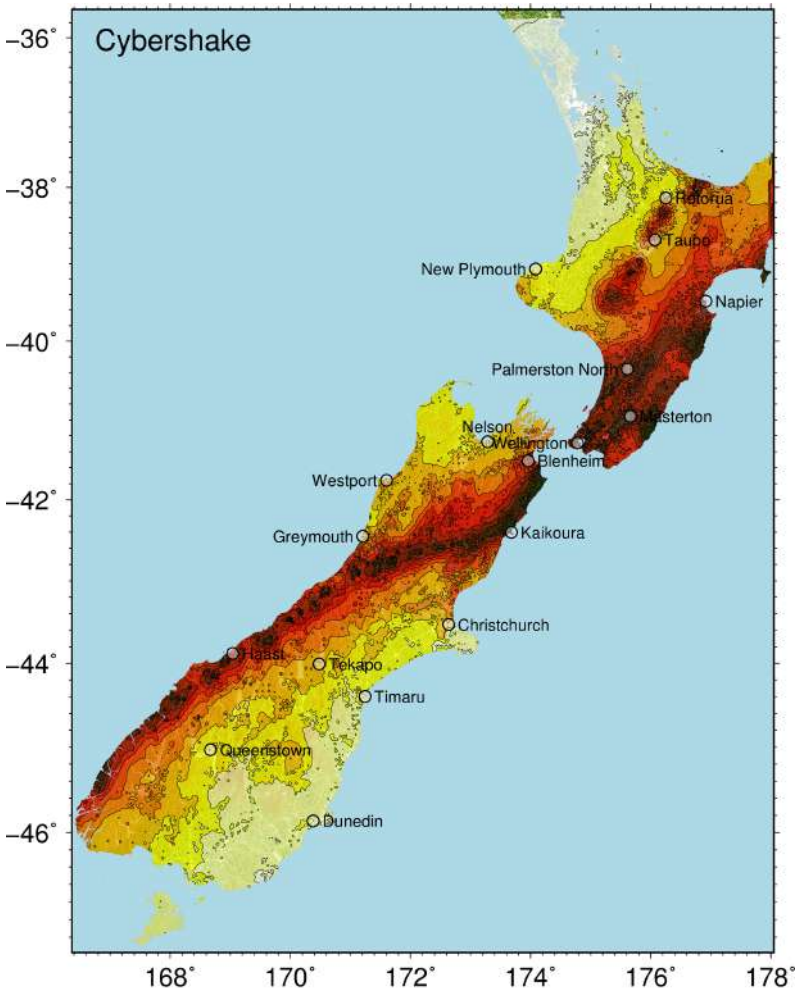
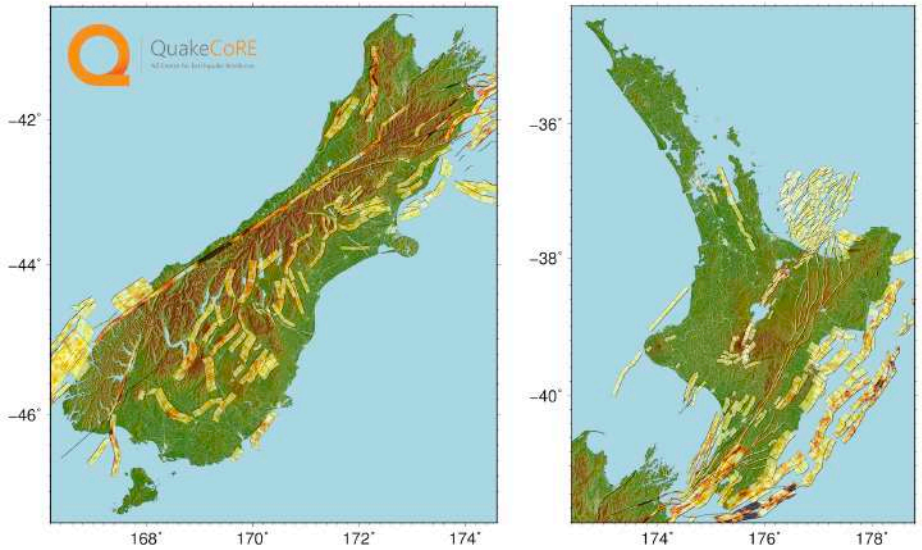
Cybershake NZ 20.4-20.6 and comparison with prior efforts

