

Distant, delayed, Darfield: study of earthquake triggering in Canterbury, New Zealand

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Introduction

Motivation

Evidences of GPS movement and tremor activity suggest Dusky Sound Earthquake (July 2009) is equipped with high static and dynamic triggering potential. We suspect it reactivate the dormant basement faults on the Canterbury Plain that produce series of events between 2010 and 2012. Here we examine the microseismicity in the region between March 2009 and September 2010 Darfield Earthquake to see if the rate change reflects our hypothesis.

Data and Methods

We use continuous record from GeoNet stations OXZ, MQZ and catalog earthquakes before Darfield earthquake and one-month long aftershock sequence as the templates. Templates are 3-sec-length P- and S-wave waveforms filtered to 2-20 Hz. The threshold is 12 MAD (Mean Absolute Deviation) of the summed cross-correlation functions of six channels. We use relative amplitude of vertical component to estimate the magnitude of the detections.

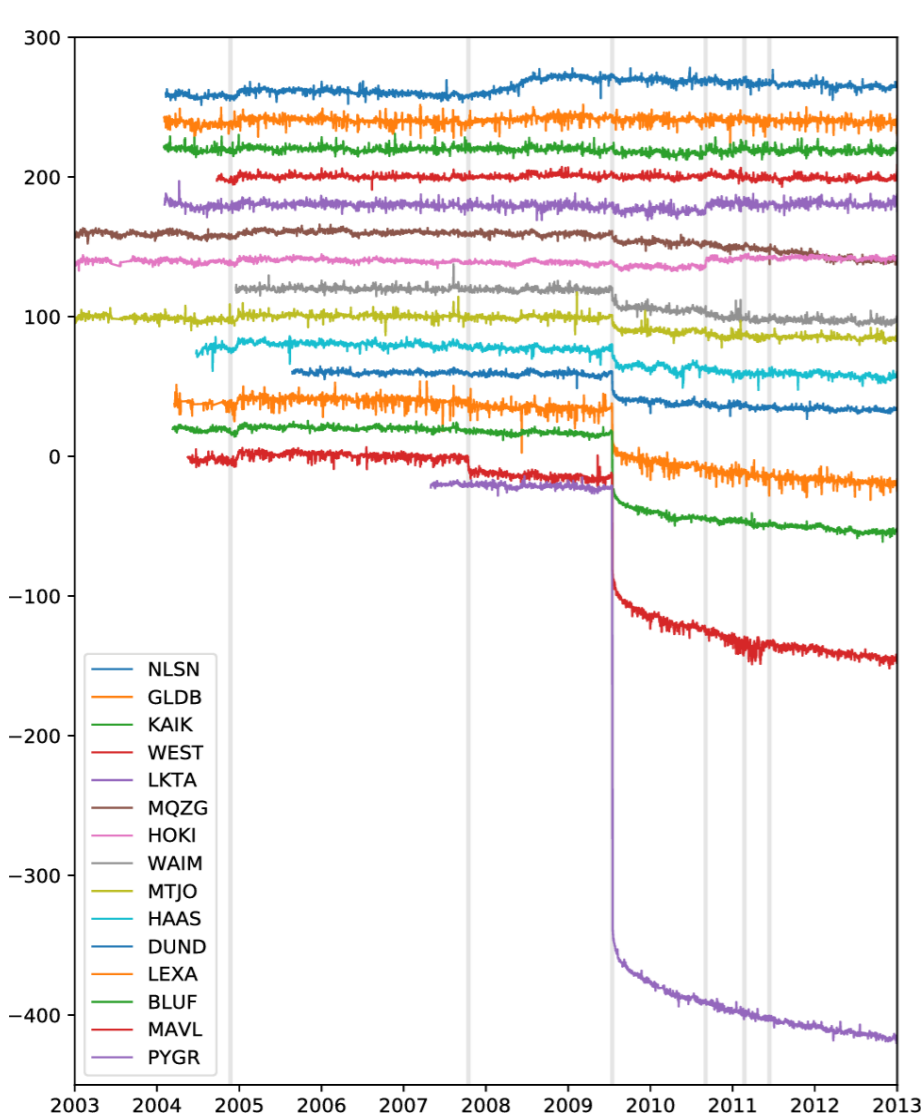


Fig.1 GPS daily solution detrended before Fjordland earthquake (2007). Co-seismic movement of MQZG during the Canterbury sequence is removed.

