The Cascadia Region Earthquake Science Center

Innovative science for a resilient society

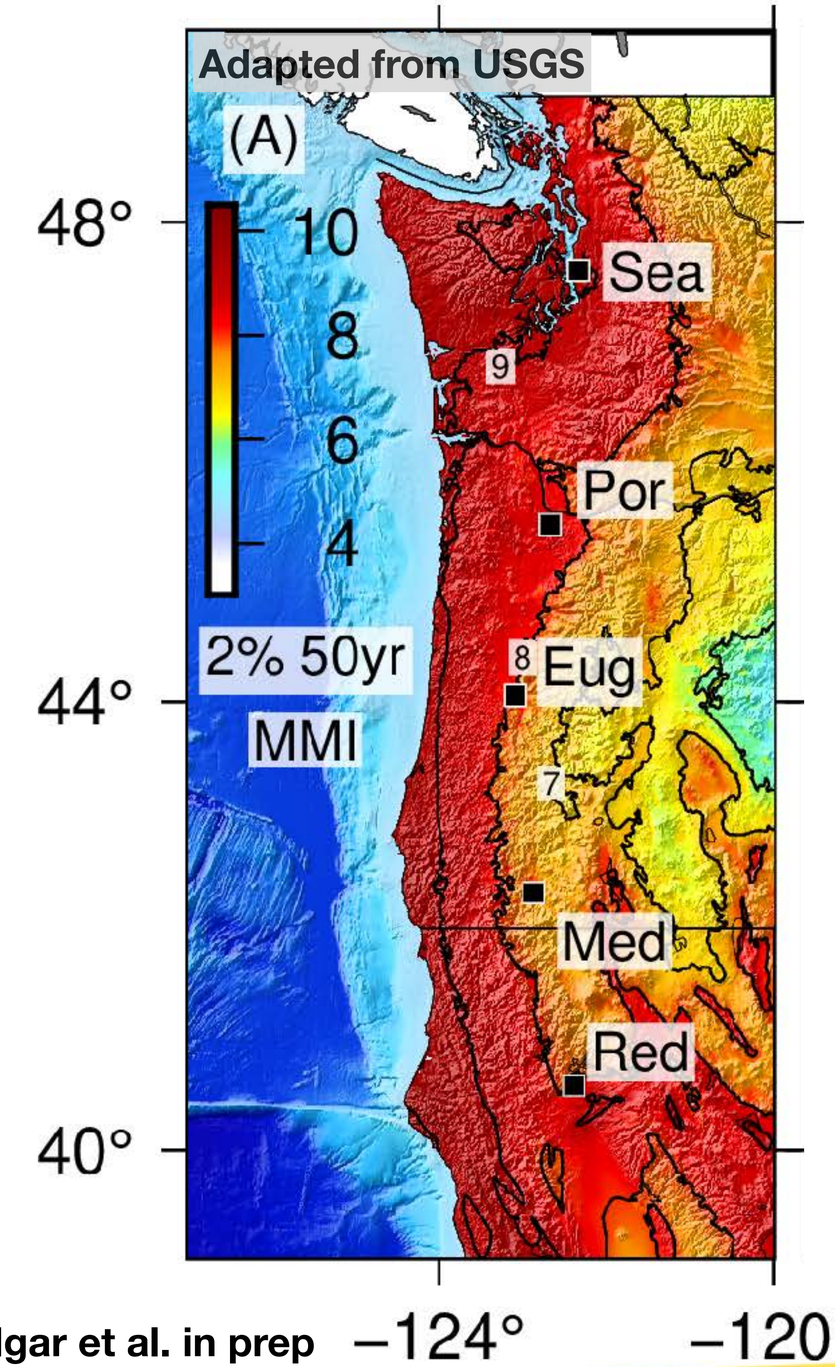
Earthquake hazards in Cascadia

Probably where damage begins to get serious in OR/WA

SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
DAMAGE	None	None	None	Very light	Light	Moderate	Moderate/heavy	Heavy	Very heavy
PGA (%g)	<0.0464	0.297	2.76	6.2	11.5	21.5	40.1	74.7	>139
PGV (cm/s)	<0.0215	0.135	1.41	4.65	9.64	20	41.4	85.8	>178
INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

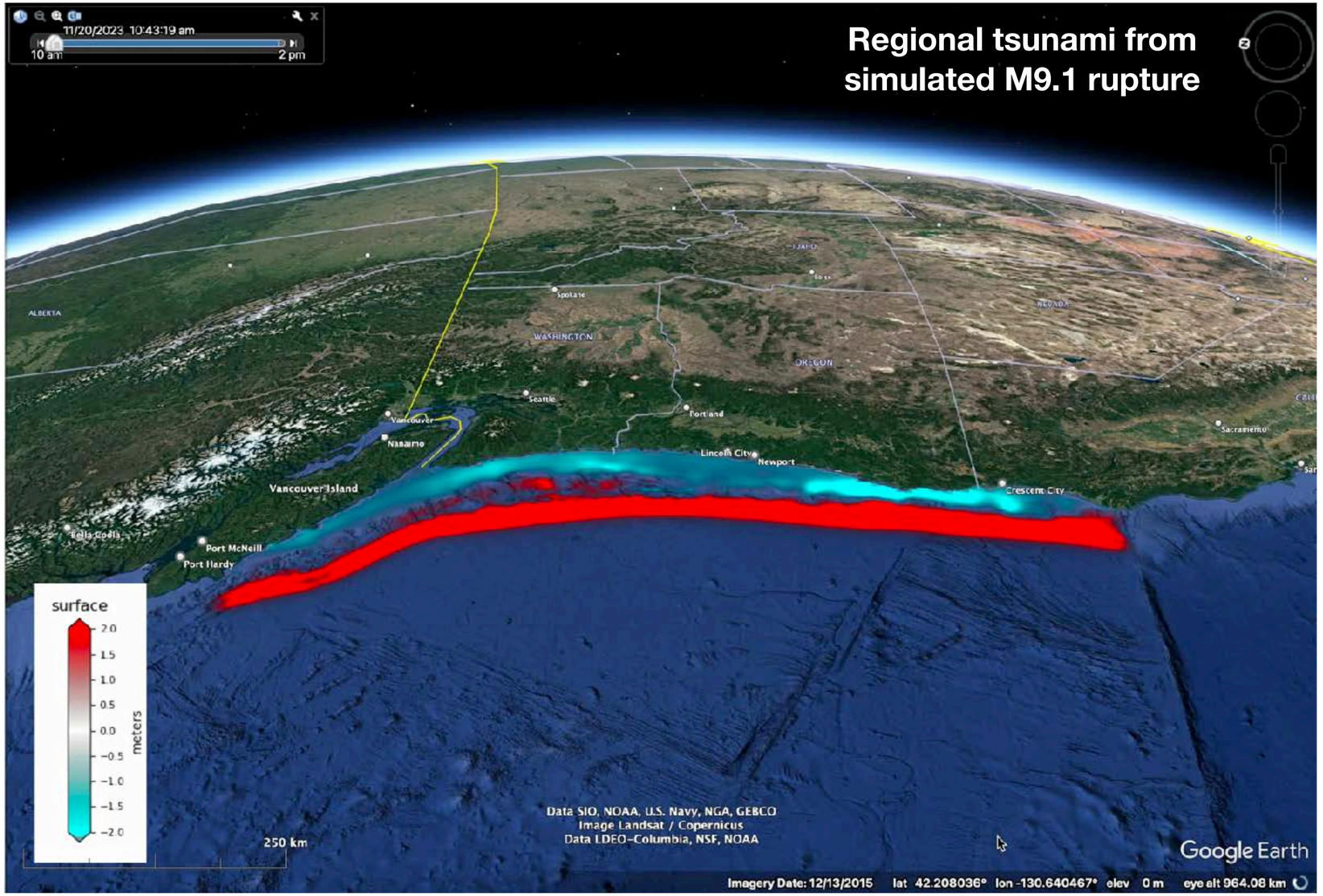
Scale based on Worden *et al.* (2012)

