INVERSÕES PARA A FONTE SÍSMICA BASEADAS EM DADOS SÍSMICOS E GPS

COMBINING DIFFERENT DATASETS IN EARTHQUAKE SOURCE INVERSIONS

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SUMMARY

In this paper we focus on combining different datasets to obtain a rupture model for the 2004 Mw 6.0 Parkfield Earthquake, in such a way as to take advantage of the specific information contained in each dataset. The Parkfield earthquake is perfect for this study due to the great amount, quality and diversity of data it generated. We will combine information provided by strong-motion seismic data and 1-Hz GPS data. The finite-fault inversion is performed in two steps. On the first step the static GPS data is inverted to find a map of the co-seismic slip amplitude. The second step consists of an inversion of strong-motion data, where the slip amplitude is constrained by that inferred from the inversion of GPS data. The weight and use of the GPS data depends on its resolution, length-scale and error. Our two-step inversion results on a rupture model that describes the earthquake in terms of slip amplitude, slip rake, rupture velocity and rise time. Our work explains the disparities observed between rupture models obtained from different datasets.

Resumo

On September 28, 2004, a M_w6 earthquake struck Parkfield, California. This earthquake had long been anticipated and a vast network of geophysical instruments was in place to record it. Despite of its moderate magnitude, the 2004 Parkfield earthquake generated datasets of unprecedented quantity and quality. In particular, the 2004 Parkfield earthquake was recorded by a network of over 50 strong-motion accelerographs located within 20 km of the fault. A network of 13 continuous GPS sensors also recorded co-seismic ground displacements during the earthquake. In this paper we combine the seismic and geodetic datasets to infer a co-seismic rupture model. We use a two-step approach to invert the geodetic and seismic datasets in our search of a rupture model that satisfactorily explains the observed data. The first step of our method consists of an inversion of the static field (geodetic data), which yields a map of the distribution of slip amplitude on the fault. The second step is an inversion of the wavefield (seismic dataset), which yields both the spatial and temporal evolution of slip on the fault. On the second step the slip amplitude is constrained to resemble that inferred from the first step (inversion of the GPS data). This constraint on the second-step of the inversion diminishes the intrinsic trade-offs between rupture time, risetime and slip amplitude. Thus, the result from the GPS inversion (distribution of slip amplitude) is used to consolidate the seismic (wavefield) inversion. This approach naturally takes into account the differences in resolution of the seismic and geodetic datasets.

The result of our two-step inversion is a model for the spatial and temporal evolution of slip on the fault. This model is given by the distribution of four rupture parameters on the fault plane: slip amplitude, rake angle, rupture time and risetime. We image two main regions of slip, which show distinct rupture behaviors. Slip started at the hypocenter with a very strong bilateral burst of energy. Here, slip was localized in a narrow area approximately 10 km long, the rupture velocity was very fast (>3.5 km/s), and slip only lasted a short period of time (<1 s). Then the rupture proceeded to a wider region 12 – 20 km northwest of the hypocenter. Here, the earthquake developed in a more moderated way: the rupture velocity slowed to 3.0 km/s and slip lasted longer (1 – 2 s). The maximum slip amplitude was 0.45 m.