CRESCENT Offshore Observations SIG

Meeting Starts at 12:35 PM

USGS Subduction Zone Science Meeting
University of Washington
January 8, 2025

Offshore Observations Special Interest Group (SIG)

https://cascadiaquakes.org/offshore-observations/

The source region of the next large subduction zone earthquake in Cascadia is offshore where few instruments are located. Enhancing the quality and quantity of offshore observations in Cascadia is critical to long-term efforts of advancing CRESCENT science goals and estimating the seismic hazard. The Offshore Observations special interest group will gather broad community input on observational needs and priorities and will identify specific areas for accelerated progress through coordination and the development of collaborations that link the academic community, government entities, private companies, and international partners. In 2025, CRESCENT will host a community workshop, bringing the Cascadia offshore science community together to discuss recent progress, observational needs, and the path forward for the Offshore Observations group.

How the group works

- Build a big team (in progress)

Brian Boston, Ben Brooks, Joseph Byrnes, McKenzie Carlson, Erik Fredrickson, Jianhua Gong, Jesse Hutchinson, Hiba Kunwer, Anna Ledeczi, Maddy Lucas, David Schmidt, Janet Watt, Matt Wei, William Wilcock, Miao Zhang

- Identify topics where discussions and coordination can make a difference
- Zoom meetings at a sustainable rate (every 2 months?)
- In person meetings

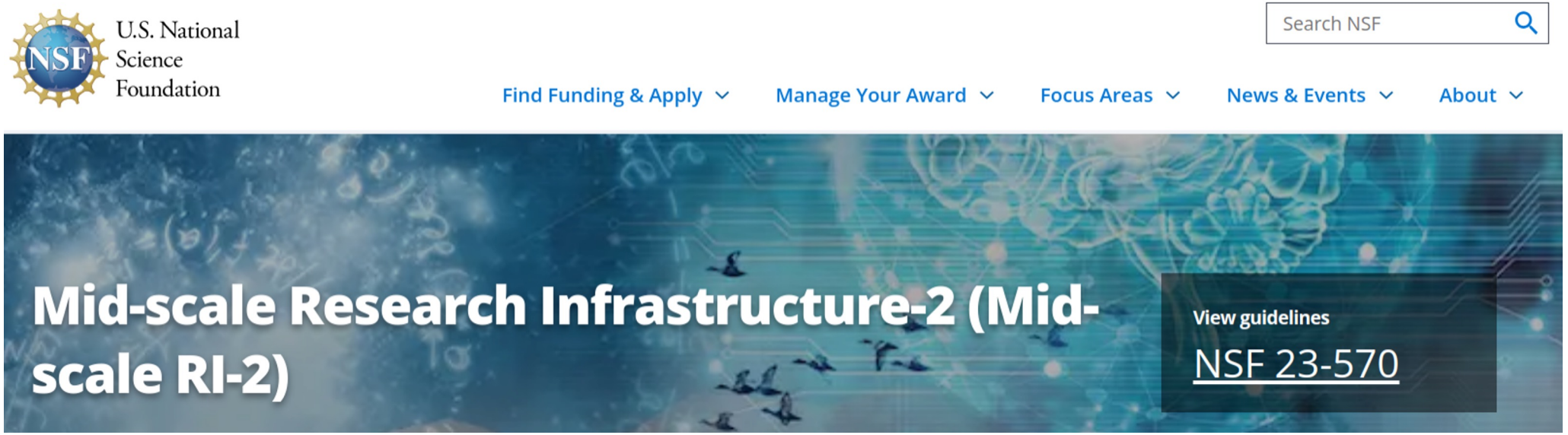
  October 22, 2025, location TBD
  preceding the Fall CRESCENT meeting (October 23-24)

Today's Agenda

12:15	USGS SZ Science meeting adjourns
	20 minutes to grab lunch in the HUB foodcourt
12:35	Introduction to the CRESCENT Offshore Observations SIG
12:40	Topic 1. Update on SZ4D planning for offshore observations in Cascadia and Alaska
13:00	Topic 2. Shallow deformation of the Cascadia accretionary wedge
13:20	Topic 3. Other planned SIG activities
13:35	End
13:45	USGS SZ Science meeting resumes

Topic 1. Update on SZ4D planning for offshore observations in Cascadia and Alaska

- Nov 18 — Virtual Discussion of SZ4D Offshore in Cascadia
- Jan 6 — SZ4D Organized Meeting
  Cascadia & Alaska Infrastructure/Data Planning Meeting
- Today — Quick Recap of yesterday's meeting
- Feb 18, 8:30-10 AM Pacific Time
  Virtual Discuss of SZ4D Offshore in Cascadia II



Supports the implementation of research infrastructure - including equipment, cyberinfrastructure, large-scale datasets and personnel - whose total project costs fall between $20 million and $100 million.

