

CEUS Ground Motion Models Used in The 2014 NSHMs

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U.S Geological Survey

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CEUS GMMs & Weights in 2008

2008 GMM	Abbreviation	Type	Weight	
			RLME	GridSrc
1. Frankel and others (1996)	F96	Single corner – point source	0.1	0.125
2. Toro and others (1997), Toro (2002)	T02	Single corner – finite fault	0.2	0.25
3. Silva and others (2002)	S02	Single corner – finite fault	0.1	0.125
4. Atkinson and Boore (2006)	AB06	Dynamic corner	0.1	0.125
<ul style="list-style-type: none"> • 140 bar stress drop • 200 bar stress drop 			0.1	0.125
5. Campbell (2003)	C03	Hybrid	0.1	0.125
6. Tavakoli and Pezeshk (2005)	TP05	Hybrid	0.1	0.125
7. Somerville and others (2001)	S01	Full waveform simulation	0.2	0

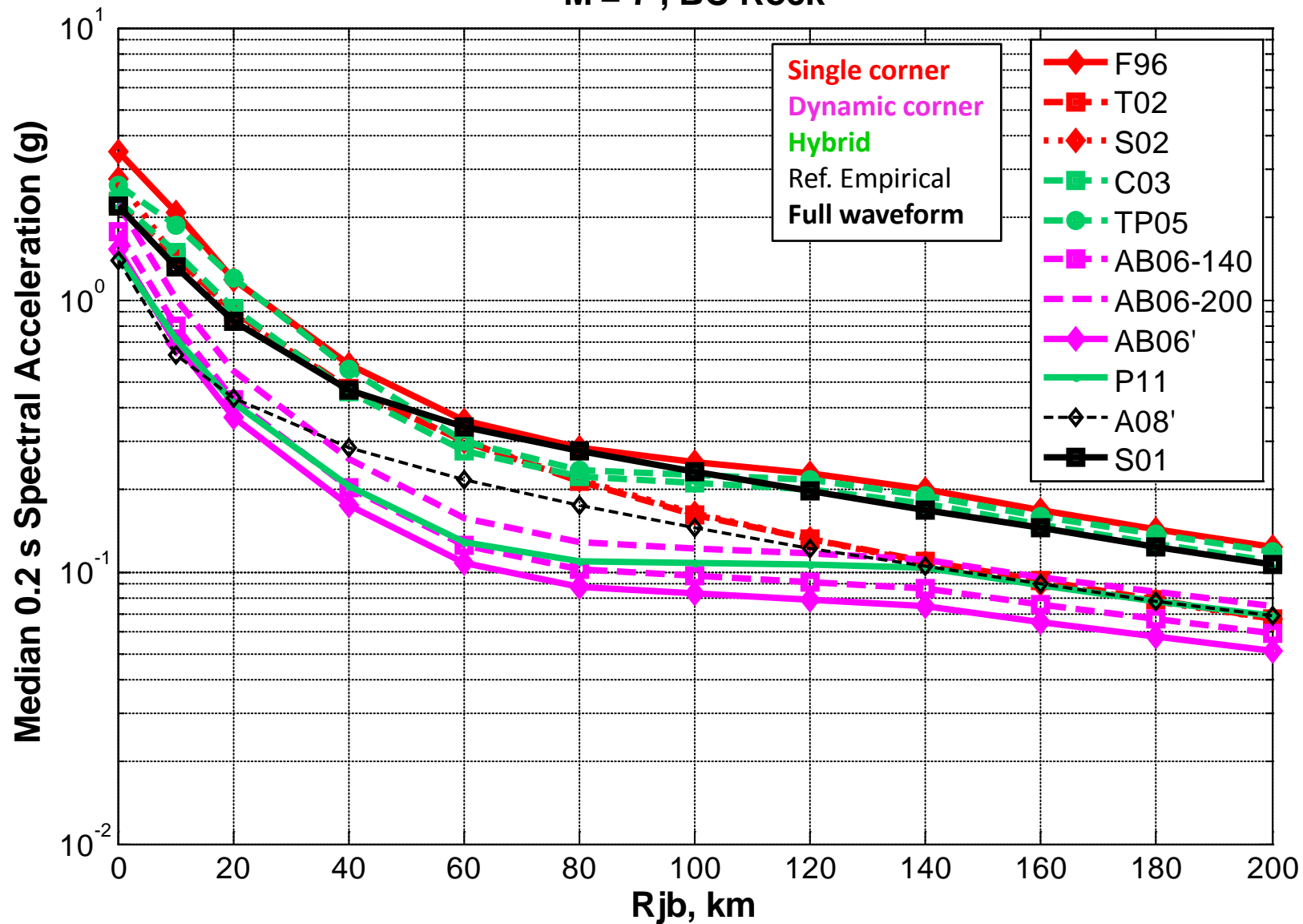
CEUS GMMs & Weights in 2014

2014 GMM	Abbreviation	Type	Kappa (rock to 760 m/s)	GS	Weight*		
					RLME	GridSrc	>500 km
1. Frankel and others (1996)	F96	Single corner	0.01	R ⁻¹	0.06	0.06	0.16
2. Toro and others (1997), Toro (2002)	T02	Single corner	0.01	R ⁻¹	0.11	0.13	0
3. Silva and others (2002)	S02	Single corner	0.01	R ⁻¹	0.06	0.06	0
4. Campbell (2003)	C03	Hybrid	0.01	R ⁻¹	0.11	0.13	0.17
5. Tavakoli and Pezeshk (2005)	TP05	Hybrid	0.01	R ⁻¹	0.11	0.13	0.17
6. Atkinson and Boore (2006')	AB06'	Dynamic corner	0.02	R ^{-1.3}	0.22	0.25	0.3
7. Pezeshk and others (2011)	P11	Hybrid	0.02	R ^{-1.3}	0.15	0.16	0.2
8. Atkinson (2008')	A08'	Reference Empirical	0.02	NA	0.08	0.08	0
9. Somerville and others (2001)	S01	Full waveform	0.01	NA	0.10	0	0

