QuakeCoRE
NZ Centre for Earthquake Resilience

QuakeCoRE GMSV research coordination and current priorities

SCEC GMSV workshop 2016

Brendon Bradley

WEB: www.quakecore.nz
WIKI: https://wiki.canterbury.ac.nz/display/QuakeCore/

UC University of Canterbury · The University of Auckland New Zealand · Resilient Organisations · GNS Science · Massey University · Victoria University of Wellington · The University of Waikato · BRANZ

QuakeCoRE Flagship Programmes

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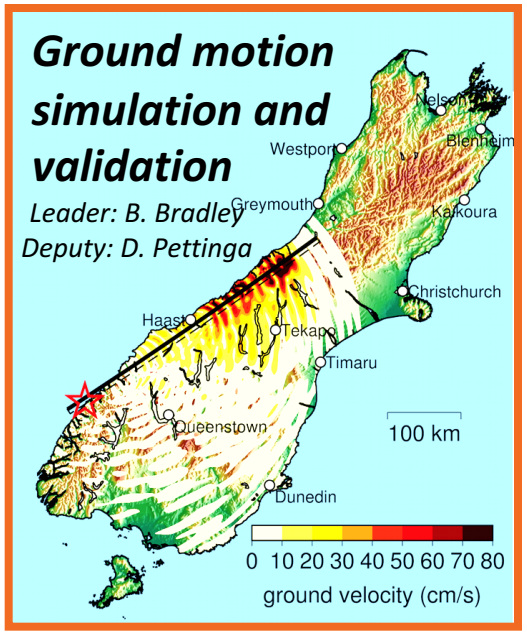

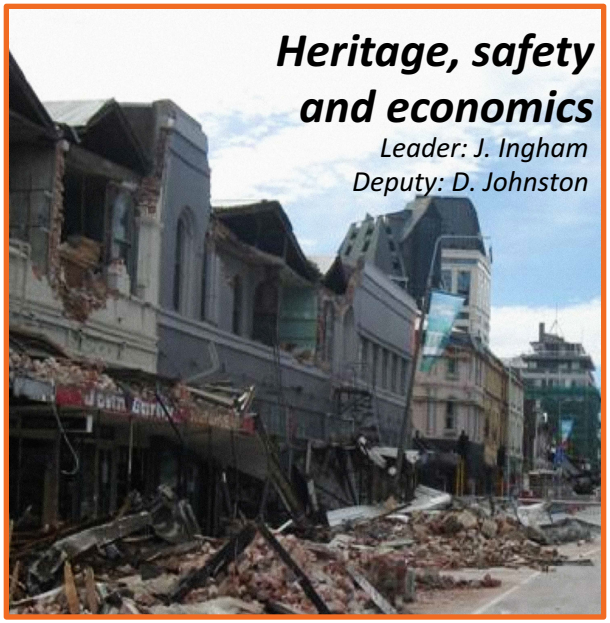

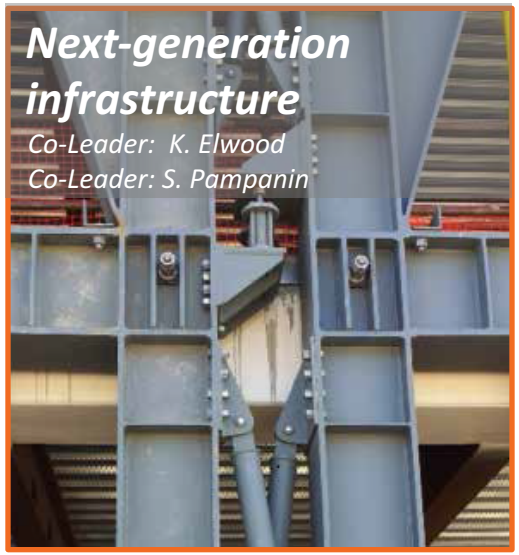

FP1: Spectrum of research

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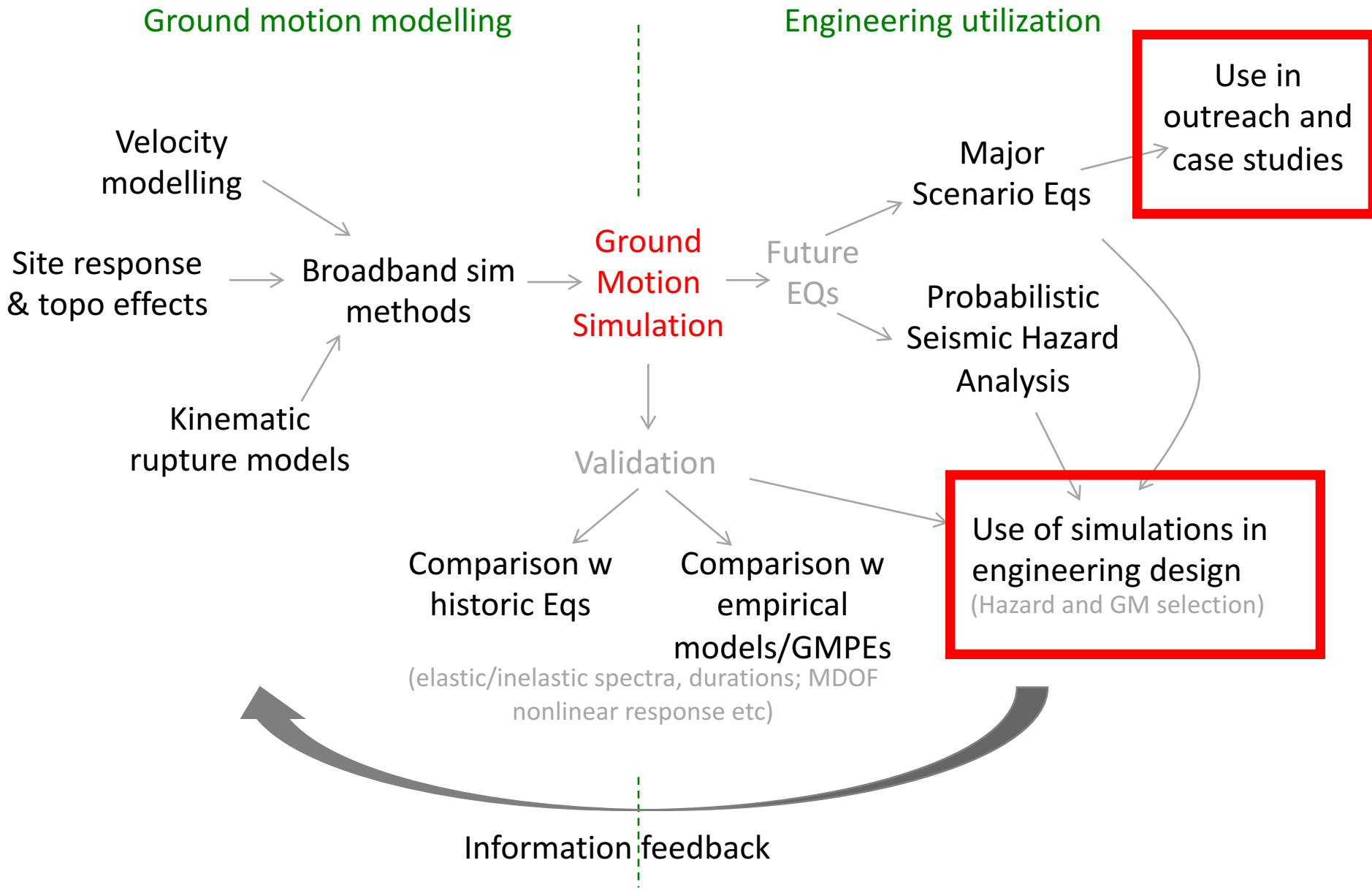

