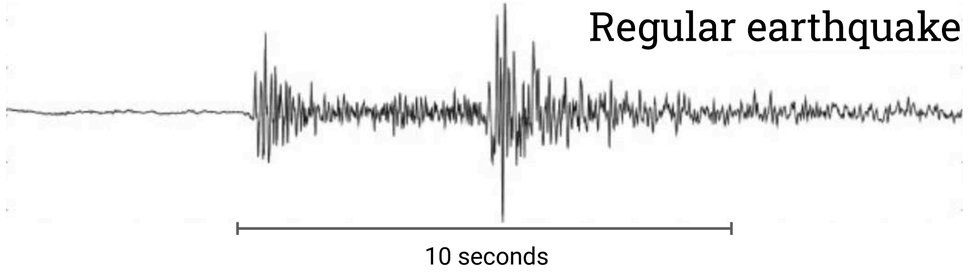
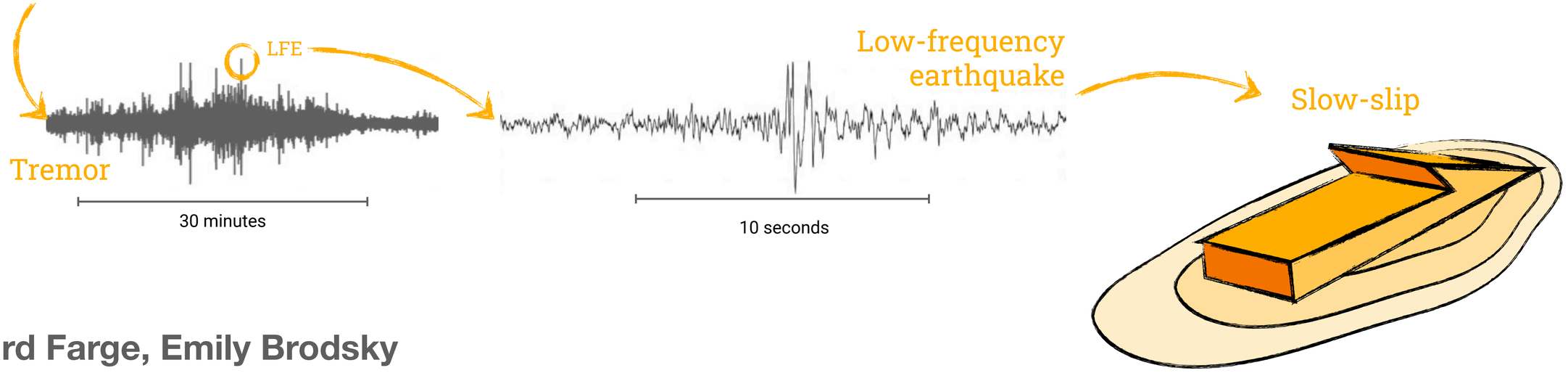
Causal relationships between fast earthquakes and slow earthquakes

Gaspard Farge, Emily Brodsky

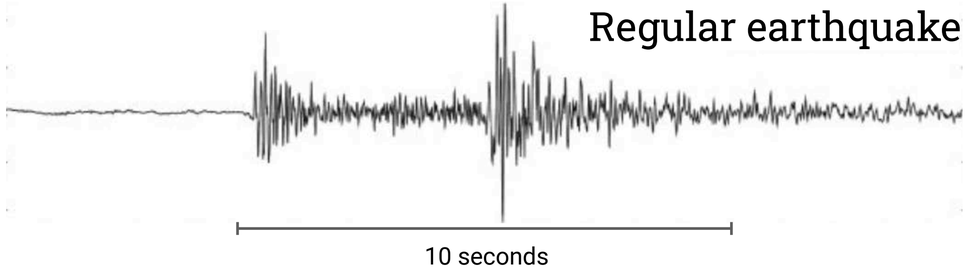
Causal relationships between fast earthquakes and slow earthquakes

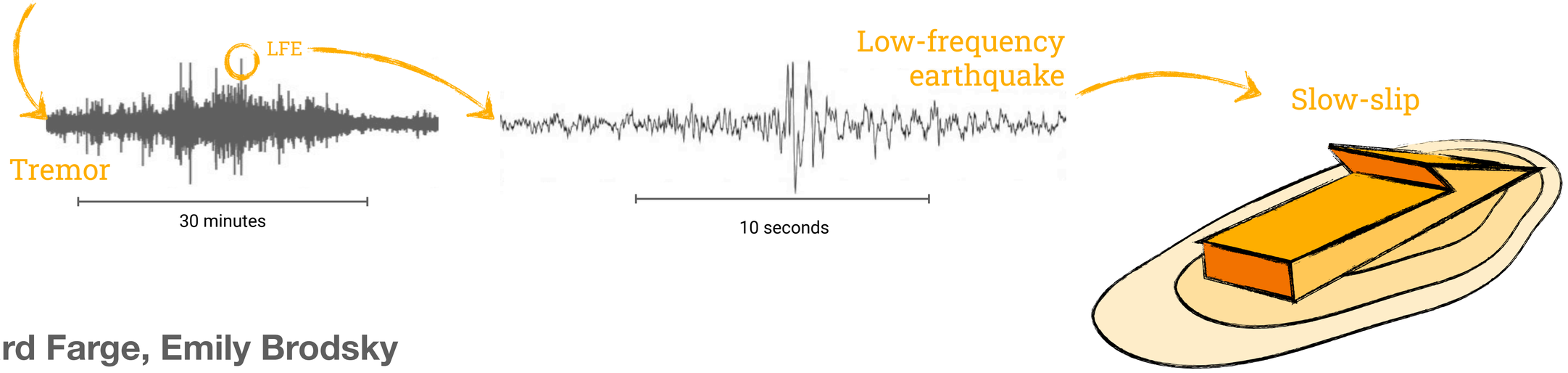




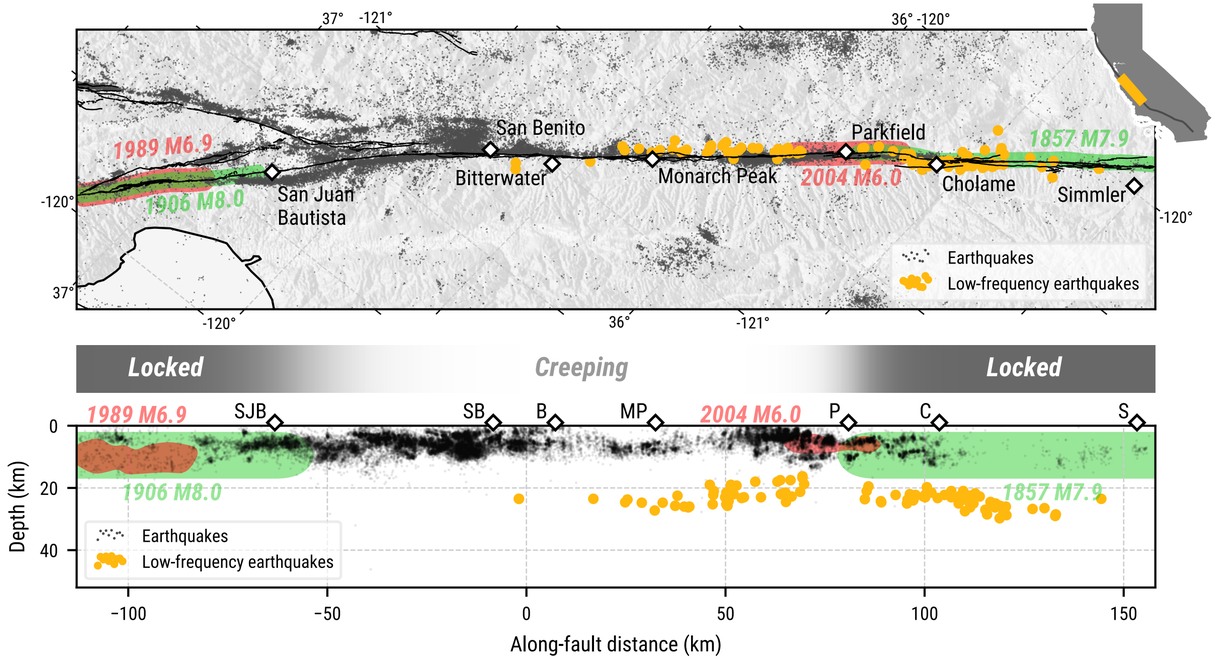
Gaspard Farge, Emily Brodsky

Causal relationships between fast earthquakes and slow earthquakes





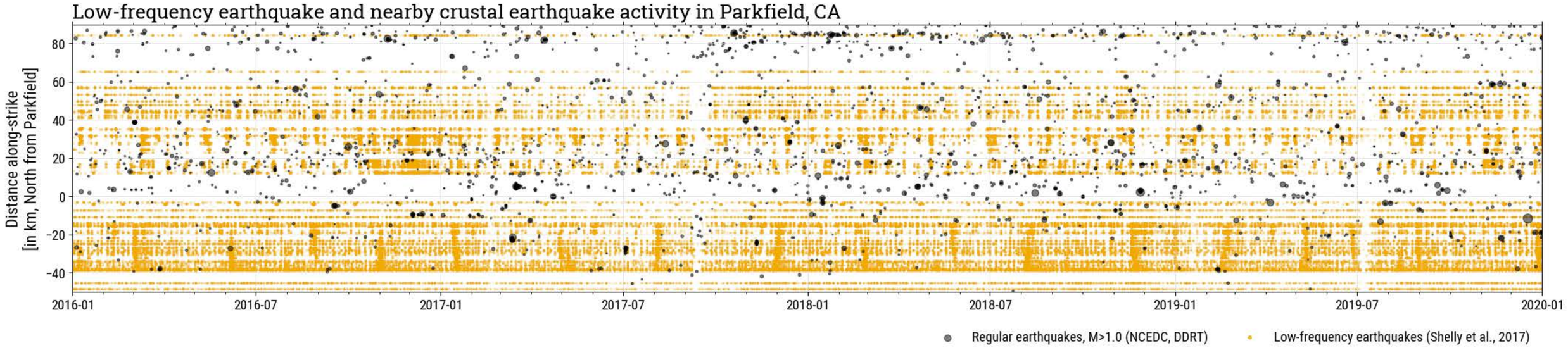
Gaspard Farge, Emily Brodsky



1. Can LFEs be used to predict earthquakes?

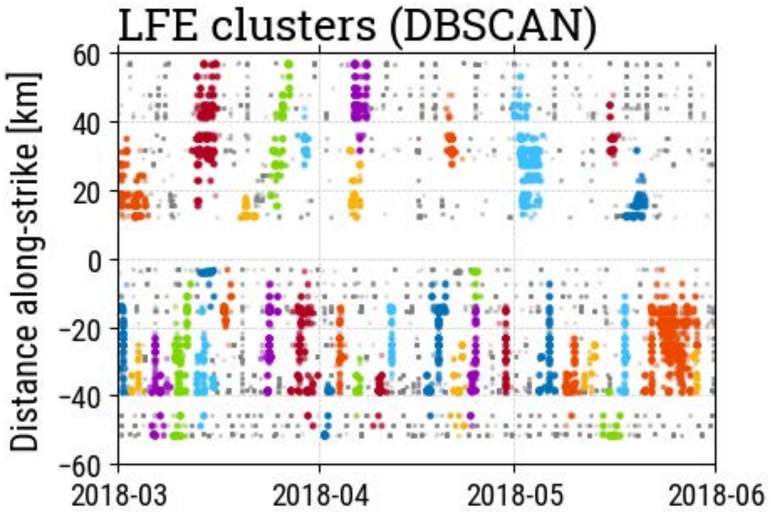
- Wealth of data to add to modeling frameworks
- Tracks stress transients at depth

- Transients would be small and local but location is difficult
- Detection is extremely sensitive to other seismic noise



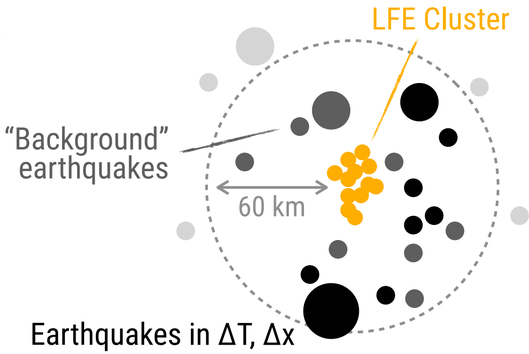
1. Can LFEs be used to predict earthquakes?

