

Joint Rupture Generation

Physical Constraints

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

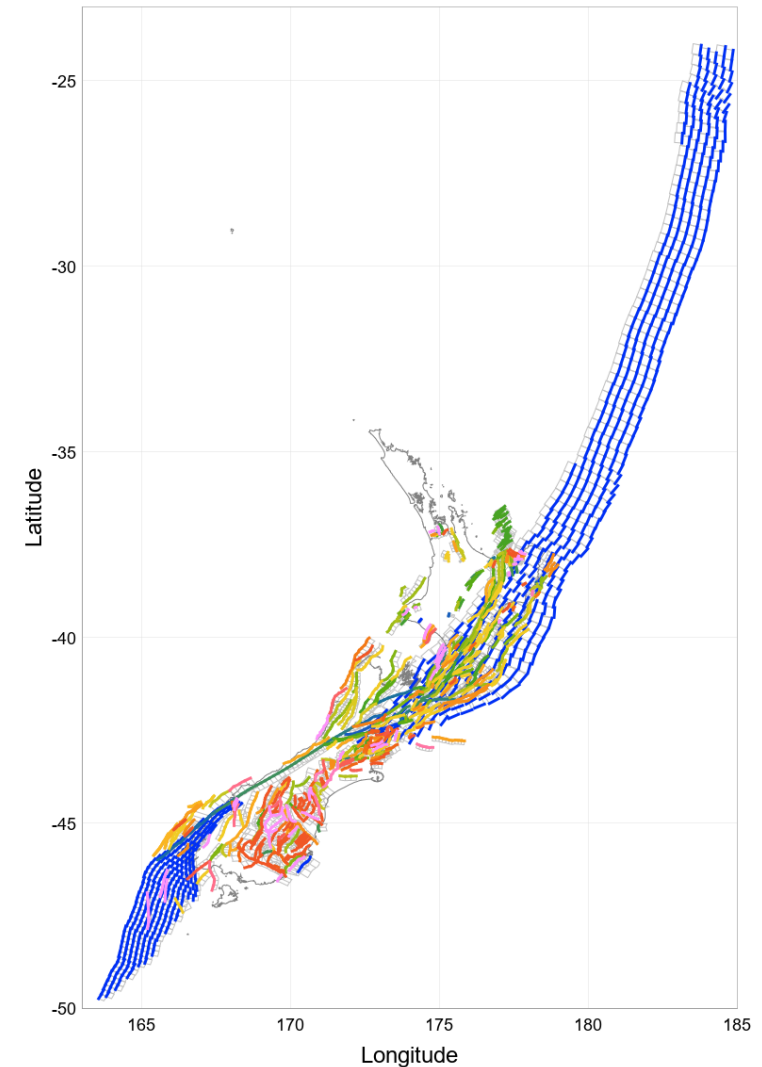
Toka Tū Ake **EQC**

Science Input Required

The shape of plausible joint ruptures

Selection of relevant joint ruptures

Scaling relationship



Oakley's World: Ruptures in OpenSHA

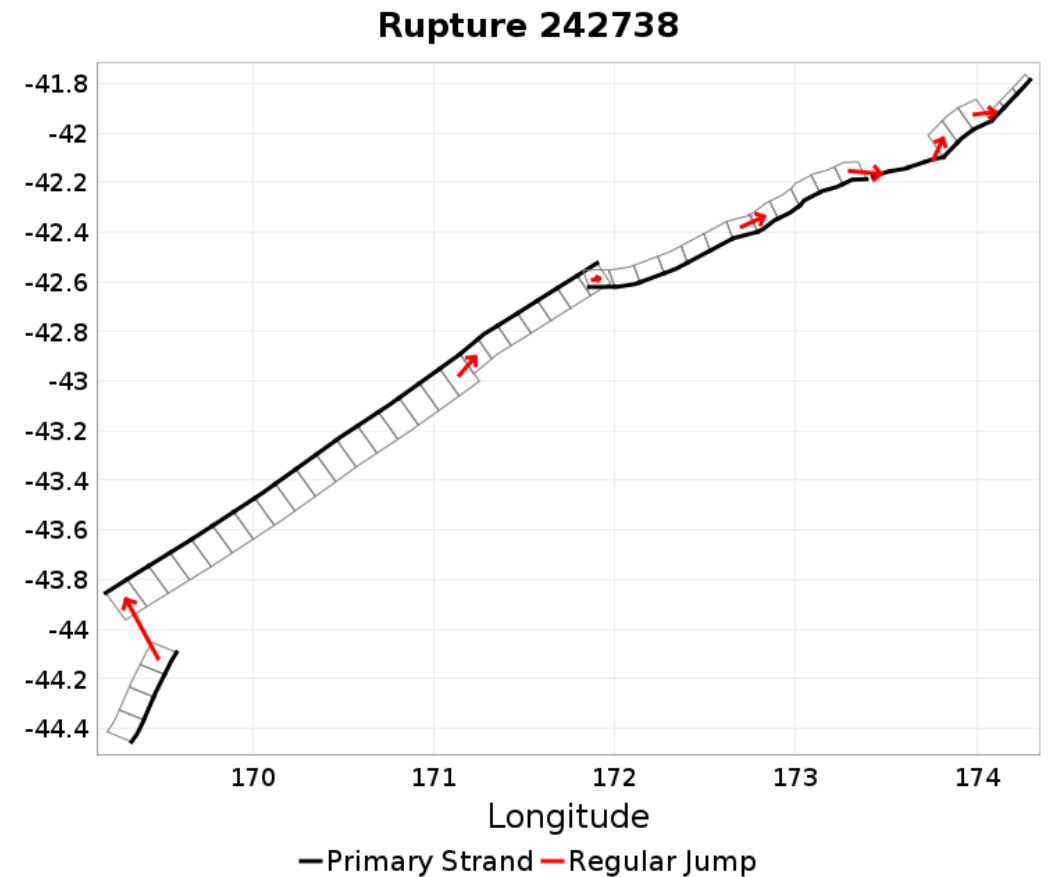
Ruptures are strings of sections on faults connected by jumps

NZSHM22:

- } no splays
- } Jumps have to be between crustal faults

Algorithm:

- } Find at most one possible jump between each fault pair
- } Generate all possible connected permutations
- } Filter out implausible ruptures

