Overview of subduction GMPE issues for Cascadia

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Comments reflect proposed approach for 2012 Cdn national hazard maps

(still under discussion)

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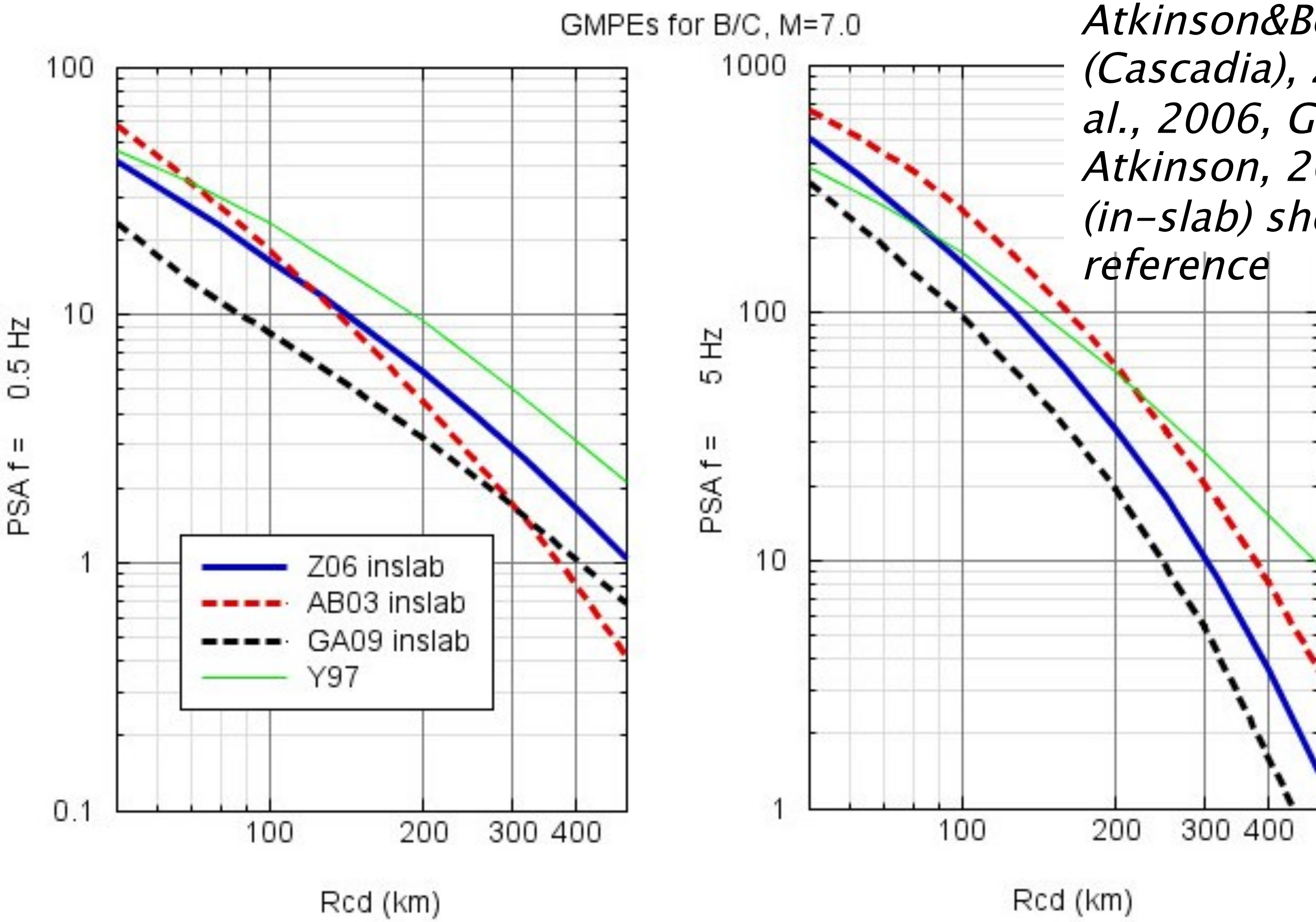
Issues

