QuakeCoRE and NeSI's strategic partnership towards earthquake resilience via High Performance Computing

Richard M. Clare[1], Brendon A. Bradley[1,2], Dan Sun[3], Sung Bae[3], Chris McGann[4]

[1]QuakeCoRE, [2]Department of Civil Engineering, University of Canterbury, [3]HPC University of Canterbury, [4]Washington State University

richard.clare@canterbury.ac.nz

UC UNIVERSITY OF CANTERBURY Te Whare Wānanga o Waitaha CHRISTCHURCH NEW ZEALAND

NeSI New Zealand eScience Infrastructure

1. Overview

QuakeCoRE is a Centre of Research Excellence fostering innovative research in earthquake resilience for New Zealand. Significant portions of this research require large-scale computationally-intensive numerical simulations of the following three modules:

1) Earthquake-induced ground motion shaking over a region,

2) Deformations and damage to the built environment from this shaking,

3) Environmental, economic, and social impacts as a result of built environment damage.

A desired paradigm shift in these simulation modules is being undertaken via collaboration between QuakeCoRE and NeSI, using parallelised computing on NeSI HPC resources and inter-disciplinary scientific workflows. This poster provides an overview of the numerical computations both currently undertaken, and envisaged in the future, for these three major numerical simulation modules and how they are intended to both grow the capability of leading researchers, as well as increase the utilization of scientific tools by the wider QuakeCoRE researcher community.

2. Current simulation space

For each of the three modules listed in the overview, there are a number of existing simulation codes that we will make use of within QuakeCoRE. These software codes lie on a spectrum between open source (in languages such as C, C++, Python and Fortran) and commercial software packages as shown in Figure 1. The input and output data requirements for each of the three modules are listed in the rightmost column of Figure 1. The outputs from 1) ground motion simulation are inputs for 2) infrastructure component modelling, whose outputs are inputs for 3) loss estimation.