- Construction only (5 years):
  - Infrastructure procurement/fabrication, commissioning, and installation
- Operations and Maintenance is separate and also must be affordable to NSF-GEO

Courtesy Diana Roman

MSRI-2 Pre-Award Process (2023 Cycle)

Preproposal anticipated in June 2025

SZ4D is working towards an MSRI-2 submission in the next cycle (assumed 2025, so all dates +2 years).

Courtesy Diana Roman

Locations for study

Recommend:

- Complementary domestic and international sites

Regions of Special Interest:

- Chile

70% Instrumentation; 50% Activities

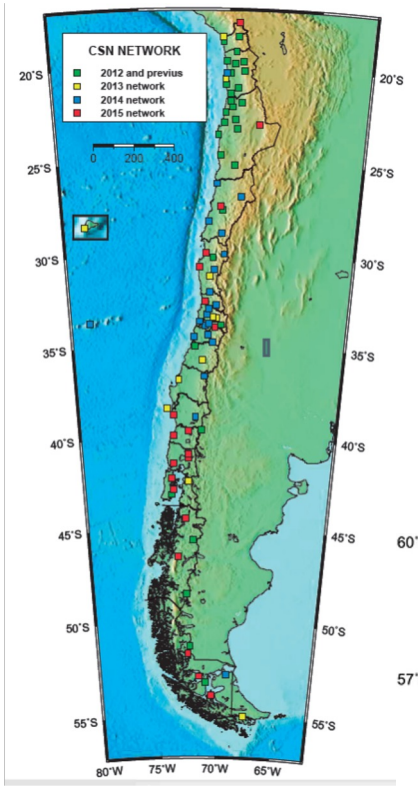
- **Cascadia**

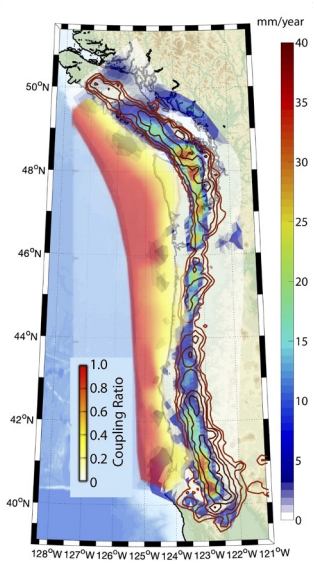
20% Instrumentation; 40% Activities

- **Alaska**

10% Instrumentation; 10% Activities

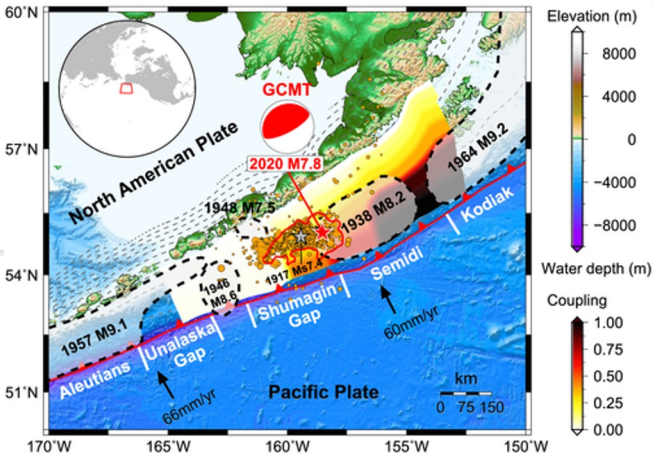
Courtesy Diana Roman





Bartlow (2020)

Liu et al. (2020)



SZ4D MultiHazard Array: Alaska and Cascadia Nodes

SurfaceArray:

- Opportunistic studies and event response to mass movement events (Alaska and Cascadia)

EarthquakeArray:

- **9 OBS/GNSS-A (Alaska)**
- 10 onshore seismic/GNSS (Alaska)
- **9 GNSS-A+APG (Cascadia) + 2 wavegliders**

VolcArray:

- 3 Volcano Sensor Arrays (Cascadia)
- 2 Volcano Imaging Arrays (Cascadia)
- 5 Volcano Sensor Arrays (Alaska)

Courtesy Diana Roman

Faulting and Earthquake Cycles (FEC) Science Questions (see https://www.sz4d.org/fec)

1. How do subduction zone fault systems interact in space and time? How do these fault systems and associated deformation regulate subduction zone evolution and structure?
2. What controls the speed and mode of slip in space and time?
3. Do distinctive precursory slip or distinctive foreshocks occur before earthquakes? What causes either foreshocks or precursory slip?
4. Under what physical conditions and by what processes will slip during an earthquake displace the seafloor and increase the likelihood of generating a significant tsunami?

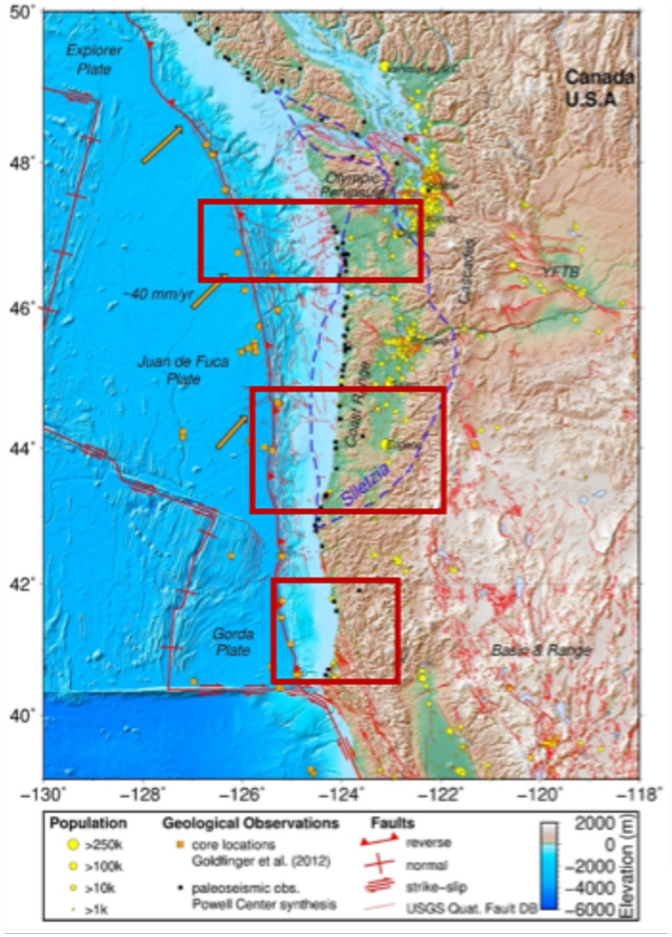
Courtesy Diana Roman

Cascadia EarthquakeArray Corridors

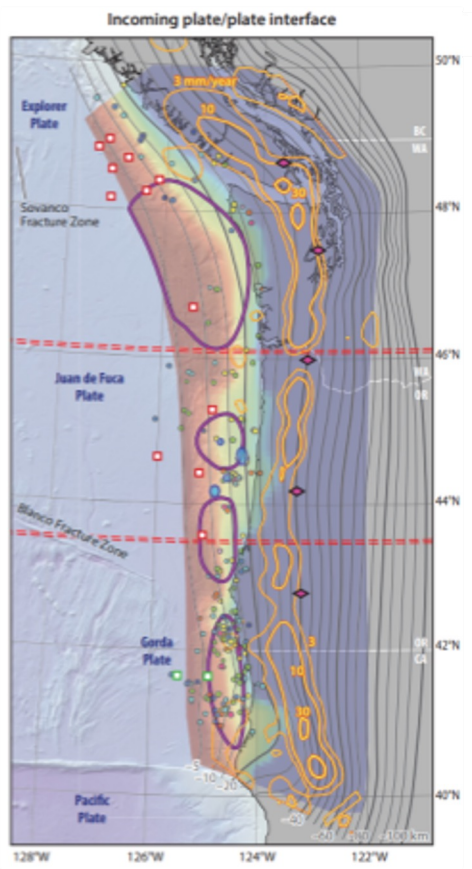
(~3-4 GNSS-A + APG per transect)

1. Northern Cascadia: Widest locked zone, which may continue to trench; overriding plate faults
2. Central Cascadia: Variation in locking and upper plate terranes
3. Southern Cascadia: Relationship of upper plate faulting and megathrust

Refine based on other planned deployments (community geodesy experiment, OOI cable deployment plan) and logistics (e.g., bathymetry, CASIE seismic lines)



(Figure from CRESCENT, 2024)



Walton et al. (2021 Annu. Rev.)