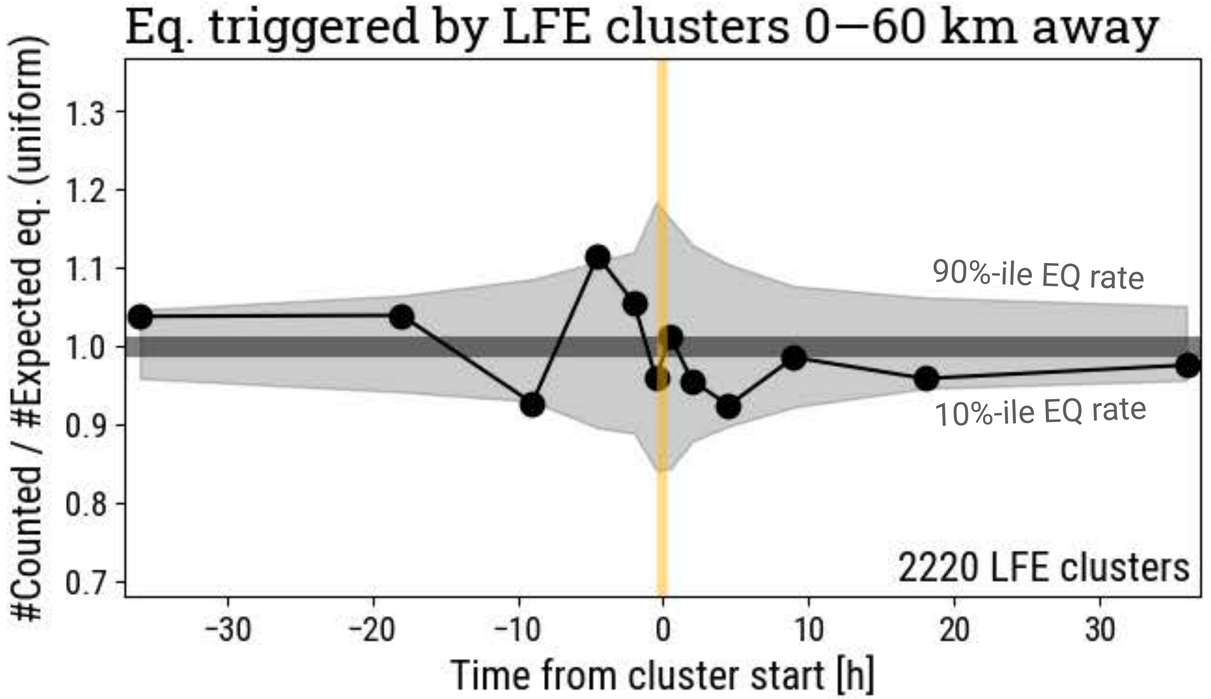
1. Detect episodes (slow slip transients?)



2. Count earthquakes around LFE clusters

- We count the number of earthquakes around LFE clusters
- We compare it to the number of earthquakes expected if the rate was uniform in time (keeping spatial distribution)
- Bootstrap by resampling cluster times





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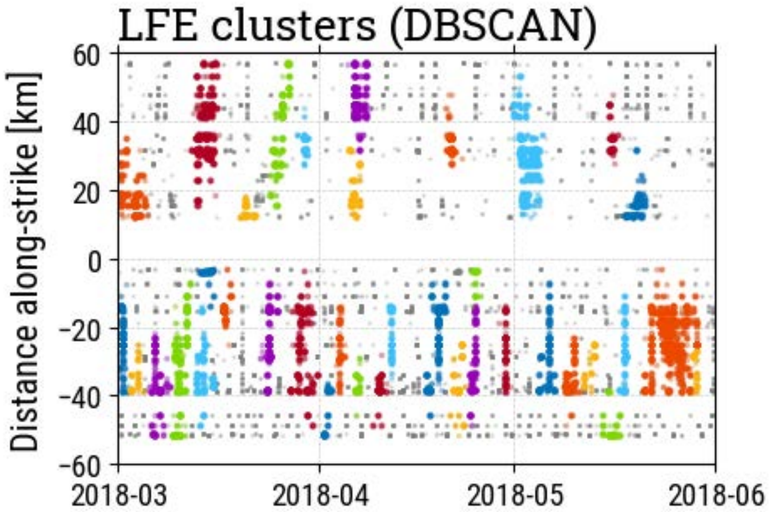

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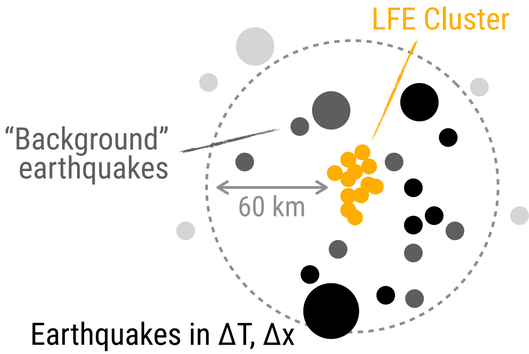
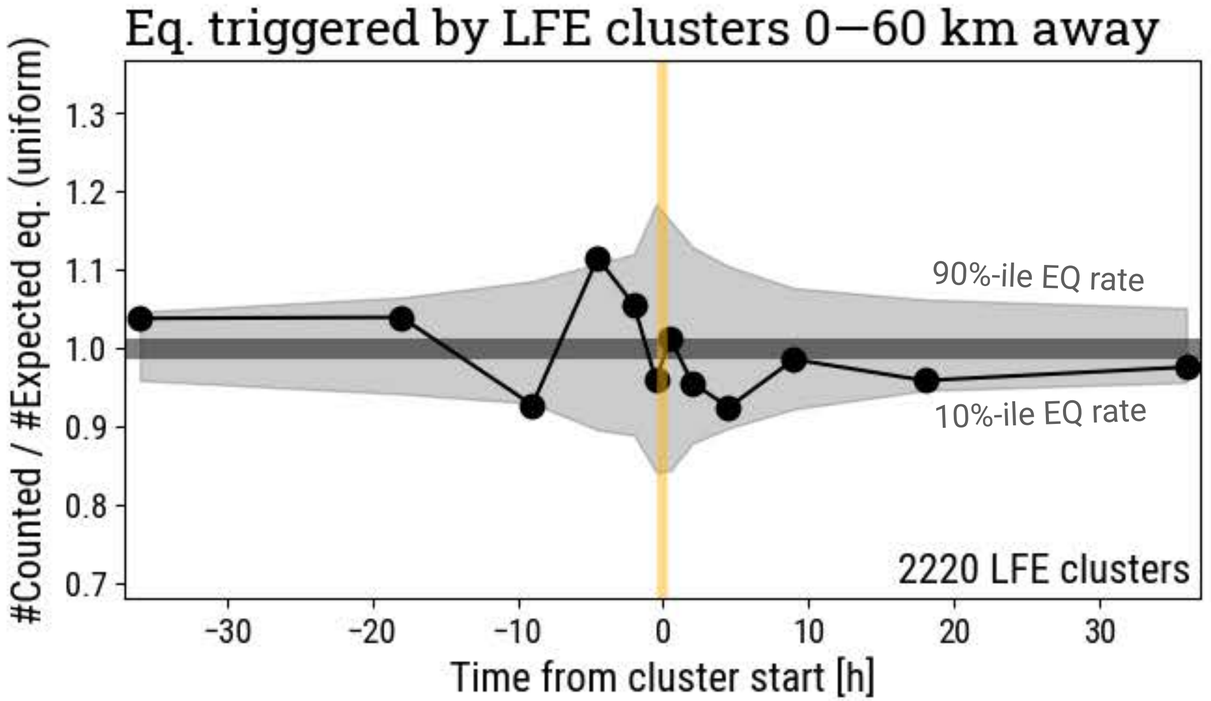
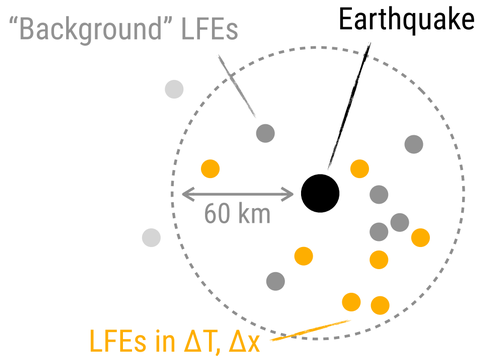




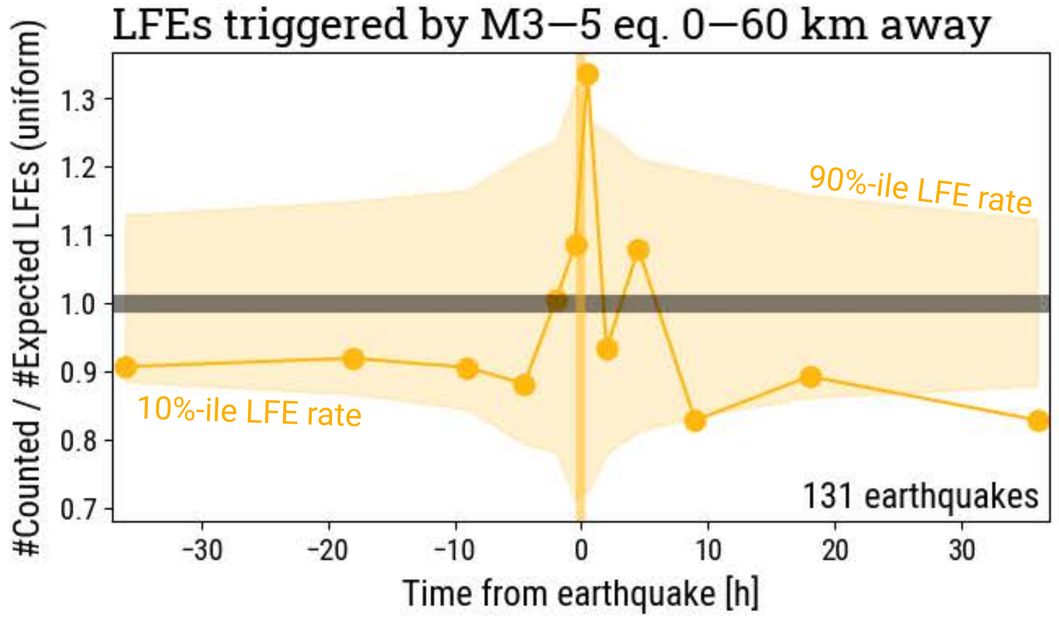
No <u>observable</u> triggering

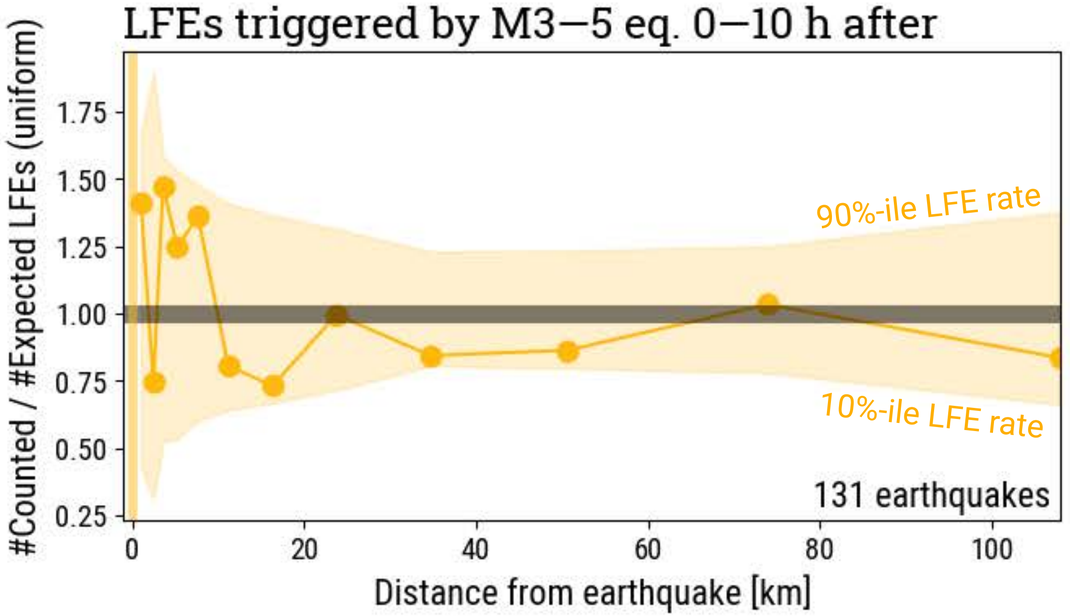
2. Can earthquakes be used to predict LFEs?