- PEER-NGA process resulted in comprehensive database and model building for active-region shallow crustal GMPEs
- By contrast, relatively sparser body of recent publications on subduction GMPEs (and less organization of databases, though there are lots of data)
- The subduction GMPEs are just as important for hazard assessment – so how to proceed?
- Note we need to define not just median GMPEs, but also their epistemic uncertainty

Proposed Principles

- Alternative published or peer-reviewed GMPEs are useful to assess uncertainty
- But uncertainty is not necessarily well captured by simply weighting alternative GMPEs
- We aim instead to use alternative GMPEs and their data constraints to guide selection of a “representative” or base-model GMPE and bounding (low, high) equations

In-slab events: typical GMPEs show apparently wide spread of motions for M~7 (h~50 km) – but site conditions are not equivalent for all GMPEs



Atkinson&Boore,2003 (Cascadia), Zhao et al., 2006, Goda and Atkinson, 2009 Y97 (in-slab) shown for reference

Modifications suggested to subduction GMPEs based mostly on Japan data

- Most recent subduction GMPEs dominated by plentiful Japanese data
- Typical site conditions shallow soil over hard rock
- Typical amplifications of >5 at frequencies of 5 to 10 Hz (as seen in studies of Tohoku and other events)
- Expected site amplification in PNW is greater at low frequency, less at high frequency
- Japan-dominated GMPEs should be adjusted for site conditions before application to PNW

