Evaluation of 5-year and 3-month models in New Zealand

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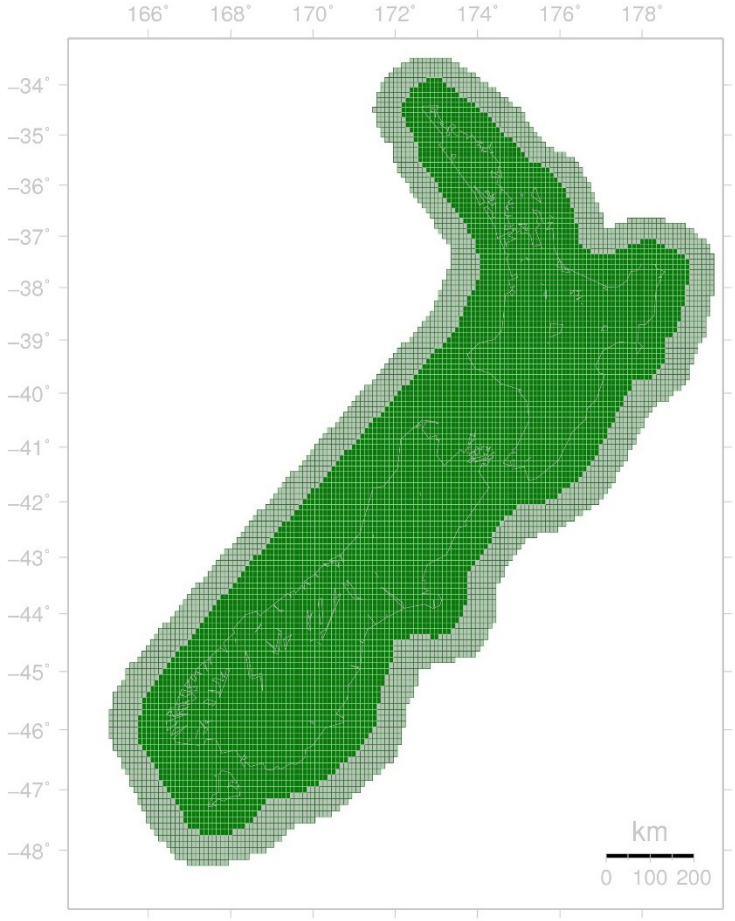
New Zealand Testing Centre

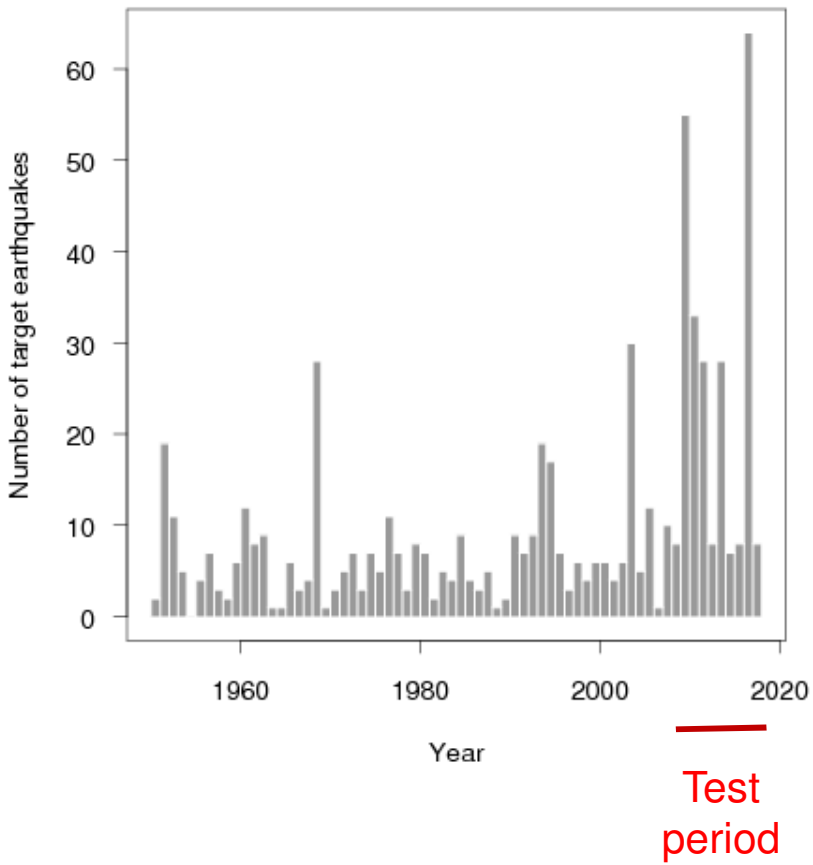
- Established in 2008
- Four testing classes: 5-years, 6-months, 3-months and 1-day.
- We present results of the 5-year and 3-month classes

