Comparison of GPS Strain Rate Computing Methods and Their Application

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Abstract: Using modeled and simulated data for comparison of several methods to compute GPS strain rate fields in terms of their precision and robustness reveals that least-squares collocation is superior. Large scale (75°E–135°E and 20°N–50°N) analyses of 1° grid sampling data and decimated 50% data by resampling (then erasing data in two 5°×10° region) reveal that the Delaunay method has poor performance and that the other three methods show high accuracy. The correlation coefficients between theoretical results and calculated results obtained with different errors in input data show that the order in terms of robustness, from good to bad, is least-squares collocation, spherical harmonics, multi-surface function, and the Delaunay method. The influence of data sparseness on different methods shows that least-squares collocation is better than spherical harmonics and multi-surface function when sample data are distributed from a 2° grid to a 1° grid. Strain rate results obtained for the Chinese mainland using GPS data from 1999–2004 show that the spherical harmonics method has edge effects and that its value and range increase concomitantly with increased sparseness. The multi-surface function method shows non-steady-state characteristics; the errors of results increase concomitantly with increased sparseness. The least-squares collocation method shows steady characteristics. The errors of results show no significant increase even though 50% of input data are decimated by resampling. The spherical harmonics and multi-surface function methods are affected by the geometric distribution of input data, but the least-squares collocation method is not.

We used GPS velocities from approximately 700 stations in western China to study the crustal deformation before the Wenchuan MS 8.0 earthquake. The GPS strain rate in the E-W direction in the Qinghai-Tibet block shows that extensional deformation was dominant in the western region of the block (west of 92°E), while compressive deformation predominated in the eastern region of the block (from 92° E to 100° E). On a regional scale, the hypocentral region of the Wenchuan earthquake was located at the edge of an intense compression deformation zone of about 1.9×10-8/yr in an east–west direction. The characteristic deformation in the seismogenic fault was compressive with a dextral component. The compression deformation rate was greater in the fault's western region than in its eastern region, and the strain accumulation was very slow on the fault scale.

The principal strain rate, derived from GPS velocities from the Tibetan Plateau and the India Plate, shows that the Himalayan tectonic belt exhibits compression deformation in a NE-NS-NE direction from the west to the east. The GPS velocity profiles reflect that the distribution of strain

accumulation is uneven: there is a 17.1 mm/yr compressive deformation distributed over 400 km along 85 °E longitude, a 20.9~22.2 mm/yr compressive deformation dispersed across 400~500 km along 79 °E longitude, and a 15.3~16.9 mm/yr compressive deformation spread across 500~600 km along 91 °E longitude. The M_W 7.8 Gorkha earthquake occurred at the edge of an intense compression deformation zone of about 6.0×10^{-8}/yr in a north–south direction, and an about 90% compressive strain is absorbed in the 300 km region near the Main Frontal Thrust (MFT).