- **Strong shaking** is likely throughout the Pacific Northwest
- We are more **vulnerable** than elsewhere because knowledge of large earthquakes was only re-established in the 1990s
- Many **precarious legacy buildings** (unreinforced masonry, soft stories etc)



Melgar et al. in prep

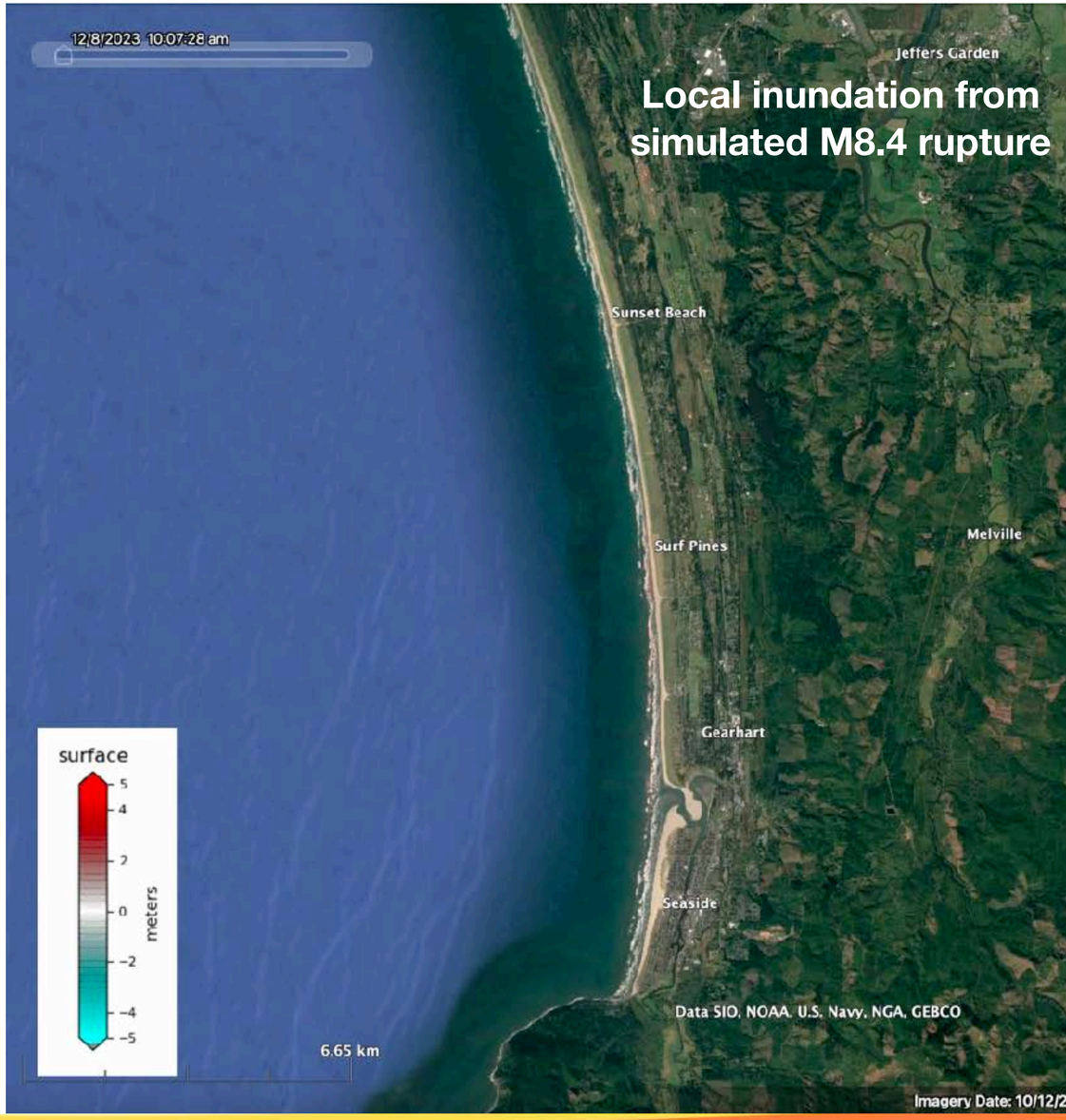
Earthquake hazards in Cascadia



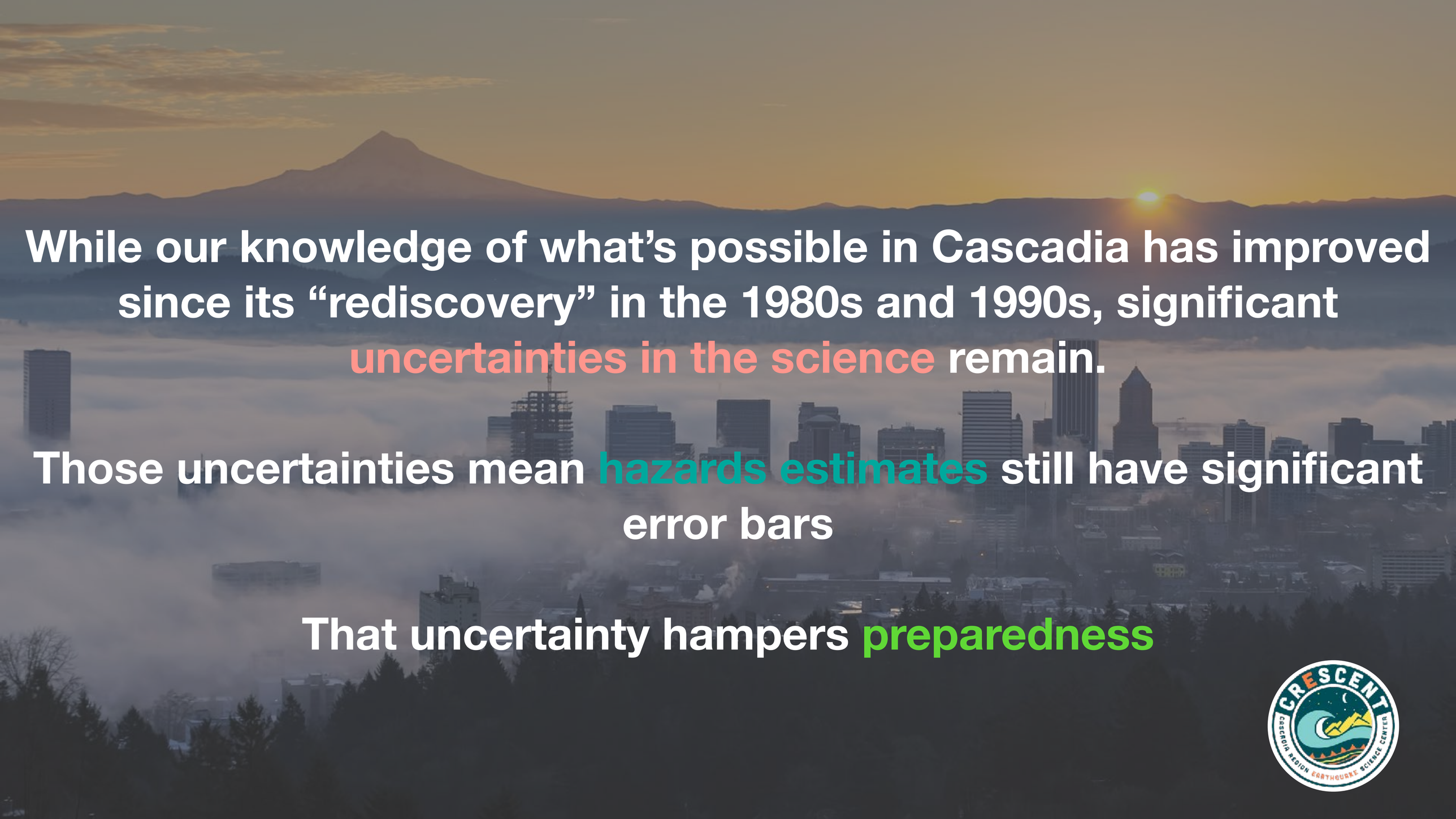
Wotruba & Melgar, in prep

Earthquake hazards in Cascadia

