Update on Recent Offshore Seismic Activity and ShakeAlert's Performance

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University of Oregon

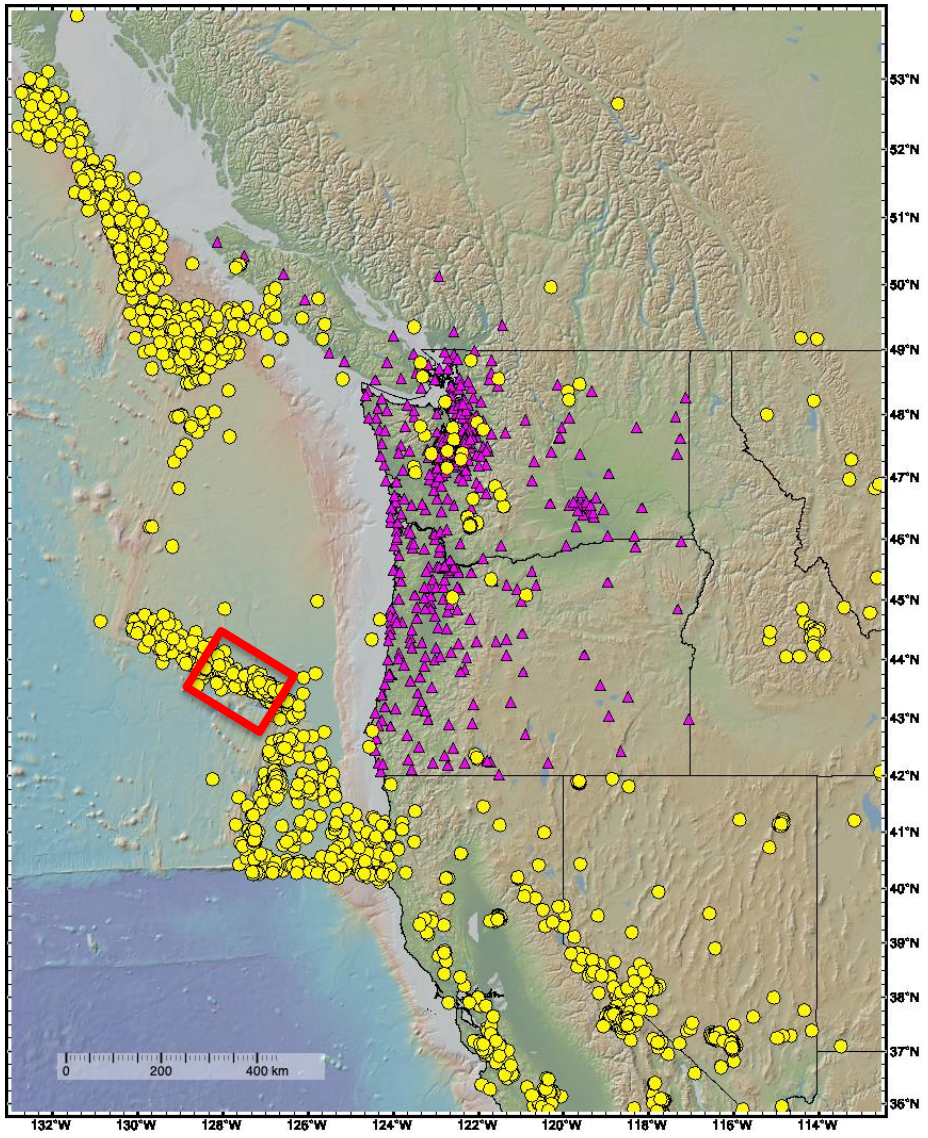
Oregon Hazards Lab

Outline

1. Recent Offshore Earthquake Activity
   - Review of recent & historical offshore seismicity
   - Recent events do not present societal risks

2. ShakeAlert Performance
   - When does ShakeAlert generate an alert?
   - Recent events occurred outside of alerting region
   - ShakeAlert performed well by not generating an alert

3. Update on ShakeAlert
   - Public Alerting, March 11, 2021!
   - Progress with State Bonds
   - Stakeholder partnerships
   - FEMA pre-applications that leverage funds and benefit regions impacted by 2020 wildfires



