

Joint Rupture Sets

Oakley Jurgens, 21 May 2024

Te Taura Matapae Pūmate Rū i Aotearoa
NSHM The New Zealand
National Seismic
Hazard Model
A GNS Science Led Research Programme

E mahi ana me
In collaboration with



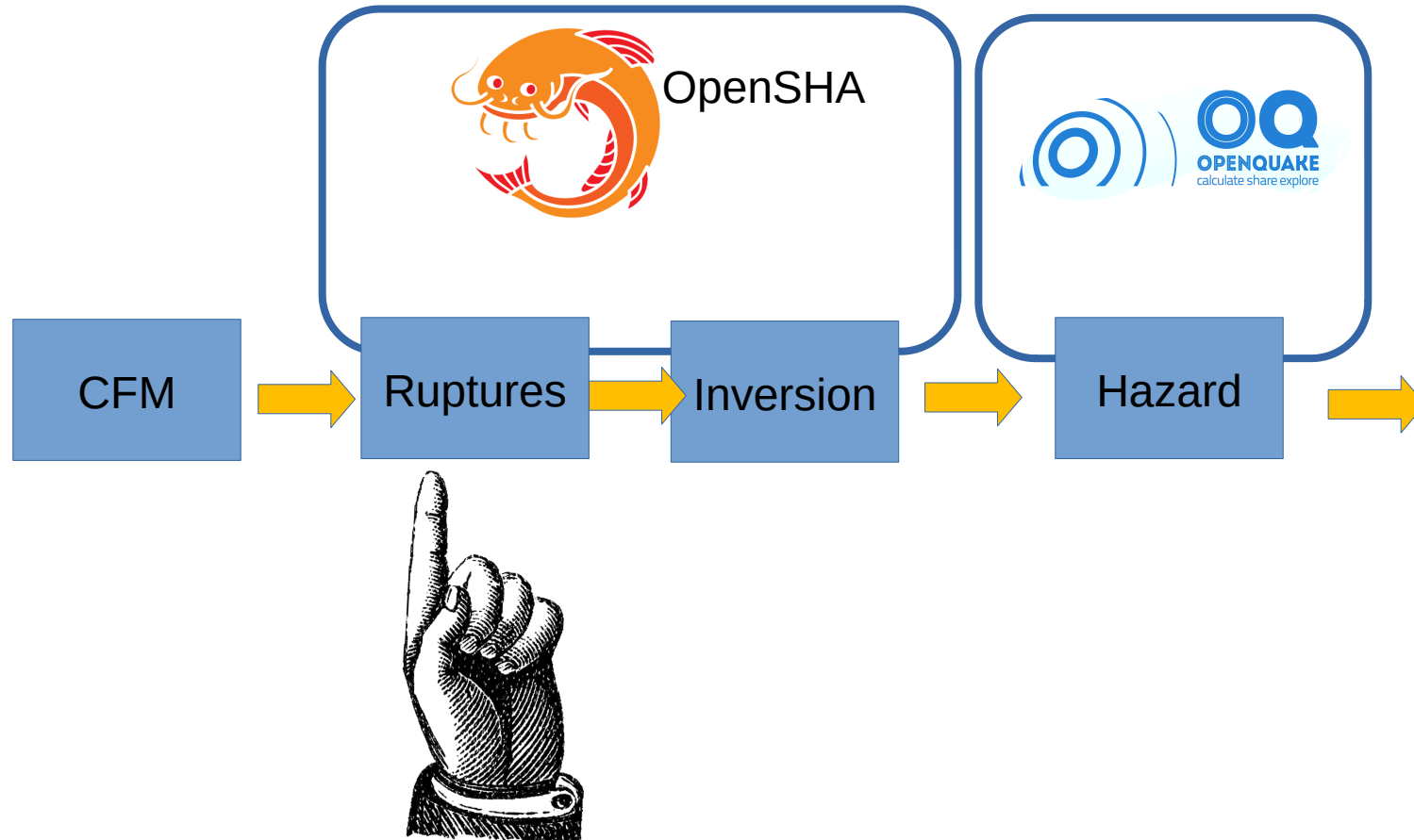
Ngā hoa tuku pūtea
Funding partners



MINISTRY OF BUSINESS,
INNOVATION & EMPLOYMENT
HĪKINA WHAKATUTUKI

Toka
Tū Ake **EQC**

Where Does This Fit In?