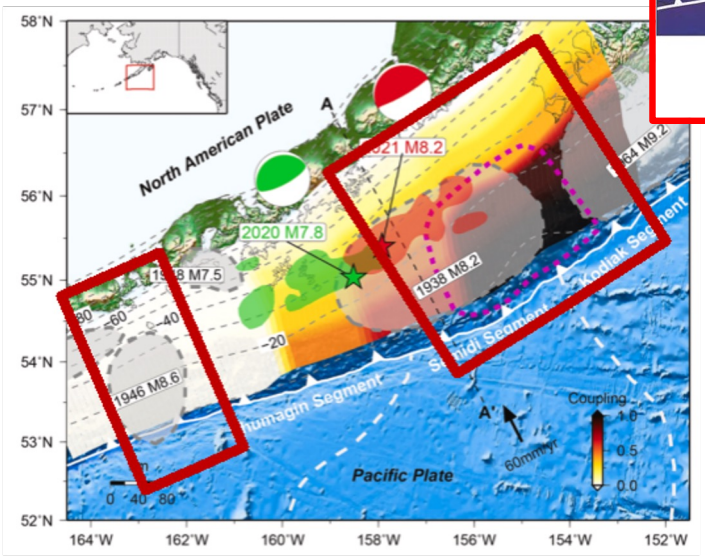
Courtesy Diana Roman

Alaska EarthquakeArray Corridors

(9 OBS/GNSS-A, 10 onshore seismic/GNSS)

1. Offshore across the major change in locking in the Semidi segment
2. Eastern part of 1964 rupture in area of active splay faulting (so very close to land)
3. Possibly 1946 rupture zone. (lower priority)

Refine based on other planned deployments



Courtesy Diana Roman

Yesterday's Meeting

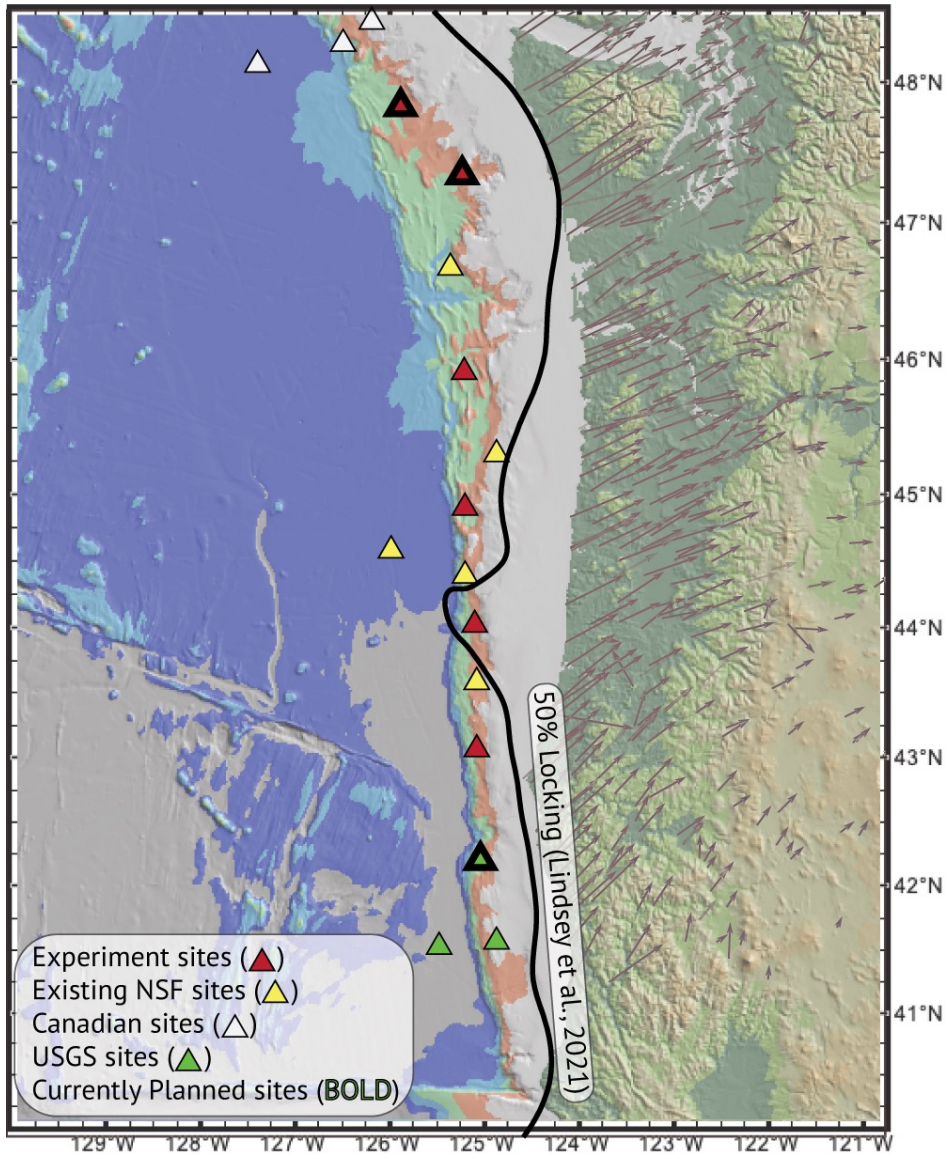
5-minute Stakeholder Presentations.