Counting LFEs around earthquakes



- Large earthquakes known to trigger LFEs/tremor globally and regionally
- Few evidence for small (M<4) local earthquakes





2. Can earthquakes be used to predict LFEs?

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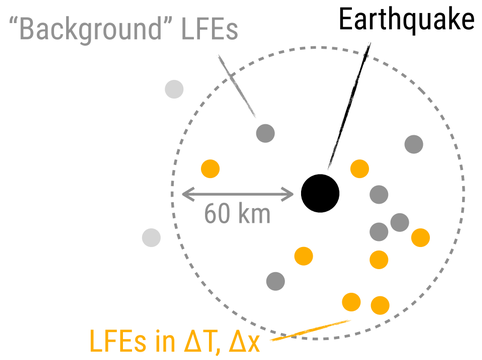

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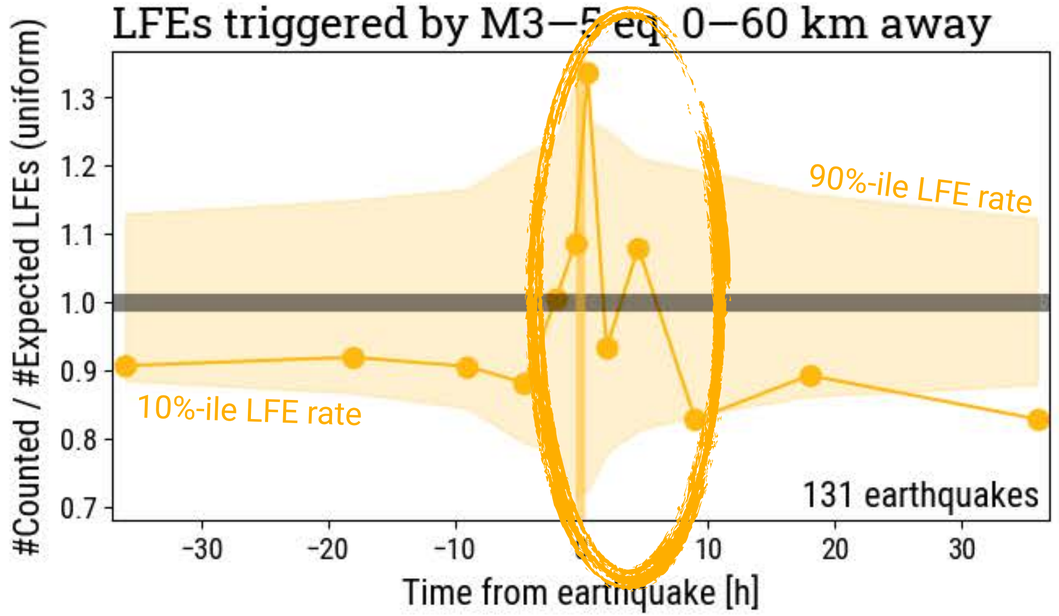
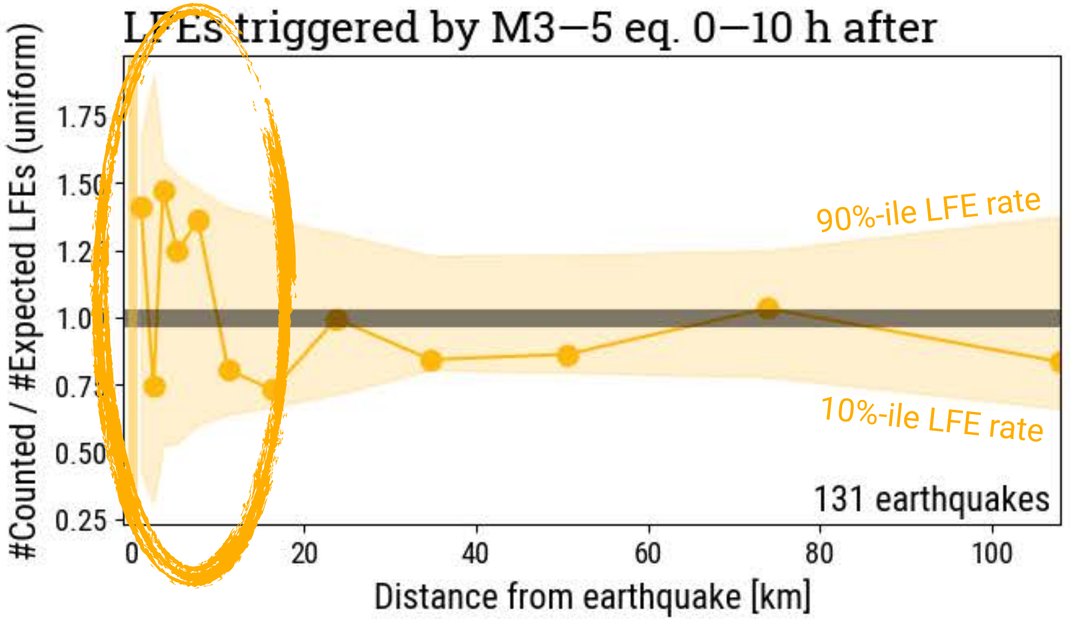
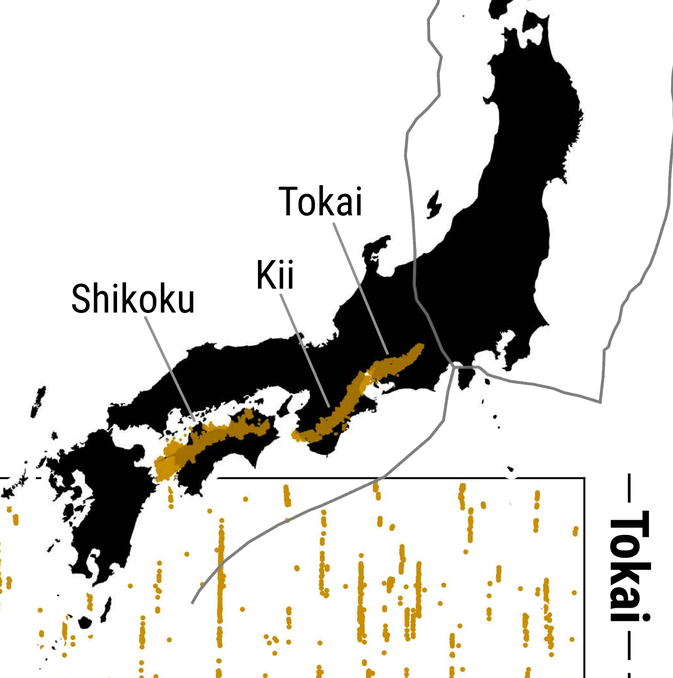
Marginal triggering





2bis. How do earthquakes affect tremor?



Tremor (Obara et al., 2010)

Longitude

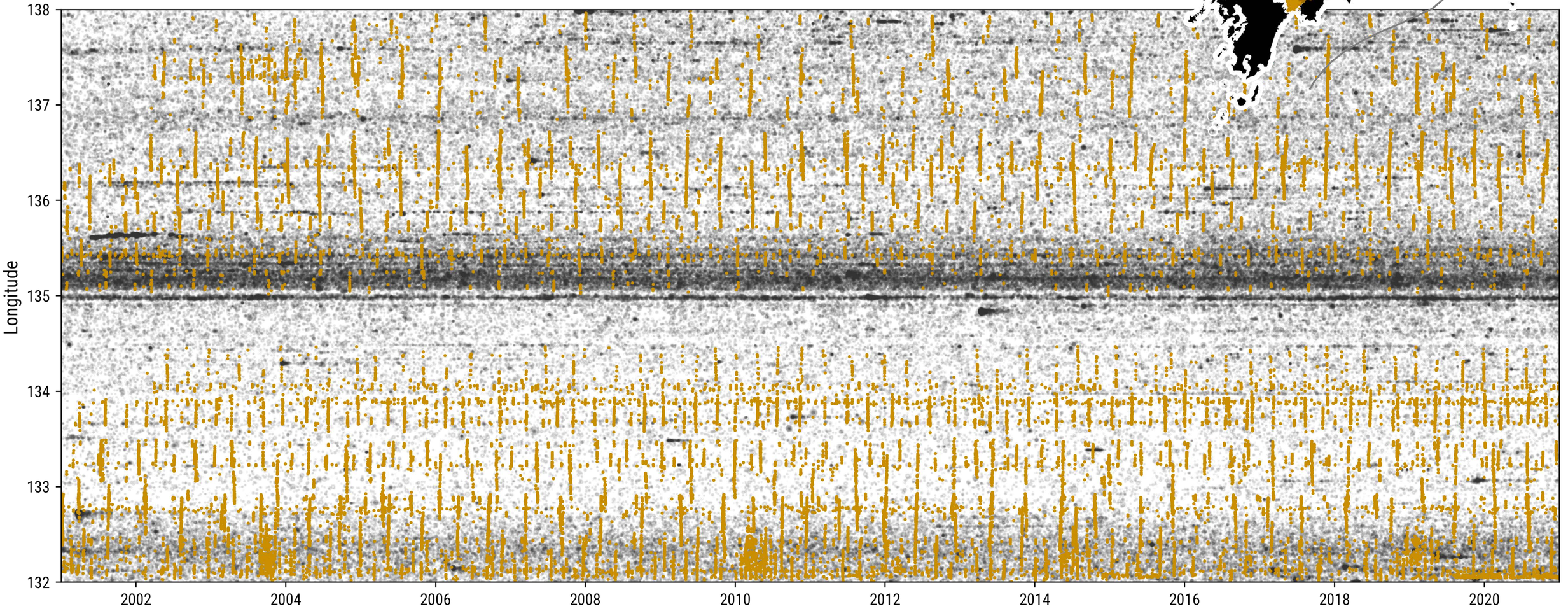
138
137
136
135
134
133
132

2002
2004
2006
2008
2010
2012
2014
2016
2018
2020

Tokai
Kii
Shikoku

2bis. How do earthquakes affect tremor?

Tremor (Obara et al., 2010) Earthquakes (JMA)