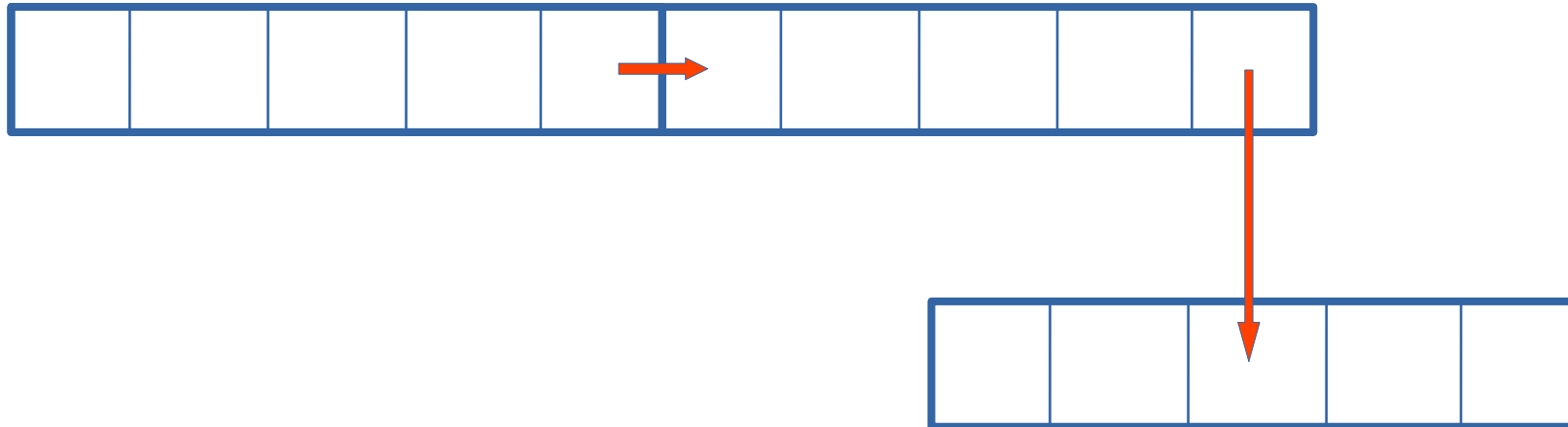
OpenSHA Rupture Generation



OpenSHA Rupture Generation

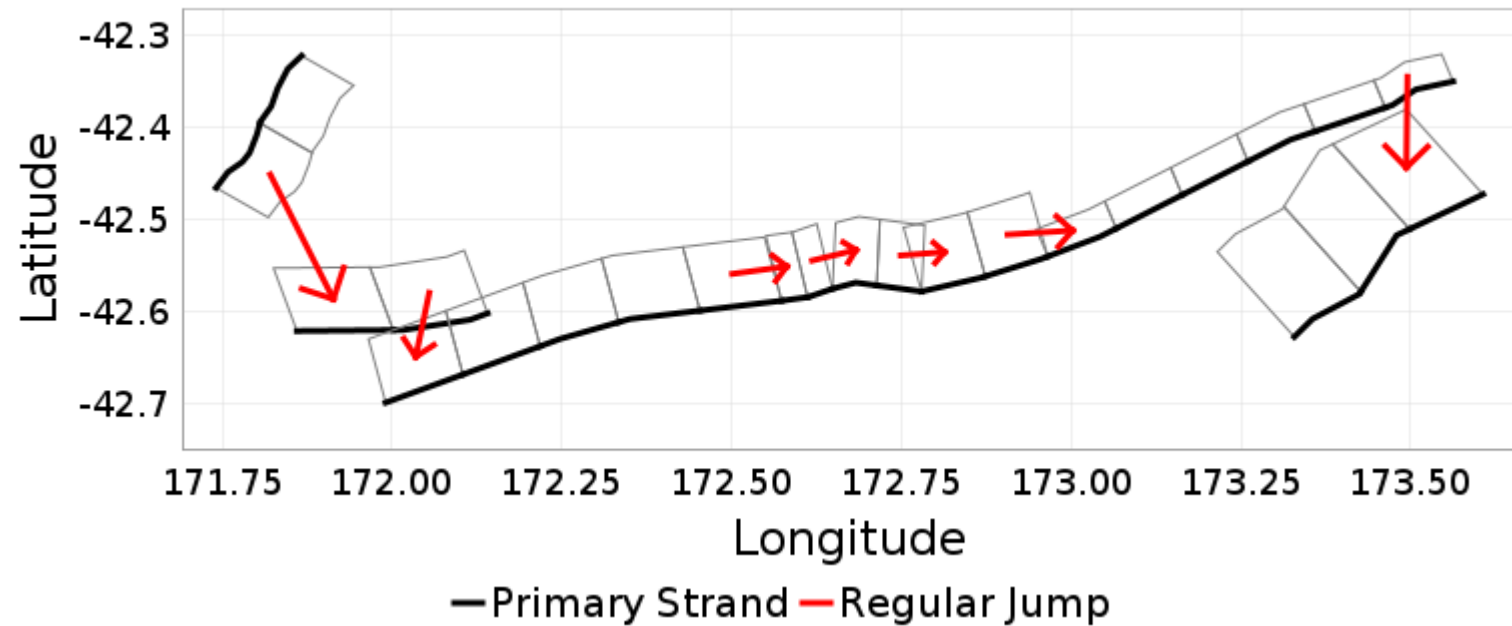


OpenSHA Rupture Generation



OpenSHA Rupture Generation

- Create all permutations
- Plausibility filters
- Thinning



Thinning

NZSHM22: 450,745 ruptures

- Crustal: 411,270
- Hikurangi: 23,675
- Puysegur: 15,800

UCERF3: 253,706 ruptures

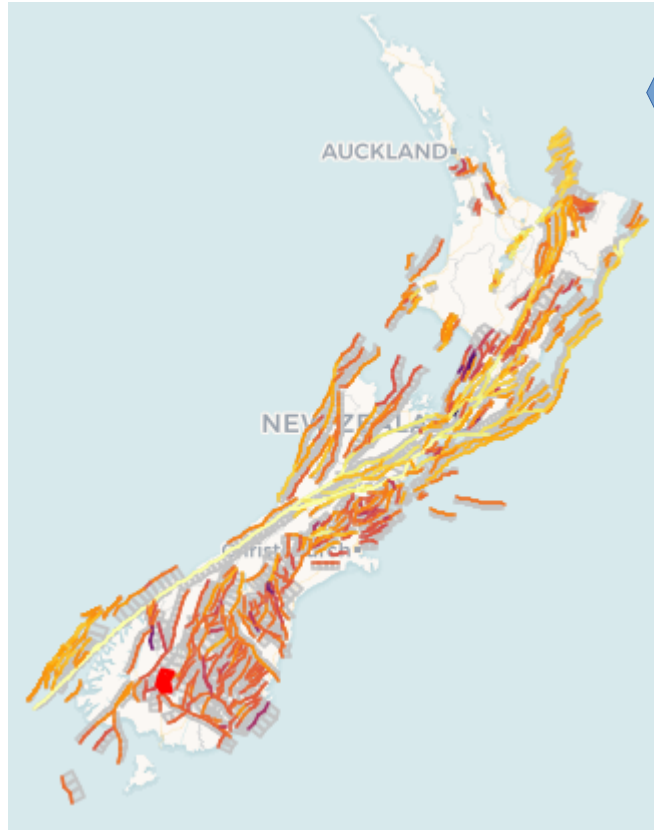
Joint ruptures: millions

