S23B-05 Re-Estimation of Earthquake Magnitudes Using a Relative Magnitude Method and the Effects of Magnitude Uncertainty on Seismic Hazard Estimates (Invited)

Tuesday, 12 December 2023

14:50 - 15:00

157 - South (Upper Mezzanine, South, MC)

Abstract

Accurate estimates of earthquake magnitude are necessary to improve our understanding of seismic hazard. Unbiased magnitudes for small earthquakes are especially important because magnitude exceedance probabilities for large earthquakes are derived from the behavior of small earthquakes. Also, accurate characterization of small events is becoming increasingly important for ground motion models. However, catalog magnitudes may vary for the same event depending on network procedures and capabilities. In addition, different magnitude scales are often used for events of varying sizes. For example, moment magnitude (Mw) is the widely preferred estimate for earthquake size but it is often not available for small earthquakes ($M < 3.5$). As a result, statistical measures such as magnitude frequency distribution (MFD) and b-value can be biased depending on magnitude type and uncertainties that arise during the measurement process.

In this research we demonstrate the capability of the relative magnitude method to provide a uniform and accurate estimate of earthquake magnitude in a variety of regions, while only requiring the use of waveform data. The study regions include the Permian Basin in Texas, central Oklahoma, and southern California. We present results in which only relative magnitudes are used to estimate MFD and b-value as well as relative magnitudes that are benchmarked to an absolute scale using a coda-envelope derived Mw calibration for small events. We also discuss potential sources of uncertainty in the relative magnitude method such as acceptable signal-to-noise ratios, cross-correlation thresholds, and choice of scaling constant, as well as our attempts to mitigate those uncertainties.

Finally, we use our new relative magnitudes to examine the effects of magnitude uncertainty on statistical products such as the MFD and b-value. Our results show that small changes in magnitude may produce biases in these statistical parameters. In particular, we find that analyses of temporal and spatial variations in MFD are particularly susceptible to magnitude discrepancies due to smaller sampling windows. Overall, these statistical biases may influence further interpretation of seismic hazard and should be mitigated as much as possible through the calculation of accurate earthquake magnitudes.

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