The South Island Velocity Model (SIVM) - Version 1: Computational implementation and Integration within the Unified Community Velocity Model (UCVM) framework

Ethan M. Thomson[1], Brendon A. Bradley[1] & Robin L. Lee[1]

[1]Department of Civil and Natural Resources Engineering, University of Canterbury, New Zealand

ethan.thomson@pg.canterbury.ac.nz

UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

1. Background and Objective

This poster presents the computational implementation of the South Island Velocity Model (SIVM) Version 1, constructed for use in physics-based ground motion simulation.

A planned integration of the SIVM within the Unified Community Velocity Model (UCVM) framework is presented which will allow researchers to generate velocity models for use in ground motion simulations using standardized approaches. The SIVM allows any fault rupture located in the South Island to be simulated. Figure 4 illustrates the results of ground motion simulations for three rupture scenarios of the Alpine Fault.

Figure 1 illustrates the SIVM domain and regions which have been, or there are immediate plans to, characterise in high spatial resolution.

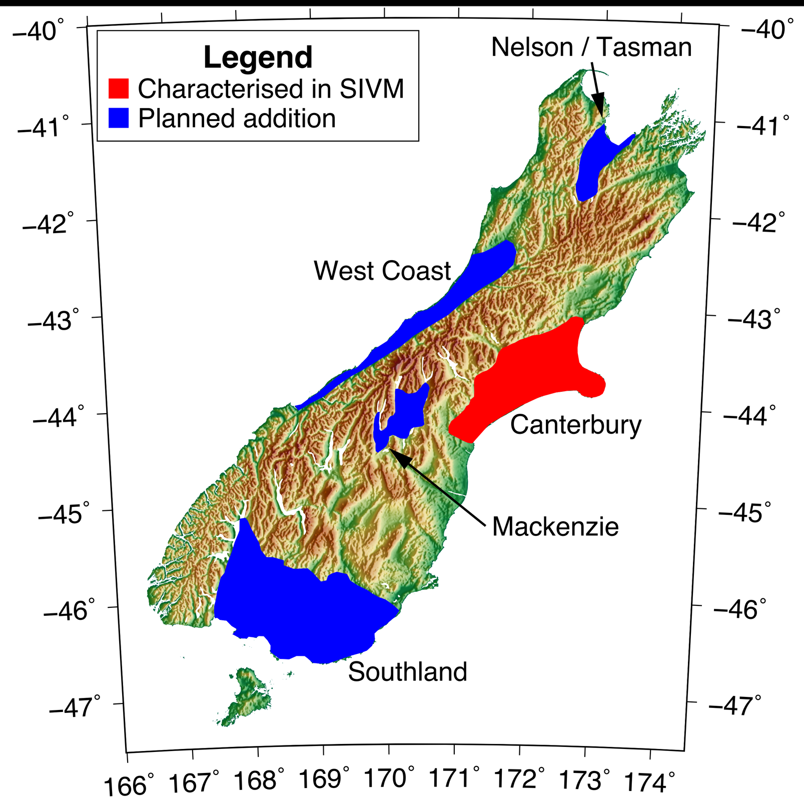

Figure 1: SIVM Domain showing locations of sedimentary basins

2. Prescription of velocities

The SIVM utilises a rule-based methodology to prescribe P- and S-wave velocities, and density values (V_p, V_s and ρ) to grid-points. This approach employs 3D surfaces to differentiate between geologic units of different geophysical properties depending on their depth, age and lithology.

The source code for the SIVM is written in the C programing language and its structure is illustrated in Figure 2.