- Computational complexity
- Memory and storage requirements
- Tools struggle

Goals

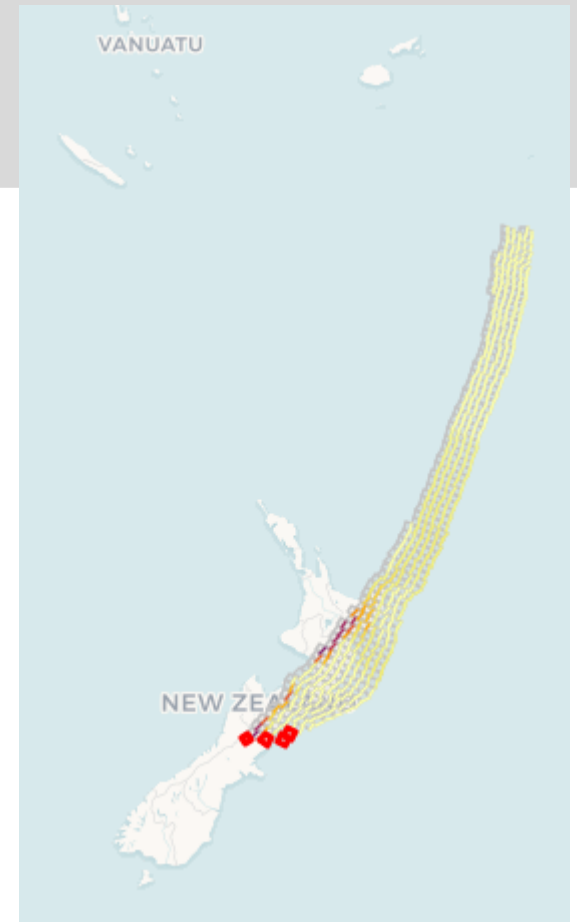
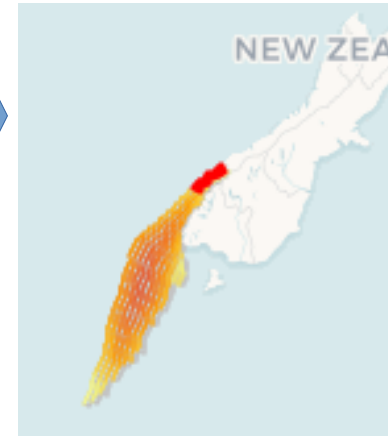
- Reduce rupture set size
- Maintain good coverage of relevant ruptures in each area
- Minimise impact on hazard

NZSHM22 Rupture Sets



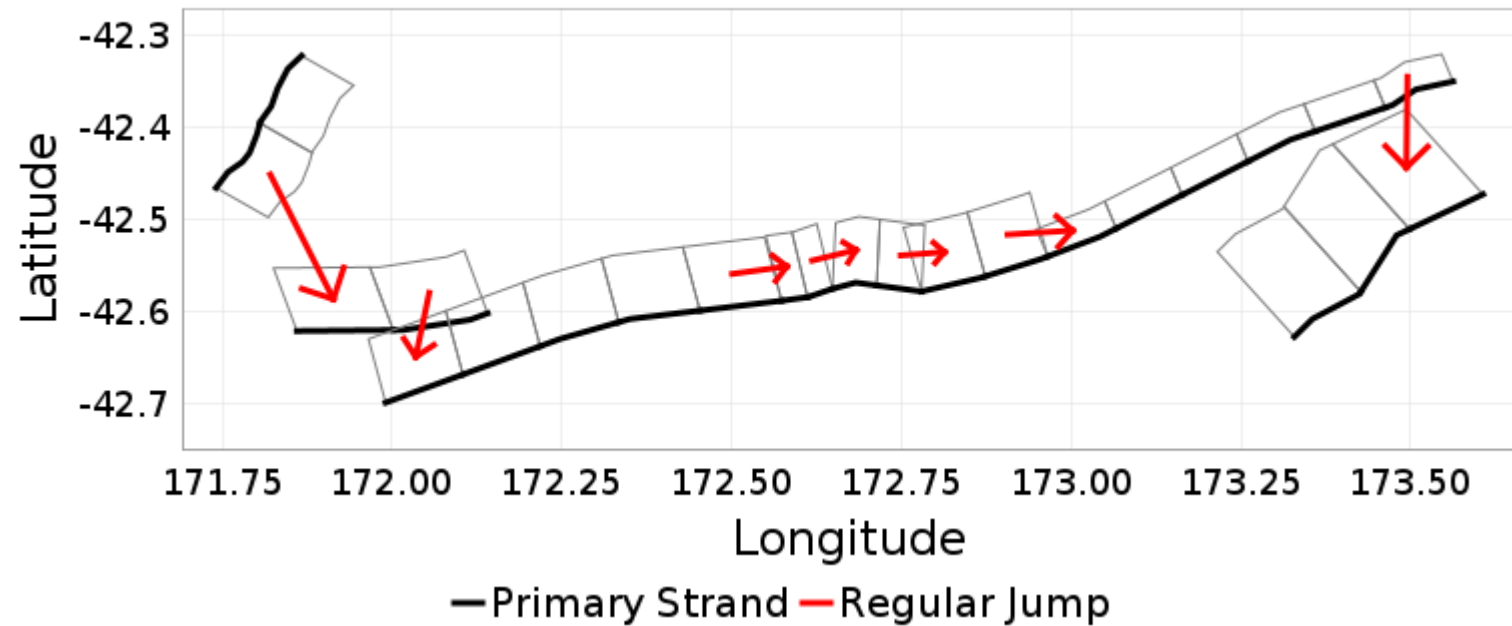
- Strings of fault sections
- No splays
- Filtering:
 - Coulomb
- Thinning:
 - 10% growth

