Validation of Strong Ground Motion Simulations of two Historical New Zealand Subduction Zone Earthquakes on the SCEC Broadband Strong Ground Motion Simulation Platform

Paul Somerville, Mehrdad Hosseini, Jeff Bayless and Andreas Skarlatoudis*

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ACKNOWLEDGMENTS

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Key Objectives

1. Use SCEC BBP to perform validations of two historical New Zealand subduction zone earthquakes:

    - 15 July 2009 Mw 7.57 Fiordland
    - 2 Feb 1931 Mw 7.4 Hawke's Bay

1. Develop the capability for other users to perform broadband strong motion simulations of New Zealand subduction earthquakes and to validate these simulations against recorded ground motions (where available)

Validation Study

- *Tohoku, Japan, 2011*

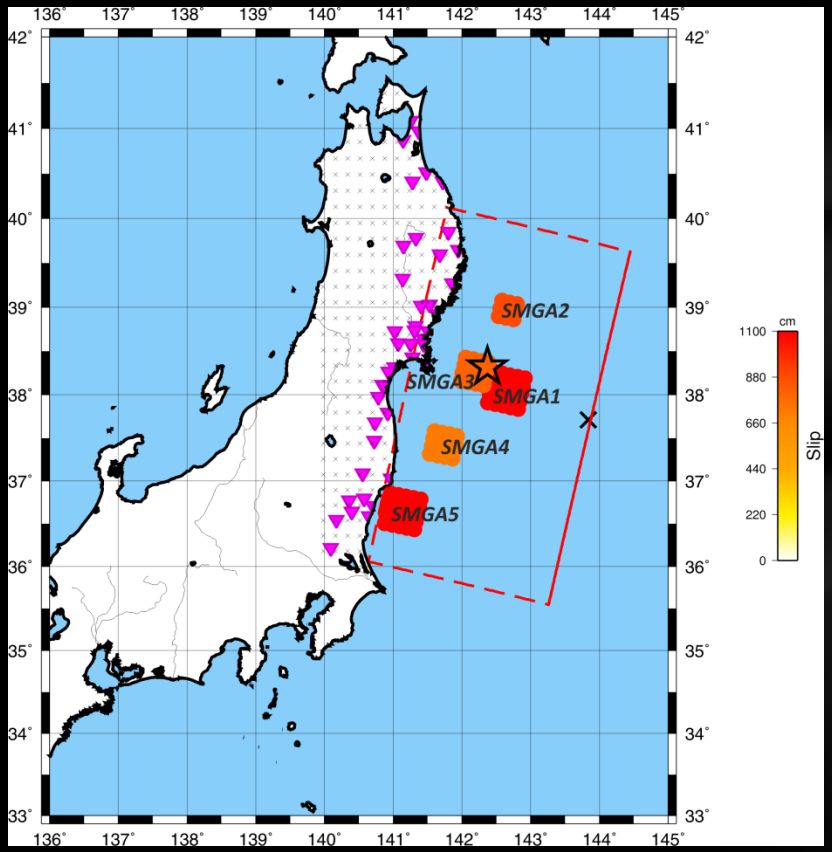
Somerville et al. (2013b); (Research supported by USGS)

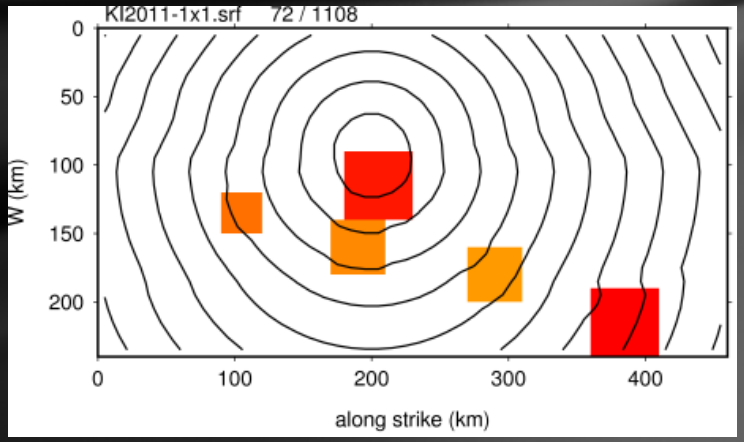
Implementation on the SCEC Broadband Platform supported by SCEC

