

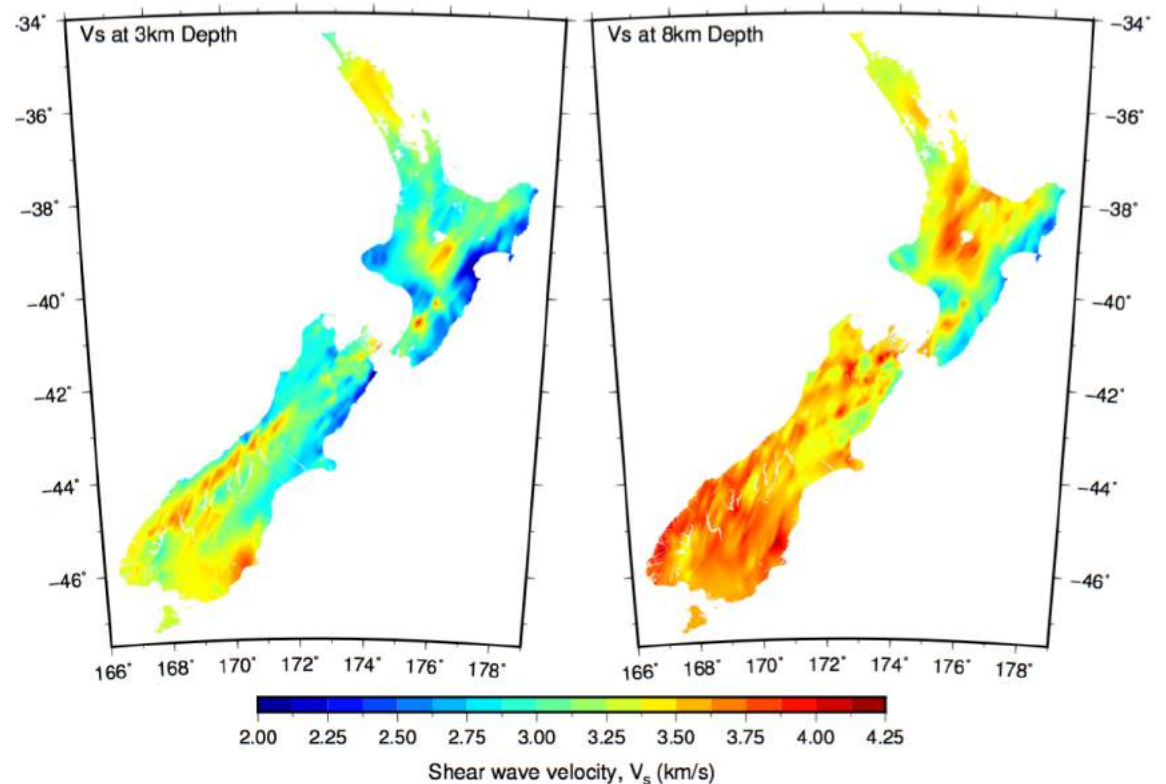
New Zealand Velocity Model (NZVM) v2.0 and Preliminary Hope Fault Simulations

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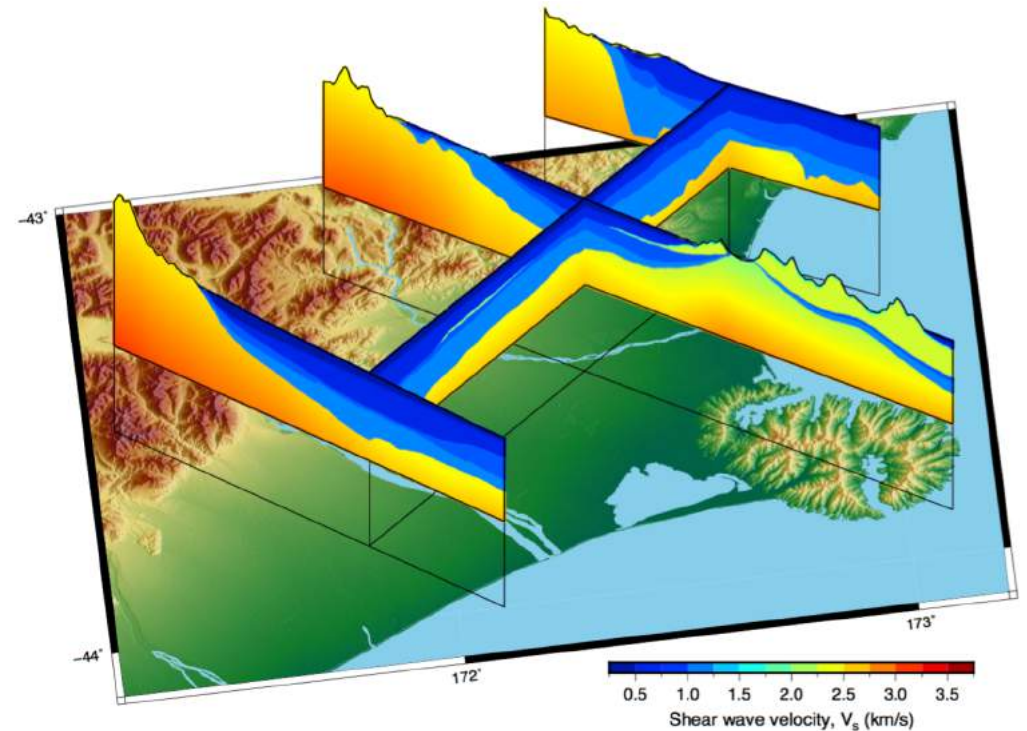
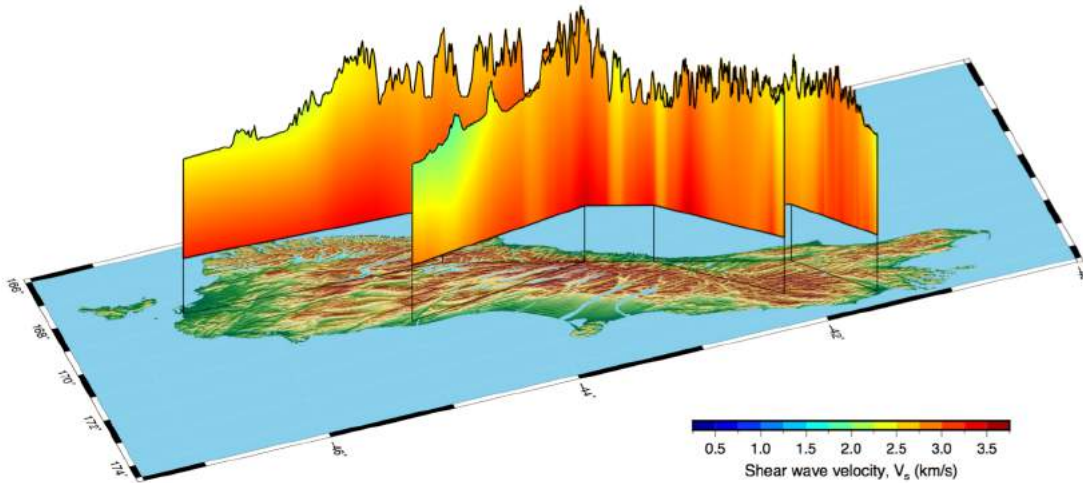
New Zealand Velocity Model (NZVM)

