On joining near-field and far-field data for robust earthquake source modelling

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Abstract

Incorrectly modelled locations, mechanisms and sizes of earthquakes can strongly affect deductions about the strain at fault zones. However, solving for these first-order earthquake source parameters is a very non-linear as well as non-unique problem. A combined use of different measurements with complementary information, like static surface displacements (e.g. InSAR data, pixel offsets and GNSS data) and seismic waveforms, helps to robustly constrain the first-order source parameters.
The goal of our developments is to estimate the earthquake source characteristics for common shallow crustal earthquakes and the associated model uncertainties, by using globally available data. Furthermore, we aim for a consistent and high-performance combination of near-field static displacement data and seismic waveforms with consideration of the individual data errors to obtain comparable model solutions.
We present here case studies of some significant earthquakes for which we applied our joint-data, non-linear optimisation framework. In these case studies we combine InSAR and GNSS data with seismic waveforms. For the forward modelling we use finite source models and Green's functions of layered-elastic media, which are pre-calculated and loaded from databases for good performance. For the joint optimisation we use data weighting schemes that are based on empirical data error analysis and we apply a bootstrapping scheme for Bayesian model uncertainty estimations. All our methods are implemented in documented open-source and python-based software modules of the pyrocko.org project.

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