Group 1 - David Schmidt

Participants: David Schmidt, Andy Newman, Bin he, Donna Blackman, Lynn Simmons, Yu Ren

1. What are the most important science targets offshore Cascadia?
   - Why are there no earthquakes? What makes Cascadia quiescent?
   - How do the geometry and structure of downgoing plate control locking, megathrust rupture, and tsunamis?
   - What controls water release, and relationship to asperties and fault behavior?
   - How can we use seismic imaging methods to constrain these phenomena?
   - We have few observations/constraints on the Gorda slab. Hydration state, internal deformation, plate velocity, etc.

2. What observations are needed to address these targets? Over what duration do the observations need to be made? Over what spatial distances do observations need to extend?

   - Distribution of instrumentation should be balanced between the different corridors so that they can be compared.
   - WIll OBS instruments have the proper frequency band to look for LFEs?
   - Place a few OBS be dropped in targeted locations, such as Hydrate Ridge, or on Gorda plate.
   - If there are a few OBS, battery life is still limited. So OBS would still have a 1-2 years deployment.
   - What would new OBS reveal beyond what Cascadia Initiative provided?

3. What are the potential synergies of studies offshore Cascadia with the SZ4D science goals?
   - Cascadia provides an end member case study.
   - Existing data sets and networks on which to leverage.
   - Cascadia has deep slow slip events and lots of tremor.

4. How can SZ4D optimize its planned infrastructure expenditures in offshore Cascadia?
   - It is important that there is a sequential process of getting feedback from the community on any infrastructure plan for Cascadia.
   - OOI and ONC have real-time monitoring. Those assets can be leveraged. Relatively cheap to add instrumentation to cabled networks.
   - Replacement of GNSS-A batteries should be included in SZ4D plans. Some aging transponders will need to be replaced.
   - There should be coordination in deployments with other efforts.

5. How can the SZ4D observational plans offshore Cascadia be integrated with other efforts?

What are the 3 highlights for the plenary presentation?

- Cascadia is an end member system for comparative study.
- Has greatest domestic potential hazard impact to coastal communities.
- Long-duration data sets already exist here and can be leveraged, including partnerships.

Group 2 - Matt Wei

Participants: Matt Wei, Joan Gomberg, Harold Tobin, Mark Zumberge, Helen Janiszewski

1. What are the most important science targets offshore Cascadia?

- Kinematic coupling, spatial temporal change, slow slip events,
- Small scale seismicity
- Geometry and structure of plate interface, particularly crossing coastline

2. What observations are needed to address these targets? Over what duration do the observations need to be made? Over what spatial distances do observations need to extend?

- Long term monitoring at certain sites VS move instruments to new sites for the existing stations.
- Leverage on existing cable in Cascadia could be useful - design the array taking them into account. OOI cable has new instrumentation going onto it now (2026)
- Temporal resolution to catch slow slip can be challenging for GNSS-A. APG could only see large ones. There are major weaknesses in existing instruments. Tiltmeters and fiber optic strainmeters are alternative approaches that could get at transients.

3. What are the potential synergies of studies offshore Cascadia with the SZ4D science goals?

4. How can SZ4D optimize its planned infrastructure expenditures in offshore Cascadia?

- Concerns about 9 GNSS-A plan - what will that really add to what we know already? Maybe other instruments or approaches that are more novel have higher potential payoff?
- Concern about OBS deployment plan. What will it add that we don't know already? Or clearly articulate a deployment strategy motivated by recent/ ongoing scientific research that will significantly differ from previous efforts.
- So far, the plan as presented doesn't seem to take into account existing infrastructure efforts - not shown in the presentation for example. This needs to be addressed.

5. How can the SZ4D observational plans offshore Cascadia be integrated with other efforts?

- This might be the most important question. More involvement into SZ4D planning from active seafloor geodesy scientists should be beneficial. Note Andy Newman is already involved in SZ4D design.

What are the 3 highlights for the plenary presentation?

- Concerns about 9 OBS/GNSS-A plan in Cascadia, maybe money can be used in other potential instruments/ or deployment plan needs to be clearly articulated on how will be different from past
- It would be helpful to consider the existing deployment (GNSS-A) in Cascadia.
- Temporal resolution of GNSS-A for detecting transients.

Group 3 - Erik Fredrickson

Present: Renate Hartog, David Lumley, Jim Gaherty, Erik Fredrickson, Emily Roland

1. What are the most important science targets offshore Cascadia?

Big question: Whether Cascadia is locked to the trench. Scientifically understanding what controls these processes is a primary goal of SZ4D - what controls variations in locking (notably close to the trench). Requires imaging of incoming and overriding plate, which is not part of SZ4D plan. This is something that can be a possible follow-up item - that collaborative work might help prioritize happening sooner.