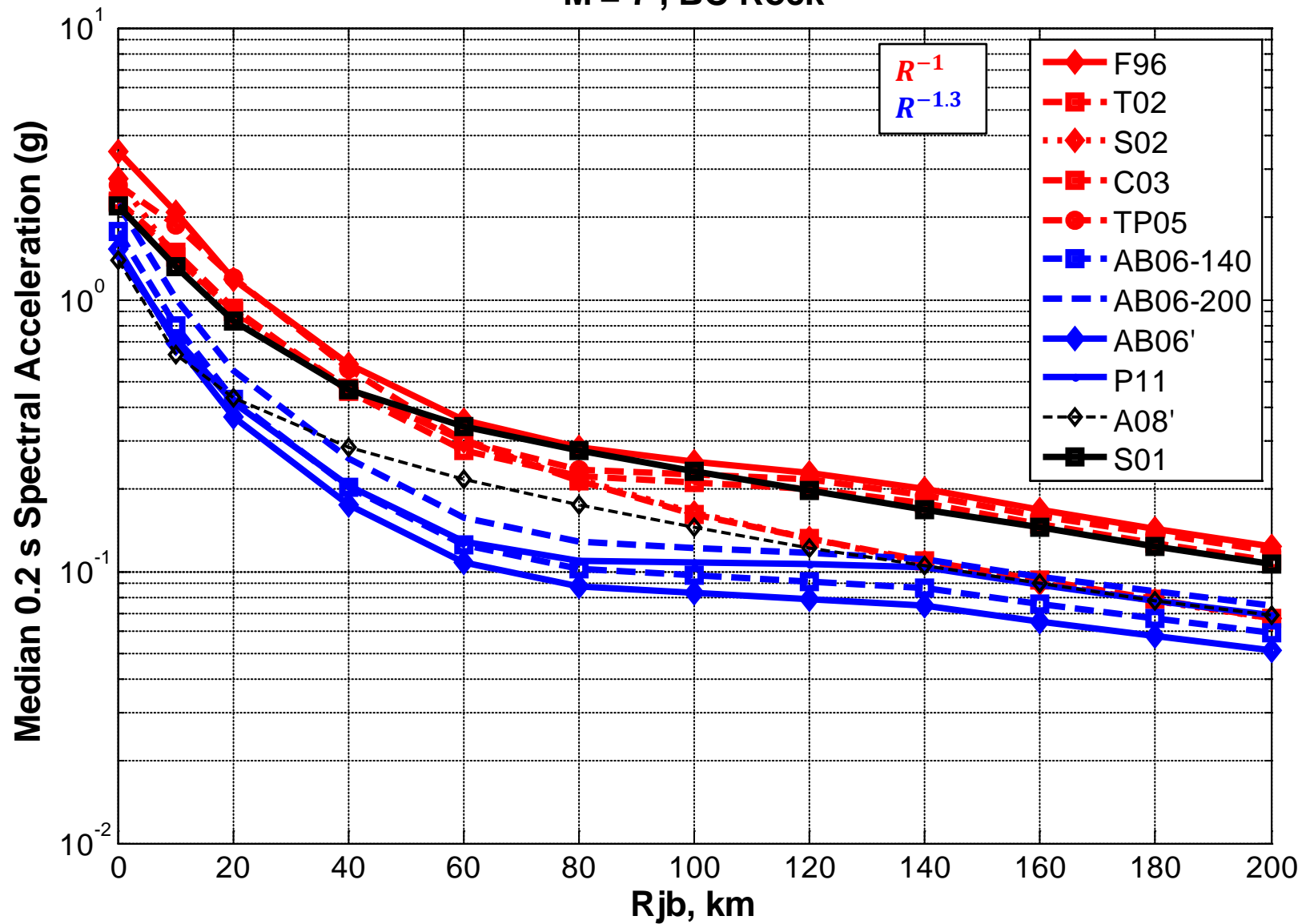
CEUS GMMs & Weights in 2014

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M = 7 , BC Rock




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Considerations in Weight Distribution

- Presentations at the Ground Motion Workshop, Berkeley, Dec 2012
- Residual studies by Cramer (total residuals) and Goulet (mixed effects)
- EPRI study
- Extrapolation and spectral shapes

EPRI 2013

Cluster	Model Types and Cluster Weights (repeated large-magnitude earthquake sources/area earthquake sources)	Models
1	Single-Corner Brune Source (0.15/0.185) 	Silva et al. (2002) – SSCSS ¹ Silva et al. (2002) – SSCVS ¹ Toro et al. (1997) – TEL Frankel et al. (1996) – FEL
2	Complex/Empirical Source ~R ⁻¹ Geometric spreading (0.24/0.282)	Silva et al. (2002) – SDCS Atkinson (2008) with 2011 modifications – A08'
3	Complex/Empirical Source ~R ^{-1.3} Geometric spreading (0.35/0.432)	Atkinson-Boore (2006) with 2011 modifications – AB06' Pezeshk et al. (2011) – PZT
4	Finite-Source /Green's Function (0.19/0)	Somerville et al. (2001); slightly different models for rifted and non-rifted (not used for distributed seismicity sources with large contribution from M < 6) – SEL