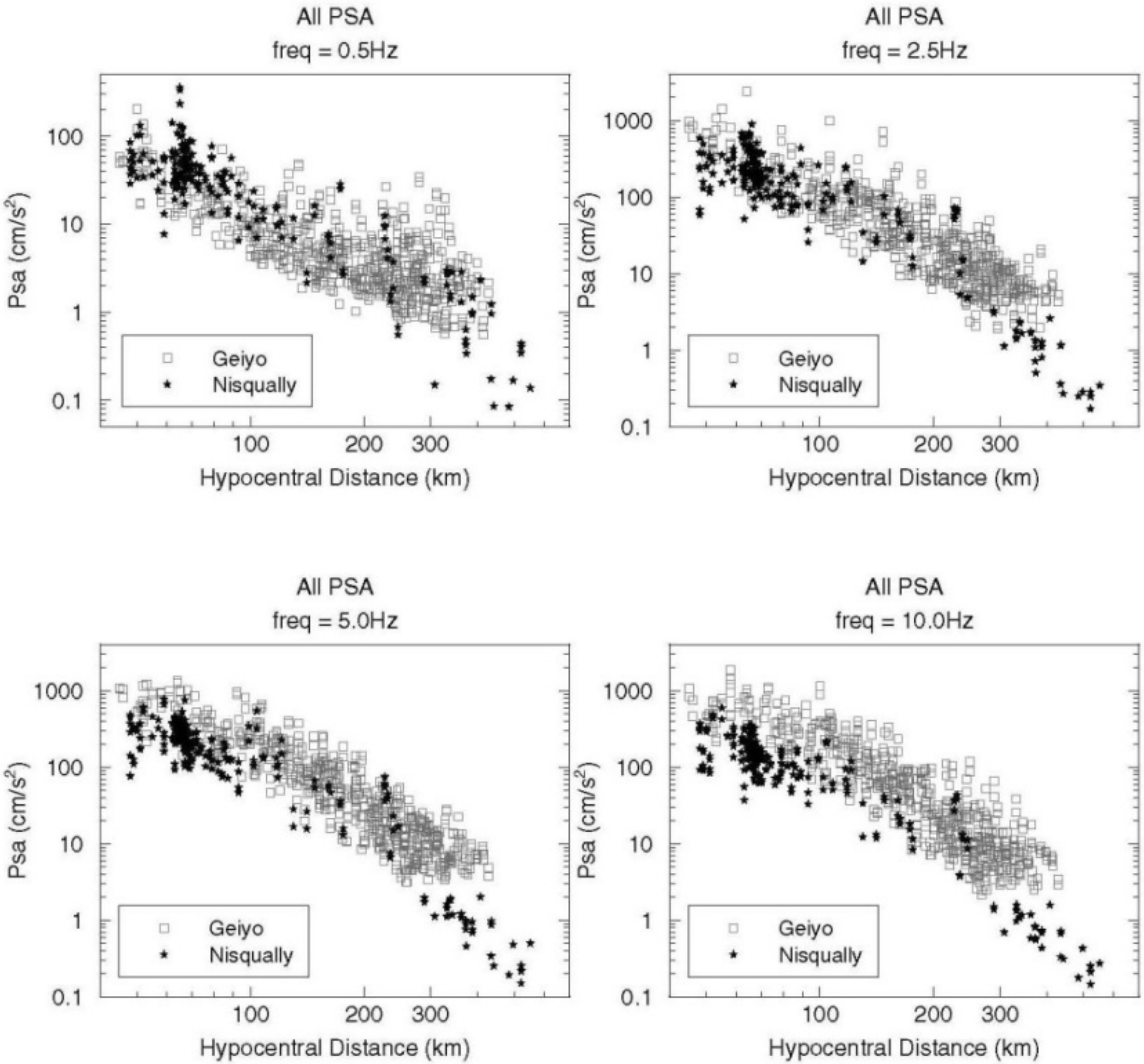


Figure 2. Response spectral amplitudes versus hypocentral distance for the Geiyo (gray boxes) and Nisqually (black stars) events at frequencies of 0.5, 2.5, 5.0, and 10.0 Hz (all data).