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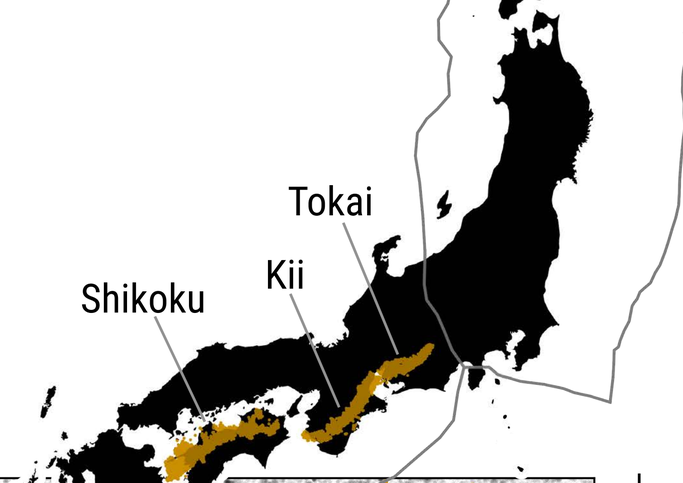
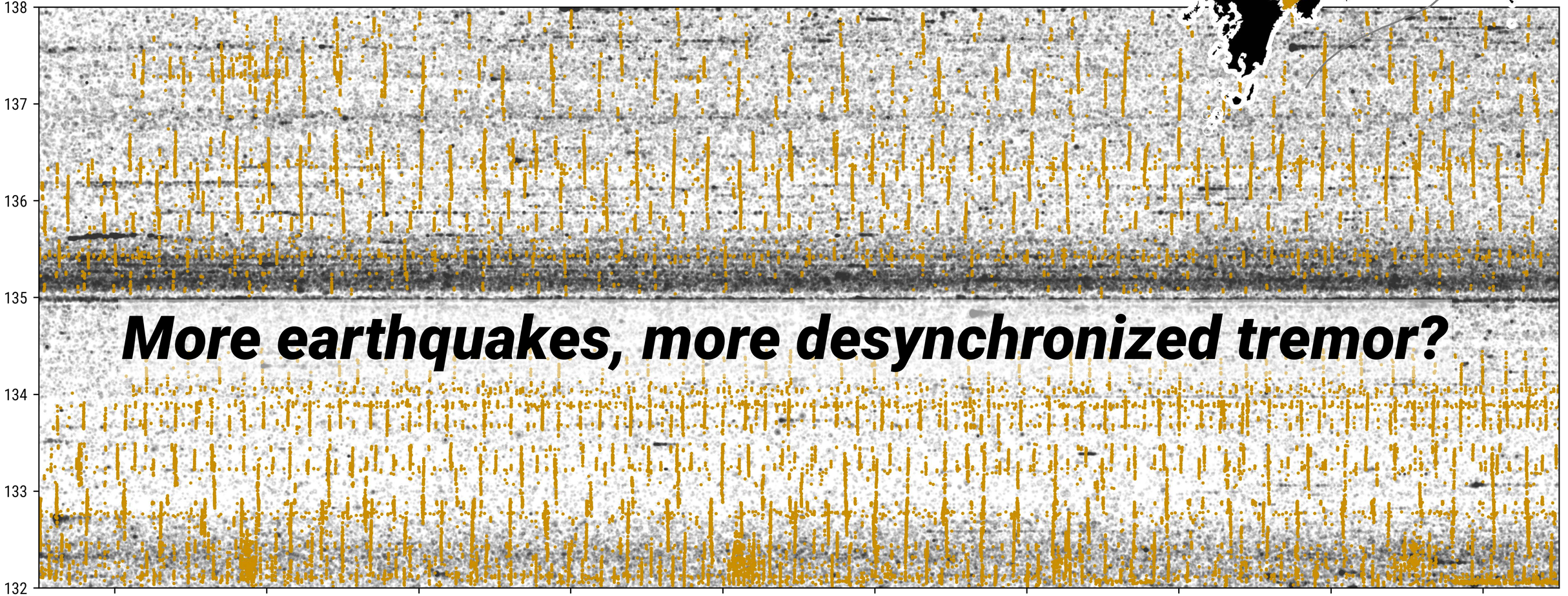


Tremor (Obara et al., 2010) Earthquakes (JMA)

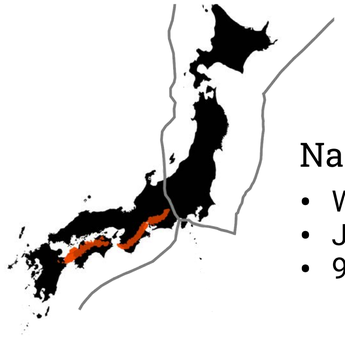


More earthquakes, more desynchronized tremor?

2bis. How do earthquakes affect tremor?

We measure regional earthquake rates and spatial synchronization in tremor zones across the world

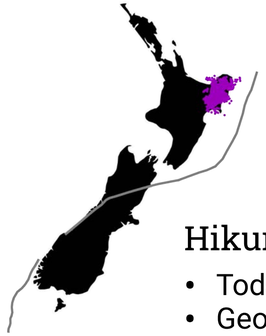
Cascadia
- PNSN tremor
- ComCat earthquakes
- 15 years, 1,200 km



Nankai
- World Tremor Database
- JMA earthquakes
- 9 years, 900 km

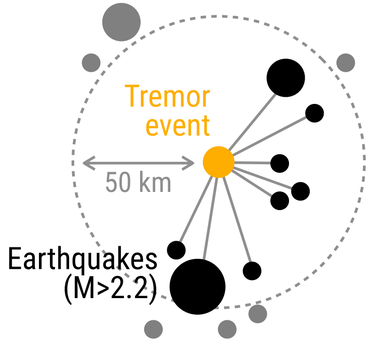
Alaska
- Wech (2016) tremor
- ComCat earthquakes
- 3 years, 350 km

Parkfield
- Shelly (2017) LFEs
- Waldhauser & Schaff (2008) earthquakes
- 17 years, 160 km



Hikurangi
- Todd & Schwartz (2016) tremor
- GeoNet earthquakes
- 7 years, 160 km

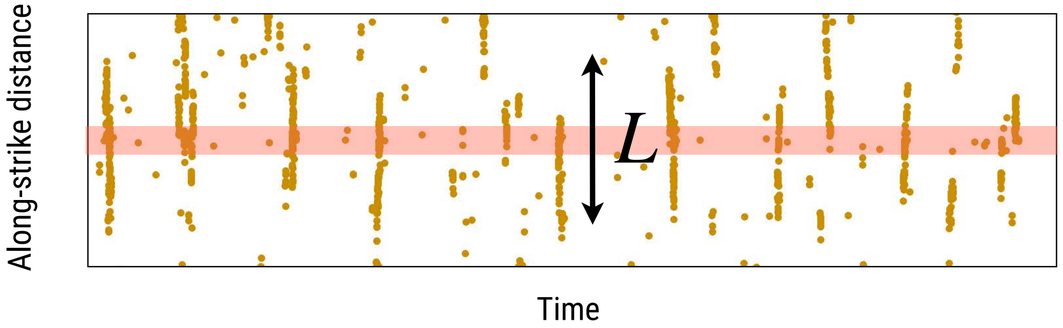
1. Measure earthquake rate around tremor



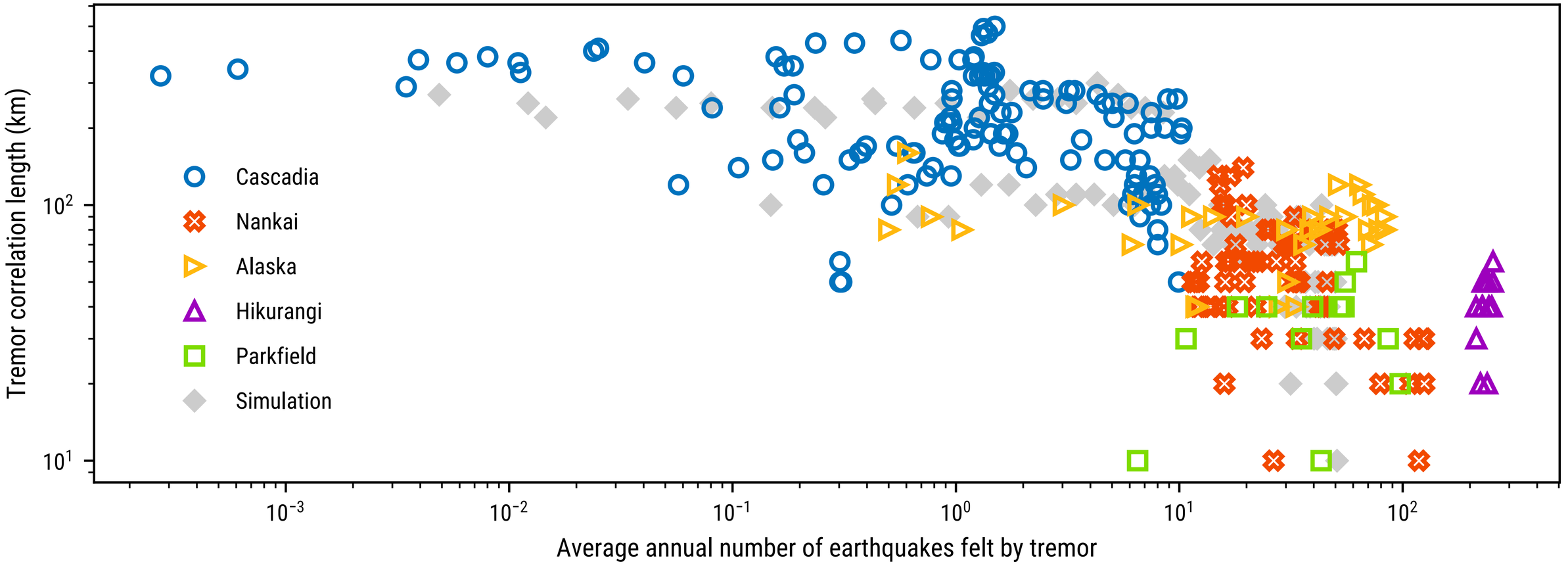
2. Measure tremor synchronization length

How far does tremor activity correlates along strike?

—> Extent of tremor bursts along strike



2bis. How do **earthquakes** affect **tremor**?



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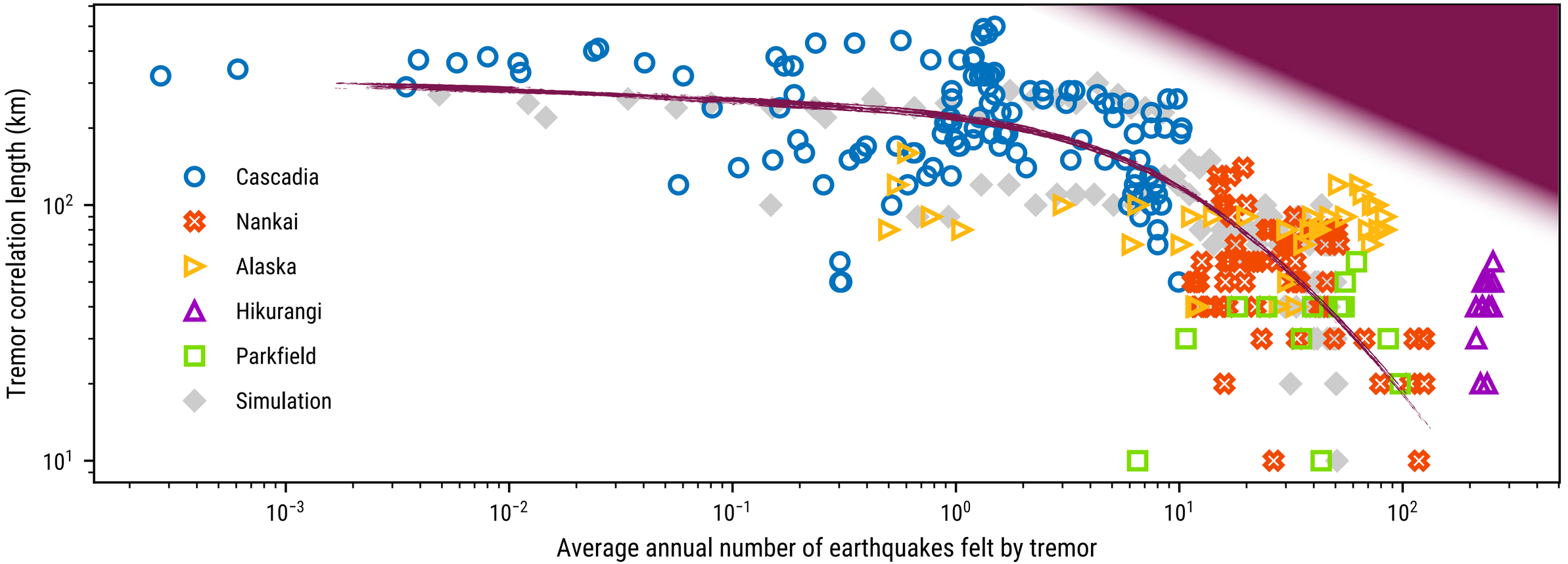