- Crustal velocity model for physics-based ground motion simulation
- Prescribes V_p , V_s , and ρ
- Two components
 - 1) Region wide seismic tomography model
 - Eberhart-Phillips et al. (2010)
 - ~10km length scale
 - 2) Embedded subregion (sedimentary basin) models
 - NZVM v1.0 – only included Canterbury, others to be added in the future



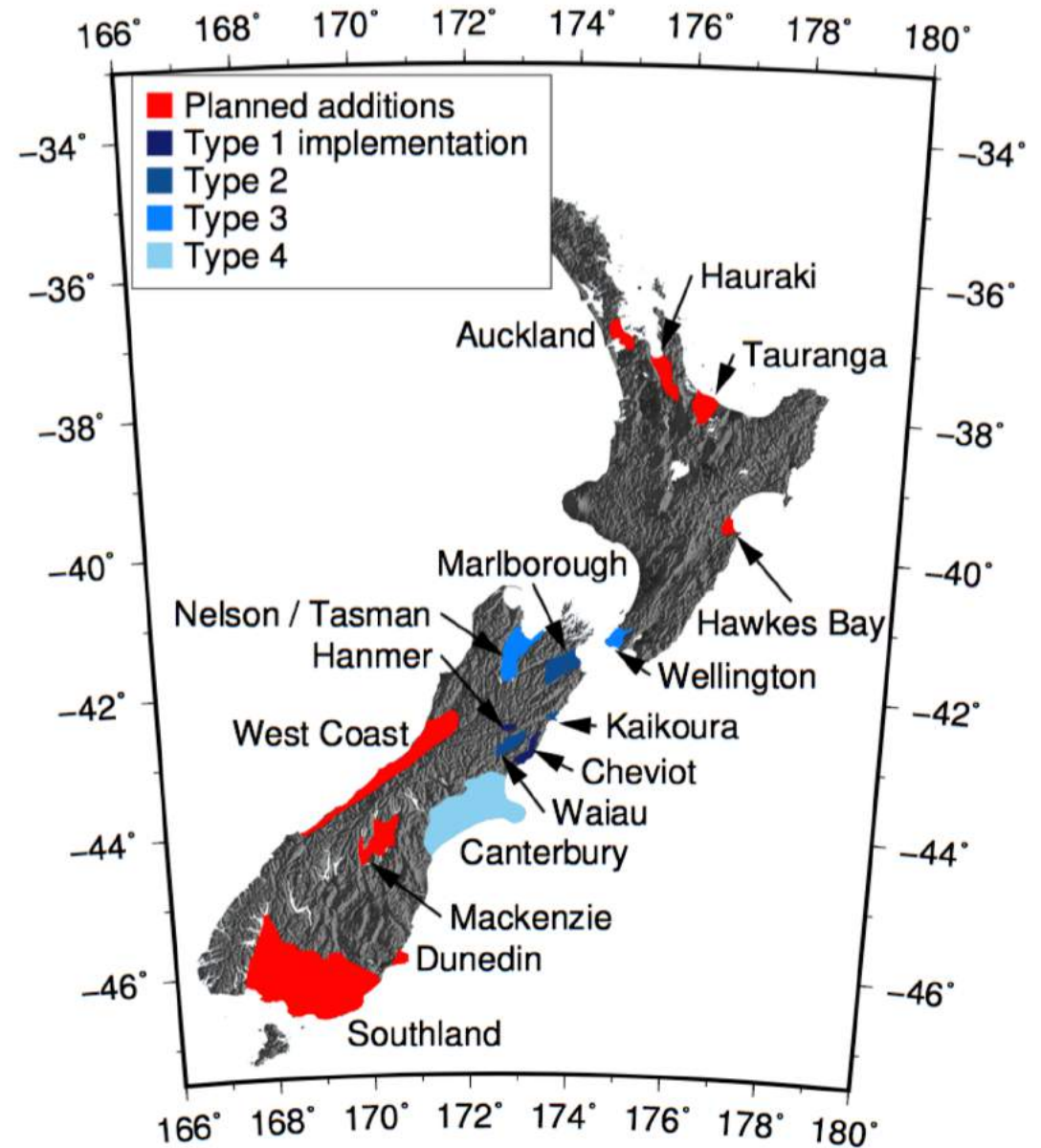
NZVM v1.0

- Full NZ coverage
 - Able to simulate motions from across NZ
- Only included a detailed subregion model for Canterbury