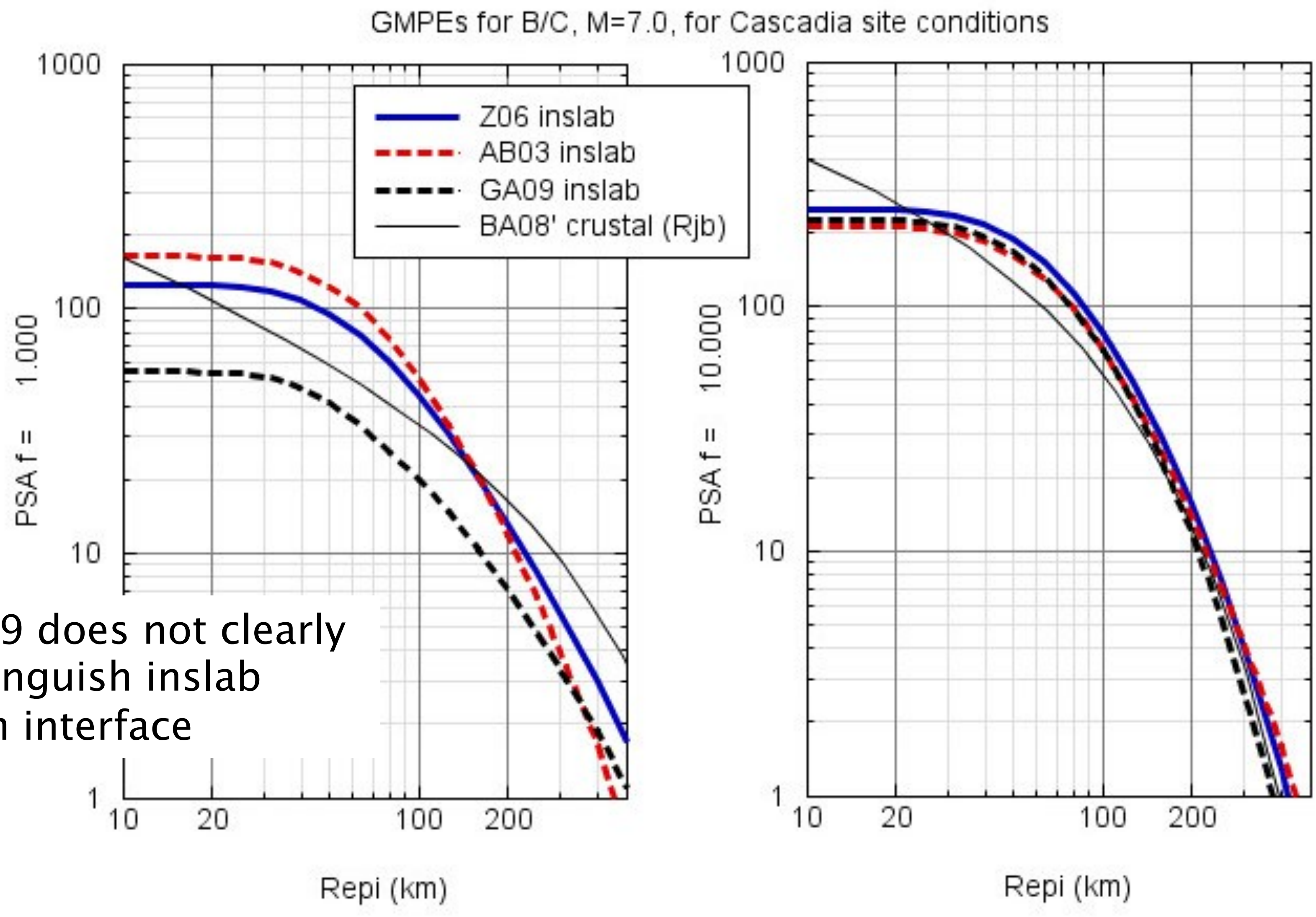
Example: *Response spectral amplitudes versus distance for* ***M6.8*** *Nisqually (Cascadia) and Geiyo (Japan) in-slab events.*