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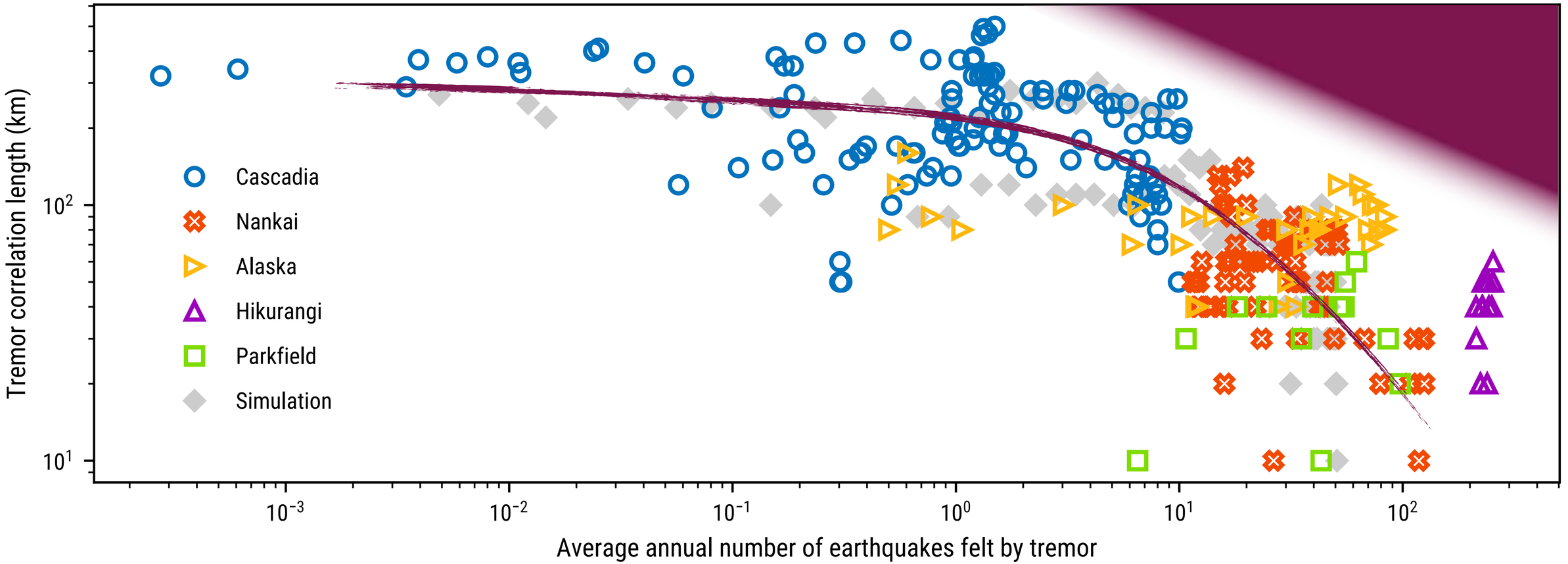
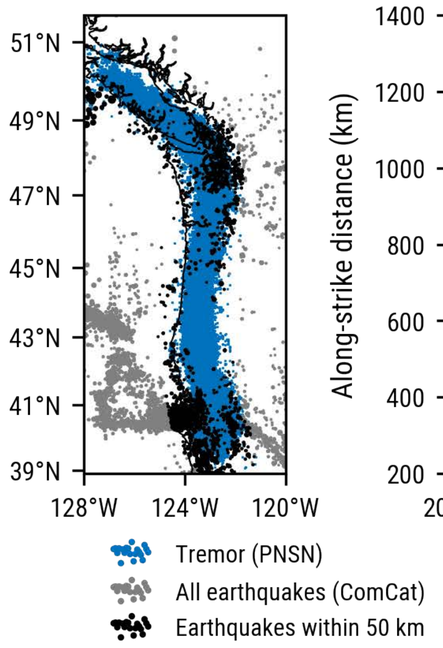
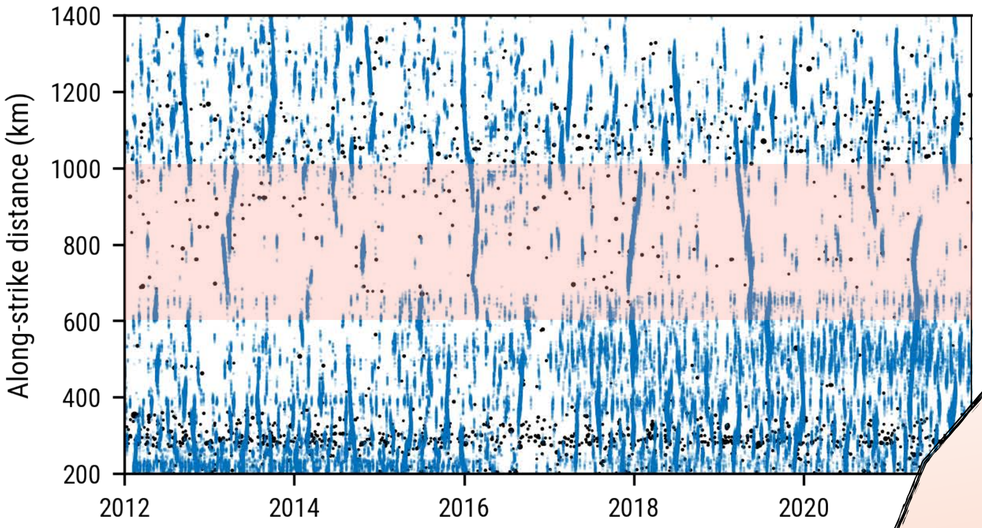
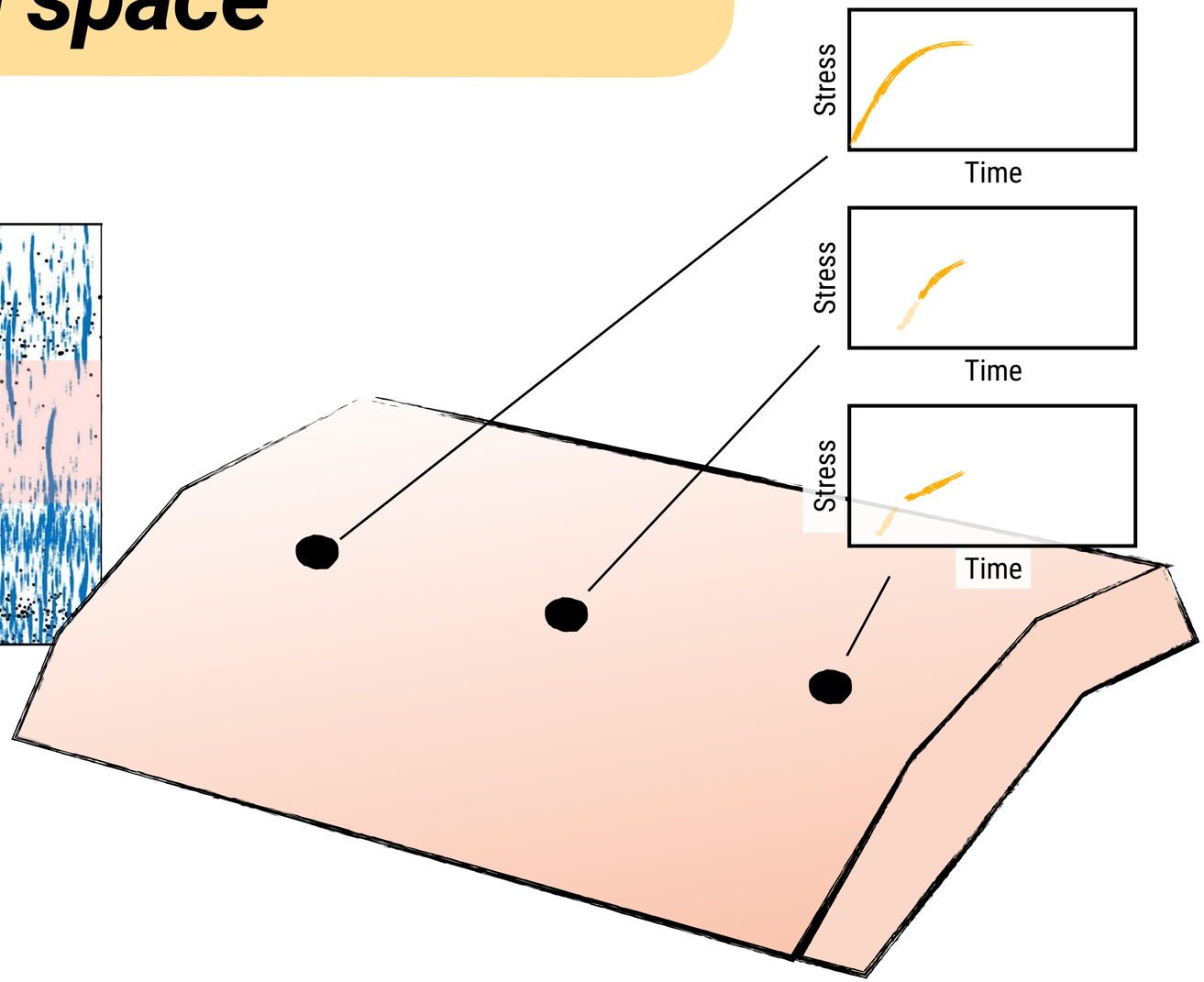


The activity of small earthquakes seems to limit the extent of tremor synchronization

Interactions through rupture synchronize fault activity in time and space







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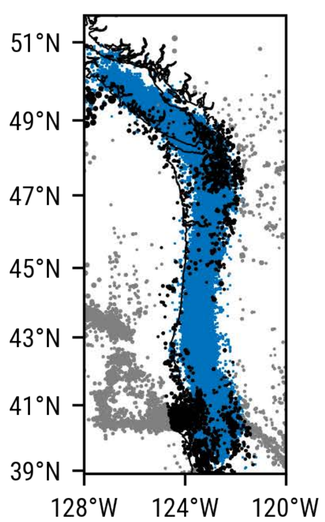
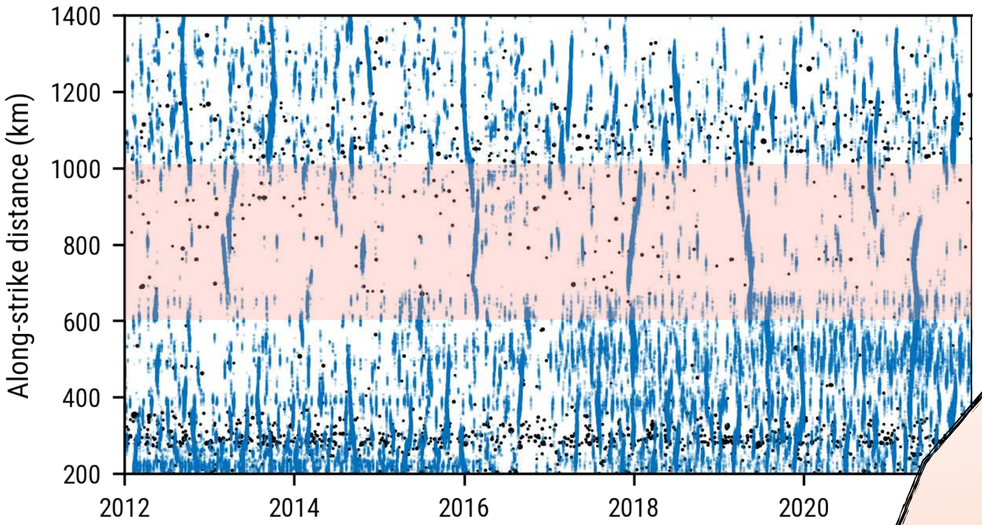
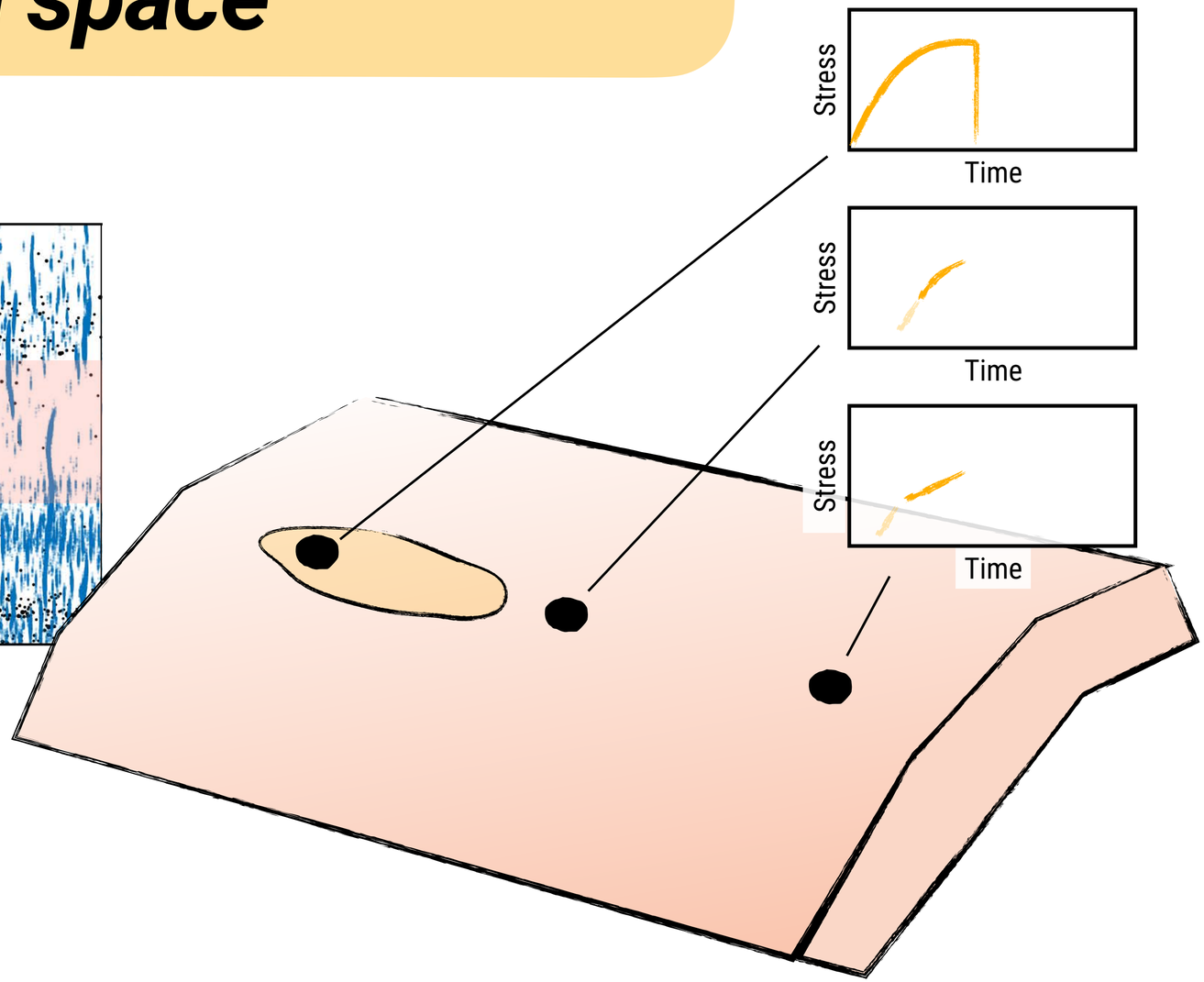