Rupture model (Kurahashi and Irikura, 2013)

	L (km)	W (km)	M_0 (Nm)	Stress Drop (MPa)	Delay from origin time (s)
SMGA 1	*62.40*	*41.60*	*2.31E+21*	*41.3*	*15.64*
SMGA 2	*41.60*	*41.60*	*7.05E+20*	*23.6*	*66.42*
SMGA 3	*93.60*	*52.00*	*4.34E+21*	*29.5*	*68.41*
SMGA 4	*38.50*	*38.50*	*3.83E+20*	*16.4*	*109.71*
SMGA 5	*33.60*	*33.60*	*3.99E+20*	*26.0*	*118.17*

Rupture model of the **M** 9.1 Tohoku, Japan earthquake 2011



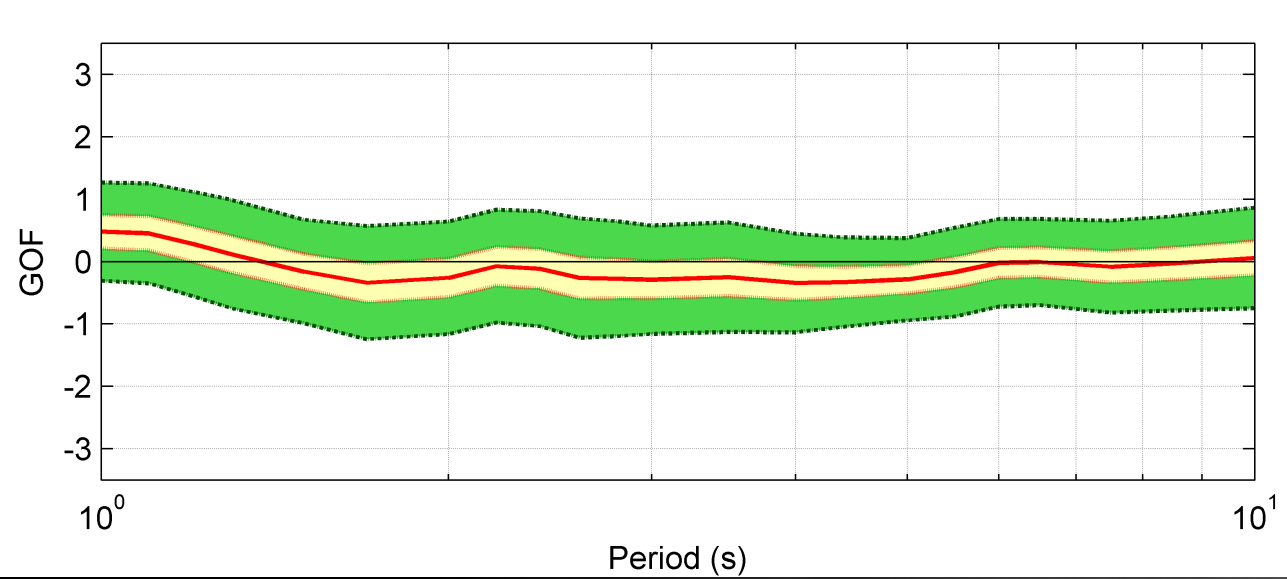


Velocity model – modified from Koketsu et al. (2008)

- *Used the Japan Integrated Velocity Structure 3D Model*
- *Average 1D model for the study area*

Thickness (km)	V_p (m/s)	V_s (m/s)	Density (Kgr/m^3)	Q_p	Q_s
0.002	1700	450	2.00	45.0	22.5
0.004	1800	650	2.10	65.0	32.5
0.006	1800	850	2.10	85.0	42.5
0.008	1900	950	2.10	95.0	47.5
0.01	2000	1150	2.20	115.0	57.5
0.07	2400	1200	2.20	120.0	60.0
0.10	2600	1300	2.40	130.0	65.0
0.16	3000	1400	2.45	140.0	70.0
0.10	3600	2000	2.55	200.0	100.0
0.44	4200	2400	2.60	240.0	120.0
5.90	5500	3200	2.65	320.0	160.0
10.20	6100	3400	2.75	340.0	170.0
14.63	6500	3800	3.00	380.0	190.0
16.00	7800	4500	3.30	450.0	225.0

Goodness-Of-Fit: No significant bias, 1-10 sec



The red line shows the bias, the light green zone shows the standard deviation, and the dark grey zone shows the 90% confidence interval of the mean.

