Slip distribution inversion by trans-dimensional Monte Carlo sampling: application to the 2009 L'Aquila Earthquake (Central Italy)

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Non-uniform slip distribution on a fault plane from geodetic data is usually estimated in two steps. First, the geometric fault parameters are inferred by non -linear inversion assuming a uniform slip on a rectangular fault. A second analysis, based on linear inversion techniques, infers the slip distribution on an arbitrary subdivision of the fault plane into patches. Two main concerns arise. First, the fault geometry determined under the assumption of a uniform slip i s not guaranteed to properly represent the fault geometry for a spatially variable slip distribution. Moreover, an arbitrary fault subdivision into patches u nrelated to the observed data could bias the model resolution, introducing spurious features.

In recent years, the availability of large coverage data, such as DInSAR images, improved mapping the coseismic displacements. The large amount of geodetic da ta from the area surrounding earthquake faults allows for improving the slip models and refining the knowledge of earthquake dynamics. Less attention has been given to the development of new inversion algorithms that can resolve the main concerns above. In particular, the question is whether the data themselves ca n constrain the slip model complexity, i.e., the unknown number and distribution of the fault patches needed to fit the observations. The reversible jump Mar kov chain Monte Carlo (RJMCMC) algorithm has been recently introduced in the geosciences to solve a variety of non linear inverse problems. RJMCMC combines a classical Markov chain Monte Carlo method with the ability to shift between models with a different number of unknowns. A posterior probability distribution of the num ber of unknowns is obtained at the end of the Markov chain, so that the model resolution is determined by the observed data.

In this study, we apply a RJMCMC method to the Mw 6.3 L'Aquila earthquake that occurred on April 6th 2009 in Central Italy. Three DInSAR images, mapping the c oseismic displacement, are inverted to constrain not only the slip distribution but also the number of unknowns (i.e., the number of fault patches) and the ge ometry of non-rectangular patches.