- **Geologic evidence** of widespread tsunami inundation in past events
- Models show **catastrophic inundation** for many low-lying coastal areas
- Very **long evacuation times** in some places
- **Vertical evacuation structures** necessary regionally



Wotruba & Melgar, in prep

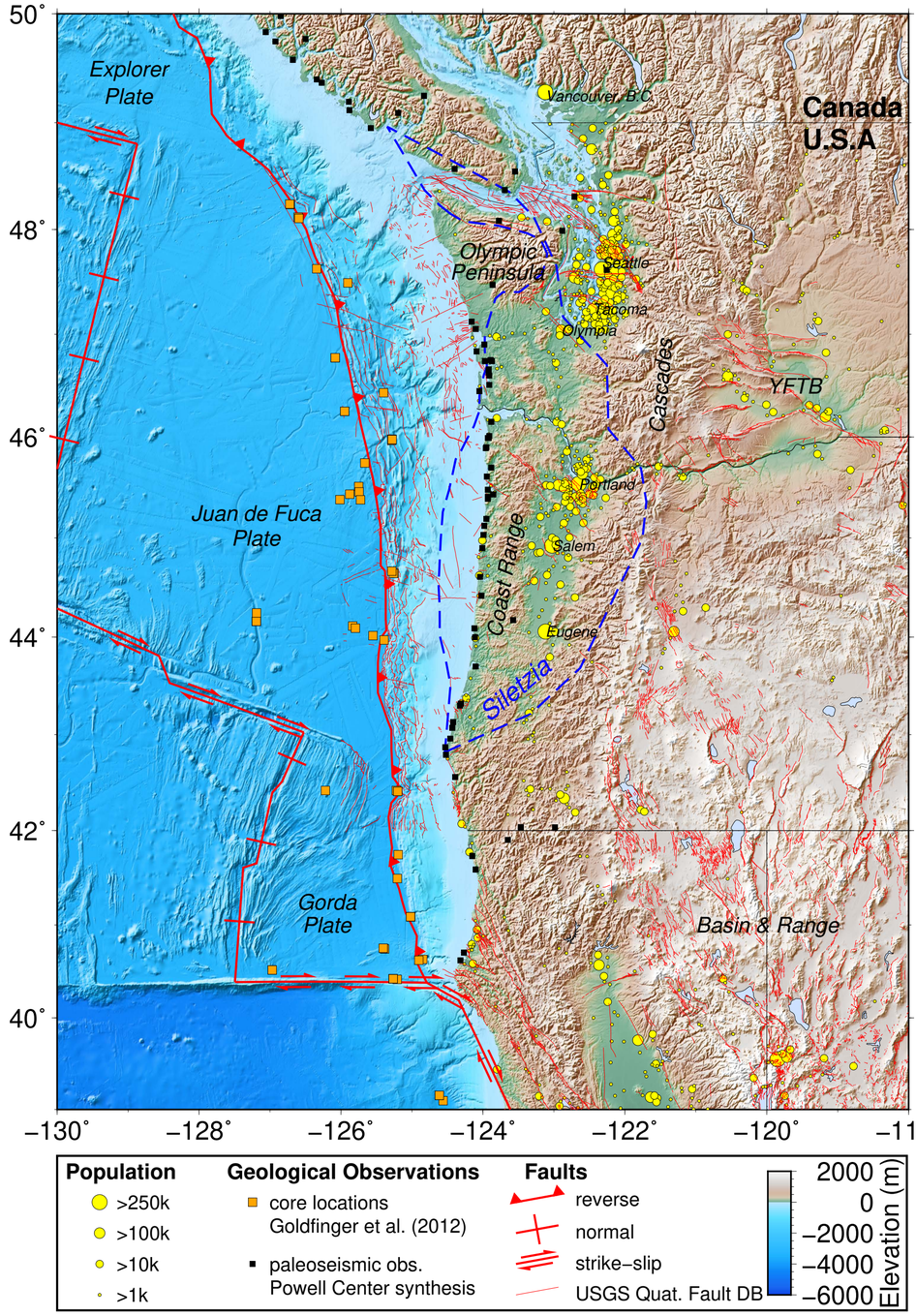


While our knowledge of what's possible in Cascadia has improved since its "rediscovery" in the 1980s and 1990s, significant uncertainties in the science remain.