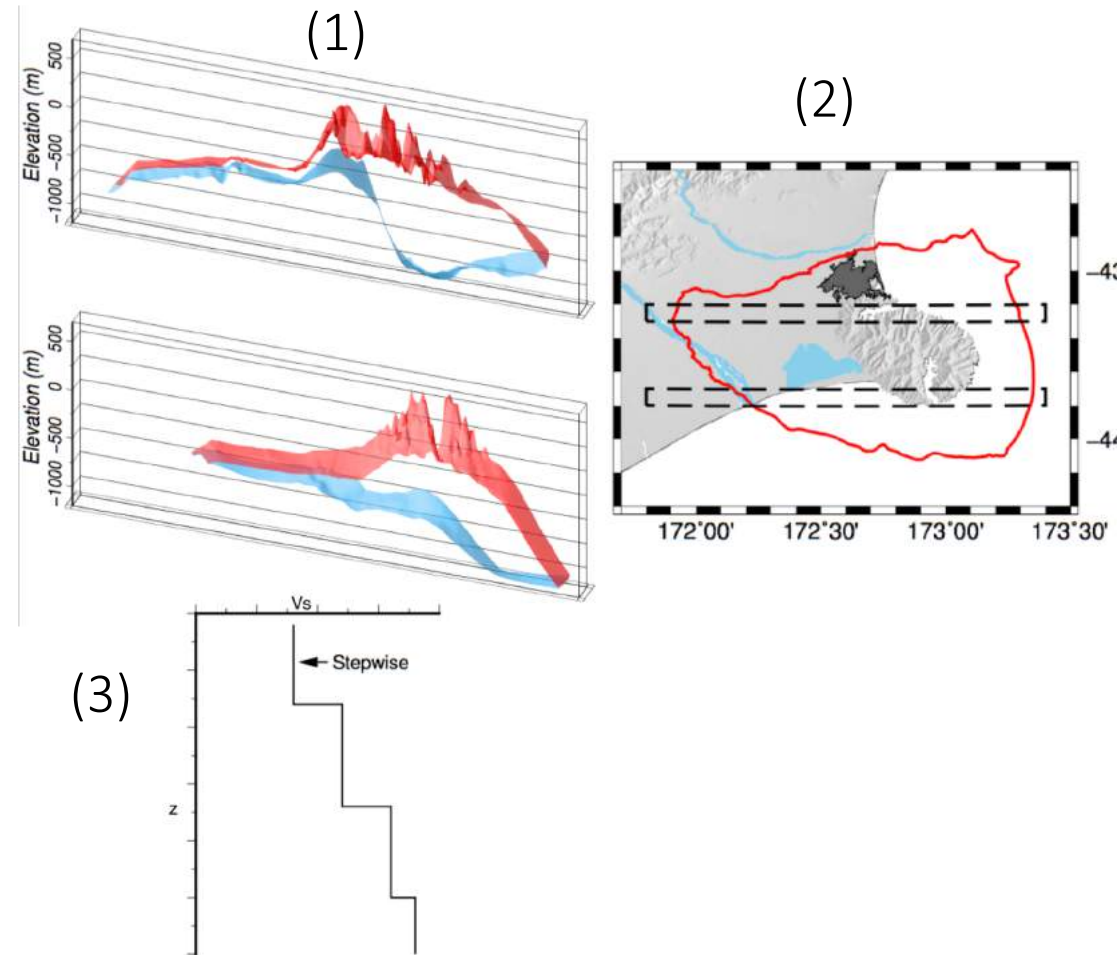
NZVM v2.0

- Addition of new subregion models with varying degrees of characterisation
 - Wellington
 - Nelson / Tasman
 - Marlborough
 - Waiau
 - Cheviot
 - (Many more planned)
- New offshore basin-edge smoothing regime