- Rectangular selections
- No jumps, no splays
- Filtering:
 - aspect ratio
 - fill



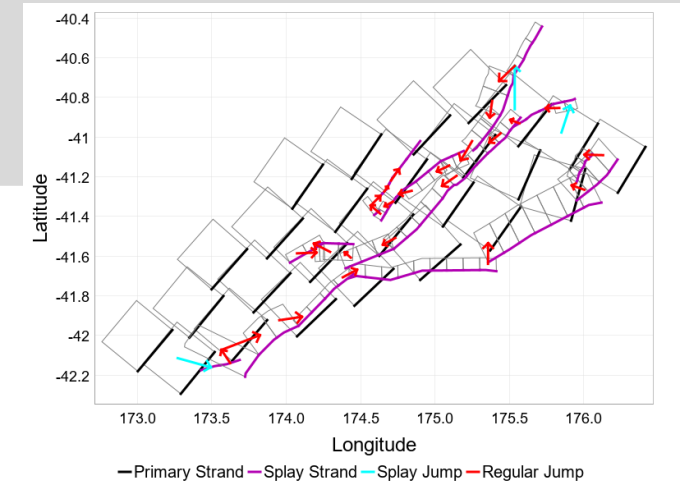
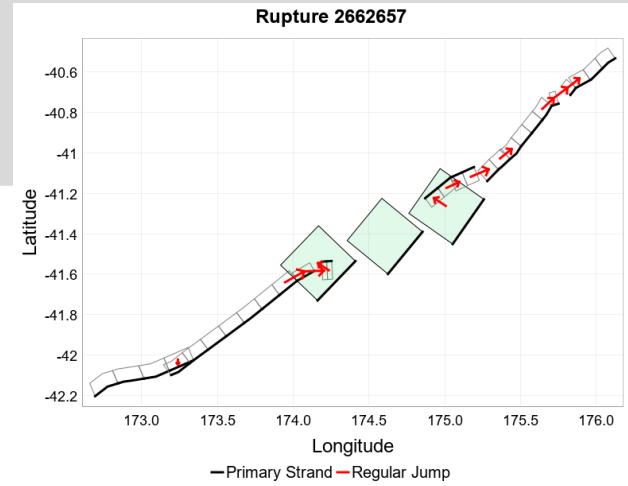
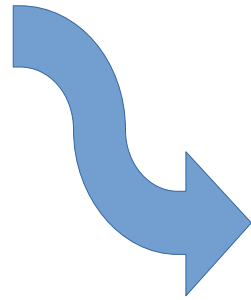
Joint Rupture Generation

- Create all permutations
- Plausibility filters
- Thinning



Joint Rupture Generation

- Create all permutations
- Plausibility filters
- Thinning



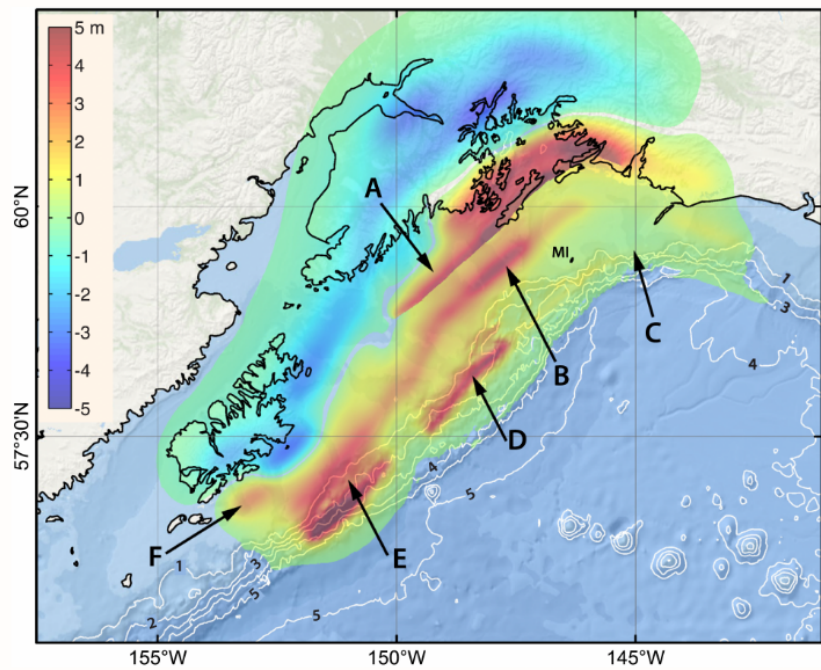
Heuristics:

- What are the crustal/subduction section proportions?
- Do relative azimuth, dip, rake, matter?