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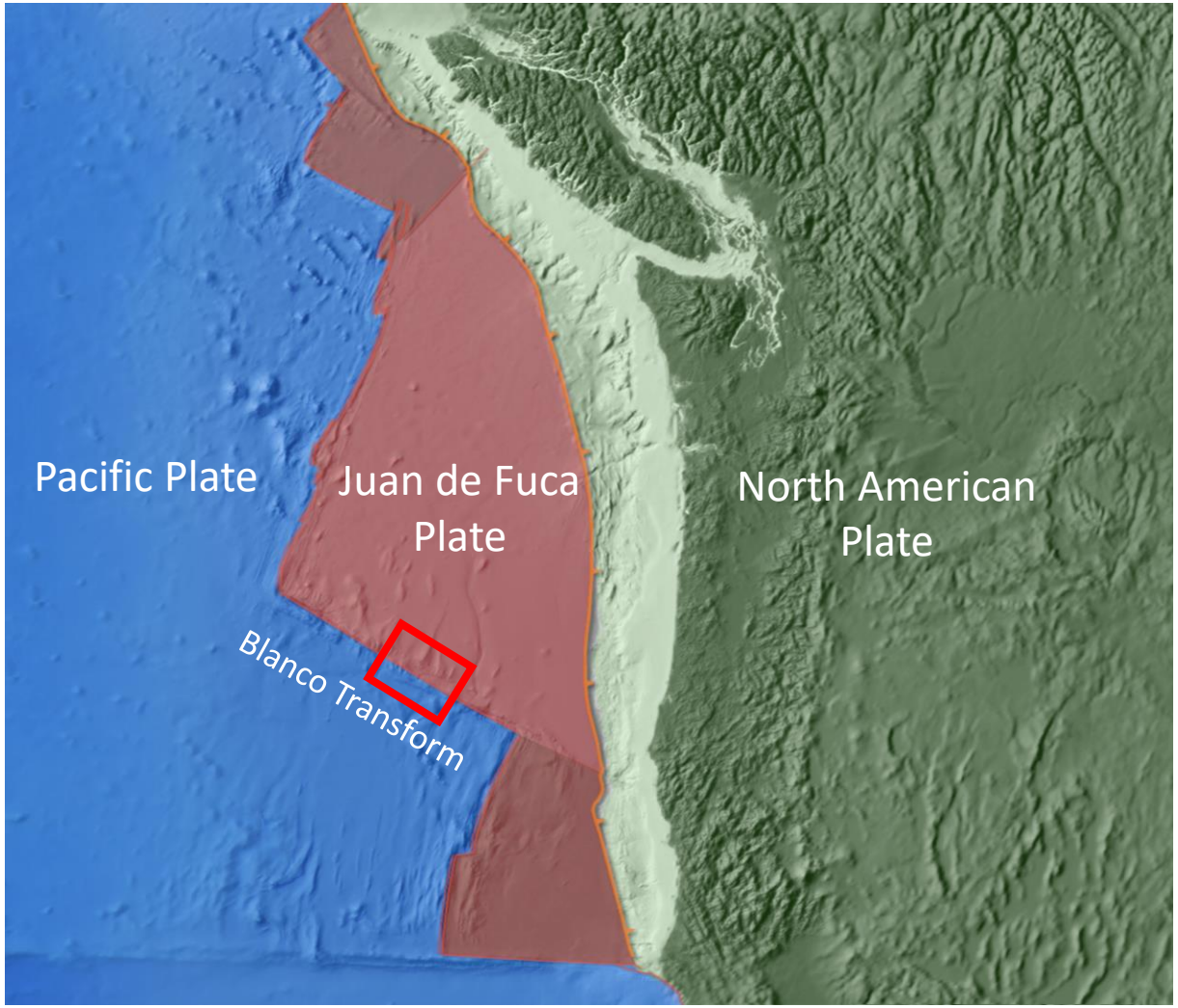
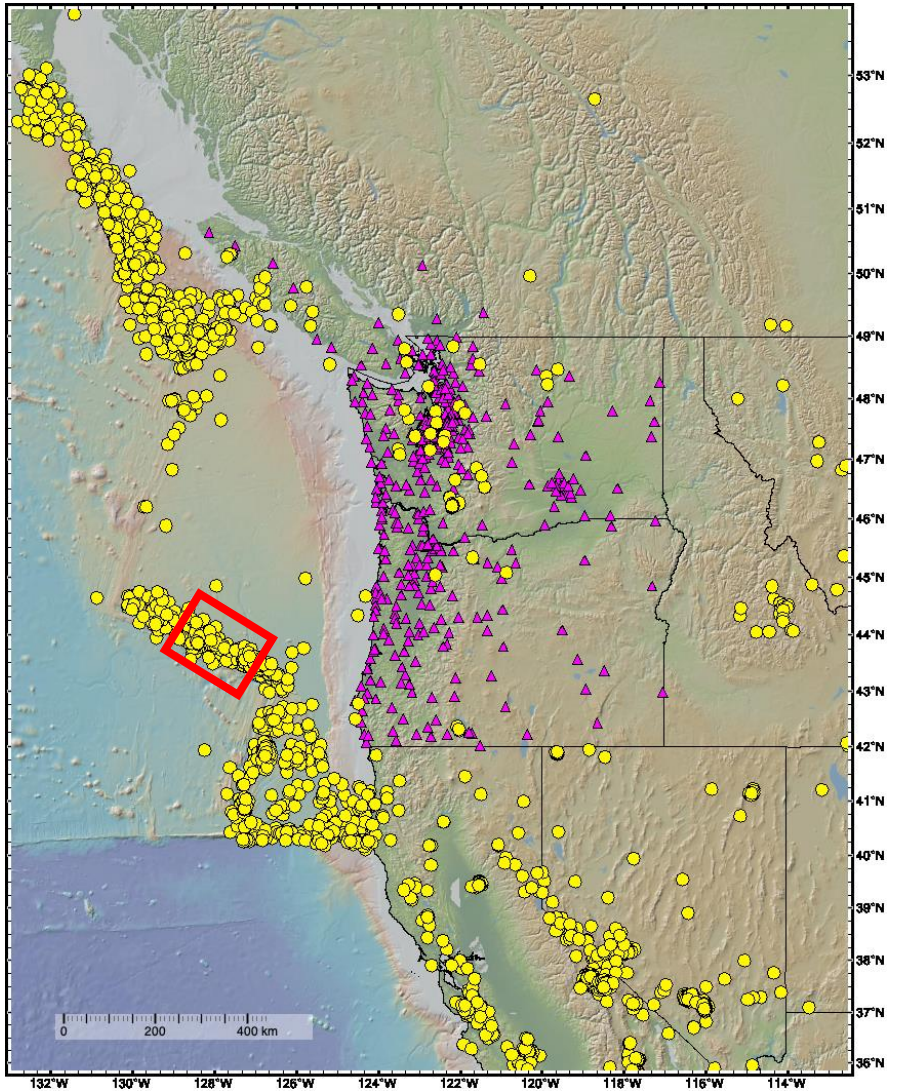