Thrust Areas and 2016 projects

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1. Simulation methods: Development/refinement of ground motion simulation methods that enable the generation of acceleration time series for the seismic response analysis of infrastructure (including kinematic 'rupture generators').

#16002(Somerville) Sim Validation of two historical NZ Subduction Eqs

2. Velocity model development: Development of 'velocity models' of the earth's crust in new regions of NZ, or improve those in existing regions; such models should provide resolution at the length scales necessary for broadband ground motion simulations

#16027(Wotherspoon) Site Characterization Nelson/Tasman Region

#16030(Bradley/Lee) 3D Tomography to improve Canterbury Vel Model

3. Nonlinear site and topographic response: Develop, validate, and apply models for nonlinear near-surface site and topographic response for use in conjunction with GM simulation methods.

#16030(Bradley/Jeong) Topographic simulation Port Hills, Christchurch

4. Application for major NZ EQ scenarios: Utilize ground motion simulations to forecast the severity of ground shaking over spatially-distributed regions in future major NZ earthquakes.

#FP1Postdoc(Nazer) Sim Porters Pass fault rupture

5. Uncertainties and PSHA: Examination of modelling uncertainties in ground motion simulation methods and utilization for probabilistic seismic hazard analysis

#16006(Stirling) Sim Validation Clyde fault using Fragile Geologic Features

#16030(Bradley/Razafindrakoto) Non-ergodic analysis Canterbury simulations

6. Use of simulations in earthquake engineering analyses: Explore the role of simulated ground motions for use in seismic response analysis of engineering infrastructure, including comparisons with as-recorded ground motions and development of procedures for simulated ground motions in infrastructure seismic design guidelines.

#16035(Pettinga) Guidelines for utilizations of GM sim in eng practice

#16057(Luco) Coordination of QuakeCoRE and SCEC GMSV efforts

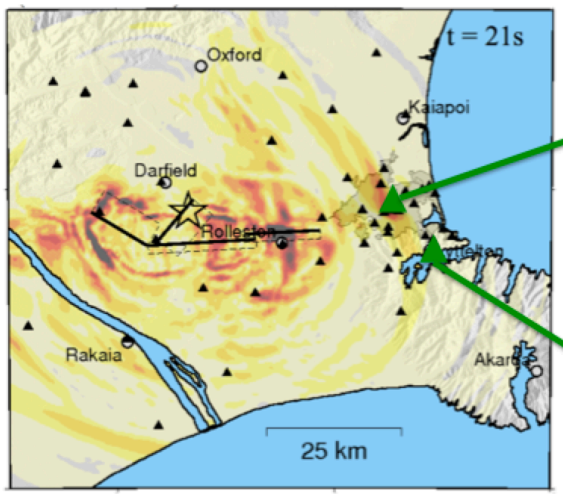
Poster #284, #286

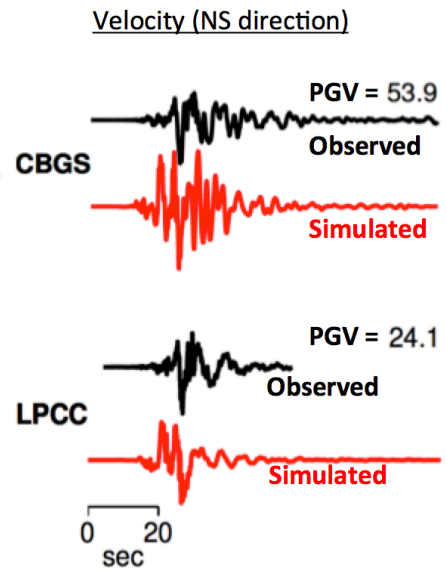
Ground motion sim validation

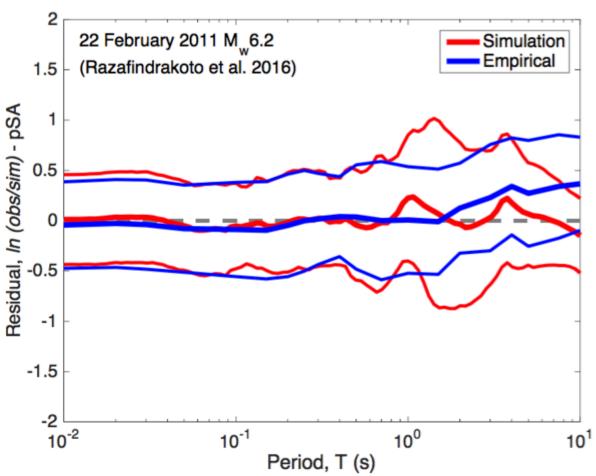
Razafindrakoto, Lee et al.