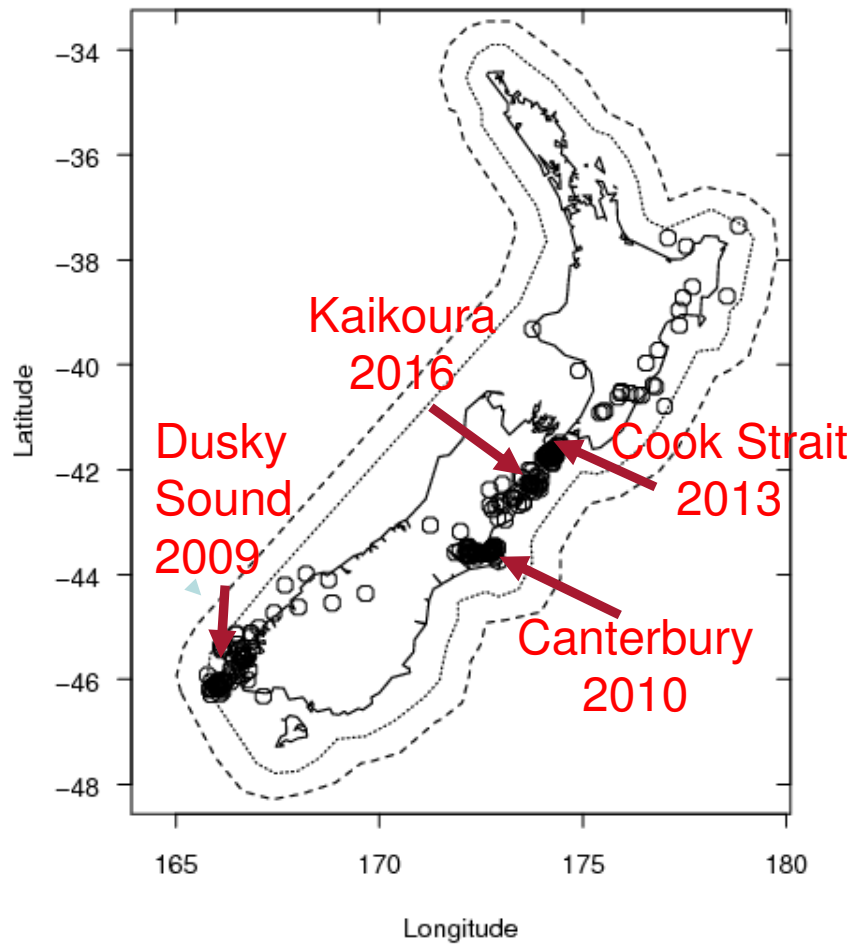


Catalogue transition and latency

- 2012 transition in GeoNet from CalTech-USGS seismic processor (CUSP) to SeisComP3 (SC3) system.
- Long latencies in finalising the CUSP catalogue.
- First few months of SC3 catalogue withdrawn when location anomalies notices.
- Both CUSP and SC3 produce local magnitudes, but magnitudes of small earthquakes (M<5) are lower in SC3
- Catalogue supplied to testing centre has variable quality and sizeable gaps.
- Testing centre not configured to upload the SC3 catalogue until September 2014.
- Since August 2016 only the CUSP catalogue has been picked up by the testing centre.