Breakout 1 (Cascadia/Alaska) focused more on scientific priorities.

Breakout 2 (Onshore/Offshore) focused more on broader data utility and network logistics.

Diversity of ideas/opinions focused on providing the SZ4D proponents with constructive input to optimize the scientific impact and synergies of their infrastructure plans.

GNSS-A Cascadia



Courtesy Andy Newman

GNSS-A Alaska

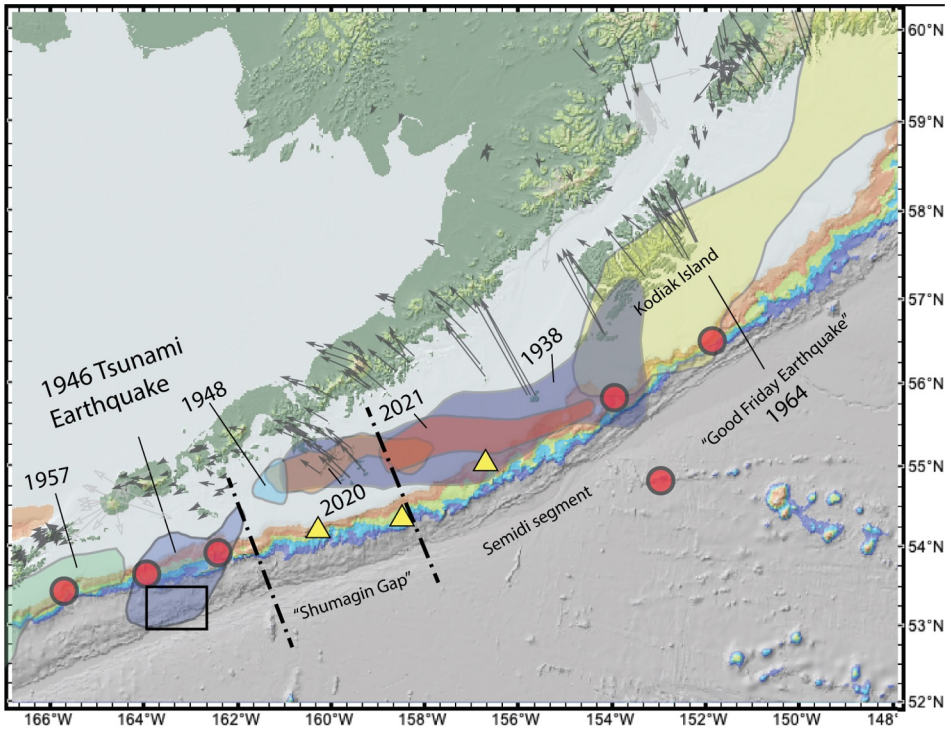


Figure 1: Alaska GNSS-Acoustic instrument deployment in summer 2024, including 6 GNSS-Acoustic triads (18 transponders) for the Near-Trench Community Experiment, and the 10-transponder Mesh network described here. Also shown are three previously operated sites (yellow triangles; Brooks et al., 2023), earthquake history within the past century (Tape and Lomax, 2022), and on-land GNSS results relative to a fixed North American Plate (Elliot et al., 2020).