In the oceans, earthquakes cluster near plate boundaries



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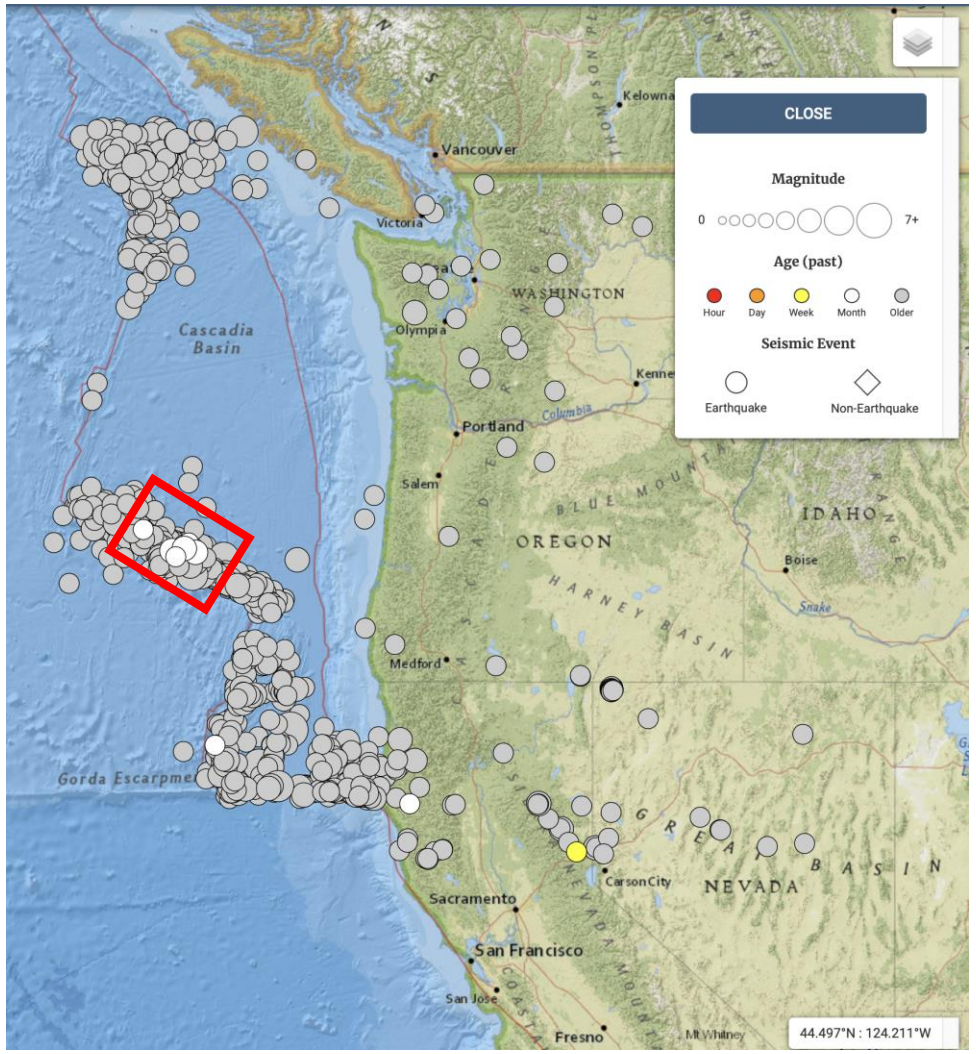
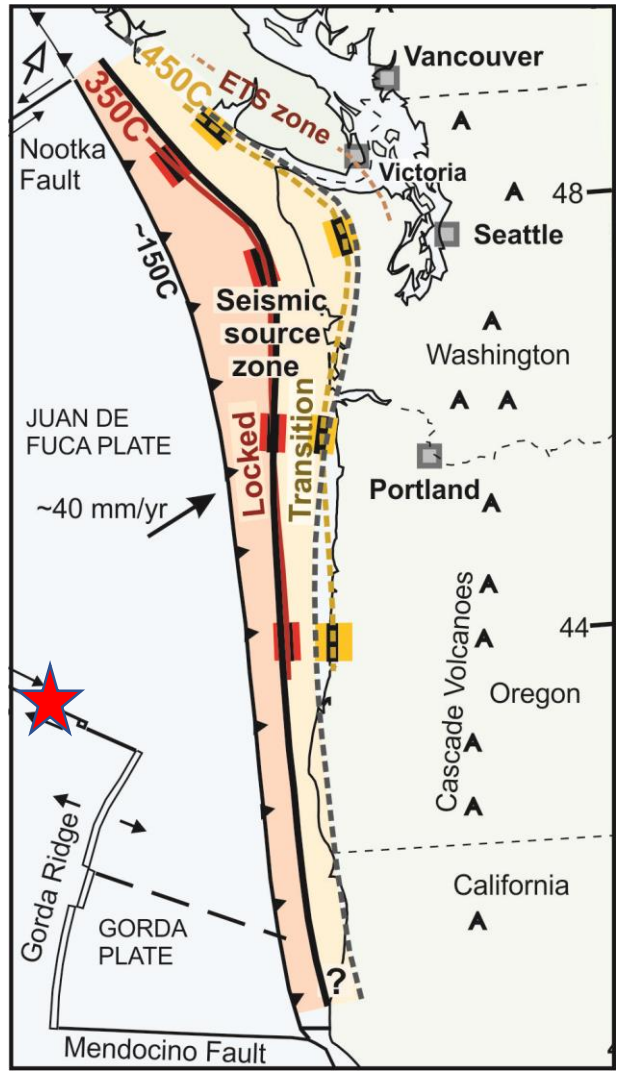
April 29, 2021: Blanco Transform Sequence