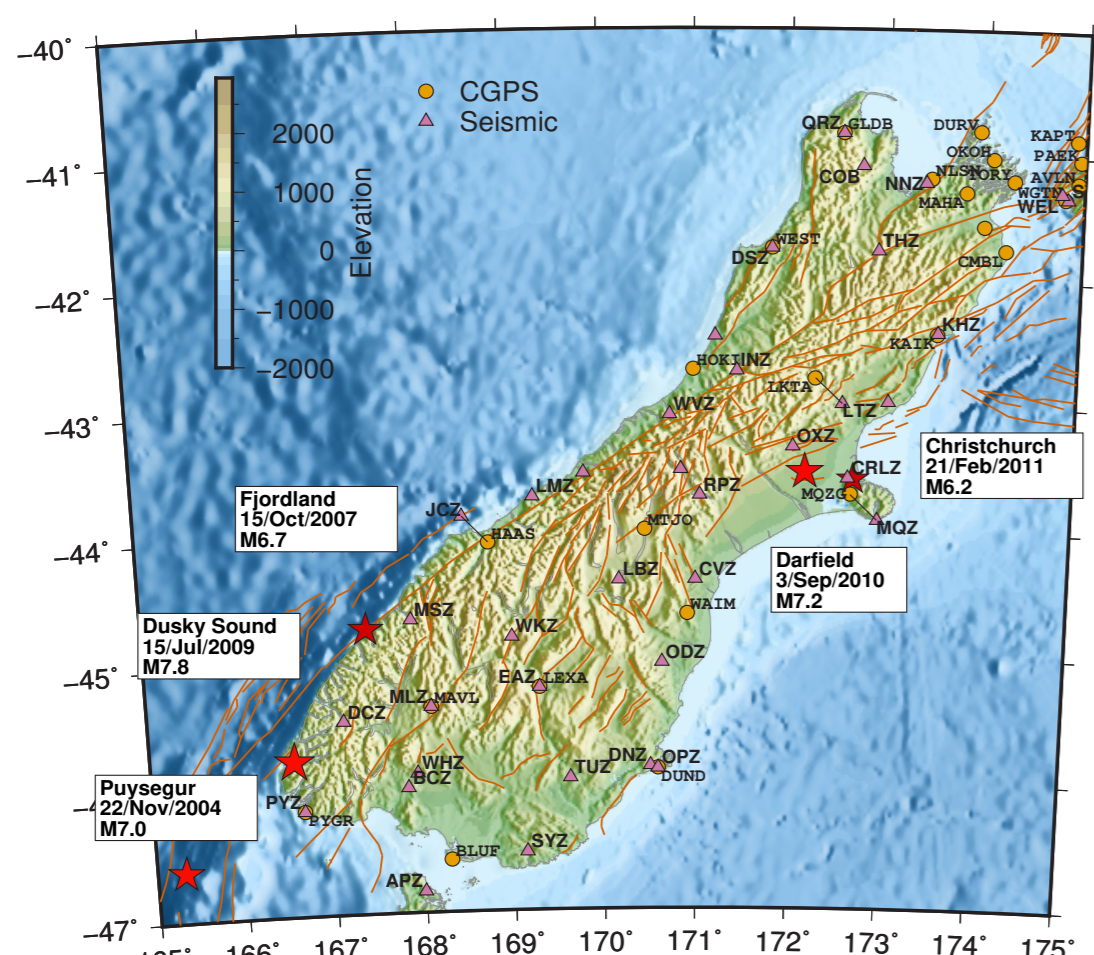


Fig.2 Regional map marking locations of major earthquakes, seismic and GPS stations. Orange lines are NZ active fault model.

Fig.8 (Right) Geological map of Canterbury Plain and Chatham Rise near the coast. Basement Faults and fault lines of Darfield Earthquake are marked (Browne et al., 2012).

