

The Canterbury Earthquake Sequence

Presentation to the Canterbury Earthquakes Royal Commission

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Photo: P Stalder

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Introduction

1. The Canterbury earthquake sequence
 2. Active faults and historical earthquakes in the Canterbury region
 3. Likely future rates of seismicity in Christchurch
 4. Implications for building design motions
 5. National implications and conclusions
 6. Questions and panel discussion
- The focus is on the earthquakes and the shaking they produced – not the impacts
 - This is ‘work in progress’, so results will change
 - Many of the initial scientific results are already published or ‘in press’ in international scientific journals
 - Our report to the Commission has been peer reviewed

Earthquake Magnitude

Magnitude measures the size of an earthquake. For each unit increase in magnitude there is a 30-fold increase in energy. Largest earthquake $M_w 9.5$.

Local (or 'Richter') magnitude, M_L :

- Uses local seismograph data
- Quick and easy to calculate, used by GeoNet
- Not so accurate (over-estimates), saturates around $M_L 7+$

Moment magnitude M_w :

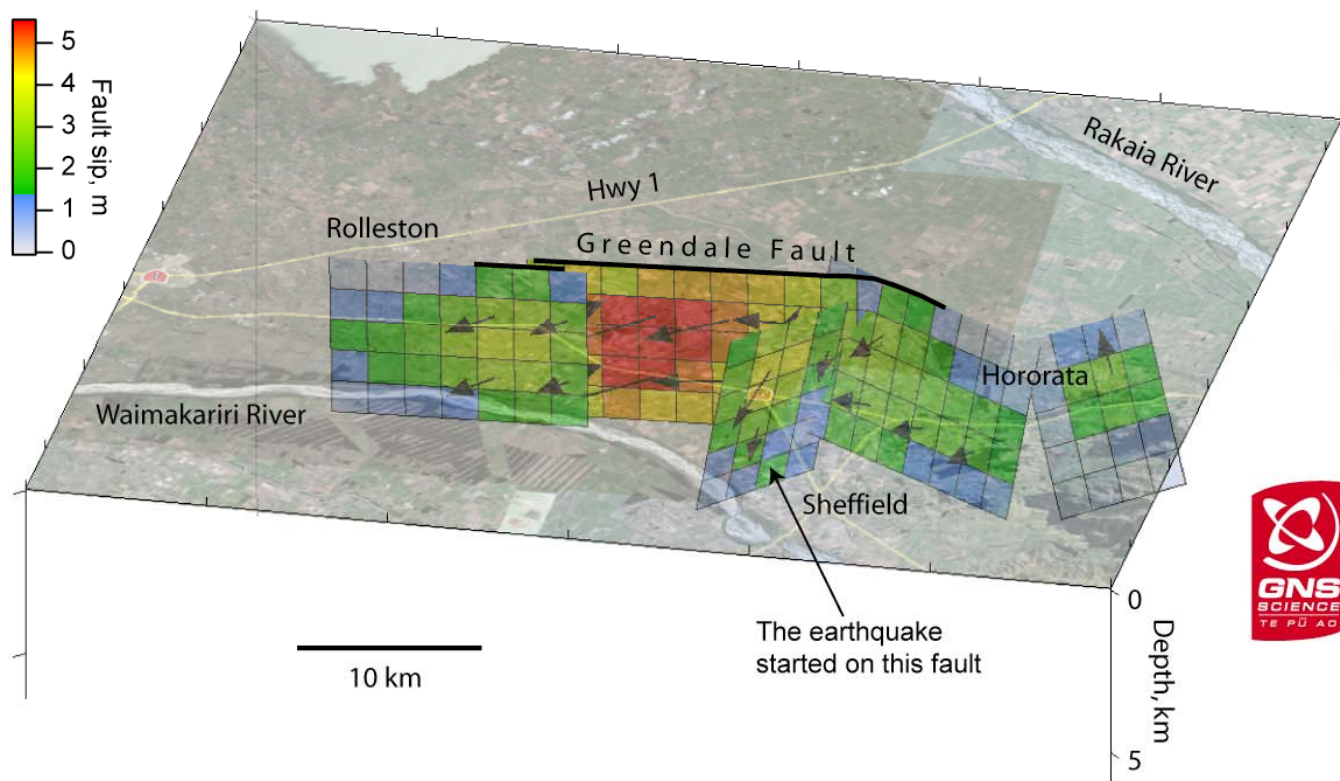
- Requires sophisticated computer processing using local or global data
- Slow to calculate, but more accurate, especially for large earthquakes
- GeoNet is implementing M_w in faster and more automated ways

Modified Mercalli Intensity, MM

- A measure of the shaking felt by people or impacting buildings.
- Scale 1 to 12, onset of building damage MM8.

The September 4th Mw 7.1 Darfield Earthquake

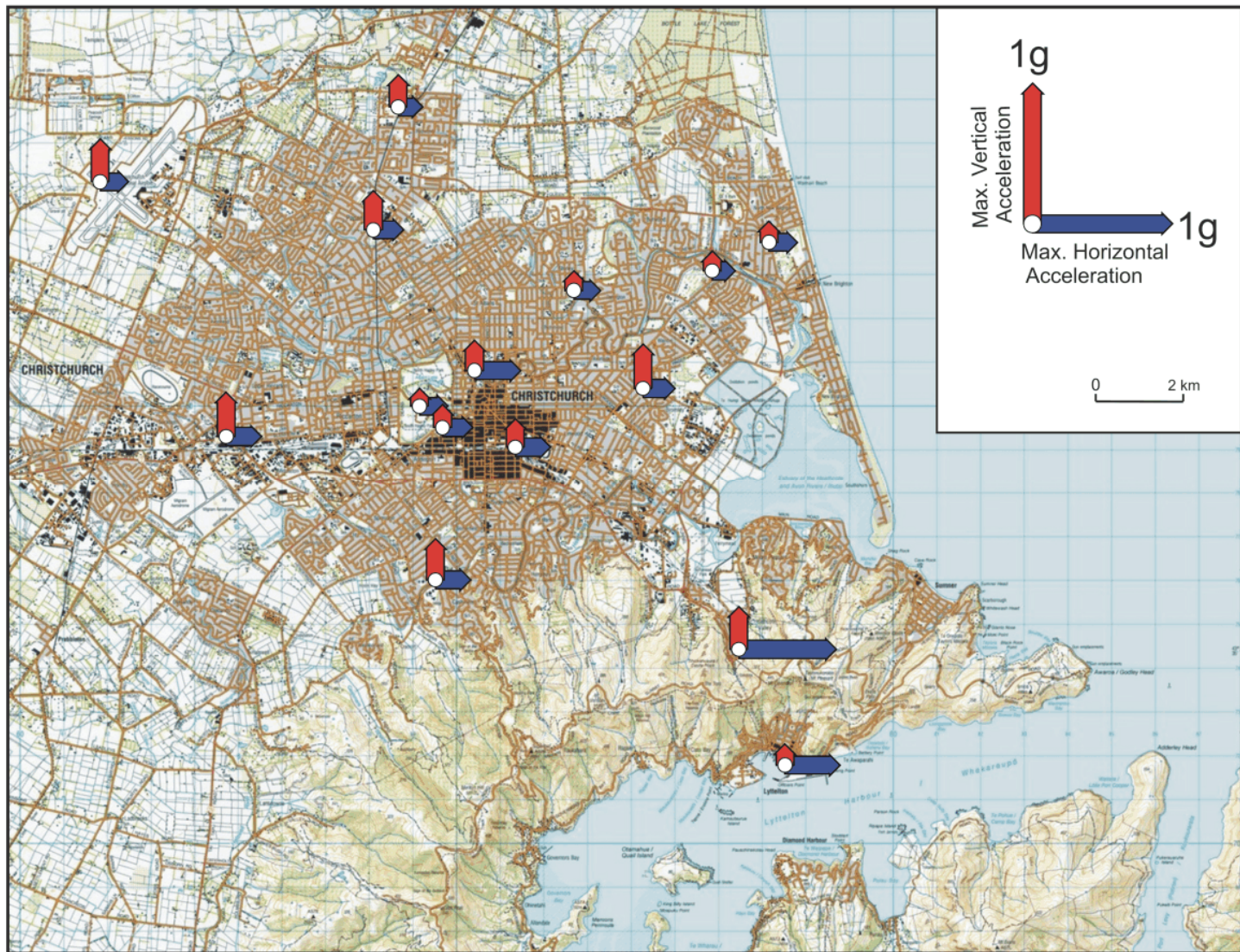
Simplified view of September 4th faulting, looking southeast towards Lake Ellesmere from above the Waimakariri Gorge



