Recent updates to rapid kinematic source characterization at the USGS

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Wavelet and simulated Annealing SliP (WASP), the kinematic earthquake slip modeling software employed by the U.S. Geological Survey (USGS) National Earthquake Information Center (NEIC), is now publicly available for community use and contribution. WASP allows joint inversion of (1) teleseismic broadband P, SH, and long-period surface wave arrivals, (2) local strong-motion accelerometer waveforms, (3) local Global Navigation Satellite System (GNSS) waveforms and static offsets, and (4) Interferometric Synthetic Aperture Radar (InSAR) observations. Integration of Deep-ocean Assessment and Reporting of Tsunamis (DART) data is in progress to improve source characterization of tsunamigenic earthquakes.

Using simulated annealing, WASP solves a nonlinear inversion, modeling slip amplitude, rake, rupture time, and rise time on a discretized fault plane. Inputs required are a moment tensor solution and any of the previously listed observation types. If waveform data are included, WASP will perform a kinematic inversion; if only permanent deformation observations are available (static GNSS, InSAR), WASP will return a static inversion.

Publication of the WASP software to the USGS GitHub software repository supports reproducibility of NEIC's rapid fault models published during event response (e.g., 2023 Türkiye) and provides a new, accessible tool to the earthquake source modeling community to create slip models for events for research purposes (e.g., 2024 Noto). The software repository includes installation scripts and documentation, as well as a Jupyter notebook tutorial. WASP's command line interface (CLI) provides a simple structure for interacting with the software. Users can easily create a slip model using an automatically generated set of inversion parameters based on the event size. Similarly, the CLI guides user interaction to modify data and model parameters for various needs.

In this presentation, we demonstrate use of the WASP software for both rapid event response and more detailed source characterization research using examples from recent, large magnitude earthquakes.