BSSA12 GMPEs

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for the 2014 Update

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Model Description

- BA08 functional form for M and R_{jb} scaling
- Change from BA08:
  - Modified V_{s30}-scaling from NGA-West2 Task 8.

The GMPE (same as used in BA08, except for F_s)

$$\ln Y = F_{\boldsymbol{M}}(\mathbf{M}) + F_D(R_{JB}, \mathbf{M}) + F_S(V_{S30}, R_{JB}, \mathbf{M}) + \varepsilon\sigma$$

F_M, F_D, F_S are magnitude, distance, and site functions. ε is the fractional number of standard deviations of a single predicted value of away from the mean value of (*e.g.*, would be 1.5 standard deviations smaller than the mean value). All terms, including the coefficient σ, are period dependent. σ is computed using the equation

$$\sigma = \sqrt{\phi^2 + \tau^2}$$

where ϕ is the intra-event aleatory uncertainty and τ is the inter-event aleatory uncertainty.

The Distance and Magnitude Functions

Distance dependence:

$$F_D(R_{JB}, \mathbf{M}) = [c_1 + c_2(\mathbf{M} - \mathbf{M}_{ref})]\ln(R / R_{ref}) + c_3(R - R_{ref})$$

where

$$R = \sqrt{R_{JB}{}^2 + h^2}$$

The Magnitude Function

Magnitude Dependence (Primary):

For $M \le M_h$:

$$F_M(\mathbf{M}) = e_1 SS + e_2 NS + e_3 RS + e_4(\mathbf{M} - \mathbf{M}_h) + e_5(\mathbf{M} - \mathbf{M}_h)^2$$

For $M > M_h$:

$$F_M(\mathbf{M}) = e_1 SS + e_2 NS + e_3 RS + e_6(\mathbf{M} - \mathbf{M}_h)$$

$$(e_6 \ge 0.0)$$

Mechanism	SS	NS	RS
strikeslip	1	0	0
normal	0	1	0
reverse	0	0	1

The Site Amplification Function

$$F_S = F_{LIN} + F_{NL}$$

Linear Amplification:

$$F_{LIN} = b_{lin} \ln(V_{S30} / V_{ref})$$

$$(V_{ref} = 760 \text{ m/s})$$

The coefficient b_{lin} depends on period. We use the Stewart and Seyhan (2012) model.

The Site Amplification Function

$$F_S = F_{LIN} + F_{NL}$$

Nonlinear Amplification:

$$F_{NL} = b_{nl} \ln\left(\frac{PGA_{760\text{m/s}} + 0.1g}{0.1g} \right)$$

The coefficient b_{nl} depends on period and V_{S30}. We use Stewart and Seyhan’s (2012) model 2, where b_{nl} is called f_2.

Not Included

- Directivity
- Basin depth
- Hanging wall (using R_{JB} accounts for this to some extent)
- Other possible predictor variables (e.g., dip, Ztor, etc.)

Determination of Coefficients (2-stage regression)

- Select data:
  - no basement or large structure records, etc;
  - R_{JB} < 80 km
  - event class 1, as determined by CR_{JB}=10 km
- Adjust observations to V_{s30}=760 m/s using SS12 site amps
- Constrain c_3 (anelastic term) to the BA08 values
- Regress for other coefficients, including pseudodepth h

Stage 2 regressions

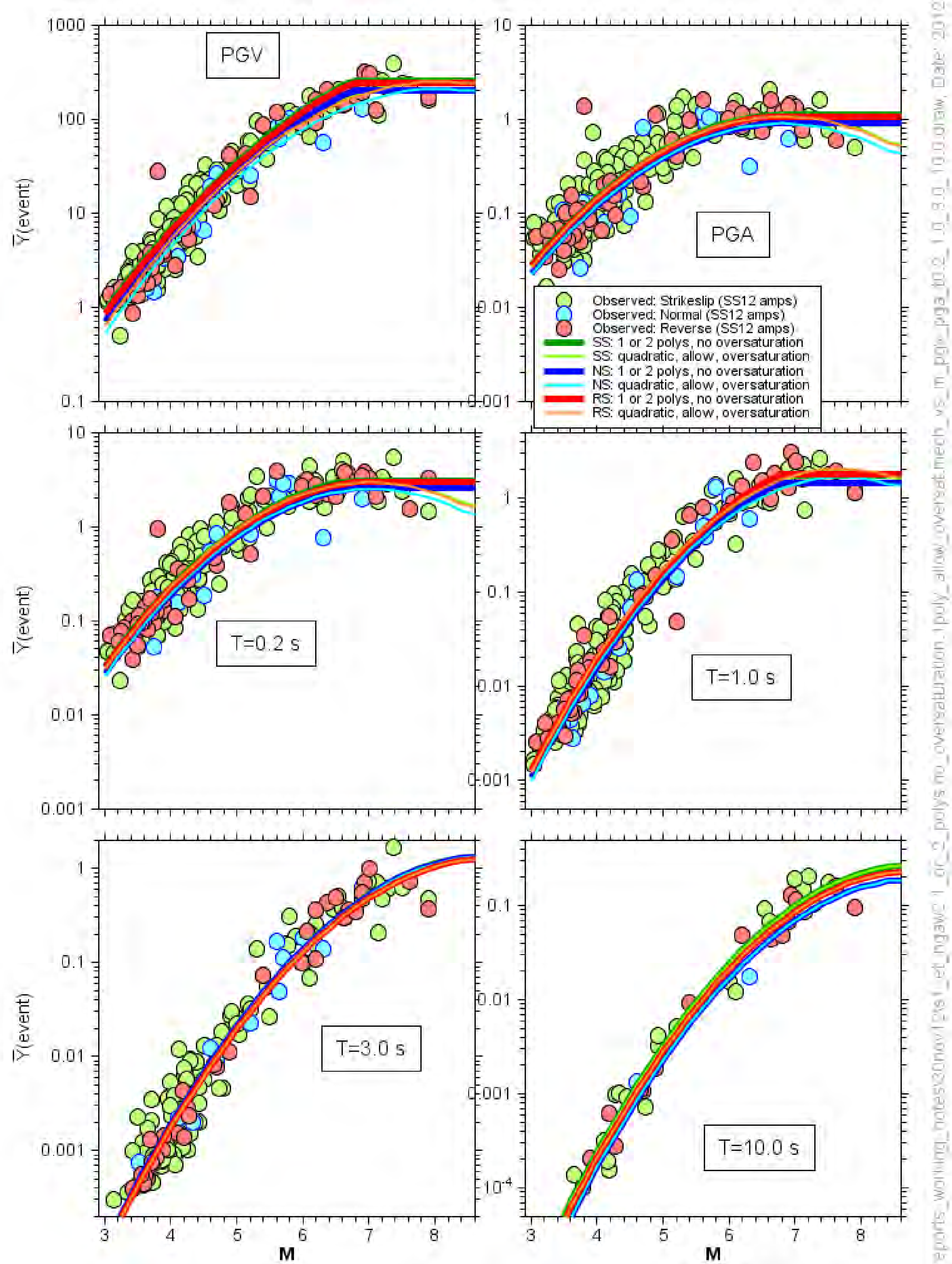
Thick Lines

All but T=3.0, 10 s: quadratic to 6.75; linear beyond, not allowed to go negative