Joint EM and seismic insight, and specifically EM imaging to probe for fluids in Cascadia has not yet been done.

What could be done to achieve 3D structural insight offshore? How much additional insight is still needed following recent (2021) seismic imaging efforts - how do we need to consider updating models with this new data.

Do we have slow slip/tremor up-dip and how does this compare to the spatial transition to the locked zone?

Borehole observations can be critical for observing slow-slip transients - for example Nankai observing technology. This may be one example of an observing strategy that would work well for characterizing transient slip and stress events and should be included in an integrated observatory.

How could we develop a monitoring network capable of observing precursory activity? It seems like building from the OOI is a useful starting point for this - but what about other places, and what kind of additional observations would be useful - DAS?

2. What observations are needed to address these targets? Over what duration do the observations need to be made? Over what spatial distances do observations need to extend?

3. What are the potential synergies of studies offshore Cascadia with the SZ4D science goals?

4. How can SZ4D optimize its planned infrastructure expenditures in offshore Cascadia?

There is some uncertainty/ambiguity in some of the existing instrumentation and how it will be funded long-term. (Is SZ4D looking to those deployments to stay in the water independently, while those deployments are hoping to get funded by SZ4D, etc.?)

Also realizing that there is currently no plan for seismic instrumentation offshore Cascadia as a part of SZ4D - This perhaps misses an opportunity to provide for the first longer-term earthquake or tremor observations - outside of the OOI - offshore a domestic subduction zone that represents a significant hazard from a near-term great earthquake.

5. How can the SZ4D observational plans offshore Cascadia be integrated with other efforts?

Certainly coordinate between OOI Expansion and Seafloor Geodesy efforts. How to coordinate Community or PI-drive experiments with the larger and hopefully longer-term efforts being coordinated by SZ4D.

Use CRESCENT to tap into local and regional stakeholders

What are the 3 highlights for the plenary presentation?

1) Locking and heterogeneity
2) Structural insights to guide and make sense of our observations efforts
3) SZ4D working close with existing efforts and all sides clarifying their needs and expectations

Group 4 - Joseph Byrnes

Participants: Joe Byrnes, Jeff Freymueller, Surui Xie, Chuanming Liu

1. What are the most important science targets offshore Cascadia?
The highest science target is likely locking fraction with modern seafloor geodetic instrumentation - how much locking and where.
Many observations in Cascadia are still one-sided (that is, mostly or completely onshore) - like the downdip extension of tremor.
Some limited geodetic observations suggest we do not have sufficiently accurate plate motion models for the JdF. It's not north-south, but could be surprisingly different than the plaeomag-inferred motion.
Incoming plate structure from seismics - how consistent are the different models and where can improve them?
Many area in Cascadia, like Gorda, are internally deforming at poorly constrained rates.

2. What observations are needed to address these targets? Over what duration do the observations need to be made? Over what spatial distances do observations need to extend?
Offshore geodetic sites - revisiting one site once a year for 5 years should be reliable. Longer data and quite high precision might be necessary - possibly measurements below mm/year for internal deformation rates in particular. Shallower plate than in Chile, so potentially easier target.

3. What are the potential synergies of studies offshore Cascadia with the SZ4D science goals?
Exceptional offshore geodetic data across multiple seismically hazardous subduction zones, each quite distinct, would synergize well.

4. How can SZ4D optimize its planned infrastructure expenditures in offshore Cascadia?
Choosing the location for transects in detail - are the three proposed ideal? 4 sparser or 2 denser, for example. Similarly for OBS data - we have good broad band and active source data in Cascadia, so where is structure least constrained, and where are current observations least consistent?

5. How can the SZ4D observational plans offshore Cascadia be integrated with other efforts?
Open question as to how existing infrastructure best integrates with more instruments - as opposed to simply the best sites for science questions.

What are the 3 highlights for the plenary presentation?

- Plate motion constraints in offshore Cascadia and esp locking fractions across and downdip in multiple subduction zones - Cascadia being an excellent target.
- Incoming plate structure - how well do we know it and where are observations inconsisent
- Optimization between existing/preexisting instrumentation and science goals in Cascaida.

Group 5 - William Wilcock

Not Active

Group 6 - Lingchao He

Not Active

Group 7 - McKenzie Carlson

Members:

- Brian Boston
- Jill Elizabeth
- McKenzie Carlson

1. What are the most important science targets offshore Cascadia?

- Understanding locking zone
- Understanding plate boundary geometry (using CASIE21 data)

2. What observations are needed to address these targets? Over what duration do the observations need to be made? Over what spatial distances do observations need to extend?