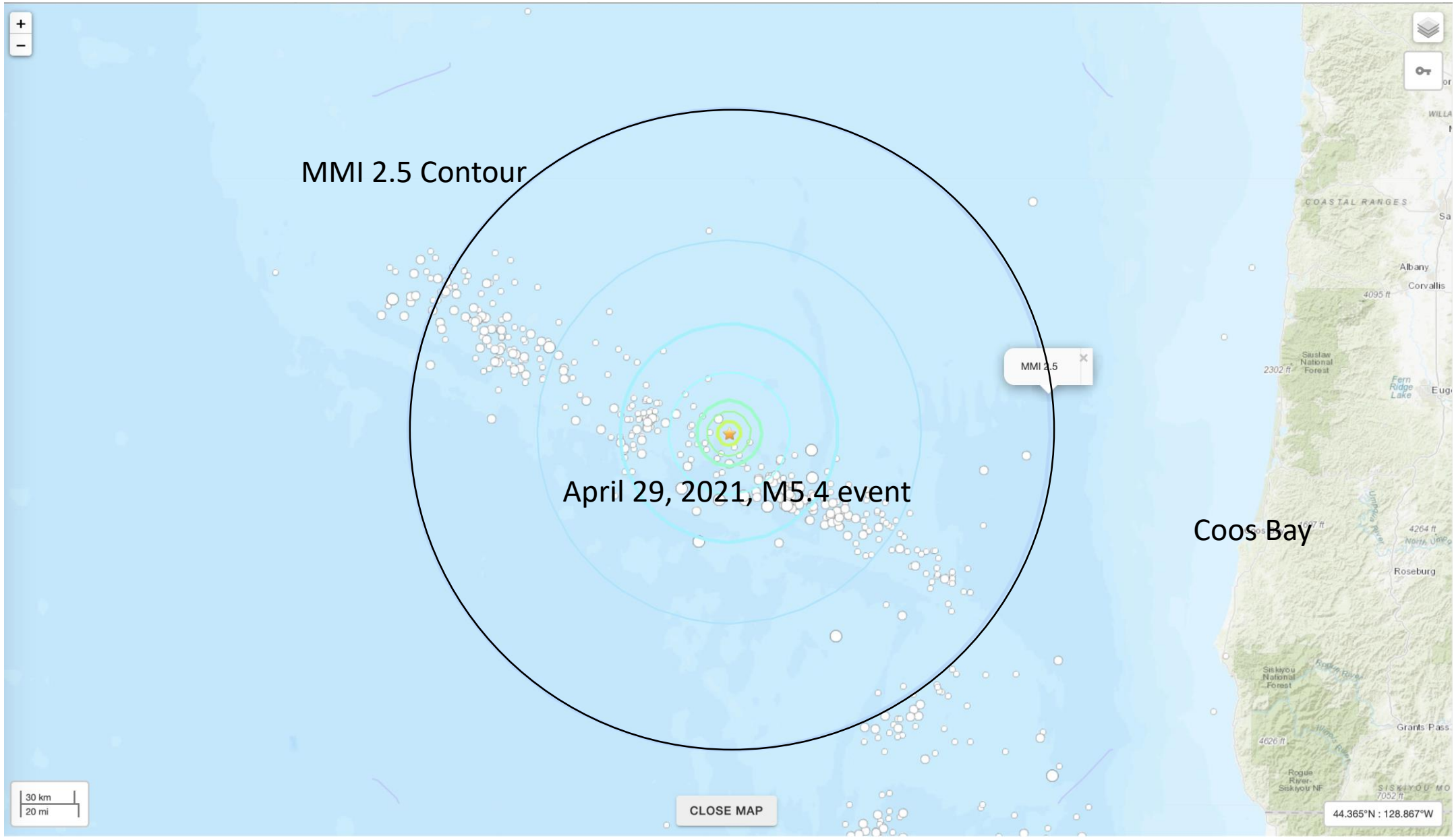
- Largest event M5.4
- Sequence of M4 to M5.4 events
- Epicenters (white circles in read box) ~200 miles from Oregon coast
- Not a societal risk
- Shaking not felt on coast
- Type of earthquake does not generate a tsunami





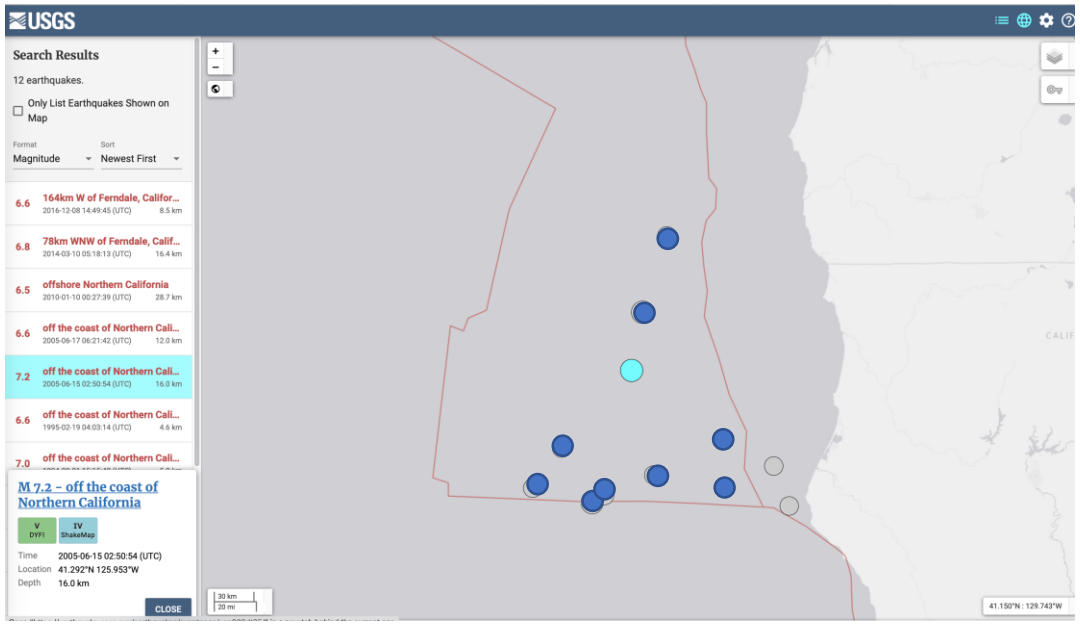
Modified Mercalli Intensity (MMI) Scale: What a person feels

