Topography Effects on Ground Motion

Simulation and analysis plans

Caltech: Kami Mohammadi
Domniki Asimaki

U. Canterbury: Seokho Jeong
Brendon Bradley

U. Memphis: Khurram Aslam
Ricardo Taborda

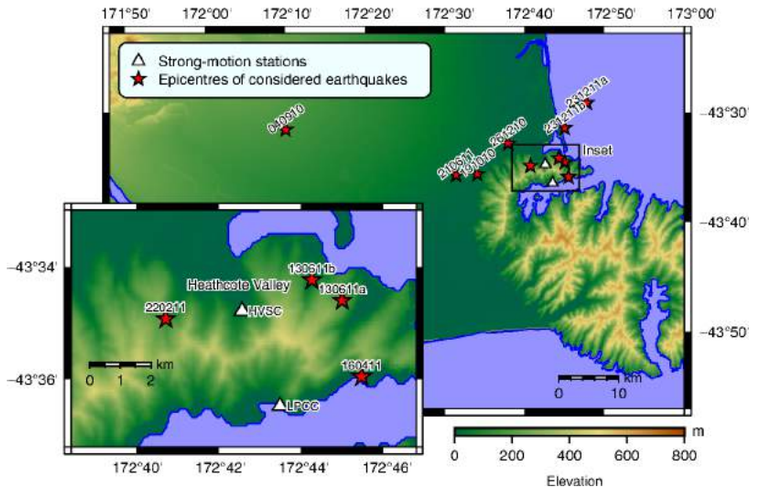
U. Canterbury – Summary of Progress and Plans

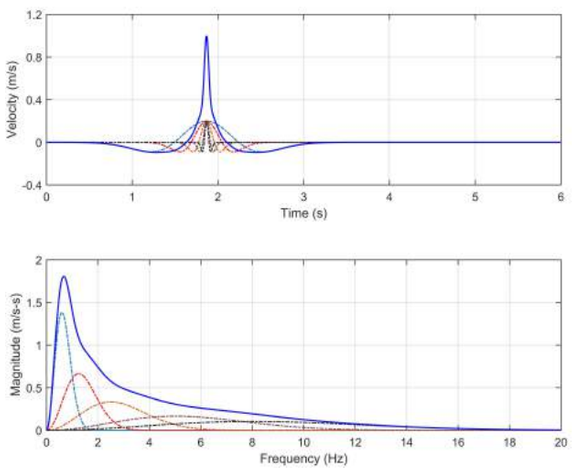
- Done:
    - Conducted experimental measurements in Heathcote Valley
    - Adopted SPECFEM3D for New Zealand simulations with topography
    - Built meshes for for SPECFEM3D using SIVM data (not trivial)
- In progress:
    - Submission of a manuscript on experimental results about topography effects
- Plans for this year:
    - Adapt to use of finite fault models in SPECFEM3D
    - Compare with other simulations (e.g., Hercules)
    - Compare results with data (qualitatively)

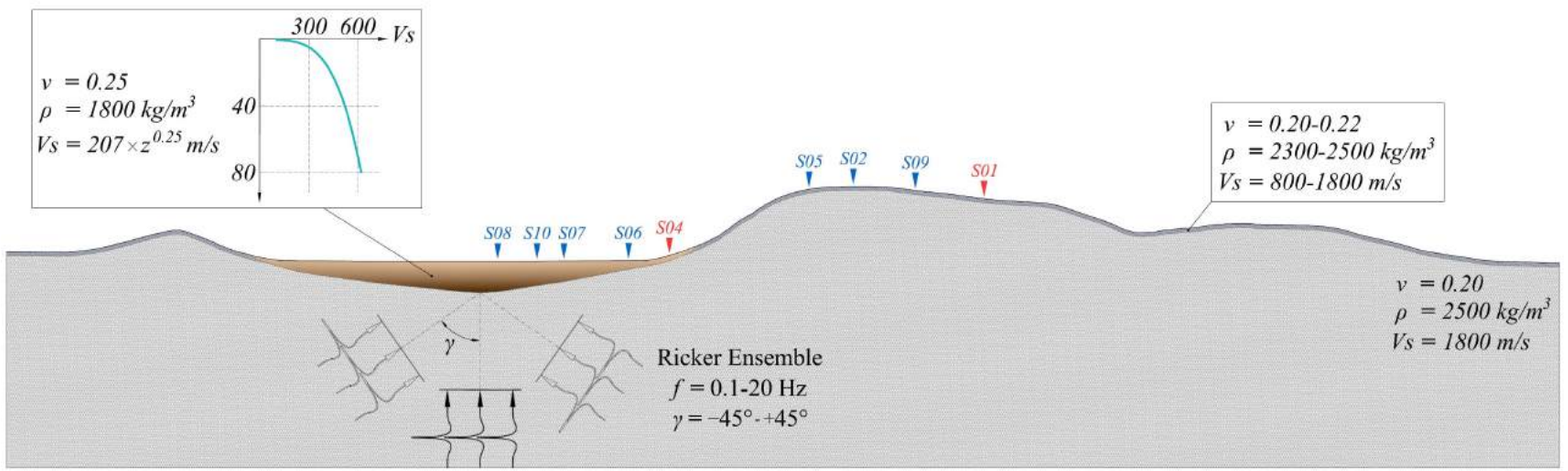
Caltech – Summary of Progress and Plans

- Done:
    - Analysis of experimental data with U. Canterbury (S. Jeong)
    - 2D/3D numerical simulations using…
        - 8-m DEM for surface geometry
        - CPT and HVSR data for simple material model
        - Superposition of Ricker pulses with energy in 0.1–20 Hz
        - SV (2D) and SH (3D) plane waves for variable incident angle
    - Comparisons with experimental results are in good agreement based on what can be expected from the model.
- In progress:
    - Further refinement of SH model and results
    - Submission of a two-parts manuscript (review and experimental/numerical results)