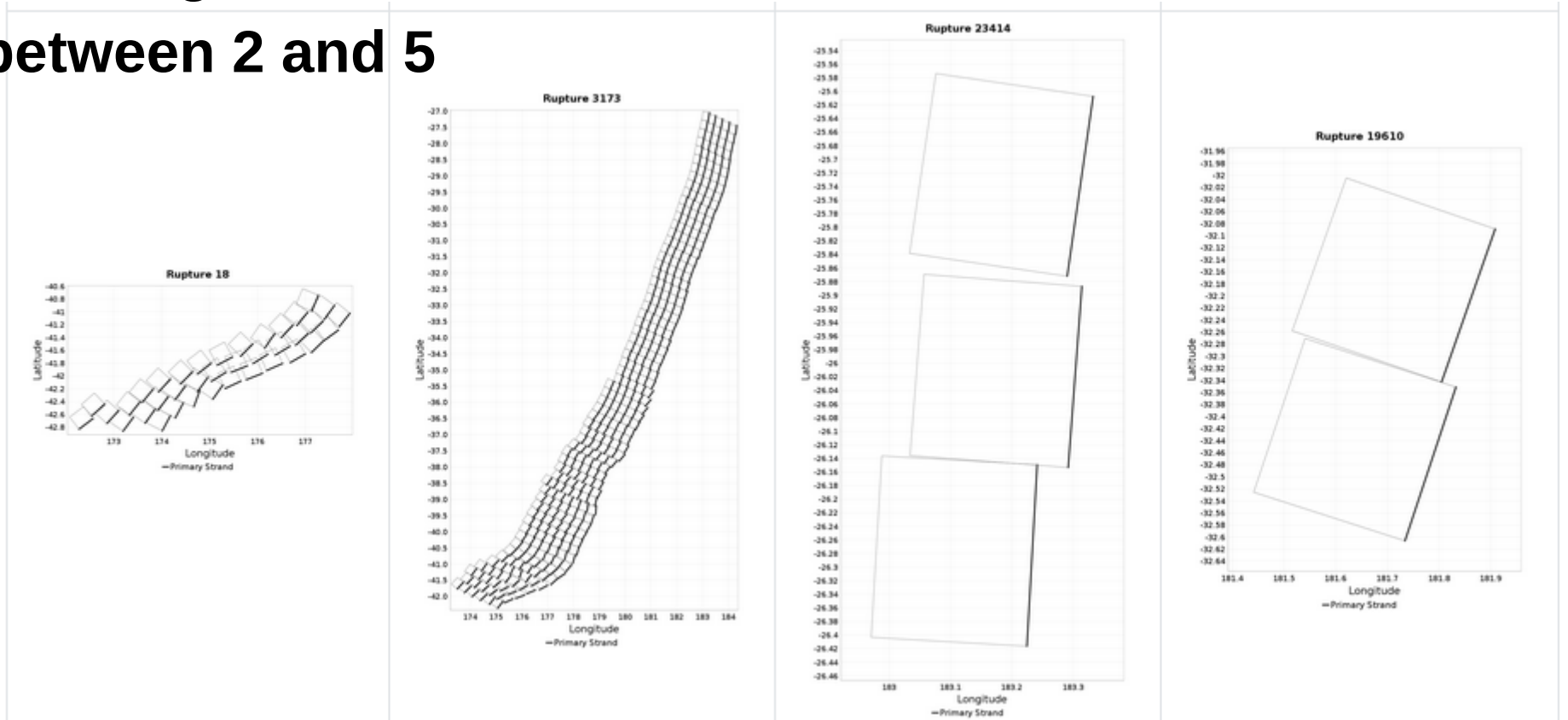


NZSHM22 Subduction Ruptures

Hacked into OpenSHA

“Rectangular” on a grid

Aspect ratio between 2 and 5



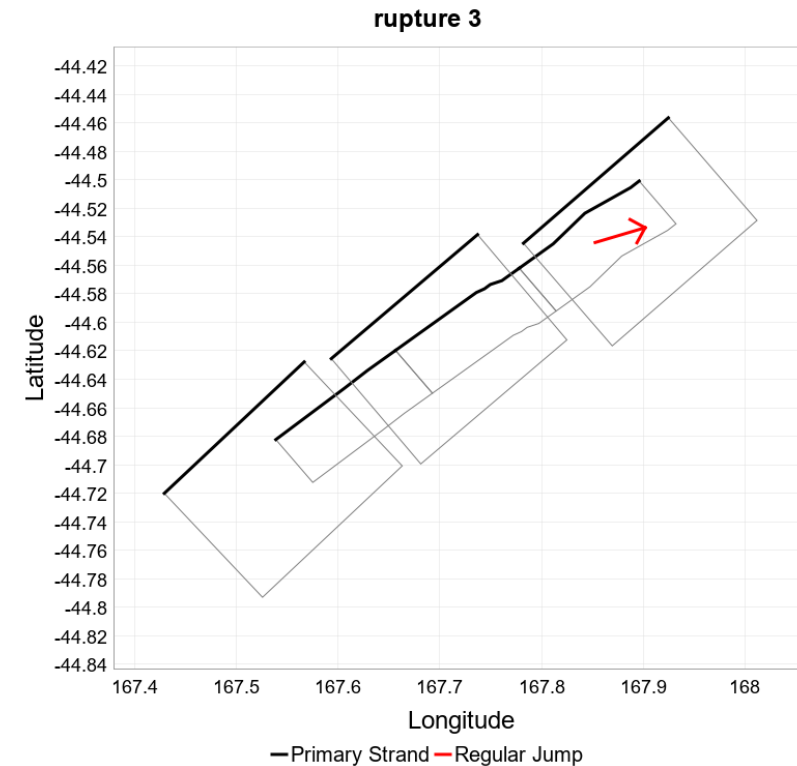
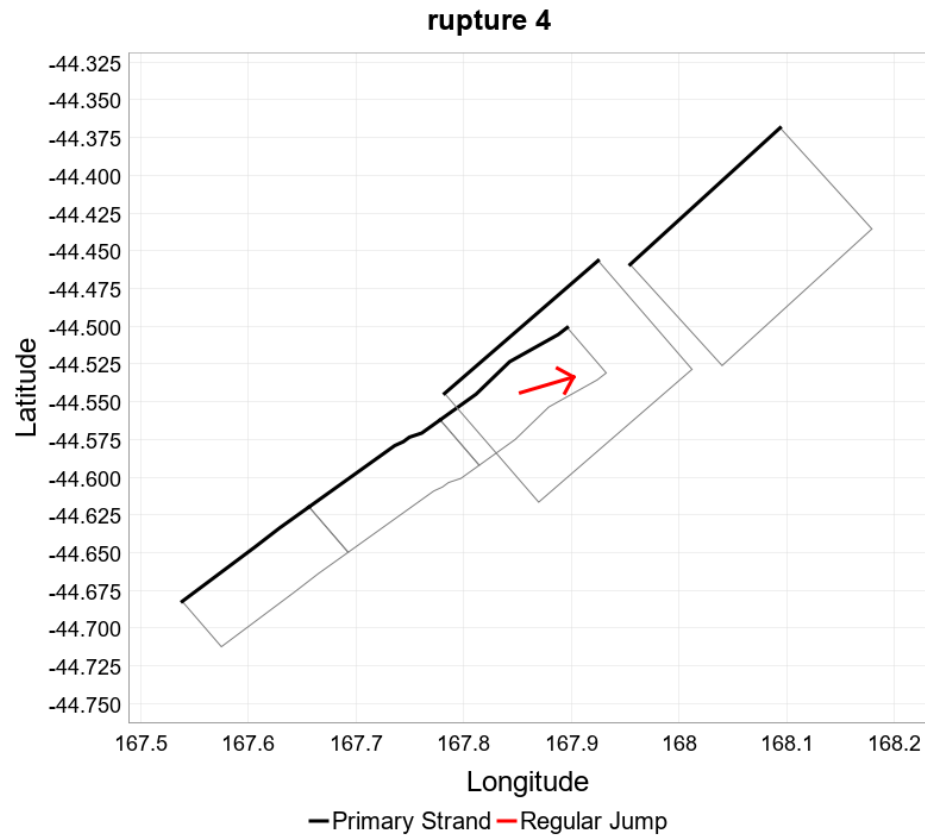
Joint Rupture Shapes: I Have Questions