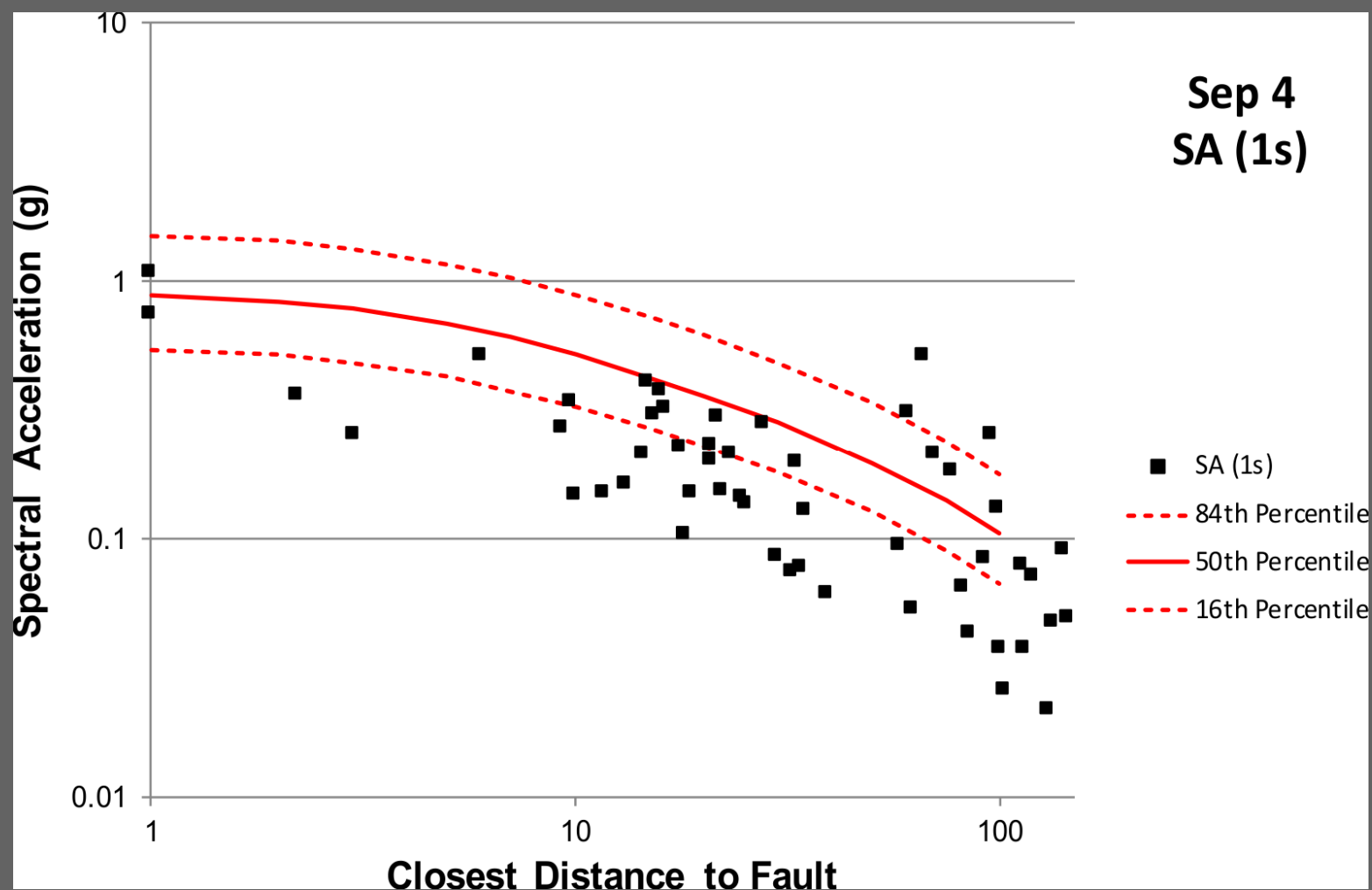
Surface Faulting – 30 km



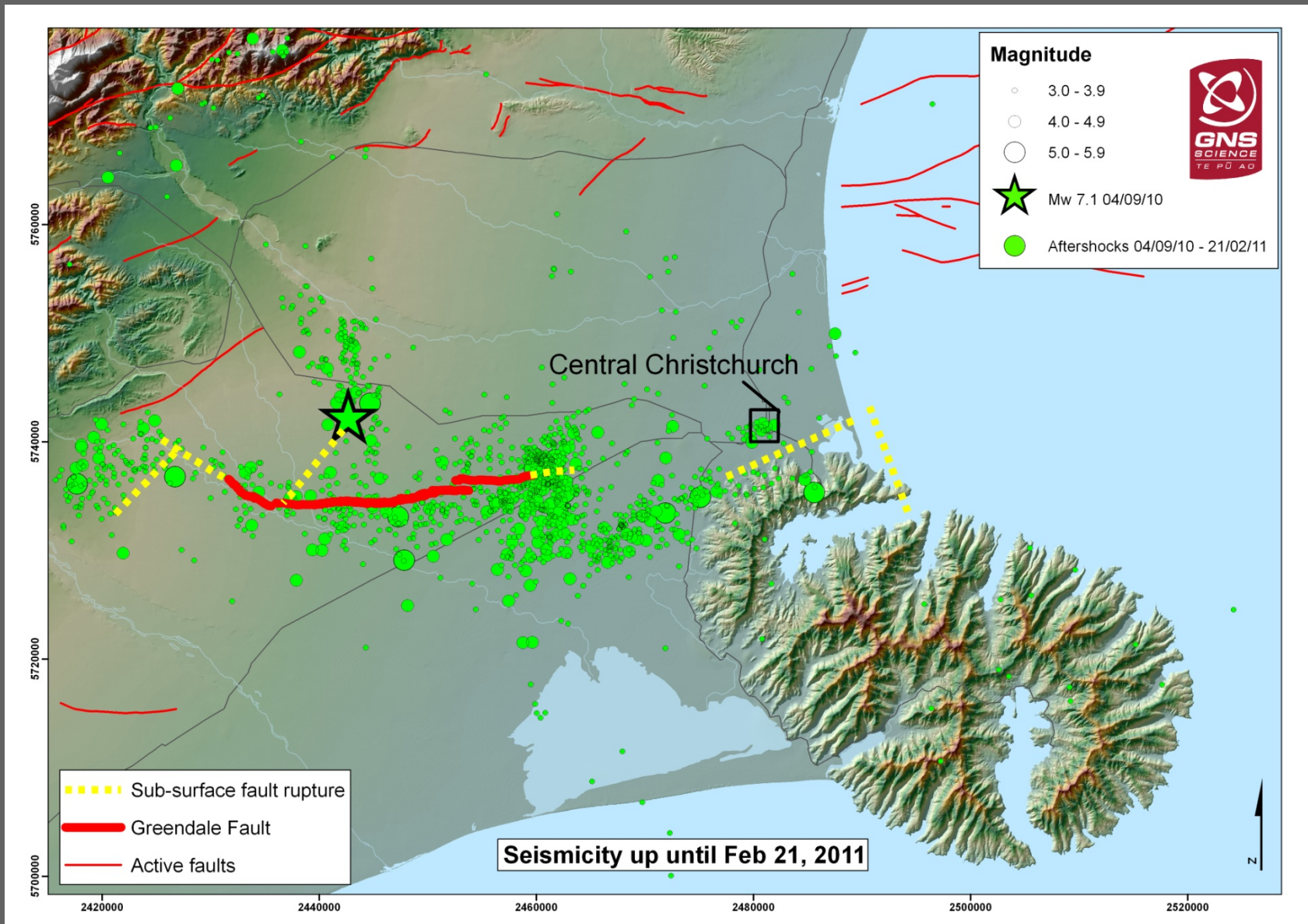
Shaking in Christchurch in September



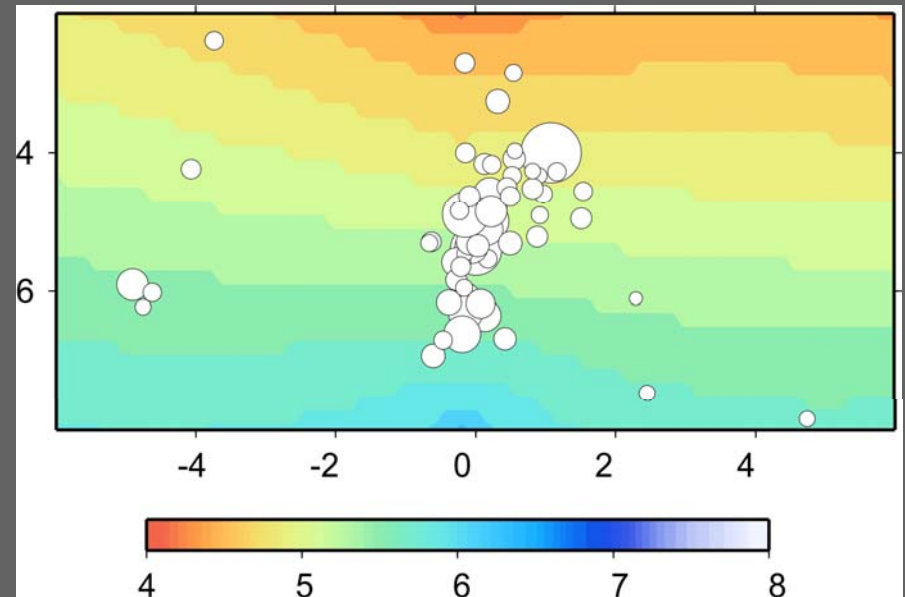
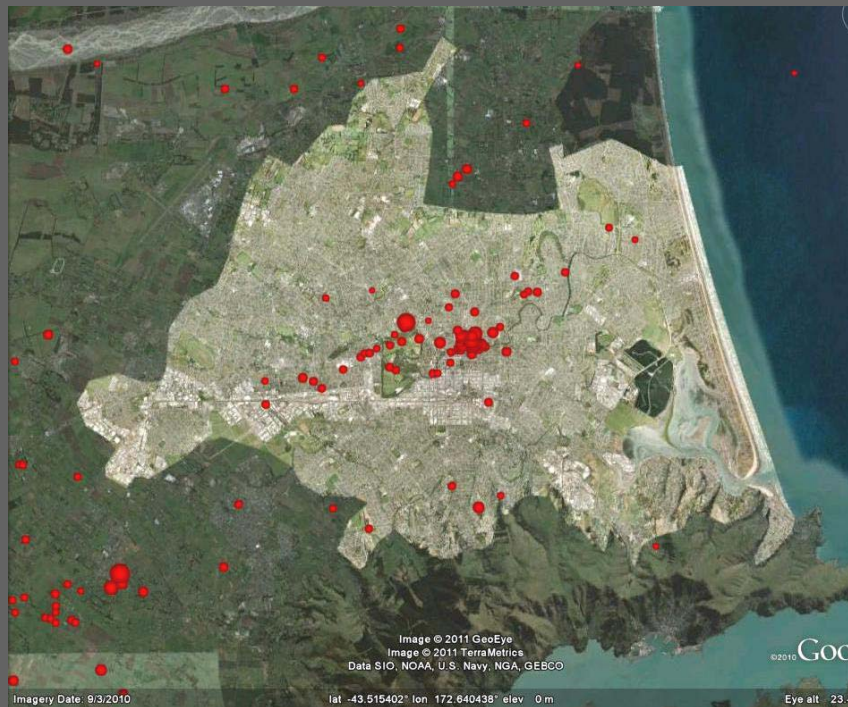
Shaking measured by instruments *versus* distance, compared to NZ Model