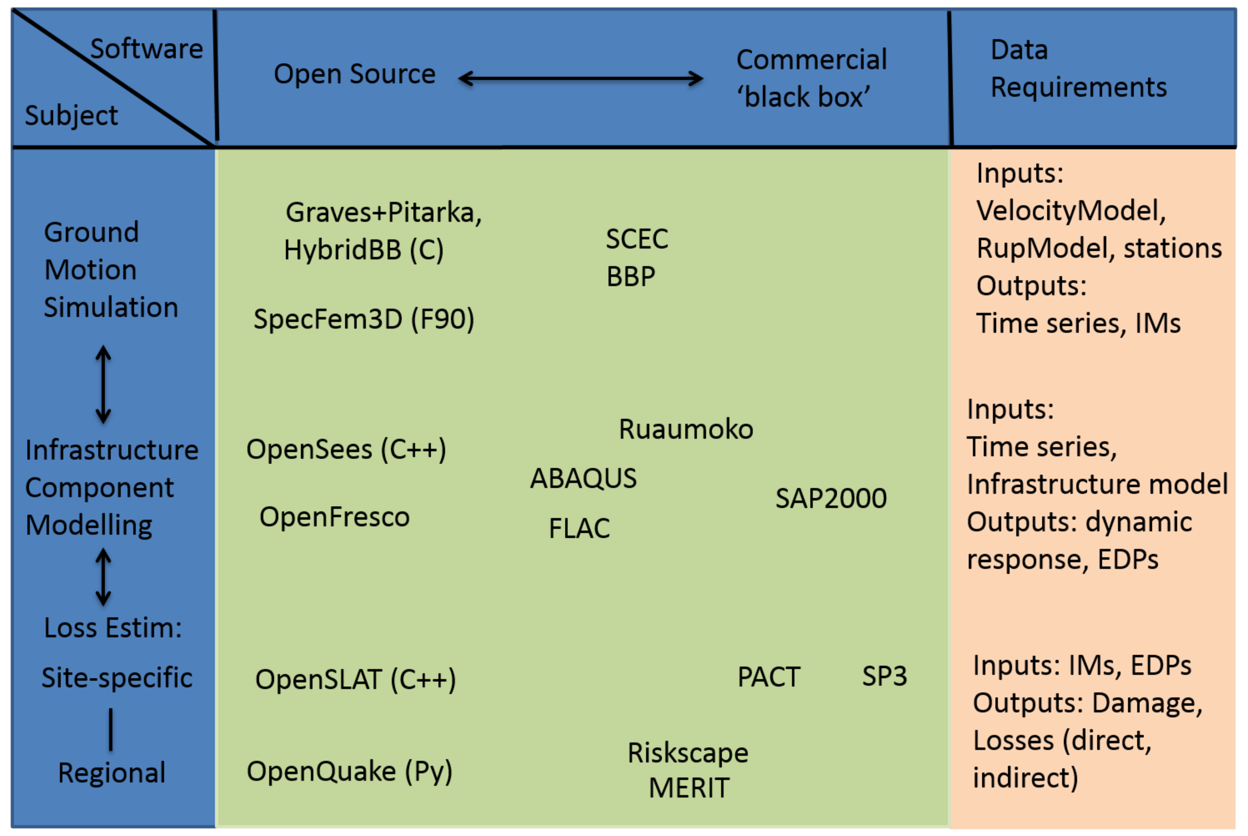

Figure 1: Overview of QuakeCoRE heterogeneous software ecosystem.

3. Broadband ground motion simulation module

We will focus on the Broadband ground motion simulation module, which computes the velocity time series at specified regions of interest and is currently computed on the NeSI Blue Gene machine at the University of Canterbury. Figure 2 compares the simulated velocity time series with those observed in the 4th September 2010 Darfield earthquake.