Validation against 10 major events in the Canterbury EQ Sequence

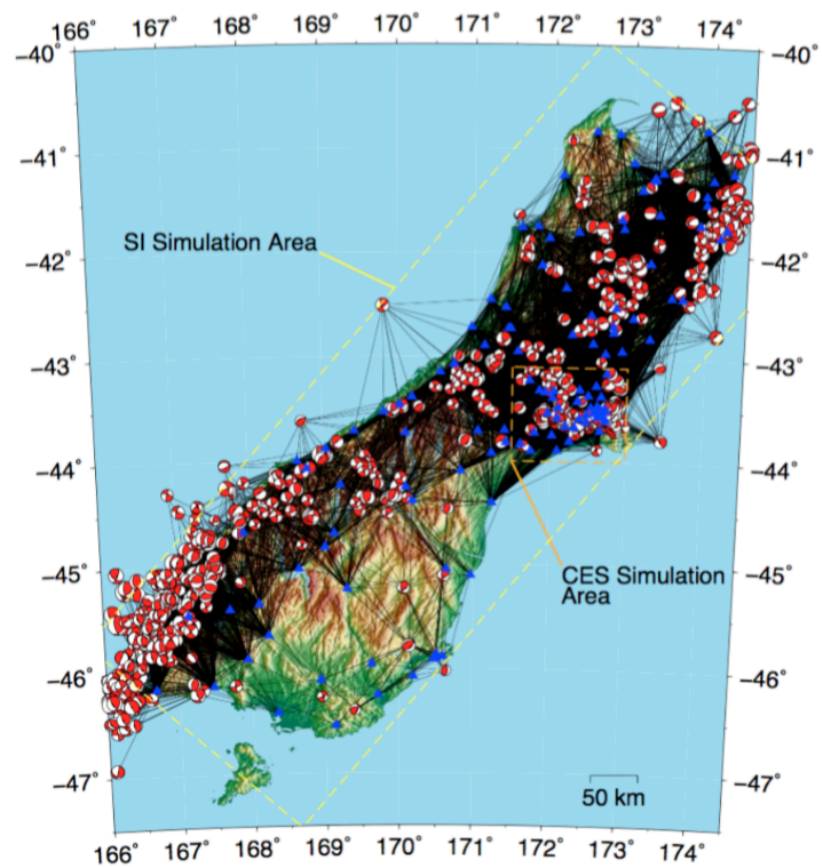
Validation against small-to-moderate (Mw3.0-4.5) EQs







Result: *Simulations as good as empirical models at short periods, and better at long periods*



Validation of Strong Ground Motion Simulations of two Historical NZ Subduction Zone Earthquakes on the SCEC BBP

Somerville et al.

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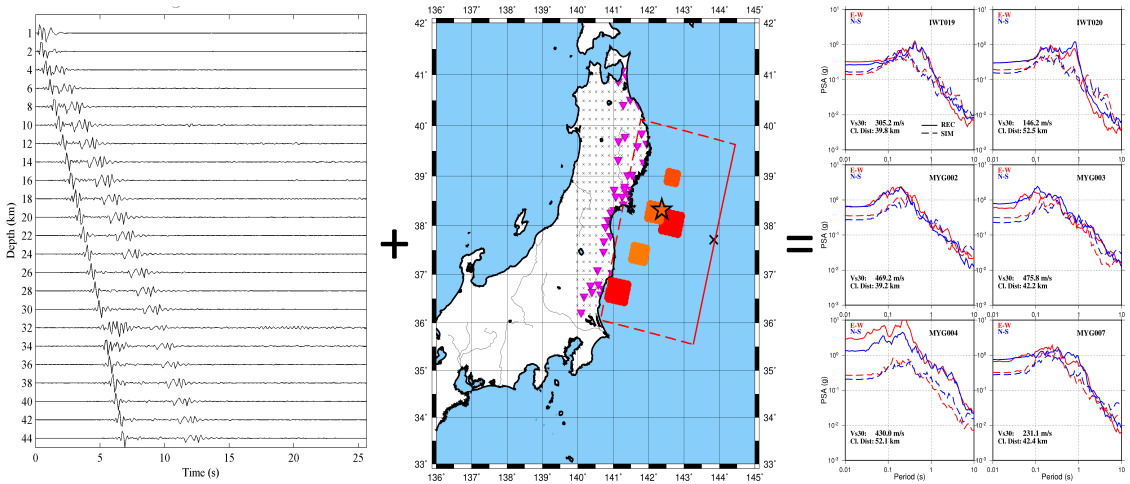
1. Simulation of the Tohoku M9.0 Event in BBP

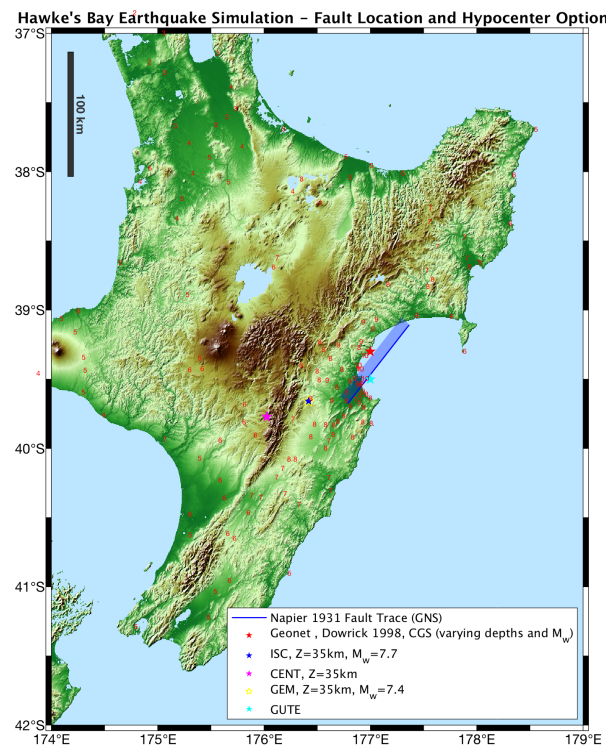


- ***2. 1931 Napier: GNS fault geometry: imbricate reverse fault in accretionary prism, depth 20 km***
- ***Use the Geonet hypocenter and magnitude***
- ***Estimate MMI from simulations and compare with the observed values from Dowrick (1990)***