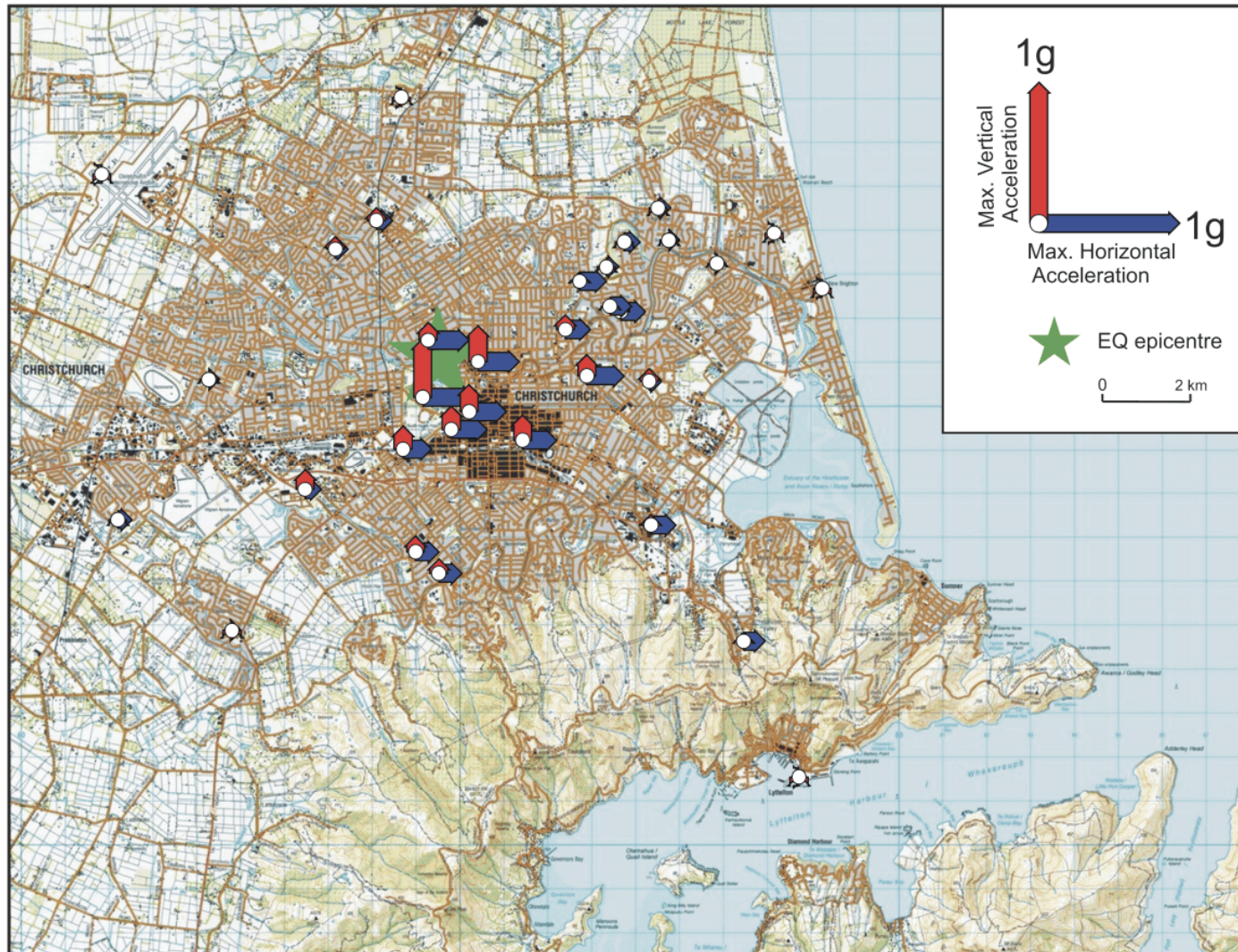
Seismicity September 2010 – February 2011