Those uncertainties mean hazards estimates still have significant error bars

That uncertainty hampers preparedness

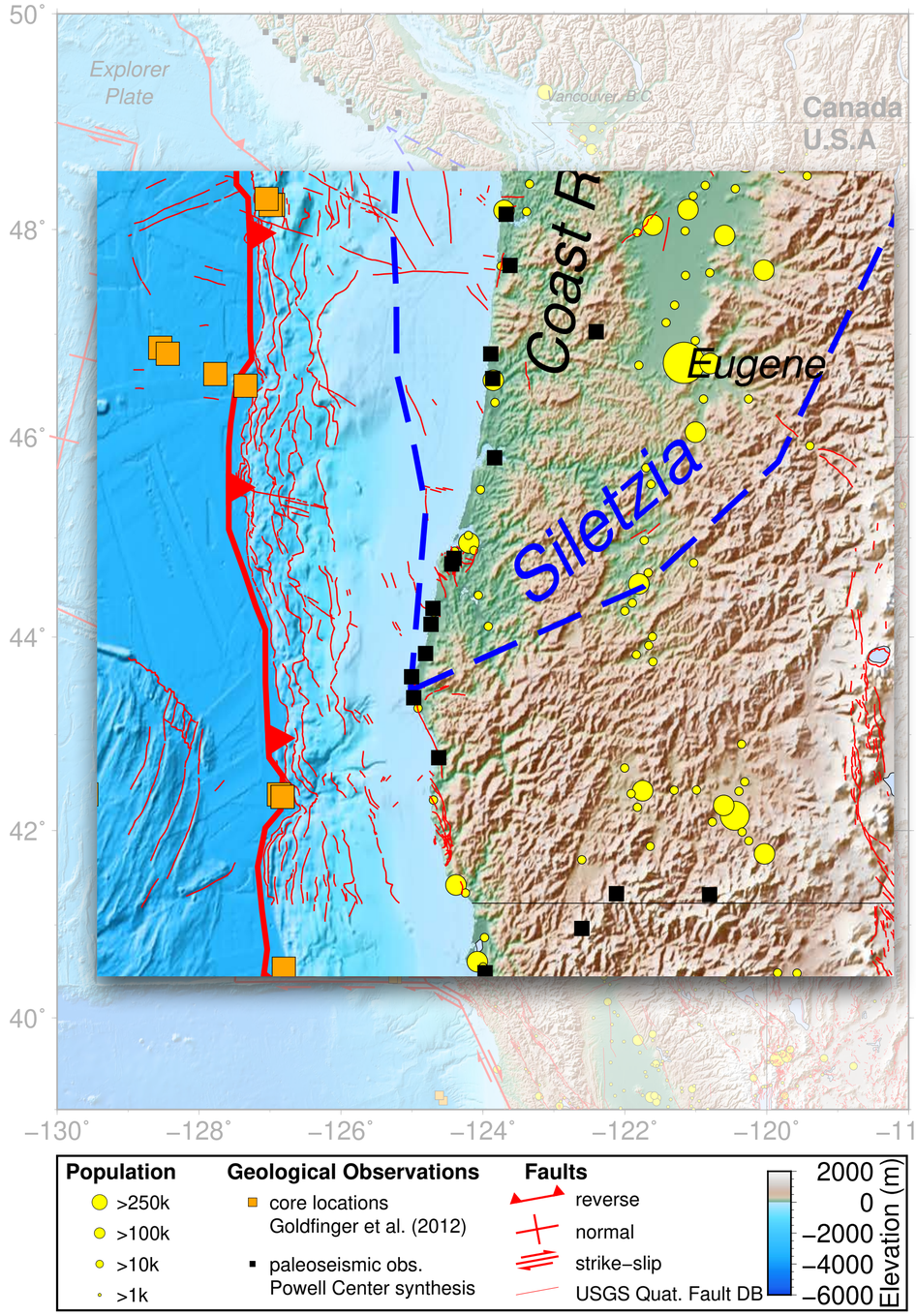
Shoreline crossing science



CRESCENT, 2023

Shoreline crossing science

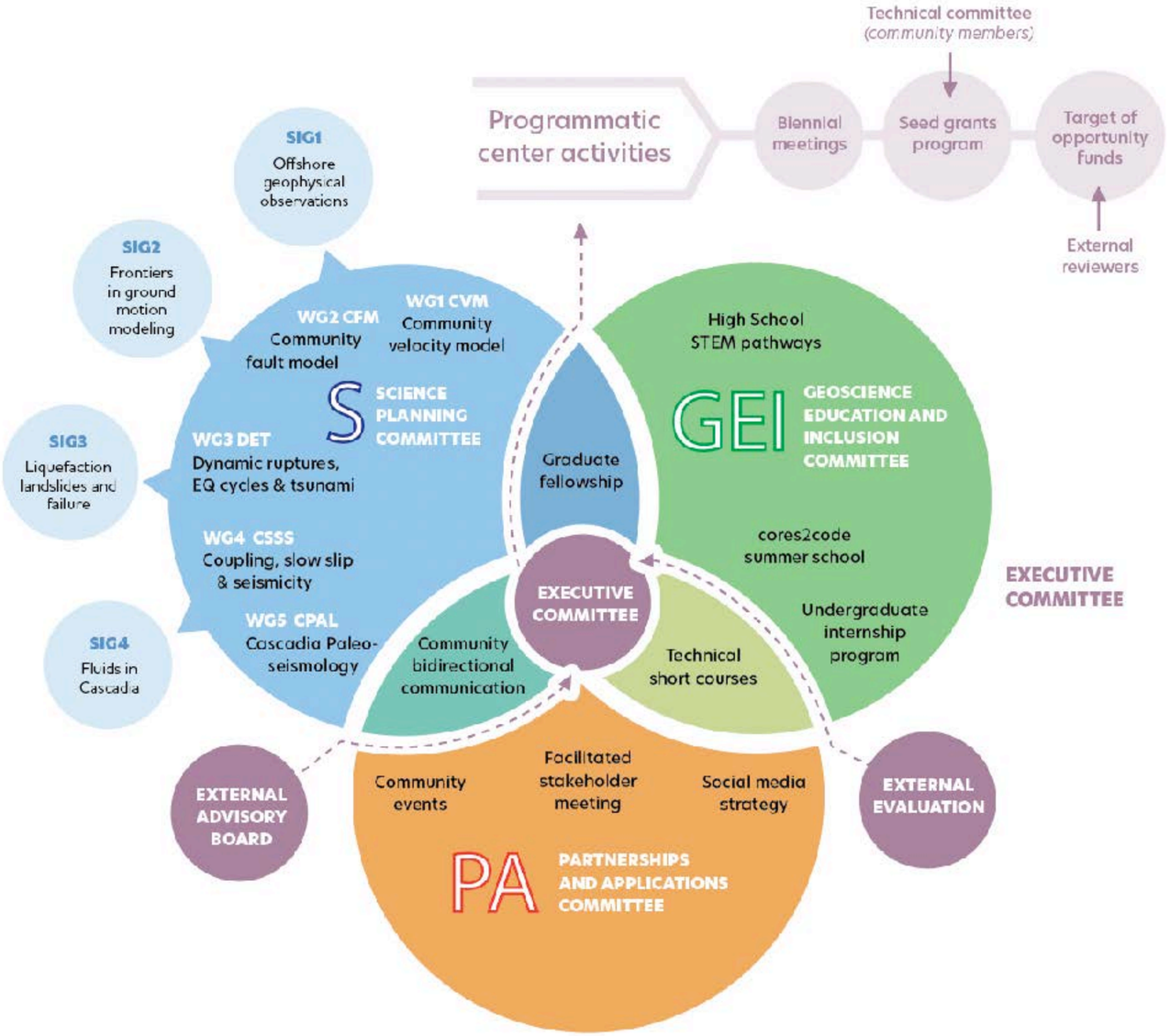
- We cannot understand the geodynamics and hazards of Cascadia without a holistic view that considers both its **onshore** and **offshore** portions



CRESCENT, 2023

CRESCENT's 3 pillars

- A new $15M NSF-funded center comprising 14 universities and over 40 researchers
- 6 **center staff**, program management and cyberinfrastructure
- The **science** behind earthquakes and their hazards
- Connecting the science to meaningful societally relevant outcomes through **partnerships** and development of **applications**
- Expanding access to careers through **geoscience education and inclusion.**



CRESCENT's programs

Science

- Working groups and community models
- Cyberinfrastructure
- Topical meetings
- Small grants

Partnerships & Applications

- Community connections meetings
- Dedicated staff to establish and maintain relationships
- Connections between center scientists and community members
- Cyberinfrastructure to develop "turnkey" products
- Small grants