**Sequential vs Parallel
Rupture Component Size
Jump distance
Jump locations
Splays**

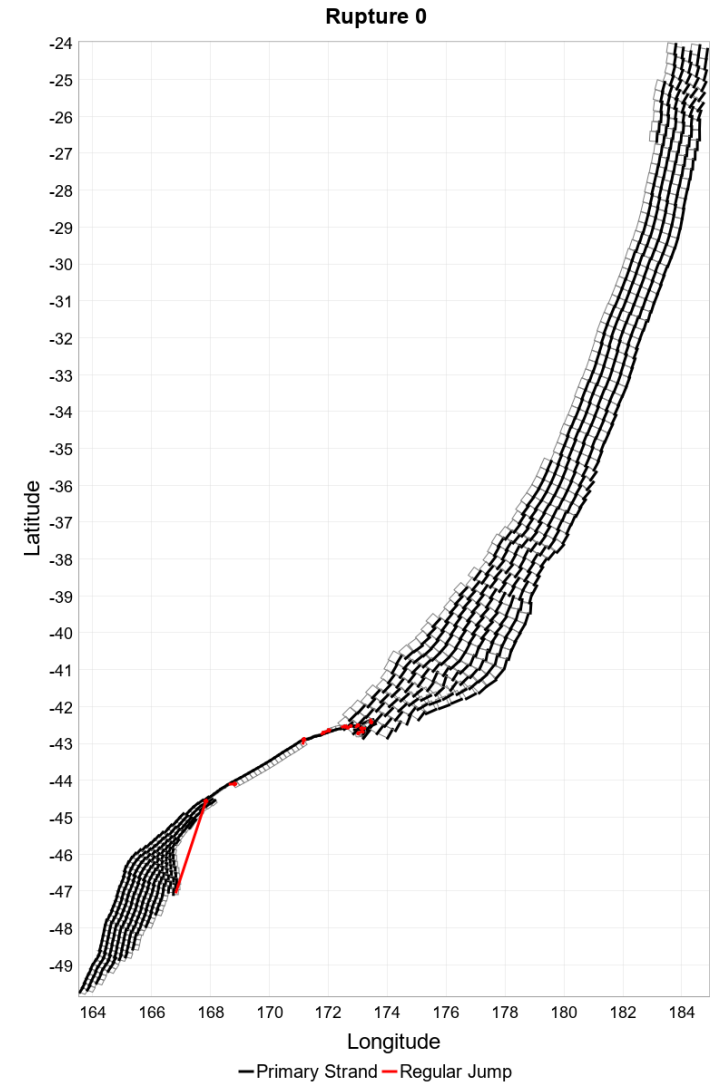
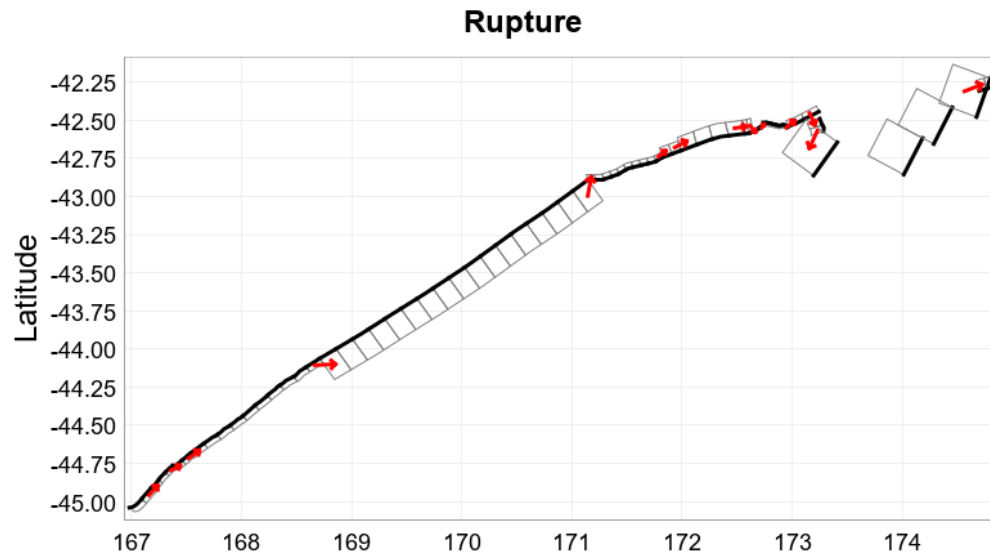