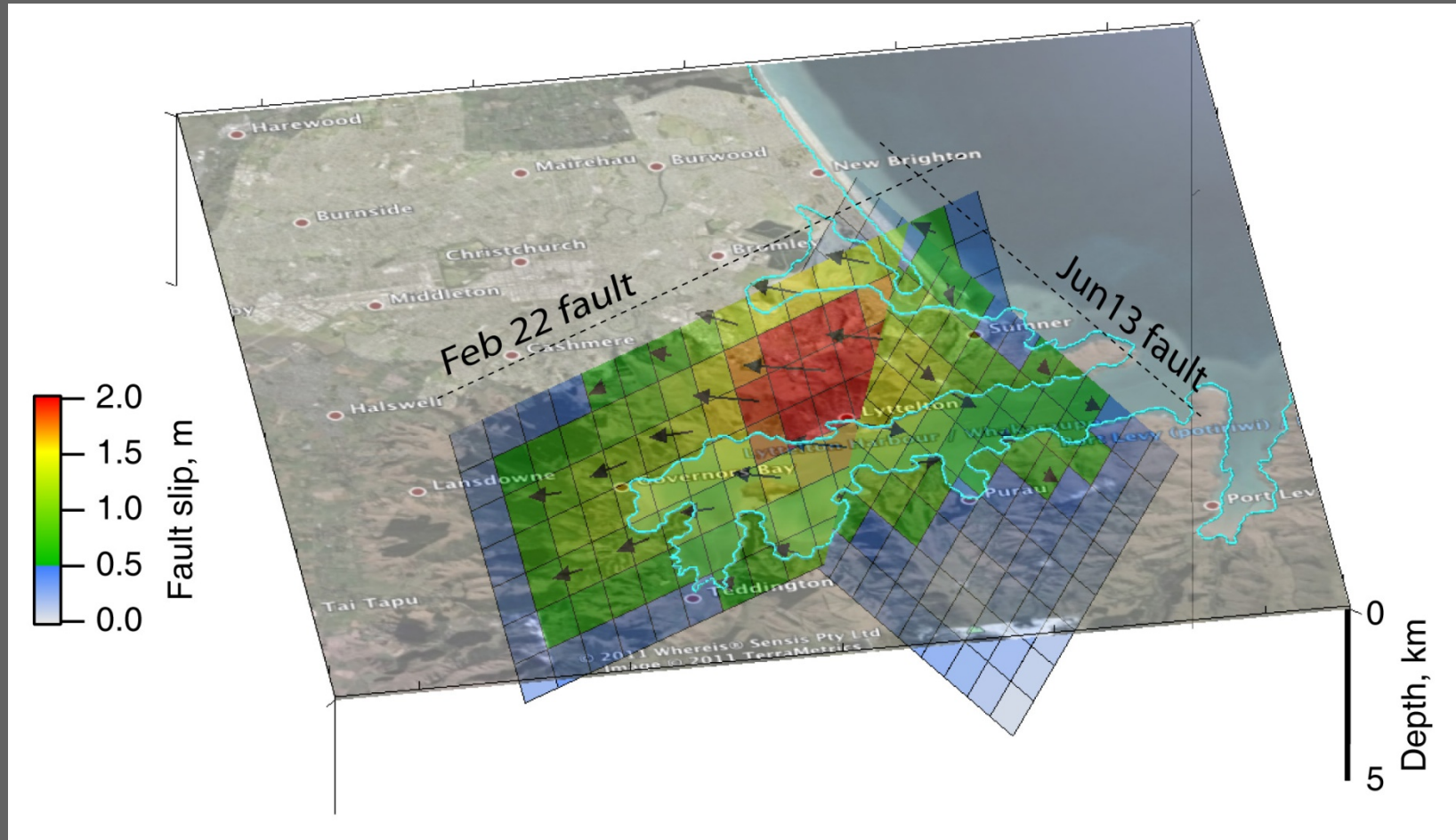
The 2010 M_w 4.7 Boxing Day Earthquake



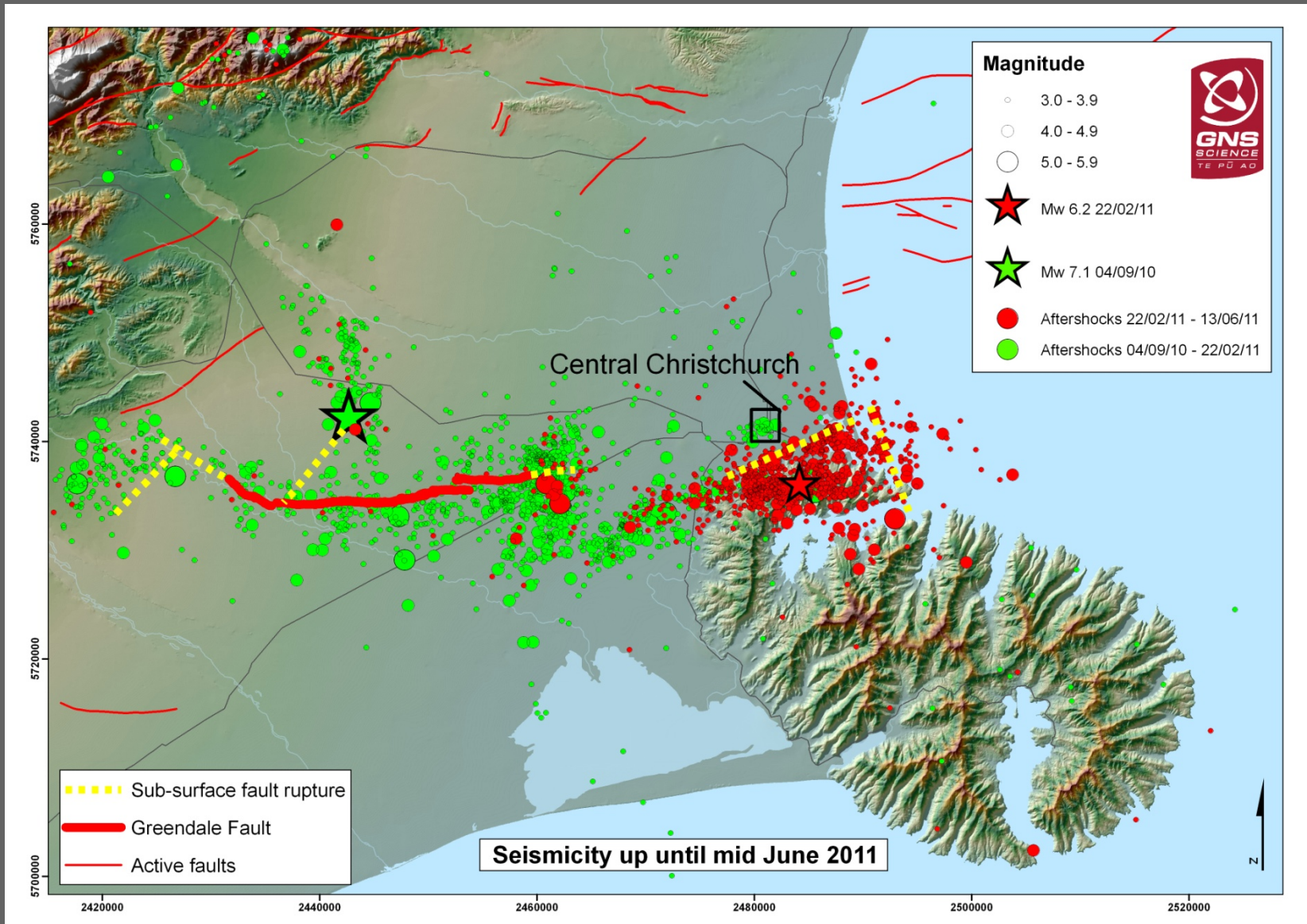
Shaking in Christchurch in December



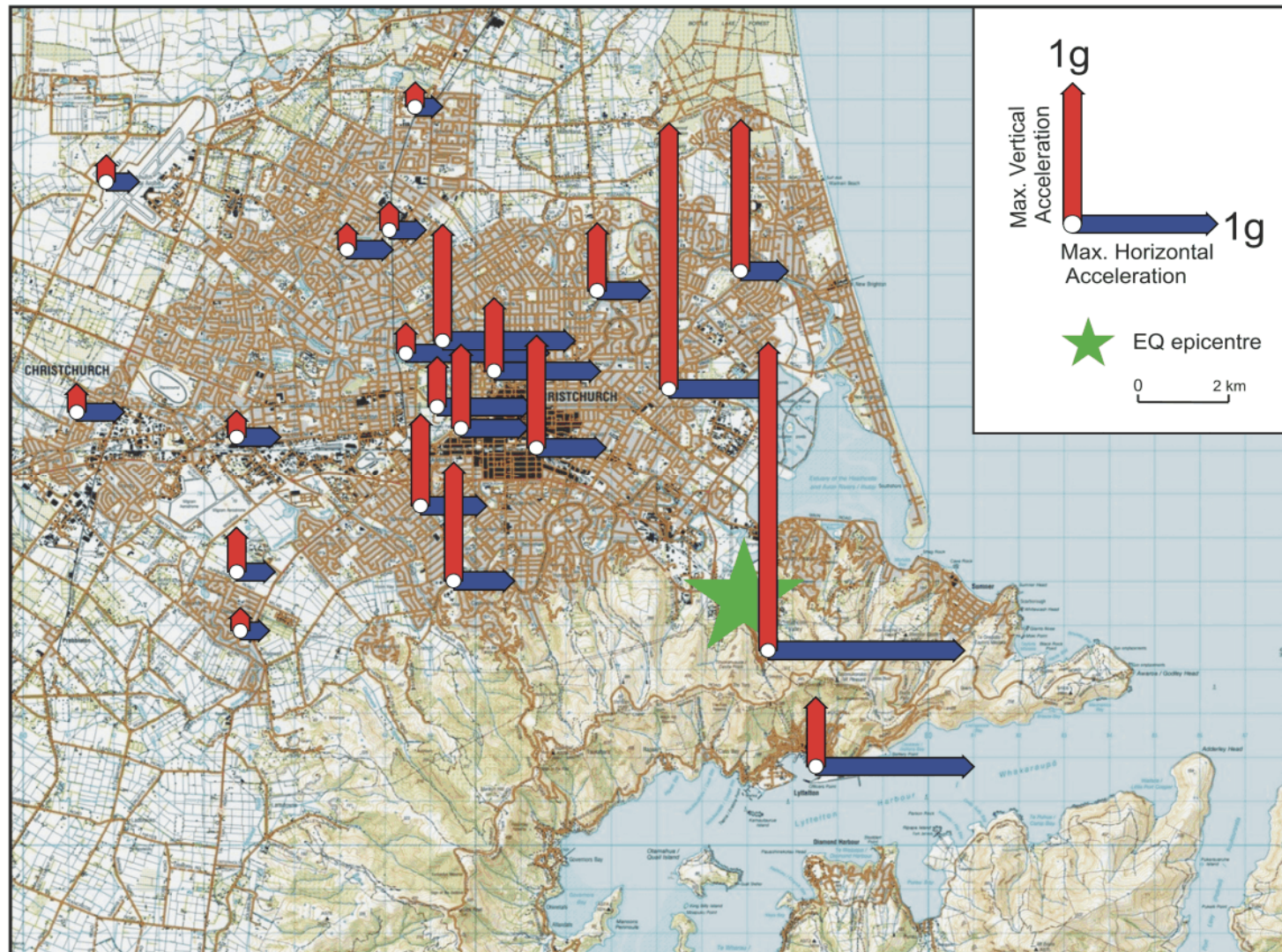
The February 22nd M_w 6.2 Christchurch Earthquake



