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Equivalent-bodyforce approach on modeling elastic dislocation problem using finite element method

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Dislocation theory is well applied to calculate coseismic and postseismic effects. A key signature of the theory is that the solution of displacement is discontinuous. Various numerical methods can handle such discontinuous problems using a mesh which includes the discontinuous plane as boundary between cells. However, generating such a mesh could be challenging and time consuming. We introduce an equivalent-bodyforce approach to handle discontinuities appearing in elastic dislocation theory. This approach gets rid of meshing the fault plane explicitly and simplifies the FEM modeling process.
Based on Burridge and Knopoff's work, we deduced a close-formed formula representing equivalent-bodyforce in FEM framework. Then compared our numerical results with Okada's analytical solution in a test case in order to check the correctness of our formula and codes. At last, the 2011 Mw9.0 Tohoku-Oki earthquake was studied. We compared our numerical results with GPS observations to check the correctness of our formula and codes again, and discussed the co-seismic effects in North China of this earthquake.
In the test case, our numerical results differ from Okada's analytical solution less than 3% in most computing regions. In modelling co-seismic effects of the 2011 Mw9.0 Tohoku-Oki earthquake, our numerical results of displacement field agree well with GPS observations in both direction and magnitude. The co-seismic stress changes in North China are in east-west tension with a magnitude about 1kPa. The north-south compression is one order of magnitude lower. The coulomb failure stress changes on active faults in North China are negative which indicates more stable, except at the north end of the Tanlu fault zone where the coulomb failure stress change is about 100Pa.
Equivalent-bodyforce approach is applicable and accurate in FEM modeling. The 2011 Mw9.0 Tohoku-Oki earthquake makes faults in North China more stable except the north end of the Tanlu fault zone.