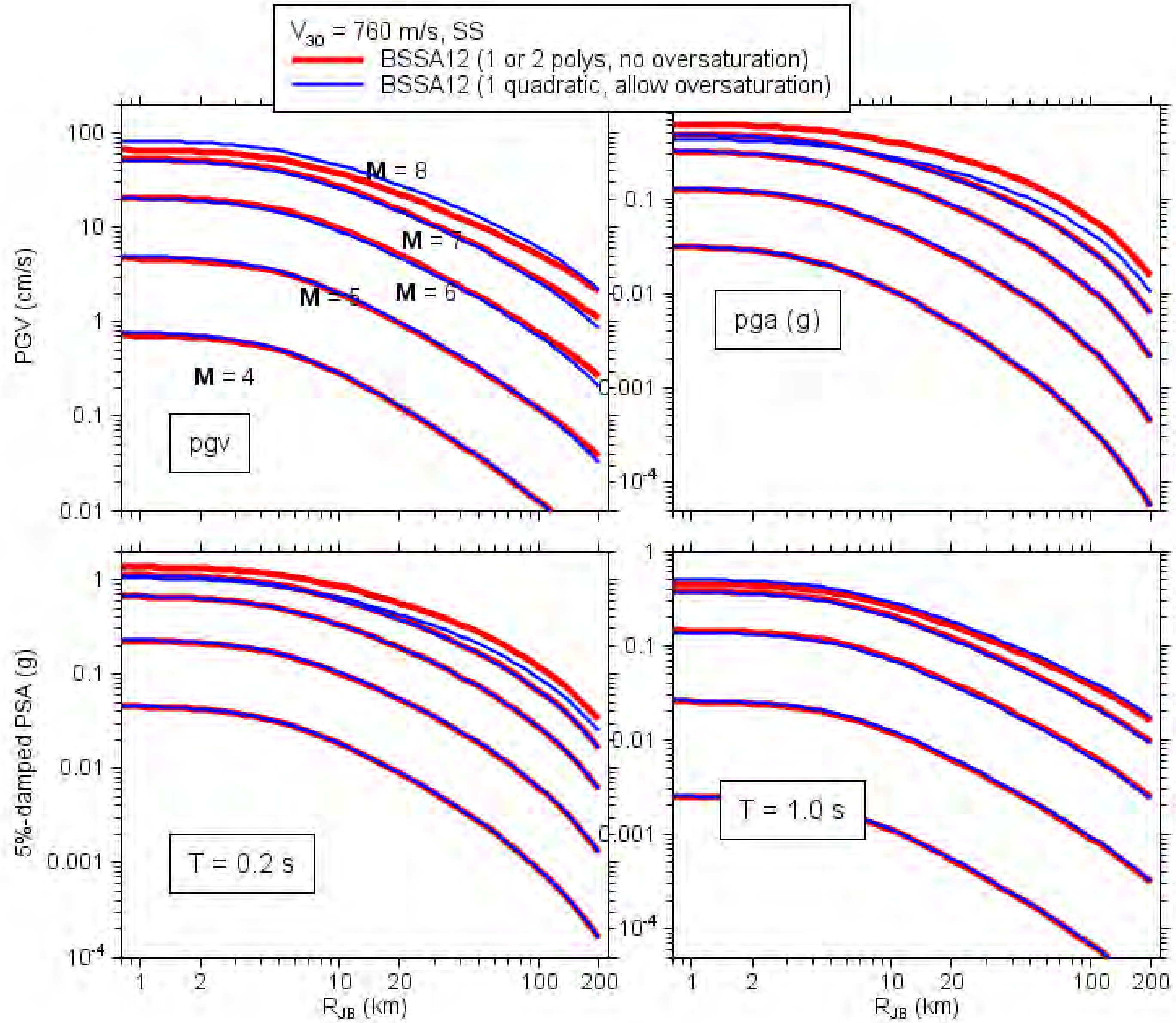
T=3.0,10 s: quadratic

Thin Lines

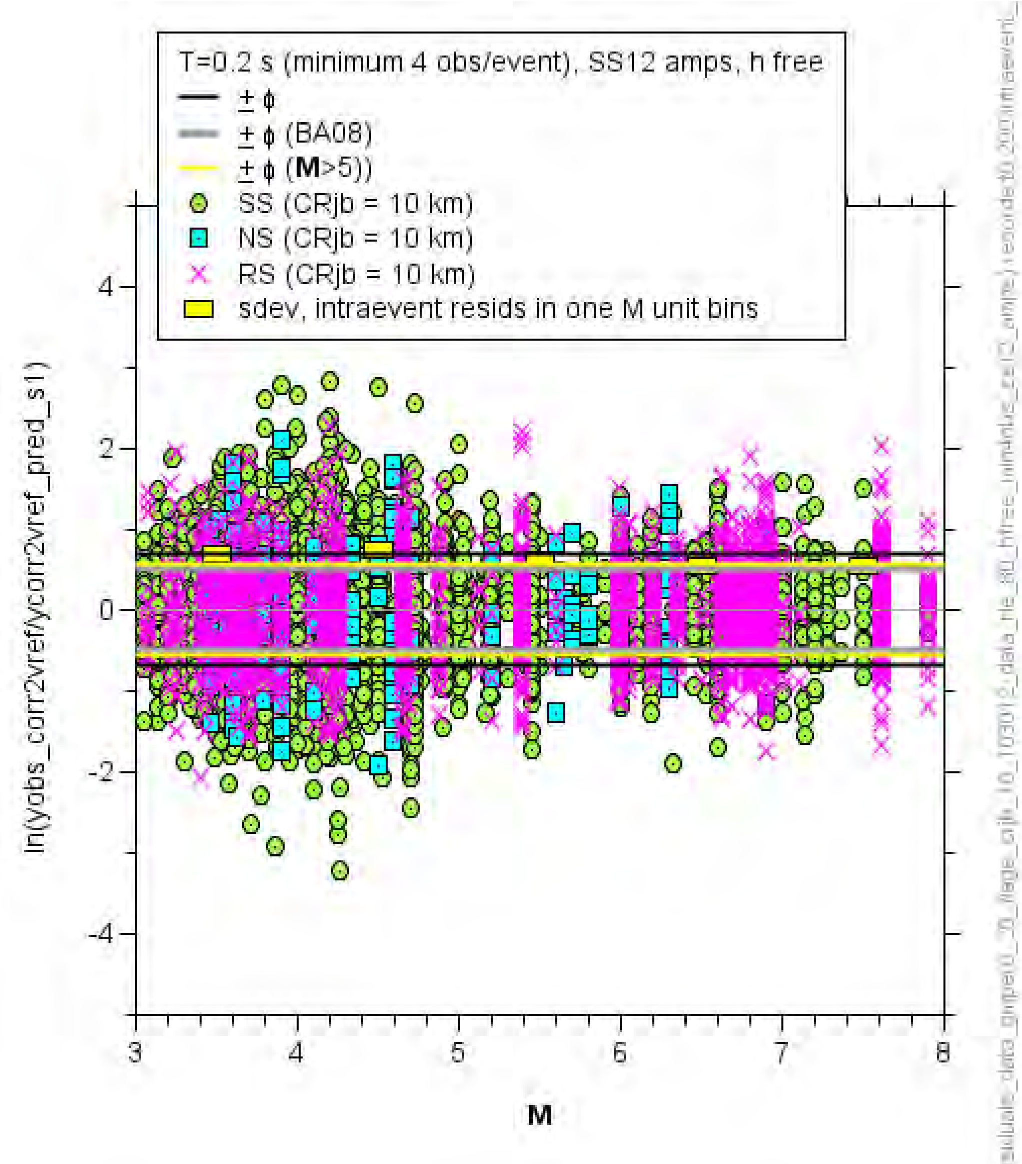
1 quadratic (allow oversaturation)