**Artist's rendering:
Oakley joining crustal and subduction faults**

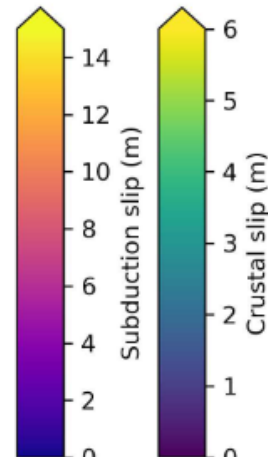
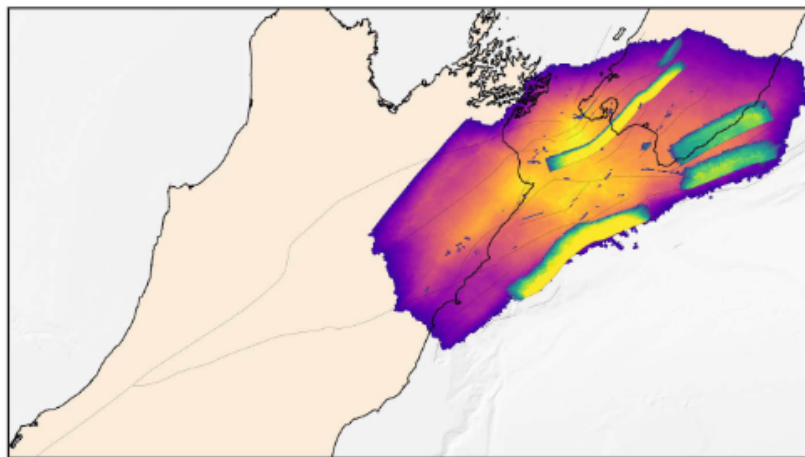
Joint Rupture Shapes: Sequential vs Parallel



Joint Rupture Shapes: Sequential vs Parallel

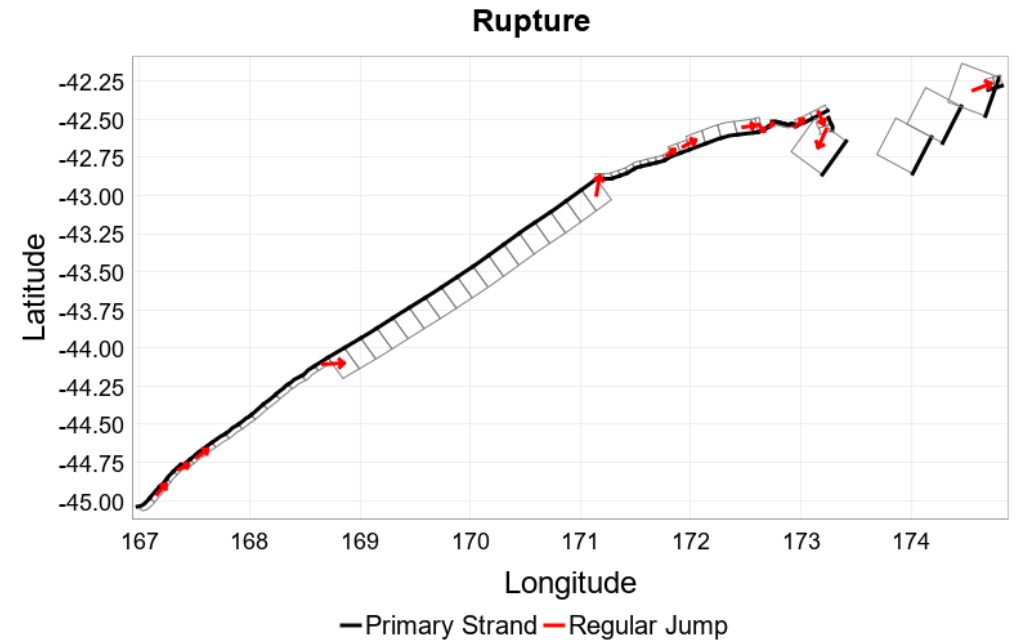
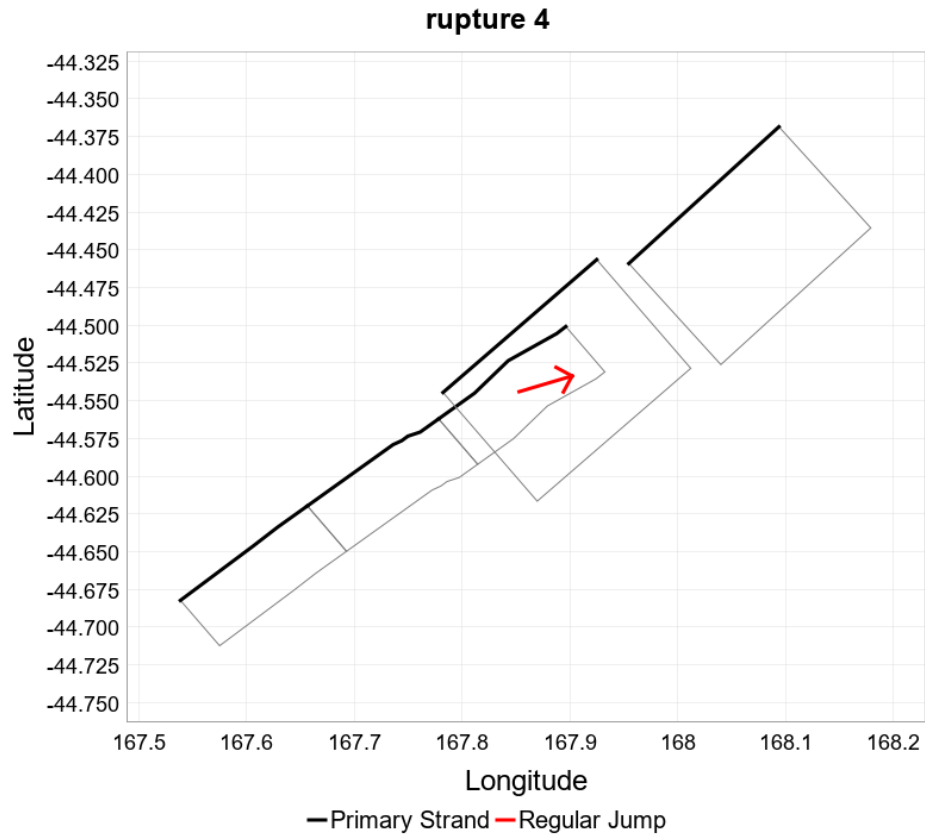