Physics:

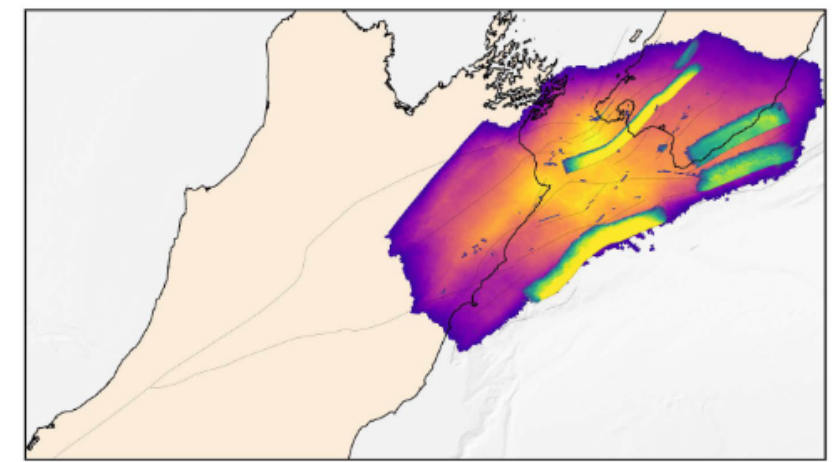
- Can we apply Coulomb filtering?
- How does a crustal rupture unlock an interface?
- How does an interface rupture unlock a crustal fault?
- How deep do the crustal faults go?

Joint Ruptures: What do they look like?

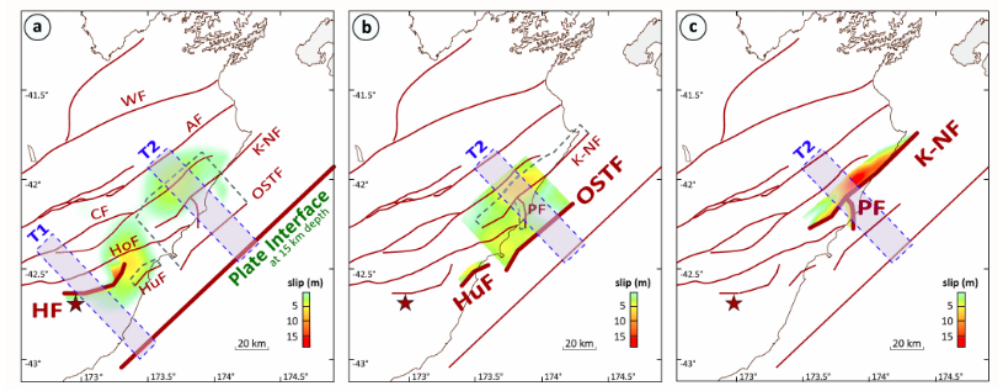


Suleimani and Freymueller [2020]

Event 243318 (Mw 8.5, year 11811)



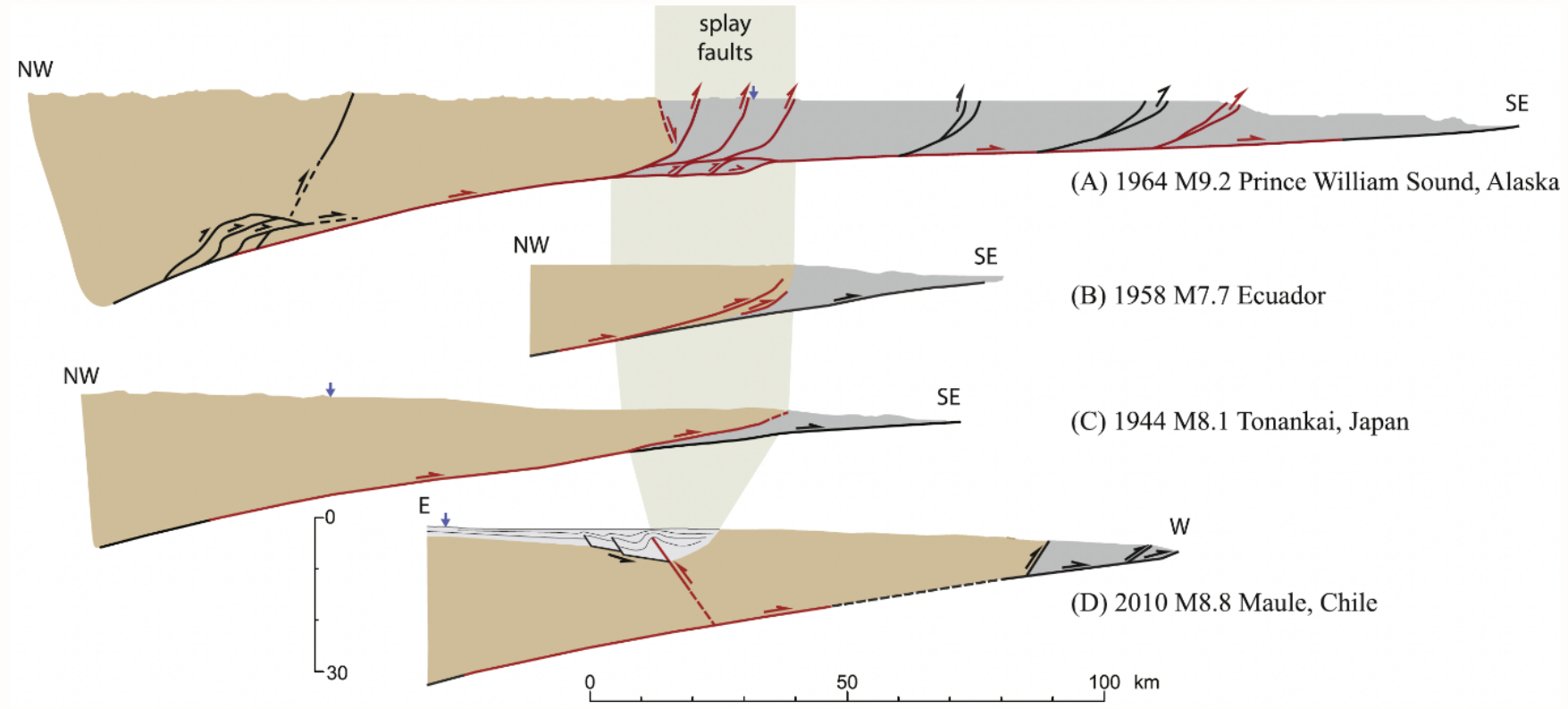
Andy Howell and Camilla Penney (UC), using RSQSIM



