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/
QuakeCoRE Flagship Programmes

**Ground motion simulation and validation**
Leader: B. Bradley
Deputy: D. Pettinga

**Liquefaction impacts on infrastructure**
Leader: M. Cubrinovski
Deputy: S. van Ballegooij

**Heritage, safety and economics**
Leader: J. Ingham
Deputy: D. Johnston

**Next-generation infrastructure**
Co-Leader: K. Elwood
Co-Leader: S. Pampanin

**Pathways to resilience**
Leader: E. Seville
Deputy: T. Hutton

**Distributed infrastructure (with RNC)**
Leader: L. Wotherspoon
Deputy: R. Fairclough
FP1: Spectrum of research

Ground motion modelling
- Velocity modelling
- Site response & topo effects
- Kinematic rupture models

Broadband sim methods

Ground Motion Simulation

Validation
- Comparison w historic Eq's
- Comparison w empirical models/GMPEs

Information feedback

Use in outreach and case studies
- Future Eq's
- Major Scenario Eq's
- Probabilistic Seismic Hazard Analysis

Use of simulations in engineering design (Hazard and GM selection)
- Engineering utilization
- Future EQs
- Probabilistic Seismic Hazard Analysis
- Major Scenario Eq's
- Future Eq's
- Use in outreach and case studies
- Use of simulations in engineering design (Hazard and GM selection)
Thrust Areas and 2016 projects

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


   #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
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.

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

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

- 2.1 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
Validation of ground motion simulations using Precariously Balanced Rocks: Bowie et al.
A 3D seismic velocity model of Canterbury  

- 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.

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
Future large magnitude earthquakes

Nazer, Bae et al.

**Mw7.2 Porters Pass Earthquakes**

- West-to-East rupture
- Strong directivity-basin coupling

**Mw8 Alpine Fault Earthquakes**

Simulation used for CDEM AF8 exercise (Orchiston et al.)
GMSV computational workflow

Bae et al.

Implemented on NZ's two largest supercomputers

Real-time ground motion simulation
Strategic QuakeCoRE/NeSI/GeoNet partnership
Current HPC within QC

![Graph showing the comparative usage of HPC between NeSI (NZ) capacity and SCEC HPC usage, with a projected increase in new NeSI HPC platforms for 2016 and 2017.]
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