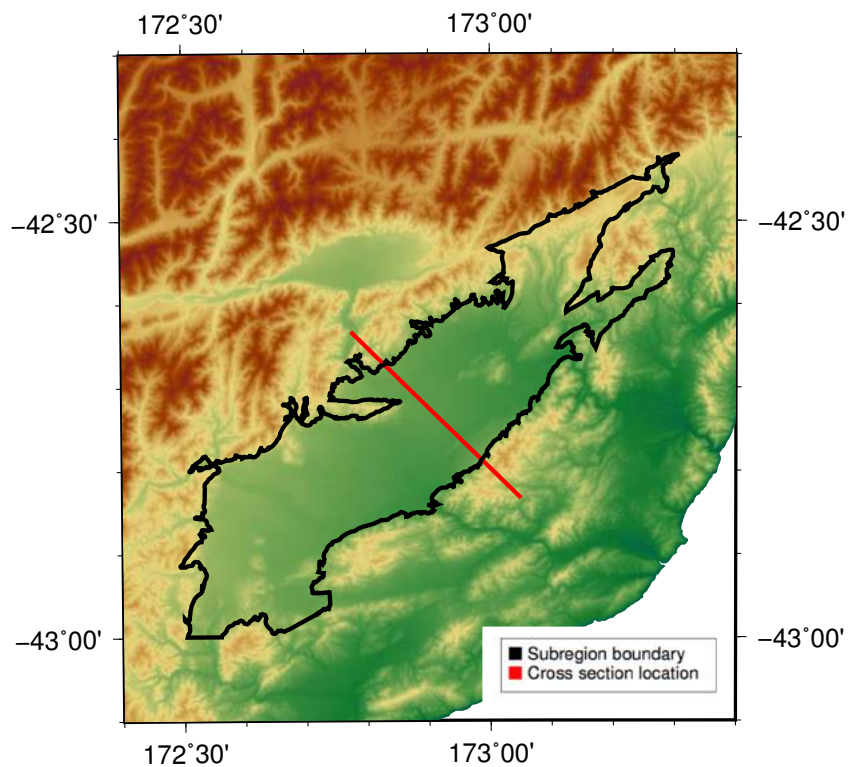


Adding new subregion models – 3 components

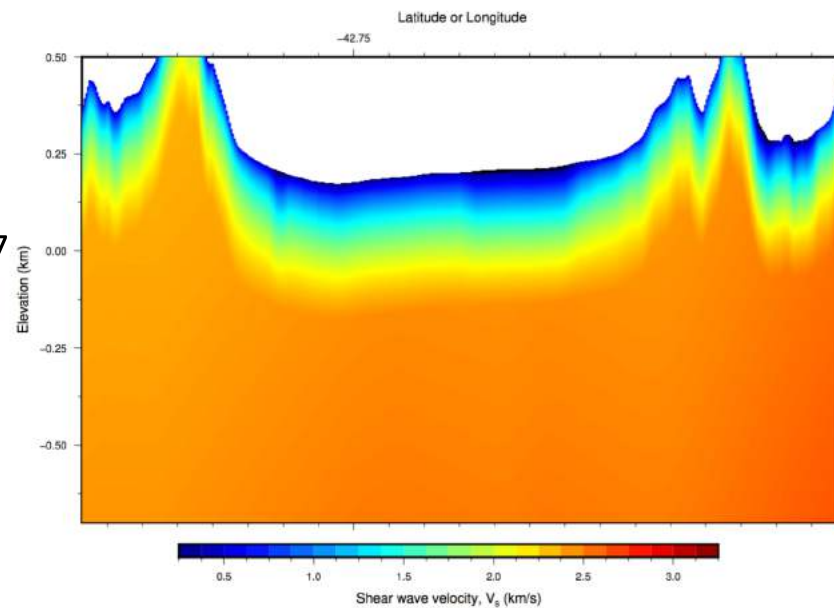
- 1) Bounding surfaces (top and bottom)
- 2) 2D boundary in the Lat-Lon plane
- 3) Velocity parameterization to apply
 - Implemented a stepwise 1D parameterization for all new subregions