Mouslopoulou et al. [2019]

Joint Ruptures: What do they look like?

Some cases of joint ruptures/splay fault ruptures around the world



(A) 1964 M9.2 Prince William Sound, Alaska
(B) 1958 M7.7 Ecuador
(C) 1944 M8.1 Tonankai, Japan
(D) 2010 M8.8 Maule, Chile

Haeussler et al. [2015]

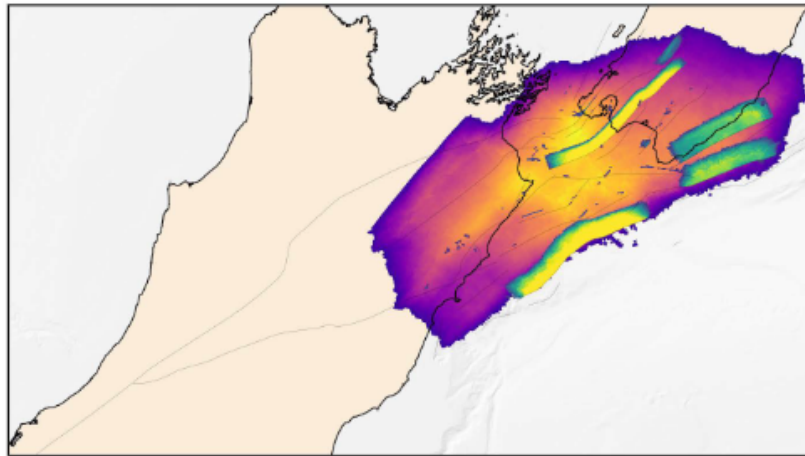
Tooling

- Splays
- Performance
- Reporting

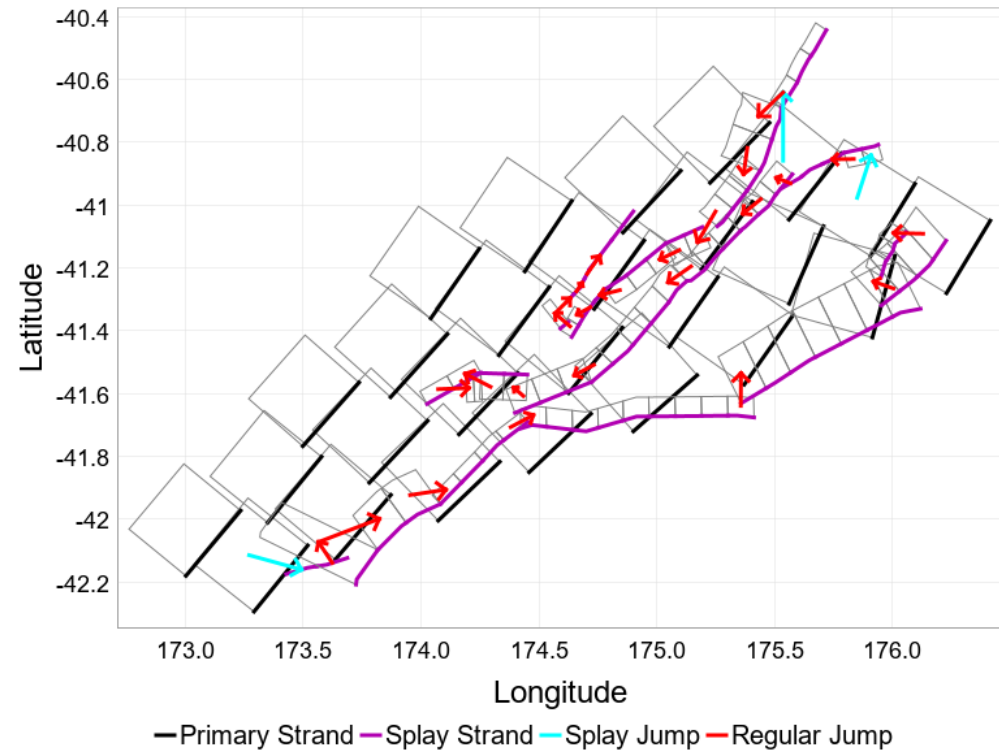


Splays

Event 243318 (Mw 8.5, year 11811)



