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Toward Real-Time Ground-Shaking-Intensity Forecasting Using ETAS and GMM: Insights from the Analysis of the 2022 Taitung Earthquake Sequence

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Earthquake forecasting, combined with precise ground-shaking estimations, plays a pivotal role in safeguarding public safety, fortifying infrastructure, and bolstering the preparedness of emergency services. This study introduces a comprehensive workflow that integrates the epidemic-type aftershock sequence (ETAS) model with a pre-selected ground-motion model (GMM), facilitating accurate short-term forecasting of ground-shaking intensity, which is crucial for effective earthquake warning. At first, an analysis was conducted on an earthquake catalog spanning from 1994 to 2022 to optimize the ETAS parameters. The dataset used in this analysis allowed for the further calculation of total, background, and clustering seismicity rates, which are crucial for understanding spatiotemporal earthquake occurrence. Subsequently, short-term earthquake activity simulations were performed using these update-to-date seismicity rates to generate synthetic catalogs. The ground-shaking impact on the target sites from each synthetic catalog was assessed by determining the maximum intensity using a selected GMM. This simulation process was repeated to enhance the reliability of the forecasts. Through this process, a probability distribution was created, serving as a robust forecasting for ground-shaking intensity at sites. The performance of the forecasting model was validated through an example of the Taitung earthquake sequence in September 2022, showing its effectiveness in forecasting earthquake activity and site-specific ground-shaking intensity. The proposed forecasting model can quickly deliver short-term seismic hazard curves and warning messages, facilitating timely decision-making.