USGS R⁻¹ category

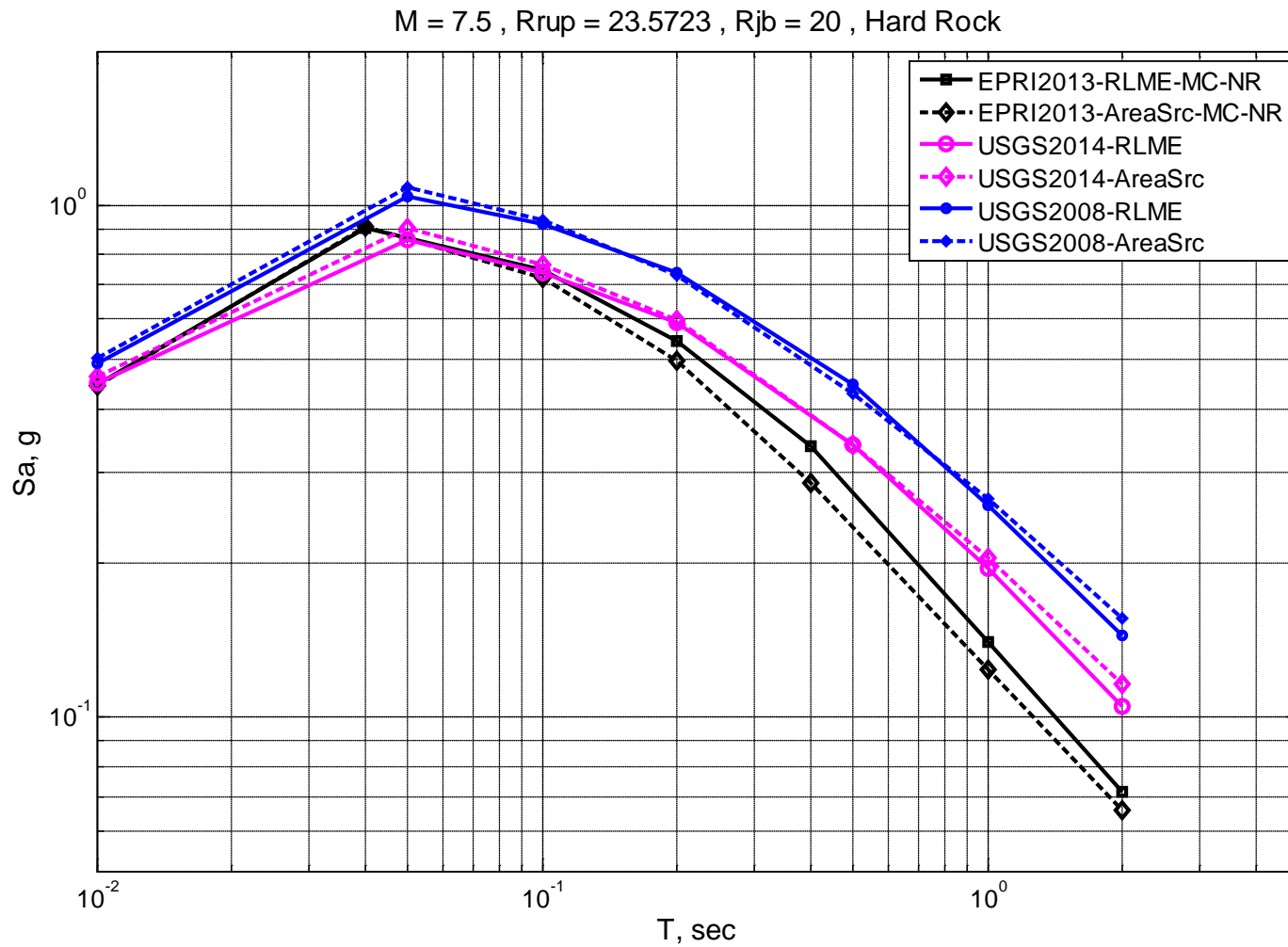
- Campbell not in EPRI
- Tavakoli-Pezeshk not in EPRI
- Only one Silva version in USGS
- A08' not R⁻¹ in USGS