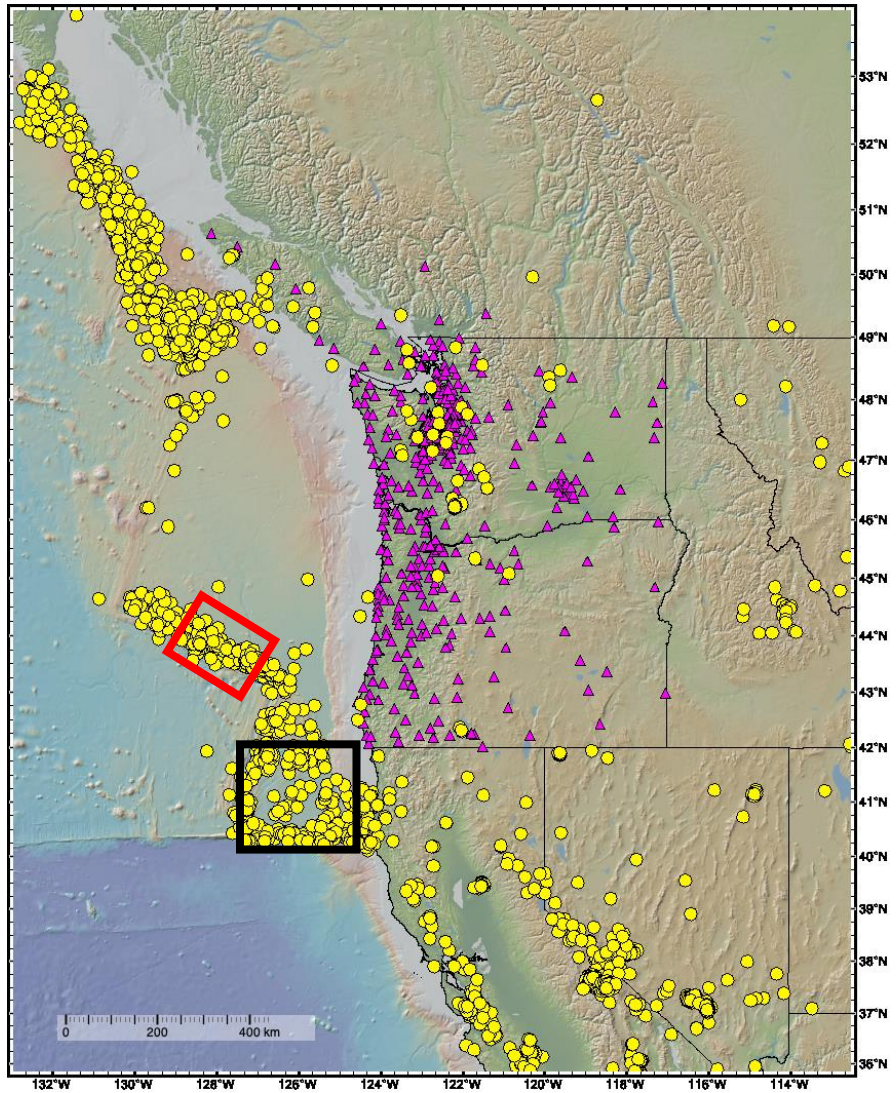
Intensity	Shaking	Description/Damage
I	Not felt	Not felt except by a very few under especially favorable conditions.
II	Weak	Felt only by a few persons at rest,especially on upper floors of buildings.
III	Weak	Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibrations similar to the passing of a truck. Duration estimated.
IV	Light	Felt indoors by many, outdoors by few during the day. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like heavy truck striking building. Standing motor cars rocked noticeably.
V	Moderate	Felt by nearly everyone; many awakened. Some dishes, windows broken. Unstable objects overturned. Pendulum clocks may stop.
VI	Strong	Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight.
VII	Very strong	Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures; some chimneys broken.
VIII	Severe	Damage slight in specially designed structures; considerable damage in ordinary substantial buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned.
IX	Violent	Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations.
X	Extreme	Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent.


MMI 2.5 Contour
April 29, 2021, M5.4 event
Coos Bay
MMI 2.5
CLOSE MAP
30 km
20 mi
44.365°N : 128.867°W
COASTAL RANGES
Albany
Corvallis
Roseburg
Grants Pass
Fern Ridge Lake
Siuslaw National Forest
Siskiyou National Forest
Rogue River-Siskiyou NF

Other offshore events

- The region offshore of Northern California is seismically active (black box)
- Largest event, M7.2 occurred on June 15, 2005
  - 100 miles offshore
  - Strike slip earthquake
  - Did not generate tsunami
  - MMI on coast of CA typically III to IV (weak to light shaking)





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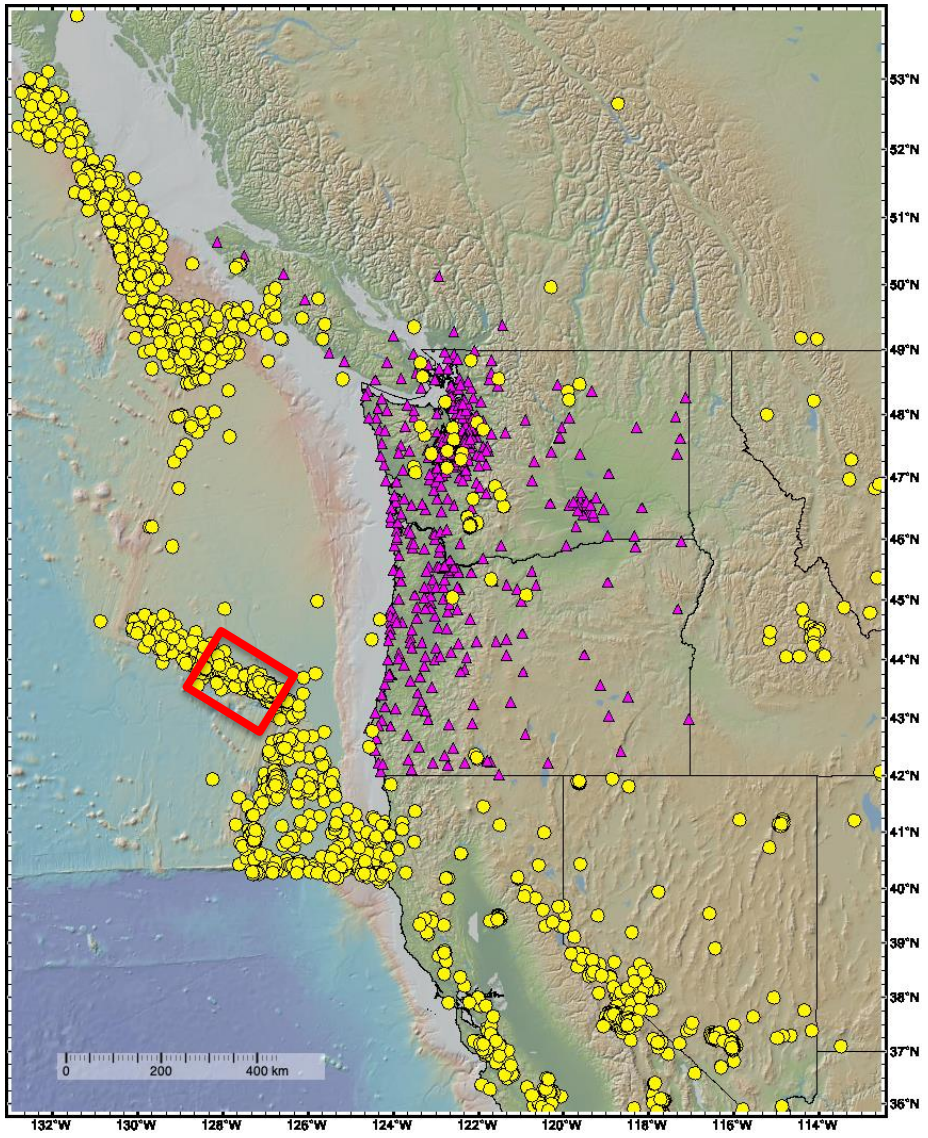