Results

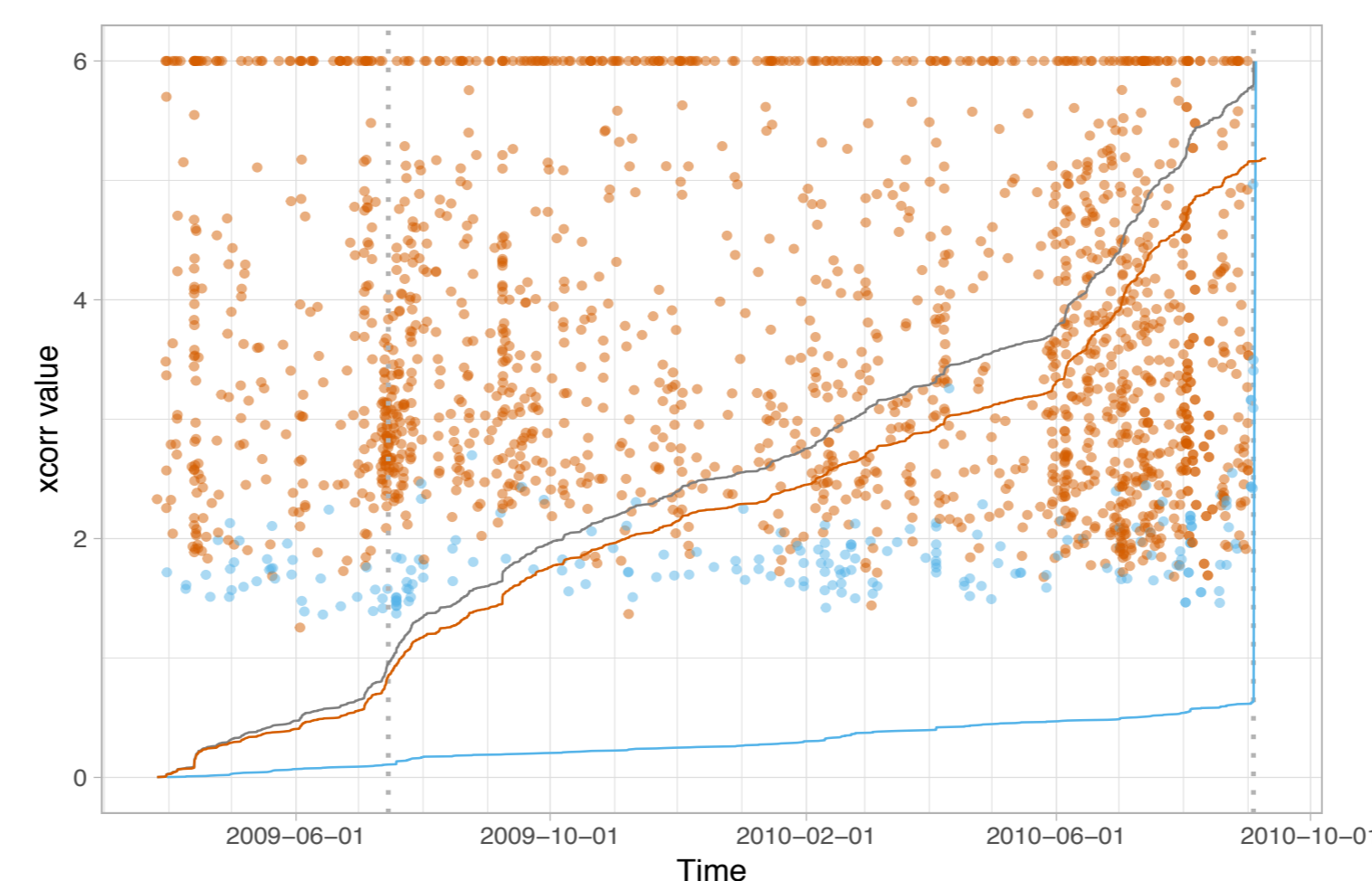


Fig.4 Detections plotting against correlation values and grouped by pre/postshock detections. Cumulative number of detections are overlaid with the same colors. Two major events are marked by grey dashed lines. Two periods of sharp rise in detection rate are seen close to the events.