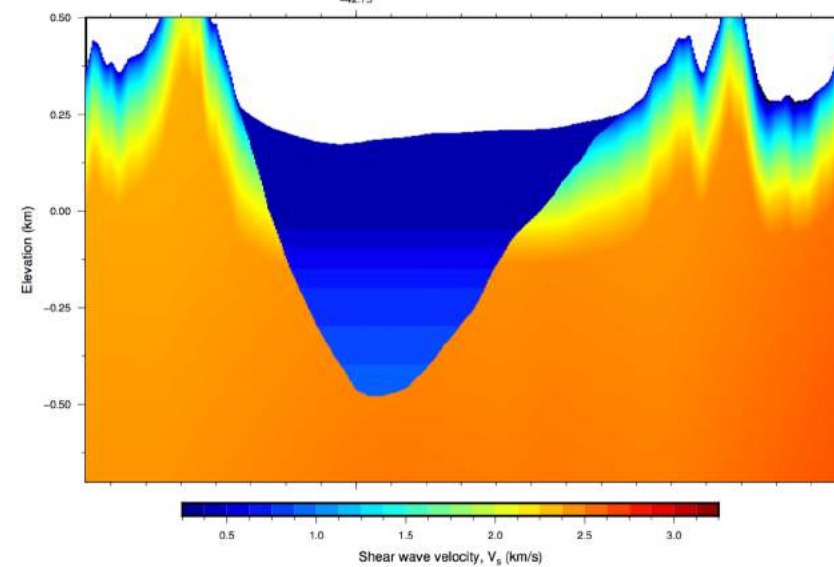
Waiau Subregion



NZVM v1.67



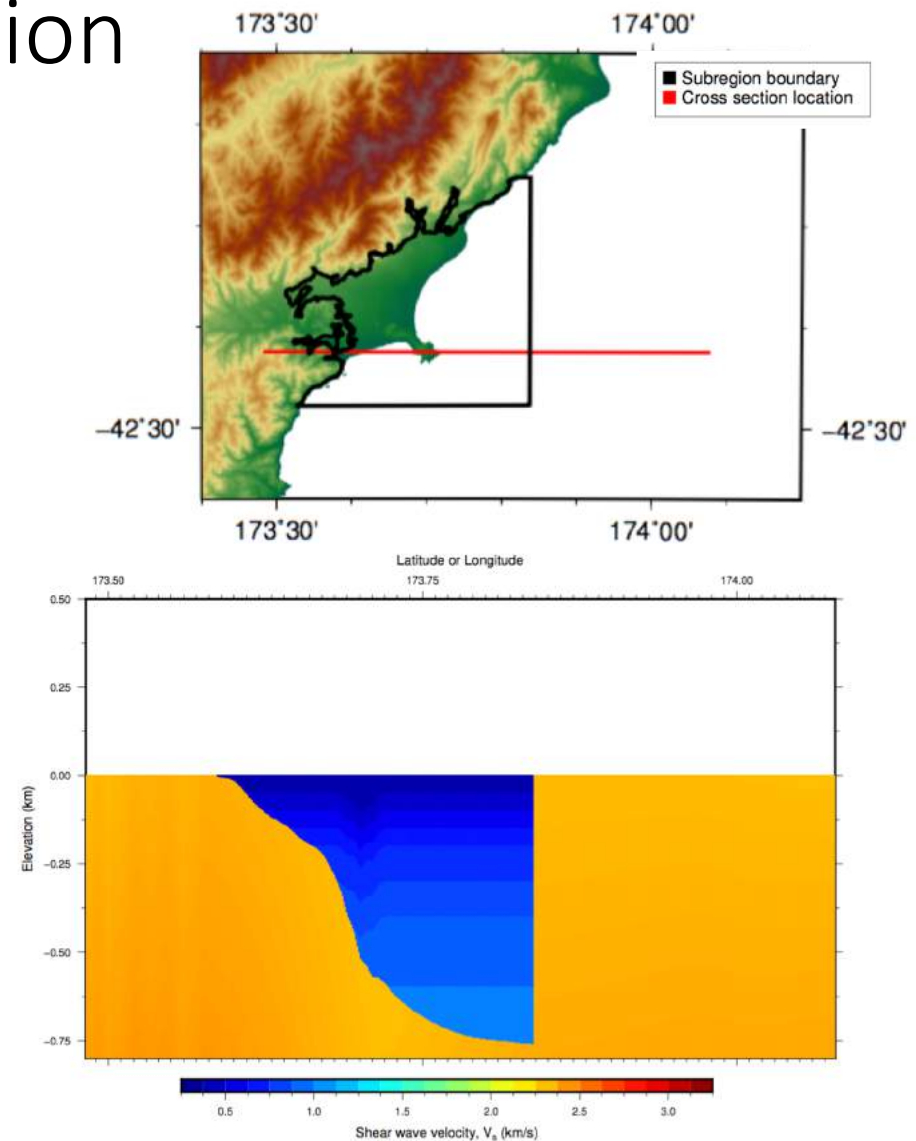
NZVM v2.0



Offshore smoothing at subregion edge

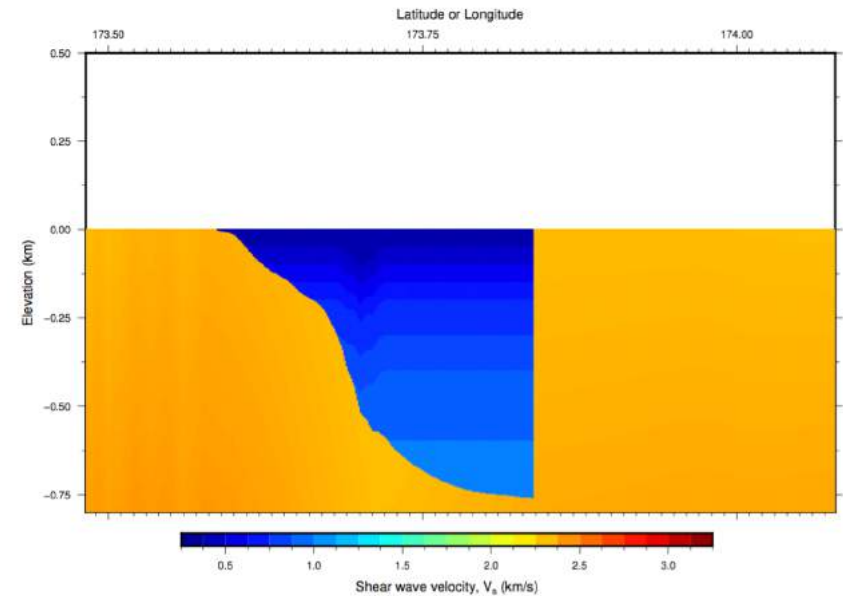
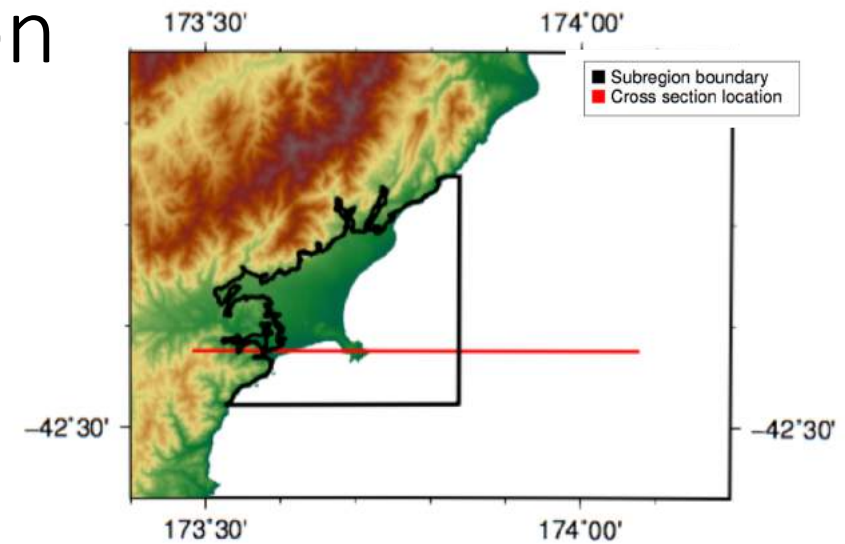