From Atkinson and Casey (2003).

Atkinson&Casey factors based on QW calcs for typical profiles. Atkinson&Boore factors based on regression residuals for Cascadia and Japan relative to global GMPE.

Table:		Cascadia/Japan site factors:	
Freq. (Hz)	Atkinson &Casey	Atkinson &Boore	Recommended Cascadia Multiplicative Factor (log)
0.2			1 (0.000 log units)
0.33		1.23	1.20 (0.079 log units)
0.5	1.47	1.55	1.51 (0.179)
1	1.08	1.00	1.04 (0.017)
2.5	1.16	0.83	1.00 (0.000)
3.33			0.81 (–0.091)
5	0.71	0.50	0.60 (–0.222)
10	0.53	0.35	0.44 (–0.357)
25		0.35	0.44 (–0.357)
PGA		0.45	0.50 (–0.301)
PGV			1.00 (0.000)

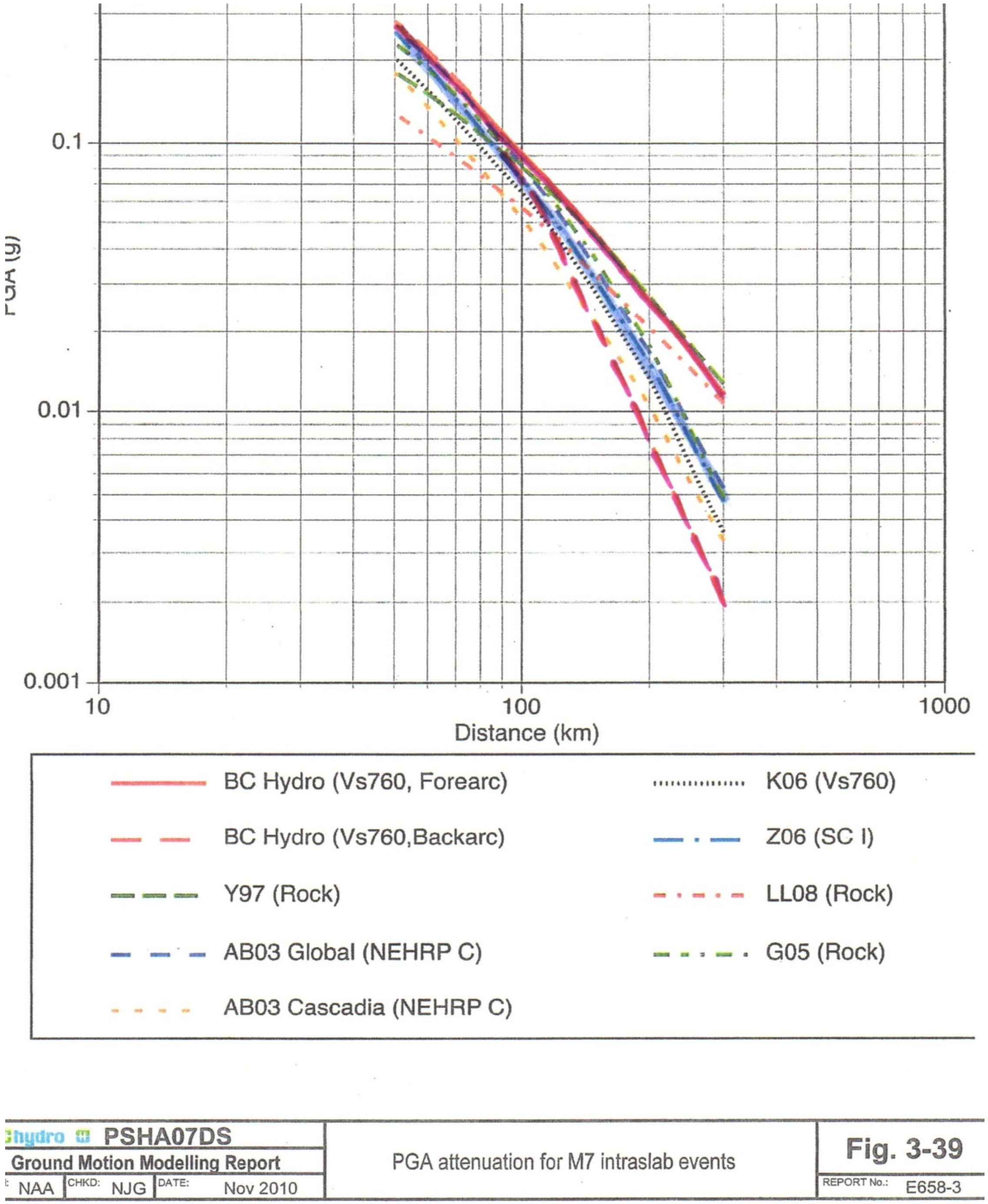
AB03 and Z06 look very similar for in-slab M7 after site correction – and not unreasonable relative to BA08 crustal