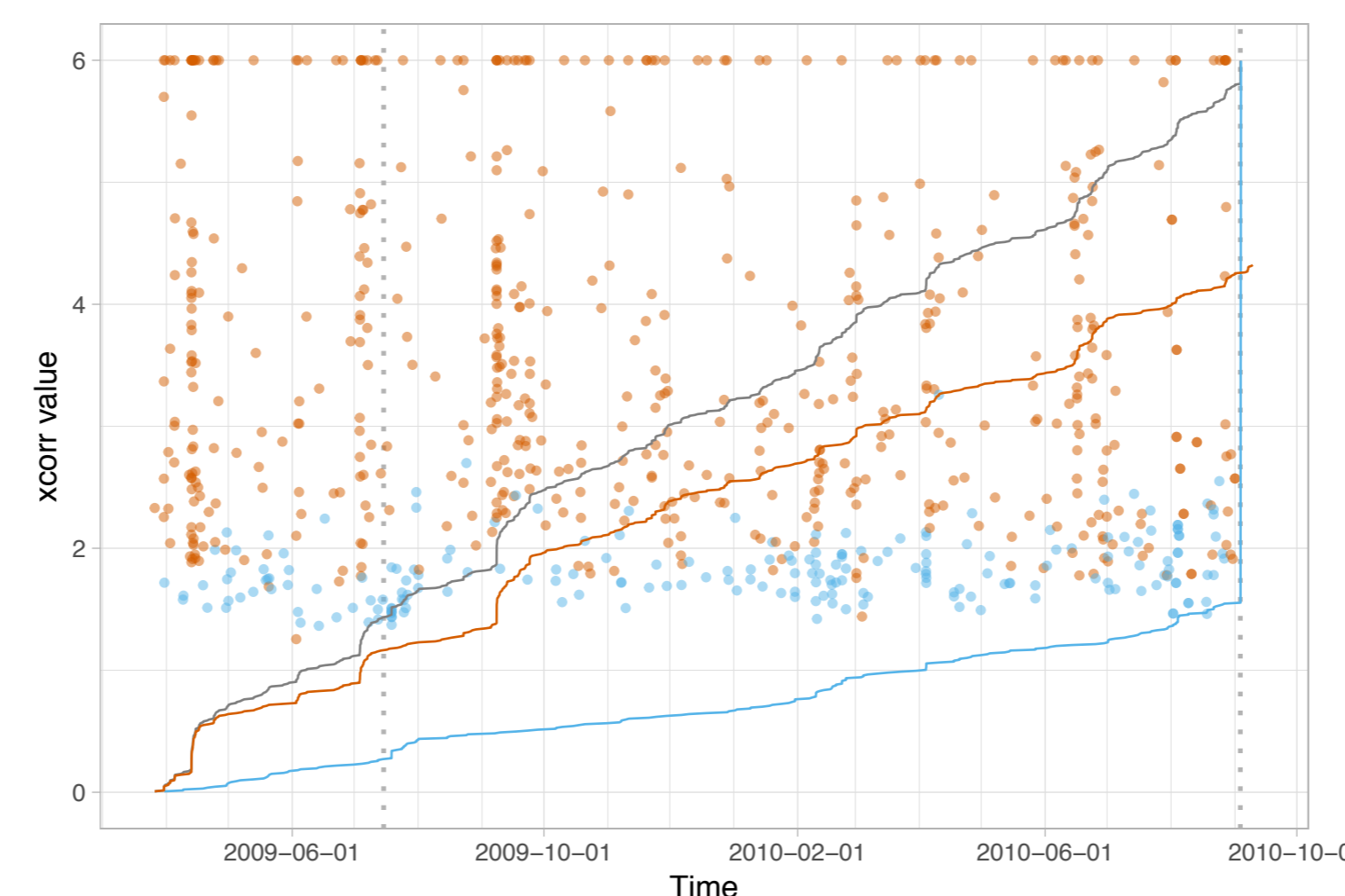


Fig.5 Detections made by events on the Canterbury Plain and surrounding foothills. The trend seen from the above plot is removed.