Andy Howell and Camilla Penney (UC), using RSQSIM

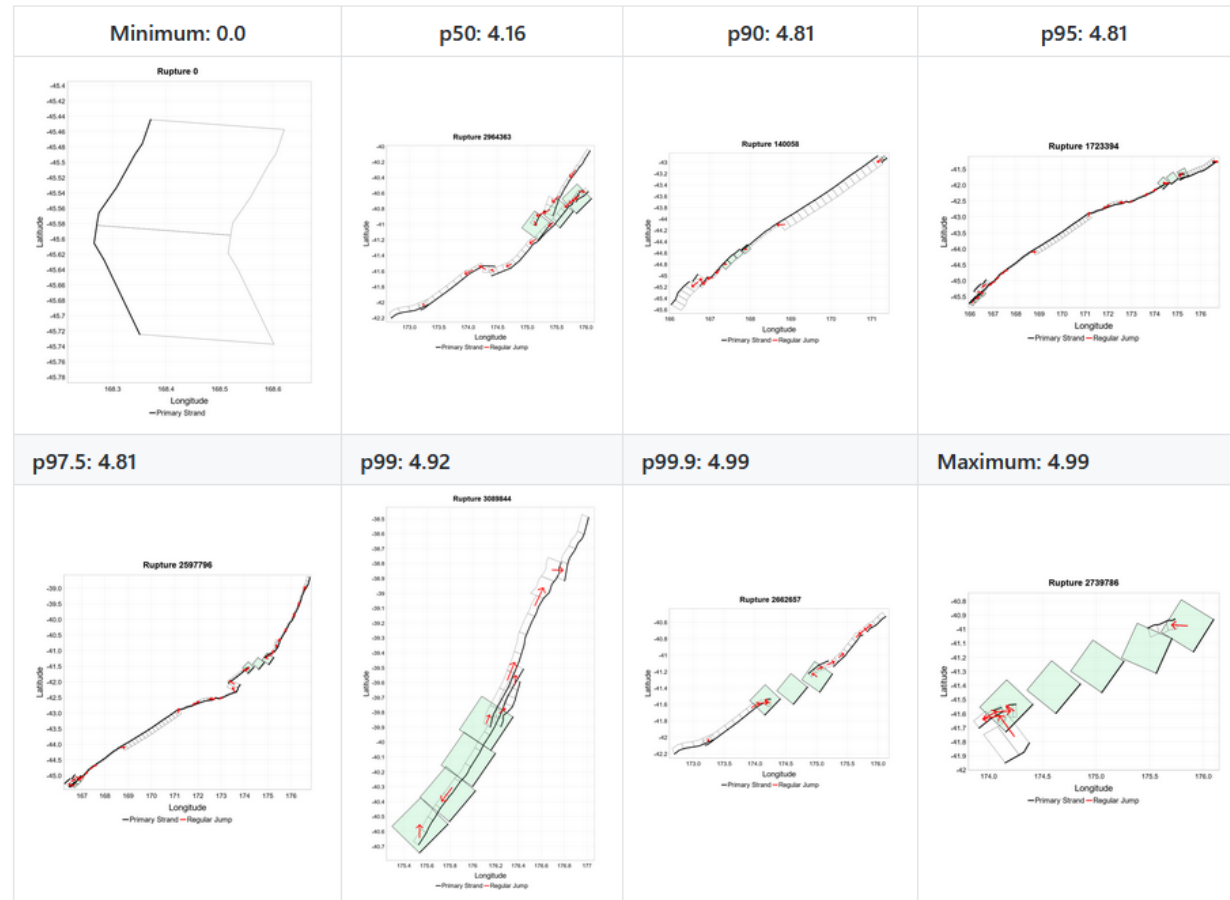


Reporting

Maximum Jump Dist Extremes & Examples

[\(top\)](#)

