Alaskan Ground Motion Versus Intensity-Empirical Relationships between Ground-Motion Parameters and ”Did you Feel It?” Intensity

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Alaskan Ground Motion Versus Intensity—Empirical Relationships between Ground-Motion Parameters and “Did you Feel It?” Intensity

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INTRODUCTION
The relationship between the quantitative ground motion and intensity, known as the ground motion intensity correlation equation (GMICE), is an important topic in seismic hazard analysis. Although numerous such studies have been conducted in the United States, they often focus on the eastern, central and California regions. An Alaskan GMICE does not currently exist, but the need for Alaska-specific correlations has been recognized. This study examines the potential for an Alaskan GMICE using measurements reported alongside geocoded fault data.

DATA
- PGA, PGV, and Spectral Acceleration (SA), at 29 different periods (87 - 10s) for five distinct earthquakes.
- Available Alaskan CDI and orange +’s are for ground motion values from CDIs exceeding 8.2, the conversion equation. In the figure, OC17 = Ogweno & Cramer, (2017); AK07 = Atkinson & Kaka, (2007); AS00 = Atkinson & Sonley, (2000); W97 = Wald et al., (1999); WH02 = Warden et al., (2002); T09 = Tullis & Danciu (2009); KA04 = Kaka & Atkinson, (2004).

METODOLOGY
Established a novel correlation between observed ground motion and CDI in Alaska.

CONCLUSIONS
- Established a novel correlation between observed ground motion and CDI in Alaska.
- Interpolation technique better justifies the assigned intensity rather than using the average value across a specified radius.
- Distance and magnitude correction factors did not significantly improve our relationships.
- Comparing the 1964 M9.2 Alaska earthquake’s ground motion observations and estimates with current ground motion models reveals some deficiencies (significant over and under predictions) in the current GMMs, indicating the need for Alaska-specific correlations for Alaska seismic hazard estimation.

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REFERENCES

Fig. 1: Flow diagram explaining a general approach used in establishing ground motion intensity correlation equations (GMICE).

Fig. 2: Map of Alaska showing the location of the epicenter of each earthquake used (yellow star), ground motion stations (triangle), CDI reported in the area (green dot), and the ground motion stations used (triangles in red circles). The 2m slip contour of the 1964 co-seismic slip, projected and redrawn from Ishinomi et al. (2007), is depicted in bold red.

Fig. 3: Regression between CDI and GMAPs (a) log10PGA, (b) log10PGV, (c) log10SA at 0.2s and (d) log10SA at 1s. Regression fits are established for both OLS (black line) and TLS (dashed red line). Red diamonds are the mean of the GMPs between each CDI interval (2007), is depicted in bold red.

Fig. 4: Residuals observed in GMAPs (observed minus predicted ground motion at the period of interest), (a) PGA, (b) PGV, (c) SA at 0.2s and (d) SA at 1s plotted as a function of log10(Distance). Dashed red line is the best fit to the residuals and dashed blue is the zero line. The error bars in magenta represent mean ± 1σ for the binned mean residuals obtained by dividing the distance into fifty equally spaced bins for each magnitude bin. The best fit line to the residuals and dashed blue is the zero line. The error bars in magenta represent mean ± 1σ for the binned mean residuals obtained by dividing the distance into fifty equally spaced bins for each magnitude bin. The best fit line to the residuals and dashed blue is the zero line. The error bars in magenta represent mean ± 1σ for the binned mean residuals obtained by dividing the distance into fifty equally spaced bins for each magnitude bin.

Fig. 5: Distance term corrected residuals plotted as a function of magnitude for some selected GMPs, (a) PGA, (b) PGV, (c) SA at 0.2s and (d) SA at 1s plotted as a function of magnitude. Confidence limit and the shaded region in dark khaki green is the 95% prediction limit of the estimated relationship using TLS.

Fig. 6: Comparing our relationships between some selected GMAPs (a) PGA, (b) PGV, (c) SA at 0.2s and (d) SA at 1s) with GMICE from previous studies. Blue circle is the reported Alaskan CDI and orange +’s are the MM obtained using the OGS1 conversion equation. In the figure, OC17 = Ogweno & Cramer, (2017); AK07 = Atkinson & Kaka, (2007); AS00 = Atkinson & Sonley, (2000); W97 = Wald et al., (1999); WH02 = Warden et al., (2002); T09 = Tullis & Danciu (2009); KA04 = Kaka & Atkinson, (2004).

Fig. 7: Comparison of M9.2 Alaska CDI intensities converted to ground motions (red circles) for PGA (a), 0.2 s spectral acceleration (b), and 1.0 s spectral acceleration (c). Black asterisk data points are for ground motion values from CDIs exceeding 8.2, the upper limit of CDI observations of our dataset. GMAPs for rock (dashed) and N208 B/C (solid) boundary (solid) are red – A16 forearc; magenta – A16 backarc; green – Z06, A16 forearc; orange – Y97. NGA Sub-GMMs in black are solid – K20 B/C, short dashed – K20 C, long dashed – P20 B/C, long dash dot – P20 C, long dash short dash – P20 B/C, long dash double dot – P20 B/C, and dotted – A20 B/C.