The process for prescribing velocities at a grid point (defined by latitude, longitude and depth) is as follows:

- The geologic surface depths at the grid-point (Lat, Lon) location are determined from interpolation
- The geologic unit that the grid-point lies within is determined using the previously determined surface depths
- Rule-based sub-velocity models are used to prescribe V_p, V_s and ρ

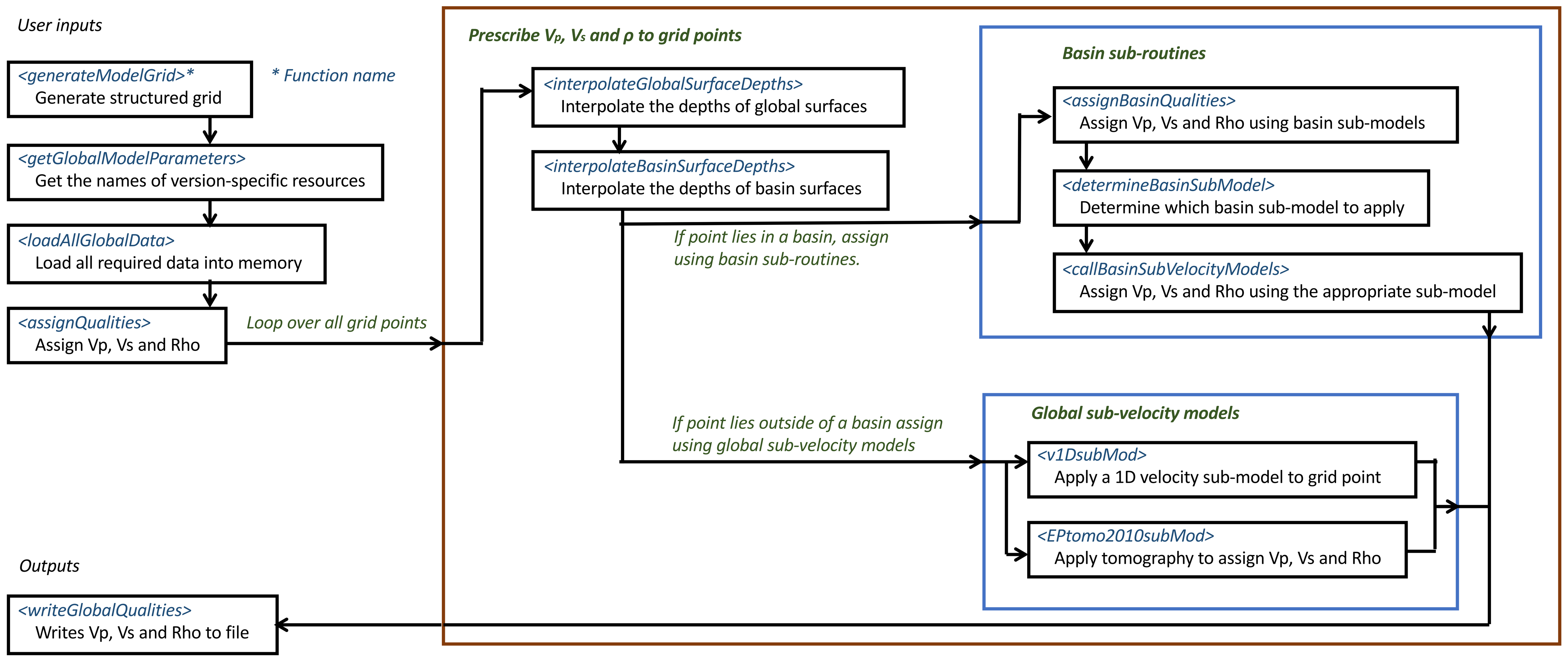

Figure 2: Source code implementation of SIVM showing functions and subroutines used to build SIVM

SIVM Version 1 uses the following data sources in its construction, in order of increasing depth:

- A 1D velocity model, constructed using bore logs, is applied in the near surface region (depth ~<500m)
- Four layers representing geologic units which are lithological distinct are modelled in the Canterbury Region, the Pliocene, Miocene, Paleogene and Banks Peninsula Volcanics (BPV). These layers are currently modelled using constant velocities while efforts to introduce depth- and age- dependencies are ongoing.
- All other regions are modelled using travel time tomography (Eberhart-Phillips et al. 2010).