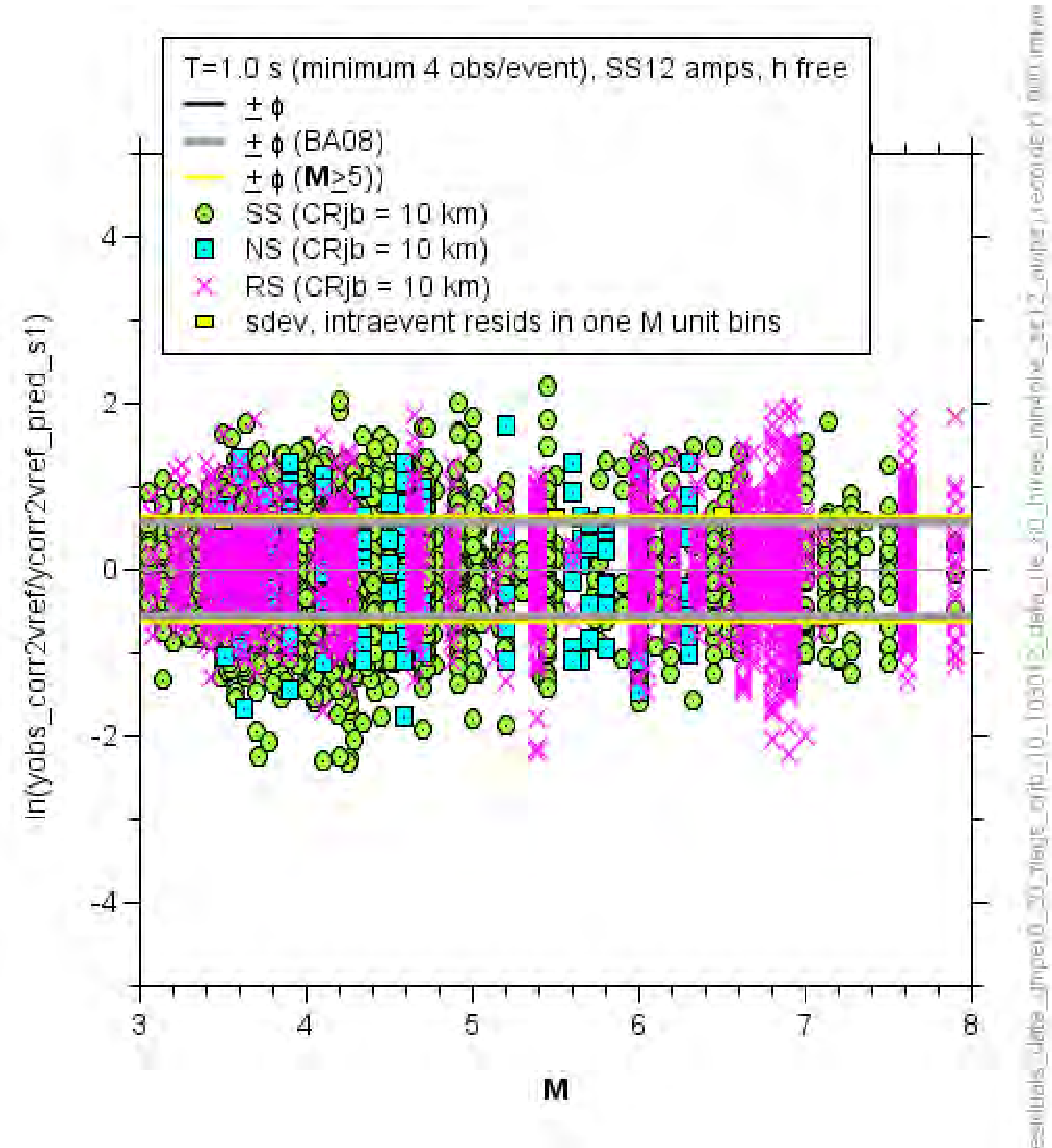
Note: oversaturation at short distances does NOT imply over saturation at all distances



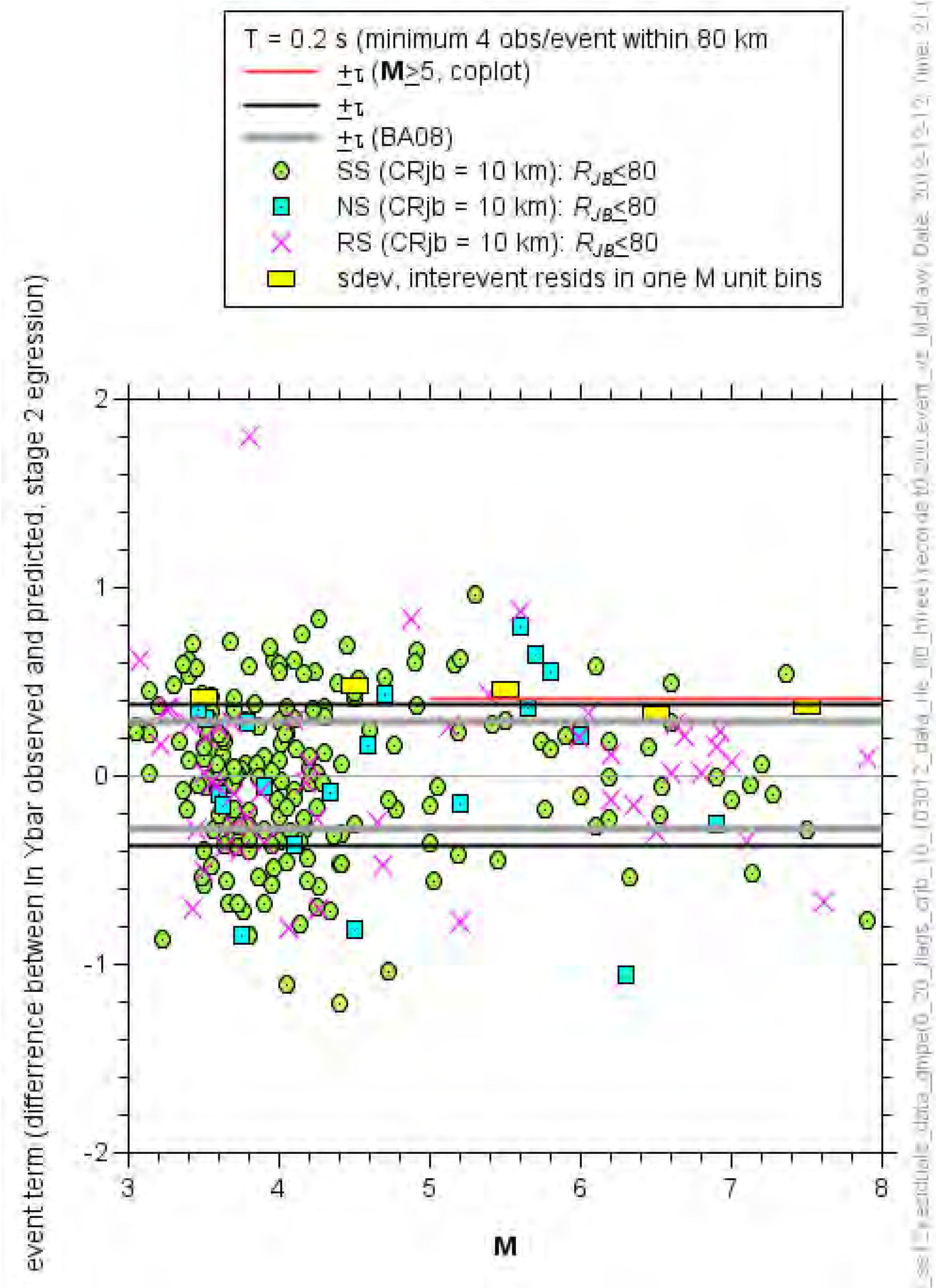
intraevent residuals vs **M** (T=0.2s)



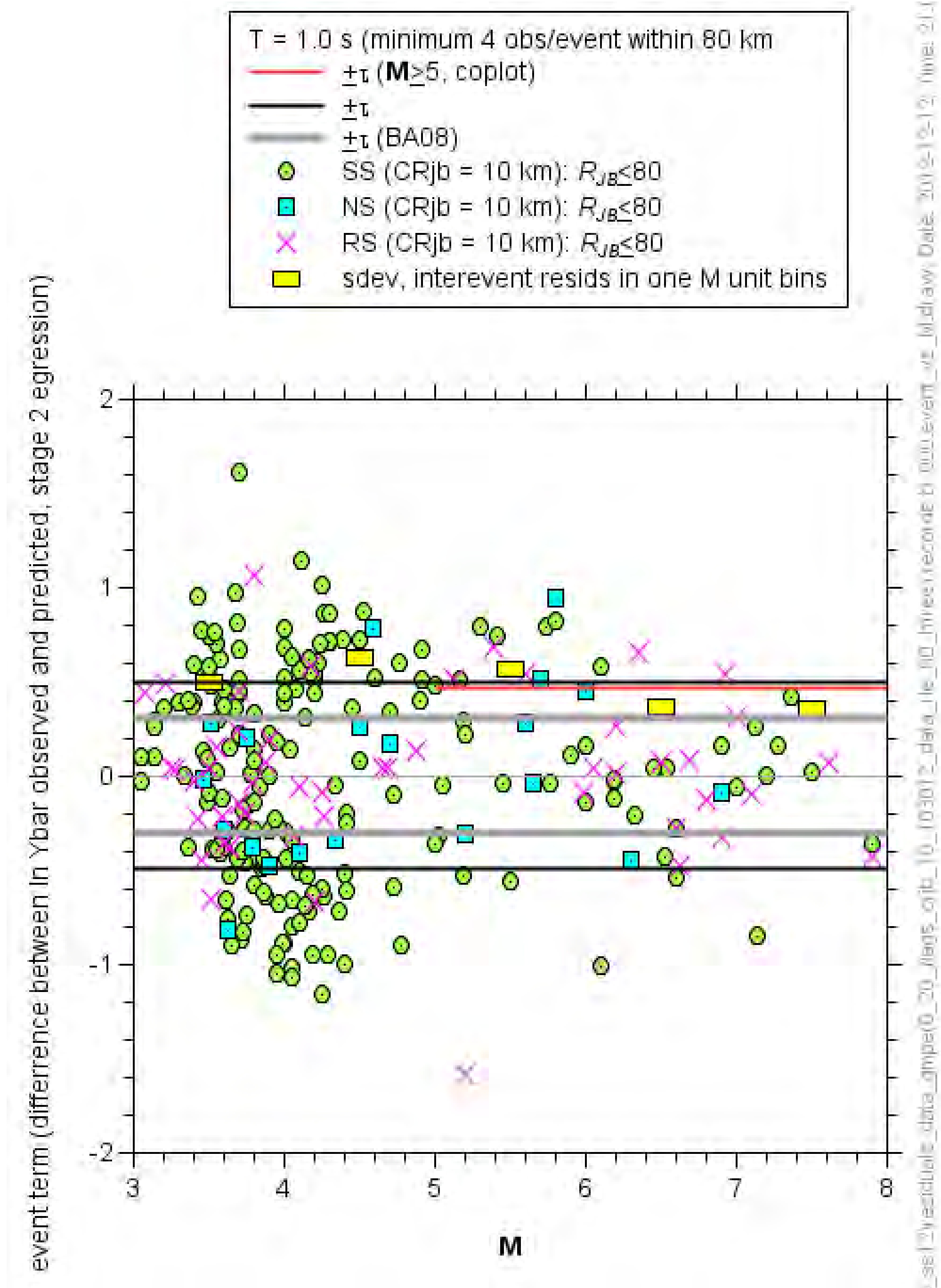
intraevent residuals vs
M (T=1.0s)



