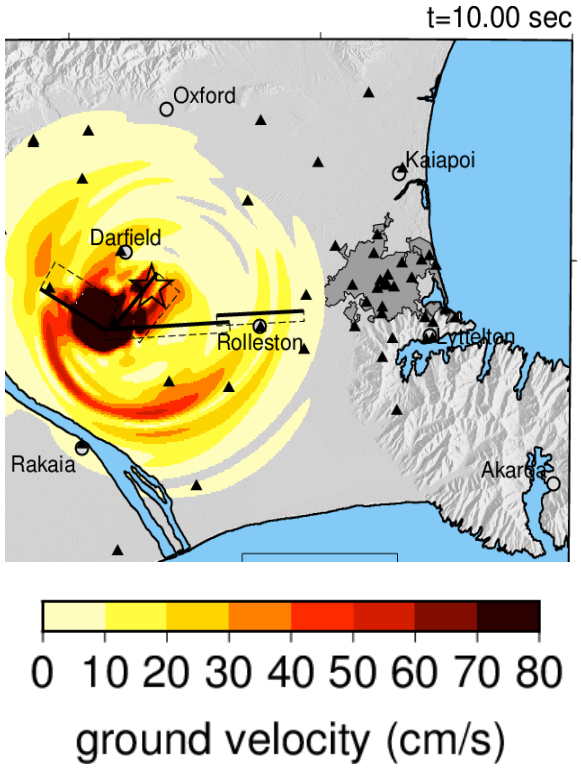
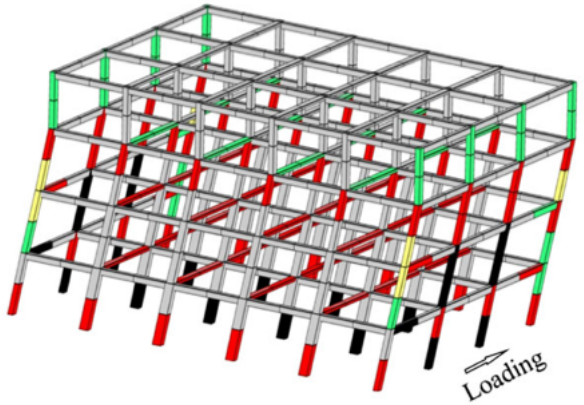
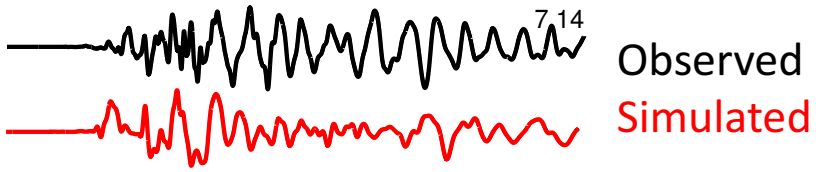
Flagship Project 1:
Ground motion simulation & validation







