By compared several methods in their precision and robustness for computing GPS strain rate fields using simulated data, we found that least-squares collocation is superior. The analysis to the scale (75°E–135°E and 20°N–50°N) in 1° grid sampling data and its 50% constraining data (erasing two 5°×10° region) reveal that delaunay method performed poorly while other 3 methods demonstrate the accuracy. The correlation coefficient between theoretical and calculation results with different errors in input data shows that the quality sequence is least-squares collocation, spherical harmonics, multi-surface function and delaunay method in robustness. The influence of the data sparseness on different methods illustrates that the least-squares collocation is better than spherical harmonicas and multi-surface function with the sampling data distributing from 2°to 1° grid. The strain rate on China mainland calculated from GPS date during 1999-2004 illustrate that harmonics method has much edge effect and its value and range enlarged with the sparse degree increasing. And the multi-surface function method shows non-steady-state characteristics and the sparse degree is larger the errors of results is bigger. Otherwise least-squares collocation method shows steady characteristic and the errors of results has no significant increase even the input data is only 50%. Based on above research, we calculate strain rate parameter before Kunlun Mountain $M_38.1$ earthquake occurring in 2001 and Wenchuan $M_38.0$ earthquake occurring in 2008 using the least square collocation method, and the results showed consistency between the deformation characteristics and the mechanisms of each earthquake.