Interevent residuals vs
M (T=0.2s)



Interevent residuals vs **M** (T=1.0s)



Period	ϕ (revised)	τ (revised)	σ (revised)	ϕ (BA08)	τ (BA08)	σ (BA08)
PGA	0.51	0.40	0.65	0.50	0.26	0.56
0.2	0.56	0.40	0.69	0.52	0.29	0.60
1	0.63	0.46	0.78	0.57	0.30	0.65

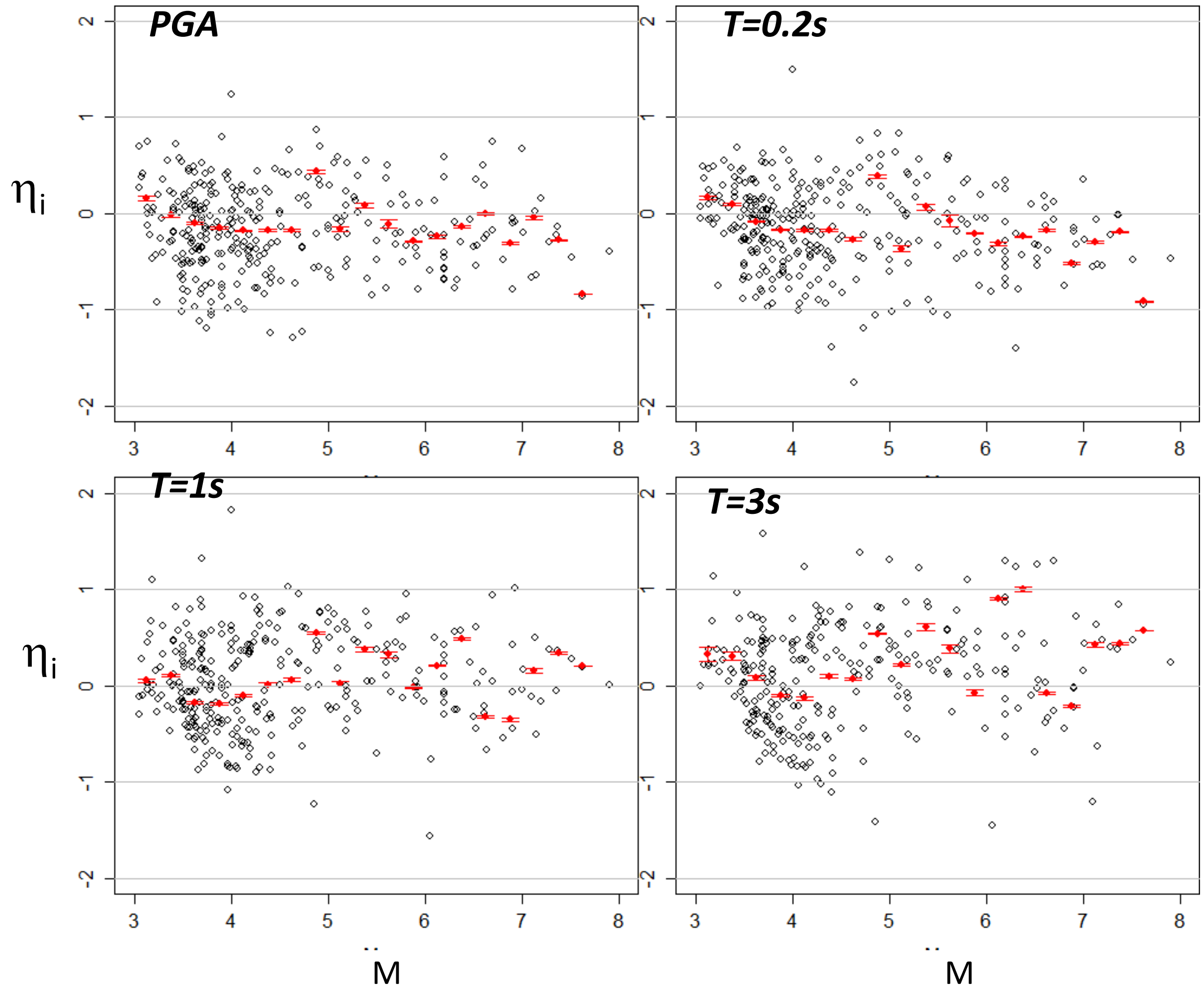
RE Residuals Analysis

- Purpose: evaluate model performance using broader data set (> 80 km considered, C1 & C2 events, 15600 recordings)
- Procedure: compute *c* and η_i from following RE regression (*i* is event index, *j* is record index):