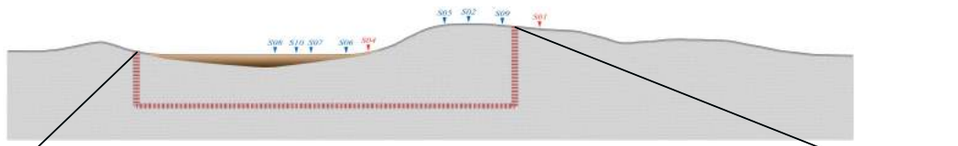
Region of Interest, Instrumentation, 2D Modeling



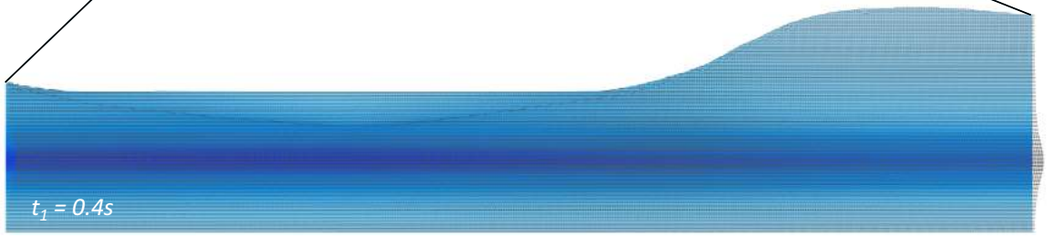


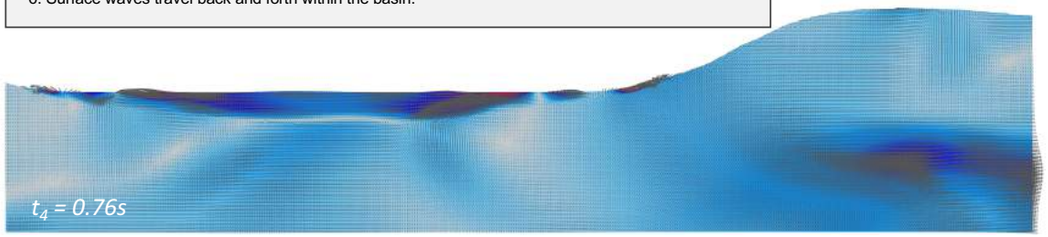


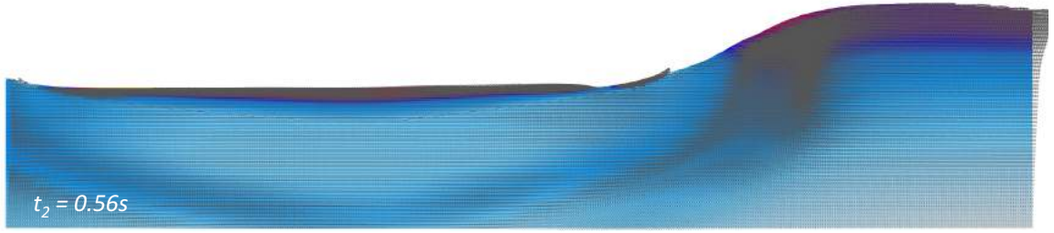
Results from 2D Simulations

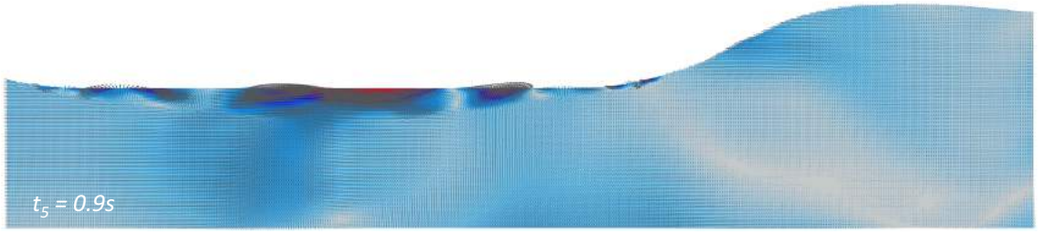


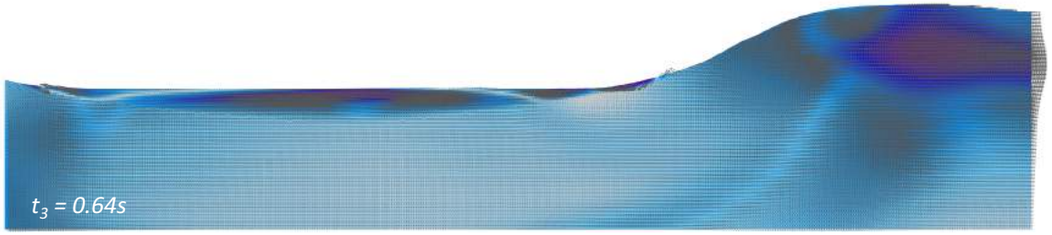
1: Incident SV wave reaches the scatterer i.e. the basin.
2: Topographic amplification occurs (low frequencies).
3: Over reflection, part of the energy remains in the basin.
4: Wave trapped in the basin starts to interfere.
5: Constructive interference results in higher amplification.
6: Surface waves travel back and forth within the basin.