GA09 does not clearly distinguish inslab from interface

Proposed in-slab GMPEs

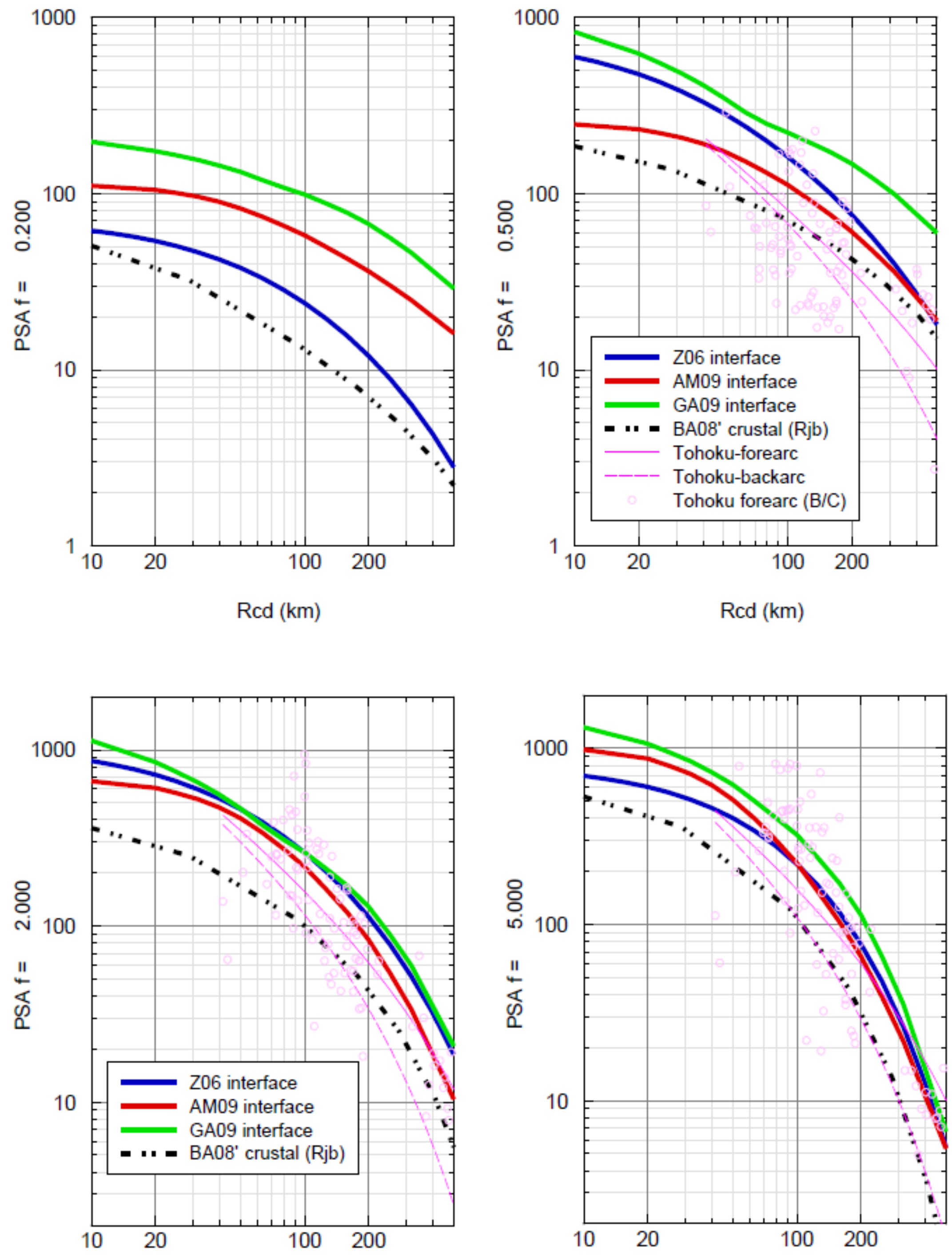
- Use Zhao et al., 2006, corrected to Cascadia site conditions
- Define epistemic uncertainty as ~0.15 log units, based on inspection of plot of other GMPEs
- In-slab GMPEs of Zhao need to be capped at large M (>7.5) but this does not affect Cascadia (will return to capping in a bit)



Anchoring in-slab GMPEs with Zhao, 2006 is not inconsistent with B.C. Hydro GMPEs (PGA shown here for M7)