Event 243318 (Mw 8.5, year 11811)



Andy Howell and Camilla Penney (UC), using RSQSIM

Joint Rupture Shapes: Rupture Component Size

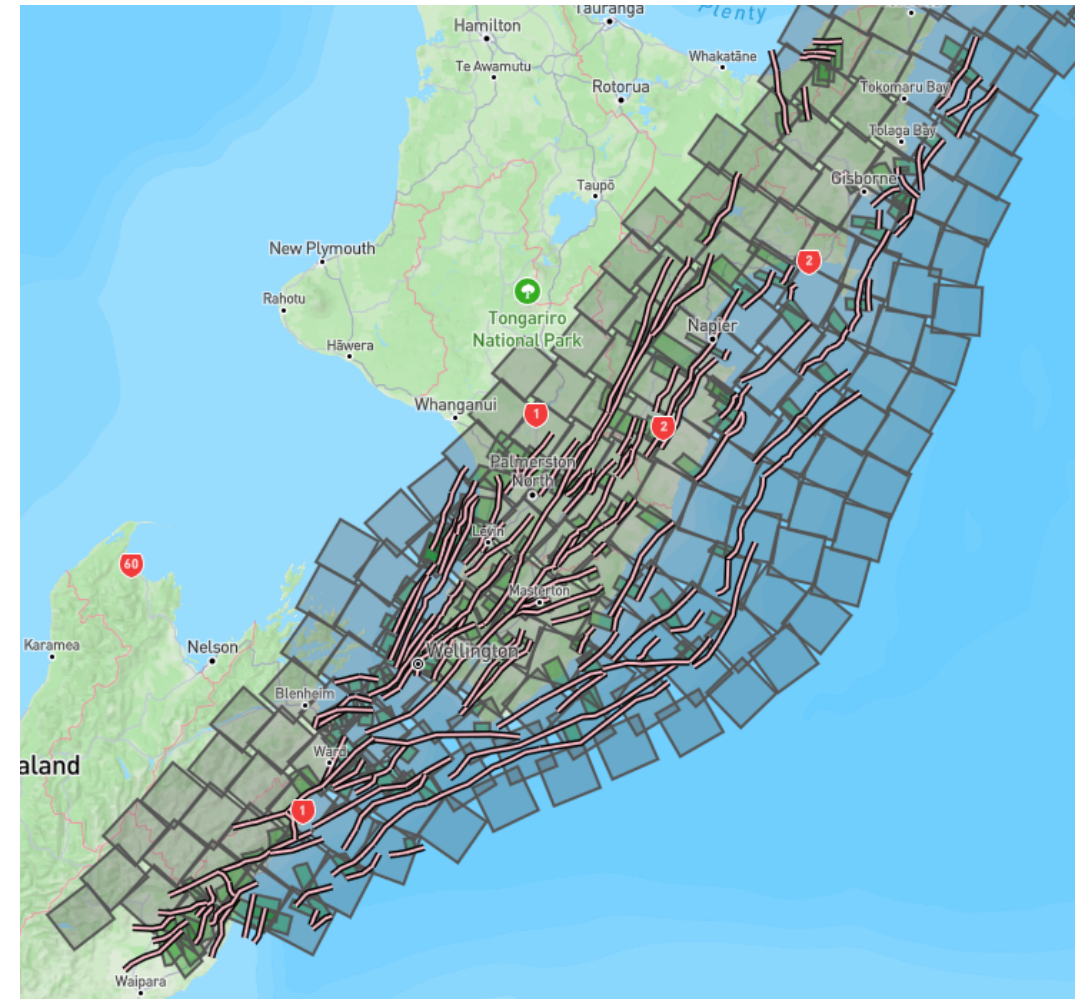
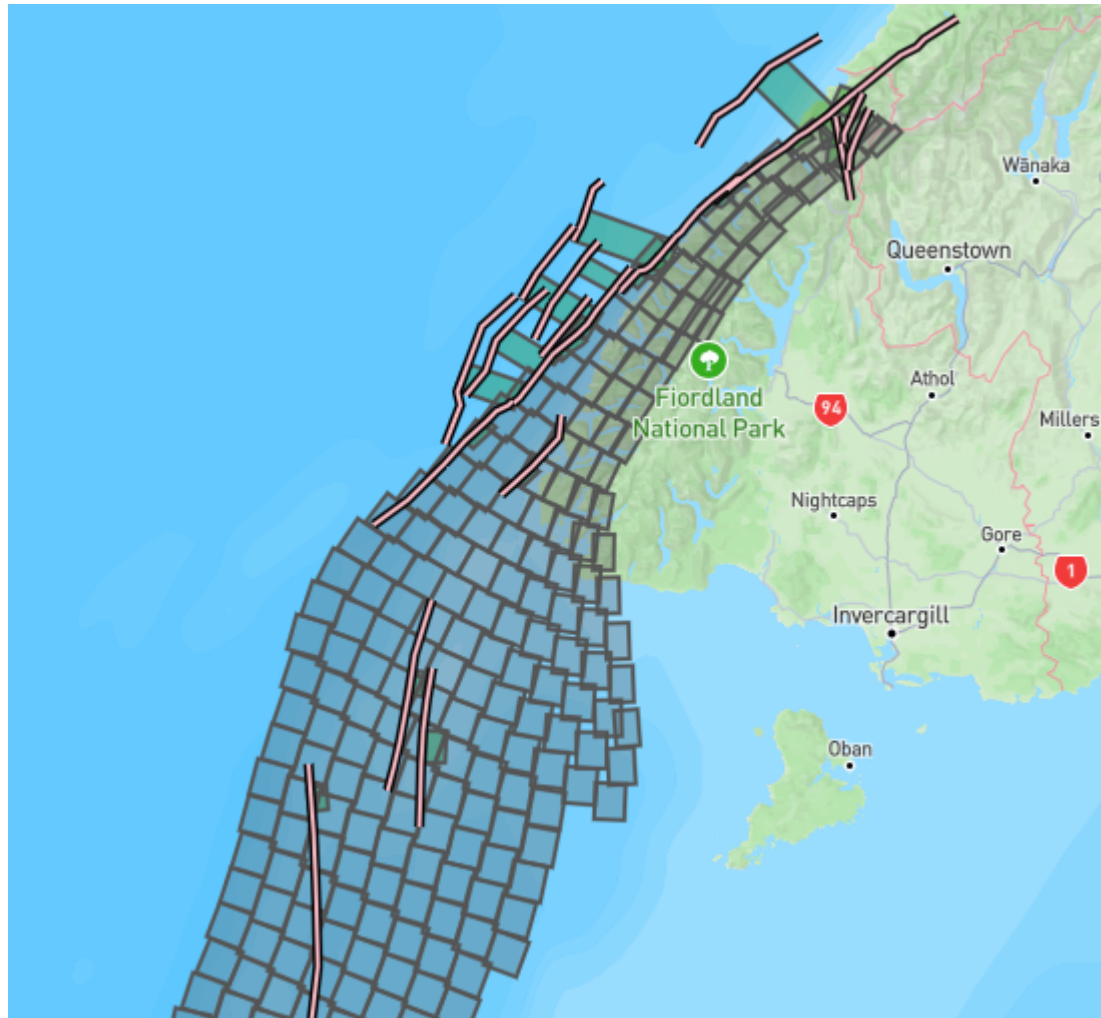