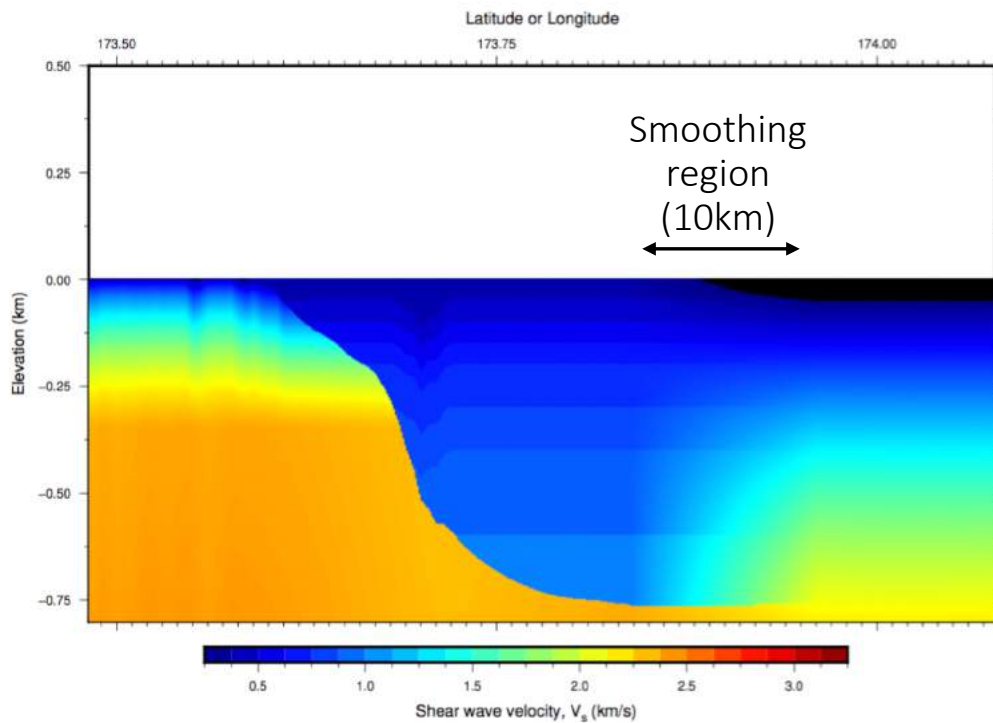
- Some subregions terminate offshore
- Large velocity impedance contrast at the subregion boundary
- Can lead to erroneous basin wave generation and simulation artefacts if contrast is large