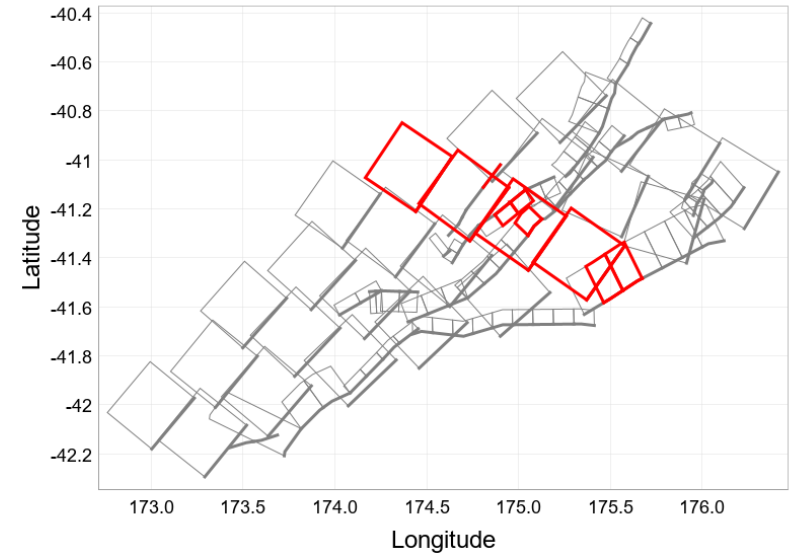
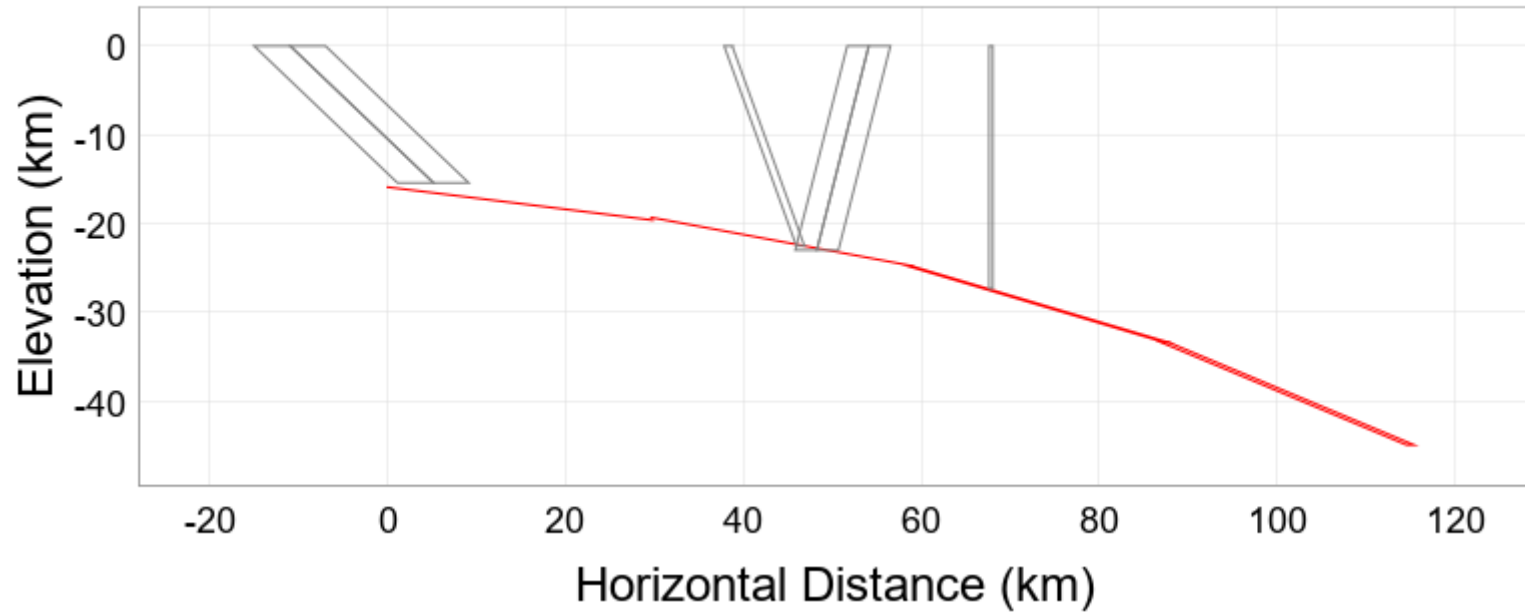
Example ruptures at various percentiles of Maximum Jump Dist



Cumulative Jump Dist

Reporting: Fishbone Diagrams

Fishbone



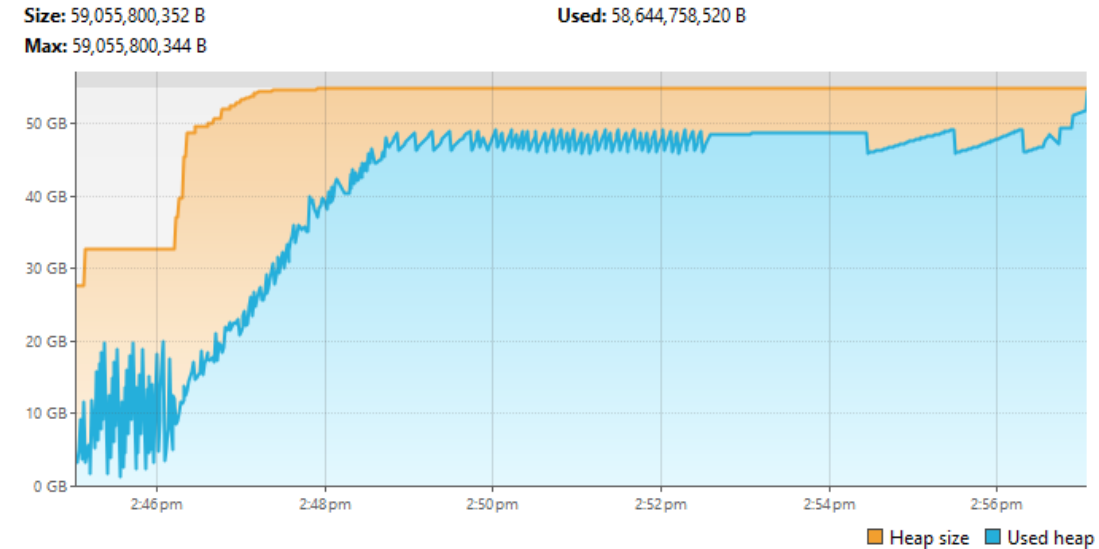
Performance

NZSHM22: 450,745 ruptures

UCERF3: 253,706 ruptures

Joint ruptures: millions

- Computational complexity
- Memory and storage requirements
- Tools struggle
- NZSHM performance improvements
- OpenSHA performance improvements
- Rupture index files larger than 2GB



Conclusion

Rupture Generation

- Heuristics
- Physical processes
- Thinning
- Scaling Relationships

Tooling

- Splays
- Reporting
- Performance

