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Performance evaluation and influential factor analysis for stacking-based seismic location

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Seismic source locations provide fundamental information on earthquakes and lay the foundation for seismic monitoring at all scales. Subsurface engineering operations, such as hydraulic fracturing, usually generate abundant microseismic events with low signal-to-noise ratios, thus raising a higher demand on the reliability and computational efficiency of seismic location methods. Stacking-based method involves reconstructing and focusing the radiated seismic source energy with a certain stacking operator, for example, the diffraction stacking operator or the cross-correlation stacking operator. They are noise-resistant, automatic, and data-driven. The source locations are resolved as images instead of discrete dots, offering more insights into source processes and surrounding structures. In this work, we conduct the performance evaluation and influential factor analysis with synthetic examples, to further improve the understanding of the method. Three categories of factors are investigated, including the velocity model, array geometry, and waveform complexity. Each of the three factors consists of several detailed factors, such as different array types and noise levels. Multiple parameters are considered for the performance evaluation, including location error/bias, imaging resolution, signal alignment with time shifts, and the computational cost. The proposed scheme is also applied to field microseismic datasets to demonstrate its feasibility. This study will be conducive to the design and evaluation of surface monitoring projects.