High seismicity since 2008

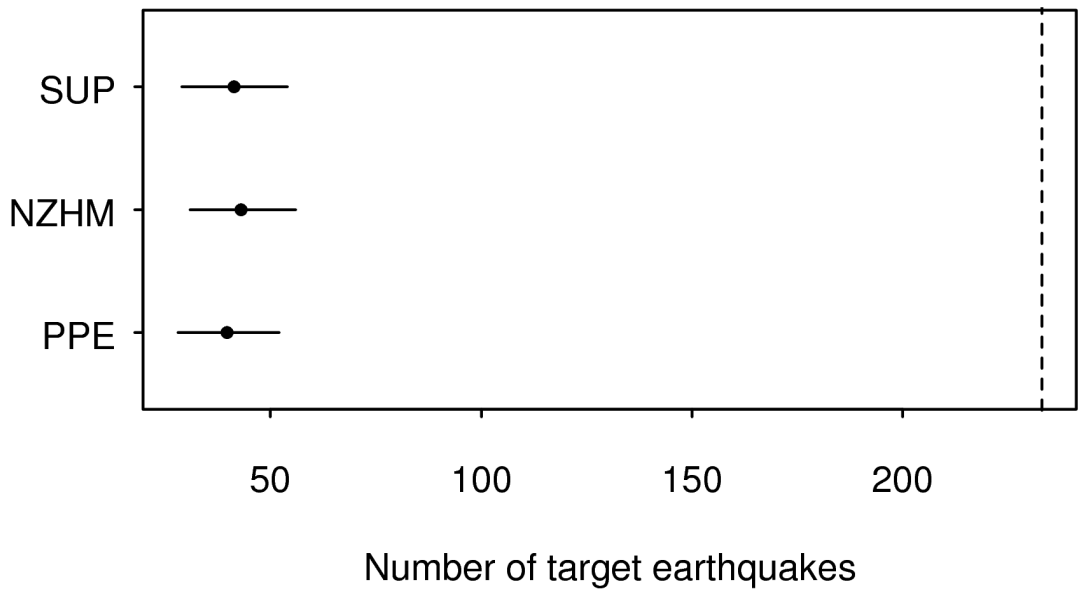




5-year (fixed) models

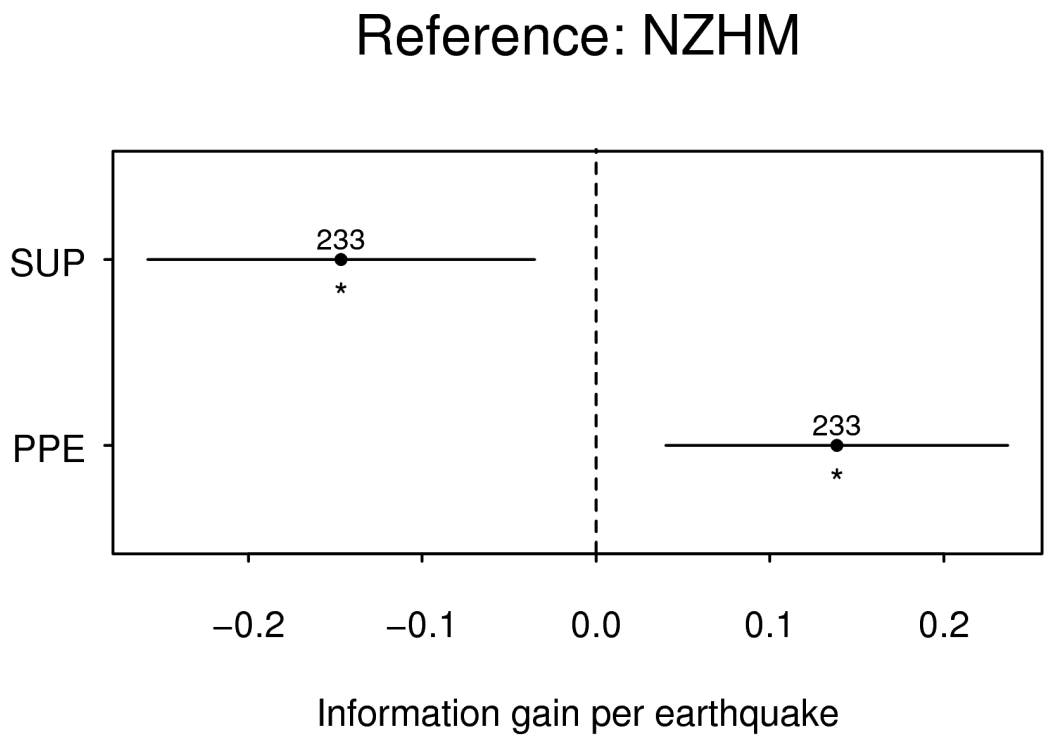
Model name	Description	Reference
SUP	Stationary Uniform Poisson – a reference model of least information	
NZHM	New Zealand National Hazard Model, including gridded version of fault sources	Stirling et al. (2002), BSSA, 92: 1878-1903
PPE	Proximity to Past Earthquakes – smoothed seismicity model.	Jackson & Kagan (1999), SRL Rhoades & Evison (2004) Pageoph. 161(1): 47-72