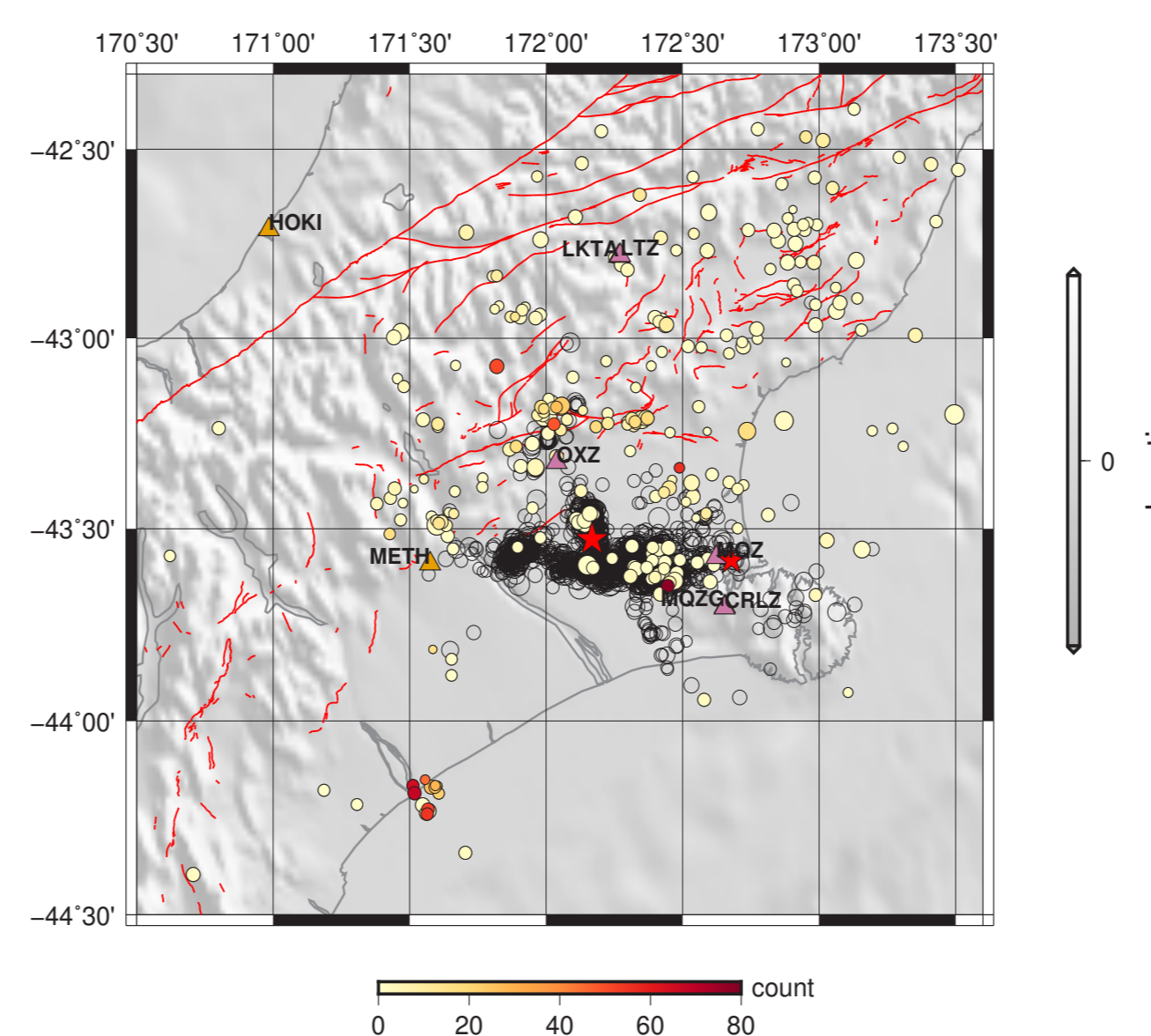


Fig.7 Cumulative detections made by individual detections. Templates make zero detections are in black dots. Few templates dominant the numbers of detections. The templates that do not make any detections are in black dots.