Interface GMPEs

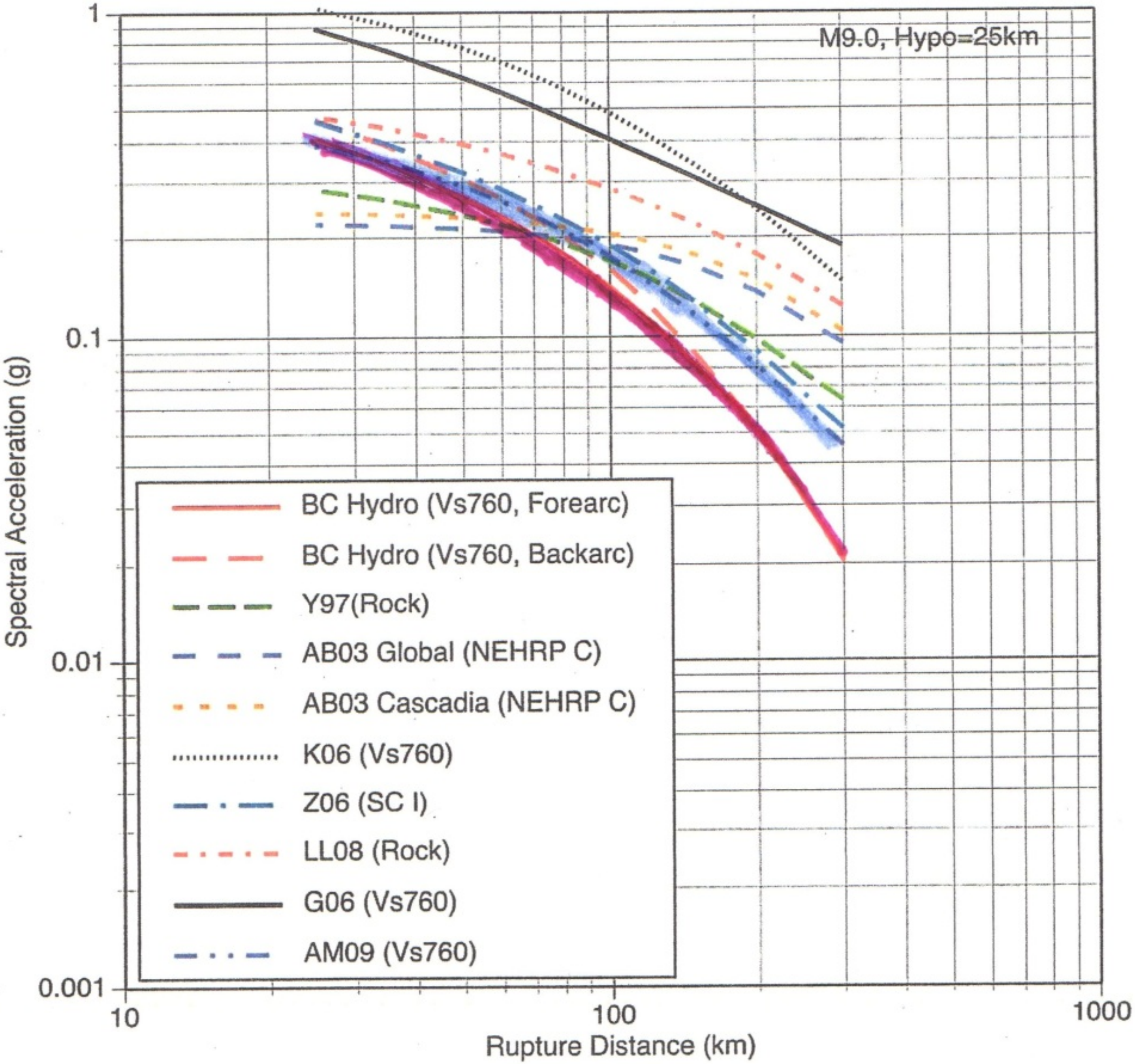
- Great new data from Tohoku, will talk about that in more detail later
- Points to importance of site effects in evaluating GMPEs
- Will look at pre-Tohoku GMPEs, adjusted to Cascadia site conditions as per the in-slab equations



Interface GMPEs for M9 Cascadia. BA08 for crustal events shown in black. Tohoku motions (B/C) and GMPEs shown in pink. (Not enough epistemic uncertainty at high frequencies). Atkinson&Macias (2009) based on simulations – tracks BA08’ well