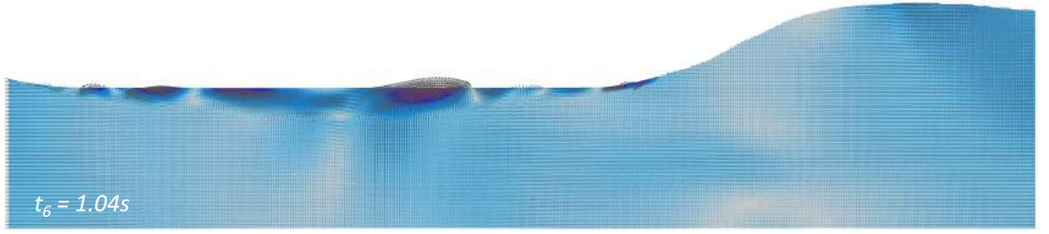




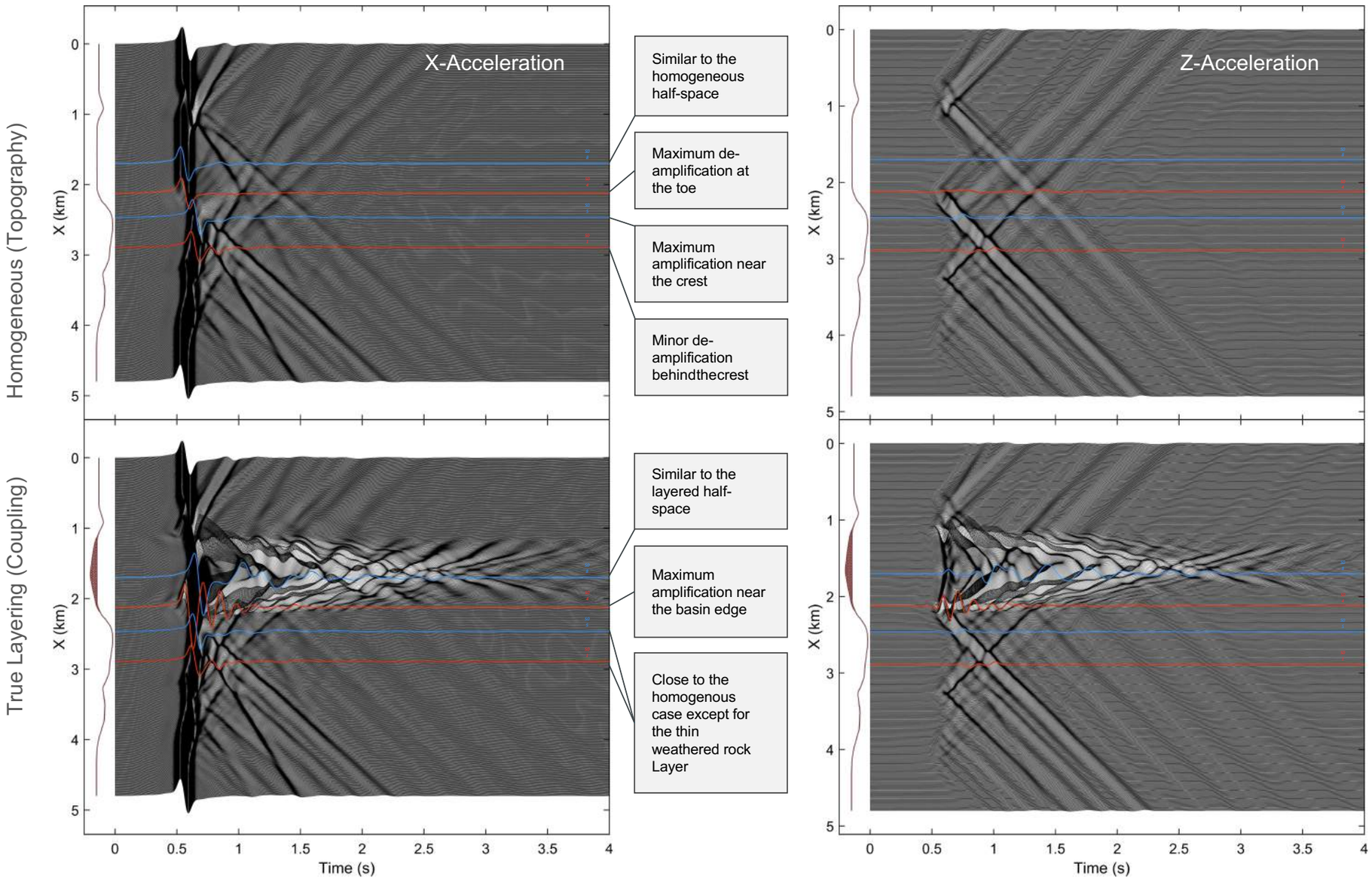




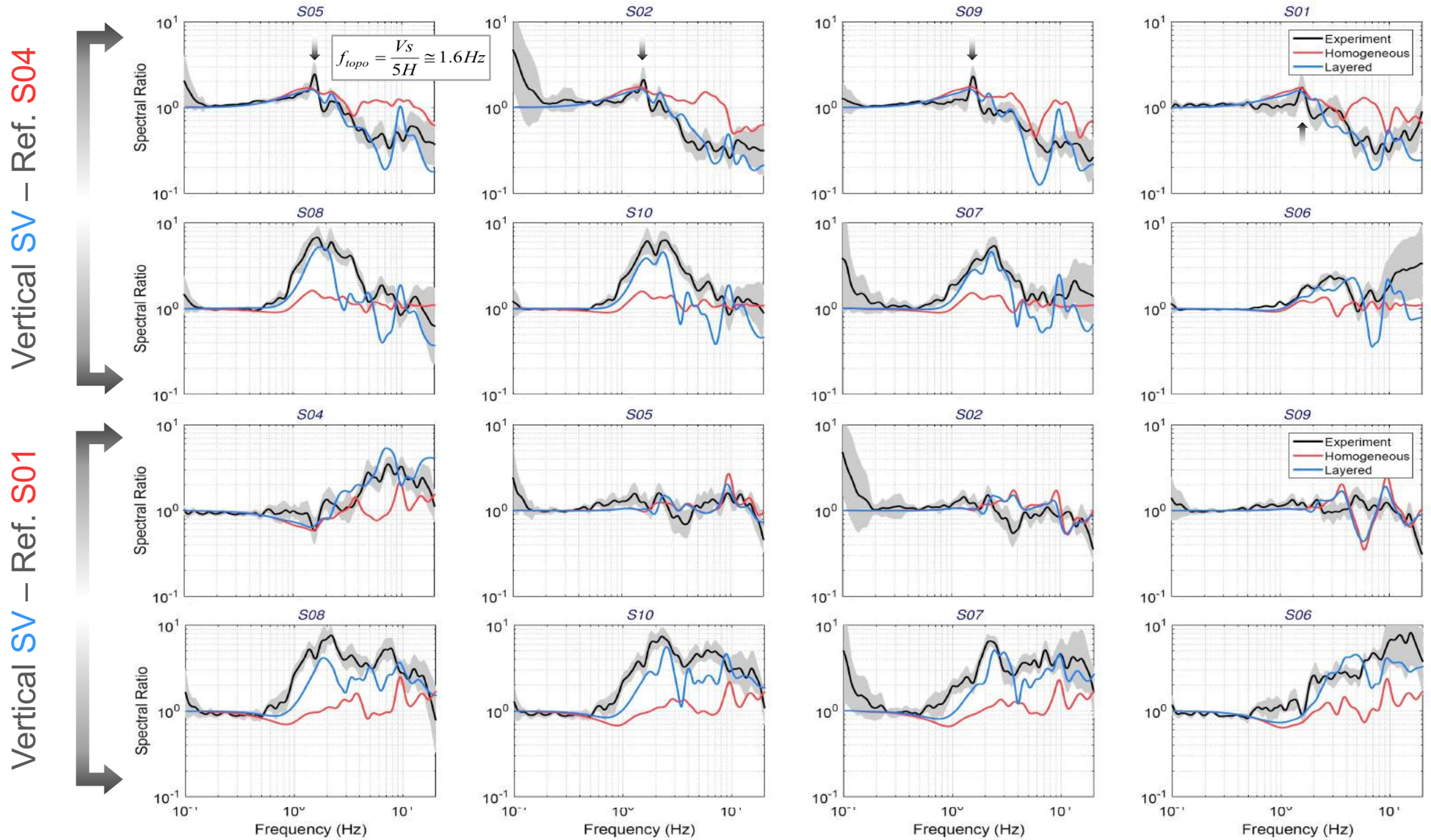




Results from 2D Simulations



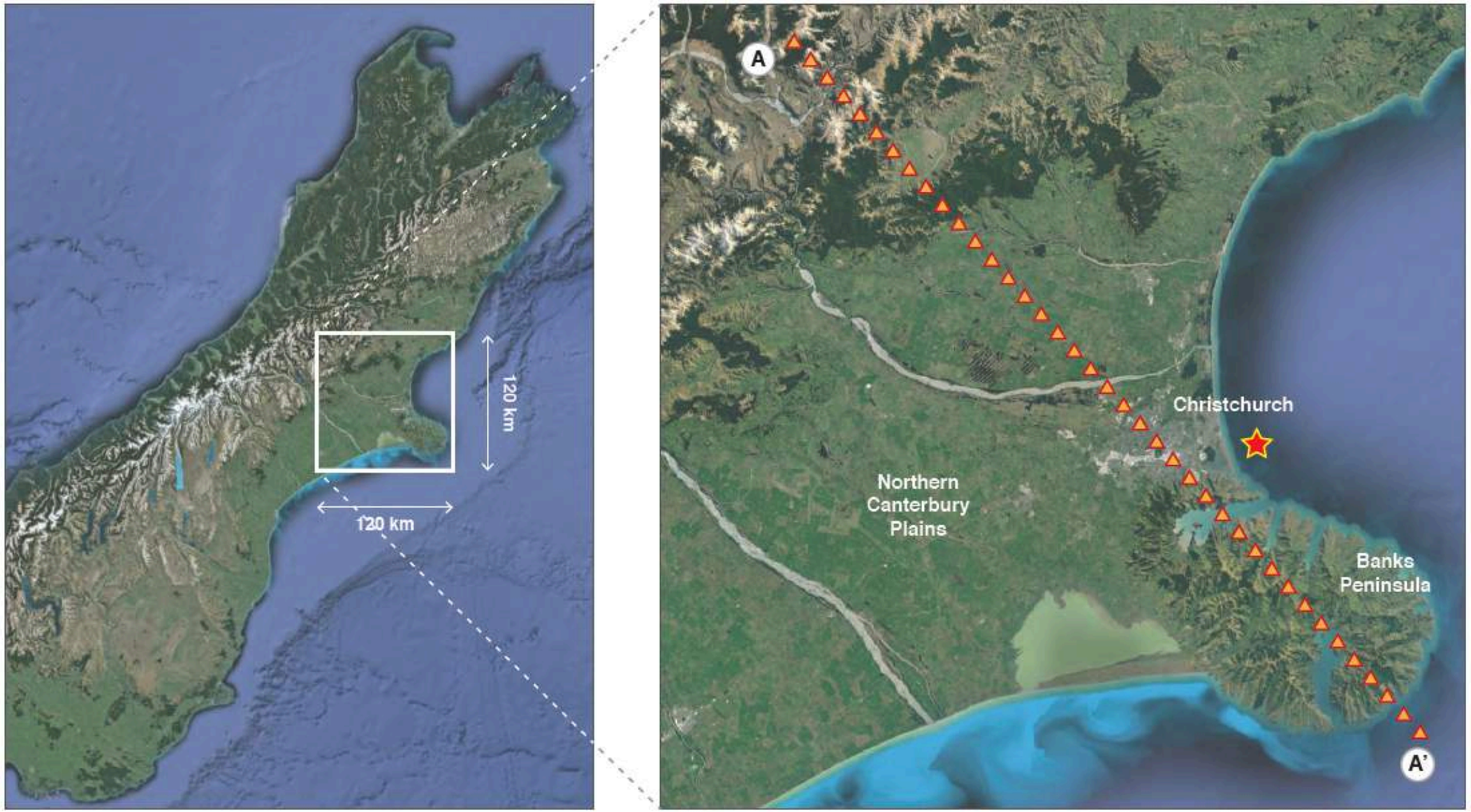
Results from Comparisons with Experiments Data



U. Memphis – Summary of Progress and Plans

- Done:
    - Modified ISVM to provide a library for iterative single-point queries