Tremor (PNSN)
All earthquakes (ComCat)
Earthquakes within 50 km



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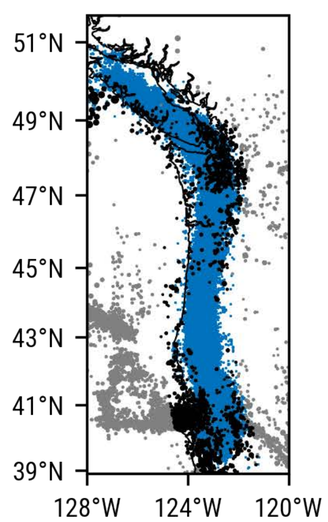

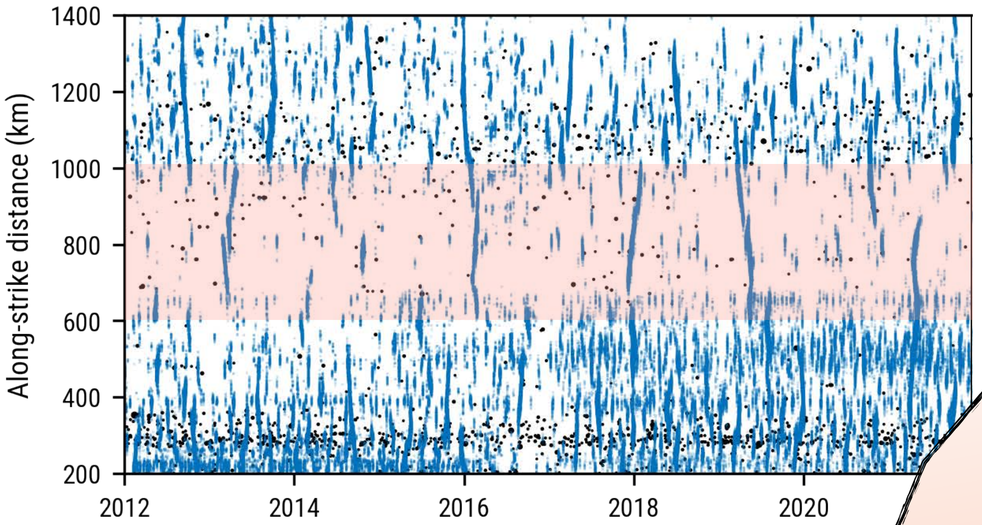

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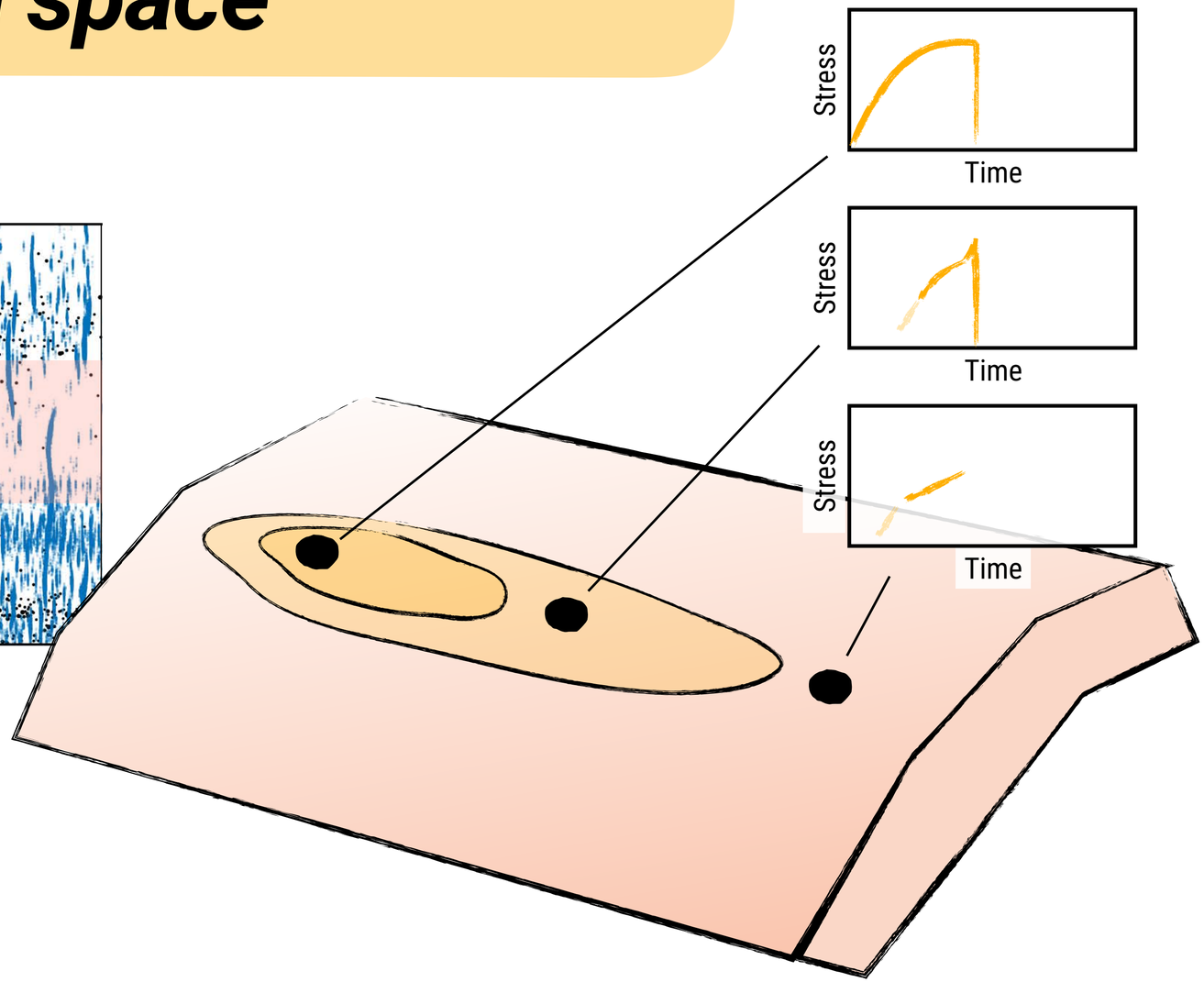

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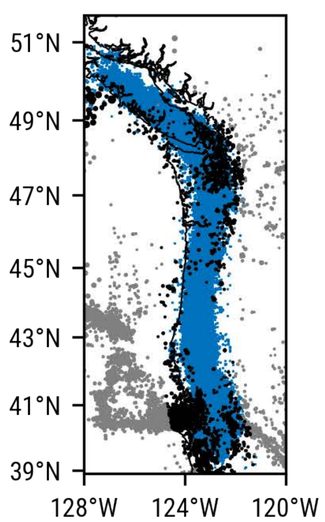