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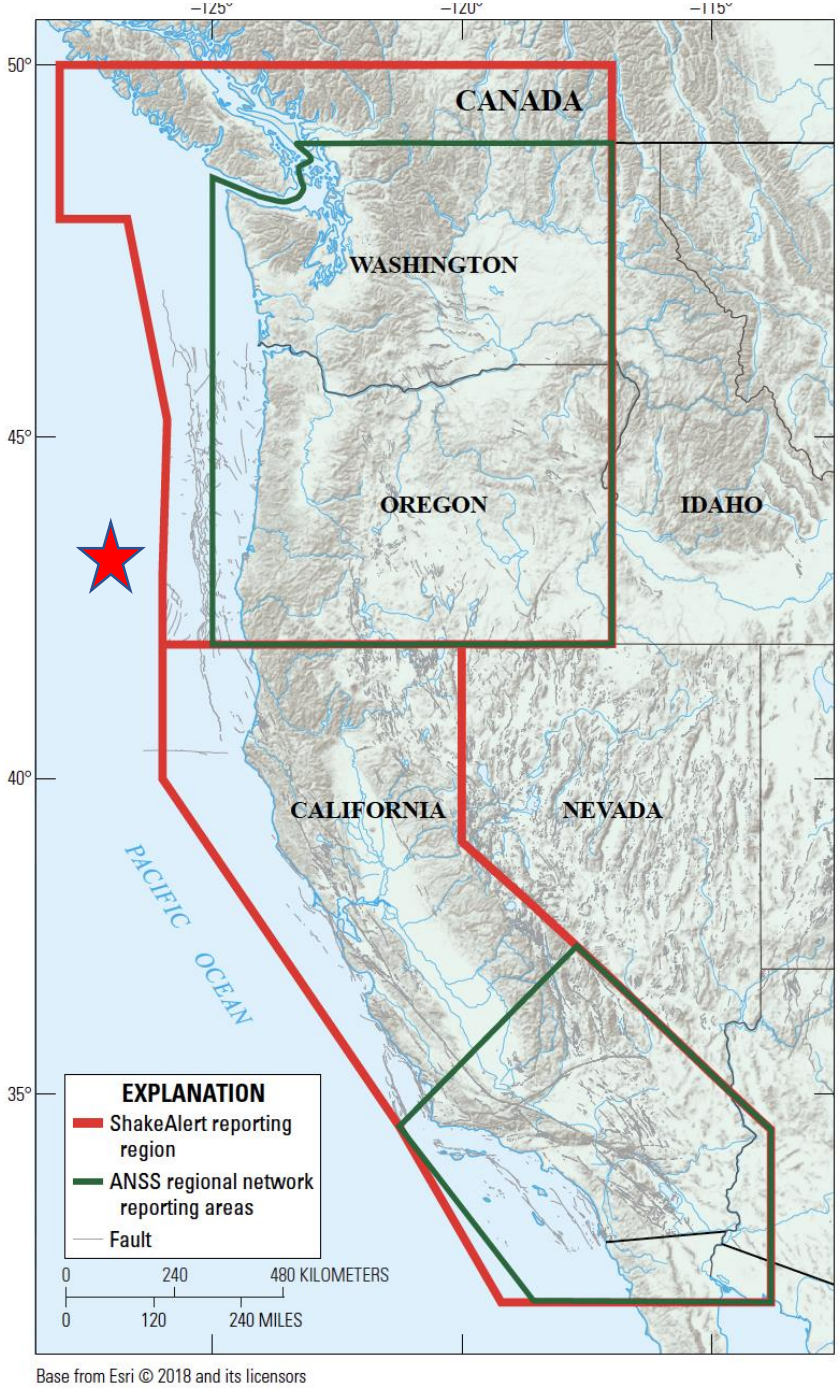
When is a ShakeAlert Delivered to Public?

- Earthquake must be within alerting region (limits of red polygon)
- Earthquake magnitude and shaking intensity exceed thresholds
  - **App Alerts** (> M4.5, MMI 3+ area; weak)
  - **WEA Alerts** (> M5.0, MMI 4+ area; light)
- The Blanco earthquakes (red star) were outside the alerting region; also, onshore MMI << 3
- ShakeAlert correctly did NOT deliver an alert; good performance