    - Coupled the modified ISVM library with Hercules
    - Carried out a suite of 3D simulations with and without topography for a point source using Vs_{min} = 500 and 100 m/s, and f_{max} = 1 and 2 Hz
- In progress:
    - New set of simulations for finite-fault models of 2 earthquakes from those recorded by the experimental instrument deployment (by S. Jeong)
- Plans for this year:
    - Complete a series of 4 Hz simulations with and without topography
    - Submit a manuscript with initial results for these simulations
    - Deploy Hercules in new Cray system at NeSI
    - Compare with other simulations (e.g., SPECFEM3D)

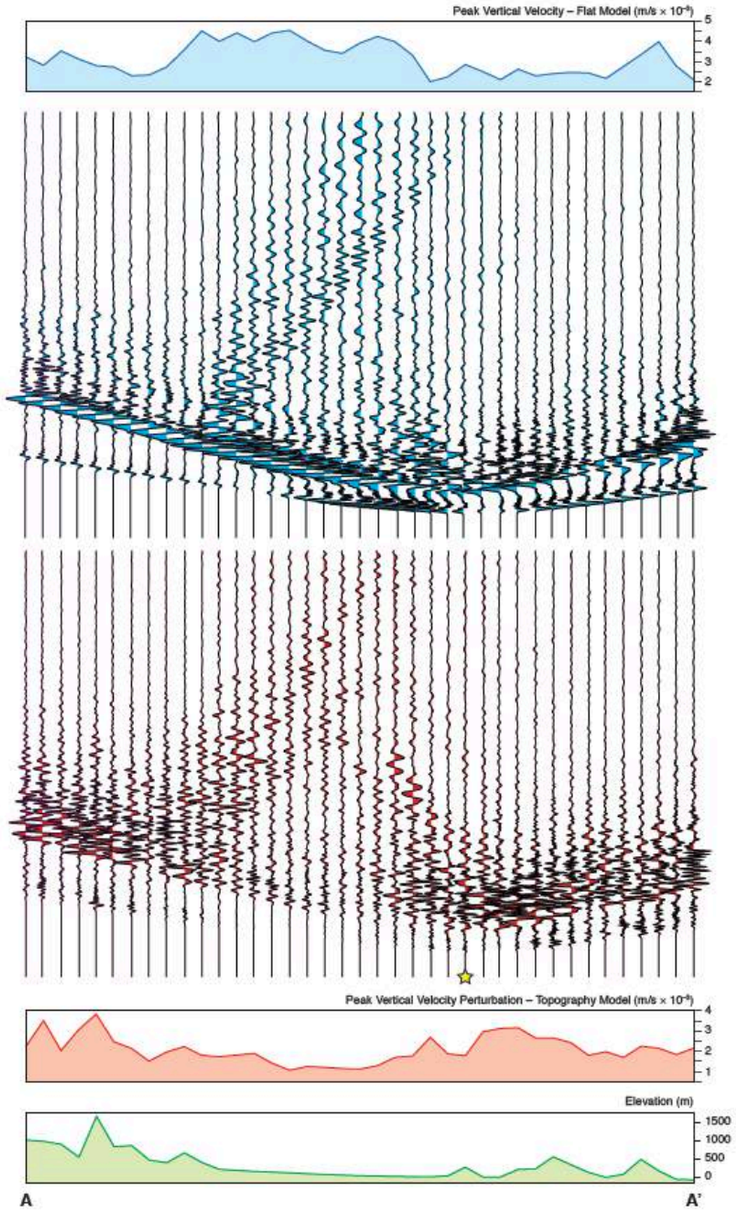
U. Memphis Simulations Region of Interest