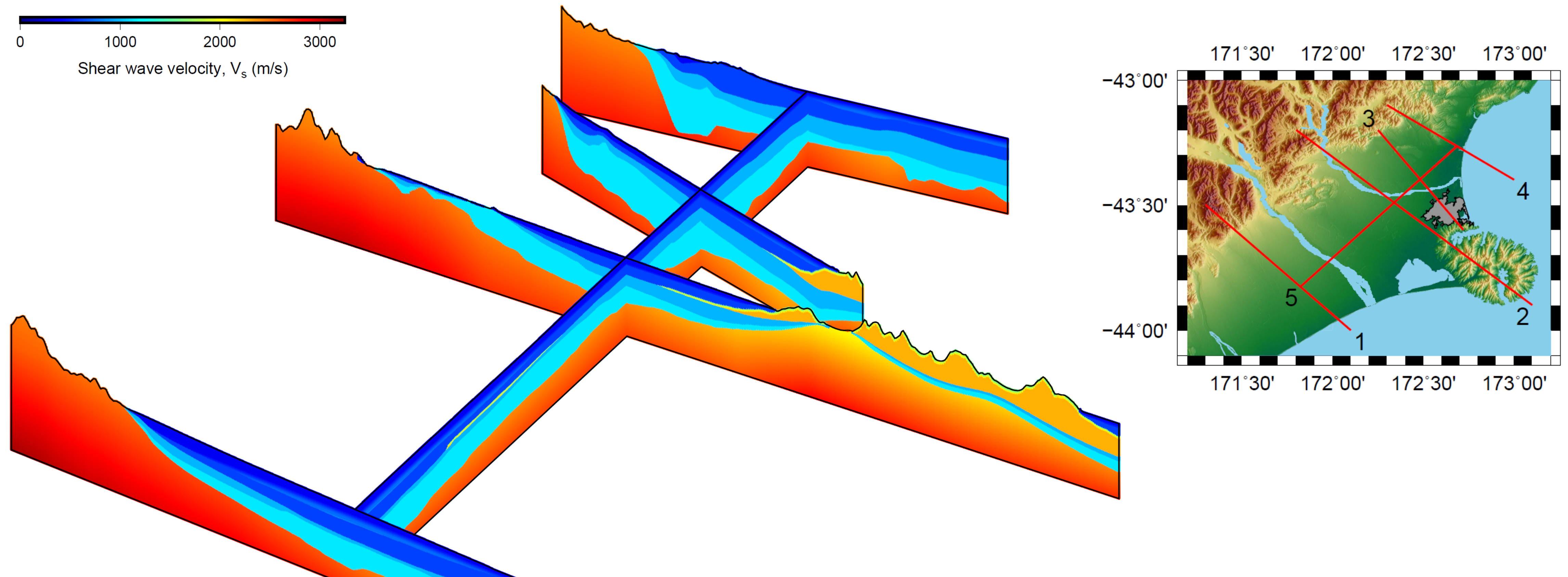

Figure 3: Fence diagram illustrating the shear wave velocity structure of the Canterbury basin within SIVM

3. Integration within the Unified Community Velocity Model framework

The Unified Community Velocity Model (UCVM) framework is an open source software package that enables researchers to query 3D velocity models through a standardised software interface:

- Originally developed for Californian velocity models (by the Southern California Earthquake Centre) but allows non-Californian models to be registered and generated
- Allows researchers to generate the SIVM on structured and unstructured meshes for finite difference, finite element and spectral element simulation methods
- UCVM contains a collection of software tools for visualization and interrogation of velocity models
- Interfacing with UCVM allows external researchers to utilise the SIVM in various physics-based ground motion simulation codes

The computational implementation of SIVM is illustrated in Figure 2 which outlines the functions and workflow involved in constructing the SIVM. Integrating the SIVM source code within the UCVM framework allows researchers to construct the SIVM for use in ground motion simulations using standardised approaches. Figure 4 illustrates a ground motion simulation of three Alpine Fault scenarios conducted using the SIVM.

