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# Current crustal deformation of the Taiwan orogen reassessed by cGPS strain-rate estimation and focal mechanism stress inversion

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We study internal deformation of the Taiwan orogen, a young and active arc-continental collision belt, which the spatial heterogeneity and mechanism remain unresolved. We aim to ascertain the depth-dependent deformation in the current orogenic crust when specifying general mechanisms of the Taiwan orogeny. To reach this goal, we used abundant data of continuous Global Positioning System (cGPS) from 1994 to 2010 and earthquake focal mechanisms from 1991 to 2010 in Taiwan to present new images of geodetic strain-rate and seismic stress fields. The both updated datasets provide a significant improvement in spatial resolution of surface strain-rate and crustal stress states. We estimated the geodetic strain-rate tensors by calculating velocity gradients from Delauney triangulation in $0.1^\circ \times 0.1^\circ$ grids, and determined the seismic stress tensors by the spatial and temporal stress inversion (SATSI) in $0.1^\circ \times 0.1^\circ \times 5$ km grids. We compared the geodetic strain-rate and the seismic stress states based on the horizontal co-grid volume covering the 40 km depth to discuss the internal deformation of the crust. To minimize postseismic effects following the 1999 Mw 7.6 Chi-Chi earthquake occurred in the central Taiwan that could be a bias on observational deformation, we corrected the linear bias in cGPS velocities and excluded the aftershock sequences within the source rupture area. We also calculated the Anderson fault parameter to quantitatively describe tectonic regimes based on stress ratios and rake angles. Our results show current crustal deformation of the Taiwan orogeny is heterogeneous and depth-dependent where a direction partitioning is inferred at the 20-km horizontal depth. In the upper crust (0-20 km), the orientations of geodetic contraction and seismic stress compression are consistent and changing southward simultaneously from N10°W to N110°W. In the lower crust (20-40 km), we find that the compressive stress orientations are most oblique with the upper crustal styles. Similar to the observed change of stress orientation at 20-m horizontal depth, we noticed that the most regimes of Taiwan are mainly characterized by reverse and strike-slip faulting above and below that depth, respectively. Our results indicate that upper crustal to surface deformation is driven by the same compressional process. However, the evident changes in lower crust indicate that a deep independent process cannot be captured by geodetic strains. The process is probably exposed in two regimes where the oblique stress orientations are founded in the shallow crust, coinciding to orogenic thin crust. This finding, coupled with other independent seismological observations, reveals that partition of stress directions is depth-dependent and may highly correlate with vertical deformation due to regional crustal thickening and thinning. We infer that the thickness of the brittle crust may not be constant due to the vertical orogeny, and this would cause stress heterogeneity at different depths.