Kappa Scaling Issues

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Kappa Scaling

- **Goal**: Modify 8 selected GMPEs developed in different regions to provide ground motion estimates in Switzerland (target region) while accounting for differences in Kappa and Vs profiles between the host and target regions.

Kappa Scaling Approaches

- **Hybrid empirical approach** (Campbell 2003, 2004):
  - Develop host-to-target correction factors obtained by dividing response spectra for the target region by response spectra for the host region
- **Empirical approach**:
  - Estimate correction factors based on the within-event residual plots versus kappa

Example of the Hybrid Empirical Approach

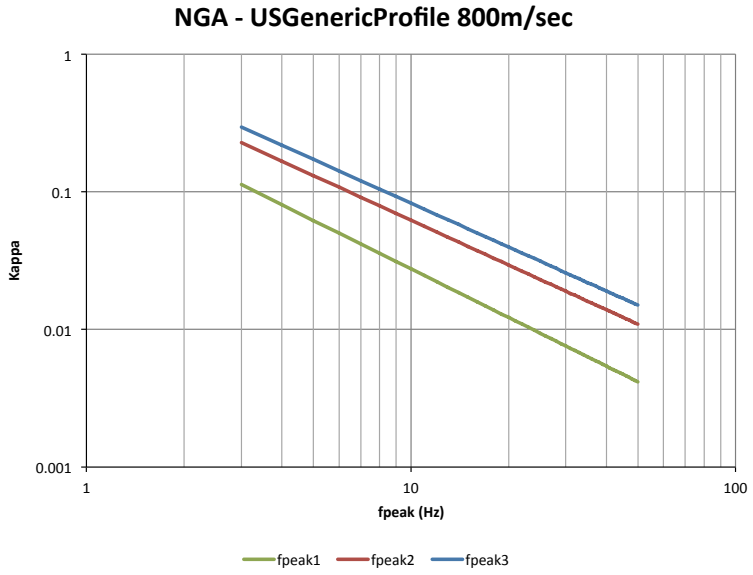
- Generating Vs-kappa correction factors for the CaBo08 GMPE to apply to Swiss generic conditions for the Pegasos Refinement Project
- **Target Region**: Switzerland
  - Vs30 = 1000 m/sec
  - Best estimate kappa = 0.017
- **Host Region**: WUS
  - Best estimate Vs30 = 800 m/sec
  - 5 Kappa estimates based on:
    - Kappa-fpeak stochastic relationships
    - Kappa-Vs30 relationships developed by Edwards et al. (2011) and Silva et al. (1999)

Kappa-fpeak Relationships

- Relationships developed based on the point-source stochastic model using:
  - Generic WUS stochastic model
  - Crustal amplification function corresponding to target Vs profile
  - Range of kappa and magnitude-distance scenarios

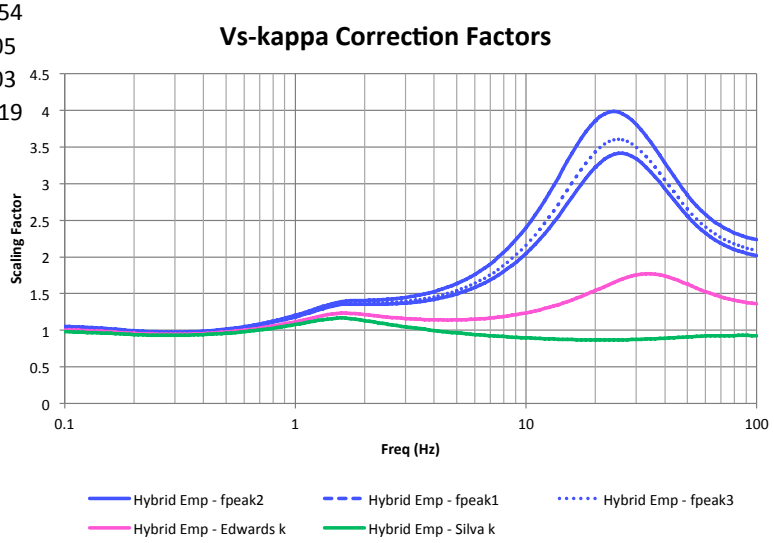
- Definition of fpeak:
  - **fpeak1**: Geometric mean of the frequencies corresponding to PSA 5% below the peak of the spectrum
  - **fpeak2**: Highest frequency that corresponds to PSA = 2 * PGA
  - **fpeak3**: Highest frequency that corresponds to PSA = EXP [(ln(max Sa) + ln(PGA)) / 2]

Kappa-fpeak Relationships (cont'd)