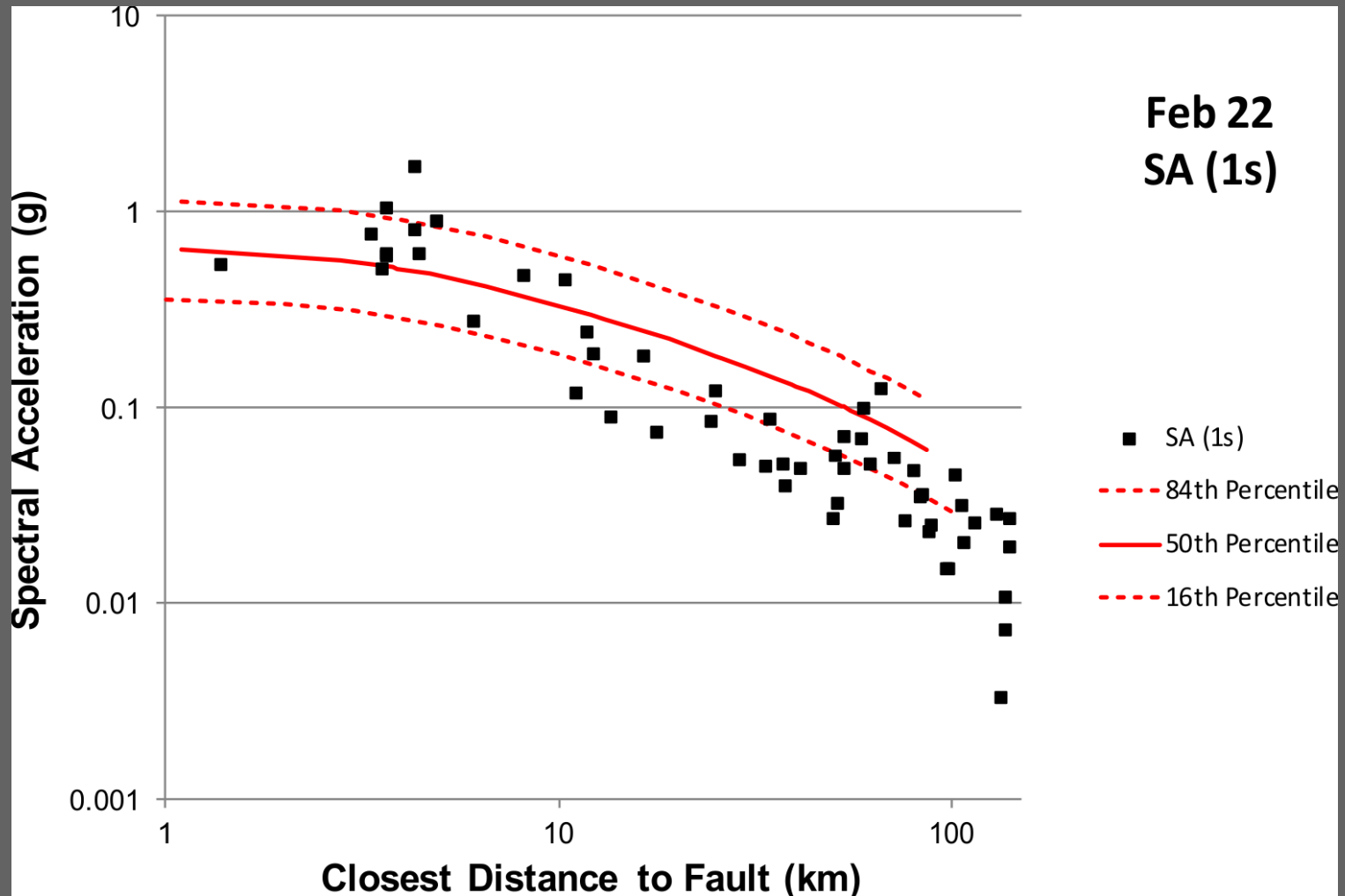
Seismicity September 2010 – June 2011



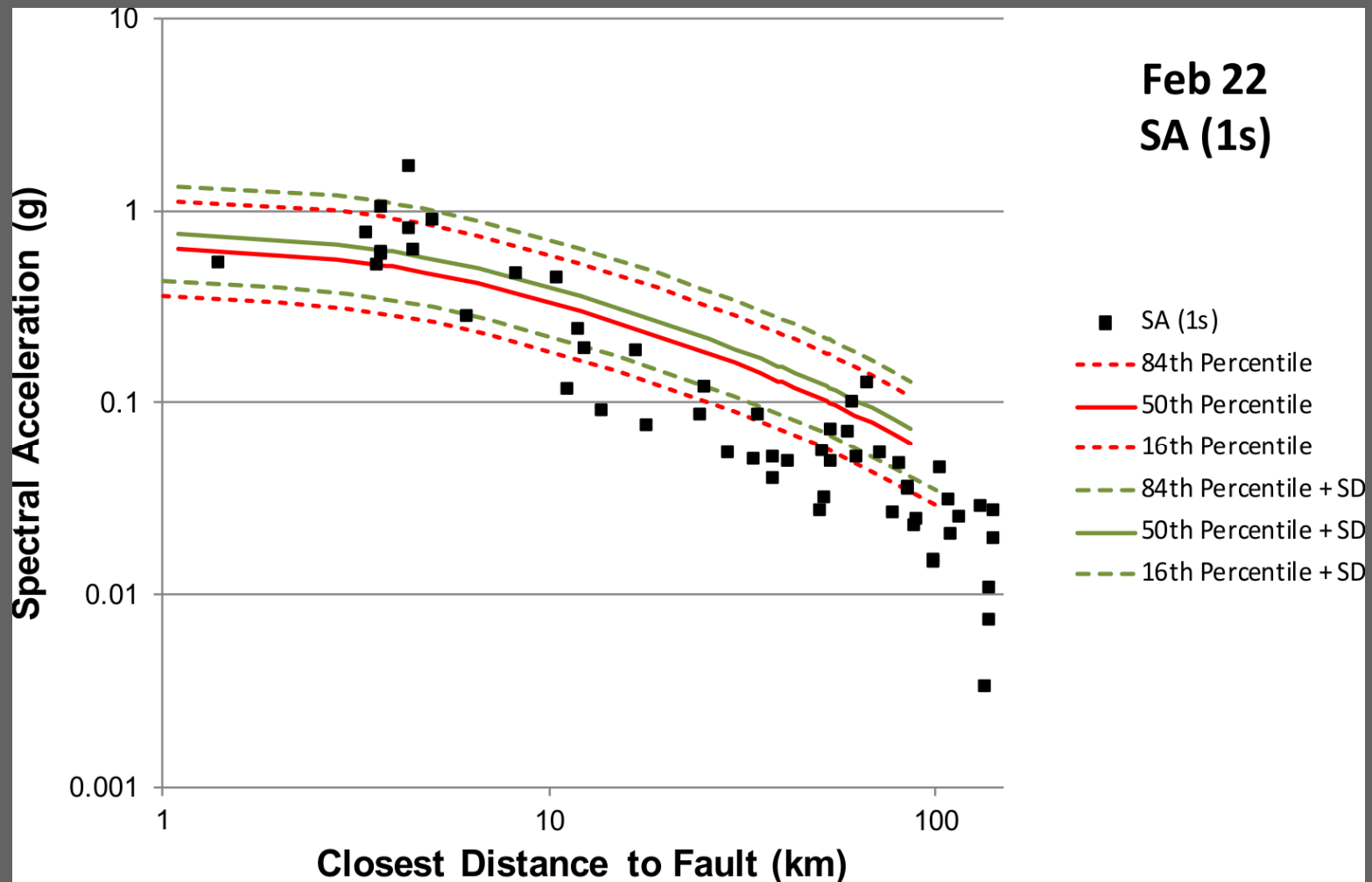
Shaking in Christchurch in February



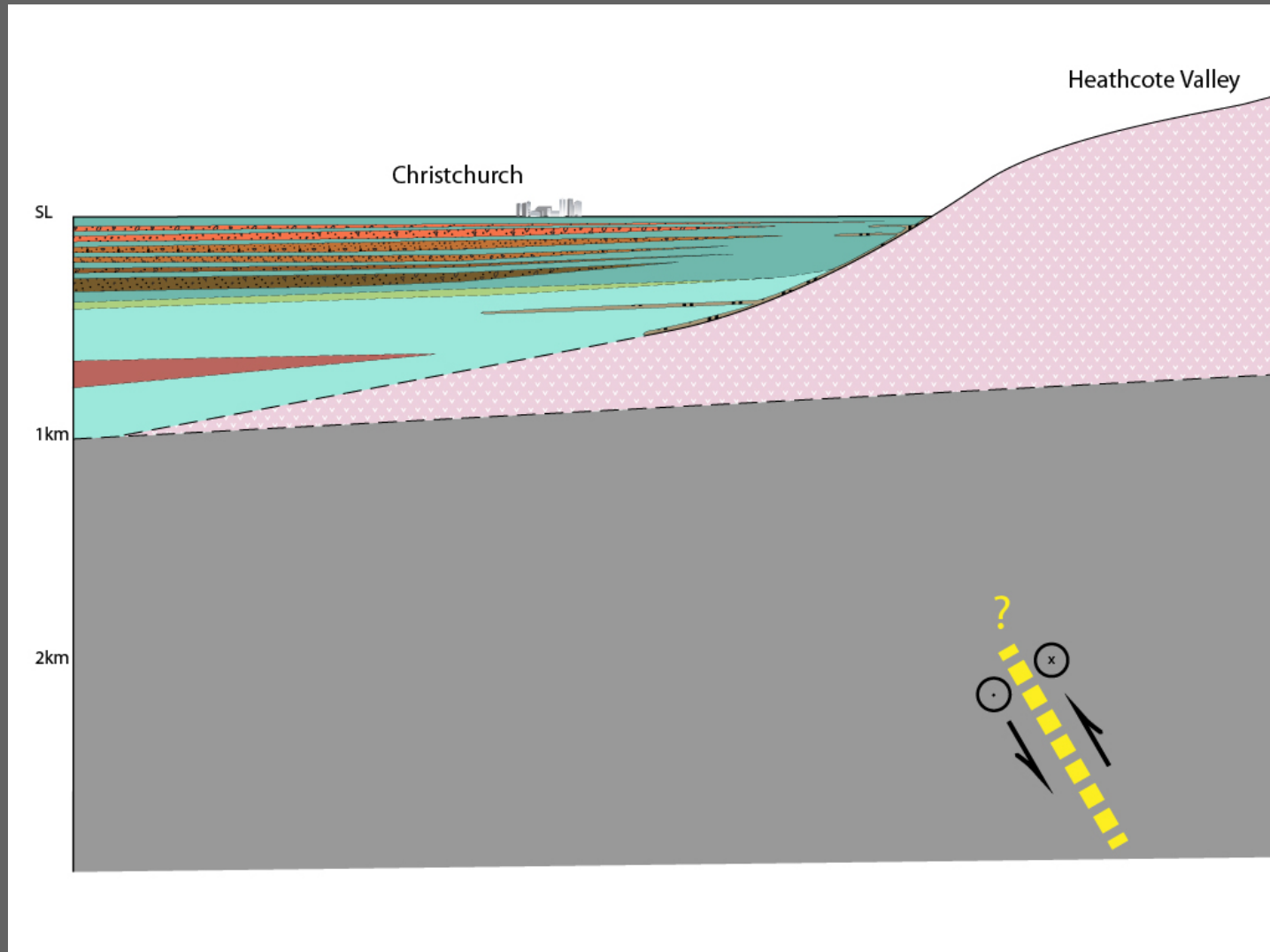
Shaking measured by instruments *versus* distance, compared to NZ Model



