High Frequency Earthquake Ground Motion Scaling in Mountainous Region: Example from Zagros

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Objective

The objective of this study is to create a forward model that explains the observed ground motion and involves:

• High frequency ground motion processing
• Source parameter determination
• High frequency ground motion modeling
• Future directions
What we observed?

Processing of seismic network data in Northern Iraq, Iraq. 761 events recorded at 10 stations yield over 18,000 regional S phases.
Data Processing

- Process raw seismograms
  - Pick P, S
  - Transform observed records (digital counts) to ground velocity (m/s)

- Compute tables consisting of -
  - Peak ground motion
  - Duration between 5% and 75% of the Spectra
  - Energy
  - RMS signal shape

- Apply coda normalization

- Regression
  - Peak filtered velocities
  - Fourier velocities

- Model using Random Vibration Theory or Bandpass filtered stochastic white noise

Figure 4. Illustration of method of estimating duration. The lower trace is the velocity time history filtered at 1.0 Hz. The upper trace is the integrated square velocity. The duration of 14 sec is the time interval between the 0.05 and 0.75 ordinate. The origin and P and S arrival times (IPU0 and ISU0, respectively) from the unfiltered time history are indicated. The group delay of the filter is apparent by the shift of the P and S arrivals from the picked time.
Regression Model

We perform regression on peak velocities and Fourier velocity spectra at each frequency for the model:

\[
\log A = D(r) + E(r_{ref}) + S
\]

where \( A \) is observed motion, \( D(r) \) is distance term, \( E(r_{ref}) \) is the excitation term at the reference distance, and \( S \) is a site term.

Regression specifics: Sum \( S_i = 0 \), \( D(40 \text{ km}) = 0 \);

\( D(r) \) is a piecewise linear continuous function defined by distance nodes.
Results

Frequency Dependence of D(r)

Data from NISN Regional Seismic Network stations are excellent for source and propagation studies. We have a forward model to describe the amplitude-distance relationship of 1-12 Hz ground motion in the distance range of 30 to 600 km in Northern Iraq. Source modeling of small events is possible and validates the propagation and radiation from the source. Modeling indicates that the average regional attenuation of the peak ground motion is best fit by a geometrical spreading function of $r^{-1}$ for $r \geq 1 \ km$, $r^{-0.95}$ for $r > 40 \ km$, $r^0$ for $r > 120 \ km$, and $r^{-1.25}$ for $r > 195 \ km$. The frequency-dependent quality factor is $Q(f) = 320 \ f^{0.25}$. 

![Graph showing frequency dependence of D(r)](image-url)
Come see my Poster!

**Today Poster Session:**

- **Time:** 5:15 – 7:00 pm
- **Room:** Pasadena (Exhibit Hall)
- **Poster location:** [075]