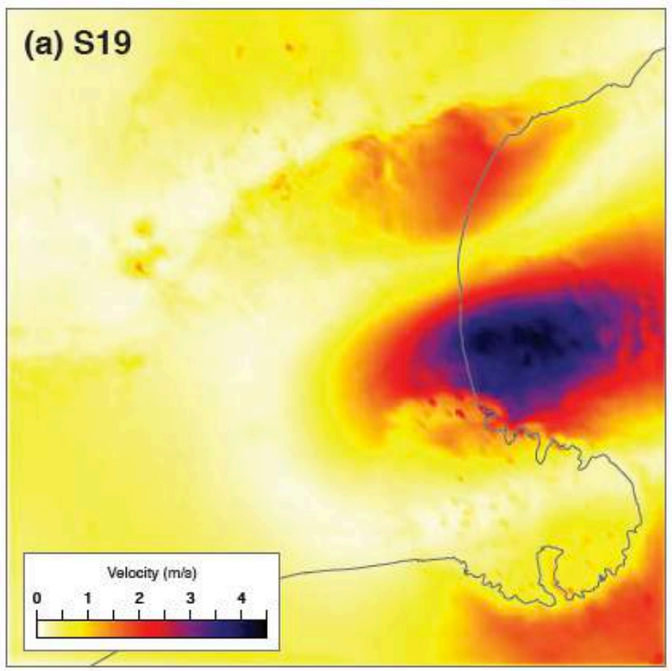


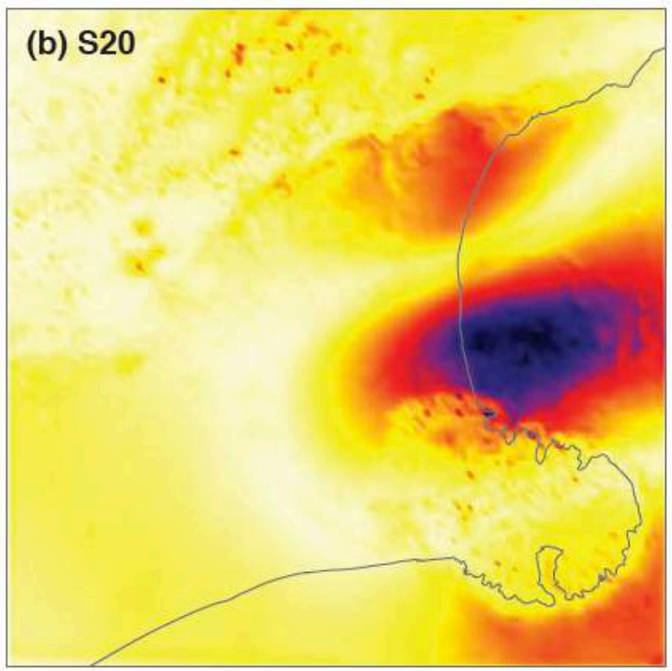
U. Memphis Simulations Log

	Maximum Frequency (Hz)						Minimum Vs (m/s)		Attenuation		Surface Geometry		Completed
	0.1	0.2	0.5	1	2	4	1000	500	With	Without	Flat	Topography	
S1	x						x			x	x		x
S2	x						x			x		x	x
S3	x						x		x		x		x
S4	x						x		x			x	x
S5		x					x			x	x		x
S6		x					x			x		x	x
S7		x					x		x		x		x
S8		x					x		x			x	x
S9			x				x			x	x		x
S10			x				x			x		x	x
S11			x				x		x		x		x
S12			x				x		x			x	x
S13				x			x			x	x		x
S14				x			x			x		x	x
S15				x			x		x		x		x
S16				x			x		x			x	x
S17					x			x		x	x		
S18					x			x		x		x	
S19					x			x	x		x		x
S20					x			x	x			x	x
S21						x		x		x	x		
S22						x		x		x		x	
S23						x		x	x		x		
S24						x		x	x			x	