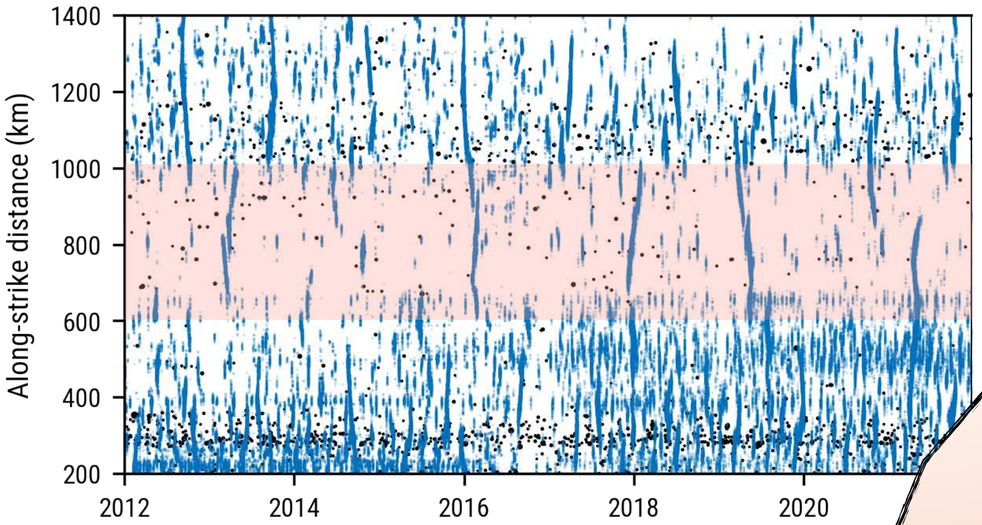

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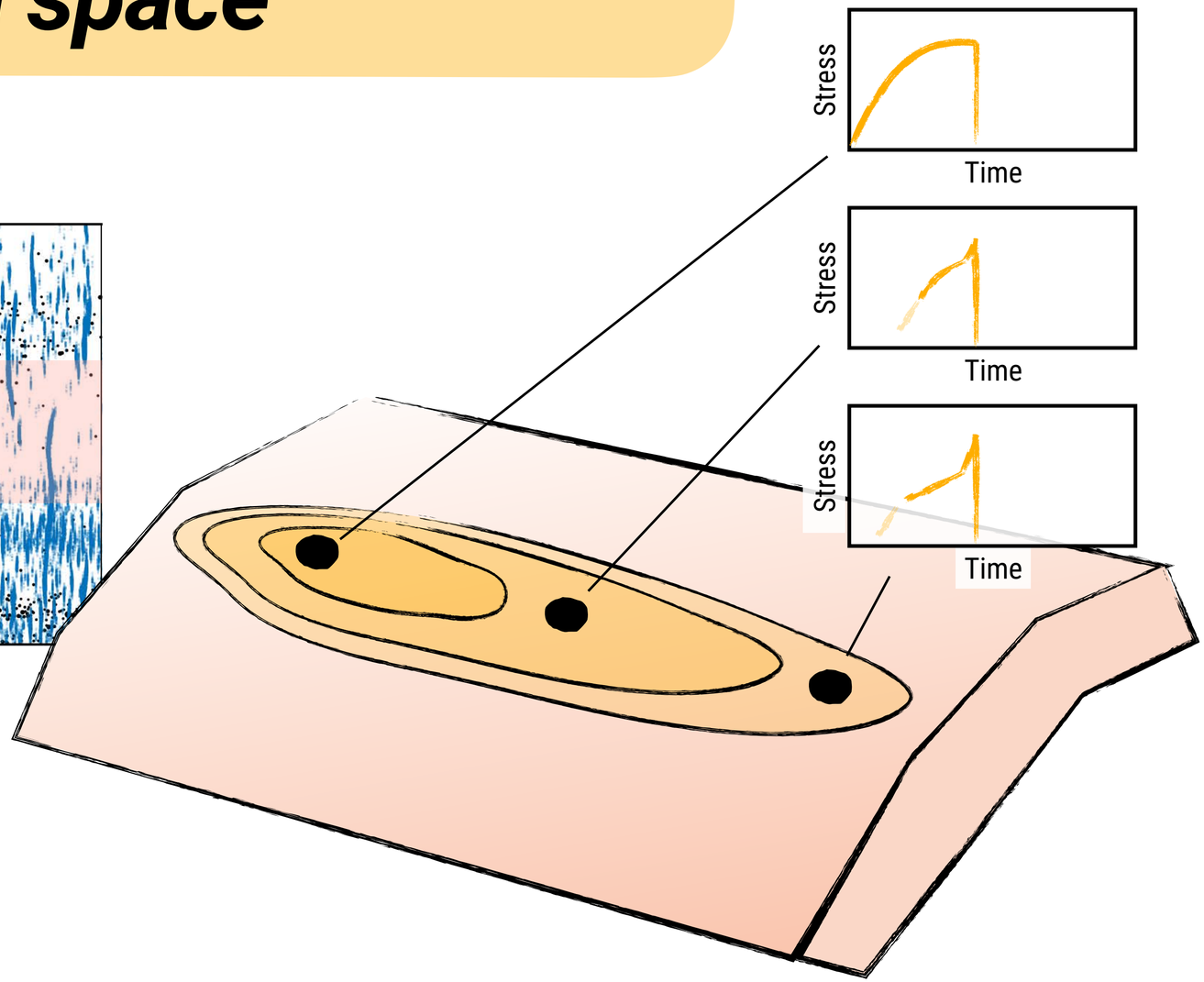
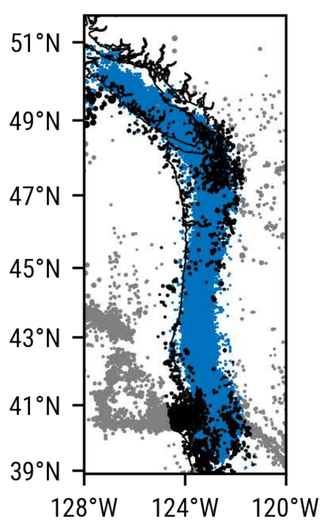
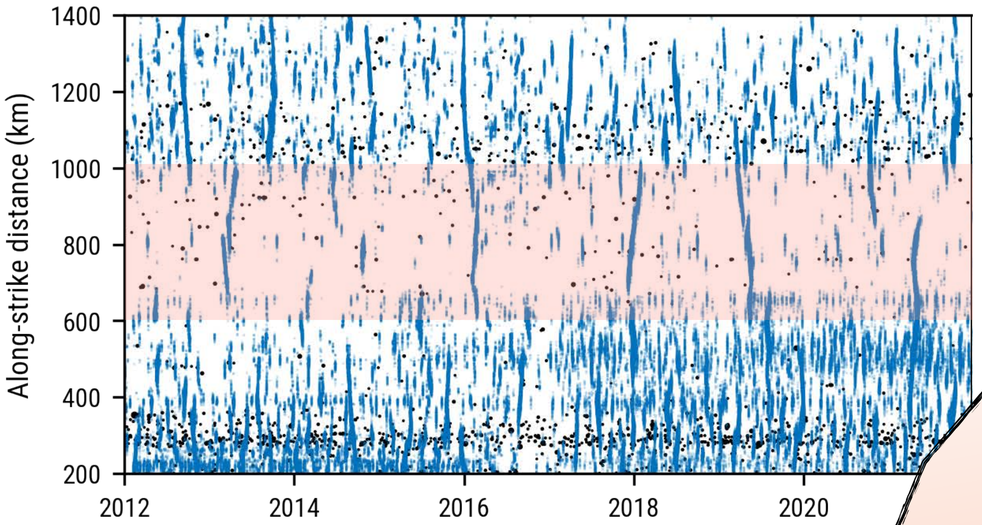


Interactions through rupture synchronize fault activity in time and space





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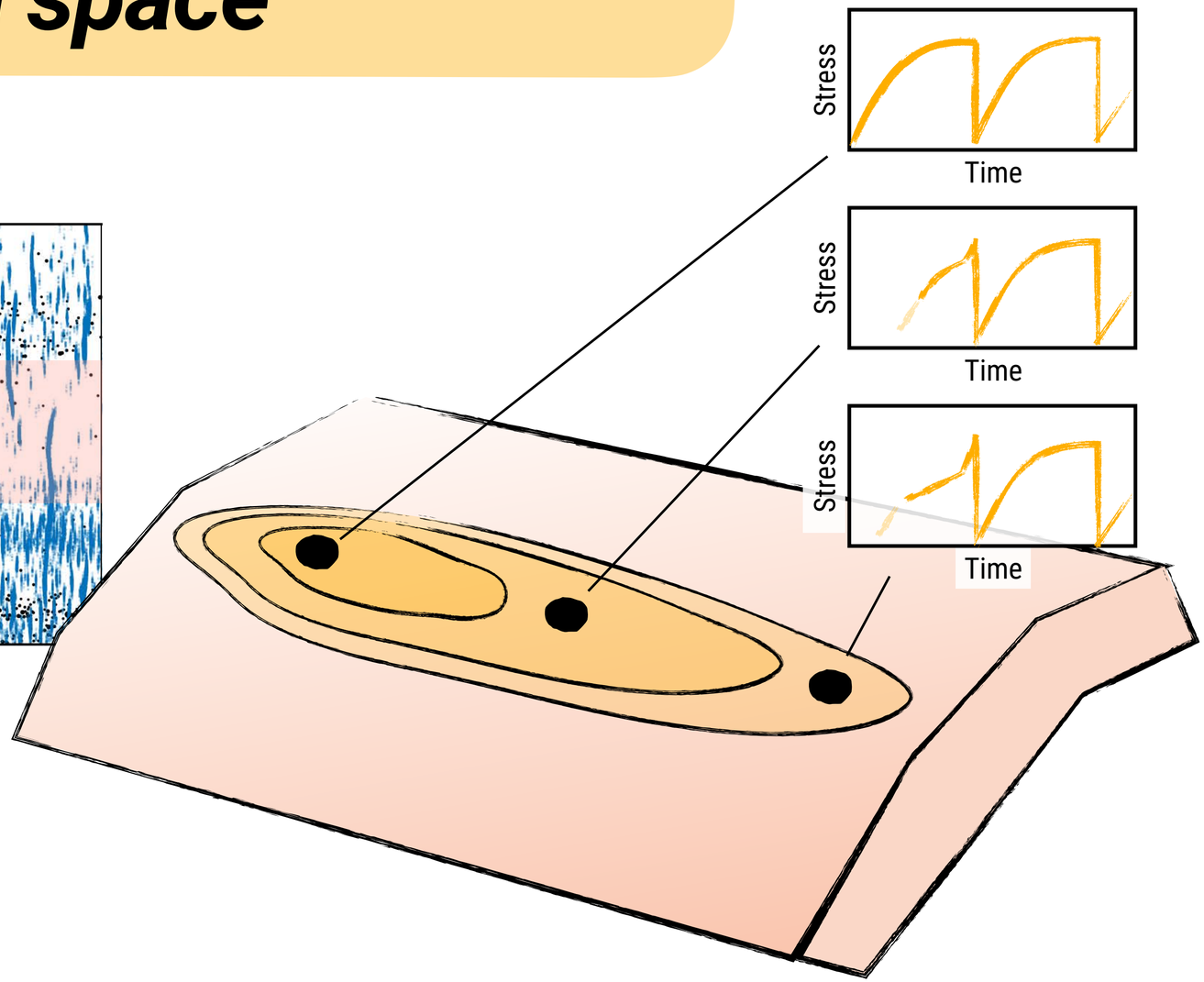
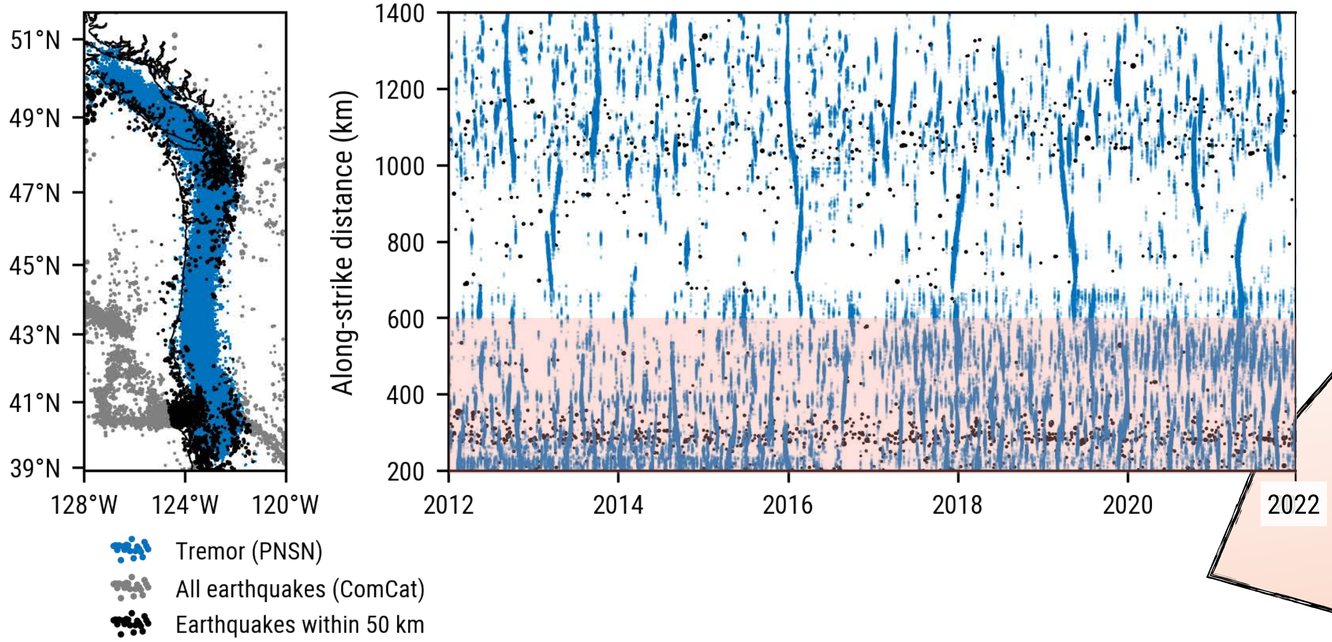
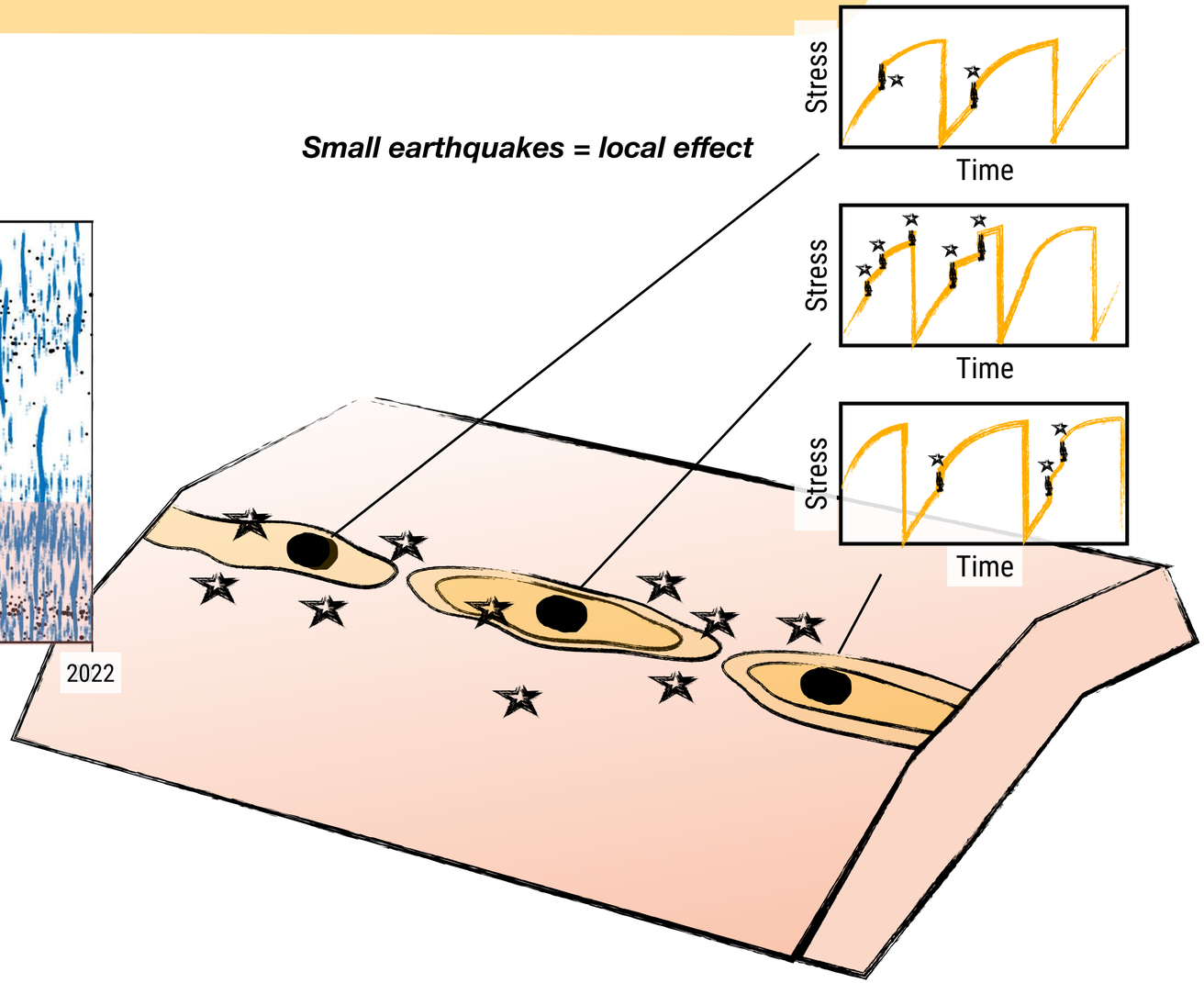