Without smoothing



Offshore smoothing at subregion edge

- Solved by implementing smoothing over a 10km distance and reducing offshore velocities



Scenario Simulations on the Hope Fault

- Goal: to simulate scenario ruptures of the Hope Fault and present comparisons with the Kaikoura Earthquake using NZVM v2.0
 - Shaking intensities in urban centers
 - Kaikoura, Hamner, Nelson, Blenheim, Wellington, Canterbury
 - Comparisons with GMMs and the Kaikoura Earthquake
 - Network infrastructure effects
 - transport and electricity supply
 - Simplified analysis for regionwide effects
 - landslide triggering and liquefaction

Hope fault characteristics

- Located in the North of the South Island, splays from the Alpine fault passes through Kaikoura and terminates offshore
- Hope fault has the second highest slip rate in the South Island, behind the Alpine fault
- Last major rupture was 1888

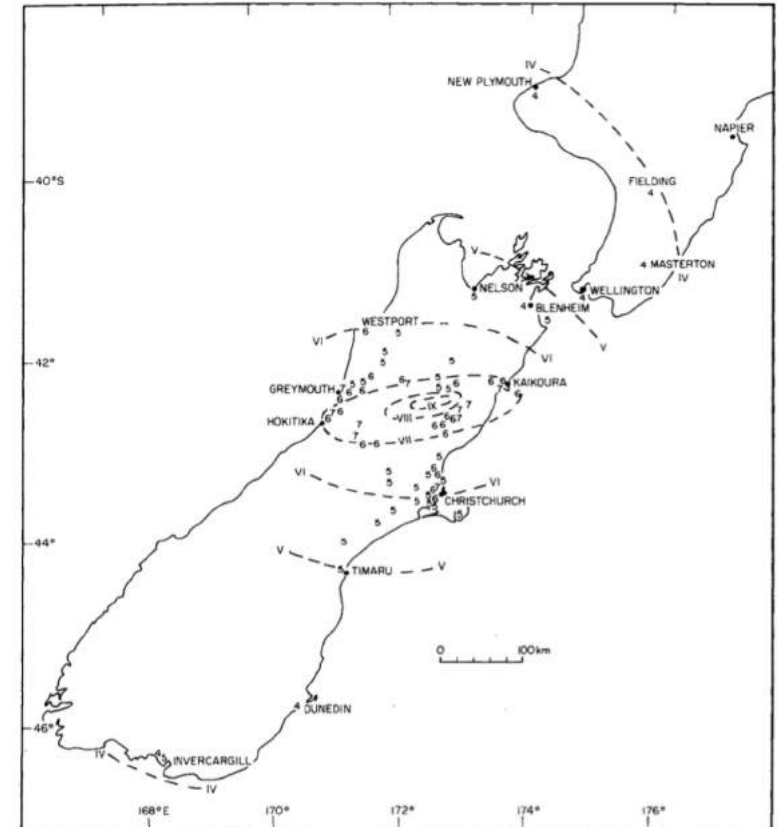


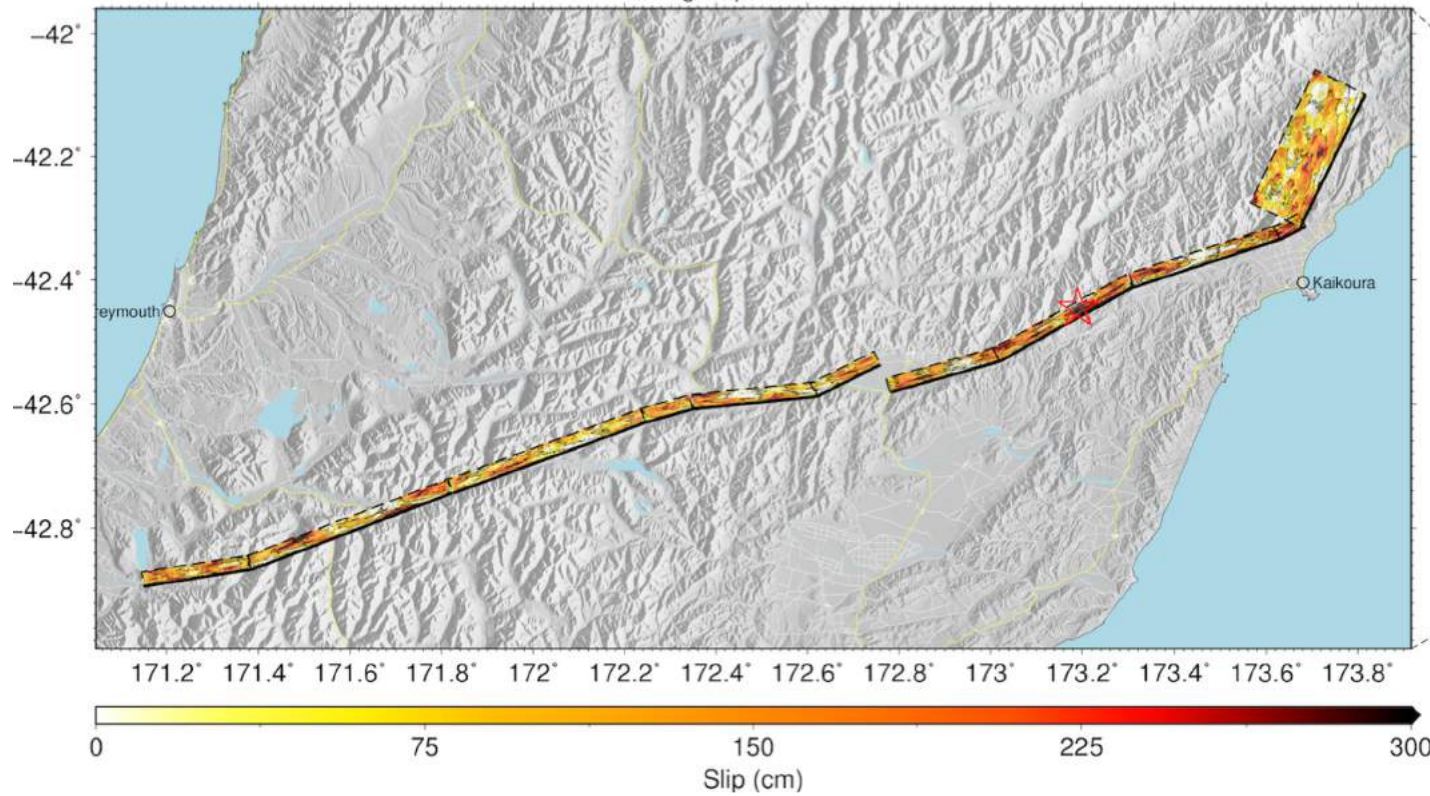
Fig. 2 – Regional isoseismal map and locations of inferred Modified Mercalli intensities for the September 1, 1888, North Canterbury earthquake, from data in Appendix 1.

Christchurch^{1,3,6,8} The upper 8 m of the Anglican Cathedral spire was destroyed, but there was no damage to other buildings in Cathedral Square. Two chimneys were thrown down from the south