$$R_{i,j} = c + \eta_i + \varepsilon_{i,j}$$

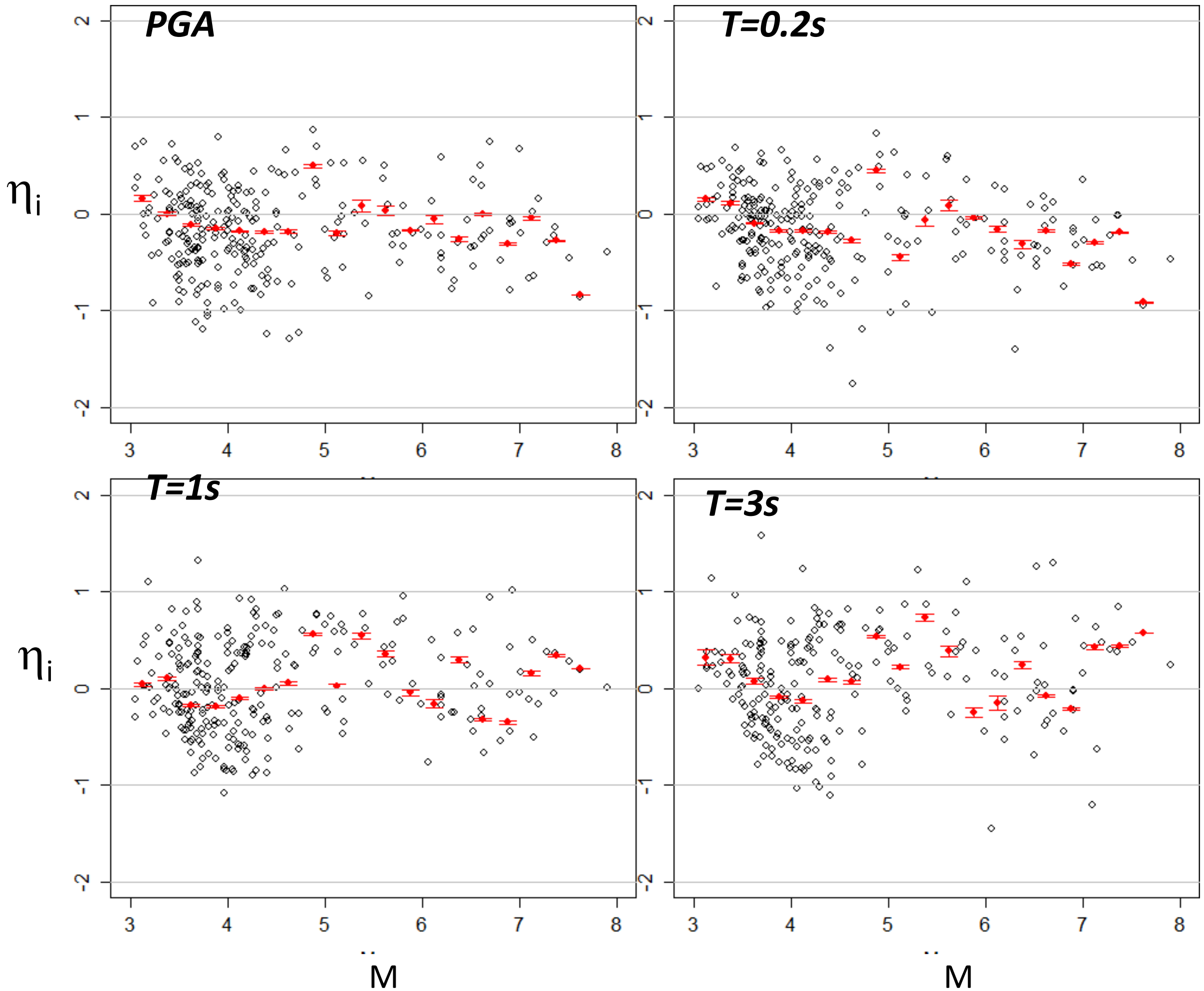
- η_i examined relative to source parameters
- ε_{ij} examined relative to R_{jb} and V_{s30}

