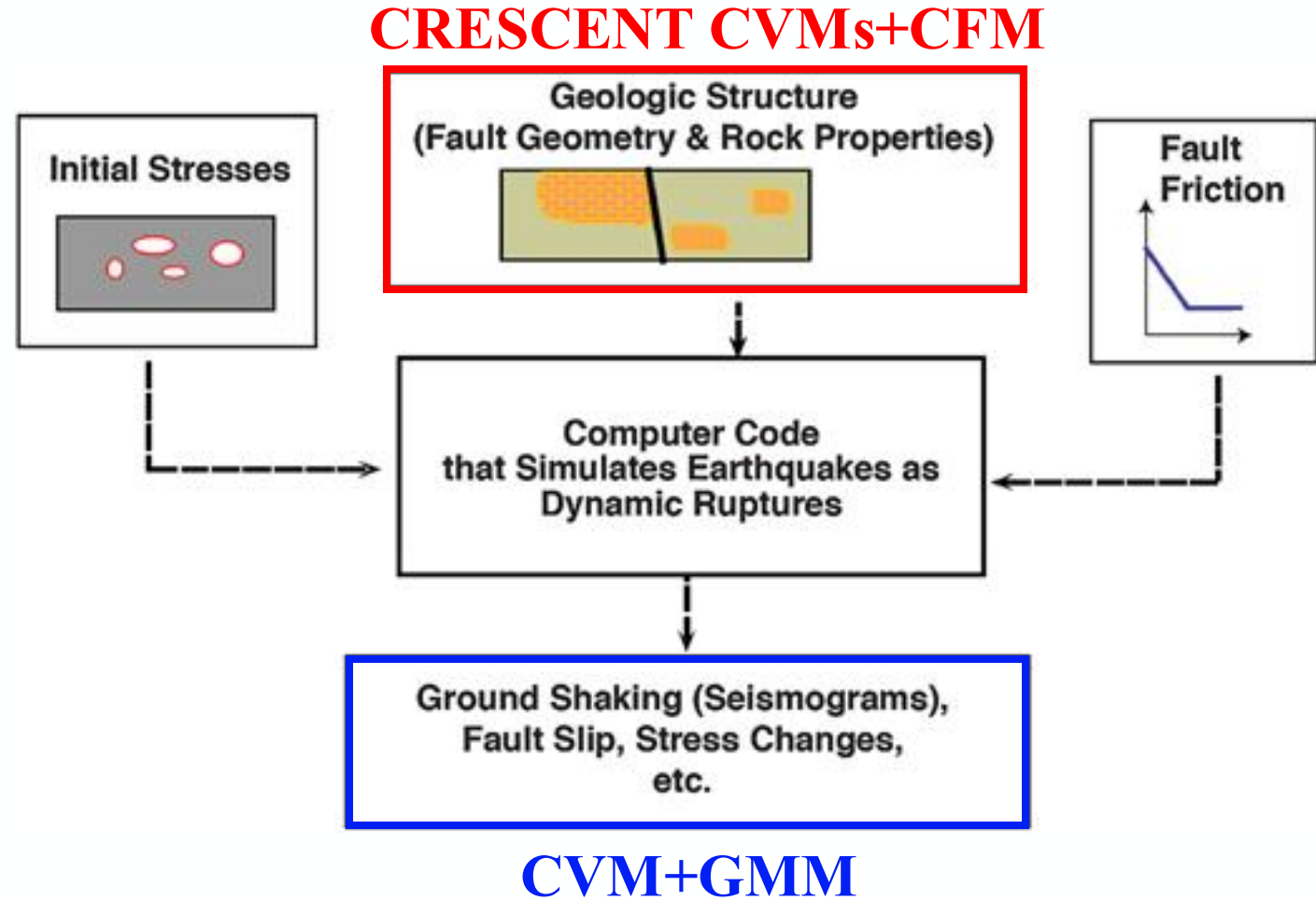
CVM-Gen0: Implications for Dynamic Rupture

