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Data Democracy in Simultaneous Monte Carlo Optimizations of Geodetic and Seismological Data

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Estimating the geometry of an earthquake source from seismological and/or geodetic data is a non-linear problem. Often, Monte Carlo optimizations methods are used to find the optimum earthquake model through a clever sampling of the misfit function in the multidimensional model space. The topology of the misfit function, however, very much depends on the data weights we assign. Consequently, also the best fitting model is influenced by the choice of data weights. Data weighting in general is commonly applied these days. Still, there is a large variation between simple arbitrary data weight assignments and weights calculated from estimated data error estimations or trial modeling results.
In geodetic source modeling, an accepted and regularly applied procedure is to weight the data, e. g. GPS and InSAR data, according to their quality by using the data error variance-covariance matrix.
In this way, we consider correlations of densely spaced data and the data weight factors are independent of the model parametrization. In seismological source studies, the data weighting often appears to be done in a more simple manner. Qualitatively, the azimuthal coverage is taken care of and only sometimes relative weights for different stations are assigned, e. g. based on apparent noise.
In a combination of geodetic and seismological data a common rationale for finding the weights would be desirable and moreover we need to find meaningful weighting between the data of different nature, like seismological and GPS data. We present such data weighting in a case study on the 2010 Haiti earthquake to test whether this improves a combined optimization of seismological and geodetic data. For the fault that ruptured during the 2010 Haiti earthquake there are so far at least four different published fault slip models. And, as is often the case, these four are not easily comparable because (1) each model differs from the other to some extent with respect to the model parametrization and the data used and (2) only in one case model parameter uncertainty estimations have been attempted. A robust source model and meaningful model uncertainty estimations to aid a proper hazard assessment in the affected region are still missing, while such an assessment may be very relevant. The official death toll for this earthquake is 316.000 and on the 12 January 2012, two years after the catastrophic event, 5.000.000 people are still living in emergency shelters.