USGS R^{-1.3} category

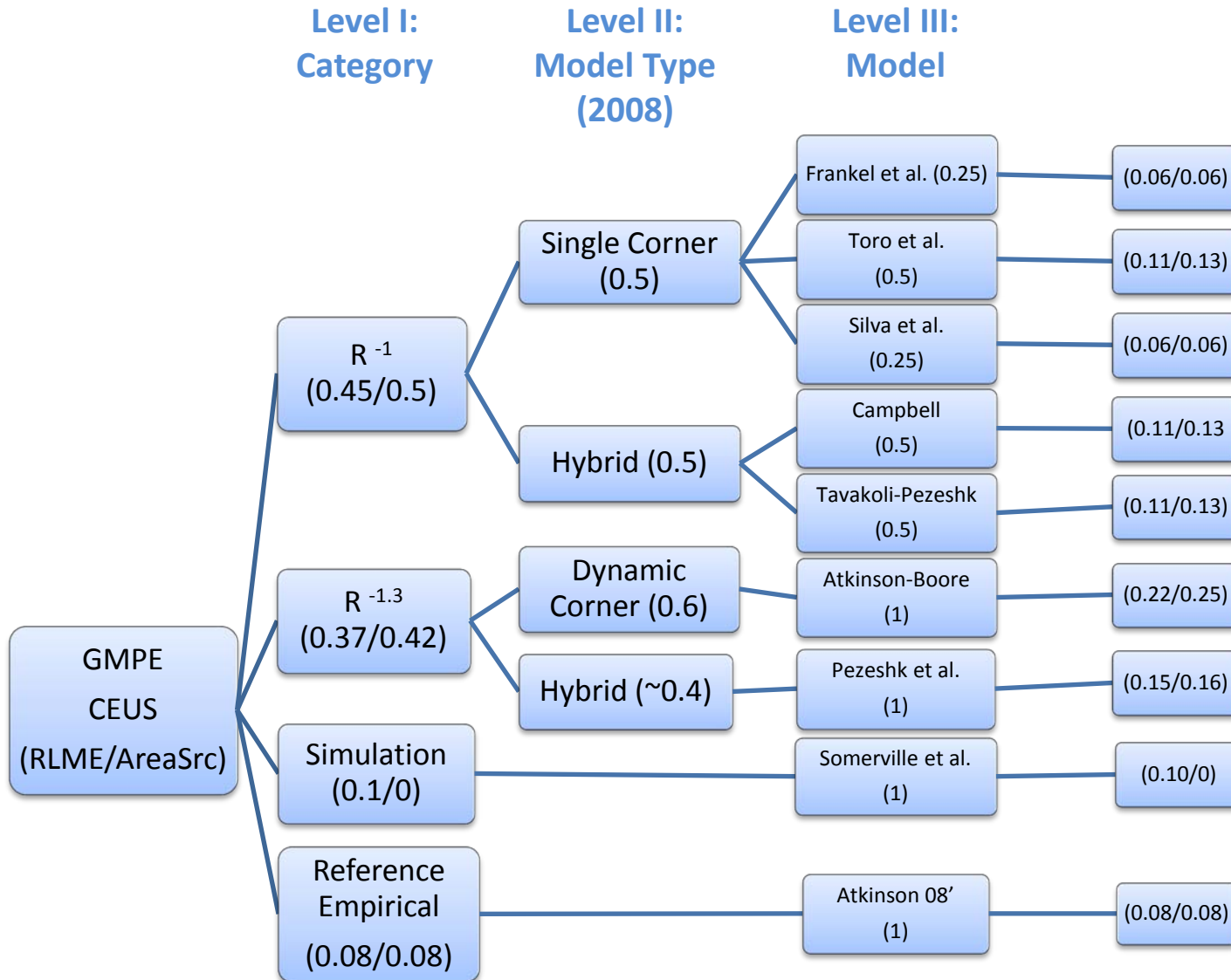
¹ Treated as one model for calculation of weights.