Joint Rupture Shapes: Rupture Component Size

	Small Crustal Component	Large Crustal Component
Small Subduction Component	no?	Crustal triggers subduction?
Large Subduction Component	Subduction triggers crustal?	yes

And what is the cut-off between "small" and "large"?

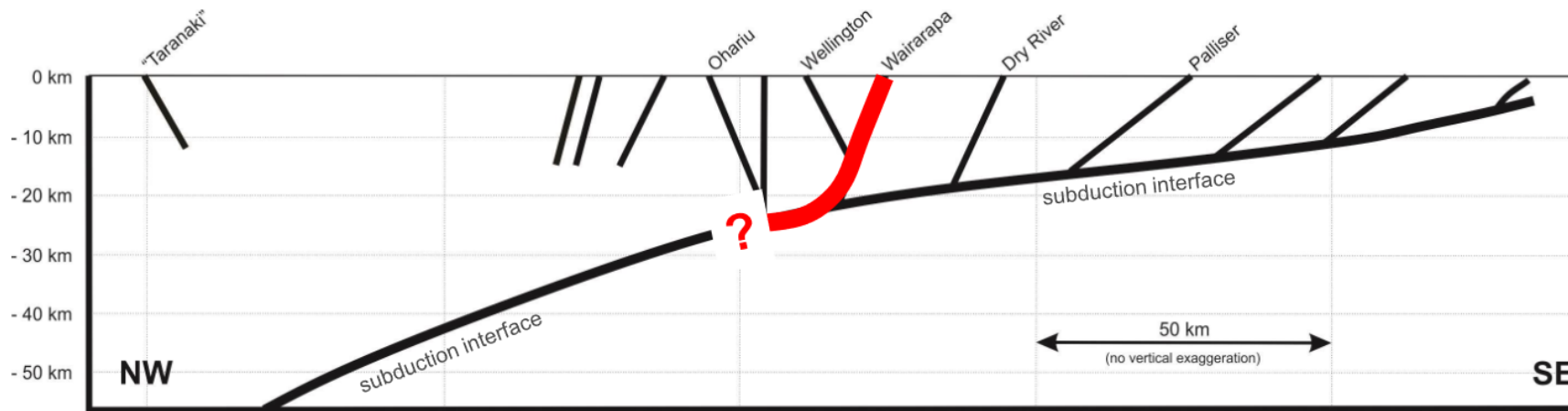
Joint Rupture Shapes: Jump Distance - Which Faults Connect?



