Insight into Earthquake Source Processes from Large Moment Tensor Catalogs

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Analysis of large seismic moment tensor datasets gives insight into general properties of many earthquakes beyond what can be obtained by studies of individual earthquakes. Our studies to date yield three intriguing results. First, the differences between moment tensors in the USGS and Global CMT Project catalogs are typically an order of magnitude larger than the reported errors, suggesting that the reported errors substantially underestimate the uncertainty due to different inversion procedures. Second, a large dataset from three global and four regional catalogs shows that non-double-couple (NDC) components are essentially independent of magnitude for earthquakes with $2.9 < Mw < 8.2$, with a mean deviation from a DC source of about 20%. There is essentially no difference in NDC components between earthquakes with different fault mechanisms, and in different geologic environments, and NDC components are only weakly correlated between catalogs. This consistency indicates that most NDC components, especially for earthquakes with $Mw < 6.5$, do not reflect actual source processes and are likely to be artifacts of the inversion. Third, numerical simulations of the effect of laterally varying Earth structure replicates general features of the pervasive NDC components in moment tensor catalogs, showing that these components are largely artifacts of the inversions not adequately accounting for the effects of laterally varying Earth structure.