3. Pending

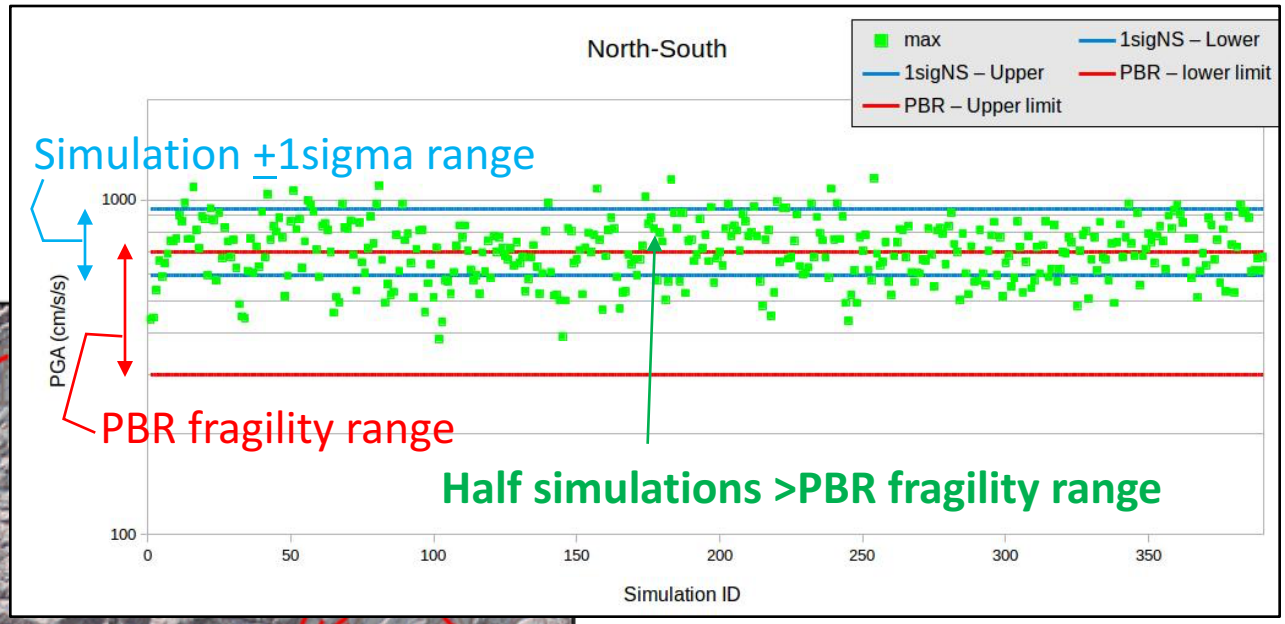
- ***Validate strong ground motion simulations for the 2009 Fiordland earthquake***

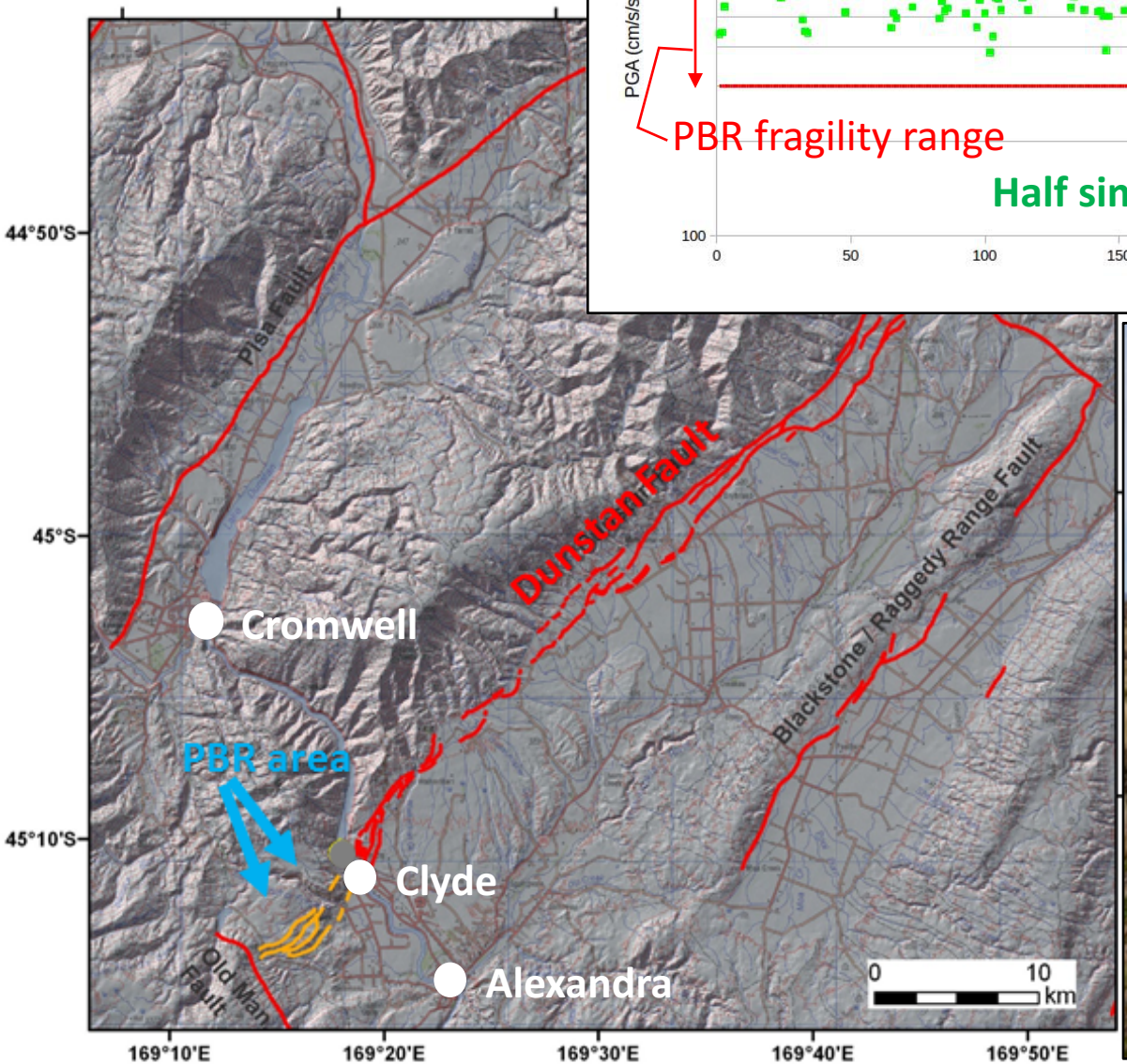
2. Validation of Strong Ground Motion Simulations of the Napier 1931 event