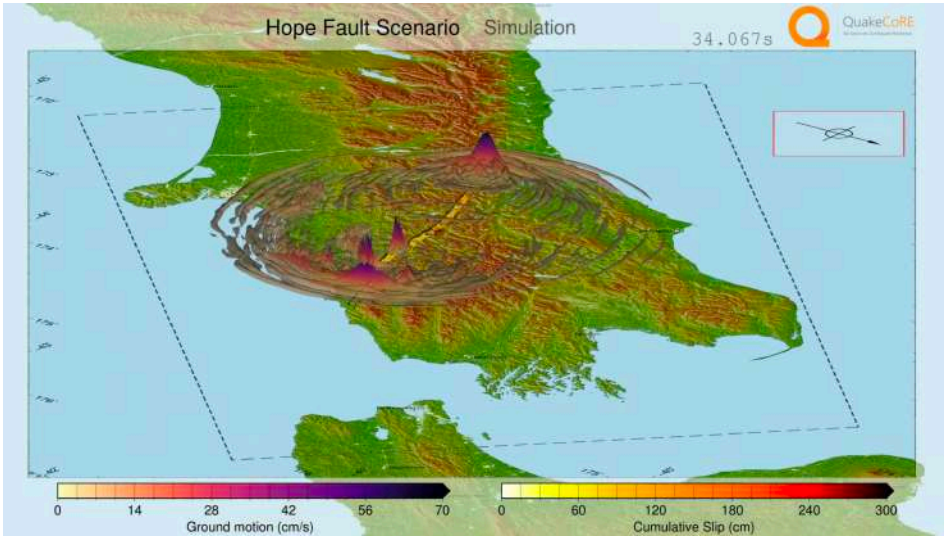


Brendon Bradley and Jason Motha

Aim: Cybershake NZ

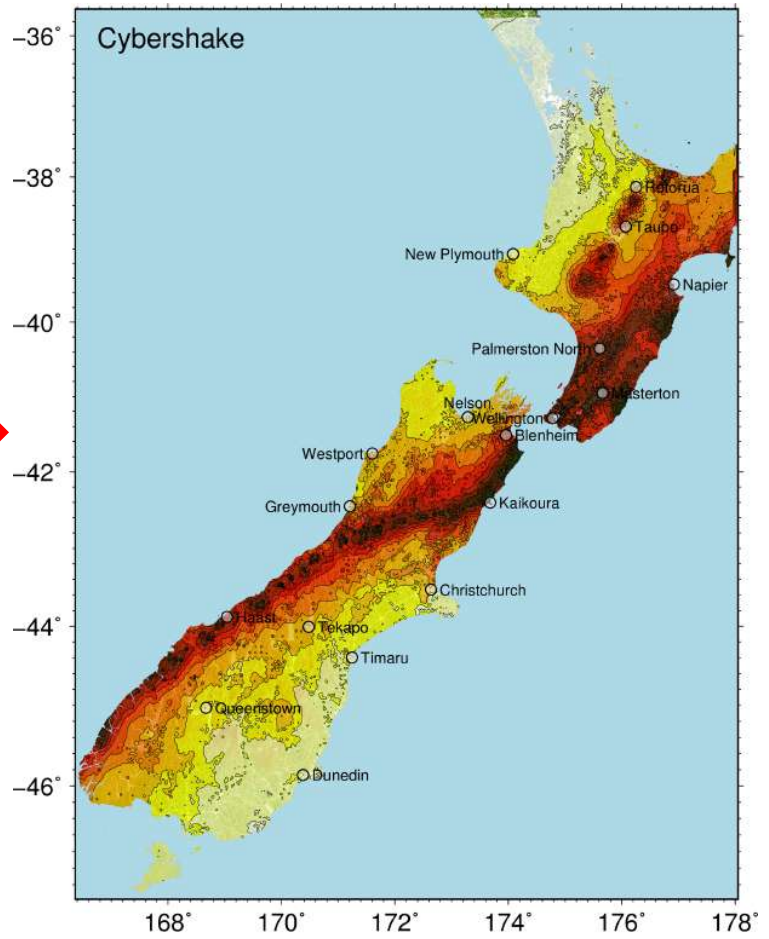


Earthquake Rupture Forecast

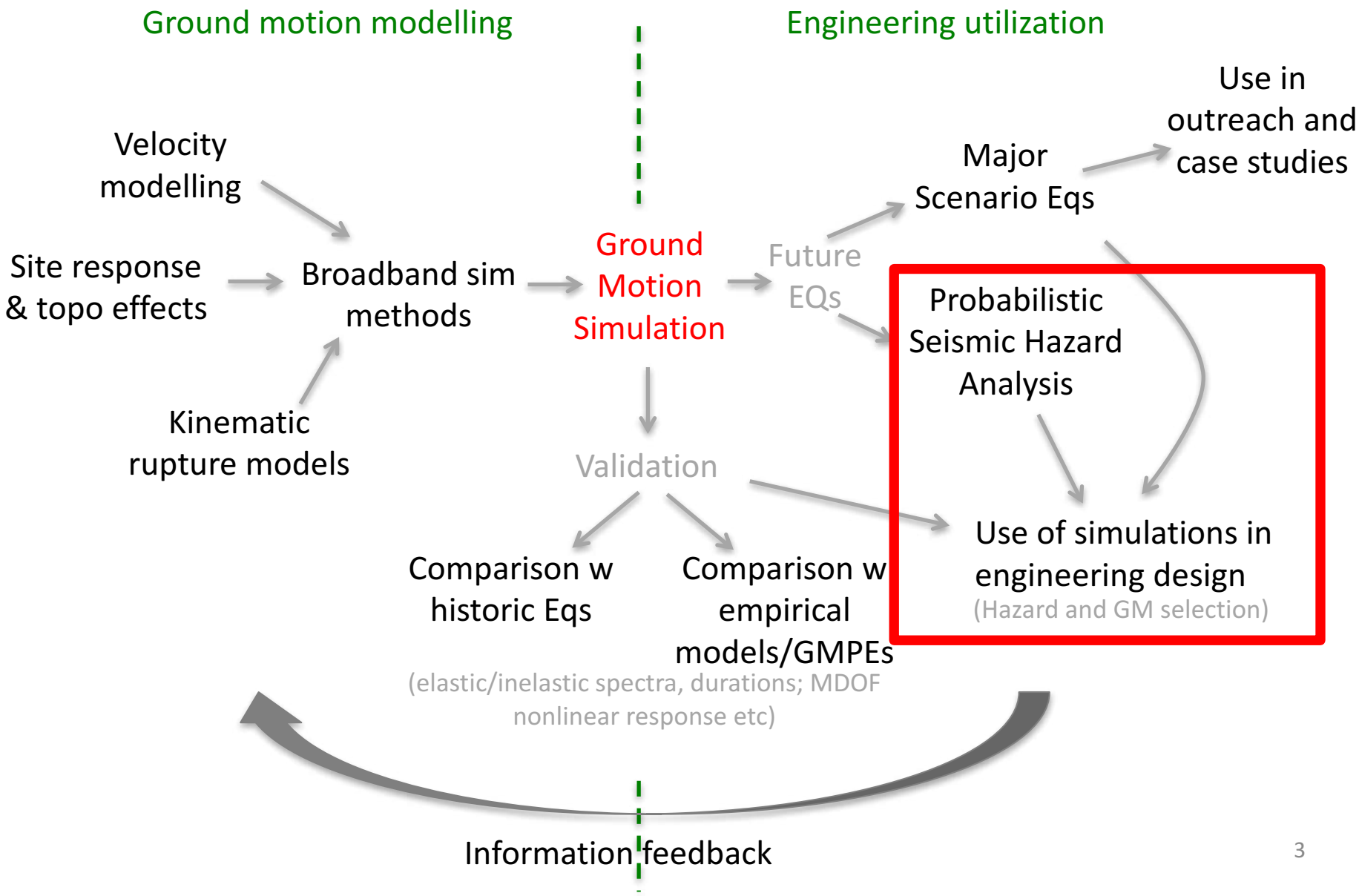


Ground motion prediction

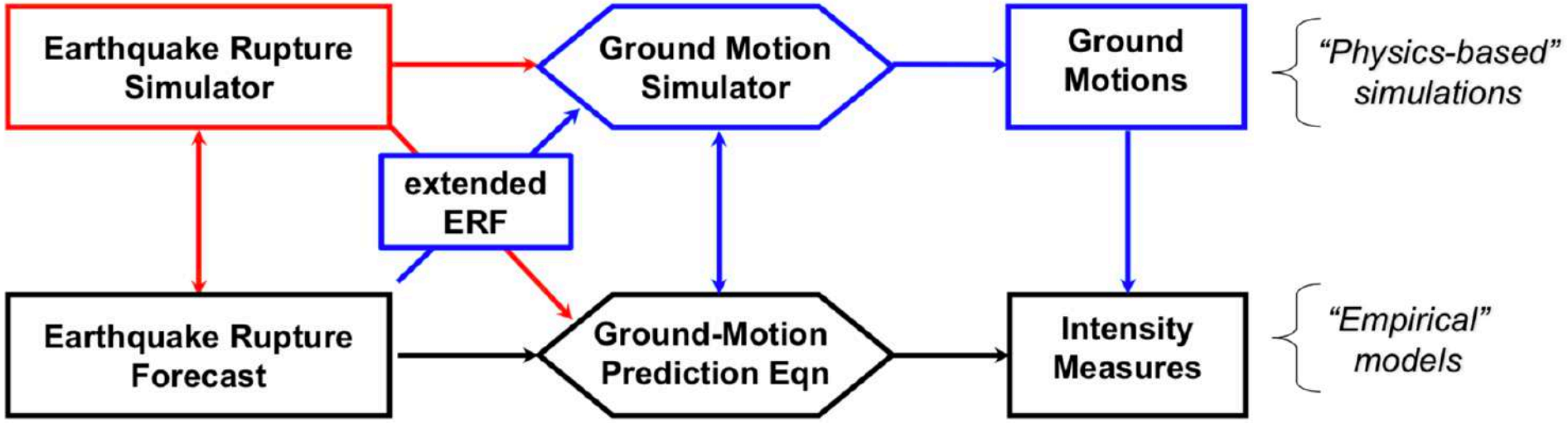
Probabilistic hazard outputs



Spectrum of research



PSHA pathway



Previous iterations

- CS17.9 – First test implementation (small region). Focus on workflow development
- CS18.6 – First NZ-wide impl. (LF at 400m grid) Further workflow streamlining
- CS19.5 – Some improvements in source modelling. Major improvements to automation of workflow
- CS20.4 – Improvements to velocity model, Vs30, non-uniform grid of outputs, and simulation method based on validation outputs
- CS20.5 - Inclusion of subduction sources
- CS20.6 – Execution of LF calculation with 200m grid (i.e., LF/HF transition frequency increased from f=0.25Hz to f=0.5Hz).