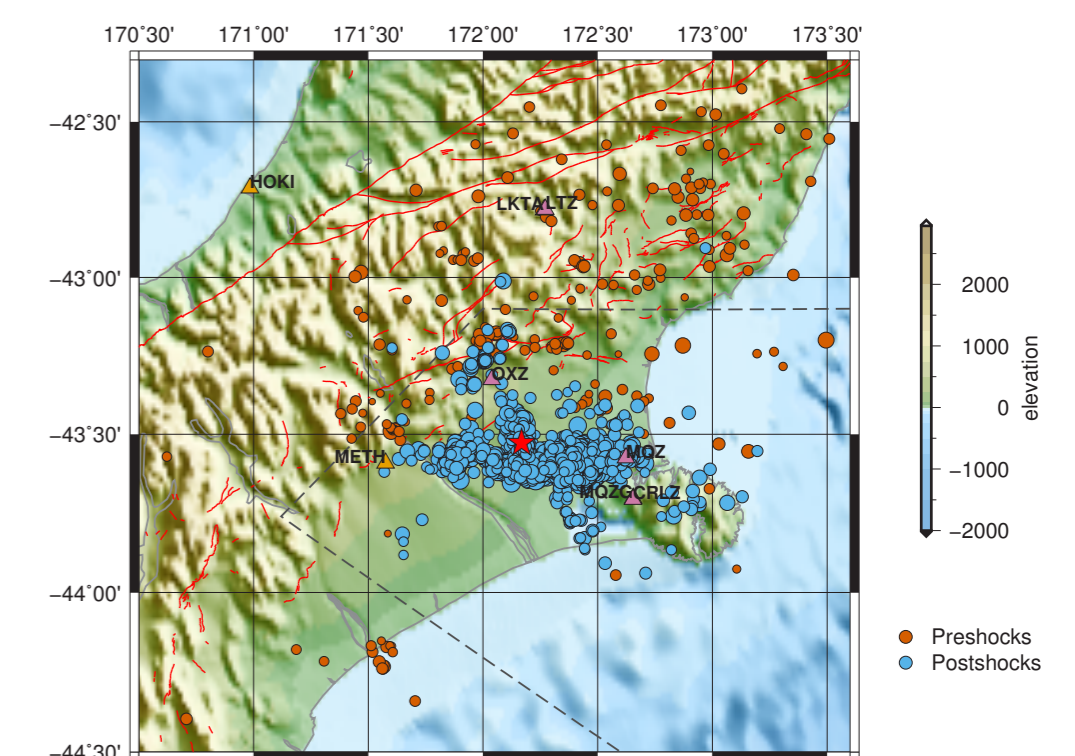
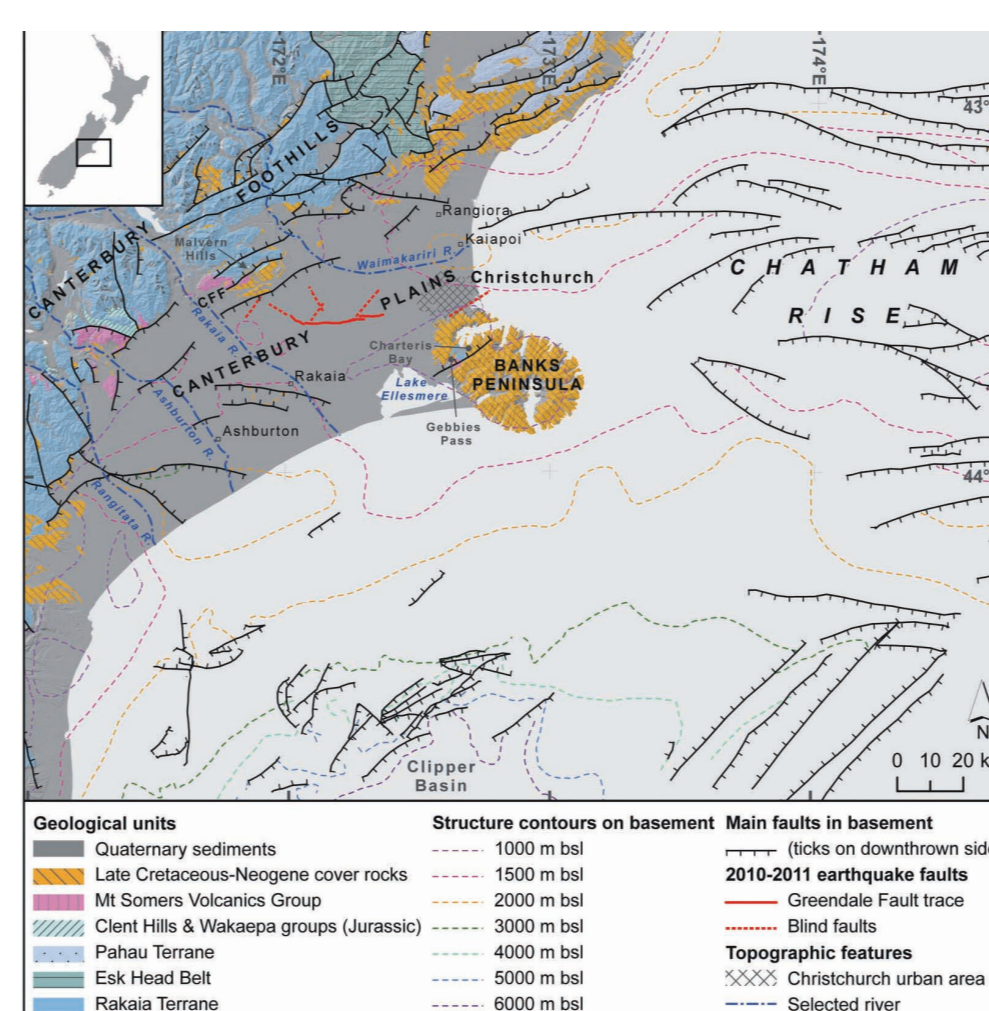


