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Kinematic source parameter estimation for the 1995 Mw 7.2 Gulf of Aqaba Earthquake by using InSAR and teleseismic data in a Bayesian framework

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The 1995 Mw 7.2 Gulf of Aqaba earthquake was primarily a left-lateral strike-slip earthquake, occurring on the Dead Sea transform fault at the western border of the Arabian plate. The tectonic setting within the trans-tensional Gulf of Aqaba is complex, consisting of several en echelon transform faults and pull-apart basins.
Several studies have been published, focusing on this earthquake using either InSAR or teleseismic (P and SH waves) data. However, the published finite-fault rupture models of the earthquake differ significantly. For example, it still remains unclear whether the Aqaba fault, the Aragonese fault or the Arnona fault ruptured in the event. It is also possible that several segments were activated. The main problem with past studies is that either InSAR or teleseismic data were used, but not both. Teleseismic data alone are unable to locate the event well, while the InSAR data are limited in the near field due to the earthquake's offshore location. In addition, the source fault is roughly north-south oriented and InSAR has limited sensitivity to north-south displacements.
Here we improve on previous studies by using InSAR and teleseismic data jointly to constrain the source model. In addition, we use InSAR data from two additional tracks that have not been used before, which provides a more complete displacement field of the earthquake. Furthermore, in addition to the fault model parameters themselves, we also estimate the parameter uncertainties, which were not reported in previous studies.
Based on these uncertainties we estimate a model-prediction covariance matrix in addition to the data covariance matrix that we then use in Bayesian inference sampling to solve for the static slip-distribution on the fault. By doing so, we avoid using a Laplacian smoothing operator, which is often subjective and may pose an unphysical constraint to the problem.
Our results show that fault slip on only the Aragonese fault can satisfactorily explain the InSAR data and that the Aqaba and Arnona faults were probably not activated in the earthquake. In addition, the teleseismic data indicate that the earthquake ruptured from South to North. Modeled fault slip comes close to the eastern shore of the Gulf of Aqaba, where significant surface faulting is still preserved in the field.