5-year models all under-predict number of target earthquakes (233 at M>4.95)



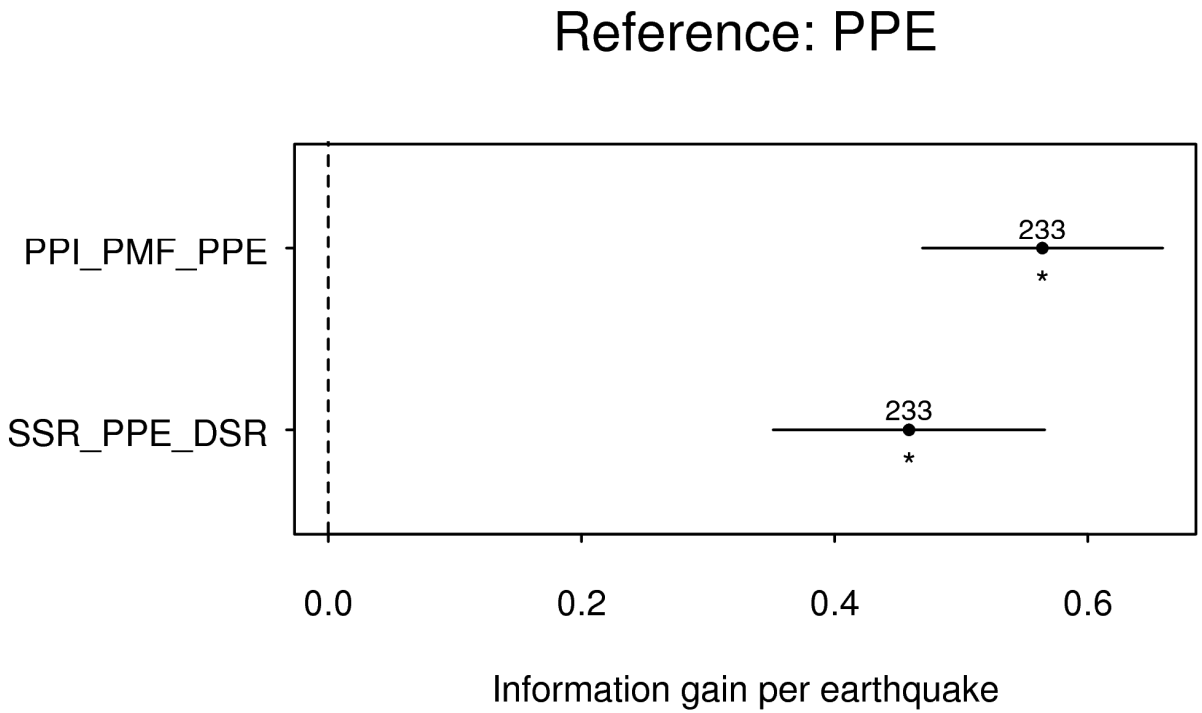
N-test comparisons of the observed number of target earthquakes (dotted line) and the number forecast by 5-year models (with Poisson 95% limits) over the period 2008 Jan 1 – 2017 Aug 8.

