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The Global Centroid Moment Tensor Catalog: Heterogeneities and improvements

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Statistical seismology relies on earthquake catalogs as homogeneous and complete as possible. However, heterogeneities in earthquake data compilation and reporting are common and frequently are not adverted.

The Global Centroid Moment Tensor Catalog (www.globalcmt.org) is considered as the most homogeneous global database for large and moderate earthquakes occurred since 1976, and it has been used for developing and testing global and regional forecast models.

Changes in the method used for calculating the moment tensors (along with improvements in global seismological monitoring) define four eras in the catalog (1976, 1977-1985, 1986-2003 and 2004-present). Improvements are particularly stark since 2004, when intermediate-period surface waves started to be used for calculating the centroid solutions.

Fixed centroid depths, used when the solution for a free depth did not converge, have followed diverse criteria, depending on the era. Depth had to be fixed mainly for shallow earthquakes, so this issue is more common, e.g. in the shallow parts of subduction zones than in the deep ones. Until 2003, 53% of the centroids had depths calculated as a free parameter, compared to 78% since 2004.

Rake values have not been calculated homogenously either. Until 2003, the vertical-dip-slip components of the moment tensor were assumed as null when they could not be constrained by the inversion (for 3.3% of the earthquakes). This caused an excess of pure focal mechanisms: rakes of -90° (normal), 0° or ±180° (strike-slip) or +90° (thrust). Even disregarding such events, rake histograms until 2003 and since 2004 are not equivalent to each other.

The magnitude of completeness (M_c) of the catalog is analyzed here separately for each era. It clearly improved along time (average M_c values being ~6.4 in 1976, ~5.7 in 1977-1985, ~5.4 in 1986-2003, and ~5.0 since 2004). Maps of M_c for different eras show significant spatial variations.