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Large-scale crustal velocity field of western Tibet from InSAR and GPS reveals internal deformation of the Tibetan plateau

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Two contrasting views continue to dominate the debate about continental tectonics – do the continents behave like the oceans, with a few large plates (blocks) separated by major faults, or is a smooth continuum a more appropriate and compact description. The Tibetan plateau has long been the testing ground for this debate and despite decades of research it has yet to be put to bed. The two models predict rather different crustal deformation patterns in Tibet: block models predict that all crustal strain is concentrated around the major faults zones, whereas continuum models predict that strain is broadly distributed within the plateau. Although a considerable effort has been made at acquiring rates of deformation in Tibet from GPS, the enormity of the plateau and the lack of easy access routes means that large gaps in the GPS coverage exist, particularly in central and Western Tibet. We have used InSAR data from multiple tracks in conjunction with available GPS to constrain a 2D velocity field model for the Tibetan plateau. Over 300 Envisat interferograms are produced spanning 6 tracks (5 descending and one ascending), covering an area 400 km (EW) by 800 km (NS) in extent. Each track is analysed using a network approach which yields line-of-sight deformation rates and realistic uncertainties. These are combined with the GPS, using full covariances, by adapting the velocity field method of England and Molnar (1997) to incorporate InSAR observations. Initially, we set up a triangular mesh spanning the target area; we then solve for the horizontal velocities on each node, as well as additional orbital and atmospheric terms for the InSAR data. The solution is regularised using Laplacian smoothing, whose weight is determined as a compromise between solution roughness and data misfit. The resultant velocity field satisfies the InSAR and GPS data with an rms misfit of less than 1 mm/yr. It reveals a series of focused strain zones within the plateau. Although focused strain zones are predicted by block models, those that we observe appear to occur away from the major faults, in the interior of the plateau. At least one is associated with a possible postseismic transient. We conclude that the observed velocity field satisfied neither the predictions of block models nor those of continuum models. Further work is required to establish an appropriate model capable of explaining these observations.