Epistemic uncertainty in interface GMPEs

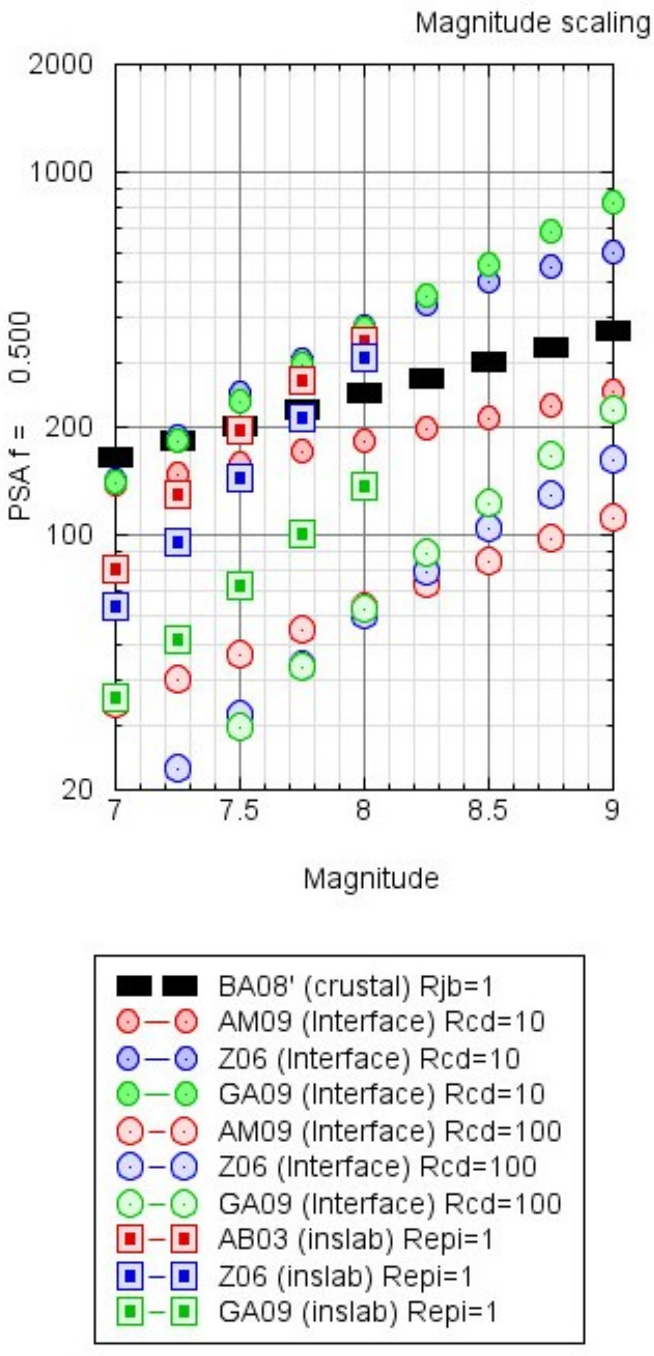
- Pick representative GMPE with proper scaling behaviour and reasonable agreement with recent event data like Tohoku
- eg Atkinson&Macias, 2009 Cascadia GMPE
- Use data and other GMPEs to define epistemic uncertainty ~ 0.2 log10 units? (should be greater than for crustal events)



Proposed approach for interface not inconsistent with B.C. Hydro interface GMPEs (M9, 1sec PSA)

Capping subduction-zone equations at large magnitudes

- Data are sparse for large-magnitude subduction events in GMPEs (pre-date Tohoku)
- Need to evaluate scaling behavior of GMPEs and ensure they make sense, for both in-slab and interface events
- Motions that grow too much at large magnitudes can be treated by “capping” GMPEs at an upper-bound magnitude
- This is more of an issue for some GMPEs than others



Magnitude scaling of PSA (0.5 Hz and 5 Hz) for alternative GMPEs at reference fault distances near 10 km and 100 km. (black is BA08 western crustal)

Conclusions

- Not all GMPEs created equal
- Need to consider representative site conditions
- Need to evaluate magnitude scaling and other issues in candidate GMPEs
- Need to evaluate epistemic uncertainty in a broader context – don’t just throw a random collection of weighted GMPEs into a basket