- Borehole observations! Tied to OOI cable? Future drilling?
- Southern Cascadia would be a good spot for future observations
    - Hasn't been looked at as much to date
- Nootka Fault system - work with Canadian colleagues/agencies
- Seafloor geodetic is good for long-term observations

3. What are the potential synergies of studies offshore Cascadia with the SZ4D science goals?

- Any SZ4D offshore instrumentation would be beneficial to CRESCENT science goals and vice versa as long as all the data are open and accessible

4. How can SZ4D optimize its planned infrastructure expenditures in offshore Cascadia?

- Optimizing data release and sharing
    - Make it easy for users to access data
- Has SZ4D talked about a plan for data release? Will it be integrated with Earthscope (or other data management organization)?
    - Who houses the data in the long-term?

5. How can the SZ4D observational plans offshore Cascadia be integrated with other efforts?

- Ensuring that other agencies/stakeholders are involved in decision making and access to data
    - Particularly state hazard groups
- Clearer funding pathways for people using the data - clear and accessible ways to get funding to use the data
- Get more people involved who aren't in SZ4D and CRESCENT

    - It can feel like if you aren't already part of either group, you're left behind, which is not the kind of environment we want to create

Other thoughts

- How can CRESCENT steer SZ4D to invest more in Cascadia
    - Proposed instrumentation doesn't seem to align with SZ4D budget allocation to Cascadia - it seems like we could do more with their proposed budget
- Seems like there's still lots of infrastructure to be built to address all the science goals and questions

What are the 3 highlights for the plenary presentation?

1. Leveraging existing datasets - CASIE21 data and OOI cable
2. Open access to data - clear plan for how data will be easily accessible to anyone who wants to use it, including funding opportunities
3. Collaboration with groups that aren't just SZ4D and CRESCENT - particularly state hazard groups

Group 8 - Wenyuan Fan

Members: Wenyan Fan, Zoe Krauss, William Wilcock, Emilie Hooft, Tianhaozhe Sun, Zoe Kraus, HyeJeong Kim

1. What are the most important science targets offshore Cascadia?

Earthquakes and tsunamis
Late in cycle. Determine rate of strain accumulation
Mechanical coupling and stress shadowing. Can shallow part of fault accumulate energy
Rupture propagation
Does strain accumulation / coupling evolve with time

How does fault network work near Mendocino
Tsunamis from M7

Role of fluid in coupling
Topography of the plate - roughness
Structure either side of the interface
Barriers to rupture - comparisons to Chile

Why do people working offshore image so little water going down in the SZ and how does this link to volcanism

Why is Cascadia so unusual? Slab torn

2. What observations are needed to address these targets? Over what duration do the observations need to be made? Over what spatial distances do observations need to extend?

Ideally cover the whole plate including the MOR since activities on MOR may affect loading on megathrust. Effect of LAB to allow stress transfer

Utilize ONC & OOI cables for long term observations

Is GNSS-A accurate enough to address questions? Need continuous observations. Borehole pressure. Seafloor tiltmeters and strain meters.

Fluids CASIE experiment with seismic data. EM studies. Seafloor venting and seep meters. Seismic activity to indicate variations

Do we want continuous EM on cabled observatories? Passive might not have enough resolution. Follow up with Samer Naif (Sp?). More efficient to measure fluids directly in borehole?

Another large scale seismic imaging experiment?

Work in progress suggests possible tremor and slow slip near deformation front offshore Oregon

Lessons from Japanese boreholes.

3. What are the potential synergies of studies offshore Cascadia with the SZ4D science goals?
4. How can SZ4D optimize its planned infrastructure expenditures in offshore Cascadia?
5. How can the SZ4D observational plans offshore Cascadia be integrated with other efforts?

Discuss together.

Science goals are the same - understand SZ hazards
Unique questions for Cascadia. Downdip limit of seismogenic zone offshore. How do we target. Take advantage of coastal and offshore paleotsunamic records
Very much infrastructure
GNSS-A saturation in measuring signals, limited time sensitivity
Discussion on the types of instrument, only GNSS-A+APG vs others?
Pressure?
Jackson/Zumberge fiber optic strain meter?
How can plans integrate with other efforts
What can only something as big as SZ4D do.
PI-led efforts?
Coherent plan -
Offshore seismometers in southern Cascadia - understand the different modes of slip

What are the 3 highlights for the plenary presentation?

- Effects of fluids in modulating coupling - Cascadia a great site to address
- Need to consider resolution of instruments when designing experiments
- Important to integrate efforts moving forward.

