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Source model resolution of the 2010 Haiti earthquake – What can we learn by combining geodetic, seismologic and geologic data?

Henriette Sudhaus (1), Frank Krüger (2), and Thomas R. Walter (1)

(1) Helmholtz Centre Potsdam GFZ, Germany (hsudhaus@gfz-potsdam.de), (2) Institute of Earth and Environmental Science, University of Potsdam, Germany

On 12 January 2010 a devastating earthquake occurred on the Hispaniola Island in the vicinity of the Haitian capital Port-au-Prince. The earthquake epicenter is located close to the Enriquillo-Plantain Garden Fault (EPGF), a major left-lateral strike-slip fault that has a very clear topographic surface expression. On the basis of ground movement measurements from GPS (Global Positioning System) a large earthquake with a typical strike-slip source mechanism had been anticipated for this fault years before the disaster.

Source complexities already emerged with the first data analyses, however. Firstly, the Centroid moment tensor solutions showed a strong thrust component and a significant portion of non-double-couple, this may point to a higher rupture complexity than expected for this earthquake. Secondly, studies that analyzed the coseismic surface deformation measured by using InSAR (Interferometric Synthetic Aperture Radar) and GPS resulted in very different fault slip models. What all source models seem to agree on is that a considerable part of the seismic energy was not released on a segment of the EPGF itself but on a northward dipping thrust fault slightly north of it.

An outstanding question is, however, whether the limited data availability can result in any number of similarly-likely source solutions. Problems are that in Haiti the local geology and fault systems are complex, as expressed in the variety of geologic/tectonic maps, and that they are only partly exposed on-land. The latter fact also hampers geodetic observation of crustal deformation in the co-seismically affected area. Furthermore, the seismic recordings of the Haiti earthquake are limited to far-field observations. The absence of directly observed surface ruptures for the 2010 Haiti earthquake adds further to the uncertainties in source model estimation here.

We here suggest a combined optimization of the data sets under consideration of the individual data errors. We attempt to estimate the extent to which data errors and gaps influence the outcome of the Haiti earthquake source modelling. Such model uncertainty estimations will provide important additional information to the single source models and form an improved basis for evaluations of seismic hazard in Haiti.