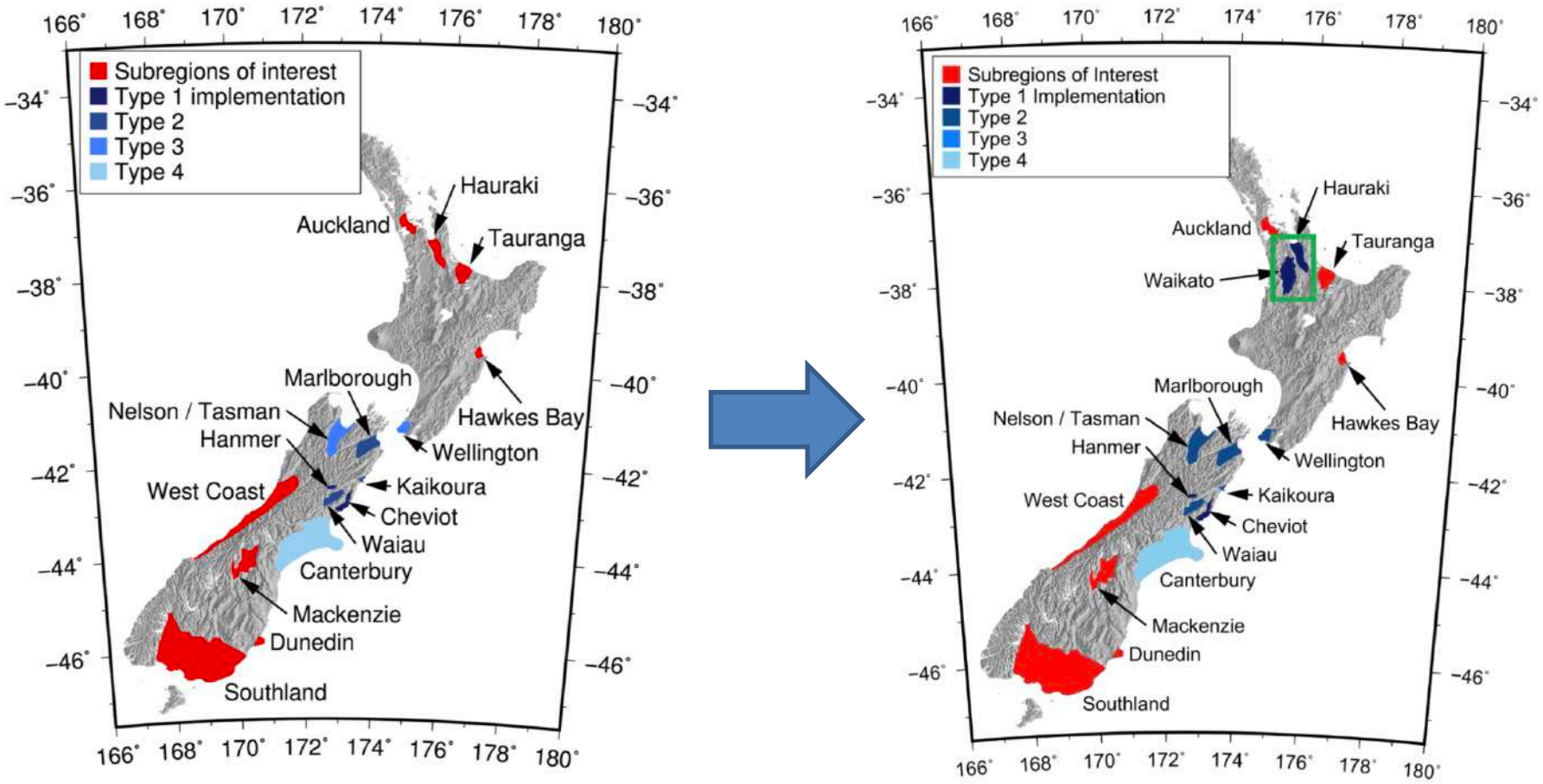
Improvements discussed here

- Basin model representation
- NZ Vs30 model
- Addition of subduction sources
- Simulation method improvements
- Increasing LF simulations from fmax = 0.25 to -0.5Hz

Basin model updates

NZVM2.X (Thomson et al., 2019)

Principal inclusion was Hauraki/Waikato basins



NZ Vs30 model updates

Vs30 model updates

CS19.5 used NZ Vs30 map of Foster et al. (2019)

Foster et al. (2019)

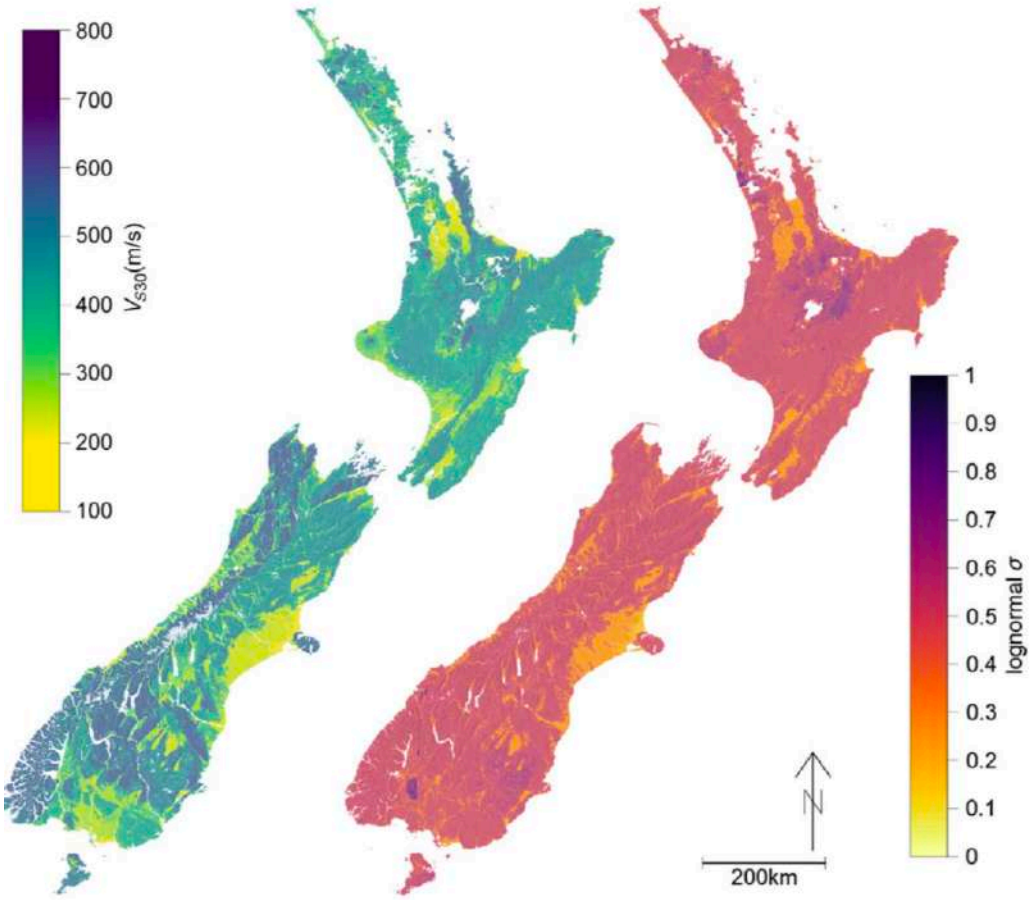
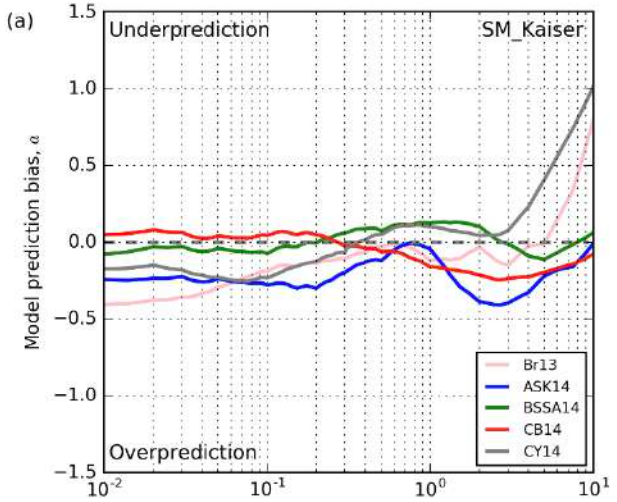
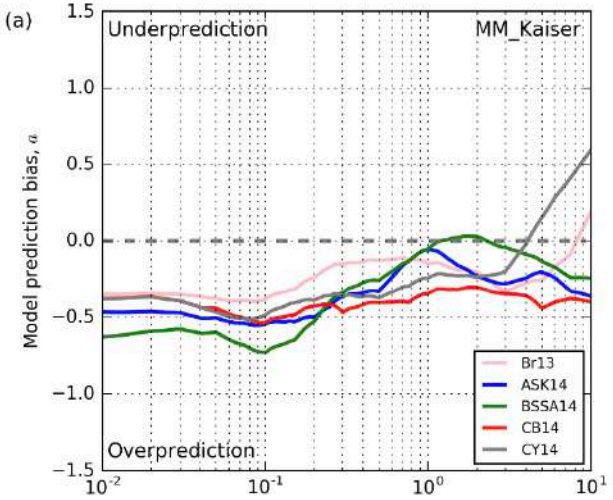
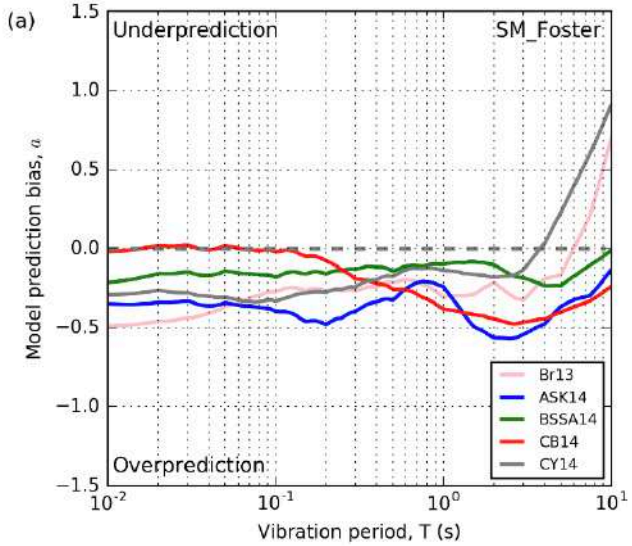