Dynamic Rupture Simulations need 3D Earth models

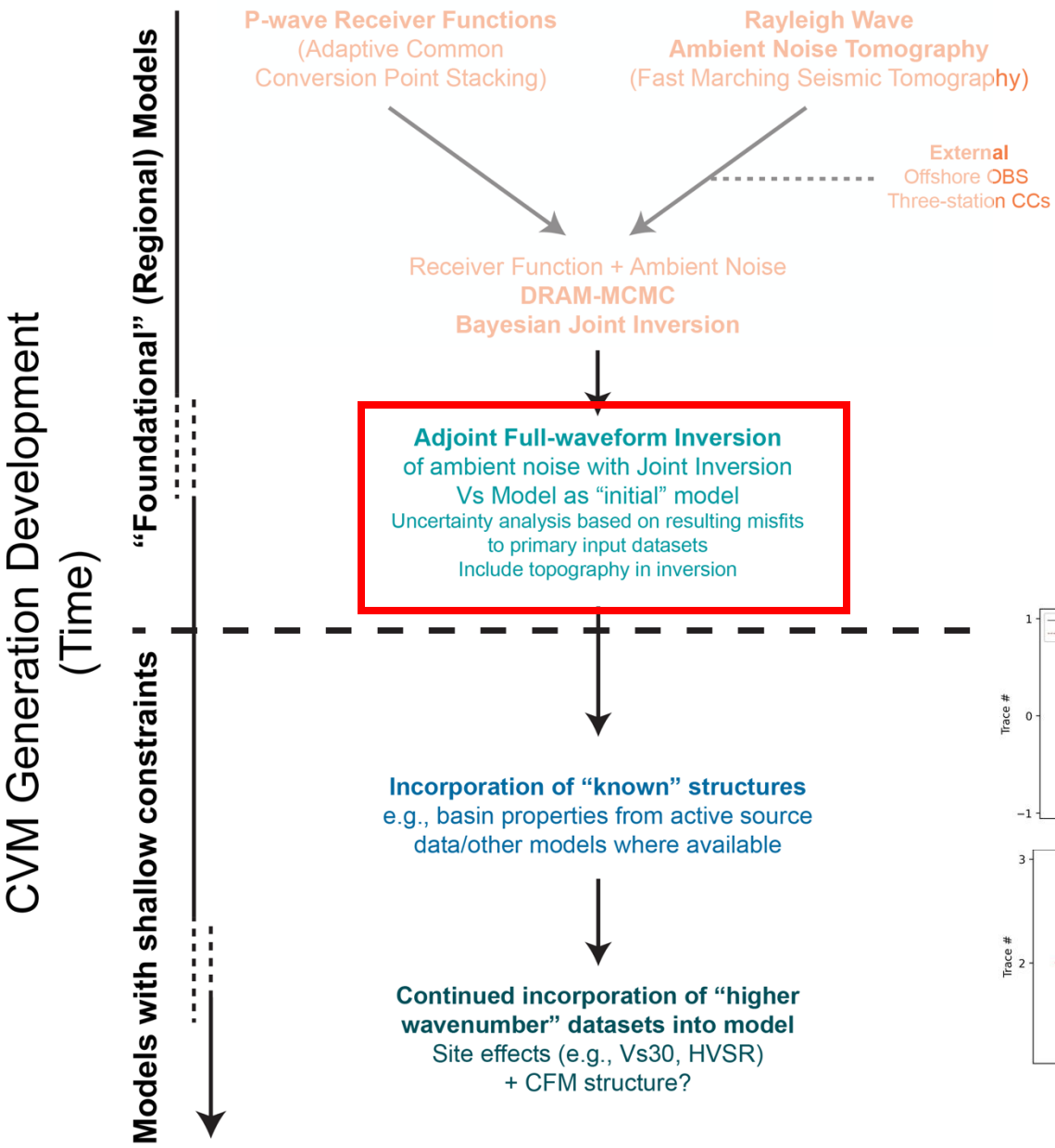
to characterize geologic structure
and rock properties

The CVM can
provide properties + uncertainties
to be used in simulations (w/ CFM)

The CVM can be used to
**model/validate shaking at the
local-to-regional scale**
(w/ GMM)



CVM-Gen1: Full waveform inversion



CVM-Gen0 is created with data products, but **we want to ensure a good fit to true waveforms in future models**

CVM-Gen1 will be created using **adjoint full-waveform tomography** with Gen0 as the initial model