Shaking measured by instruments *versus* distance, compared to NZ Model



The Fault Under Christchurch

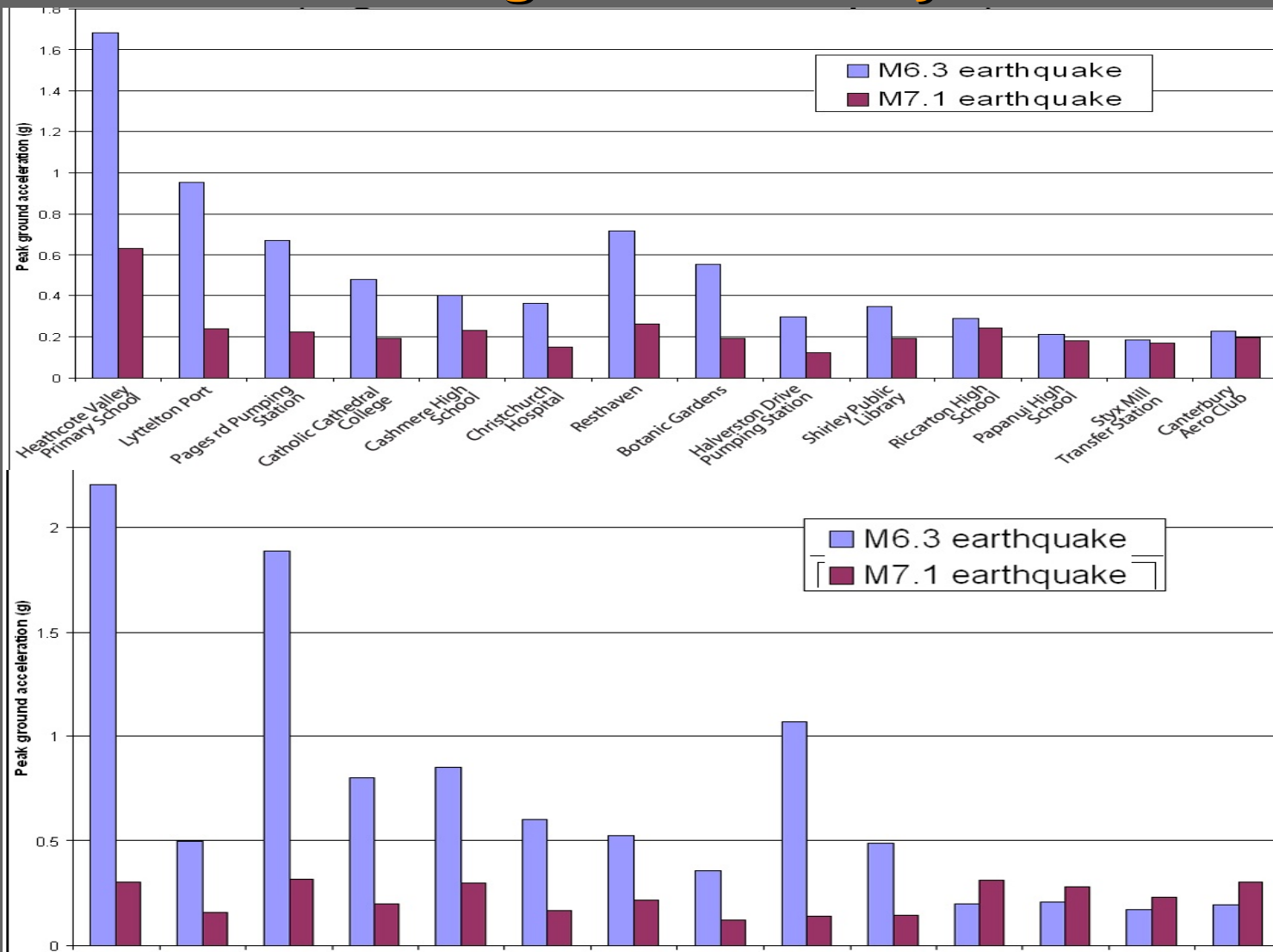


Why this amount of shaking?

A terribly unfortunate scenario :—

- Very close to CBD (an 'urban earthquake')
- Shallow
- A combination of related effects:
 - More slip than is usual (high stress drop)
 - Rupture spread across fault surface quickly
 - High directivity towards CBD (Doppler effect)
- Basin effects