Event Term Trends



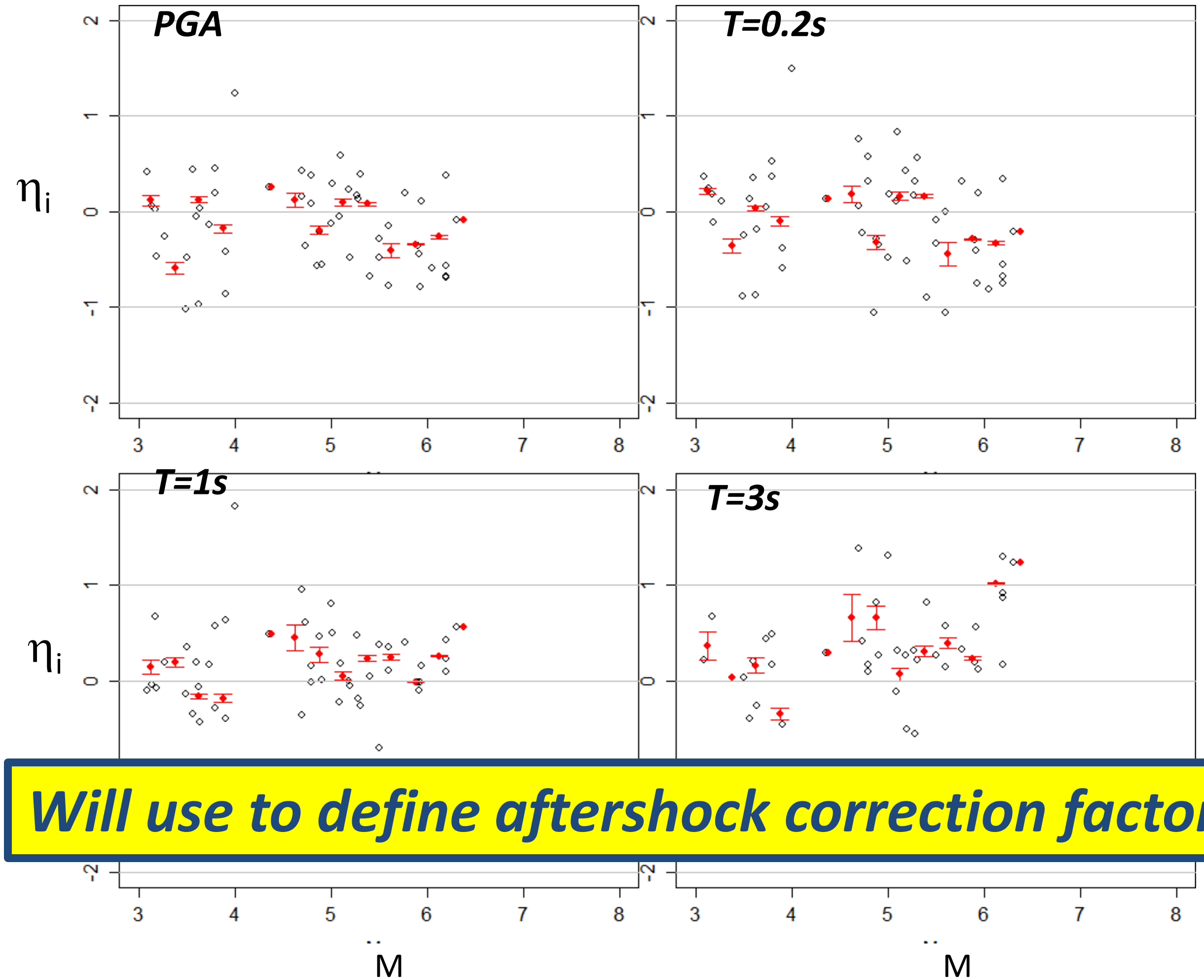
C1 & C2
CR_{jb} 10 km

Event Term Trends



C1
CR_{jb} 10 km

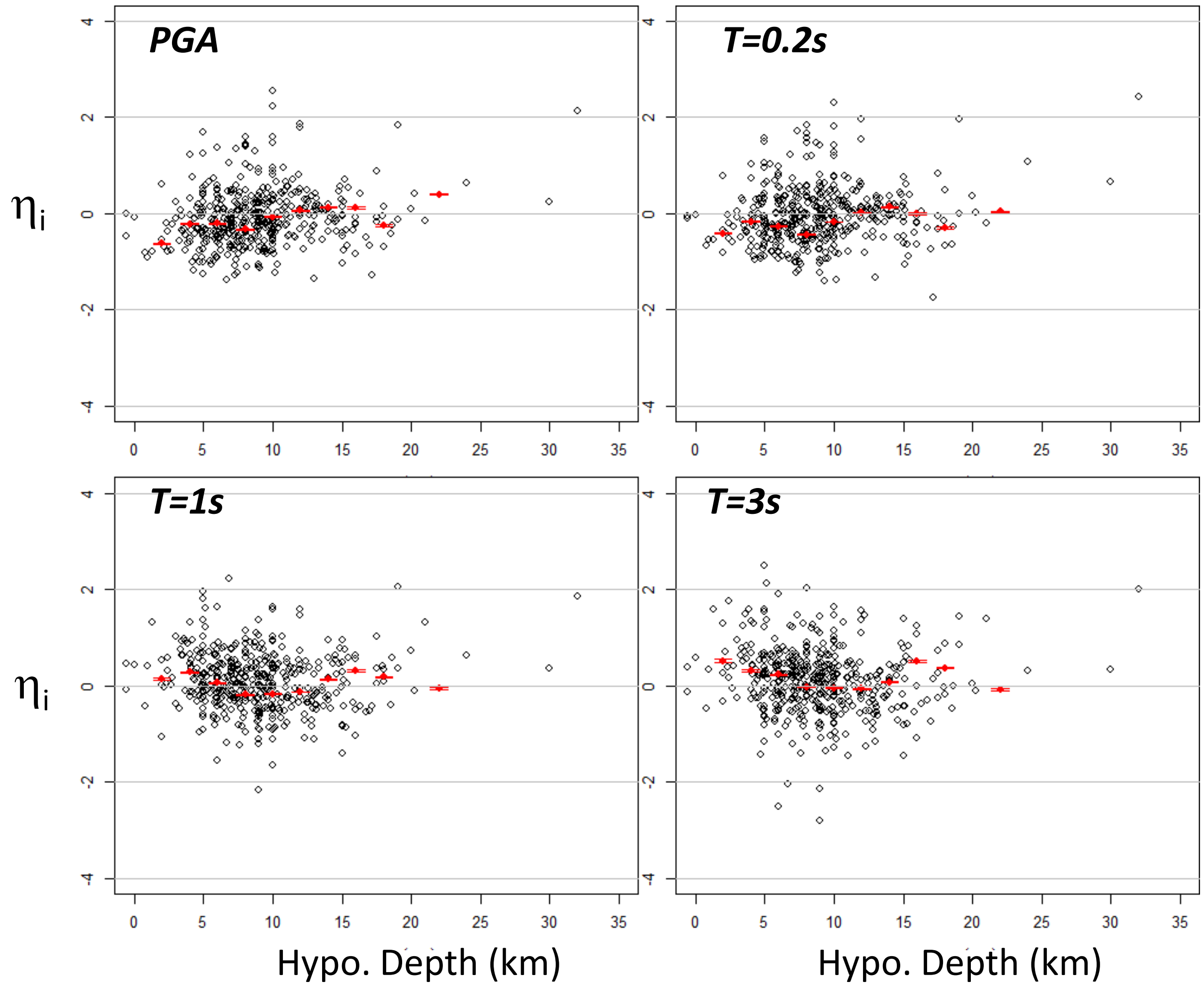
Event Term Trends



C2
CR_{jb} 10 km

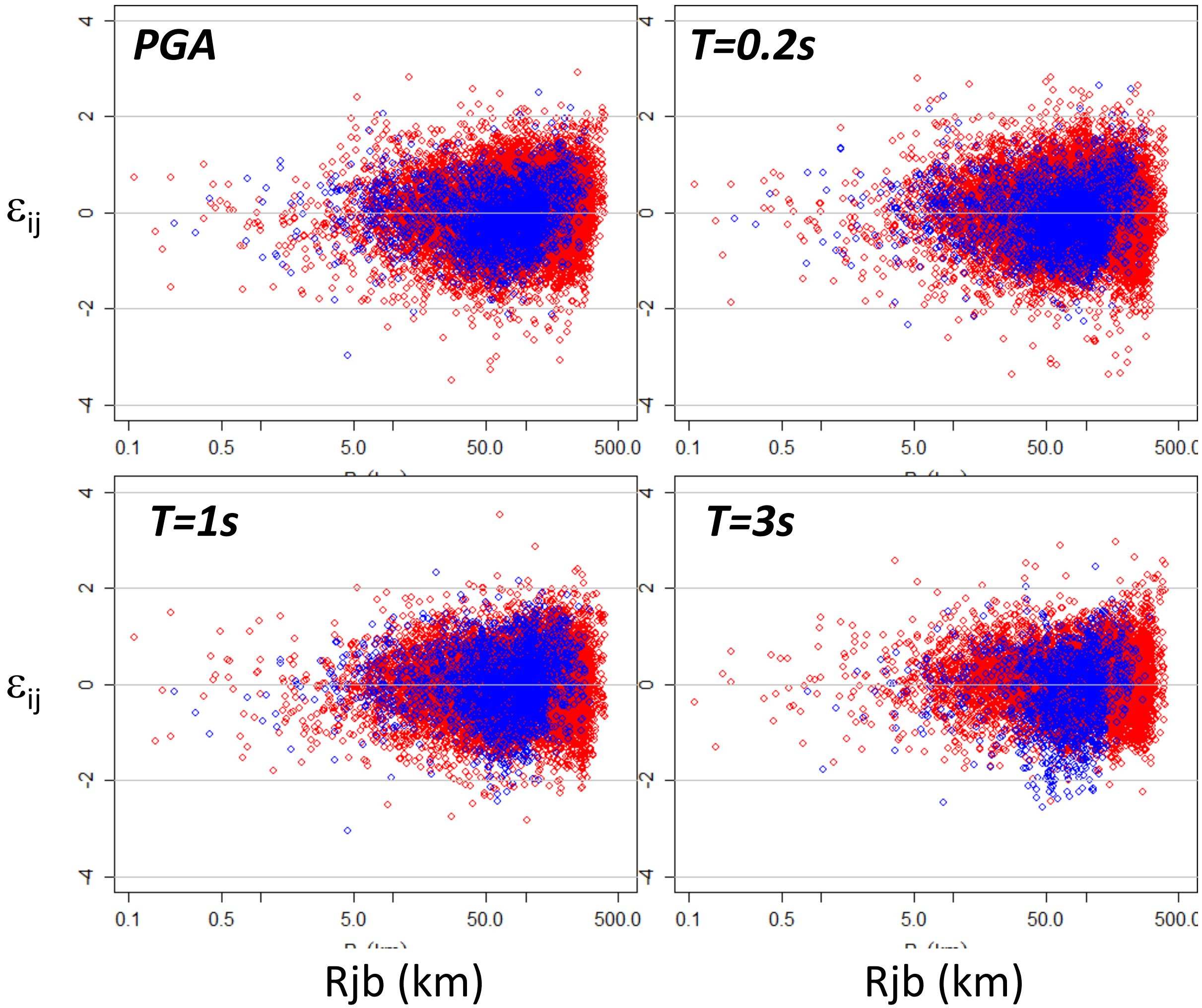
Will use to define aftershock correction factors