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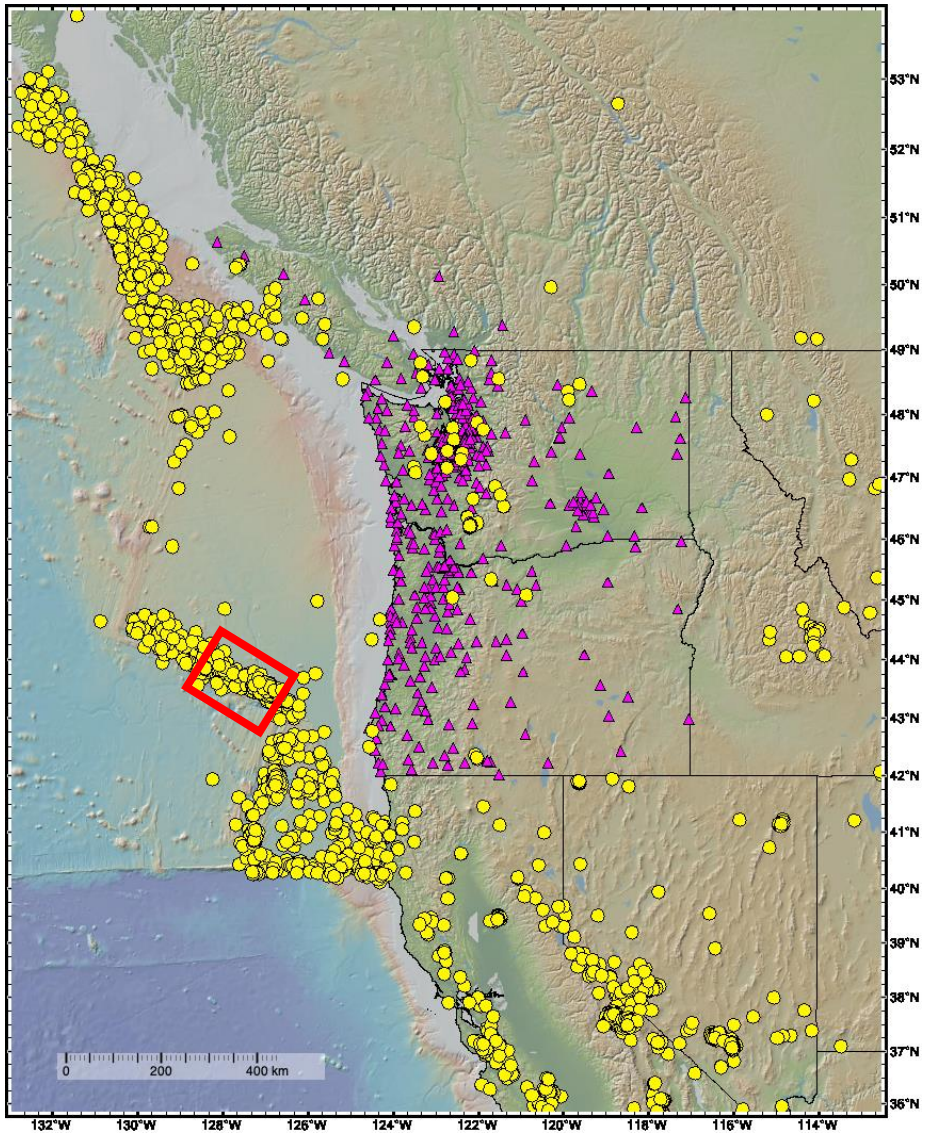

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ShakeAlert™

ShakeAlert Development Timeline

- 2006 – 2009 – Algorithm development (offline)
- 2010 – 2012 – RT Demo System, 1st **beta users**
- 2012 – 2016 – CA Production Prototype (V1.0)
- 2017 – West Coast Prototype (V1.2)
- 2018 – Open for Business, to **institutional users**
- 2019 – California **public rollout**, Oct. 17, WEA and Apps
- **2021 – Oregon public rollout, March 11** (Tohoku Anniv.)
  Public alerting with WEA and Android
- 2021 – Washington **public rollout**, May 2021
  Public alerting with WEA, Android, and App
- 2021 – 2025 – Complete stations, enter O&M phase

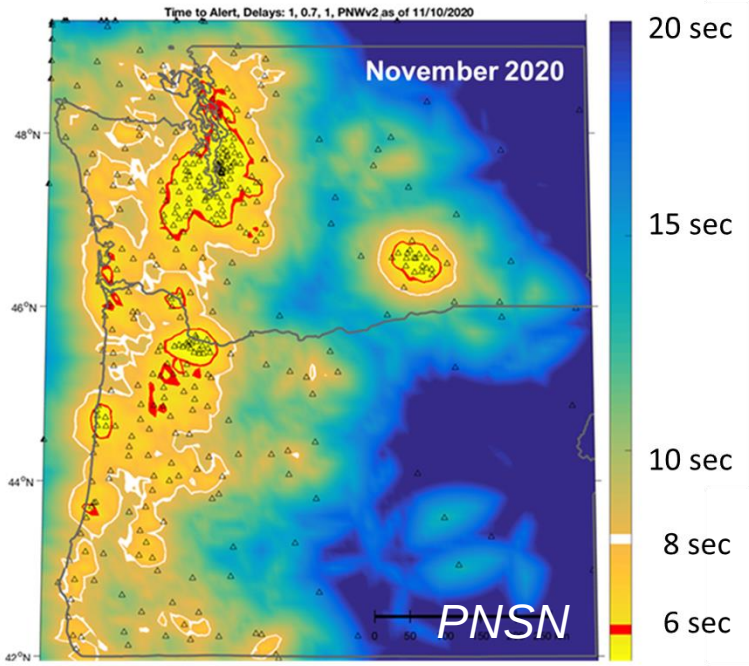
About 40 organizations are using or developing to alert personnel and take automated actions.

Water: Albany, Eugene, Grants Pass, Gresham, South Fork
Education: Portland State U., Linn-Benton CC, UofO

ANSS

ShakeAlert Seismic Station Inventory	CISN	PNSN	West Coast
Target Number	1,115	560	1,675
Contributing now	764	349	1113
Percent complete	*69%*	*62%*	*66%*
Station to be built	***351***	***211***	***562***
Unfunded stations	*91*	*102*	*193*

Station Density & Time-to-Alert



Alert time assumes 4 stations to trigger and 2.7sec for detection and delivery

ShakeAlert Station Winston, OR

Public Alerting Technologies to Phones

Wireless Emergency Alert
(WEA) (cell carriers)

Sent via IPAWS = FEMA's Integrated Public Alert and Warning System (e.g. AMBER)

Android Alerts (Google)
(36% of phones in OR)
- 'Take Action' (MMI 5+)
- 'Be aware' (MMI 3-4)
- 'Earthquake Occurred' (late)