Brendon Bradley, Flagship Project Leader

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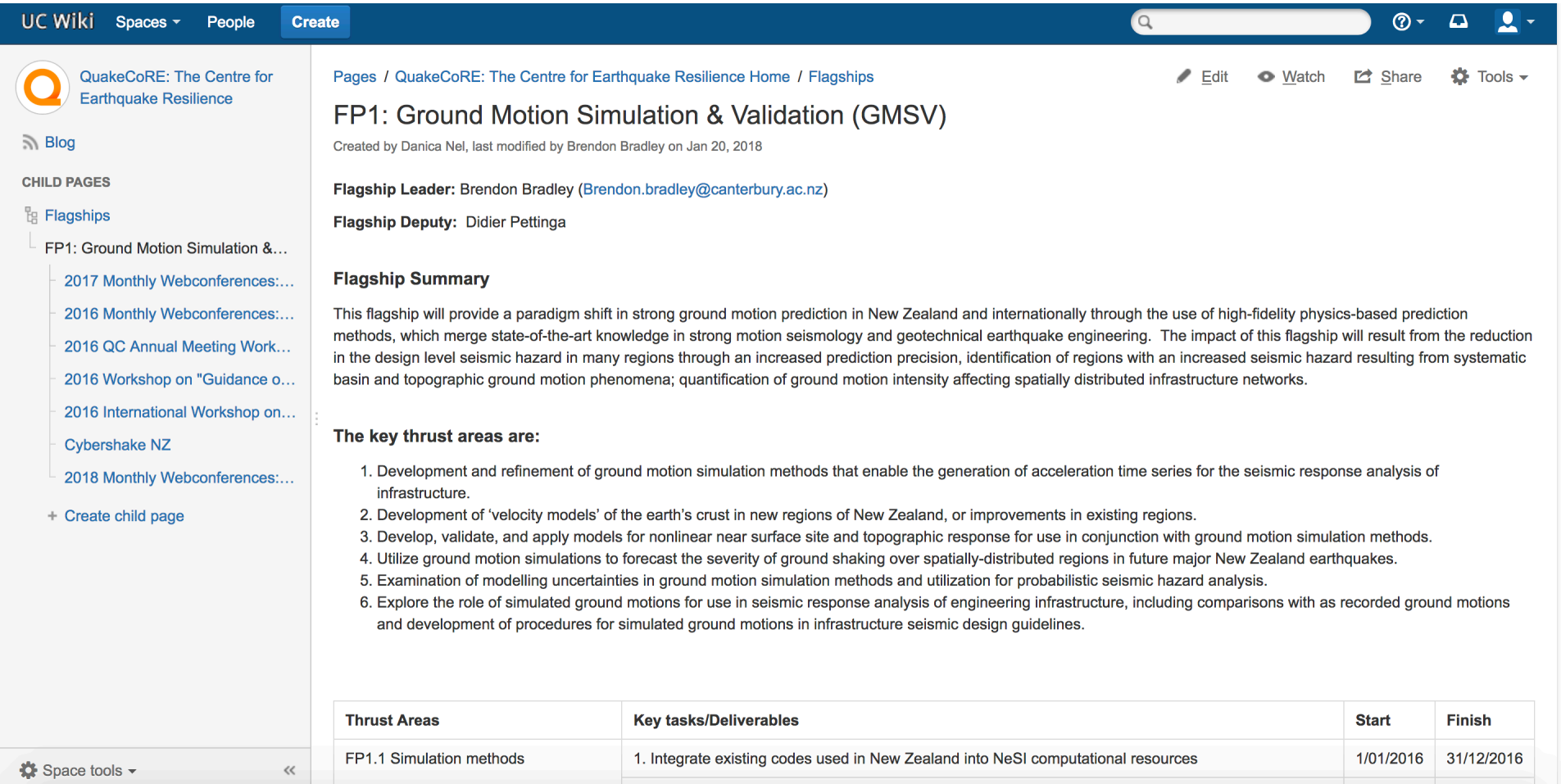

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FP1: Ground Motion Simulation & Validation (GMSV)

Created by Danica Nel, last modified by Brendon Bradley on Jan 20, 2018

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Flagship Deputy: Didier Pettinga

Flagship Summary

This flagship will provide a paradigm shift in strong ground motion prediction in New Zealand and internationally through the use of high-fidelity physics-based prediction methods, which merge state-of-the-art knowledge in strong motion seismology and geotechnical earthquake engineering. The impact of this flagship will result from the reduction in the design level seismic hazard in many regions through an increased prediction precision, identification of regions with an increased seismic hazard resulting from systematic basin and topographic ground motion phenomena; quantification of ground motion intensity affecting spatially distributed infrastructure networks.

The key thrust areas are:

1. Development and refinement of ground motion simulation methods that enable the generation of acceleration time series for the seismic response analysis of infrastructure.
2. Development of 'velocity models' of the earth's crust in new regions of New Zealand, or improvements in existing regions.
3. Develop, validate, and apply models for nonlinear near surface site and topographic response for use in conjunction with ground motion simulation methods.
4. Utilize ground motion simulations to forecast the severity of ground shaking over spatially-distributed regions in future major New Zealand earthquakes.
5. Examination of modelling uncertainties in ground motion simulation methods and utilization for probabilistic seismic hazard analysis.
6. 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.