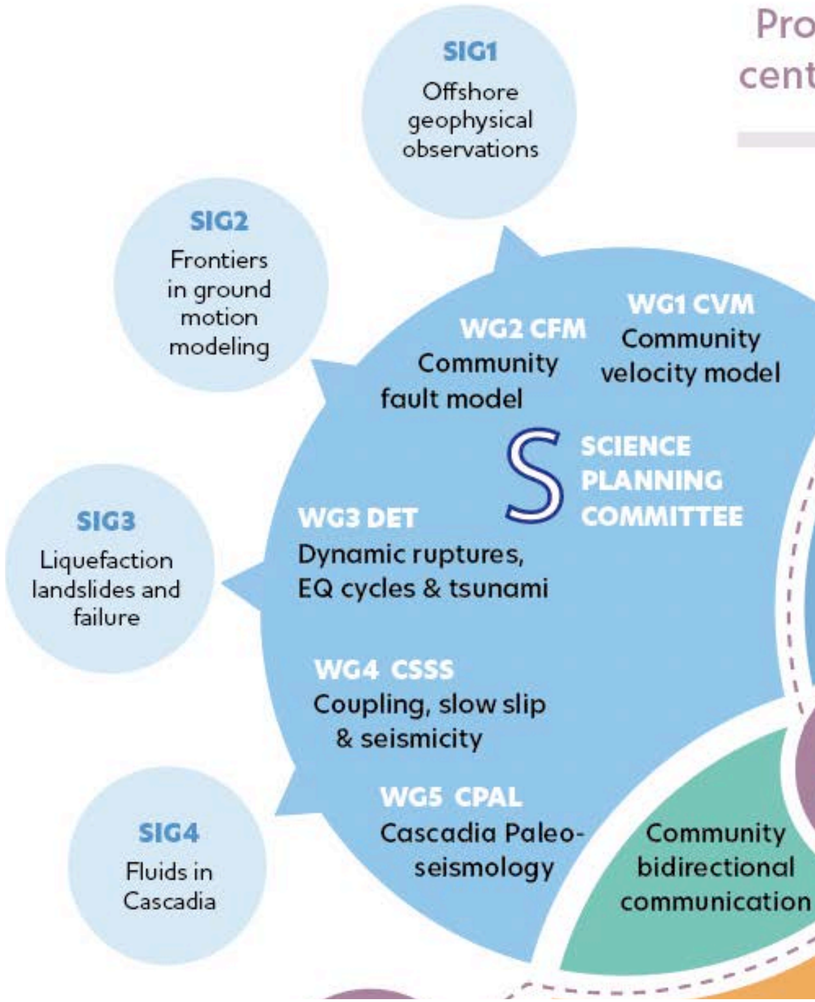
Geoscience Education and Inclusion

- Highschool STEM pathways
- Undergraduate year-long "twinning" internships
- Cores2code summer school
- Geoscience cyberinfrastructure
- Skills building curriculum
- Grad/postdoc travel grants
- Technical short courses

Strong focus on minoritized students!

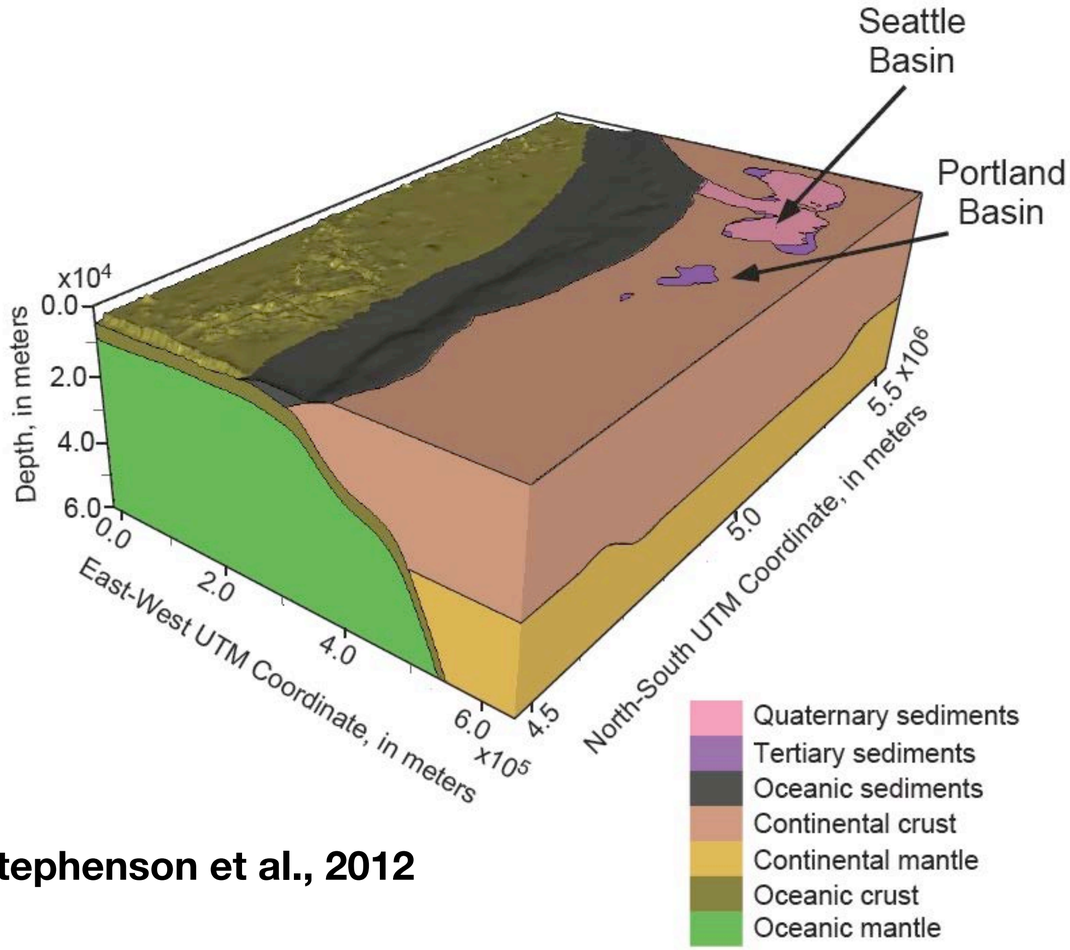
CRESCENT is primarily a research effort

- It's about understanding the **physical earthquake processes** and their **relationships to hazards**
- The bulk of the research is carried out by Working Groups (WGs) who are supported via **directed resources** and have very **specific science deliverables**
- Special interest groups are "proto" WGs and receive small amounts of resources with the hopes of **growing into WGs** later on