Group 9 - Jon Delph

Participants: Jon Delph, Doug Wiens, Guanning Pang, Manuela Hurtado, Matthew Cook
Quantao Zhu, River

1. What are the most important science targets offshore Cascadia?
Geodesy is a large driver in the offshore region– GNSS-A and pressure are strong candidates

- Along-strike variations in EQ sources, seismicity, volcanism. SZ4D seems focused on across-strike rather than along strike studies. - Perhaps CRESCENT can focus a lot on along-strike while SZ4D focuses on across strike?
- Understanding onshore and offshore strain:
  - Lack of significant seismicity means that we may need to focus more on geodetic measurements.
  - Understanding shallow slow slip using geodetic and seismologic measurements to understand deformation near the trench and how that is related to structures within the deformation front and megathrust.

2. What observations are needed to address these targets? Over what duration do the observations need to be made? Over what spatial distances do observations need to extend?

- Both vertical and lateral components of strain are necessary to understand offshore deformation and strain accumulation
- Was there consideration for deploying all 9 GNSS-A stations on the offshore accretionary wedge? For hazards, we may care more about along-strike differences in locking vs. across-strike, which may be more interested in the science questions.

3. What are the potential synergies of studies offshore Cascadia with the SZ4D science goals?

4. How can SZ4D optimize its planned infrastructure expenditures in offshore Cascadia?

- · Coupling pressure gauges with GNSS-A sites would be good because they are complementary approaches that can both contribute (as opposed to different locations).

- · Can APG data be recovered if coupled with transponder? Can be recovered with GNSS-A data.
- · Perhaps there is a role for "pressure differencing" for pressure gauges, but challenges exist due to lateral vs vertical motion components

5. How can the SZ4D observational plans offshore Cascadia be integrated with other efforts?

What are the 3 highlights for the plenary presentation?

Group 10 - Grace Barcheck

Participants: Grace Barcheck; Akmal Firmansyah; Brandon Shuck; Jesse Hutchinson; Kelin Wang; Tiegan Hobbs

1. What are the most important science targets offshore Cascadia?
- Getting a complete picture of how plates are interacting - far offshore gnss a would help a lot with this; northern and southern ends are end-member cases
    - Support for getting GNSS A farther offshore in group
    - Could be communication with nearby ridge, etc;
- The questions in presentation were good
    - What is the role of terrains and faults in behavior
    - How does that vary along strike and link to coupling
- Splay faults probably important
- Are spreading centers and subduction zones linked - if there were spreading events
- Imaging vs monitoring activities
    - SZ4D is more monitoring
        - GNSS-A - background kinematics, velocity vector over years
        - High rate monitoring, APG, borehole, seismometers, etc; can potentially detect slow slip, etc
- Still don't really know the locking state of the megathrust!
    - Middle target corridor could be creeping or not - potential target
        - Place where there is megathrust microseismicity
    - Northern corridor is likely fully locked - contrast with middle one
- Desire to extend observations further north - can't just ignore the north end
- Request someone put a map of existing instrumentation - what existing infrastructure can we tap into, versus gaps to fill in
    - Canada has lots of observations, and might be clear that it should be included to fully understand hazard
    - For example, could borrow a waveglider to help access GNSS A sites in canada more often
- Taking advantage of existing boreholes could be really useful
    - If sz4d were interested in drilling boreholes, would help community effort to get drilling done in the region

2. What observations are needed to address these targets? Over what duration do the observations need to be made? Over what spatial distances do observations need to extend?
- As long as possible! At least five years for gnss a. A decade would be better!
- Broadband seismics need a long enough duration as well for, eg, ambient noise
- Strainmeters for observing slow-slip, such as what is being developed by Mark Zumberge and Noel Jackson

3. What are the potential synergies of studies offshore Cascadia with the SZ4D science goals?

4. How can SZ4D optimize its planned infrastructure expenditures in offshore Cascadia?
    - Take advantage of ocean networks canada, neptune network, OOI networks - instrumenting the seafloor with cabled installations - room for expansion

5. How can the SZ4D observational plans offshore Cascadia be integrated with other efforts?

Strategic comment - Desire to have GNSS A distributed along the margin to get a big picture, but APG to capture short term events - should be deployed in a targeted manner

What are the 3 highlights for the plenary presentation?

- Getting good observations of locking and creep and variation along strike, and how lfes/slow slip, etc, vary with locking
    - Locking better observed with broader deployment of gnss A
- Far offshore observations - to see how the incoming plate is acting, and interaction between plate boundaries
- Synergies with existing instruments in Canadian waters, and existing cabled networks

- Look at existing instrumentation, at same time as map of proposed targets, to help with these conversations