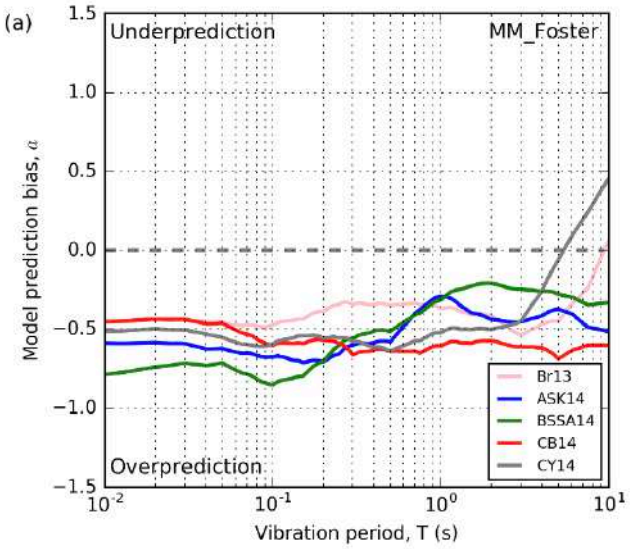
Figure 19. (a) V_{S30} and (b) σ for the final weighted model.

Validation bias observed









Vs30 assignment has a strong bearing on hierarchy of predictive capability of different models. **Need more Vs30 measurements to reduce the influence of this**

SM = small mag (M3.5-5)
MM = mod. mag (M5-7)

Vs30 values assigned to instrument locations
Kaiser = Kaiser et al. 2017
Foster = Foster al. 2019

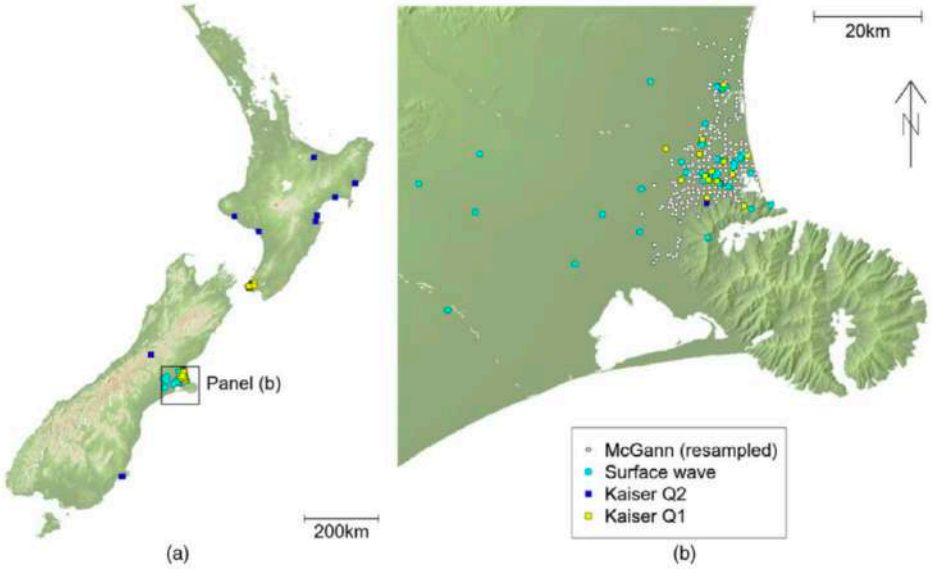
Foster et al. (2019) model

Vs30 measurement data (in 2019):

- Kaiser et al. (NZ site data paper) Q1, Q2 data (not Q3)
- Strong motion characterisation Vs30 values (predominantly in Canterbury)
- Vs30 estimates from CPT-Vs correlations (in Canterbury)

Dataset extensions:

- Additional site-specific Vs30 measurements (misc sites + dedicated SMS sites through QuakeCoRE/GeoNet funding) [various people]
- Vs30 at all instrument locations from P-wave receiver fn approach (has appreciable uncertainties that can be explicitly considered in Vs30 map method) [KevinFoster PhD]
- CPT-Vs correlation to CPTs in NZGD [Chris McGann]



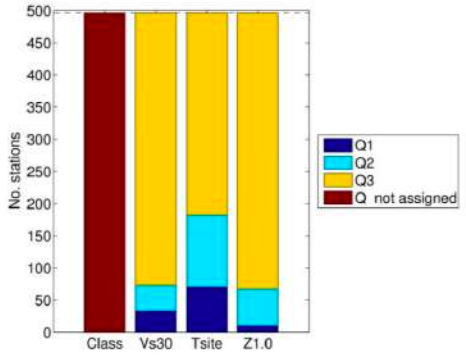
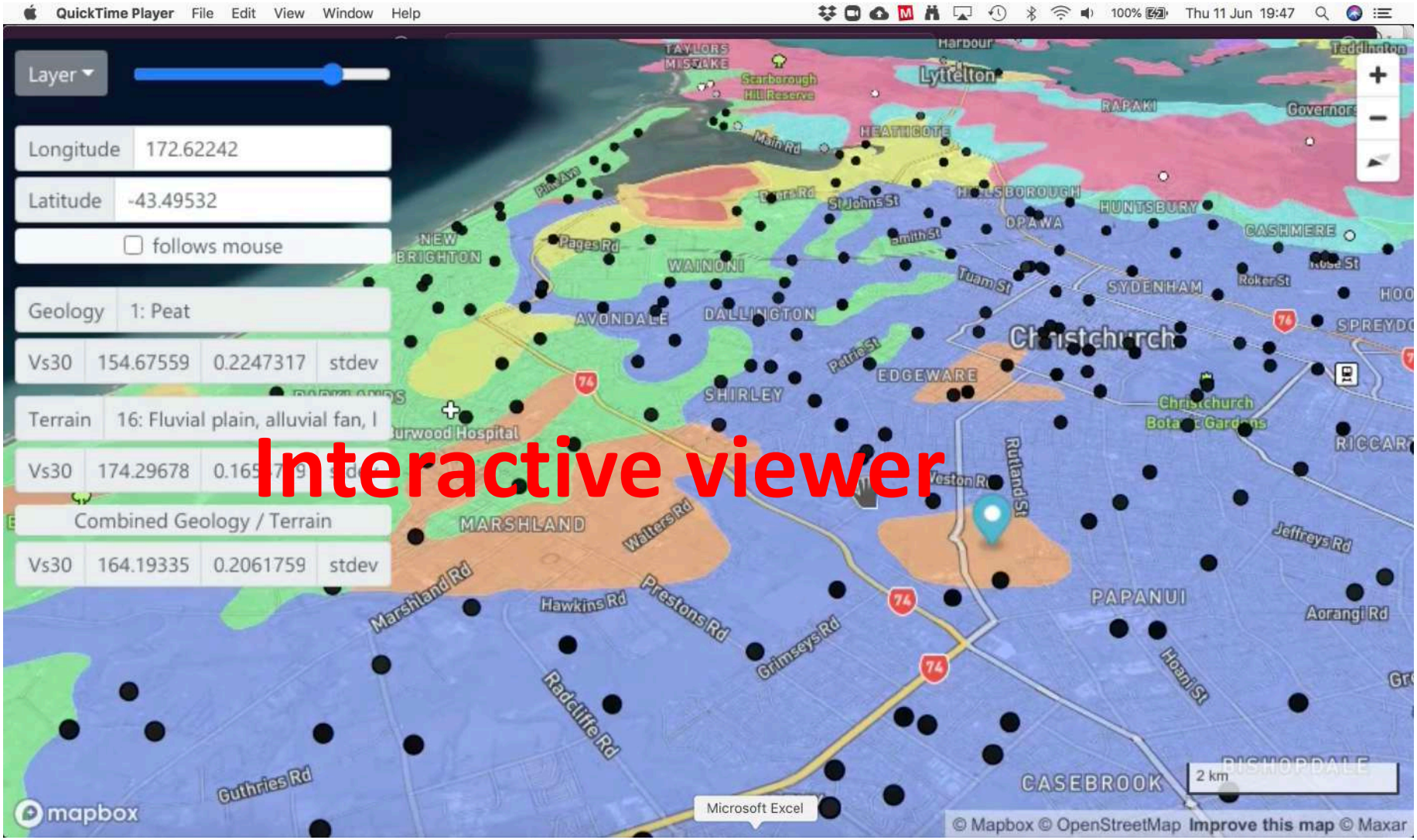


Figure 5: Site parameter quality factors for the 497 GeoNet strong motion stations in the database.