WG science and marine geophysics

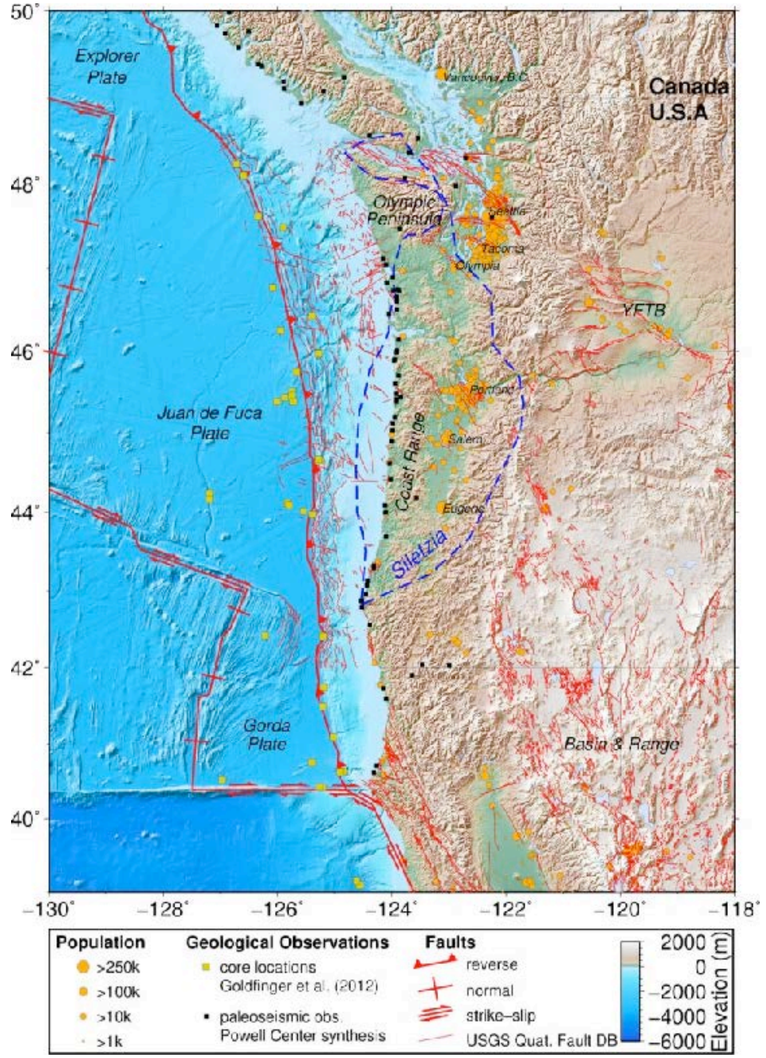
- **Community Velocity Model (CVM)**: The best three dimensional view of the Cascadia Subduction Zone
  - Synthesis and inversion of passive and active onshore/offshore seismic data
  - Ground truth/constrained by coring/drilling information



Stephenson et al., 2012

WG science and marine geophysics

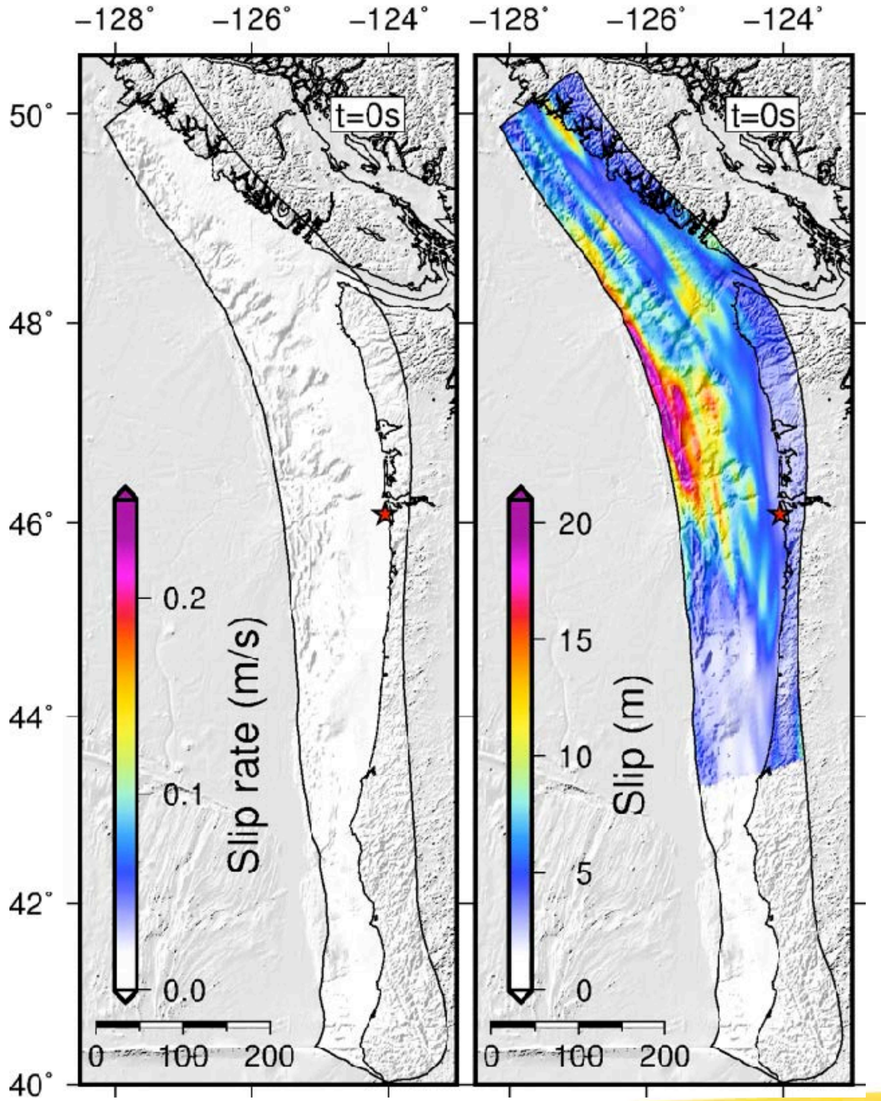
- **Community Fault Model**: A catalog of Cascadia large earthquake sources and their rates of activity
  - Informed by high-resolution bathymetry and active source seismic data
  - Requires combination of paleoseismology and geodesy to establish rates