Thrust Areas	Key tasks/Deliverables	Start	Finish
FP1.1 Simulation methods	1. Integrate existing codes used in New Zealand into NeSI computational resources	1/01/2016	31/12/2016

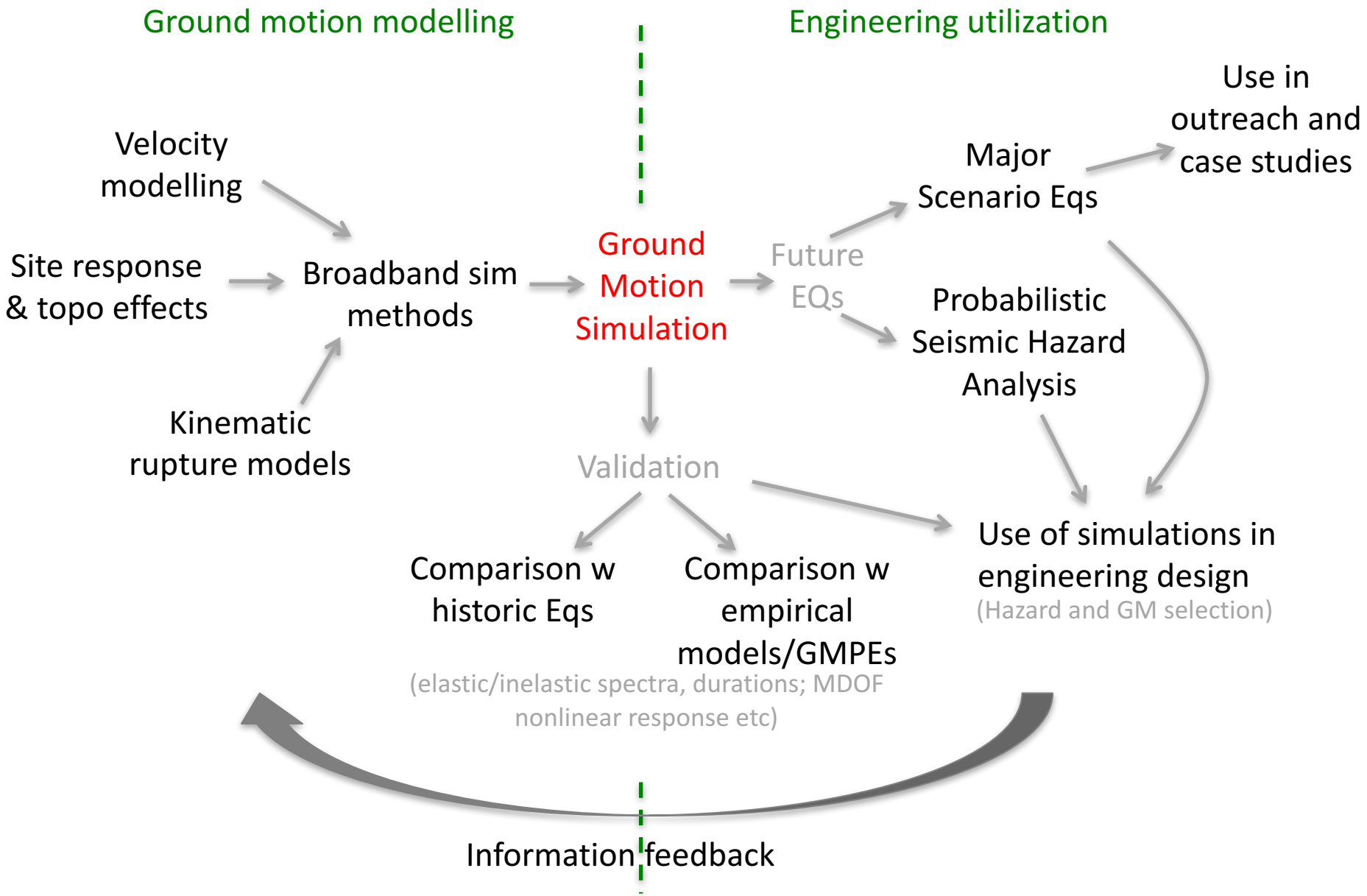
Current projects (wiki page)

Current Projects

Projects in 2018 include the flagship coordinated project, projects funded through the QuakeCoRE RfP, and students with QuakeCoRE or other university scholarships.