Joint Rupture Shapes: Jump Locations

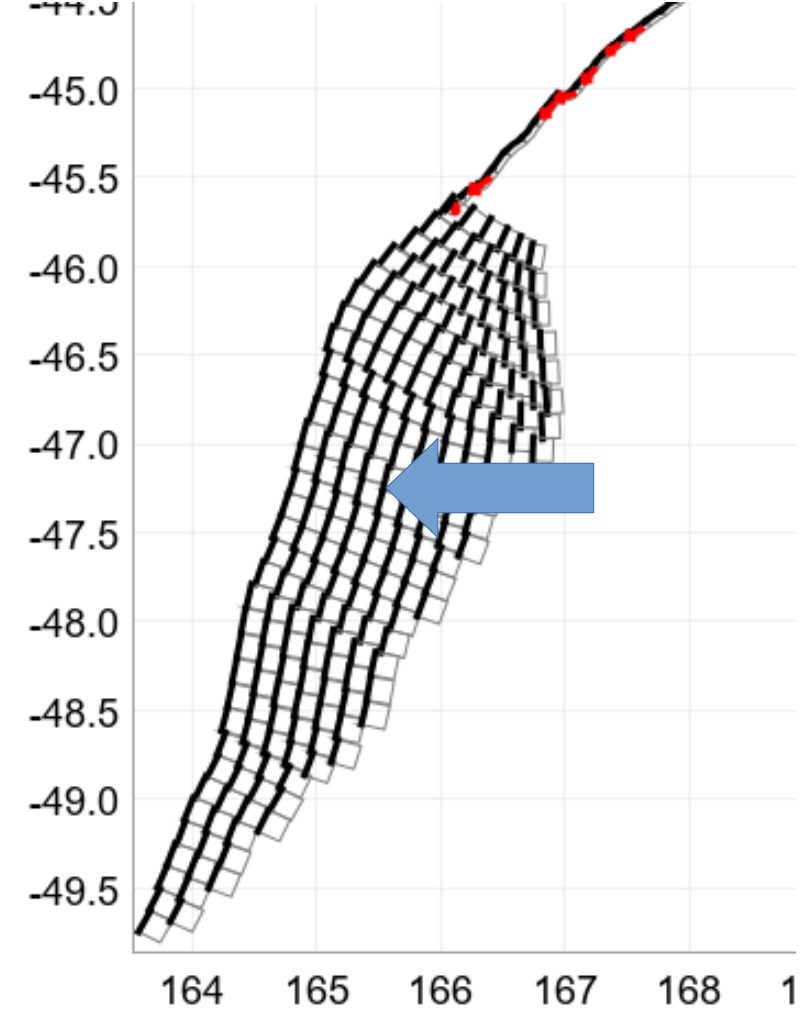
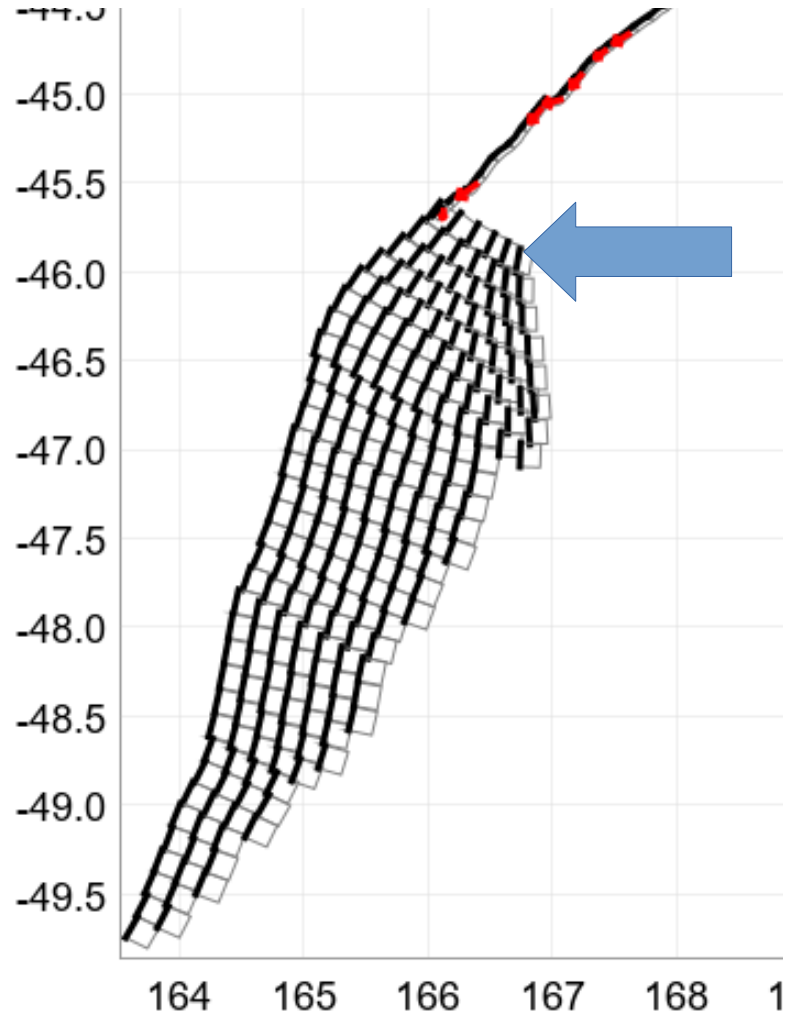
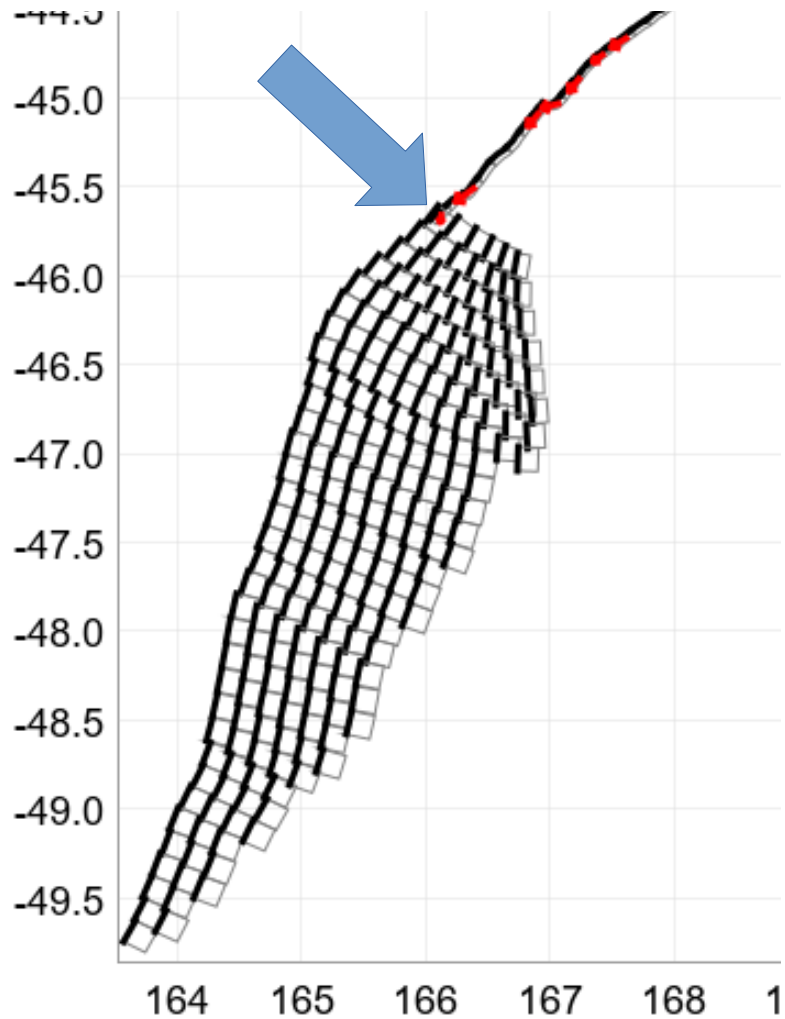
- And perhaps consideration will need to be given to Plausibility Filter rules such as:
 - Rupture is only allowed to grow onto the interface down-dip of junction with upper plate fault