Comparison of Vertical and Horizontal Ground Shaking Measured by Instruments

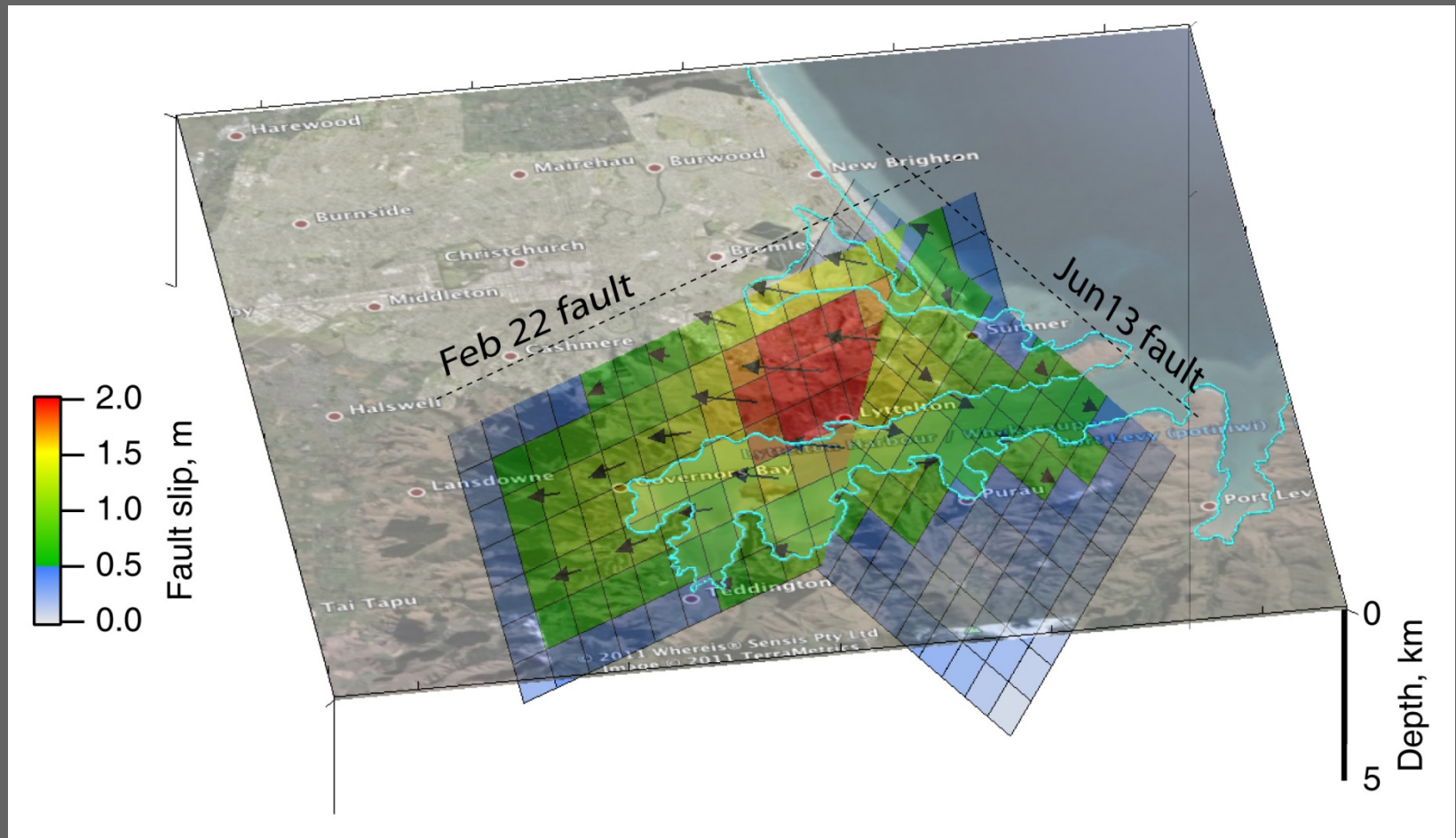


Horizontal

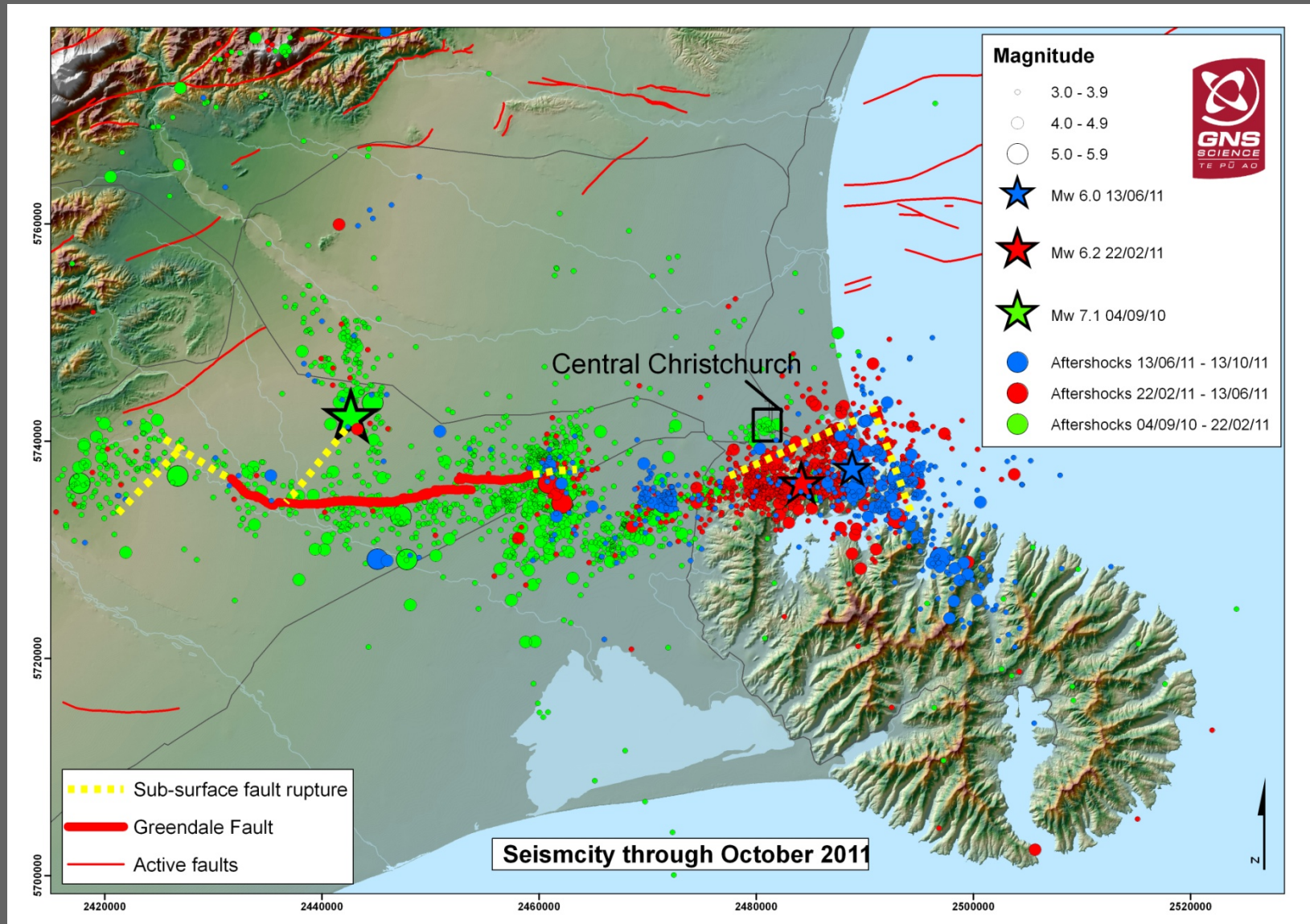
Vertical

- 500 yr code 0.30g
- 2,500 year 0.54g

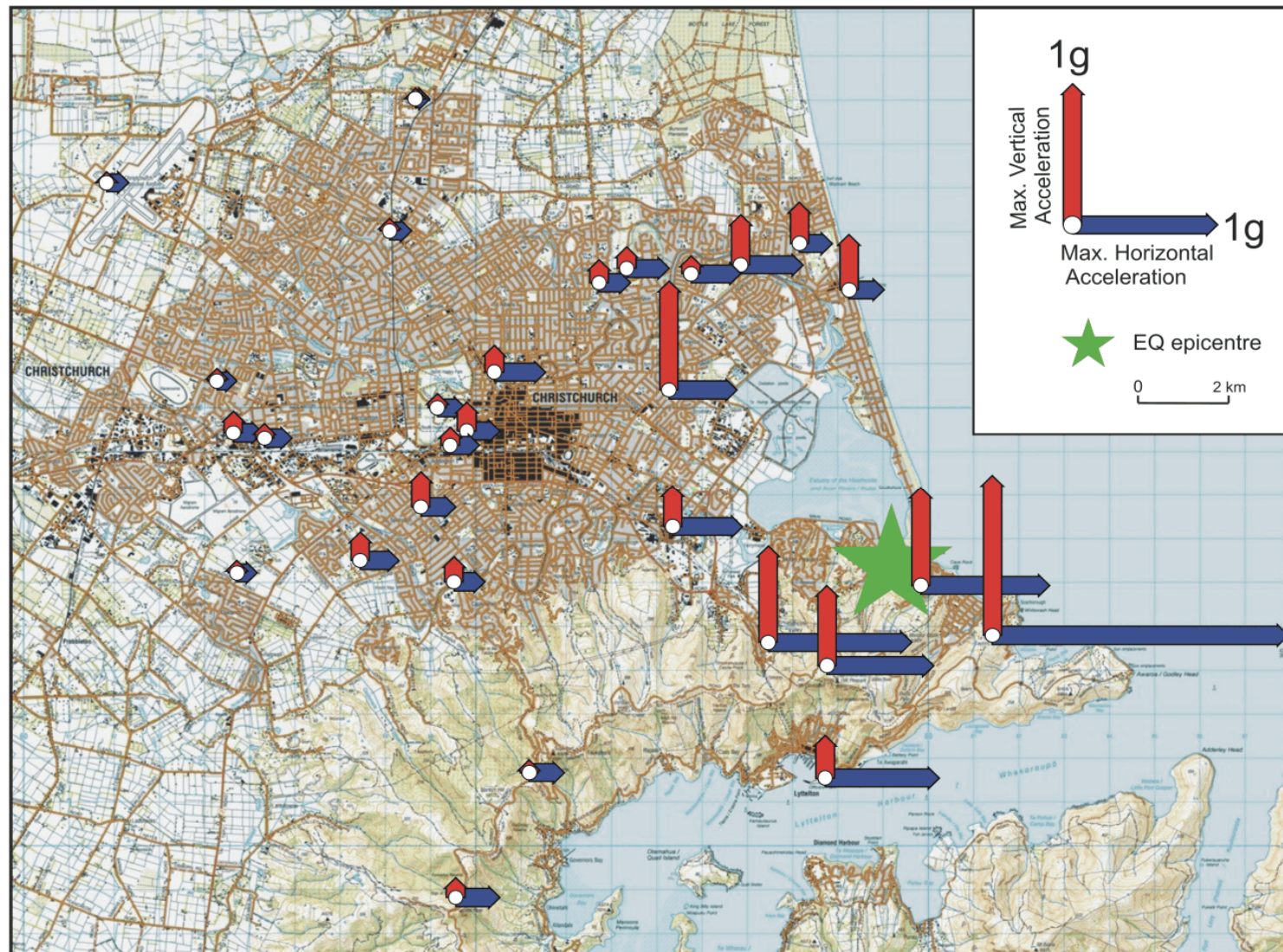
The June 13th M_w 6.0 Christchurch Earthquake