QuakeAlertUSA
Early Warning Labs

ShakeAlert Performance
Since CA Public Rollout (10/17/19)

- **Number of Public Alerts**
  - **31 App Alerts** (> M4.5, MMI 3+ area)
  - **7 WEA Alerts** (> M5.0, MMI 4+ area)
    - 3 missed alerts (all outside network)
    - 2 false alerts (real offshore events, mislocated)
- Time to Issue Alerts (after quake begins)
  (Alert time depends on station coverage)
  - Median 8.6 sec, can be under 5 sec
- Time to Deliver Alerts
  - WEA: Median 16 sec (highly variable)
    Minimum of 2 sec
  - Android: >80% of users in < 5 seconds
    2.2 million users notified of one LA event

Resiliency 2025 — State bonding

- State funding — Major milestone
  - The Governor's 2018 ask was for $12M and included support for wildfire mitigation
  - August 2020 special session awarded $7.5M for ShakeAlert (removed wildfire technology)
  - Complete buildout of ShakeAlert by 2023 (including networking upgrades)
  - Network upgrades are providing leveraging opportunities for wildfire mitigation and economic recovery

STATE OF OREGON
Office of the Governor
KATE BROWN

Resiliency 2025:
Improving Our Readiness for the Cascadia Earthquake and Tsunami

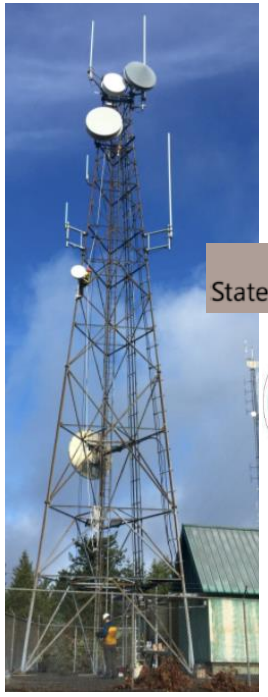
The Governor has directed the State Resilience Office to implement a statewide emergency warning system by 2023 that ties multi-hazard events: **earthquakes, wildland fires, landslides, and flooding events** into one alerting and monitoring system.

ShakeAlert™

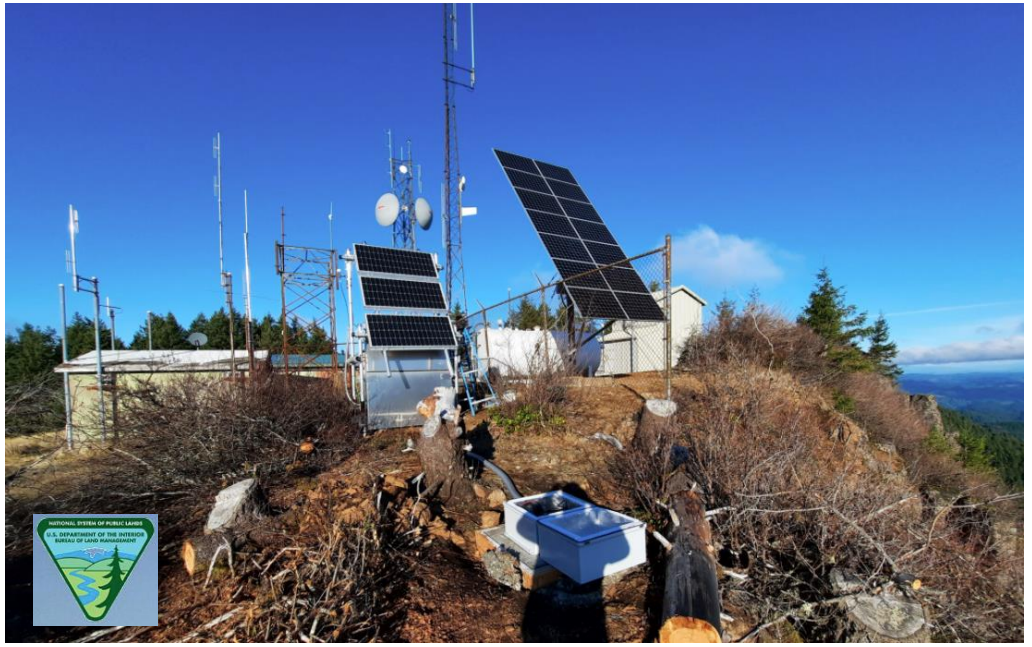
State Bond Project 2021 Progress

UO rooftop microwave:
Receive hub for 6 seis stations

- 7 New UO Project Personnel Hired:
  - Project management, field recon/deployment
- Rapid progress on shovel-ready sites:
  - Dozens of sits reconned, permitting underway or complete. Staging for contractor-facilitated installs later in 2021
- Seismic Site and Telemetry Site Buildouts:
  - UO staff installing sites in advance of contractor efforts
  - $500k in seismic equipment purchased ---------- >
- Telemetry planning, coordination is key:
  - UO Internal Network analysis working group created
  - ODOT State Radio Project focus
  - Ongoing partnerships w/ LinkOregon (fiber), Counties; Lane/Washington/Clackamas (wireless)
- Public Engagement:
  - March 11, 2021 Public Rollout. We must finish sensor buildout and strengthening of telemetry
- Staging of multiple contractors well underway:
  - Fabrication, seismic+telemetry installers, NEPA expertise



Buck Mountain ODOT hub:
link between UO and Lane County



Roman Nose seis station: collocated at Douglas County comms site, BLM land

Euchre Mountain seis station: collocated at ODOT-SRP site, state microwave backhaul

State Bonds are Leveraging Wildfire Recovery

FEMA Projects Proposed

- McKenzie-Santiam-Sisters Broadband and multi-hazards arrays
  - Mitigate risks of wildfires, landslides, flooding, while providing resilient communication infrastructure that enhances economic recovery
  - Diverse partners
- Rogue Valley Alert Wildfire Mitigation Project
  - Mitigate wildfire risks along the wildland-urban interface from Ashland to Medford
  - 11 municipalities involved
- State funding of wildfire technology would provide additional leveraging of federal and private sector support