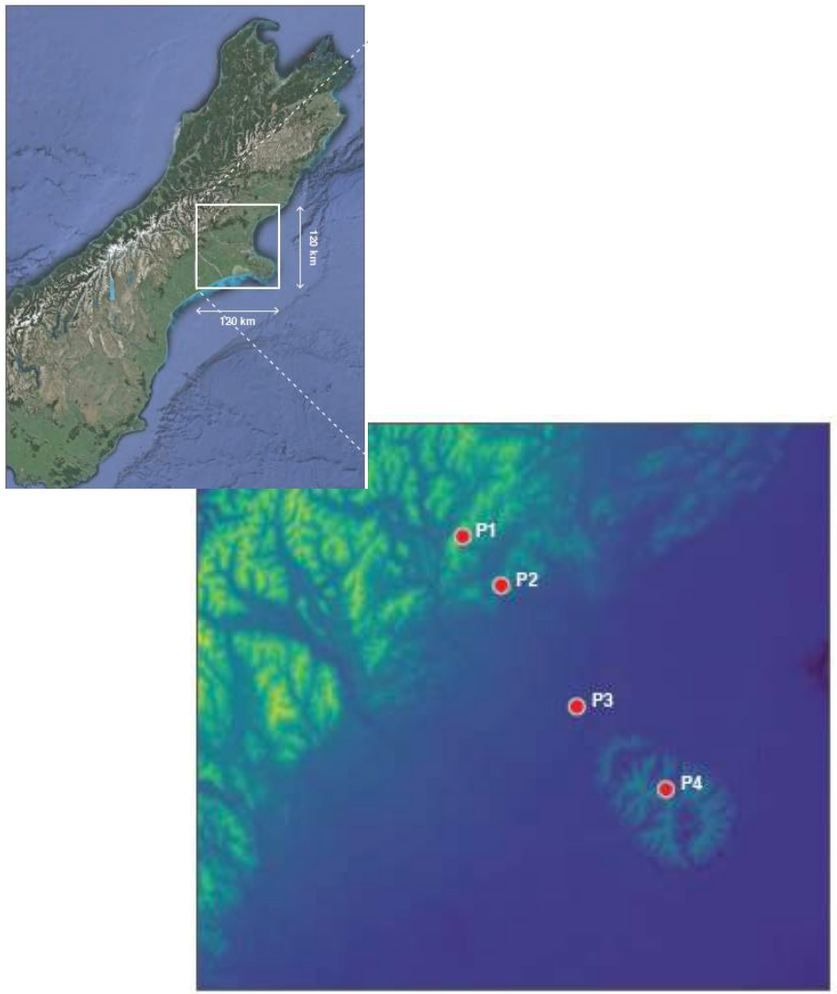
U. Memphis Simulations Results from 2017