CASE STUDY

The 1931 Mw 7.4 Hawke's Bay Earthquake

Modeling the 1931 Hawke's Bay Earthquake

- Imbricate reverse faulting in the accretionary prism of the Hikurangi subduction zone; use crustal earthquake source parameters

- Fault trace length (80km), location, and orientation from GNS (Litchfield et al., 2014); fault width 20 km.
- Hypocenter location from GeoNet; Mw 7.4.
- Velocity model: generic 1D model for the north island, developed from Eberhart-Phillips et al. (2010)

  modified in the upper 1.5 km to have a smooth transition to Vs30=863 m/s.

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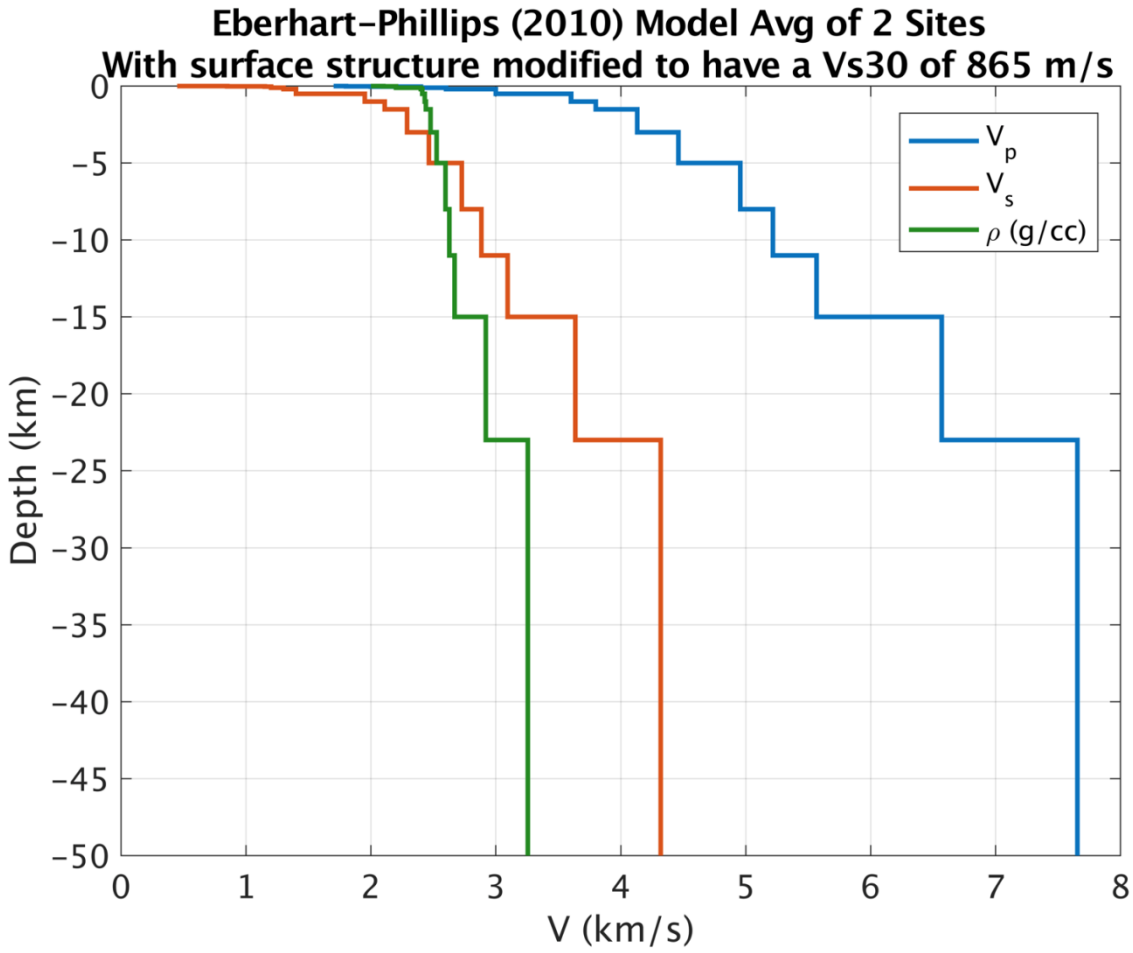
Velocity Model modified from Eberhart-Phillips et al. (2010)