Kaiser et al. (2017; NZ site data paper)

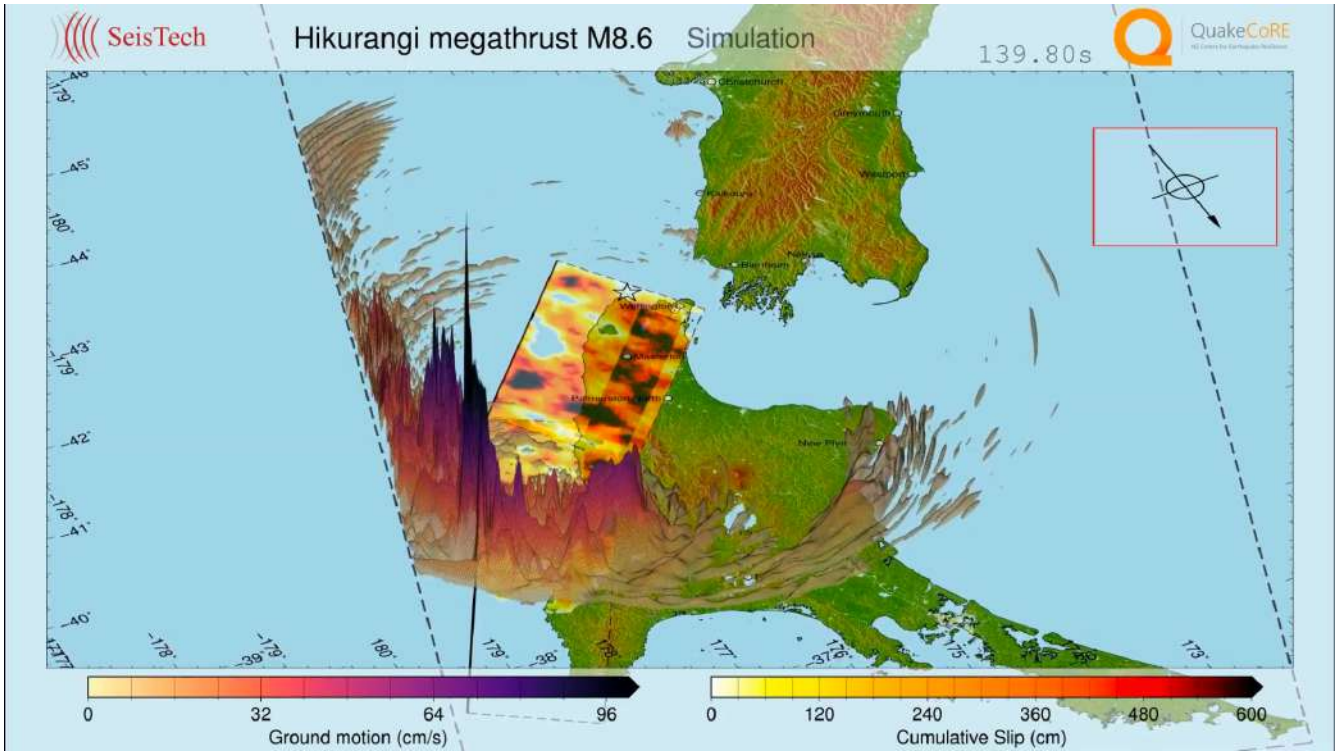
https://vs30.seistech.nz/



Addition of subduction sources

Subduction zone additions

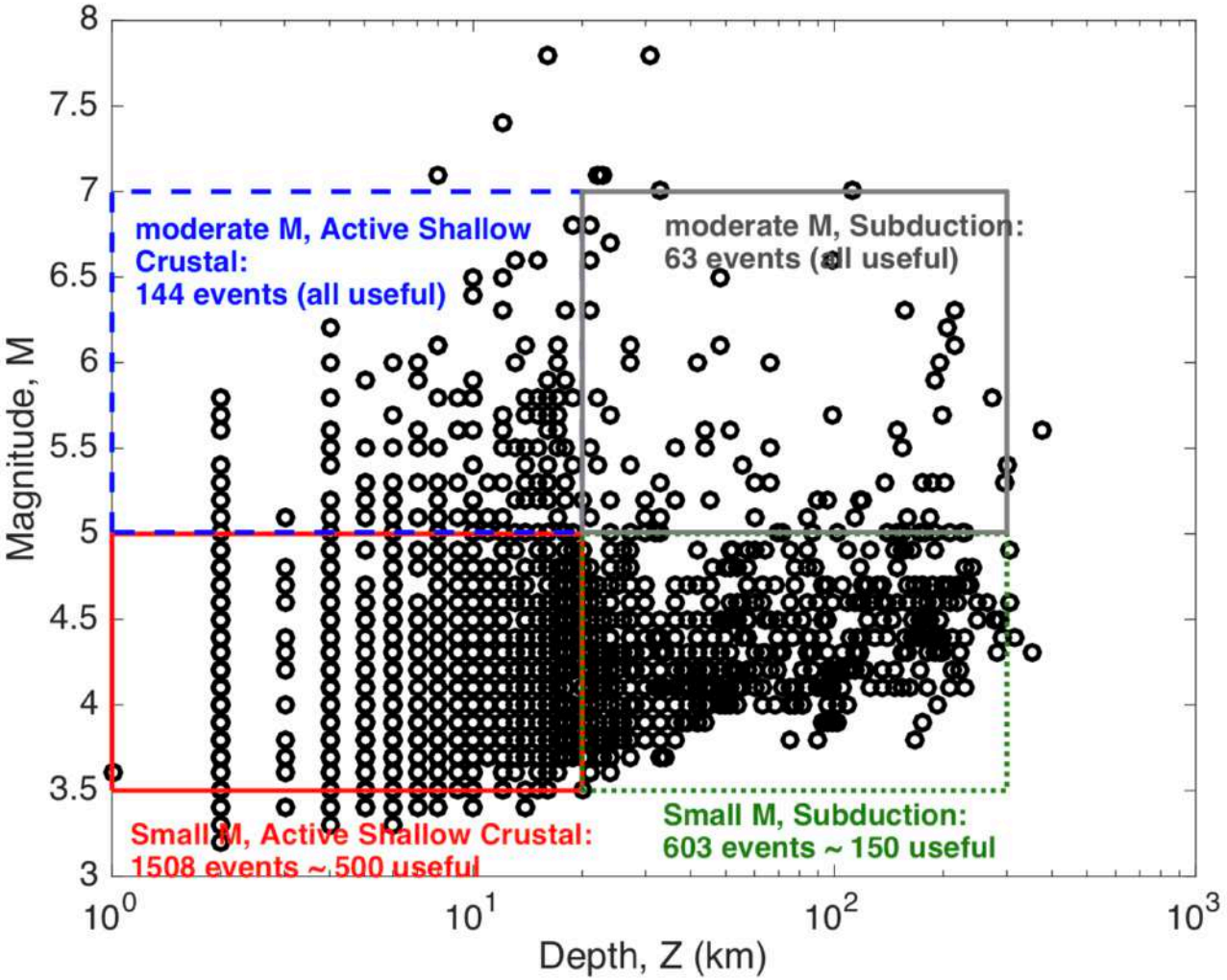
- CS19.5 ignored subduction sources via simulation (they were modelled empirically), due to computational constraints
- Now simulated explicitly in CS20.5 onward



Simulation method improvements

Sim method improvements

- Enabled via validation against historical events



By the time of CS19.5 only ASC Mw3.5-5.0 validation completed

Now validation for ASC at Mw3.5-7.0 completed, and prelim results for Subduction also undertaken