Poster #290

Validation of ground motion simulations using Precariously Balanced Rocks: *Bowie et al.*





A 3D seismic velocity model of Canterbury

Lee et al.

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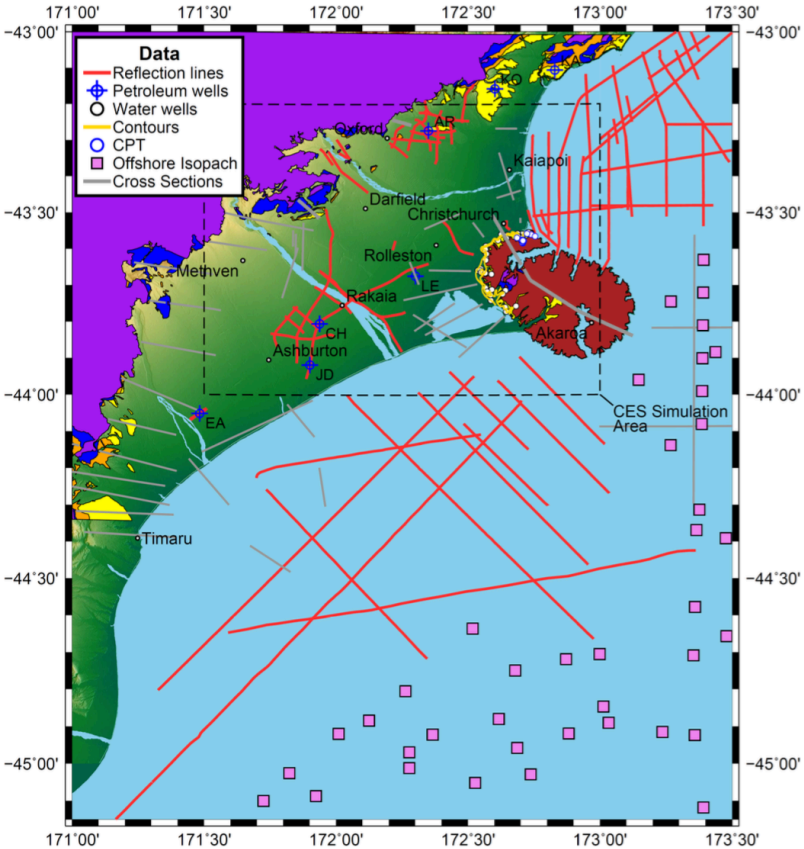
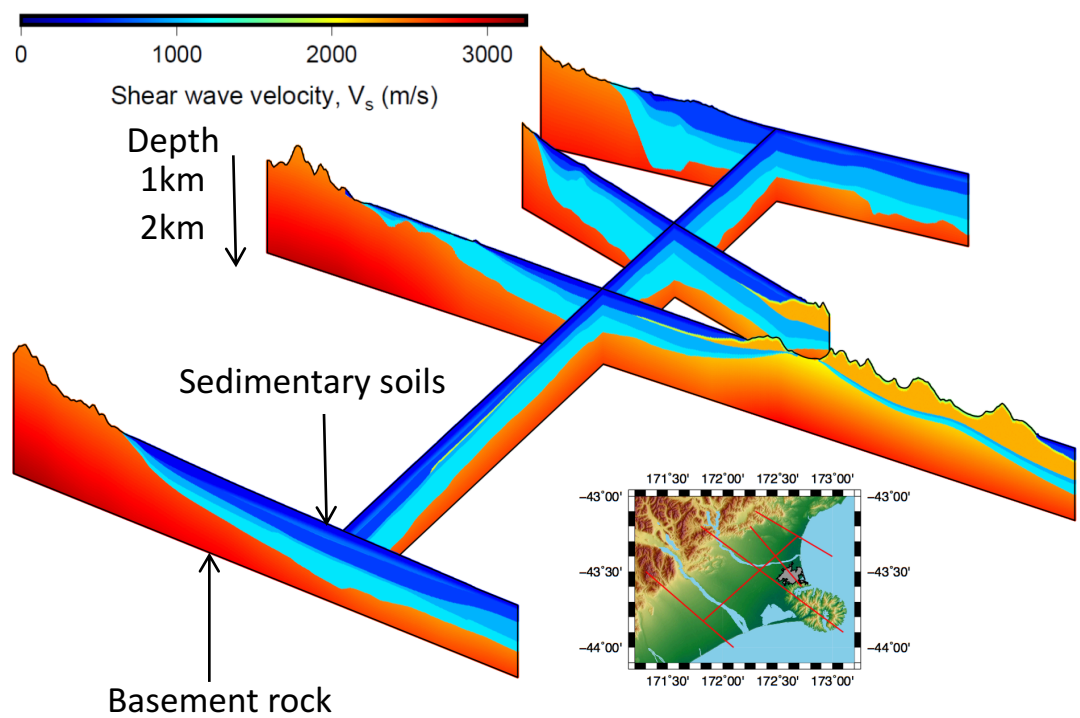
- First quantitative basin model of region integrating multi-disciplinary datasets
- Integral for accurate GM simulation at frequencies of engineering interest





Geotechnical & geophysical characterization of NZ Regions:
Wotherspoon et al.