5-year models: Information gain (T-test)



T/W-test comparisons showing information gain of other 5-year models relative to NZHM over the test period 2008 Jan 1 – 2017 Aug 8

Comparison with recent hybrid models



T/W-test comparisons showing information gain of two recently developed hybrid models relative to PPE over the test period 2008 Jan 1 – 2017 Aug 8.

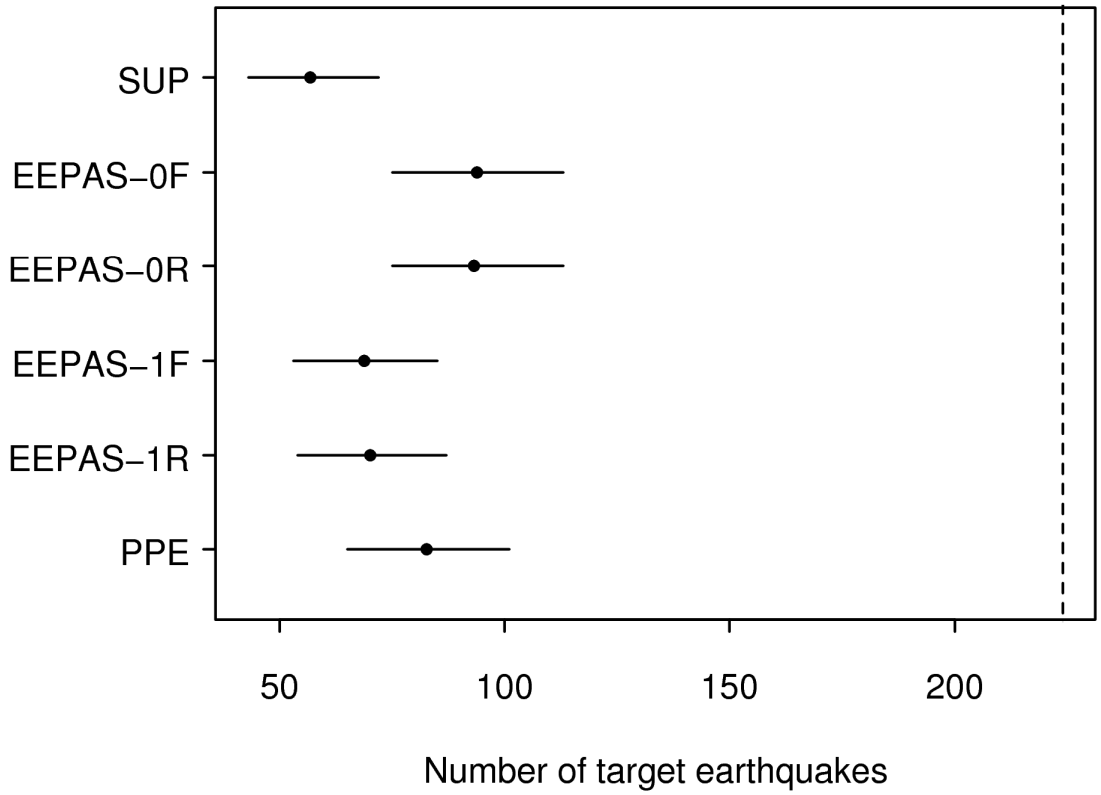
3-month models

- Processing commenced in May 2009.
- Target earthquakes M > 4.95
- Input catalogue M >2.95 ending one month before the start of each test period
- Quarterly forecasts in the testing centre from 2009-q3 to 2013-q2
- Forecasts subject to deficiencies in the input catalogue
- Extra forecasts computed from 2013-q3 to 2017-q2 outside testing centre using best available catalogue