Increasing fmax of LF simulations

Increasing fmax of LF simulations

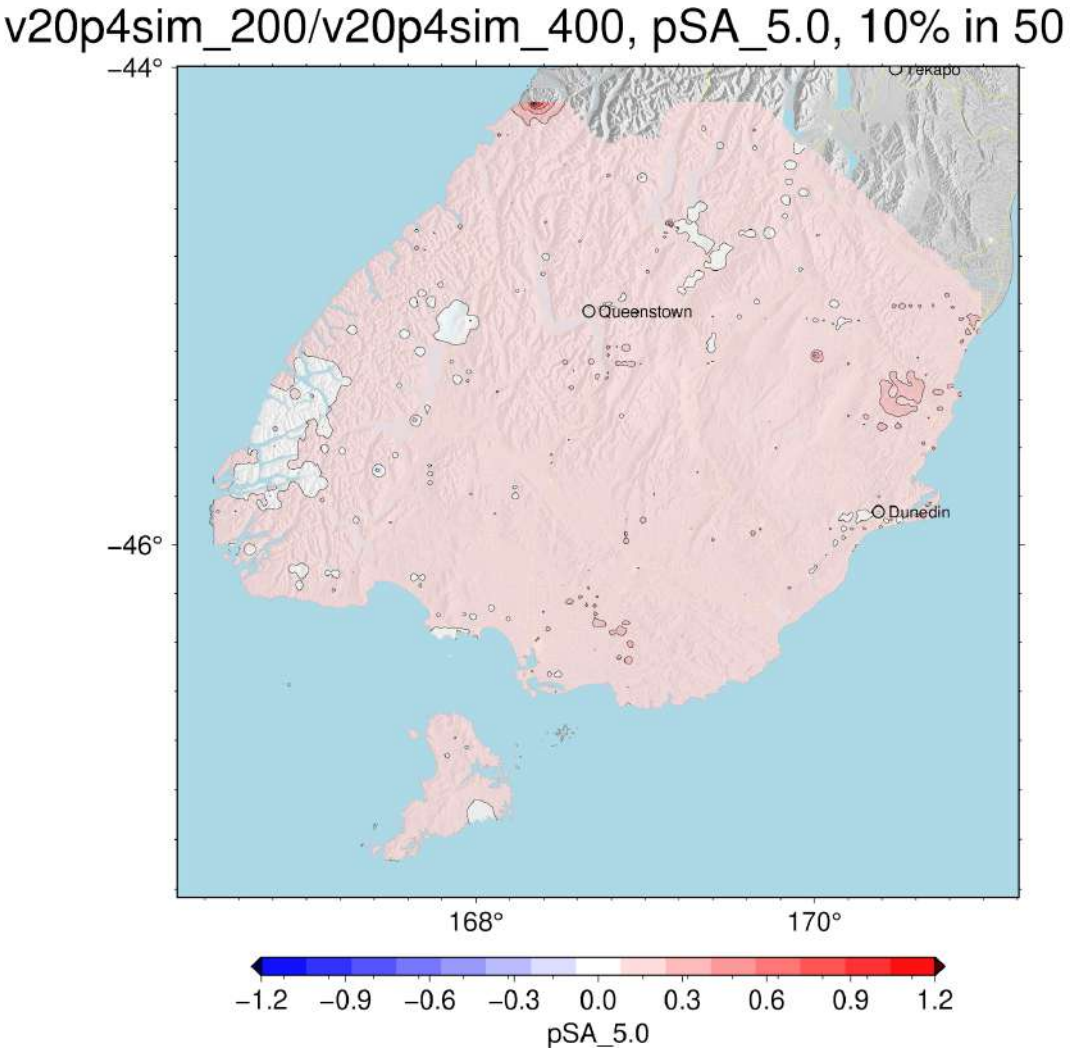
- In validation calculations we have considered fmax = 0.25, 0.5, and 1.0Hz (even some 2.0Hz scenario events)
- In CS we have previously been computationally constrained to 0.25Hz (400m spatial grid)
- With recent access to Korean KISTI HPC we have been able to extend to 0.5Hz.

Compute core hours used

	LF	HF	BB	Post-Processing
400m Shallow Crustal	167,000	41,000	10,000	17,000
400m Subduction	100,000	53,000	2,000	3,000
200m Shallow Crustal (South Island - 4731 Realisations)	853,000	25,000	6,000	6,000
200m Shallow Crustal (estimation)	~1,650,000	~53,000	~12,000	~18,000