Cluster	1				2		3	
GMPE	SSCCSS	SSCVS	TEL	FEL	A08'	SDCS	AB06'	PZT
HF Weight	0.344	0.322	0.181	0.152	0.548	0.452	0.667	0.333
LF Weight	0.343	0.324	0.175	0.159	0.667	0.333	0.667	0.333

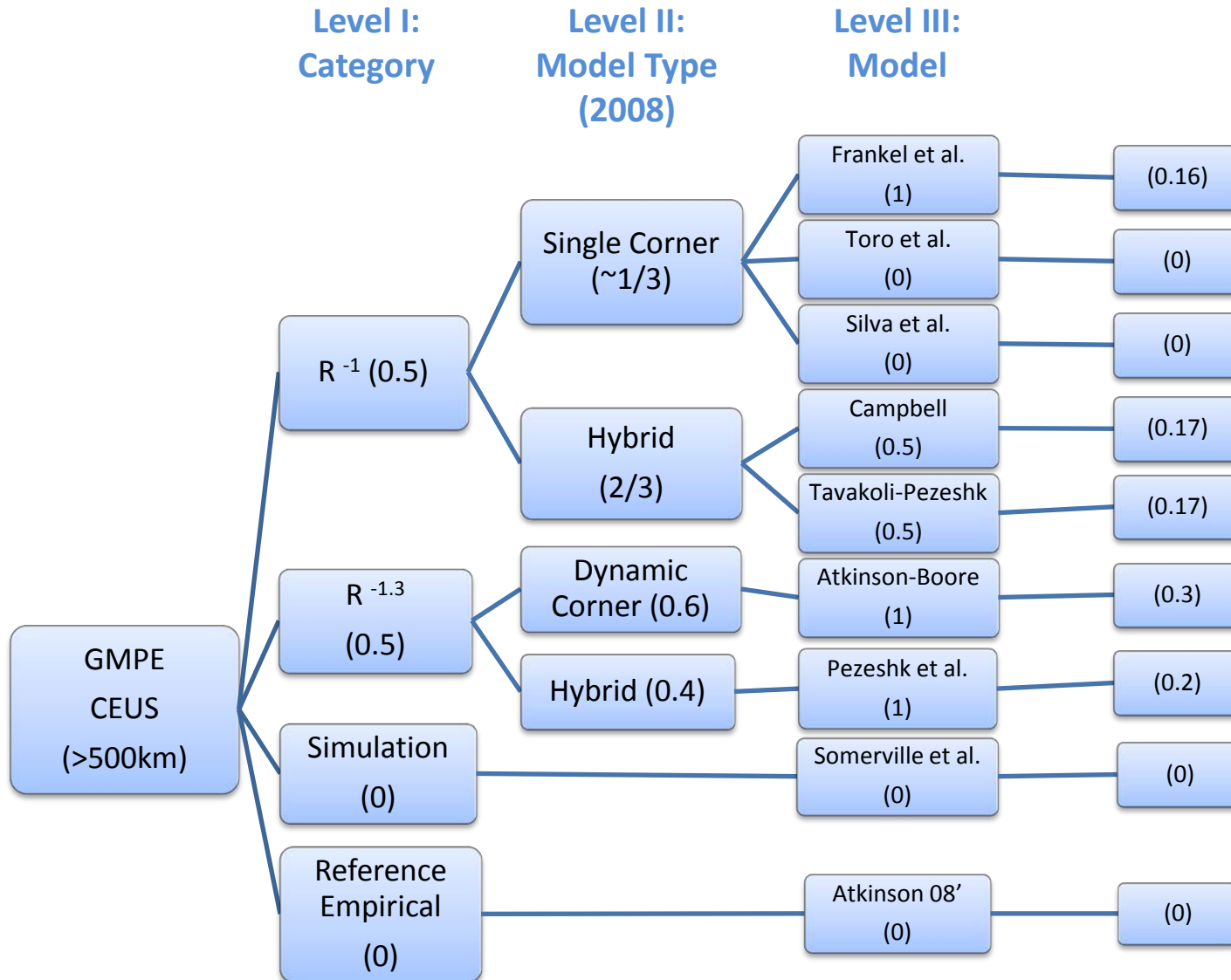
EPRI 2013



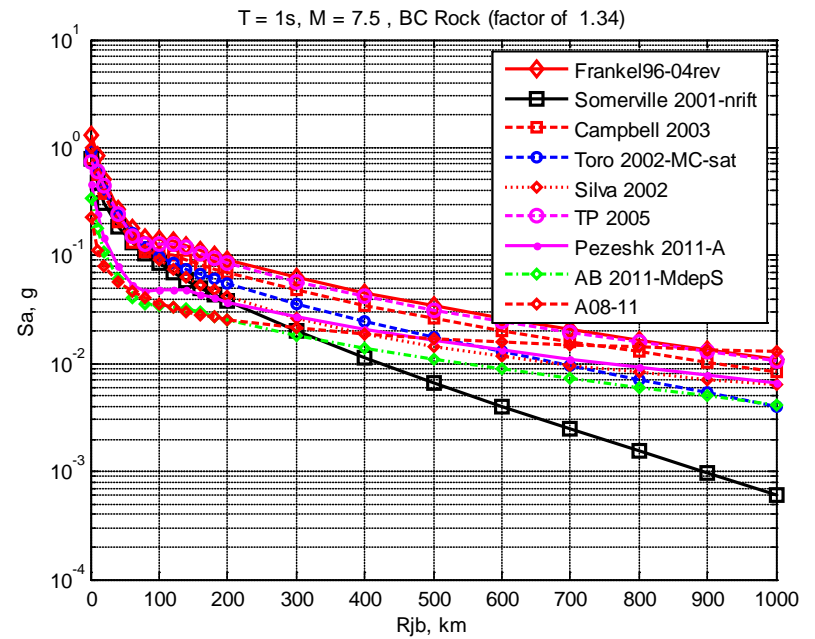
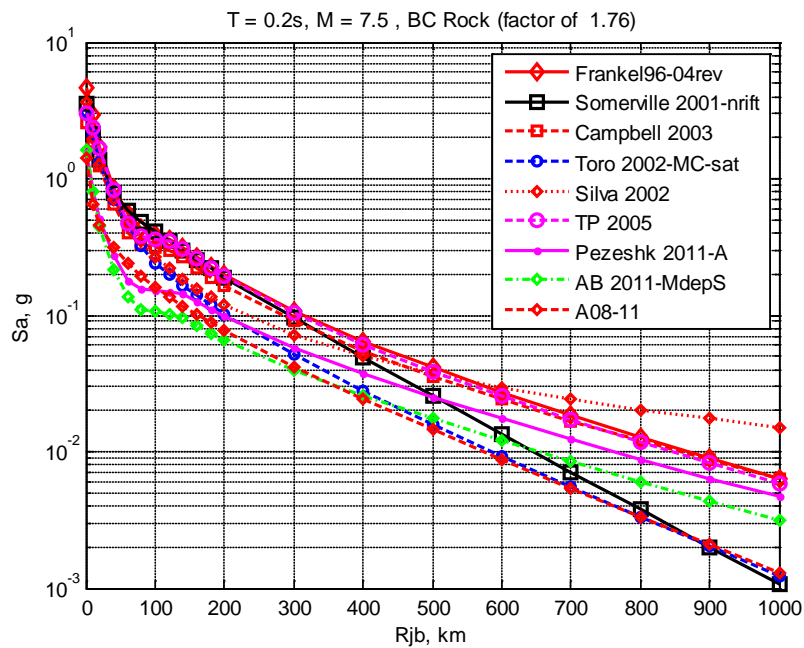
USGS Weights for < 500 km