(For major upper fault plate rupture with subordinate interface rupture)



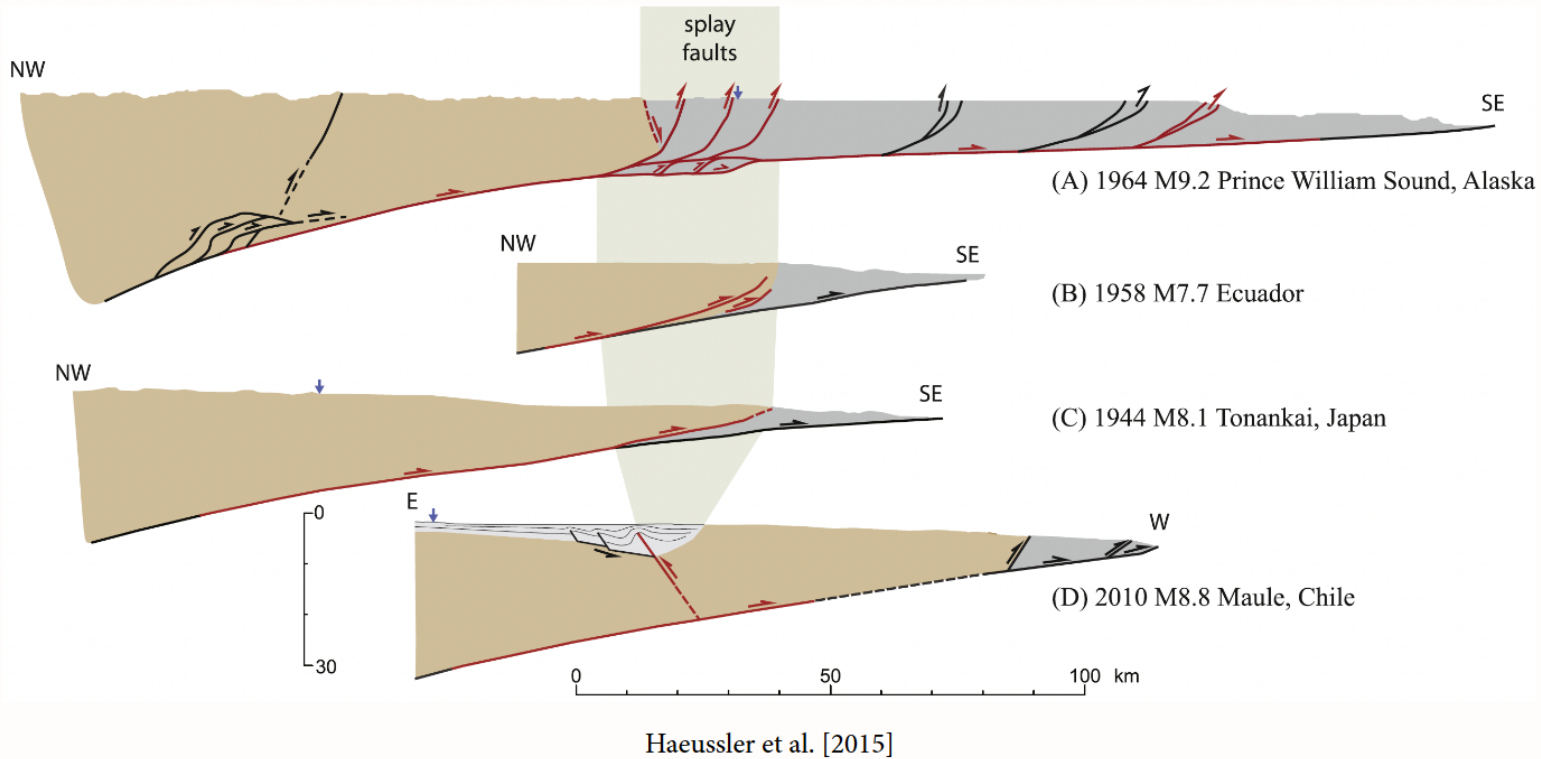
Russ Van Dissen, 2020

Joint Rupture Shapes: Jump Locations

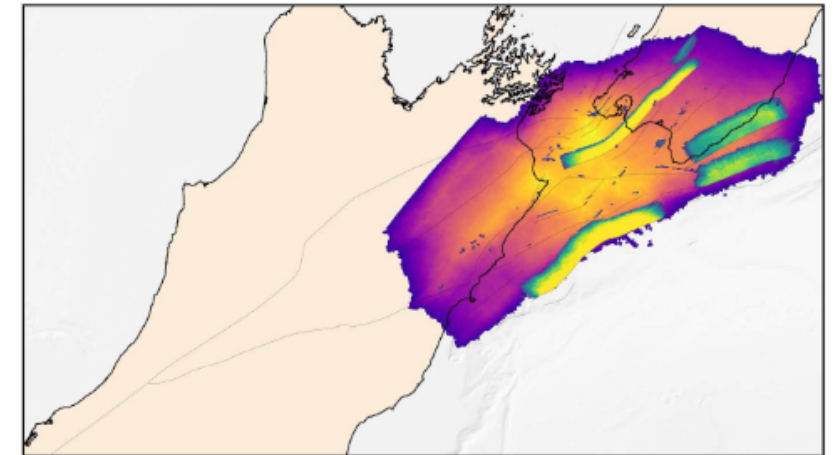


Joint Rupture Shapes: Splays

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



Event 243318 (Mw 8.5, year 11811)



Andy Howell and Camilla Penney (UC), using RSQSIM

Rupture Set Size

Joint ruptures most likely add millions of ruptures

- NZSHM22 had
 - 411,270 crustal ruptures
 - 23,675 Hikurangi ruptures
 - 15,800 Puysegur ruptures
- We get 1,986,118 ruptures when combining them with the extreme restrictions
 - Subduction components must have at least 200 sections
 - Subduction components can only grow down-dip

How do we select relevant ruptures?

Joint Rupture Generation

The shape of plausible joint ruptures

- } Sequential vs Parallel
- } Rupture Component Size
- } Jump distance
- } Jump locations
- } Splays
- } Coulomb?

Selection of relevant joint ruptures

Scaling relationship



Artist's rendering:
Oakley joining crustal and subduction faults

Thanks to Chris R for his slides!