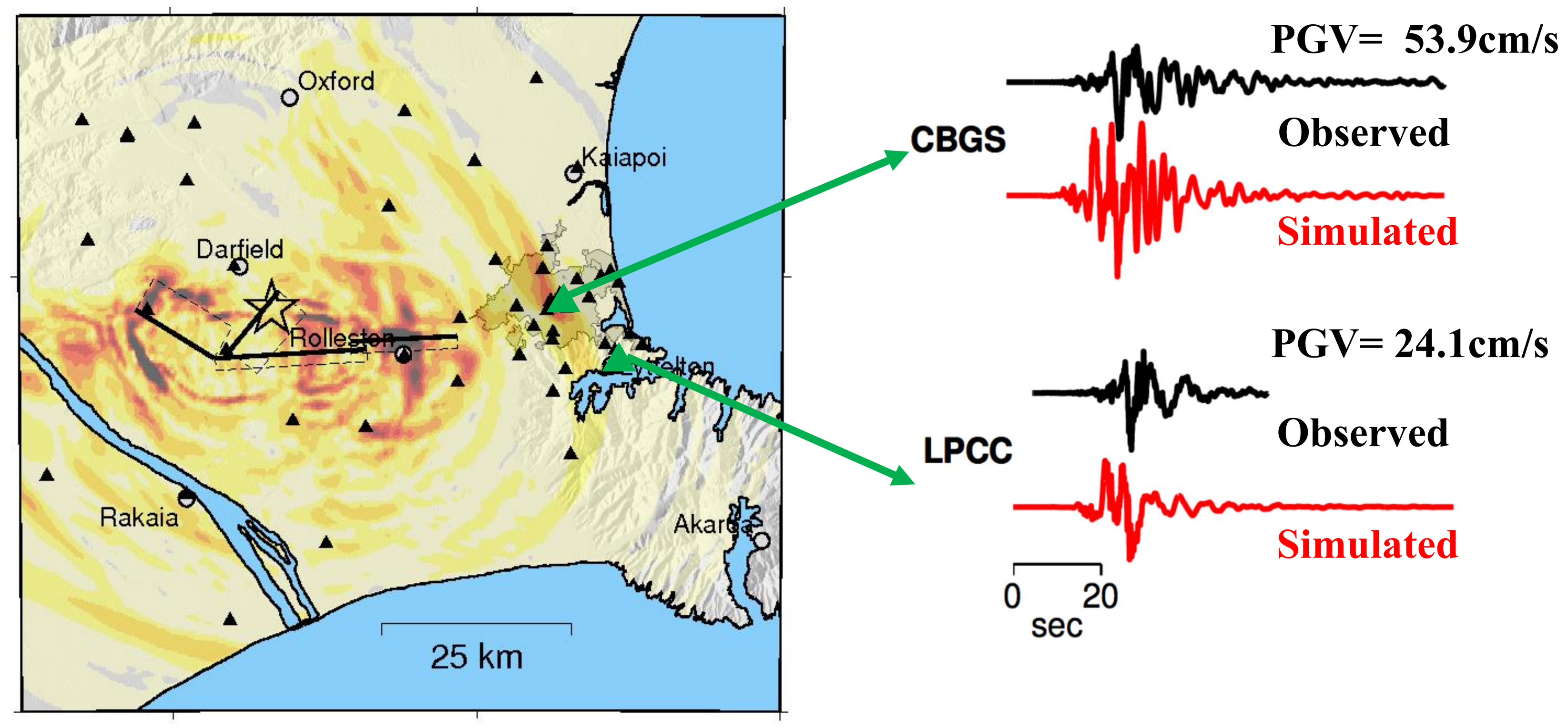

Figure 2: Numerical simulation of the 4 September 2010 Darfield earthquake (left), and comparison of the observed (black) and simulated (red) velocity time series in the North-South orientation for the CBGS and LPCC strong motion stations.

4. Current workflow for broadband ground motion simulation

We now investigate in detail the workflow for the ground motion simulation module, specifically with the Graves and Pitarka Hybrid Broadband code, which was used to generate Figure 2. As shown in Figure 3, while the main computation is performed on NeSI HPC, facilities the input parameters are computed on local machines.