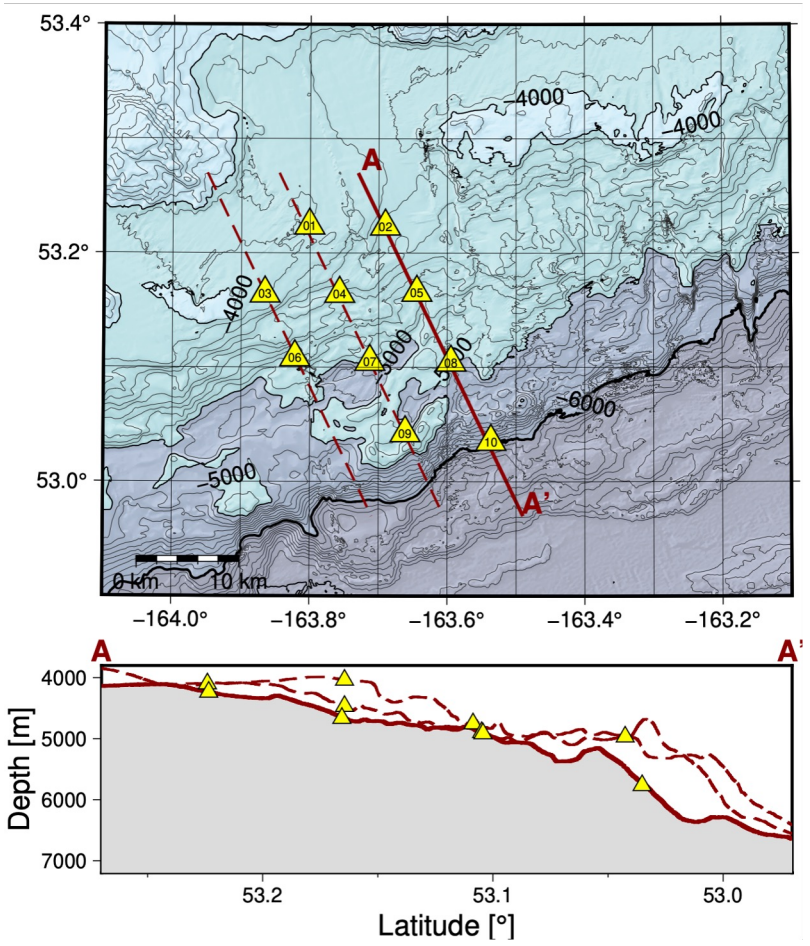


Figure 2: [top] Final deployment geometry of Mesh network was between 4000 and 6000 m water depth, with highly variable topography. [bottom] Latitudinal profiles are shown along the transects in map view. Gradients are up to ~10% nearest the trench (Max between transponders 9 and 10 @ 9.6%)

Courtesy Andy Newman

Discussion

Topic 2. Shallow deformation of the Cascadia accretionary wedge

Ben Brooks and Janet Watt presented for 20 minutes on the intersection between seafloor geodesy and seismic/bathymetric observations of recently active faults.

Ben Brooks

- USGS contributing to GNSS-A on southern Cascadia to constrain shallow locking and the dynamics of the Gorda Plate
- Examples from Taiwan, Himalaya and Central Andes where GNSS velocities can be linked to the distribution of active faults

Topic 2. Shallow deformation of the Cascadia accretionary wedge

Janet Watt

- Presentation of ongoing work by USGS and Harold Tobin's group (Anna Ledeczi & Maddy Lucas) on splay faults in Cascadia that have been active in the later Quarternary.
- Ongoing work to characterize age, slip sense, dip, length and connectivity to megathrust
- Objective is to integrate into hazards models
- Future focus
- Quantitative analysis of shallow deformation
- Enhanced geodetic observations
- Modeling to understand probability of trench rupture

Discussion

Topic 3. Other Topics

In the works:

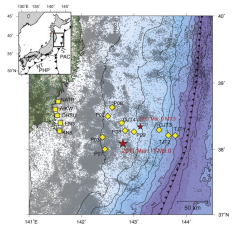
- Offshore Observations for Tsunami Forecasts
- Cabled Offshore Observations & Fiber Sensing

SIG Activity: Coordinating a search for offshore SSEs in Cascadia

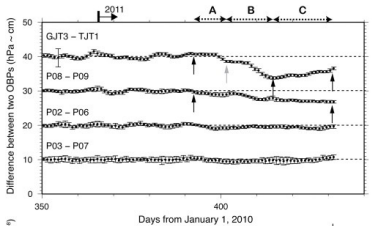
Erik Fredrickson

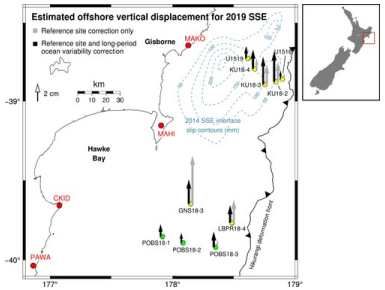
January 8, 2025

SSE activity elsewhere

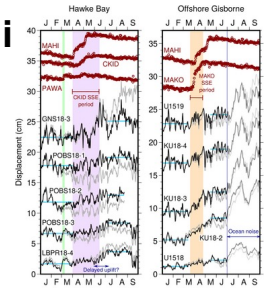


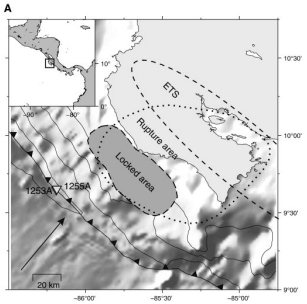
Japan Trench
Ito+ 2013

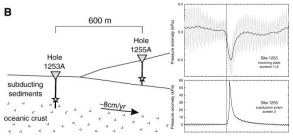




Hikurangi
Woods+ 2022

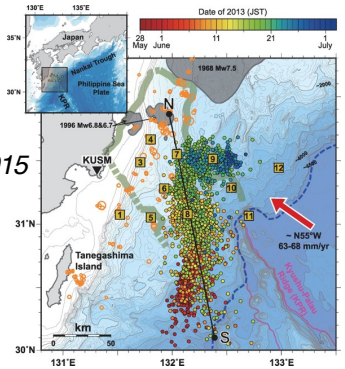






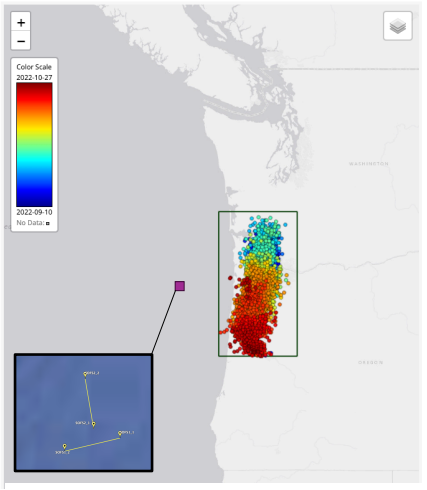
Costa Rica
Davis+ 2011

Nankai
Yamashita+ 2015



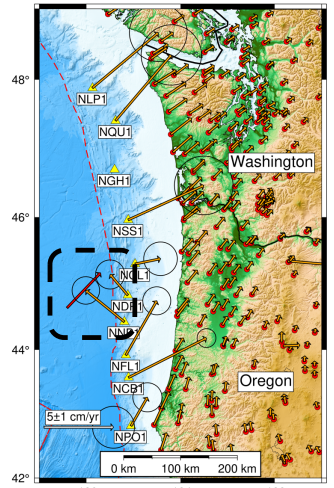
Cascadia examples?