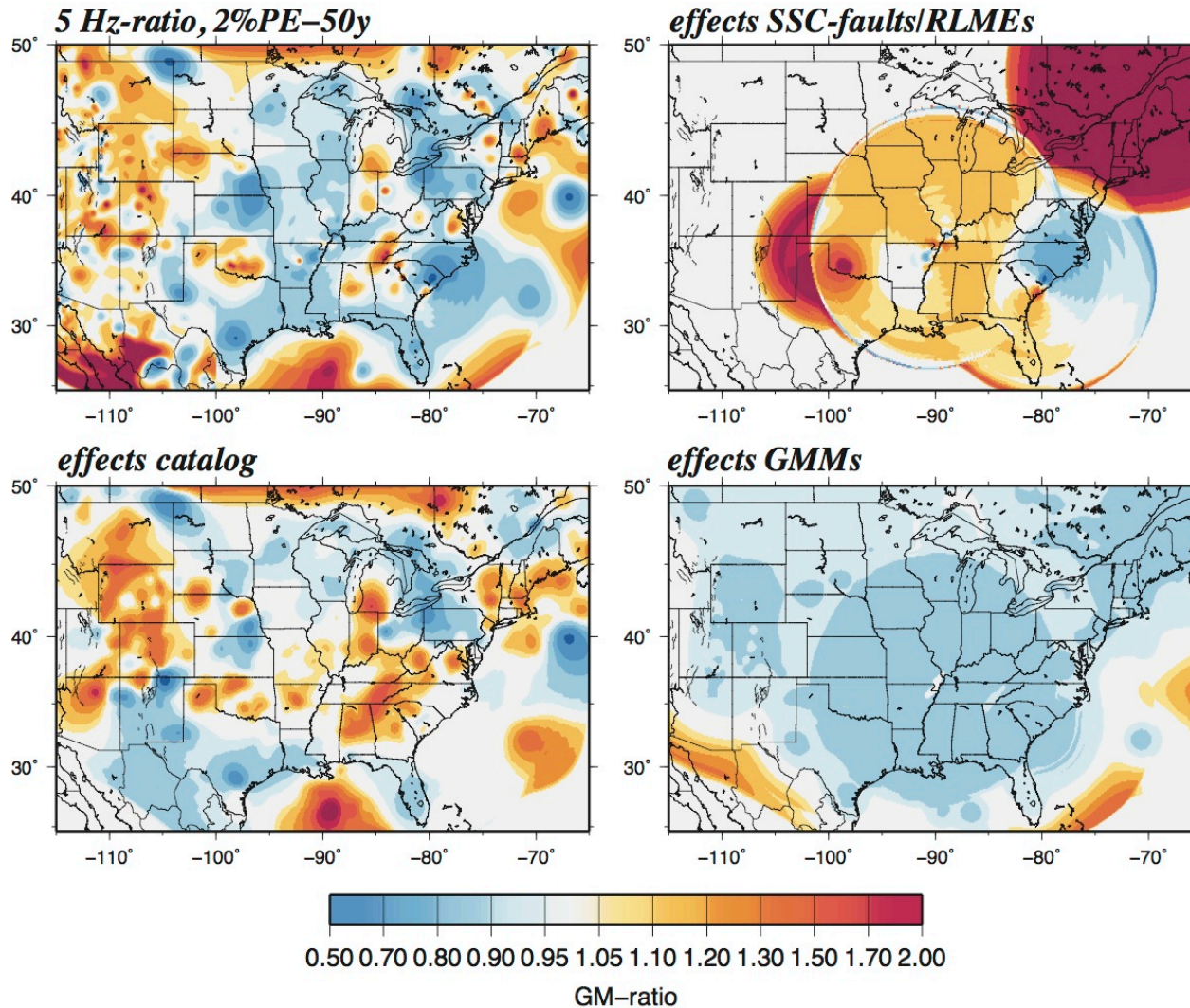
USGS Weights for 500 - 1000 km



Extrapolation to 1000 km



Ratio of 2014 to 2008 Maps:



Lower hazard (~10-20%)
due to GMMs

These maps are provisional