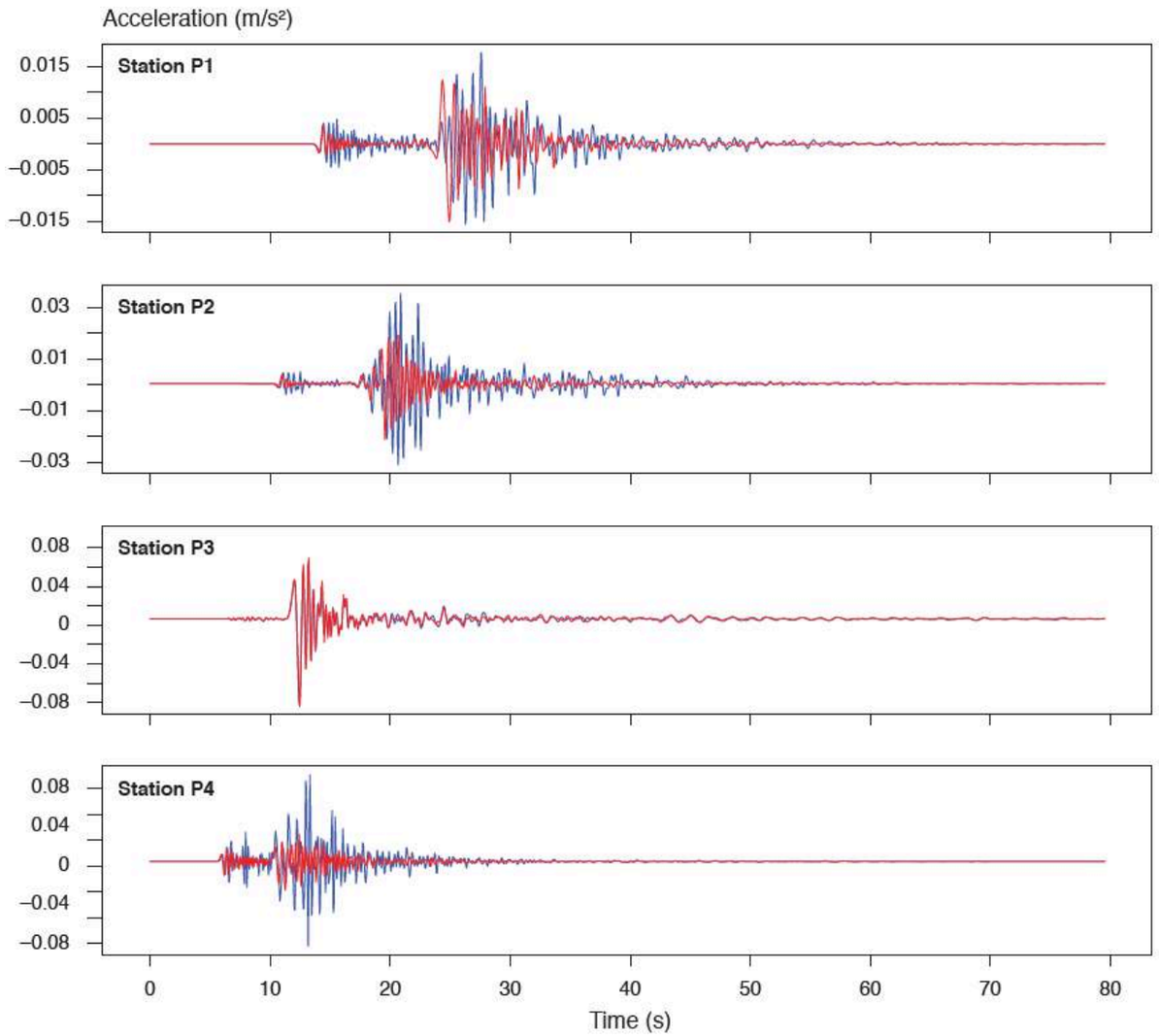




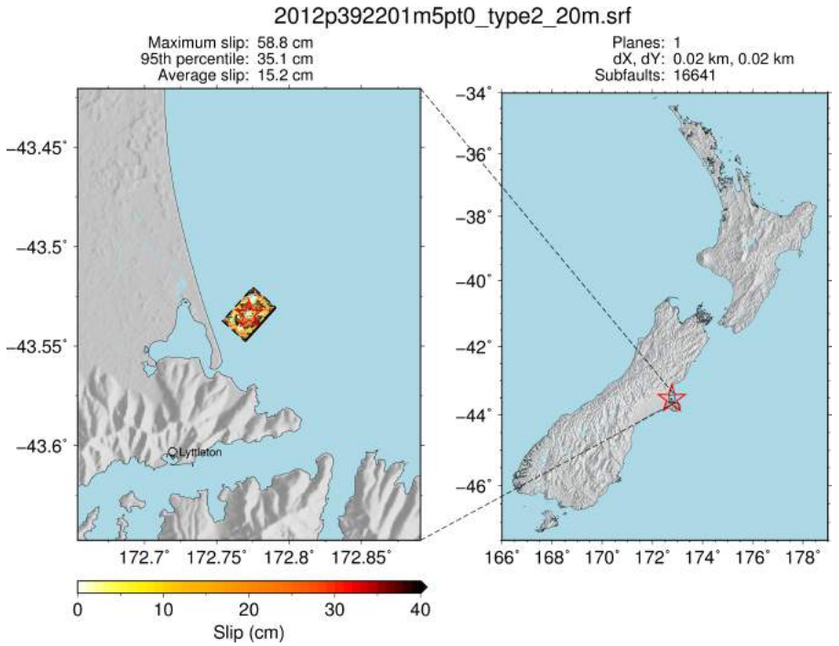
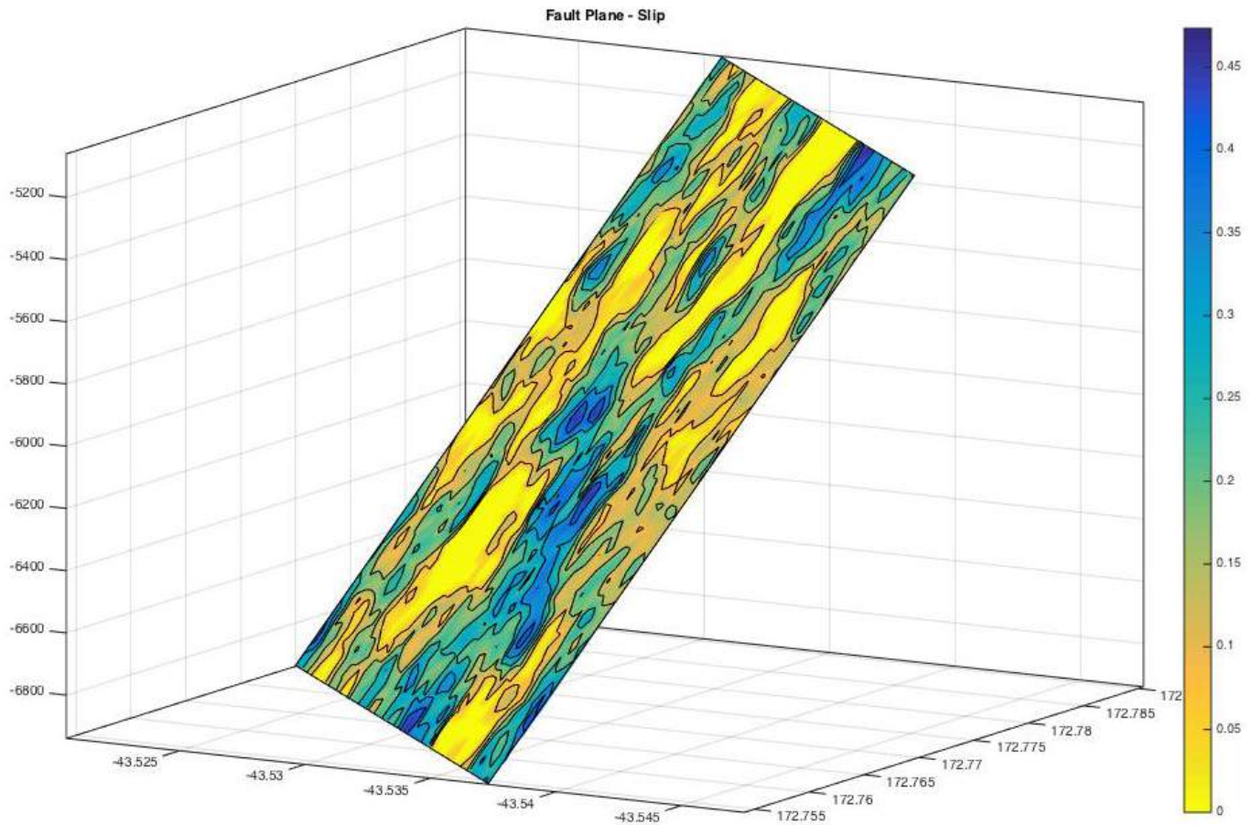


U. Memphis Simulations Results from 2017





U. Memphis Simulations Planned for 2018



- Two events selected from a list provided by S. Jeong
- Finite fault models generated using Graves and Pitarka source generator provided by R. Lee
- Models already converted for use in Hercules