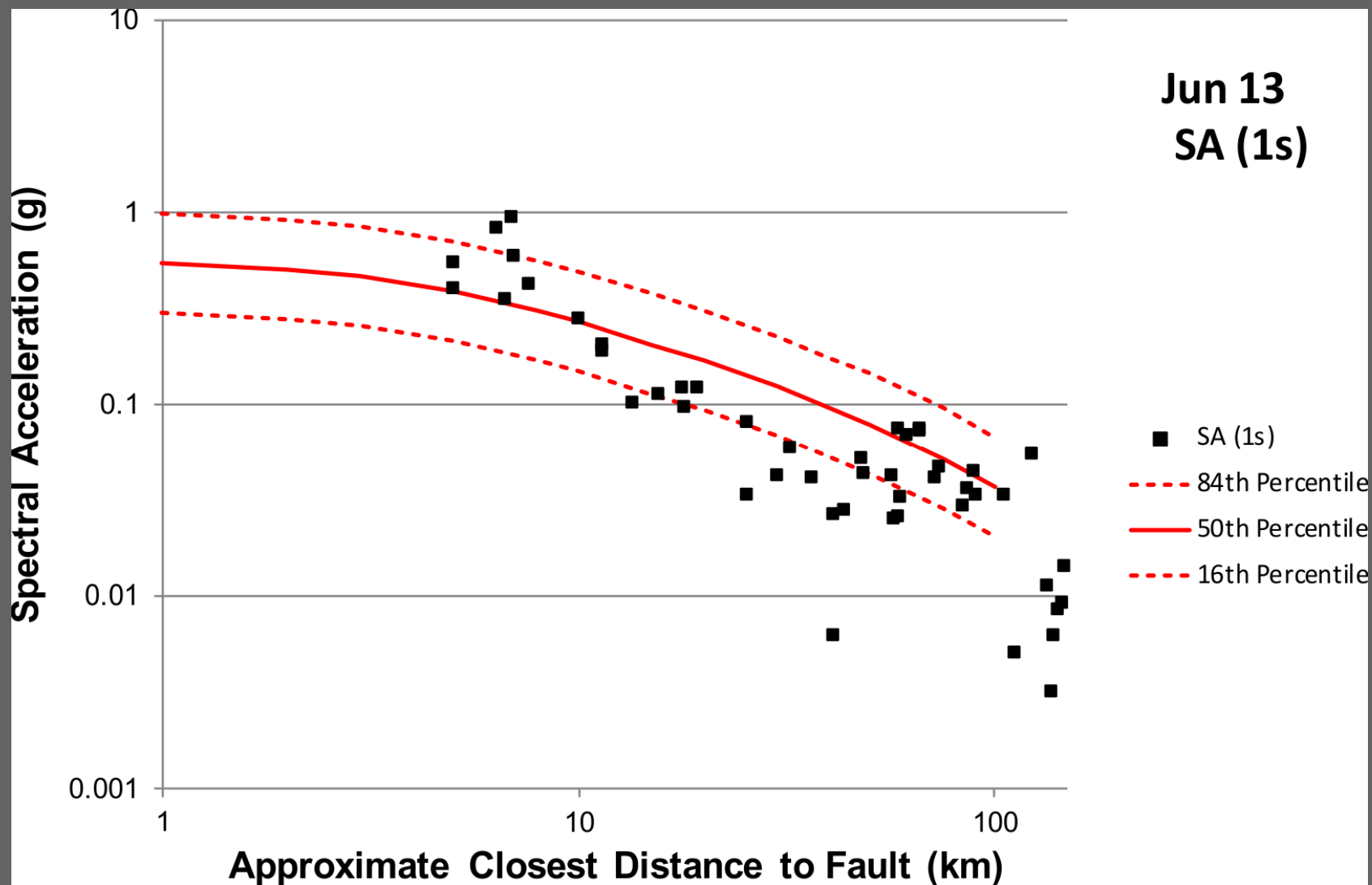
Seismicity September 2010 – October 2011



Shaking in Christchurch in June

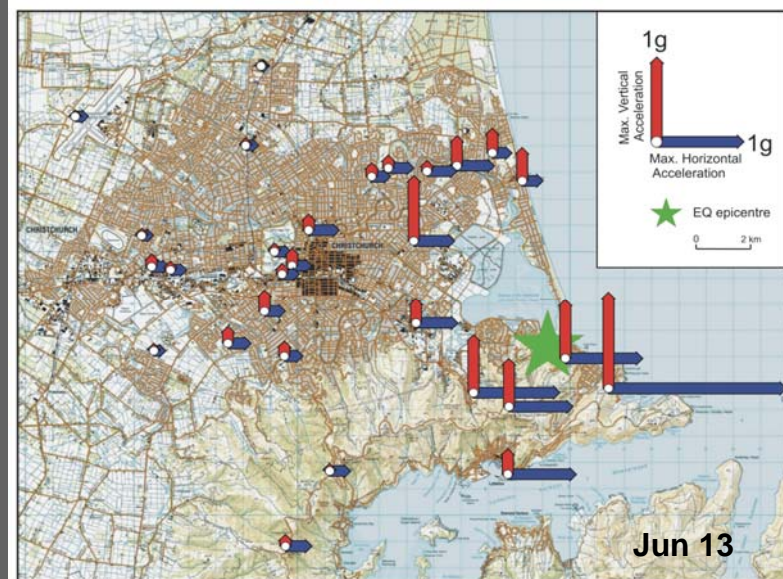
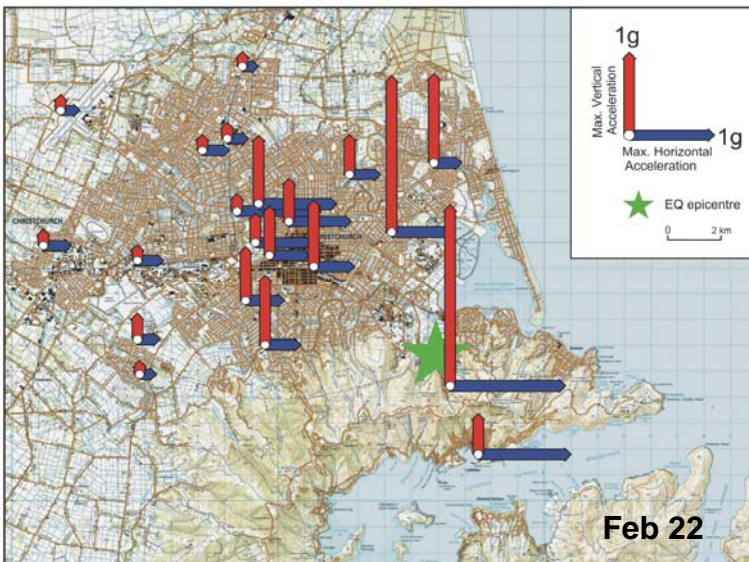
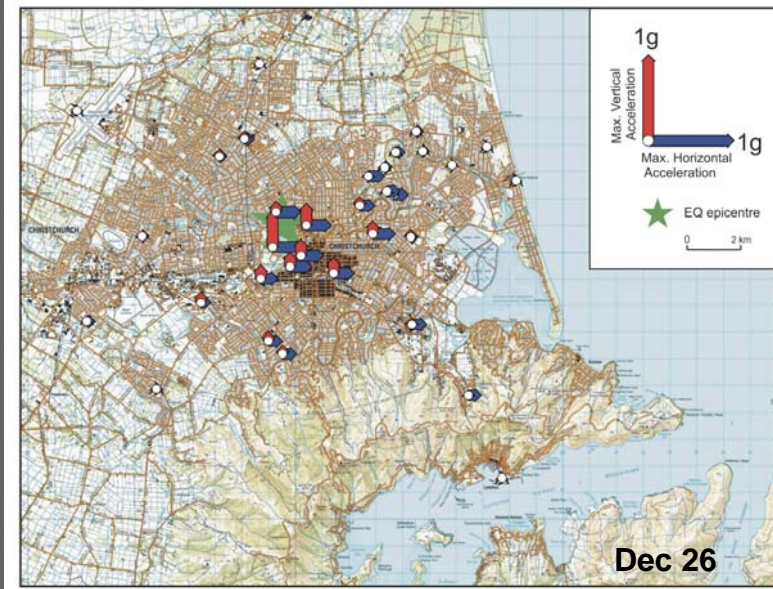
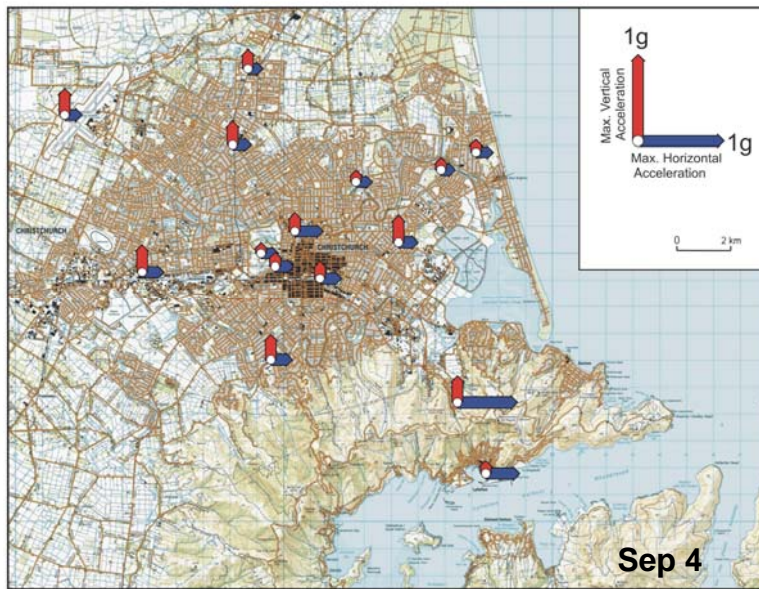


Shaking measured by instruments *versus* distance, compared to NZ Model



How much did it shake?

SEI.GNS.0010A.23



Thank you !

Programme

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