3-month models

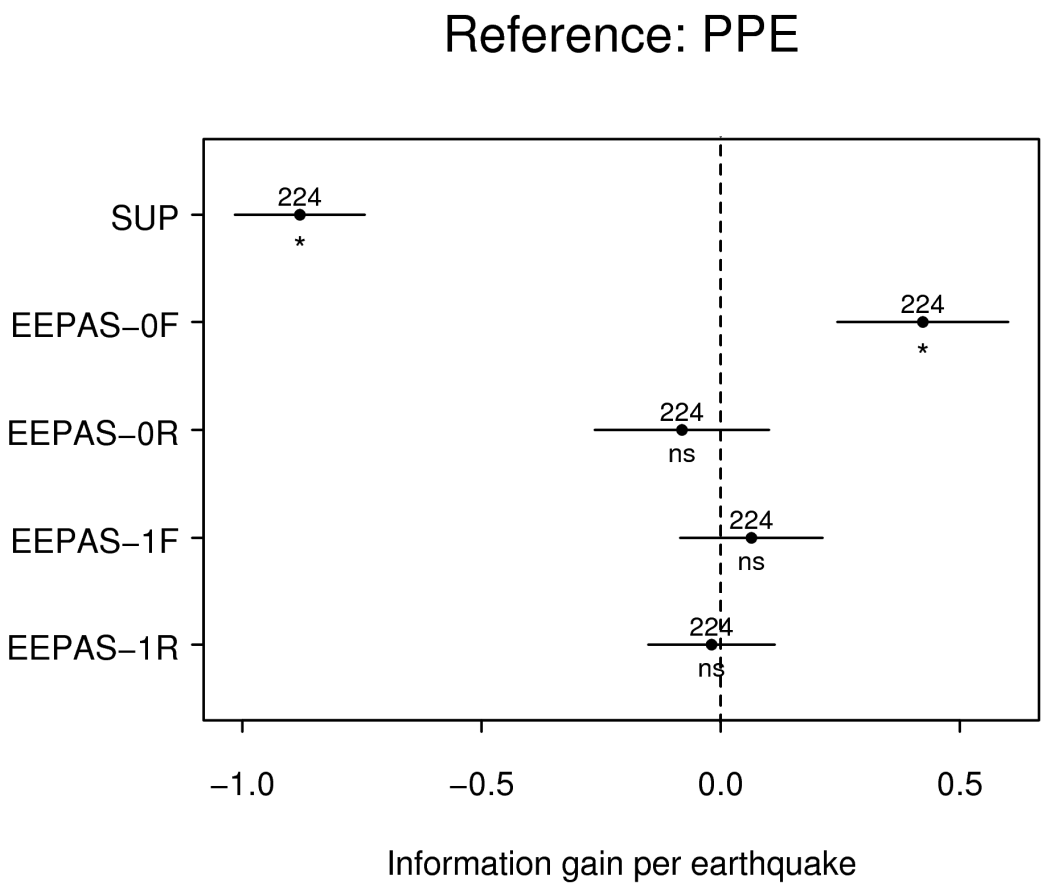
Model name	Description	Reference
PPE	Proximity to past Earthquakes (updated)	Jackson & Kagan (1999) Rhoades & Evison (2004)
EEPAS-0R	Every Earthquake a Precursor According to Scale – equal weighting, 4 parameter fit	Rhoades & Evison (2004)
EEPAS-0F	EEPAS – equal weighting, 6 parameter fit	Rhoades & Evison (2004)
EEPAS-1R	EEPAS – aftershocks down-weighted, 4 parameter fit	Rhoades & Evison (2004)
EEPAS-1F	EEPAS – aftershocks down-weighted, 6 parameter fit	Rhoades & Evison (2004)
DBM	Double Branching Model: 2012-q4 to 2013-q2 only	Marzocchi &Lombardi (2008)