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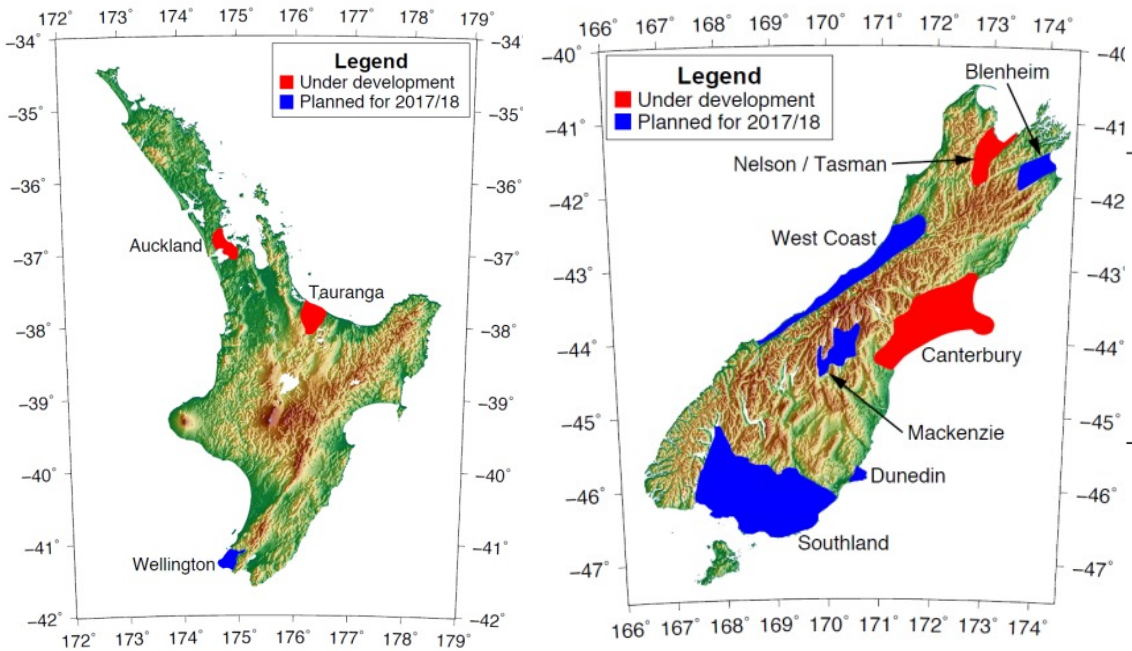
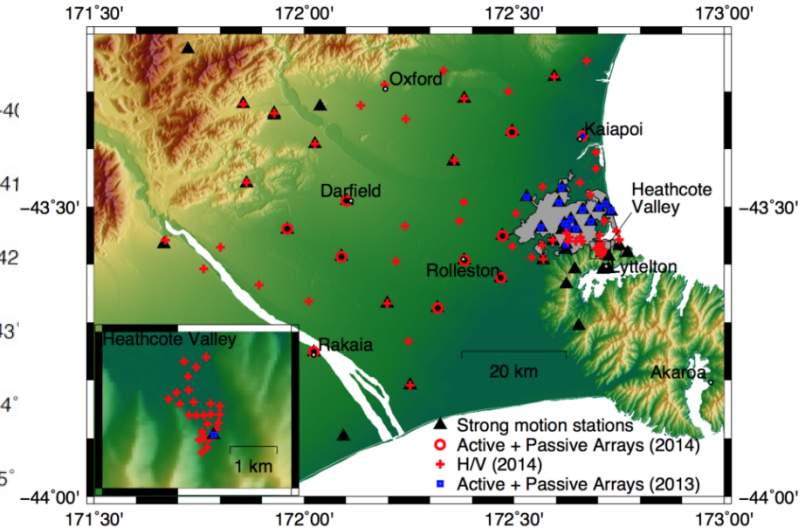
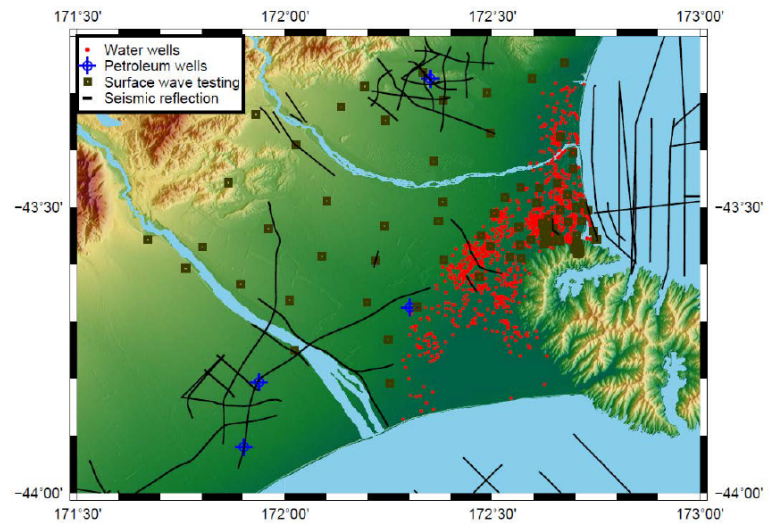


QuakeCoRE investigation regions





Canterbury Investigation Data

Canterbury: Detailed basin velocity model
Auckland: CBD waterfront T_0 model and material V_S
Tauranga: Initial basin T_0 characterisation and material V_S

Outputs feed into: Improved site subsoil classification, dynamic site metrics (e.g. T_0, V_{S30}), and velocity models for GM simulation

Poster #285,#296

Future large magnitude earthquakes

Nazer, Bae et al.