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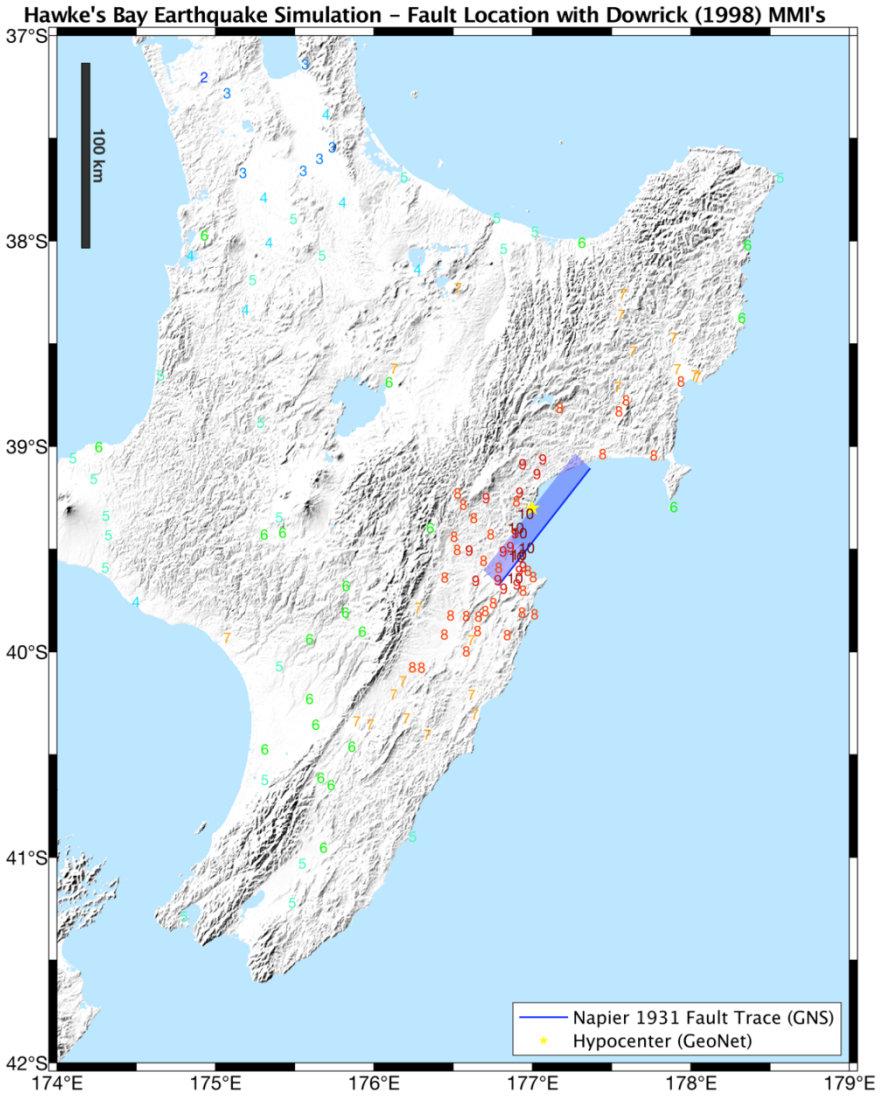
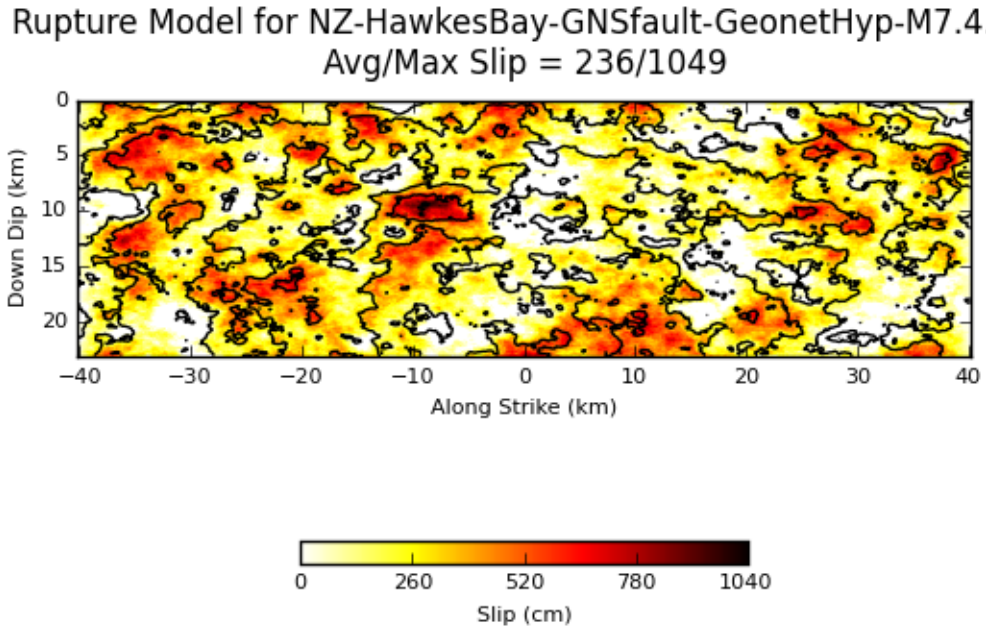
Modeling the 1931 Hawke's Bay Earthquake cont.