3-month models: N-test



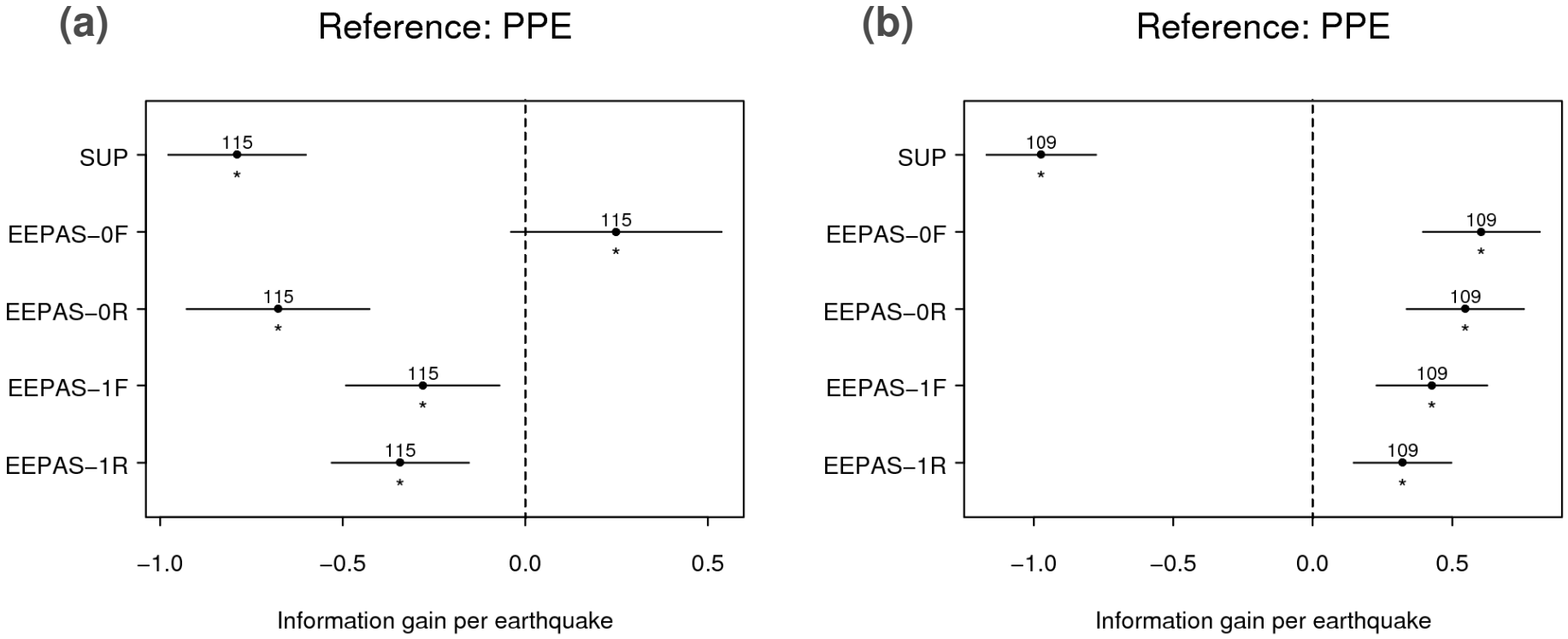
N-test comparisons of the observed number of target earthquakes (224, dotted line) and the number forecast by 3-models (with Poisson 95% limits) over the period 2009 Jul 1 – 2017 Jun 30

3-month models: T-test



T/W-test comparisons showing information gain of other 3-month models relative to PPE over the test period 2009 Jul 1 – 2017 Jun 30

3-month models: T-tests (inside & outside testing centre)



T/W-test comparisons showing information gain of 3-month models relative to PPE over the test period (a) 2009 Jul 1 – 2013 Jun 30, computed in testing centre using real-time catalogue; (b) 2013 Jul 1 – 2017 Jun 30, computed outside testing centre using final catalogue

Conclusions and comments

- **No models expected the very high level of seismicity in New Zealand during the test period**
- **3-month models have been affected by variable quality and severe data gaps in the input catalogue**
- **3-month models should be rerun inside testing centre with best available catalogue**
- **No useful 1-day forecasts during Kaikoura aftershocks: need to be re-run**
- **Two successful retrospective experiments have been conducted**
  - to test Canterbury hybrid forecasting model over 25 years, including lags
  - to test Darfield aftershock models