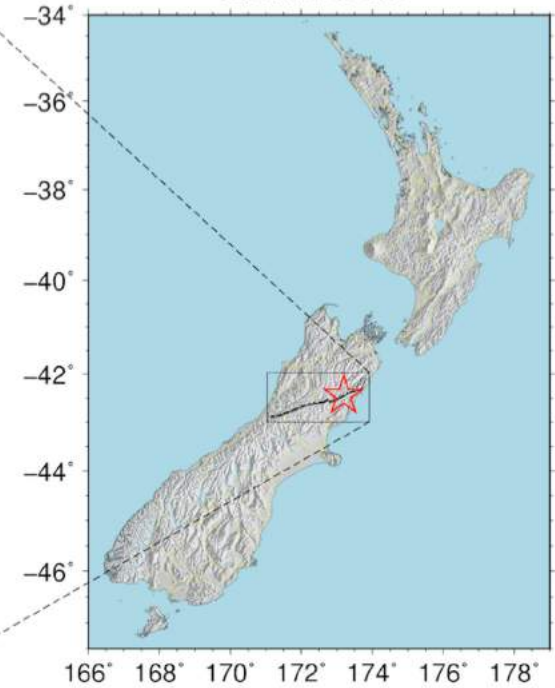
From Cowan et al. 1991

Hope Fault Scenario

Maximum slip: 475.9 cm
95th percentile: 267.2 cm
Average slip: 110.5 cm

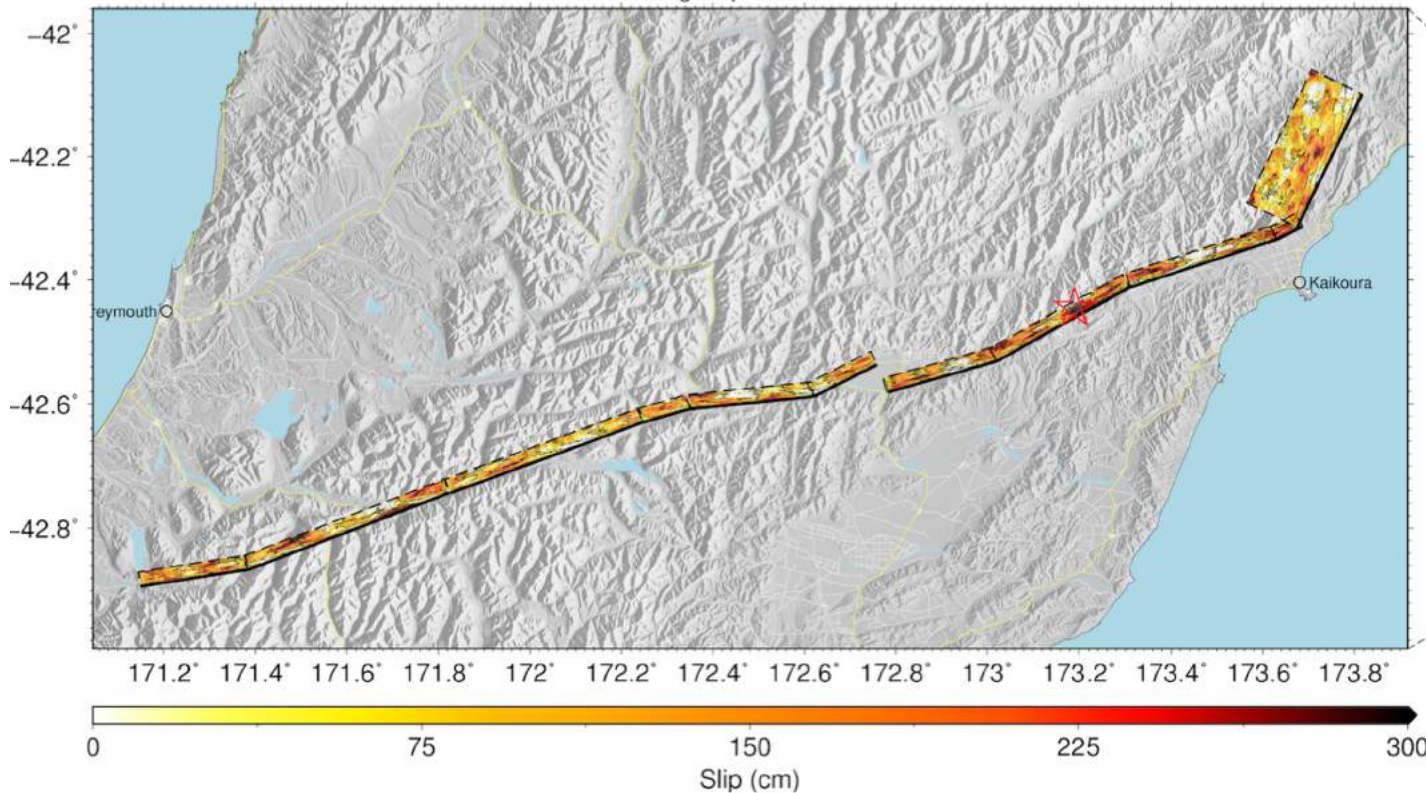


Planes: 11
dX, dY: 0.1 km, 0.1 km
Subfaults: 380534



Hope Fault Scenario

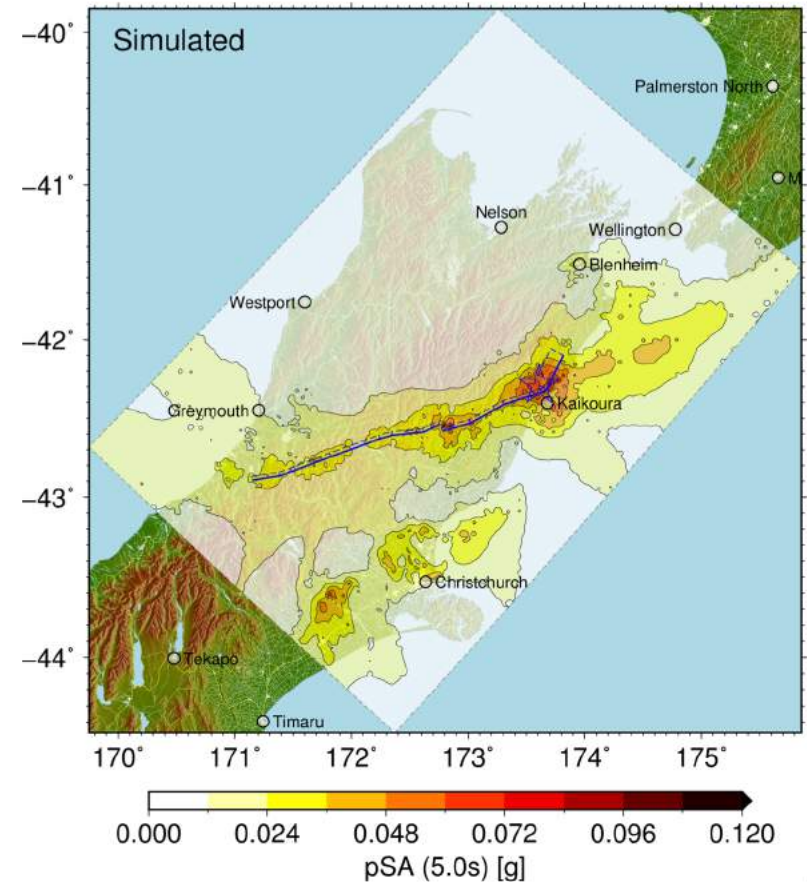
Maximum slip: 475.9 cm
95th percentile: 267.2 cm
Average slip: 110.5 cm



- 5 contributing faults from the NSHM
 - Kelly
 - HopeCW
 - Hope1888
 - HopeConway
 - Jordan Thrust
- 248km rupture length
- Area = 3825km²
- Mw = 7.57
- Kaikoura 2016, Mw = 7.8
6140km²

Preliminary simulations

- Conducted using NeSI Kupe HPC
- Graves and Pitarka (2010) methodology
- QuakeCoRE GM simulation workflow
- NZVM v2.0
 - 400m gridspacing



Hope Fault Scenario pipeline

- Validate NZVM v2.0 in the upper South Island
 - Achieved by simulating small – moderate magnitude events for which we have records
- Simulate using a more refined mesh
- Investigate hypocentre locations
- Investigate the effect of different magnitude scaling relations

Conclusions

- NZVM v2.0
 - Updated NZVM v2.0 incorporates new sedimentary basins
 - Many more subregions still to be added
 - NZVM source code available on github
<https://github.com/ucgmsim/Velocity-Model>
- Hope fault scenario simulations are ongoing

