Method: Analysis of Geodetic Velocities

The strike-parallel velocity at each station is the component of total GPS velocity (Gan et al., 2007; Figure DR1A) in the direction N110E, the average strike of the Kunlun and Haiyuan faults. We compare strike-parallel velocities by projecting all stations onto a line trending 110° from a start point between the two structures (black star in Figure DR 1A). We exclude stations within 3 locking depths of faults (50 km based on earthquake data for Tibet). Stations close to major faults (shown in gray, Figure DR 1) were excluded in order to avoid complications related to elastic behavior within the vicinity of locked structures. This analysis is analogous to the commonly applied method of estimating fault-slip rates where differences in far-field velocities are calculated from GPS data collected along fault-perpendicular swath profiles using a dislocation model in an elastic half-space (Savage and Burford, 1973; Figure DR 1B). A key advantage to the approach we take here is that it is possible to consider a continuum of change in fault slip rate along strike of parallel structures simultaneously; thereby enabling assessment of potential fault slip transfer.

The N20E velocity component is perpendicular to fault strike and parallel to the direction of Indian plate convergence. With exception to the far western extent of the study area that overlaps the Qilian Shan, the N20E component of velocity is small compared to the N110E component (Figure DR 1B). As a result, we focus the detailed analysis and main points of discussion in this paper on strike-parallel velocities derived from geodetic stations across the study area.

Figure DR 1C shows plots of strike-parallel velocity versus distance for three swaths located at western, central, and eastern locations along strike of the Kunlun and Haiyuan faults (see Figure DR 1A for locations)**.** Solid gray (Kunlun fault) and dashed black (Haiyuan fault) lines represent velocities predicted from a dislocation model in an elastic half-space with an assumed locking depth of 15 km (Savage and Burford, 1973). Differences in far-field velocities across faults represent approximate slip rates permitted by the data. Within the western swath (swath 1) fault slip rate along the Kunlun fault is ~10 mm/yr and greater than twice the Haiyuan rate of 4 mm/yr. The central swath (swath 2) demonstrates a switch to higher rates along the Haiyuan fault however rates here are less than half that of the Kunlun fault in swath 1. Swath three, located farthest to the east, shows significantly diminished rates for both faults. Results from each of the three swaths are consistent with fault slip rates calculated from a continuous function along strike of the fault (Figure 3b) and highlight a transition from greater Kunlun slip rates to greater Haiyuan rates from west to east.

Duvall and Clark, Data Repository Figure 1