

Understanding sources of variability and uncertainty in the relative magnitude method

Sydney Gable and Yihe Huang

A precise understanding of earthquake magnitudes is vital for accurate calculations of magnitude exceedance probabilities and seismic hazard assessment. However, characterization of earthquake magnitude, particularly for small events, is complicated by differences in network capabilities and procedures. Furthermore, the use of differing magnitude scales for events of various sizes introduces additional challenges and produces disparate magnitude estimates for the same events. To address the need for a consistent magnitude estimation procedure that can accurately estimate magnitude across a wide magnitude range and in diverse tectonic environments, we investigate the use of the relative magnitude method. This approach utilizes amplitude ratios of highly correlated waveforms among numerous interlinked event pairs to compute magnitude for a group of events.

While the relative magnitude method is advantageous because it can be applied uniformly in various regions and does not require distance or attenuation corrections, there are several parameters that currently require human decision which may introduce bias. These include acceptable thresholds for signal-to-noise ratios and cross-correlation, filtering procedures, sampling windows, and station selection. Our research focuses on computing new relative magnitudes for events in southern California, including the 2019 Ridgecrest sequence. We investigate the uncertainty that human decision may impose on the resulting magnitudes and compare our results to other magnitude estimation methods. Finally, we present our recommendations for routine procedures that minimize uncertainty and variability in the relative magnitude method, aiming to enhance the utility of this method for future users.