Hybrid Empirical Approach

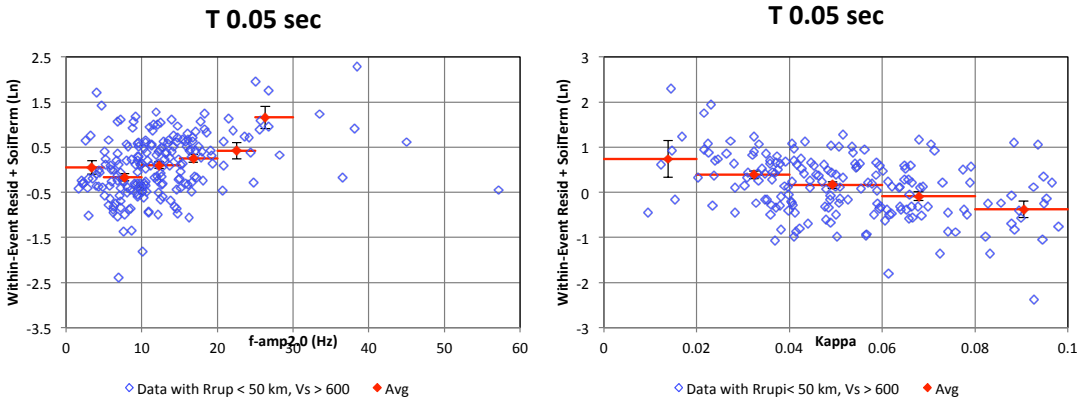
Method	Host Kappa
kappa-fpeak1	0.048
kappa-fpeak2	0.054
kappa-fpeak3	0.05
Edwards et al. (2011)	0.03
Silva et al. (1999)	0.019



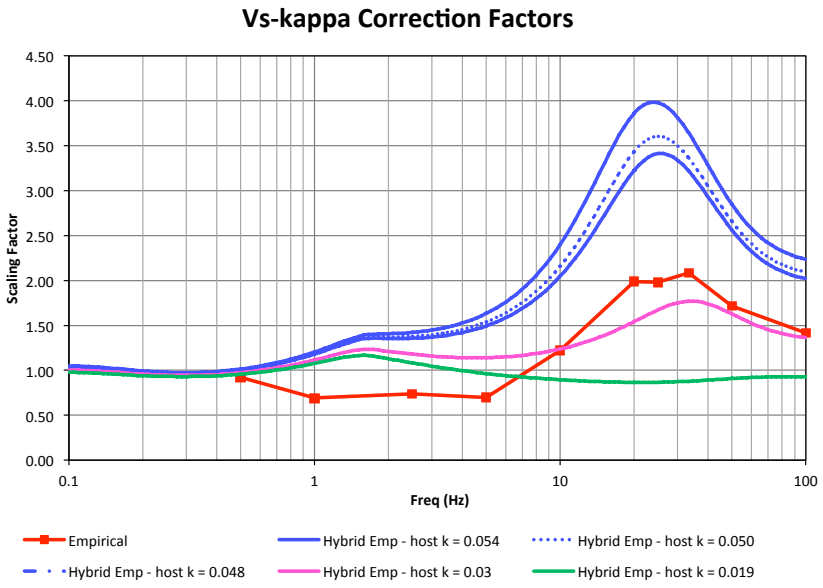
Empirical Approach Using WUS Data

- Calculate fpeak2 for the NGA West-2 recordings
- Estimate kappa for the recordings using kappa-fpeak2 relationship
- Calculate the within-event and between-event residuals of the data with respect to an updated AbSi model without Vs30 scaling term
- Plot within-event residuals versus fpeak2 and kappa for Rrup < 50 km and Vs30 > 600 m/sec
- Vs-kappa scaling factor = exp of the average within-event residual at target Swiss kappa (0.017)

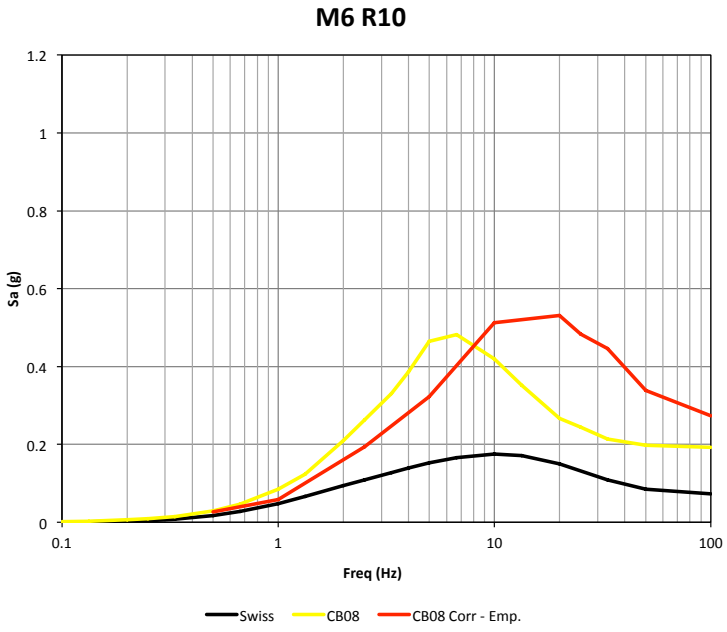
Empirical Approach Using WUS Data (cont'd)