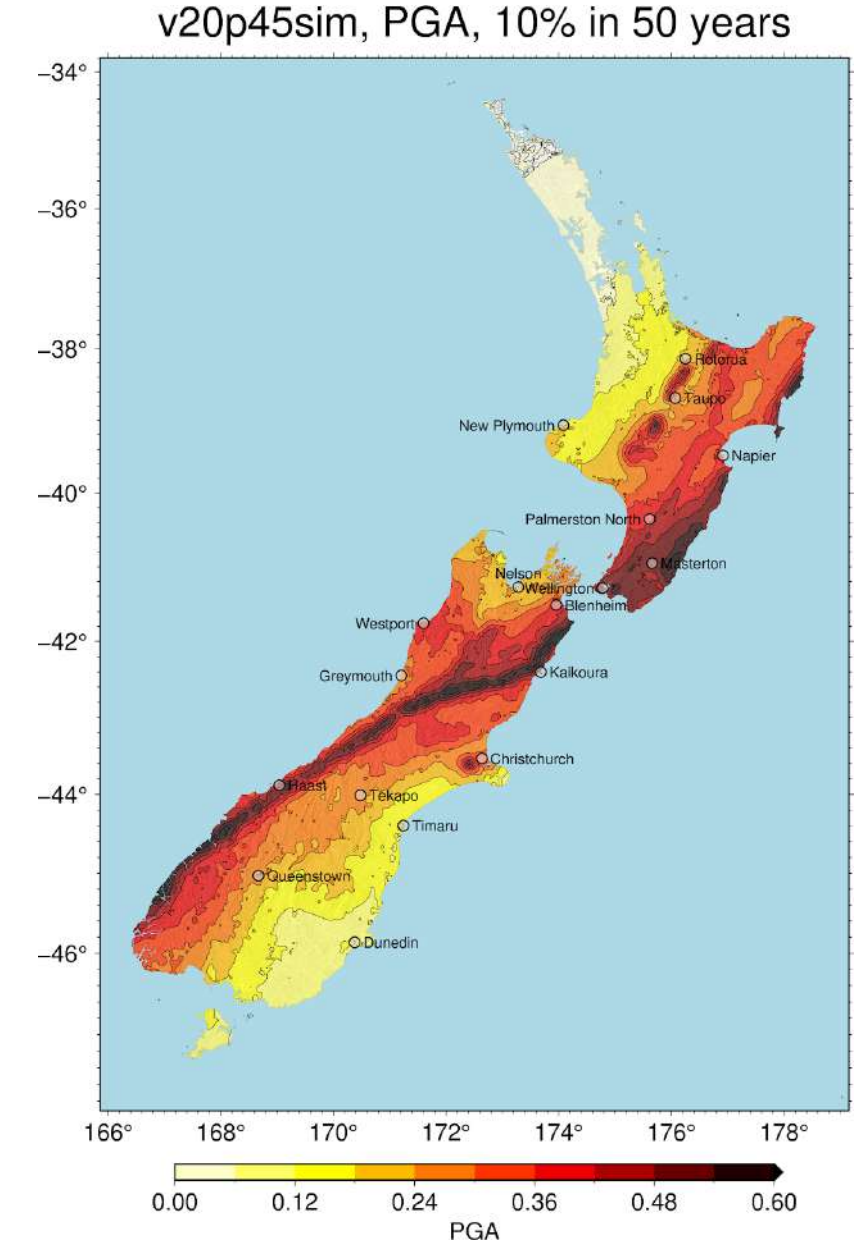
Example effect of increasing fmax

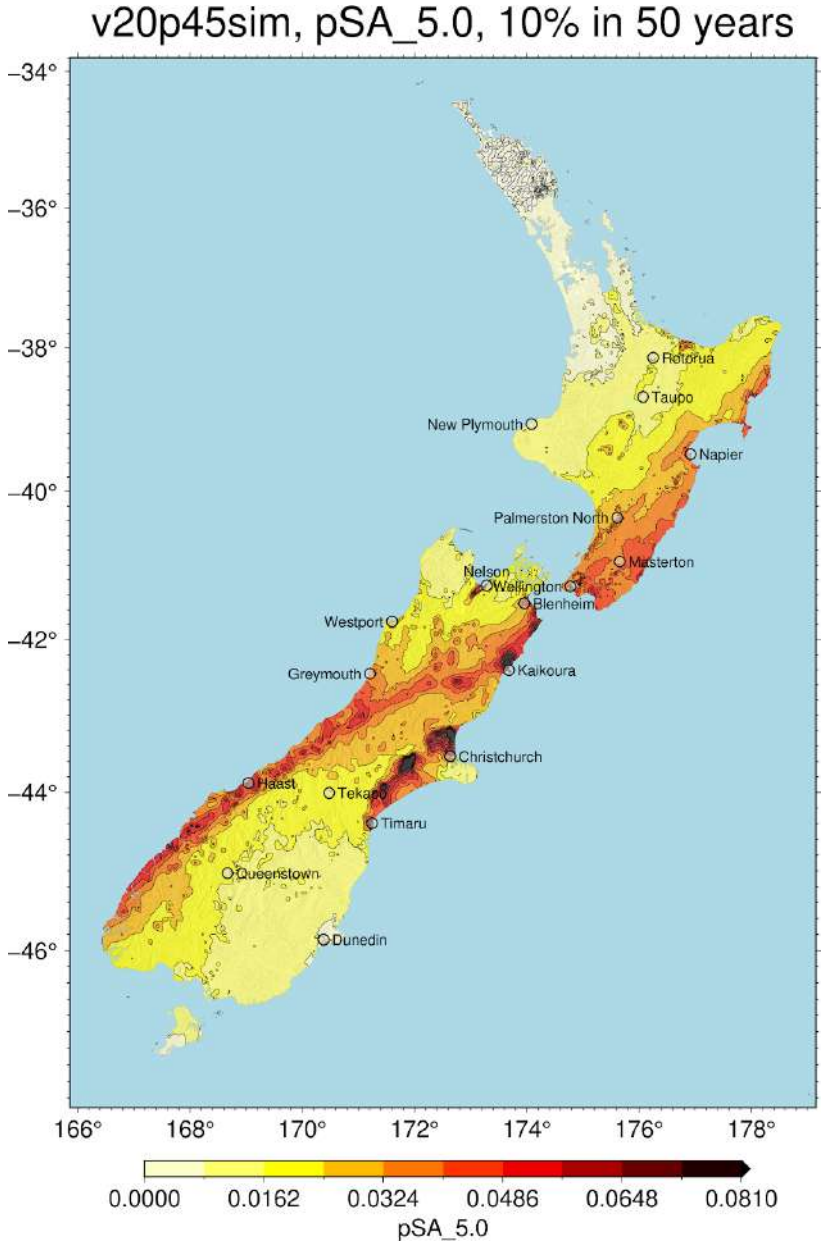
- Approx 30-40% increase



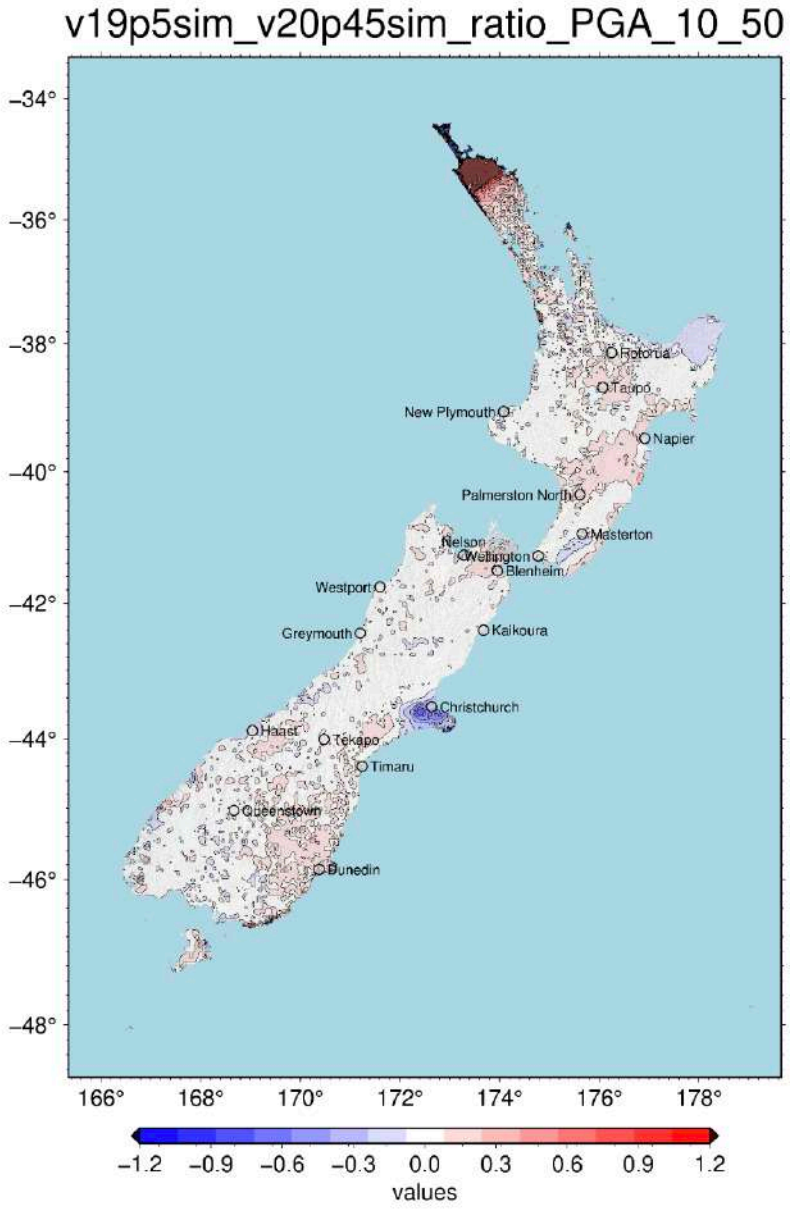
Summary of outputs

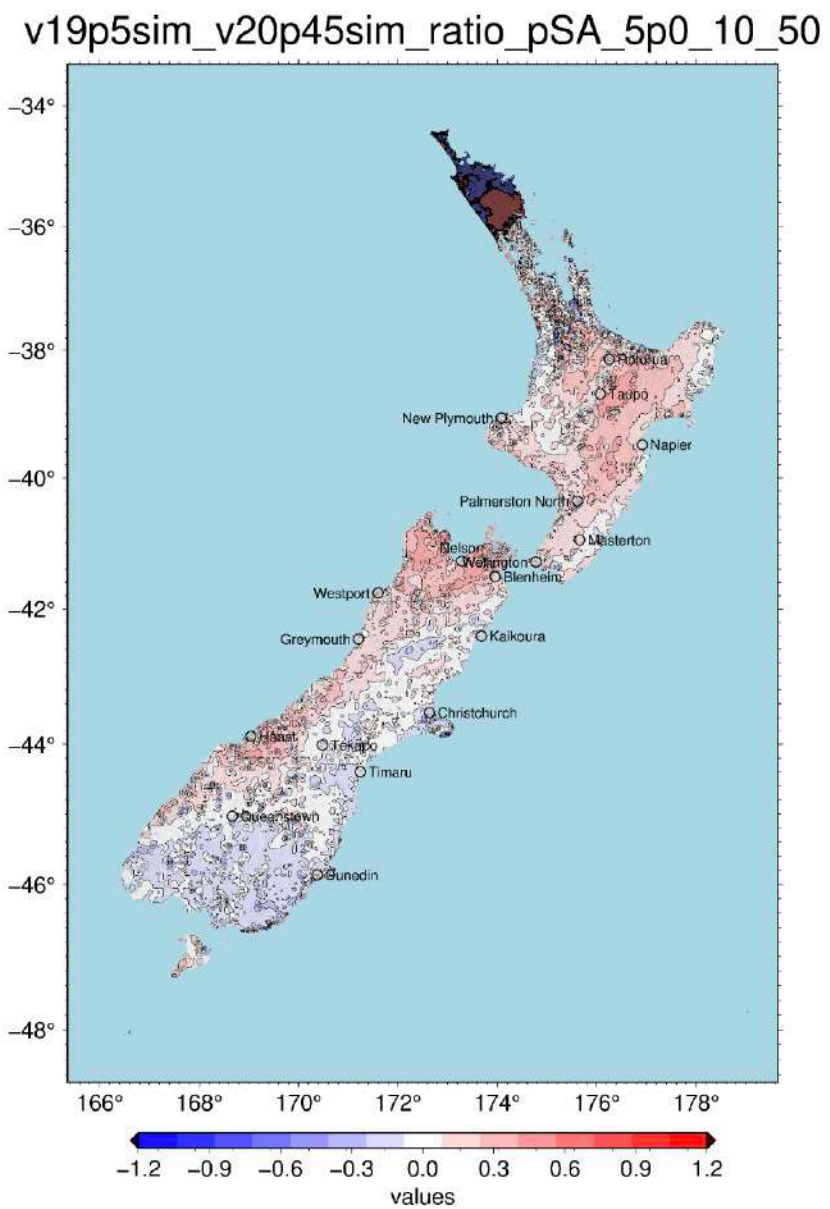
PGA and SA(5.0s) outputs for 10%/50yrs





Ratio maps of CS19.5 vs. 20.5





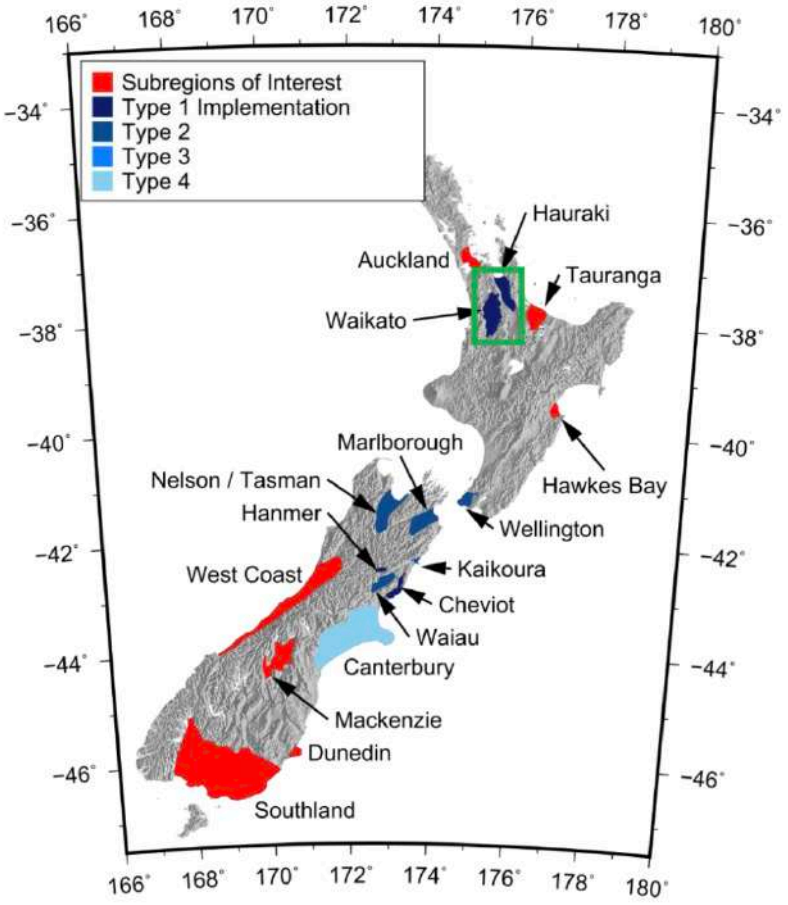
Immediate further updates planned

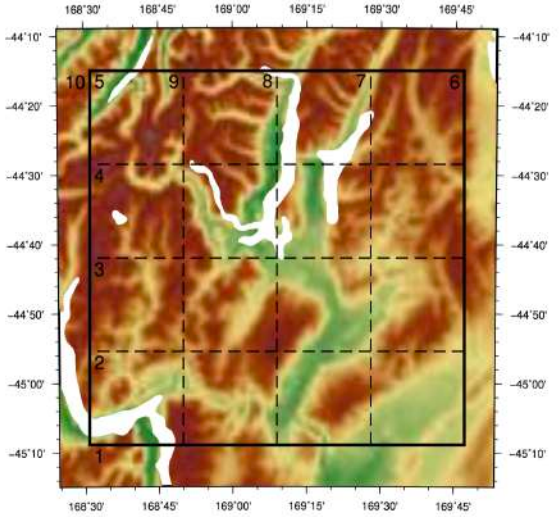
In ~CS20.10 (Oct 2020) we plan:

1. Additional basins in NZVM
2. Update to NZVs30 model
3. Combined simulation and empirical model outputs in a logic tree