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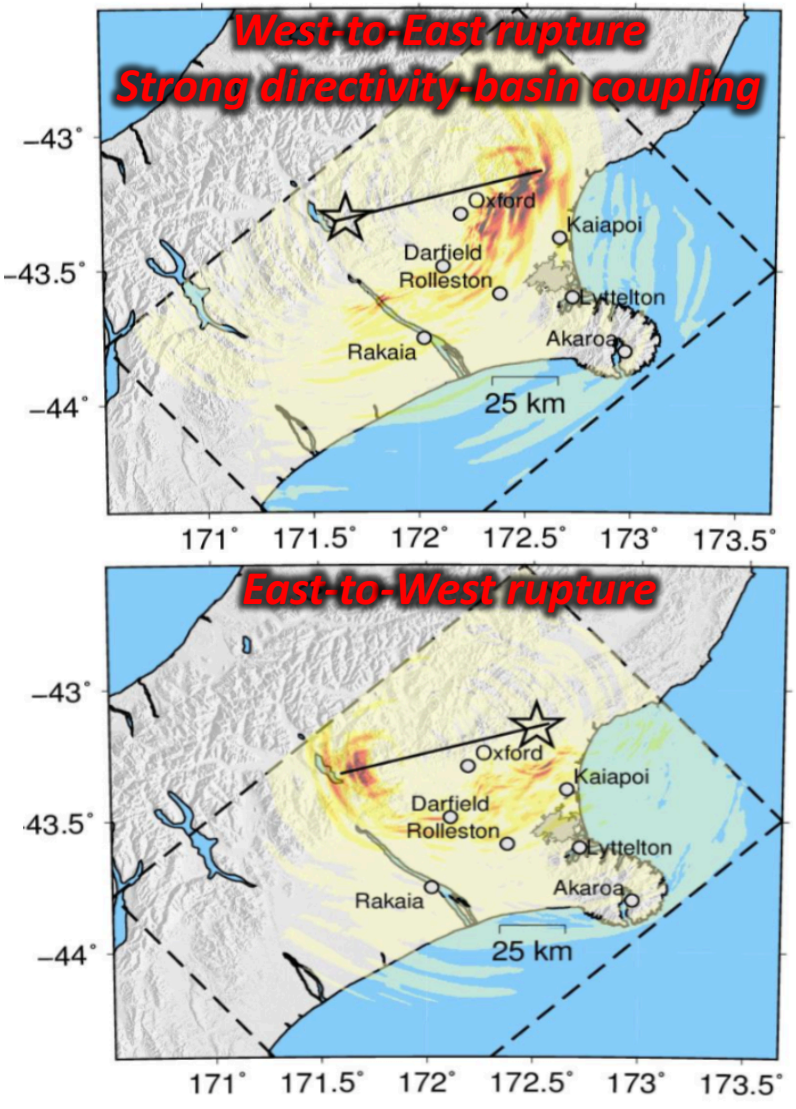
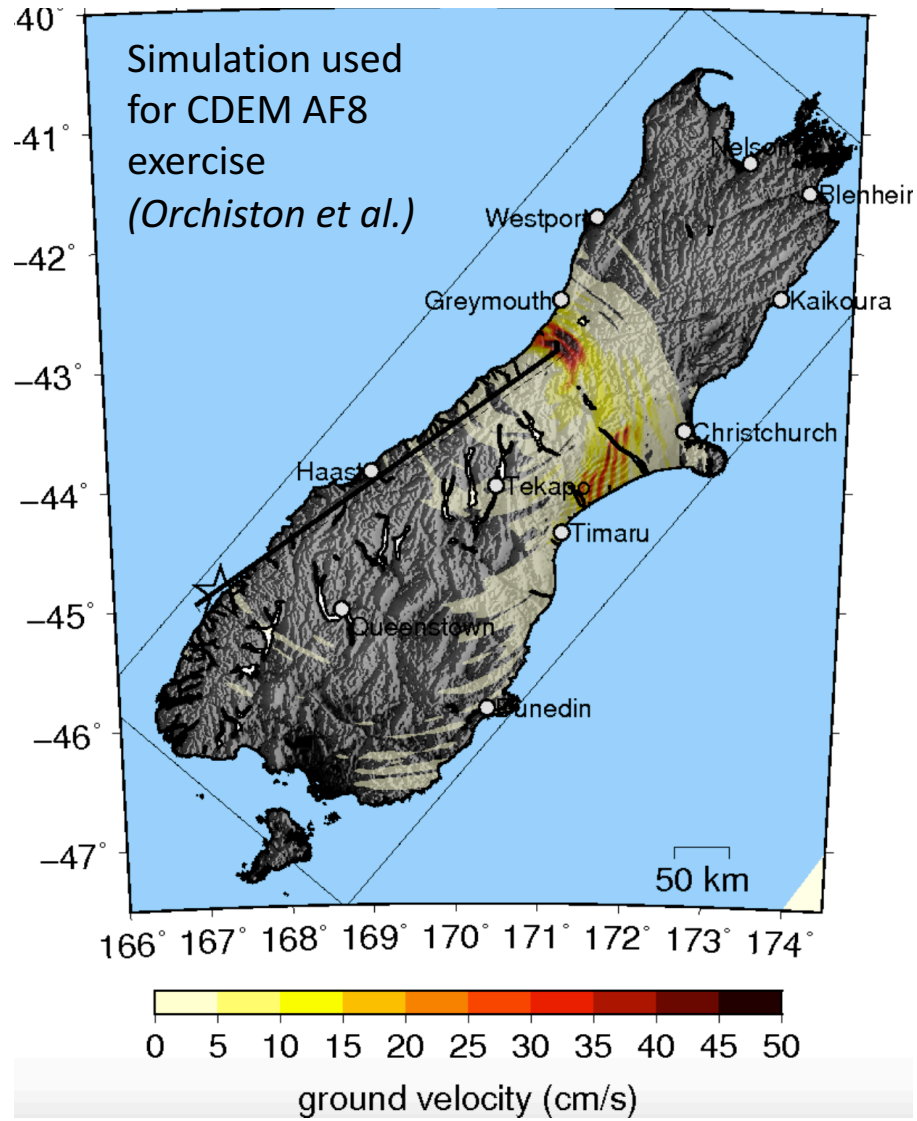
Mw7.2 Porters Pass Earthquakes



Mw8 Alpine Fault Earthquakes



Poster #350

GMSV computational workflow

Bae et al.