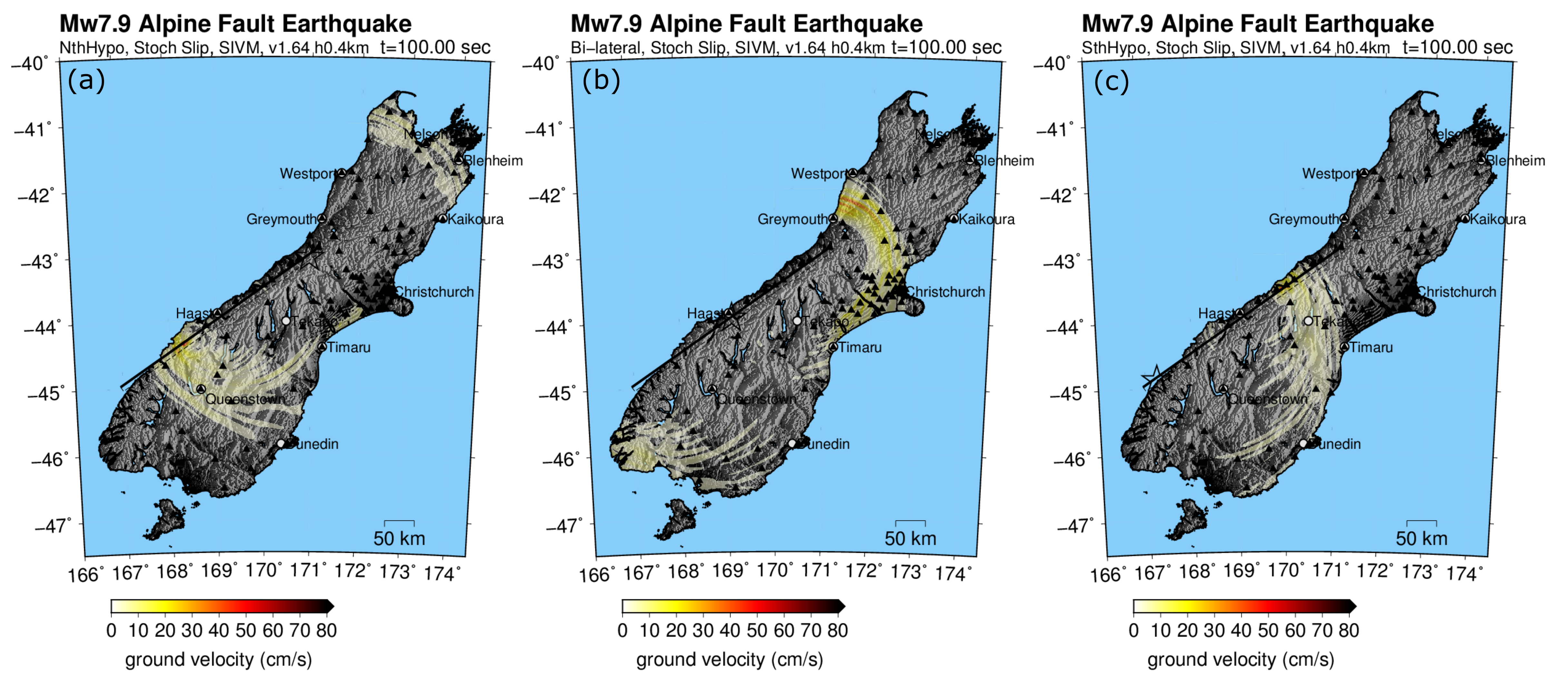

Figure 4: Ground motion simulation conducted utilising the SIVM. Three Alpine Fault rupture scenarios with different hypocentre locations are shown (a) Northern; (b) central; and (c) Southern hypocentres