4. Potential simulation method improvements
5. Further treatment of uncertainties

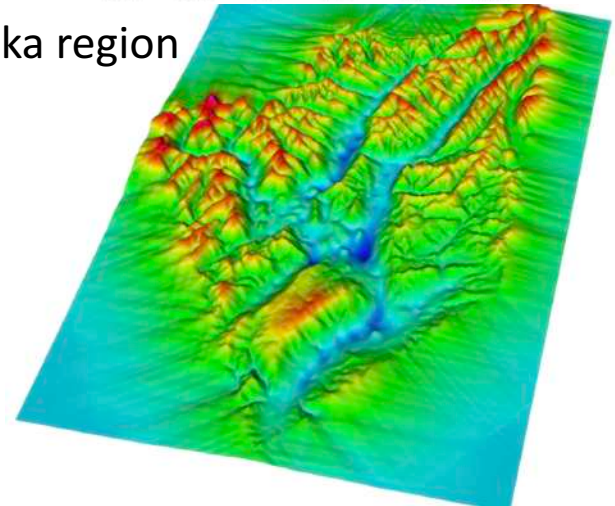
1. Additional basins

Planning to add ~10 further (Type 1) basins to NZVM, enabled by streamlined development



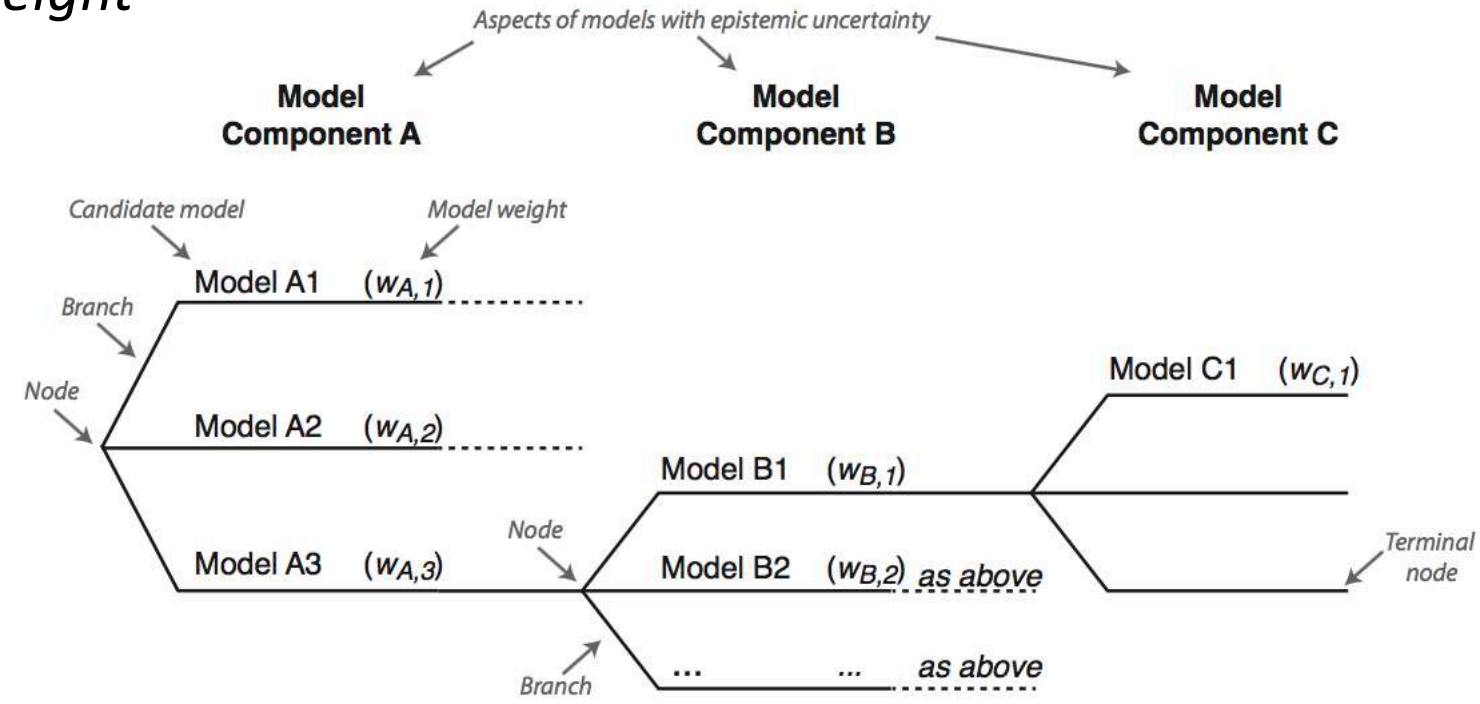


Wanaka region



3. Logic trees for model uncertainty

- Simulation-based ground motion prediction incorporated in logic tree along with empirically-based predictions
- *Predictive capability* of modelling alternatives drives *model weight*



Baker, Bradley, Stafford (2020, Cambridge Press)

Thanks