- Dowrick (1998) compiled MMI values
- Simulations are converted to intensity using the ground motion intensity conversion equation (GMICE) Caprio et al. (2015), which utilizes PGA, PGV and geographic region.
- Simulations are adjusted for site effects using Vs30-based model applied to the Fourier amplitude spectra.
- Approximations for Vs30 are obtained at the MMI locations from topographic slope (USGS).

Hawkes Bay Earthquake: Fault Model and Observed Intensities



Rupture model of the 1931 Hawke's Bay Earthquake



Rupture model computed using the Graves & Pitarka (2015) rupture generator v16.5 in BBP.

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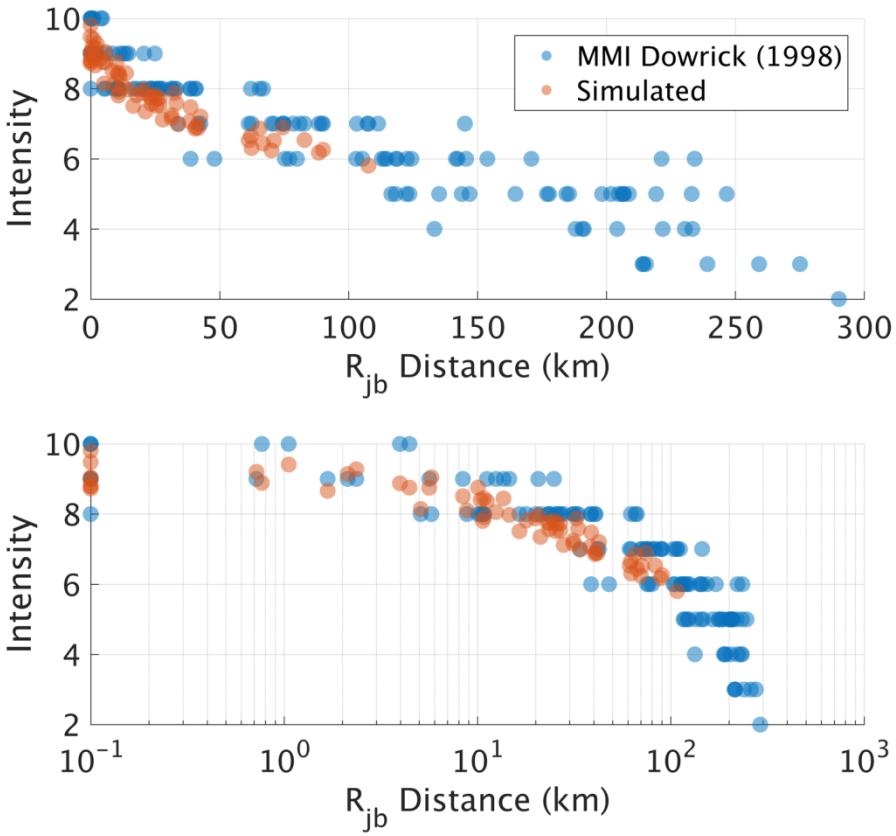
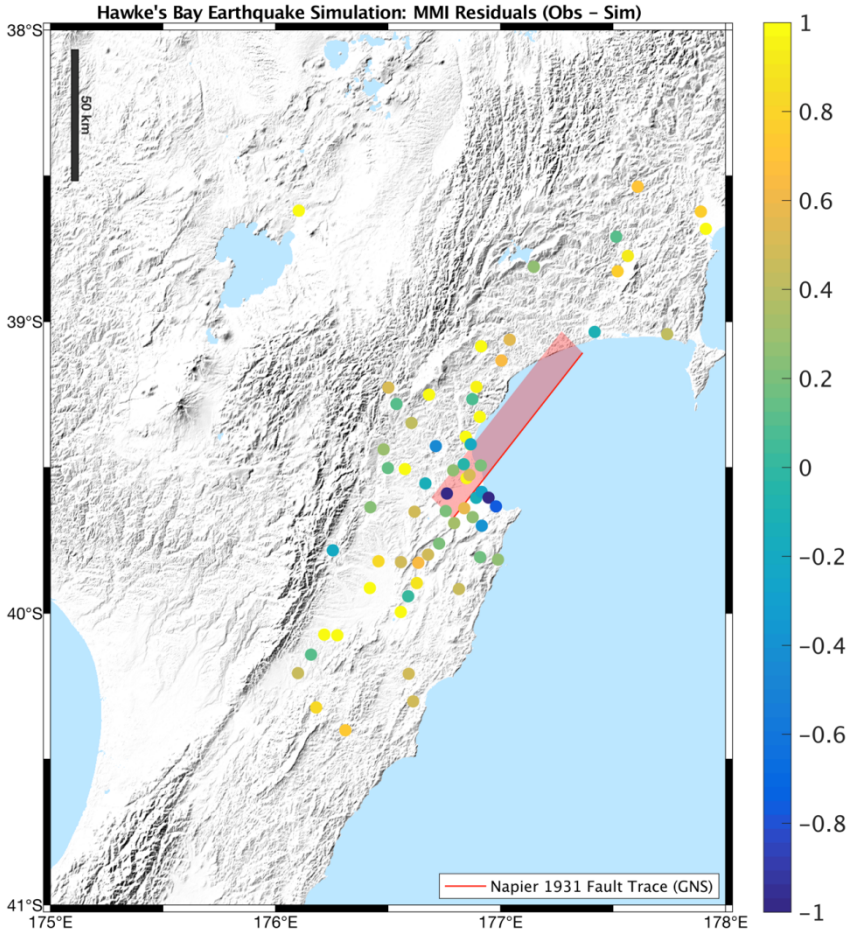
Results

MMI vs Rjb



Spatial distribution of residuals



Conclusions

We have modified the G&P15 simulation procedure to adapt it to simulate subduction earthquakes on the SCEC BBP.

Using the SCEC BBP, we reproduced our previous validation of the procedure for the 2011 Tohoku earthquake. The validation shows little systematic bias in the prediction of the ground motions in the period range of 1 to 10 seconds We are currently working on reducing the bias observed in the high frequency part (0.01 to 1s).

We have tested the performance of the simulation method against the observed intensities of the Mw 7.4 1931 Hawkes Bay earthquake.

We are now testing the performance of the simulation method against the recorded ground motions of the Mw 7.57 Fiordland earthquake.

Thank You

paul.somerville@aecom.com

mehrdad.hosseini@aecom.com

jeff.bayless@aecom.com

andreas.skarlatoudis@aecom.com