CRESCENT, 2023

WG science and marine geophysics

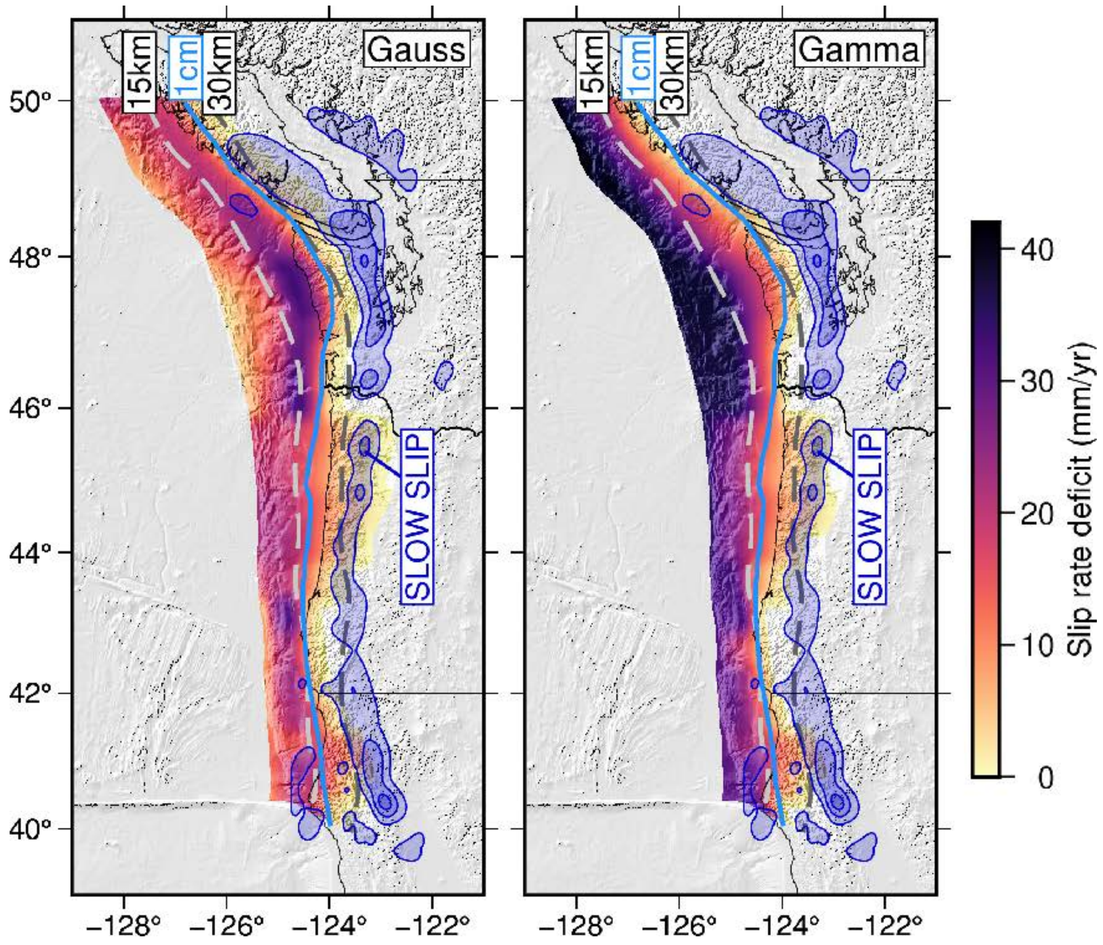
- **Dynamic Ruptures, Earthquake Cycles, and Tsunamis (DET)**: State of the art numerical models of subduction zone processes
  - The model is only as good as the inputs! Depends intimately on veracity of community velocity and fault models



Ruhl et al., 2017

WG science and marine geophysics

- **Coupling, Slow Slip, and Seismicity (C3S)**: Establishing high resolution seismicity catalogs and identifying the state of locking of the megathrust
  - Pointless without widespread seafloor geodetic constraints
  - Requires offshore broadband observations
  - Campaign is ok, long term (permanent) is better



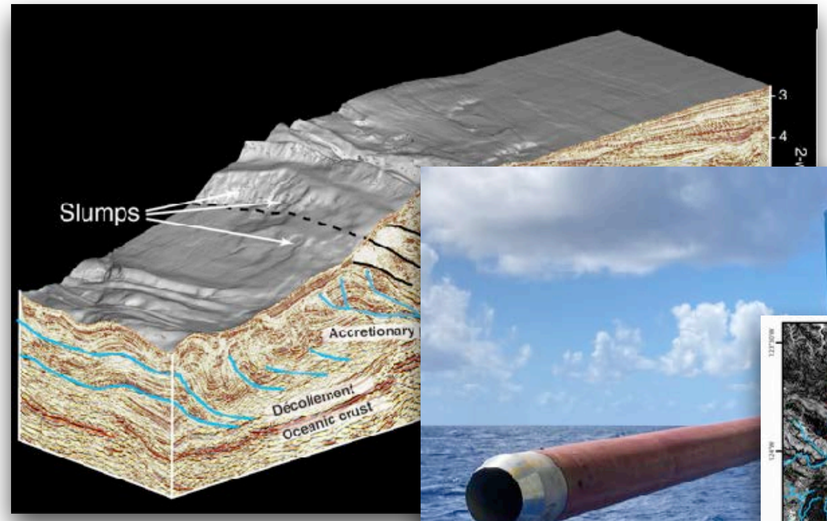
Melgar et al., 2021

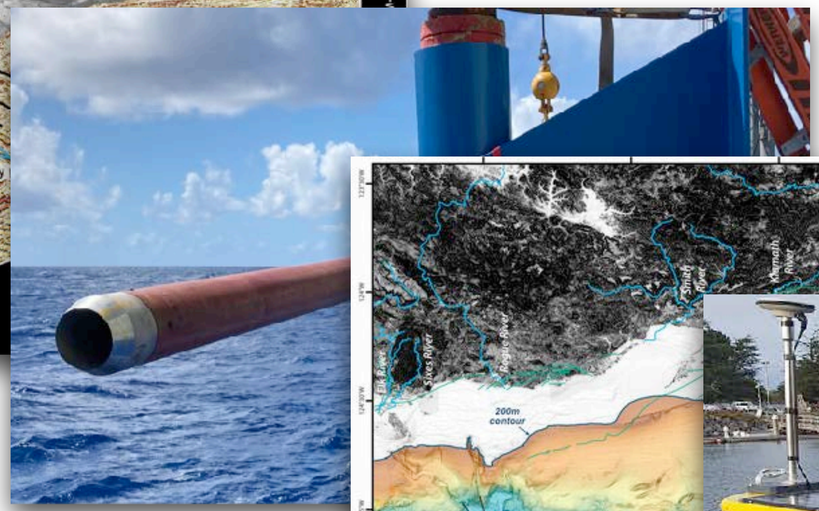
WG science and marine geophysics

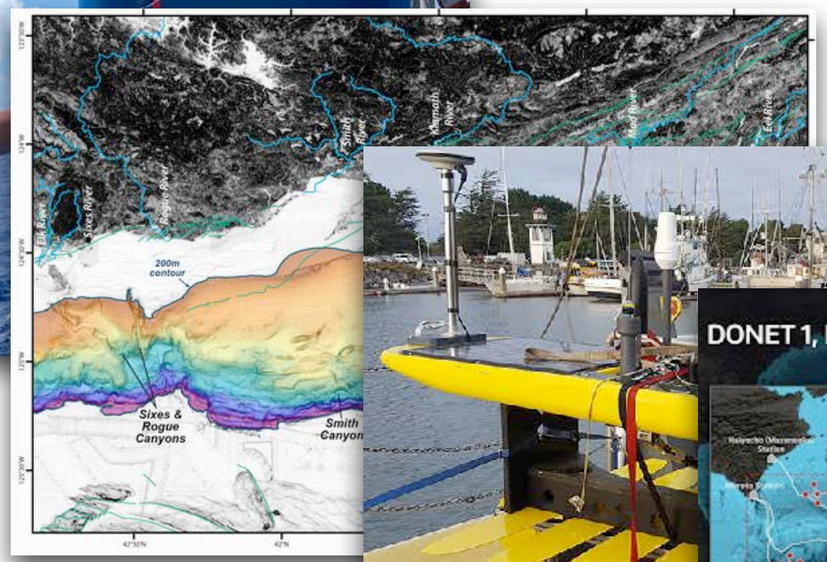
- **Cascadia Paleoseismology (CPAL)**: Establishing event chronologies of past large ruptures
  - Currently focused on onshore proxies but needs are equally great offshore
  - High-resolution bathymetry, new drilling/coring, and 3D active source are key for future work