Event Term Trends



C1 & C2
CR_{jb} 10 km

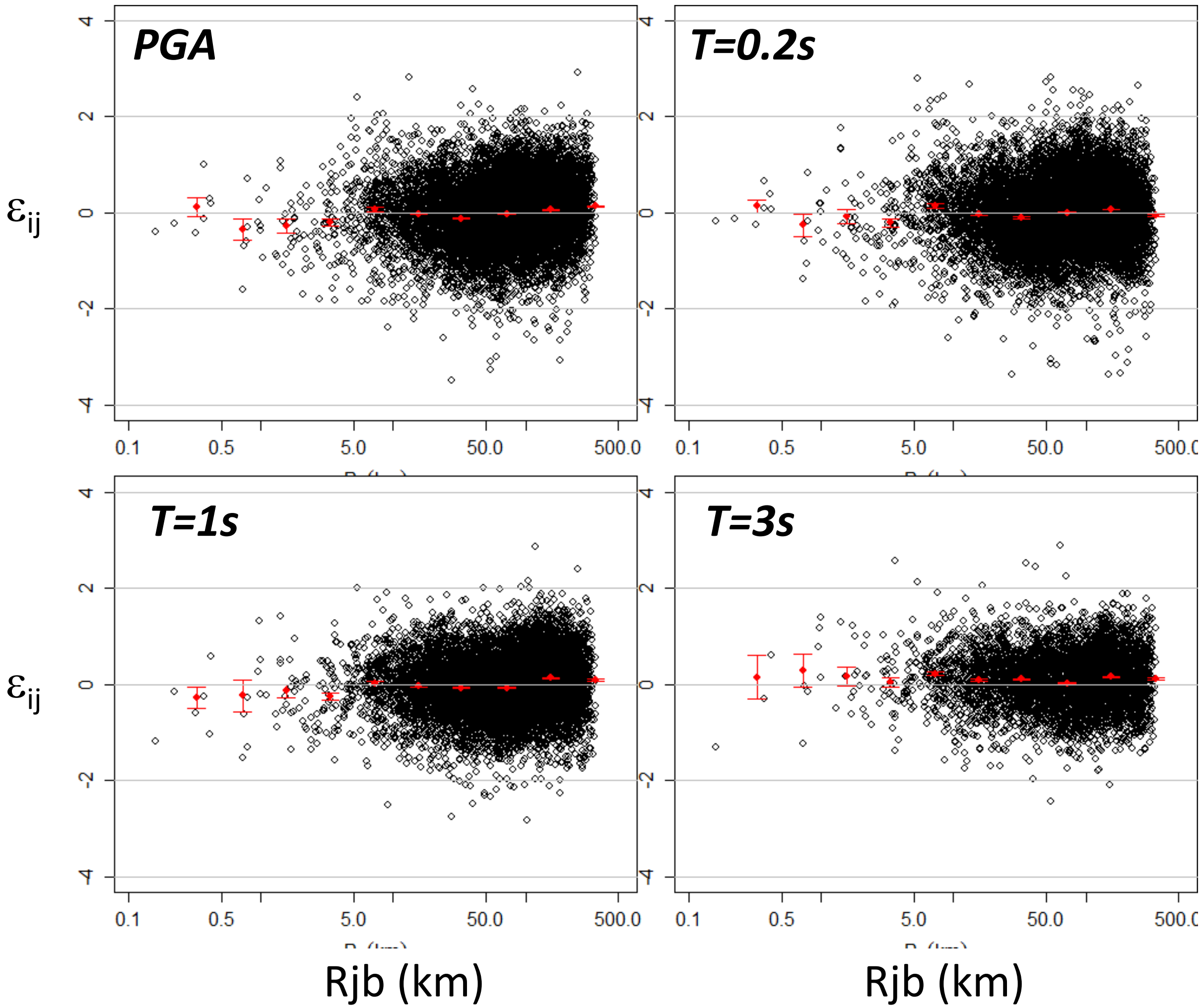
Within-Event Residuals



All data
C1 & C2
CR_{jb} 10 km

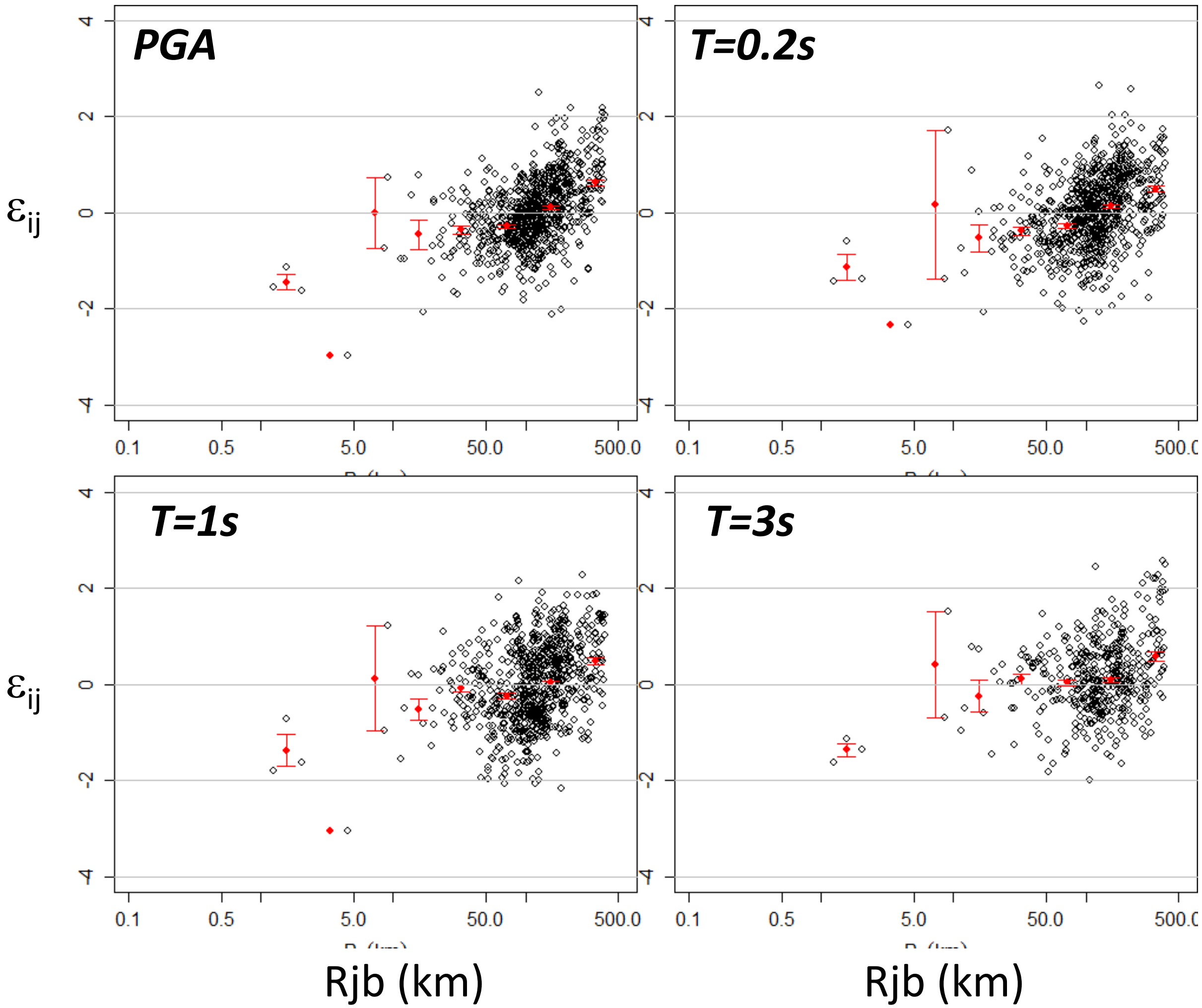
Red: C1
Blue: C2

Within-Event Residuals



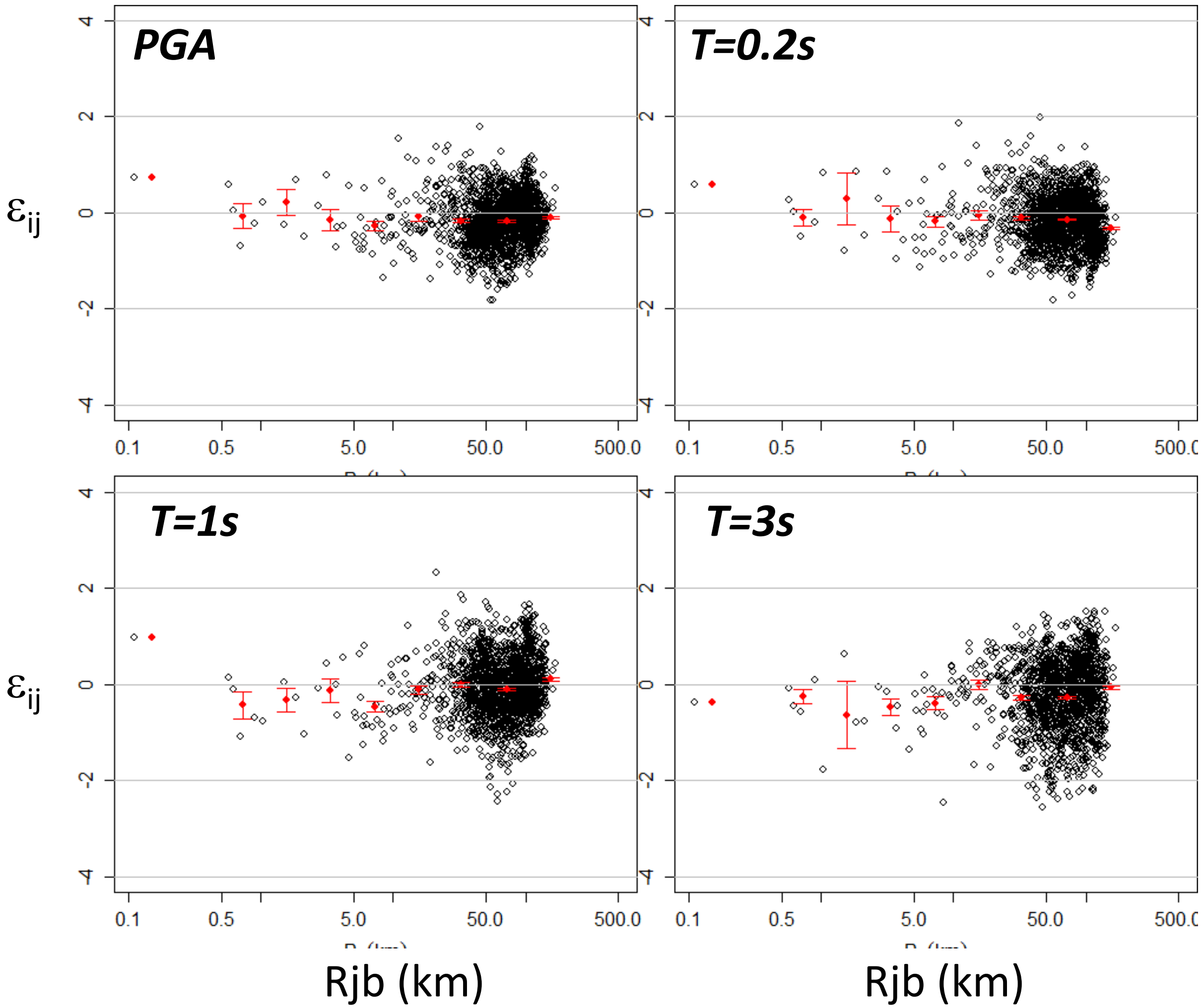
California
C1 & C2