- 18FP1 - Flagship 1 coordinated project, containing the following sub-projects:
  - 1a. Validation of simulations for NZ-wide shallow crustal events (Lee, Bradley)
  - 1b. Ground motion simulations with multi-segment rupture (Vyas, Razafindrakoto, Bradley)
  - 2a. Development of basin models in Wellington and Auckland using 1st order methods (Wotherspoon, Bradley, Kaiser, Jeong, Cox, Foster, Lee)
  - 3a. Explicit site response analysis in simulations of the Kaikoura earthquake (Bradley, Wotherspoon, Cox, de la Torre, McGann, Dismuke)
  - 3b. Topographic modelling for Alpine Fault and Kaikoura earthquakes (Taborda, Asimaki, Jeong, Bradley, Wotherspoon)
  - 4a. Simulation of Wellington Fault earthquakes (Bradley, Tarbali, Lee)
  - 4b. Simulation of Hikurangi subduction zone earthquakes (Somerville, Bayless, Skarlatoudis)
  - 4c. Simulation of moderate magnitude earthquakes in the Auckland region (Dempsey, Riffault)
  - 5a. Analysis and propagation of modelling uncertainties in ground motion simulation (Bradley, Vyas, Lee, Tarbali)
  - 5b. Simulation-based seismic hazard analysis for New Zealand at 400m resolution (Tarbali, Bradley)
  - 6a. Application of code-compatible simulation vs. recorded ground motions for structural and geotechnical systems (McGann, Hayden, Chandramohan, Bradley, Pettinga, Tarbali, Loghman)
  - 6b. Guidance on the selection of simulated ground motions as an alternative method for use in NZ (Pettinga, Fraser, Bradley)
- 18AF8 - Ground motion simulation of Alpine Fault (incl Wairau as 'Northern AF') earthquakes (Tarbali, Bradley + AF8 project)
- 18QCS - Ground motion simulations for the Dunedin-Mosgiel urban area (Stirling, Kowal)
- 18207 - Soil-foundation-structure interaction analysis of an instrumented Wellington building (McGann, Chandramohan, Hayden, Pettinga, Jeong)
- 18213 - Incorporating the influence of ground motion duration and response spectral shape in NZ structural design and assessment practice (Chandramohan, Horspool, Bradley)
- 18KF - Development of a NZ-wide Vs30 model for use in regional ground motion simulations (Foster, Bradley)
- 18ET - Parametric models for velocity characterisation of inter-bedded sedimentary deposits in the Canterbury basin (Thomson, Bradley, Wotherspoon, Wood)

Spectrum of research



Thrust Areas

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.

#18FP1a - Validation of simulations for NZ-wide shallow crustal events (Lee, Bradley)

#18FP1b - Ground motion simulations with multi-segment rupture (Vyas, Razafindrakoto, Bradley)

2. Velocity model development: Development of 'velocity models' of the earth's crust in new regions of NZ, or improve those in existing regions

#18FP2a - Development of basin models in Wellington and Auckland using 1st order methods (Wotherspoon, Bradley, Kaiser, Jeong, Cox, Foster, Lee)

#18ET - Parametric models for velocity characterisation of inter-bedded sedimentary deposits in the Canterbury basin (Thomson, Bradley, Wotherspoon, Wood)

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 simulations.

#18FP3a - Explicit site response analysis in simulations of the Kaikoura earthquake (Bradley, Wotherspoon, Cox, de la Torre, McGann, Dismuke)

#18FP3b - Topographic modelling for Alpine Fault and Kaikoura earthquakes (Taborda, Asimaki, Jeong, Bradley, Wother..n)

#18KF - Development of a NZ-wide Vs30 model for use in regional ground motion simulations (Foster, Bradley)

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.

#18FP4a. Simulation of Wellington Fault earthquakes (Bradley, Tarbali, Lee)

#18FP4b. Simulation of Hikurangi subduction zone earthquakes (Somerville, Bayless, Skarlatoudis)

#18FP4c. Simulation of moderate magnitude earthquakes in the Auckland region (Dempsey, Riffault)

#18AF8 - Ground motion simulation of Alpine Fault (incl Wairau as 'Northern AF') earthquakes (Tarbali, Bradley)

#18QCS - Ground motion simulations for the Dunedin-Mosgiel urban area (Stirling, Kowal)

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

#18FP5a - Analysis and propagation of modelling uncertainties in ground motion simulation (Bradley, Vyas, Lee, Tarbali)

#18FP5b. Simulation-based seismic hazard analysis for New Zealand at 400m resolution (Tarbali, Bradley)

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 seismic design guidelines.

#18FP6a. Application of code-compatible simulation vs. recorded ground motions for structural and geotechnical systems (McGann, Hayden, Chandramohan, Bradley, Pettinga, Tarbali, Loghman)

#18FP6b. Guidance on the selection of simulated ground motions as an alternative method in NZ (Pettinga, Fraser, Brad..y)