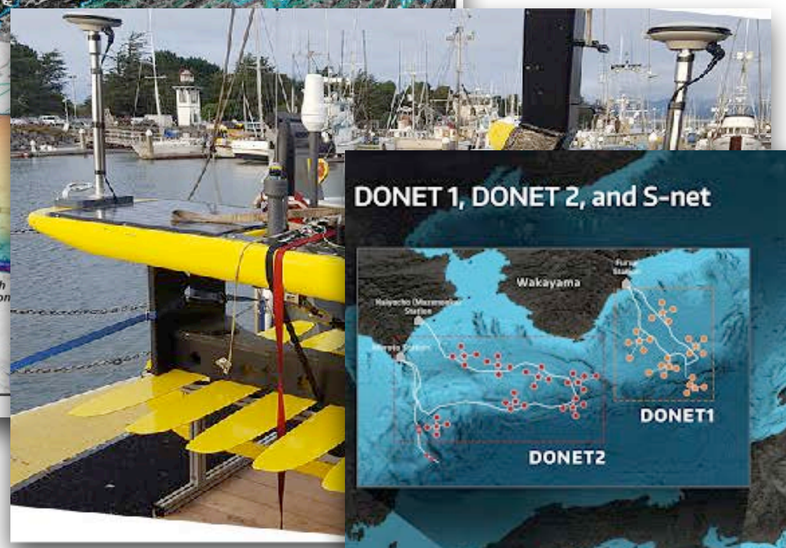
Courtesy: Tina Dura

WG science and marine geophysics









These observations are already informing working group research and models

But in many cases it's not enough to reduce uncertainty in hazards estimates

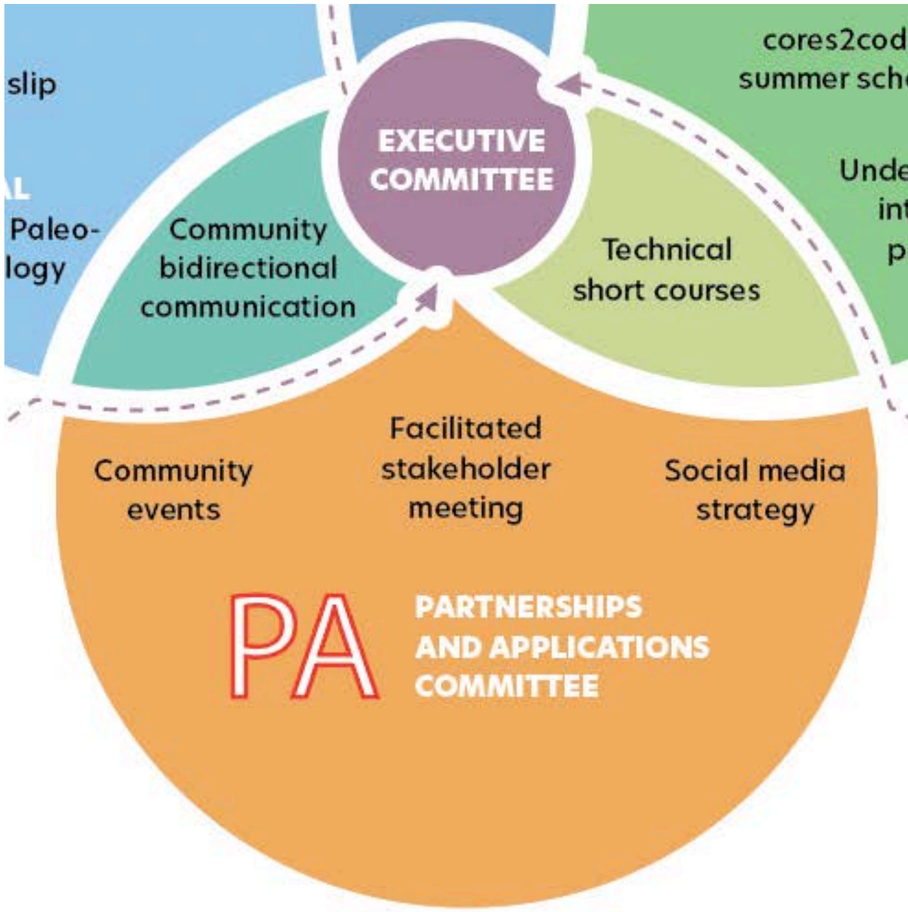
The Partnerships and Applications Pillar

- P&A has the mandate to coordinate the center activities with the CSZ community broadly defined
  - **Earthquake hazards in the CSZ affect an incredibly diverse set of communities and stakeholders each with its own set of need and interests**

- CRESCENT is attempting to be a **pipeline between science and society** and is thus a **relationship building** effort

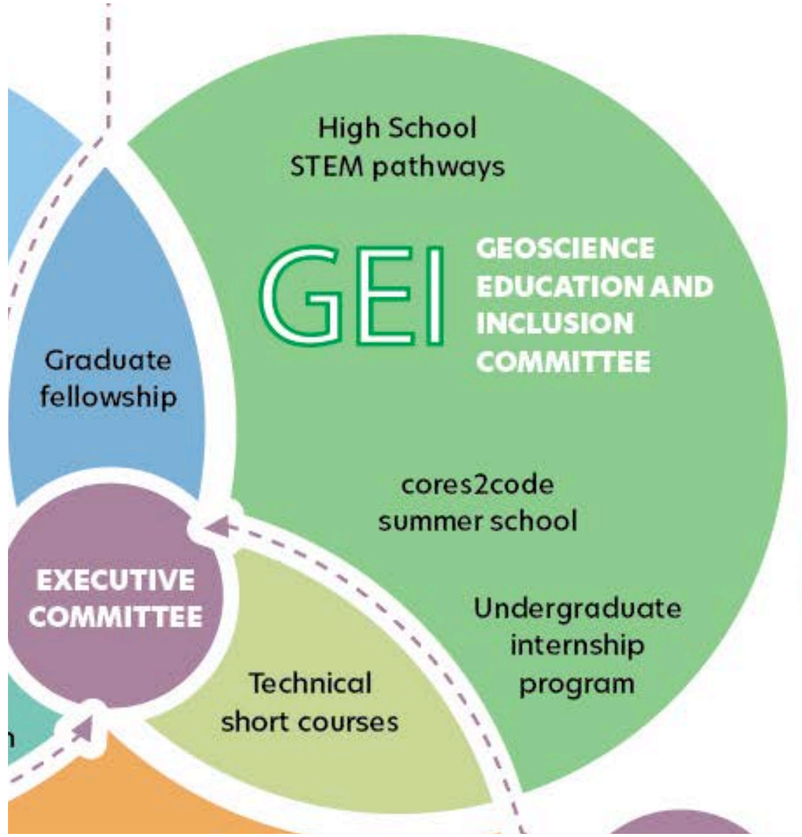
- CRESCENT also seeks to establish practices that allow **co-creation** of knowledge

- The (sometimes) **artificial onshore/offshore divide** adds complexity to this effort. Finding ways to blur that boundary will be useful



The Geoscience Education and Inclusion Pillar

- Our needs (or insufficiencies) are equally great (perhaps more?) when considering **marine geoscience**
- The field is **not perceived to be welcoming** by potential new scientists from minorities backgrounds
- Building a **modern and diverse workforce** is a major concern
- Issue is already coming to a head in other disciplines (**e.g. the geodesy crisis**)
- We need to be creative and rethink how we approach the problem. The **geosciences should be a recruitment no brainer**, why re we failing so clearly (hint: retention)?



Get in touch with us!

CRESCENT
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