Fig.3 Templates event distribution grouped by origin times before and after Darfield earthquake. There are a total of 246 foreshocks and 2113 aftershocks used.

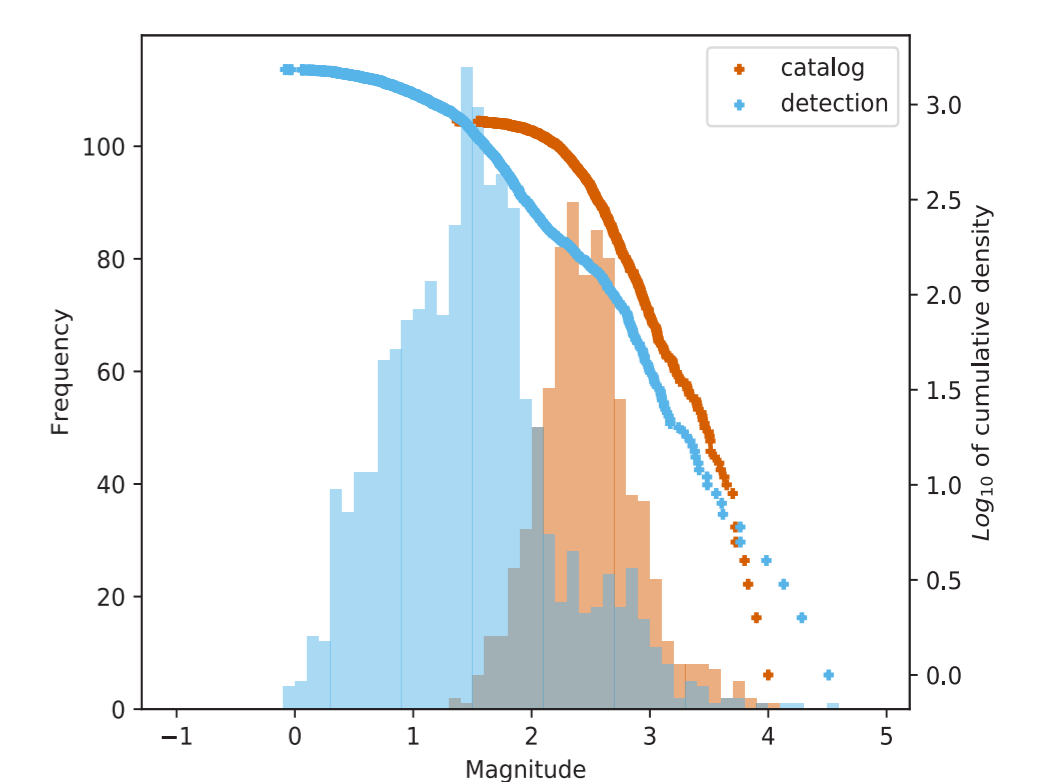


Fig.6 Frequency-magnitude distribution of the catalog earthquakes and detections. The distribution of detections are not linear for our result.

Discussion

- We detect possible triggering around Dusky Sound Earthquake and three months before Darfield earthquake.
- The locations of detections are not on the main ruptured faults of Darfield EQ, but the faultlines of northern foothills and swarm down south.
- The M_L of detections are calculated using amplitude ratios. The F-M plot shows an underestimation around M_L 1.5-2.5. So far we do not know why.

Outlook

- Time series analysis of magnitudes changes leading up to the Darfield earthquake.
- Trace back seismicity to 2004 with 5 longer-standing broadband stations.
- Seismicity rate change through several subductionzone events.

Acknowledgement

We thank GeoNet for providing all the data; Calum Chamberlain and Chet Hopp for the EQcorrscan package (Chamberlain et al., 2014).