Local earthquakes disturb the synchronization process and inhibit the emergence of large ruptures

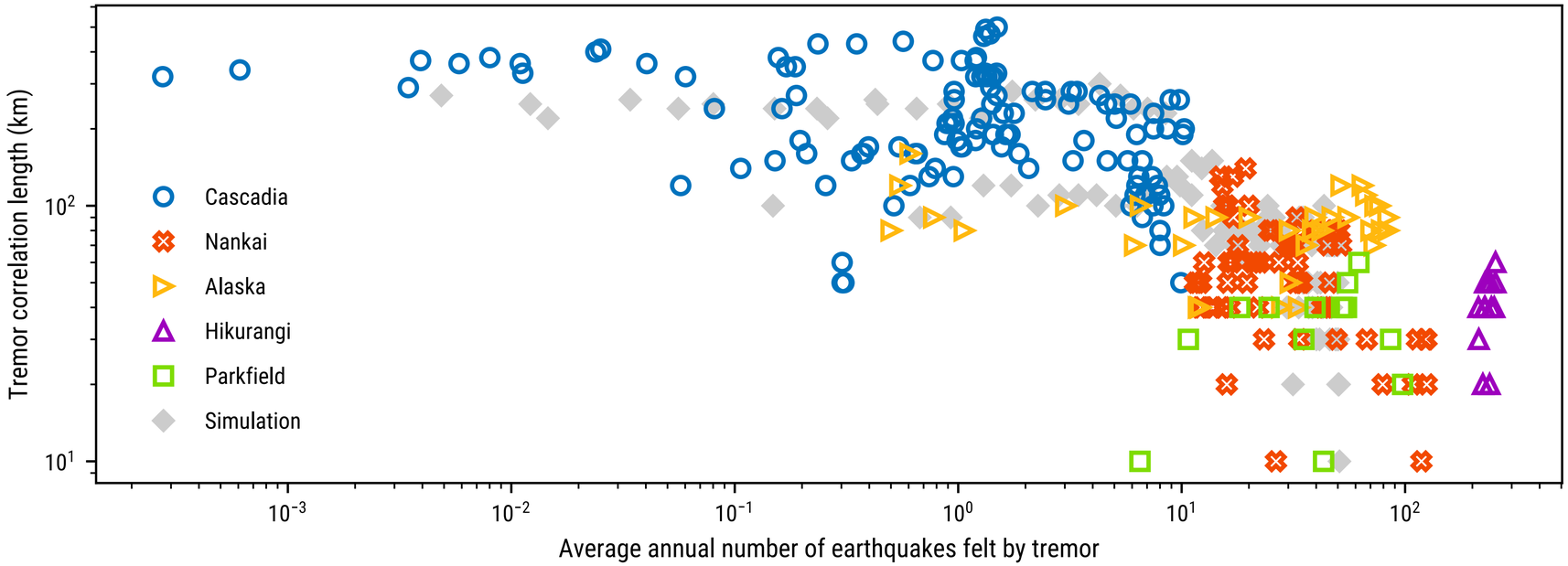




Conclusions

- No observable change of LFE activity before earthquakes in Parkfield
- Small earthquakes (M3—5) trigger LFE activity locally (< 20 km)

- **The activity of small earthquakes seems to limit the extent of synchronized tremor activity, *i*.e. of the size of slow ruptures**



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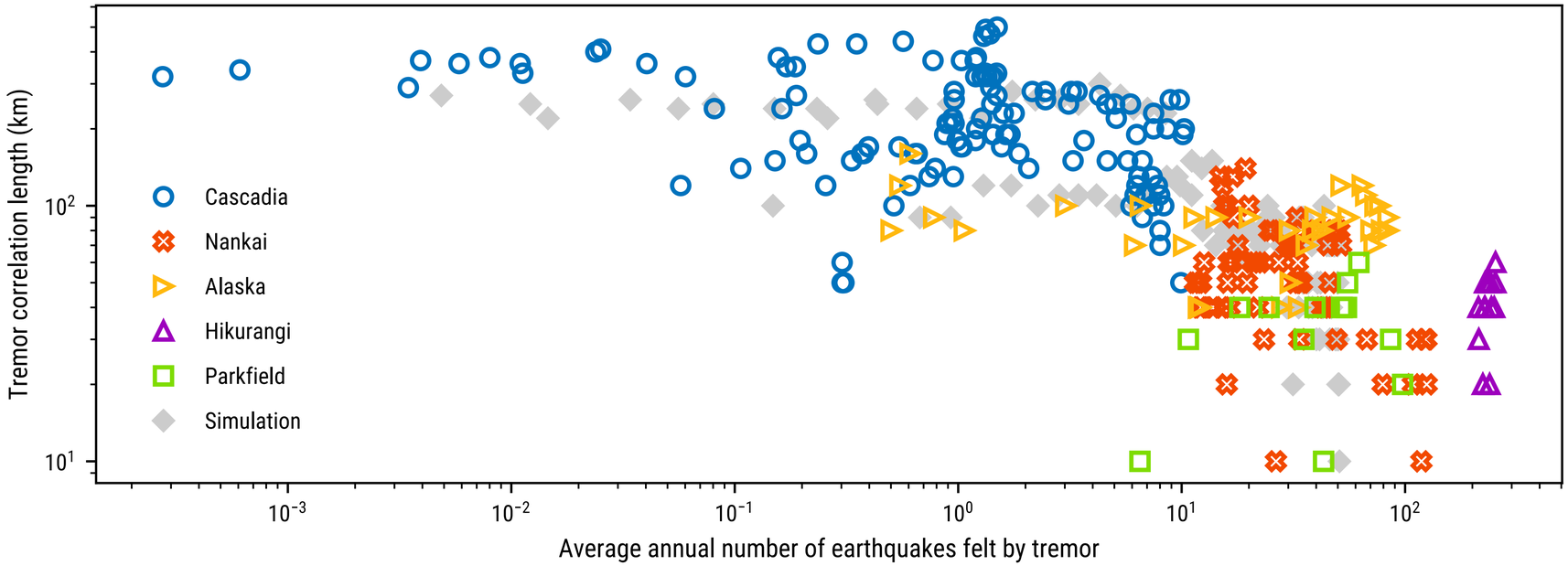

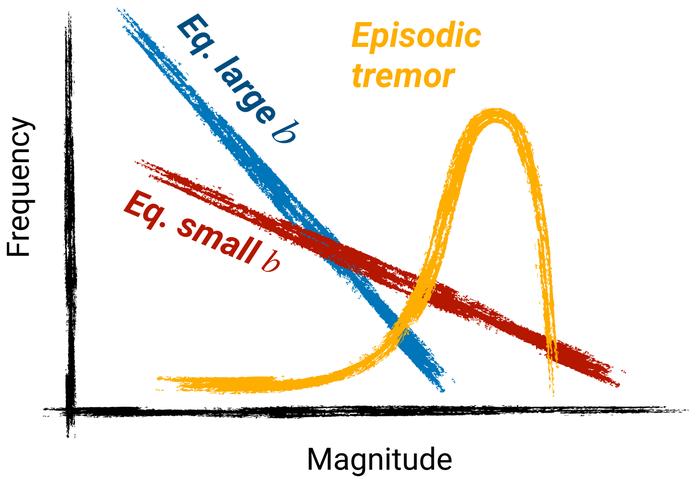

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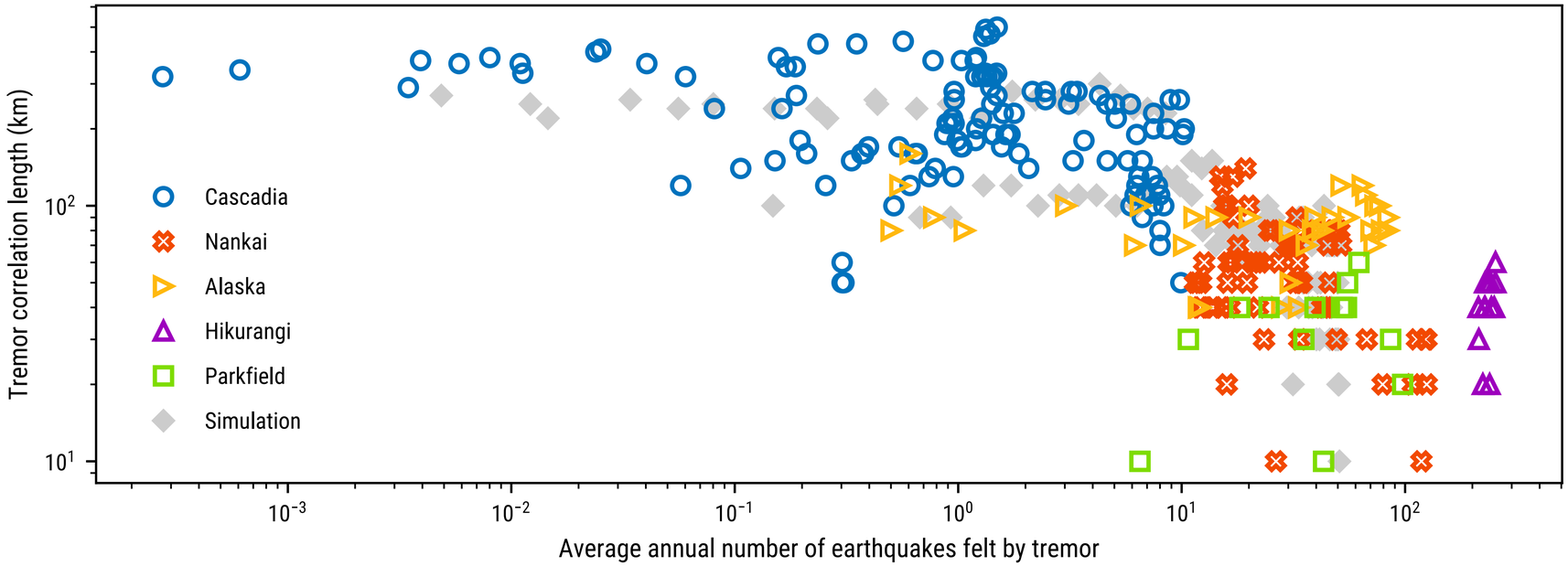

Thank you!
Poster 071 Group A