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Inputs

Rupture Model | Velocity Model | Station Information | Local Soil Conditions

1D or 3D | SRF | 1D | Stoch

Ground Motion Simulation

Low Frequency

emod3d → LF Seismograms

Merge .xyts from multi.procs

Generate time slices

Vel

High Frequency
Simulation using stochastic modelling

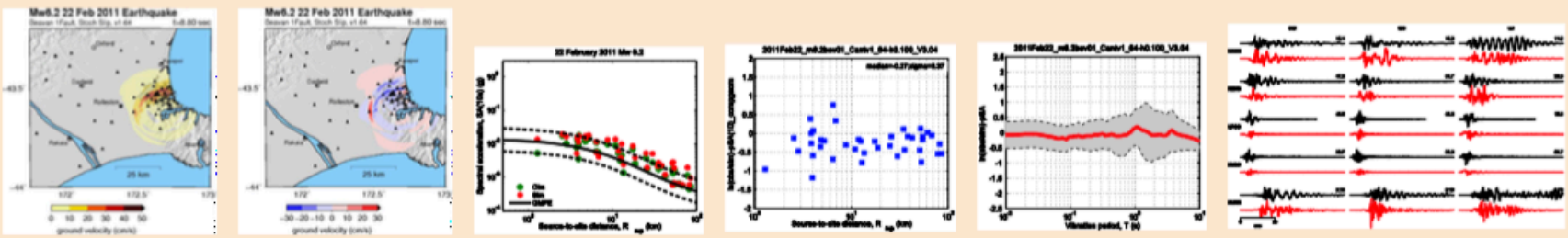
Acc

Broadband
BB seismograms (Vel and Acc)

Post-Processing

Plotting time slices in GMT → Create animation

Plotting ← Computing: PGA, PGV, CAV, AI, Ds575, Ds595, pSA



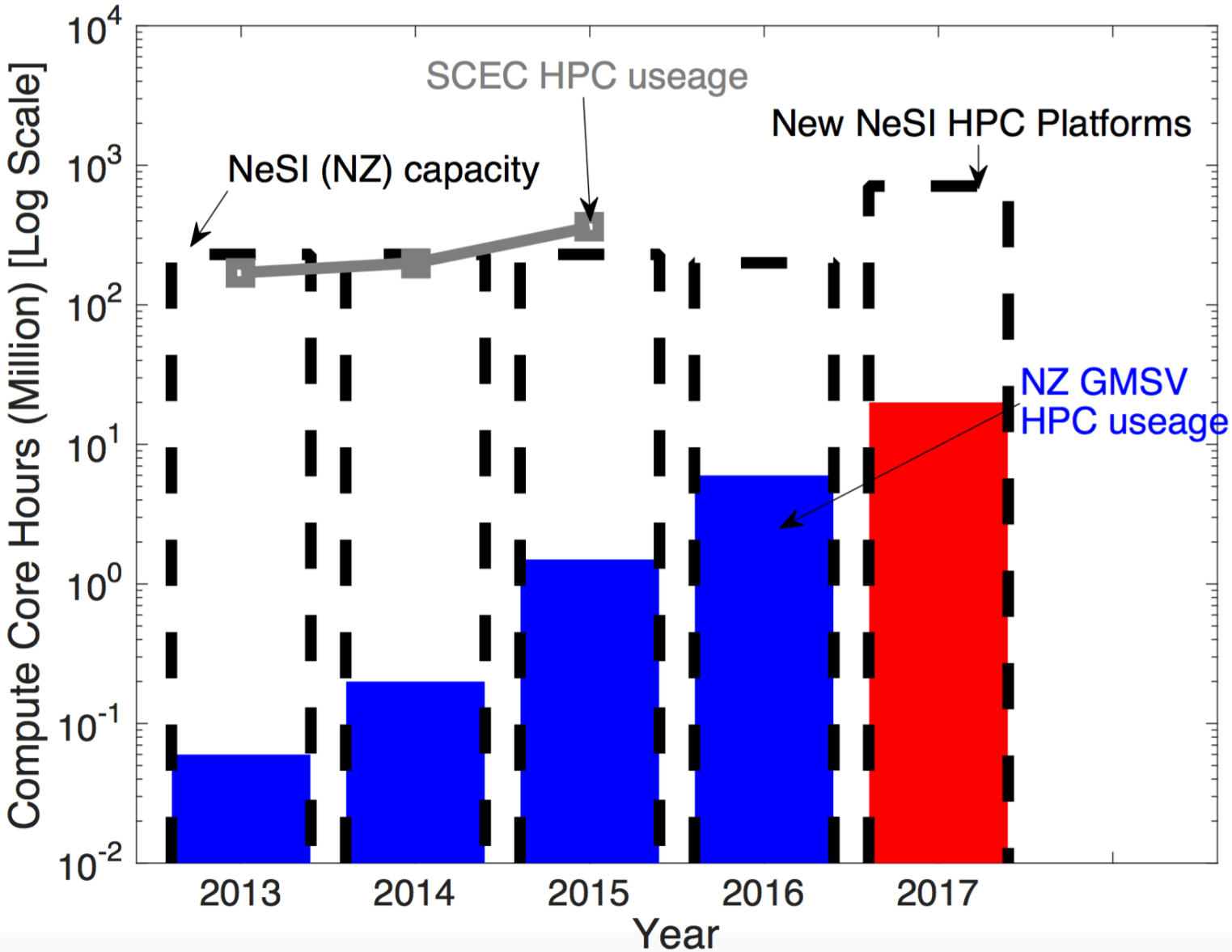
Implemented on NZ's two largest supercomputers

Real-time ground motion simulation

Strategic QuakeCoRE/NeSI/GeoNet partnership

→ GeoNet alert →  → Compute Rupture, Velocity model and approximate finite fault → Start GM simulation workflow → Simulation vs. Observation comparison

Current HPC within QC



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