CR_{jb} 10 km

Within-Event Residuals



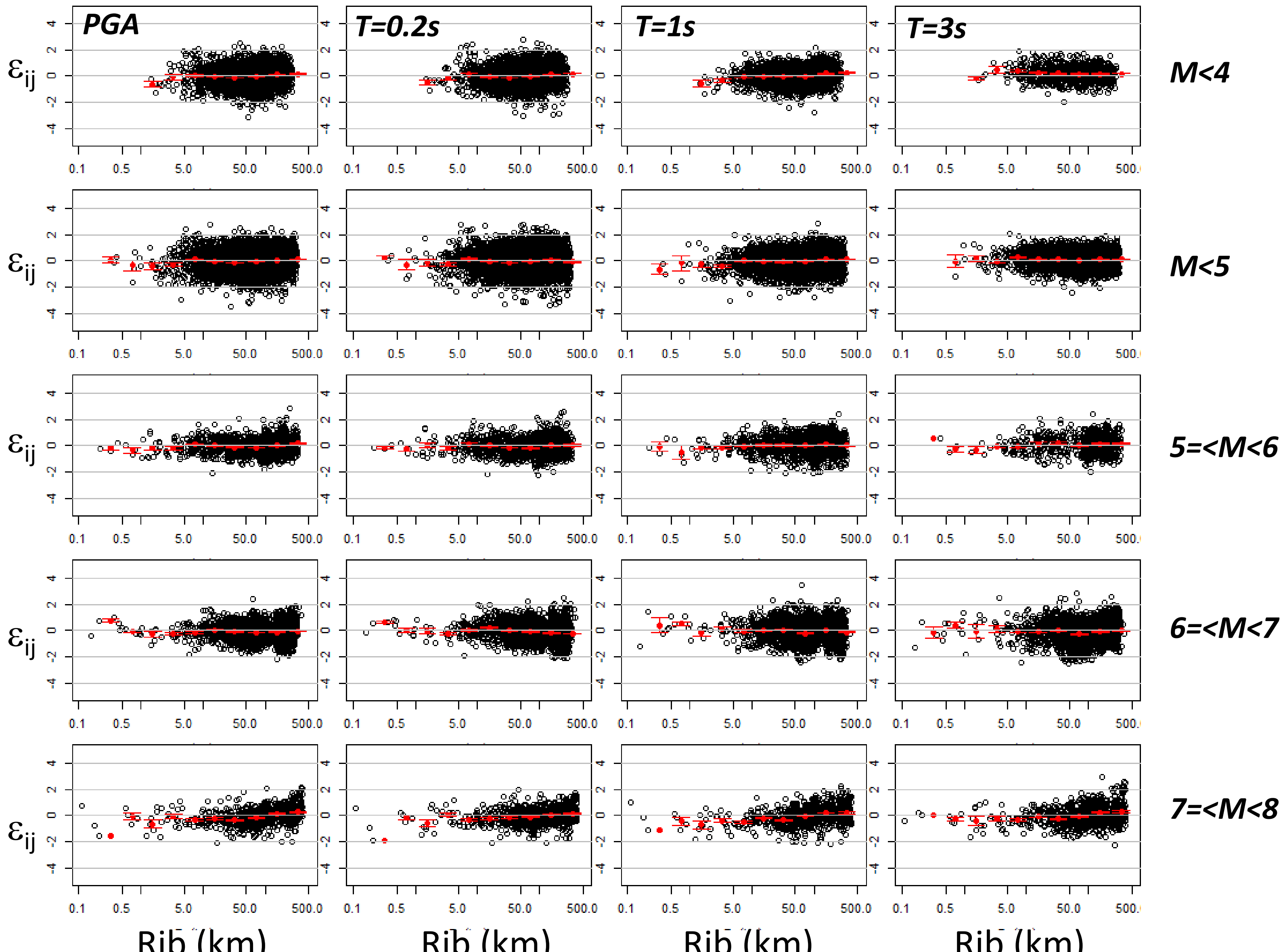
China
C1 & C2
CR_{jb} 10 km

Within-Event Residuals

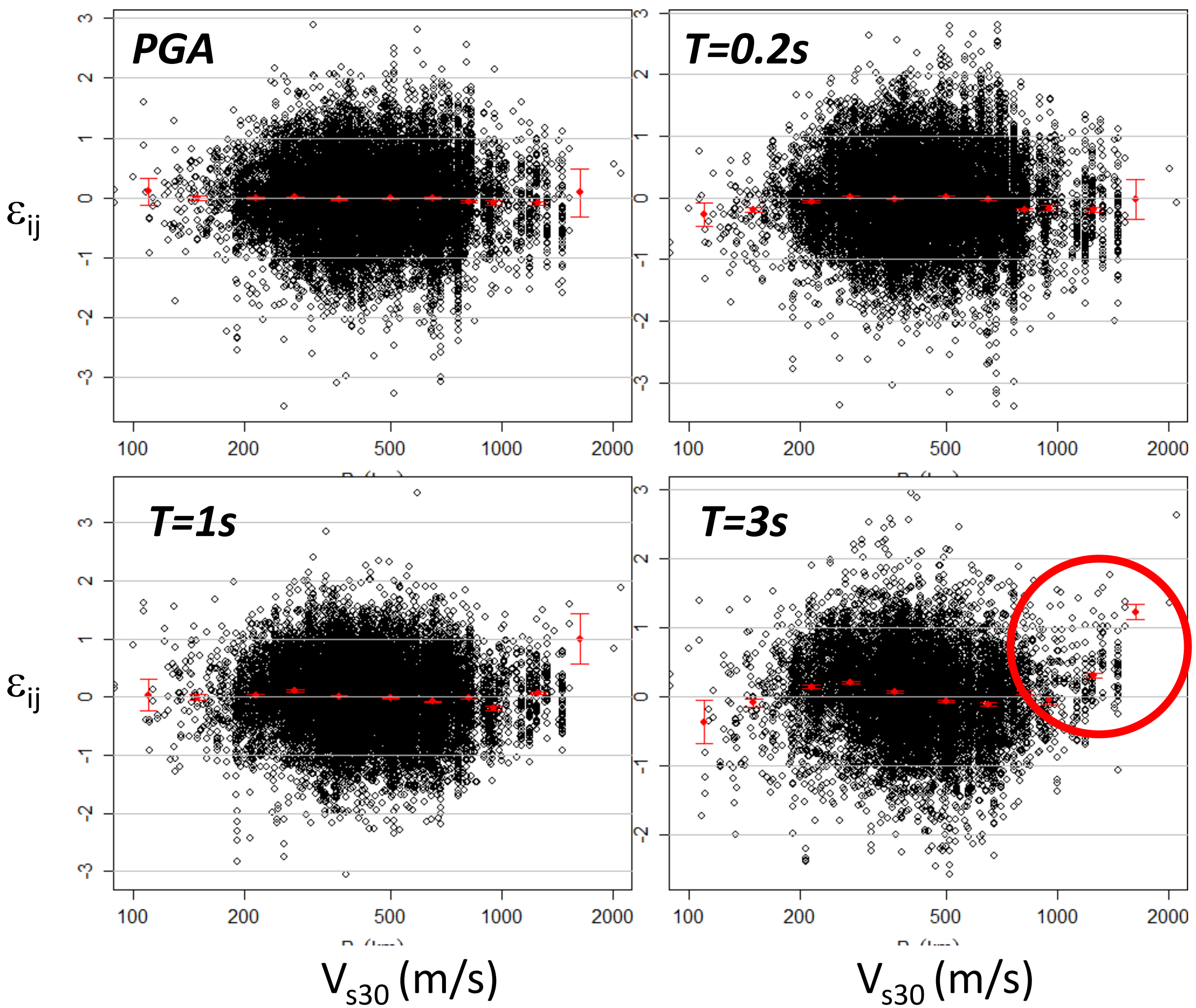


Taiwan
C1 & C2
CR_{jb} 10 km

Within-Event Residuals



Within-Event Residuals



All data
C1 & C2
CR_{jb} 10 km