Seafloor fiberoptic strainmeters



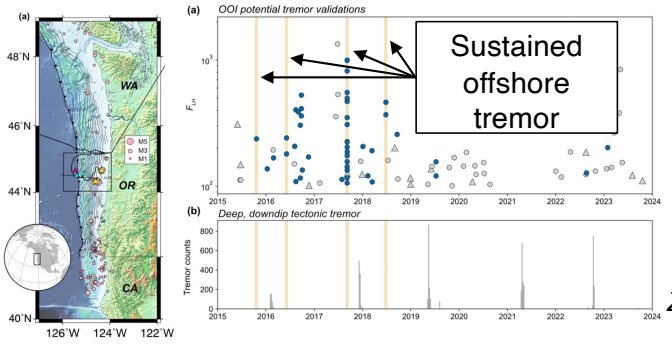
Noel Jackson

GNSS-A



John DeSanto

OBS tremor



Zoe Krauss

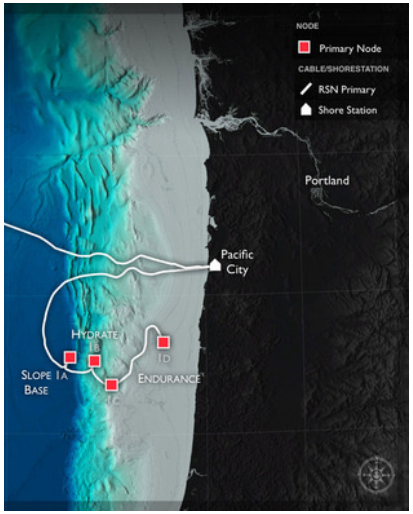
Goal: focus group activity to develop an offshore SSE detection experiment

- What kinds of observations would we want to make?
- Where would we place instruments?
- When would these be deployed and for how long?
- Cabled vs. uncabled?
- Importance of data telemetry?
- Etc., etc.

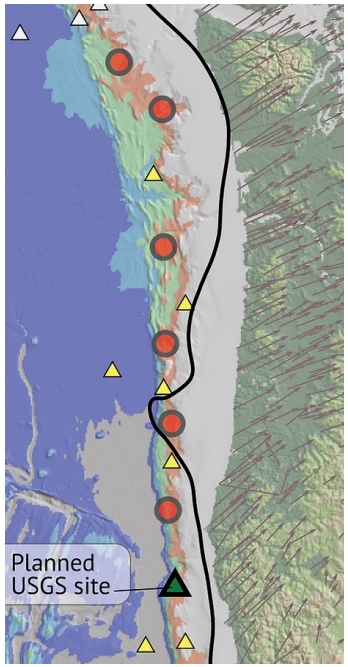
Existing Infrastructure

Ocean Networks Canada

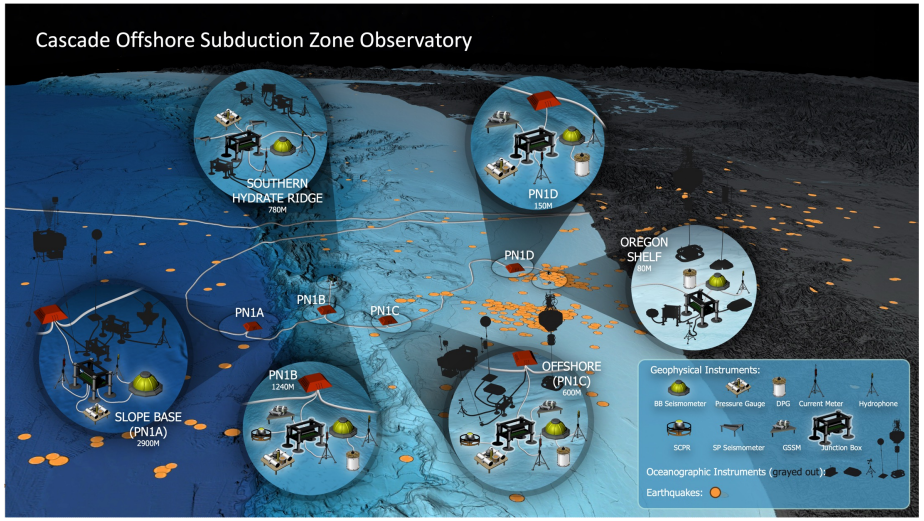
Ocean Observatories Initiative



GNSS-A



Incoming Infrastructure



SZ4D auxiliary instrumentation

- 9 GNSS-A w/ APGs

Discussion

Upcoming CRESCENT Offshore Observations SIG Events

- Virtual Discuss of SZ4D Offshore in Cascadia, part 2

  Tuesday, February 18, 8:30-10 AM Pacific Time

- Virtual Meetings

  TBA

- In person

  Wednesday, October 22, All Day, location TBA