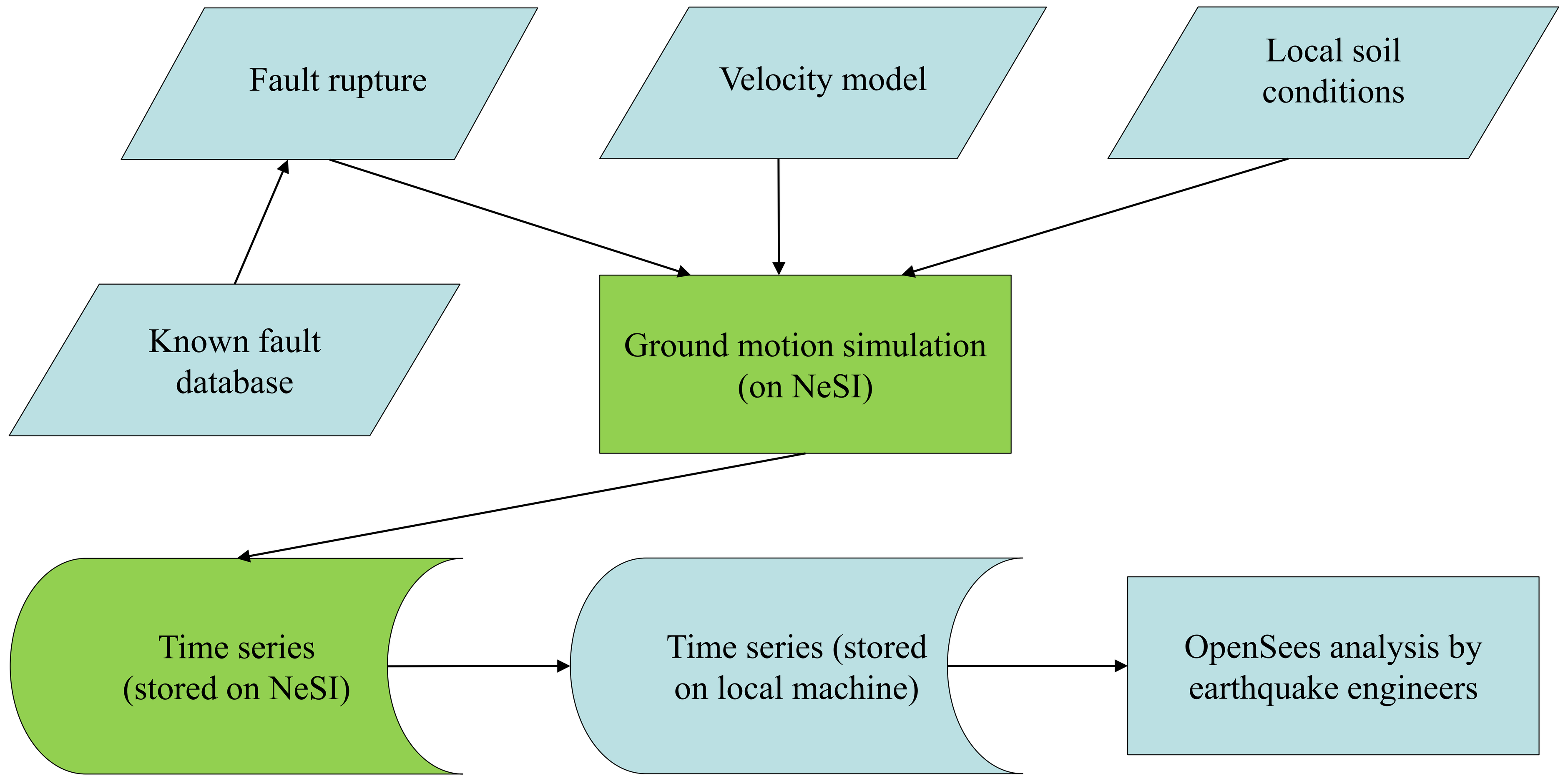

Figure 3: Current workflow of the ground motion simulation module (Key: parallelogram = input, arrow = dataflow, rectangle = process, semi-circular ended = stored data; blue = local machine, green = HPC).

5. Future workflow for broadband ground motion simulation

The workflow for the ground motion simulation module is being upgraded to remove any dependence on local machines, to use NeSI and DesignSafe-CI (a US-based research network) sources for all computations, to employ an output database and to have all inputs in a domain-specific portal.

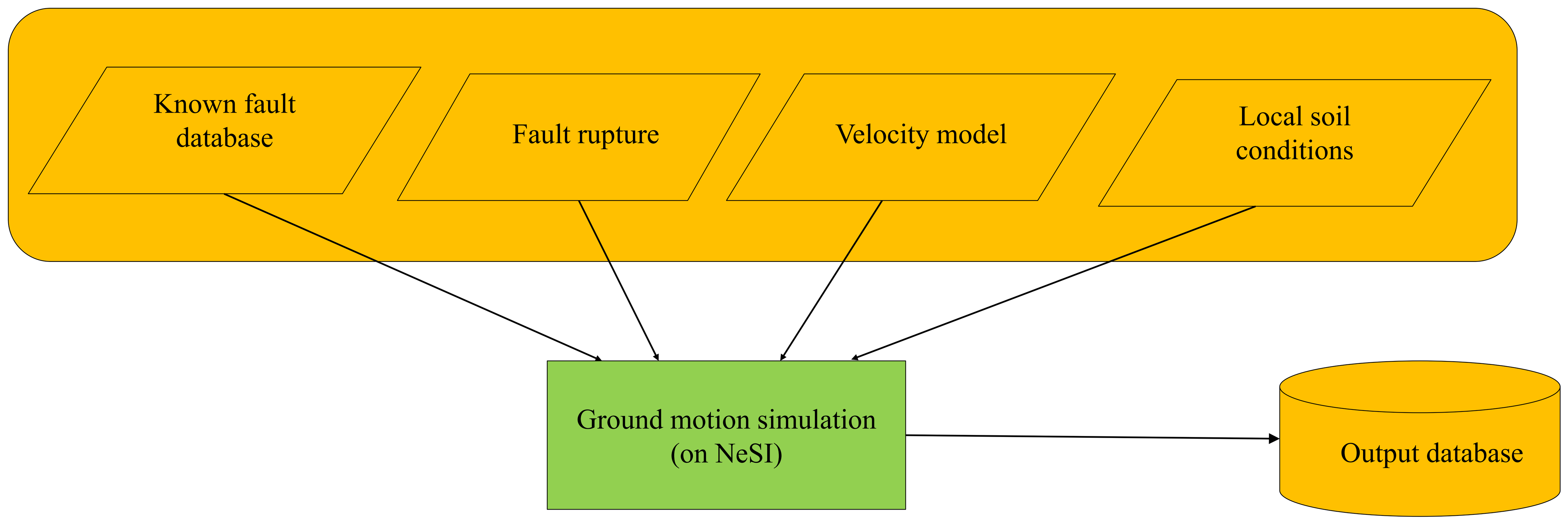

Figure 4: Future workflow of the ground motion simulation module (Key: parallelogram = input, arrow = dataflow, rectangle = process; yellow = domain-specific portal, green = HPC).