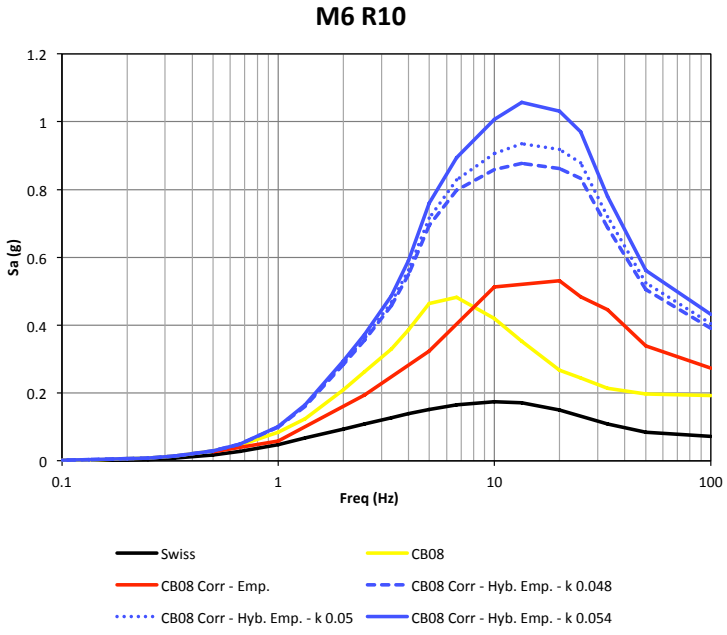
Comparison of Results



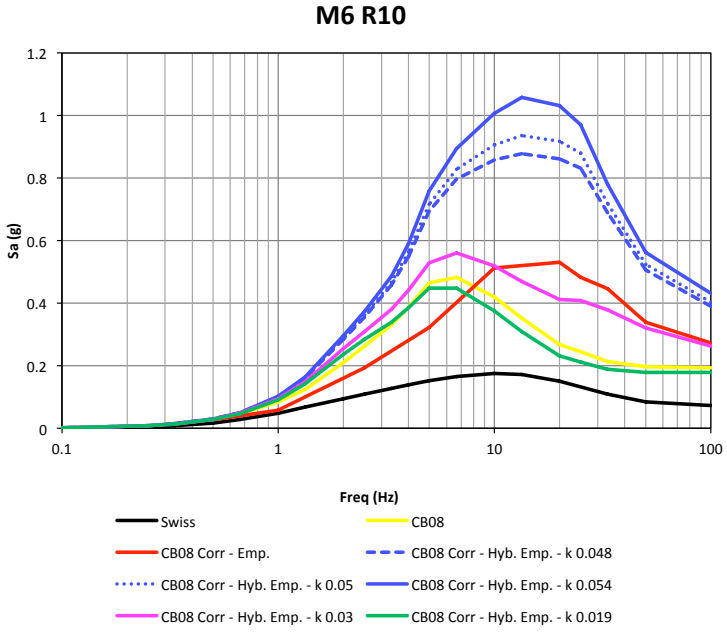
Comparison of Results (cont'd)



Comparison of Results (cont'd)

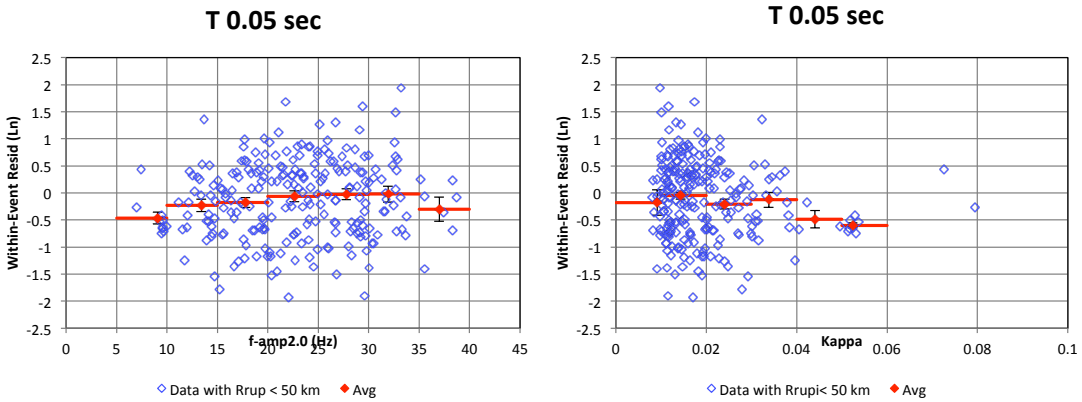


Comparison of Results (cont'd)



Empirical Approach Using Swiss Data

Model Form: $$Ln(y) = b1 + b2M + b3\log\left(\sqrt{R_{epi}^2 + b5^2}\right) + b4\sqrt{R_{epi}^2 + b5^2}$$



Empirical Approach Using CENA Data

Model Form: $$Ln(y) = b1 + b2M + b3\log\left(\sqrt{R_{epi}^2 + b5^2}\right) + b4\sqrt{R_{epi}^2 + b5^2}$$